Mapping the Values of New Zealand's Coastal Waters. 1. Environmental Values

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Contents

Page

Abstract **iii**

1 Introduction **1**
1.1 Overall objective 2
1.2 Specific objectives 2

2 Methods **3**
2.1 Study area 3
2.1.1 Development of coastal cell layer 3
2.1.2 Coastal areas 5
2.2 subcomponent and dataset selection 5
2.3 Valuation methods for Taxon Specific Diversity datasets 9
2.3.1 Total records 9
2.3.2 Total species 10
2.3.3 Species richness 10
2.3.4 Average Taxonomic Distinctness (ATD): 11
2.3.5 Variation in ATD (VarATD) 11
2.3.6 Species rarity 11
2.3.7 Species composition 12
2.4 Valuation methods for Overall biodiversity datasets 14
2.4.1 Modelled data 14
2.4.2 Derived values 14
2.5 Valuation methods for Non-indigenous species datasets 14
2.6 Valuation methods for At risk or threatened species datasets 15
2.7 Valuation methods for Habitat area within NZ region datasets 15
2.7.1 Habitat distribution 15
2.7.2 Marine Environmental Classification (MEC) Physical Habitat Categories. 15
2.7.3 Derived value: Habitat diversity 15
2.8 Valuation methods for Primary production dataset 15
2.9 Valuation methods for Marine mammal distribution datasets 16
2.10 Valuation methods for Marine Protected Areas (MPAs), sanctuaries and area-based restriction datasets 16

3 Results **17**
3.1 Subcomponent: Taxon Specific Diversity 17
3.1.1 Subcomponent: Overall biodiversity 25
3.1.2 Subcomponent: Non-indigenous species 28
3.1.3 Subcomponents: At-risk or threatened species 29
3.1.4 Subcomponent: Habitat area within New Zealand 30
3.1.5 Subcomponent: Primary productivity 31
3.1.6 Subcomponent: Marine mammal distribution 32
3.1.7 Subcomponent: Areas of MPAs and Sanctuaries and area-based restrictions 33

4 Discussion **34**
4.1 Focus group meetings and The Delphic Process 34
4.1.1 Valuation methods 34
4.1.2 Feedback using the Delphic Process 34
4.2 Data limitations and confidence in assigned values 35
4.2.1 Biodiversity measures 35
4.2.2 Intellectual property 36
4.3 recommendations 36

5 Acknowledgements **38**

6 References **39**

7 Appendices **41**
7.1 Appendix I: PRO-FORMAS of funded datasets 42
7.2 Appendix II MEC Physical habitat categories 71

Table of Figures

Figure 1 Layout of the coastal cells around New Zealand and its outlying islands. 4
Figure 2 Detailed view of the arrangement of coastal cells in a complex area. 5
Figure 3 Coastal areas for algal data 6
Figure 4 non-metric Multi Dimensional Scaling (nMDS) showing the similarity/dissimilarity of coastal areas with respect to the bryozoa data 13
Figure 5 Taxon specific diversity: Algal data (dataset 7) 18
Figure 6 Taxon-specific diversity: No. of algal species per coastal cell (dataset 7).. 19
Figure 7 Taxon-Specific Diversity: Algal data (dataset 7). Species richness (deviation from expected).. 20
Figure 8 Taxon Specific Diversity: Algal data. Average Taxonomic Distinctness. 21
Figure 9 Taxon Specific Diversity: Algal data. Variation in Average Taxonomic Distinctness. 22
Figure 10 Taxon Specific Diversity: Algal data (dataset 7); Rarity 23
Figure 11 Taxon Specific Diversity: Algal data (dataset 7); Species composition 24
Figure 12 Overall biodiversity: Modelled datasets 26
Figure 13 Overall biodiversity: Invertebrates (Derived data) Total records per coastal cell 27
Figure 14 Non-indigenous species: Number of non-indigenous genera recorded in coastal cells 28
Figure 15 At-risk or threatened species 29
Figure 16 Habitat area within NZ region: Biogenic reefs. 30
Figure 17 Primary productivity. 31
Figure 18 Marine Mammal Distributions: Hector's Dolphin (*Cephalorhynchus hectori*). 32
Figure 19 Area restrictions and marine reserves.. 33

Table of tables

Table 1 Subcomponents of environmental value 7
Table 2 Subcomponents and associated data sources, data owners and the values mapped. 8
Table 3 Coastal areas sorted by ascending order of species composition (mean resemblance values). 13

Abstract

An estimated 65,000 marine species and associated ecosystems around New Zealand deliver a wide range of environmental services that sustain considerable fishing, aquaculture and tourism industries as well as driving major biogeochemical processes. However, New Zealand's marine ecosystems are increasingly at risk of, or already experiencing, threat from anthropogenic impacts. One the greatest threats is the introduction of non-indigenous species.

The extent of the threat imposed by an actual or potential incursion of an alien marine species will vary depending on the species, habitat(s), ecosystem(s) or human use of the marine environment. Determining the actual or perceived values of an ecosystem or its sub-components and utilising this information to prioritise management is an effective method to aid biosecurity management and decision-making. However, to date there has been no attempt to map or estimate the value of New Zealand's marine environment in a consistent or comprehensive way.

This study to map the perceived measures of environmental value is one of four projects (environmental, social, economic and cultural) assessing the perceived values of New Zealand's coastal marine environment for MAF/BNZ for use in a Decision Support Tool.

Through the collation of both existing datasets and expert knowledge, a spatially-explicit database of marine environmental value has been created. This database comprises 14 attributes of marine environmental measures derived from 200 unique layers of environmental information, ranging from species occurrences and diversity indices to marine mammal breeding areas and habitat distribution. All environmental measures have been quantified to allow comparison between different areas around New Zealand and its outlying islands.

Using a Geographic Information System, this database can be used to identify areas particularly susceptible to marine incursion events through the identification of areas rich in rare species or with many coincident high or low estimated values of diversity. In addition, this study has highlighted large areas of the New Zealand coastline that are data sparse and where future research efforts should be directed. This research is likely to have a broad range of marine conservation, planning and management benefits.

Key words:

Measures of environmental value
Spatially-explicit database
Coastal, shelf and estuarine habitats
Diversity indices
Habitat distributions

1 Introduction

New Zealand, as a consequence of its extension over 30° of latitude, its position on an active plate boundary with all the consequent folding, faulting and volcanism, and its position in relation to major subtropical and sub-Antarctic water masses and current systems, has a wide variety of marine habitats. These are inhabited by an estimated 65,000 species, many of which are unique to New Zealand making it a hotspot for marine diversity worldwide (Arnold, 2004; Gordon, in press). These species and their associated ecosystems deliver a wide range of environmental services to New Zealand including the basic productivity that sustains considerable fishing, aquaculture and tourism industries.

New Zealand is also unique in being the last major landmass to be settled by humans. Until around 1300 AD, New Zealand's diverse marine biota and ecosystems benefitted from a marked geographic isolation. However, over the last 700 years New Zealand's marine ecosystems have been increasingly threatened by the activities of humans. These anthropogenic impacts include exploitation (fishing) and habitat destruction (including elevated sedimentation in shallow coastal habitats as a result of terrestrial land use changes) as well as the introduction of species foreign to the New Zealand marine ecosystem.

Introduced species are now recognised as one of the greatest threats to natural environments worldwide (Wilcove et al., 1998; Mack et al., 2000; Gordon, in press). The occurrence of these non-indigenous species can be a significant stressor and force of change in marine communities (Ruiz et al., 1999). Impacts on native organisms are often unknown or only partially understood but can arise through a variety of interactions including competition and predator-prey relationships.

New Zealand's geographic isolation means that more than 98 percent of goods are transported by shipping (Statistics NZ, Inglis, 2001; Inglis et al., 2006) which leaves New Zealand's marine environment potentially vulnerable to the arrival of non-indigenous species. The arrival of these unwanted species transported by shipping is partially controlled, offshore, through the treatment of ballast water en-route from high-risk locations. However, rapidly accelerating trade, tourism and travel, all of which help to bridge natural geographic barriers, means that despite New Zealand's best efforts to maintain a pest-free border, it is inevitable that new incursions will occur. It is also inevitable that some of these will pose significant and unacceptable threats to the safe use, environmental, aesthetic and cultural values, and public benefits of our aquatic ecosystems.

The extent of the threat imposed by an actual or potential incursion of an alien marine species will vary depending on the species, habitat(s) or ecosystem(s) threatened. Determining the actual or perceived values of an ecosystem or its sub-components and utilising this information to prioritise management can be an effective method to aid biosecurity management and decision-making (Derous et al., 2007). Ecosystem valuation for environmental conservation purposes (using economic valuation techniques) has progressed steadily over the last two decades (e.g. Anon, 2004; Emerton and Bos, 2004; MacKinnon et al., 2004; Pagiola et al., 2004) and a combination of delphic processes (independent consultation with experts) and economic valuation techniques have been used successfully to value environmental and social aspects of ecosystems (e.g. Hanley et al., 1998; McCracken and Abaza, 2001; Navrud and Ready, 2002). However, to assign economic or monetary values to biodiversity requires both the identification of a range of ecosystem services and a scenario of biodiversity change together with an identification of direct and indirect effects of this change on human welfare (Nunes and Van den Bergh, 2001; Beaumont et al., 2007). The depth of information required for this is not presently available on a New Zealand-wide scale. Mapping the measures of environmental value of New Zealand's marine ecosystem is one component of a large spatially-explicit value and risk mapping project to map environmental, social, economic and cultural values across the entire coastline and estuarine region of New Zealand, including the North, South, Stewart and outlying islands, as well as the Three Kings, Kermadec, Chatham and sub-Antarctic islands. Measures of environmental values to be mapped include a range of diversity indices and the known distribution of habitats, marine mammals and at-risk species. Within the context of the present study, the value assigned to each dataset/subcomponent is not a monetary value but rather a quantitative value to enable comparisons between environmental measures between different areas of New Zealand.

This project is the first systematic attempt to quantify measures of perceived environmental value of New Zealand's coastal marine ecosystem through the creation of a series of spatially explicit data layers derived from existing data sources (including museum and scientific cruise records). It is anticipated that this unique project will have additional conservation and management benefits outside the biosecurity perspective.

1.1 OVERALL OBJECTIVE

To determine the perceived environmental values of New Zealand's marine environment

1.2 SPECIFIC OBJECTIVES

- To identify the sub-components of environmental value for New Zealand's marine systems.
- To determine the data holdings for the subcomponents of environmental value and purchase and/or collate selected data.
- Use a Delphic process to value the sub-components for which data were collected.

2 Methods

2.1 STUDY AREA

The study area included the entire coastline and estuarine region of New Zealand (the North, South, Stewart and outlying islands) as well as the Three Kings, Kermadec, Chatham and sub-Antarctic islands. The marine habitats most likely to be impacted by incursion events and, therefore, of interest to BNZ are the coastal and shelf systems. As a result, the outer limit of the study area was 12 nm offshore or a depth of 250 m to include all the relevant coastal and shelf areas.

In order to map the measures of marine environmental value around New Zealand it was necessary to divide this area into smaller units.

2.1.1 Development of coastal cell layer

A GIS layer was created by NIWA within which the coastline was split into 300 roughly equal cells which exactly follow the New Zealand coastline, including offshore islands, and the outer limits of this study (12 miles offshore or 250 m depth, whichever is the closest; Figures 1 and 2). These cells are referred to within this project as "coastal cells".
An initial, preliminary, GIS layer was created using an automated objective algorithm. This objective method worked on a smooth version of the coastlines of North Island, South Island, and Stewart Island, and a smooth version of the 250 m bathymetric depth contour. These smooth versions of coastline and contours provide a simple version of these boundaries without the complexities of the actual boundaries. One grid point approximately every 5–10 km was used in the smooth data. The method was run separately for the North and South Islands. Starting at a smooth part of the coast (Bay of Plenty for North Island, south Canterbury for South Island) and progressing in a clockwise direction, the algorithm attempted to determine the boundaries of a grid cell subject to the following criteria: (1) the inshore edge is to be orientated along the coast; (2) the sides of the cell should be orientated normal to the smooth coastline; (3) the offshore edge should lie along the 250 m depth contour or 20 km offshore, whichever is the nearer to shore; (4) all cell edges should be approximately 20 km long; (5) the area of the cell should be approximately 400 km^2. Where it was not possible to achieve all these criteria simultaneously, the algorithm was designed to minimize the penalty function, Δ, defined as equation [1]:

$$\Delta = \left(\frac{d-d_0}{d_0}\right)^2 + \left(\frac{A-A_0}{A_0}\right)^2 \qquad [1]$$

Where d is the actual length of the inshore edge of the cell (the distance along the smooth coastline in km), d_0 is the target length of smooth coastline (20 km), A is the actual area of the cell (in km^2), and A_0 is the target area of the cell (400 km^2). The algorithm was implemented under IDL (Interactive Data Language).

This grid generating method was effective where the coastline was relatively smooth. However, it worked poorly where the coastline was complex, for example in Kaipara Harbour, Hauraki Gulf, Cook Strait, Marlborough Sounds, around Farewell Spit, and Foveaux Strait areas. In order for the new coastal cells to conform more effectively to the coastline and outer study limits, an enclosed polygon feature was created within ArcGIS ArcInfo (version 9.2) with Spatial Analyst extension using commercially available datasets to represent the 12 nautical mile boundary (LINZ data purchased from Statistics NZ Census boundaries, 2008), 250 metre bathymetric contour (NIWA, Bathymetric contours 2008) and a 1:50,000 scale vector dataset representing New Zealand's coastline and Islands (LINZ data purchased from Eagle Technology Limited, Topographic dataset 2000). The Chatham Islands and other offshore islands were combined from other data sources.

This polygon feature was then clipped based on the preliminary coastal cells layer to generate a final coastal cells layer. Manual editing was performed on those cells near-to and within estuarine areas and areas of highly complex coastline. All coastal cells were assigned a unique identification number, starting at the most northern coastal cell of the North Island and proceeding in a clockwise direction then continuing to offshore islands. Area and coastline length were then calculated for each coastline cell.

Figure 1 Layout of the coastal cells around New Zealand and its outlying islands.

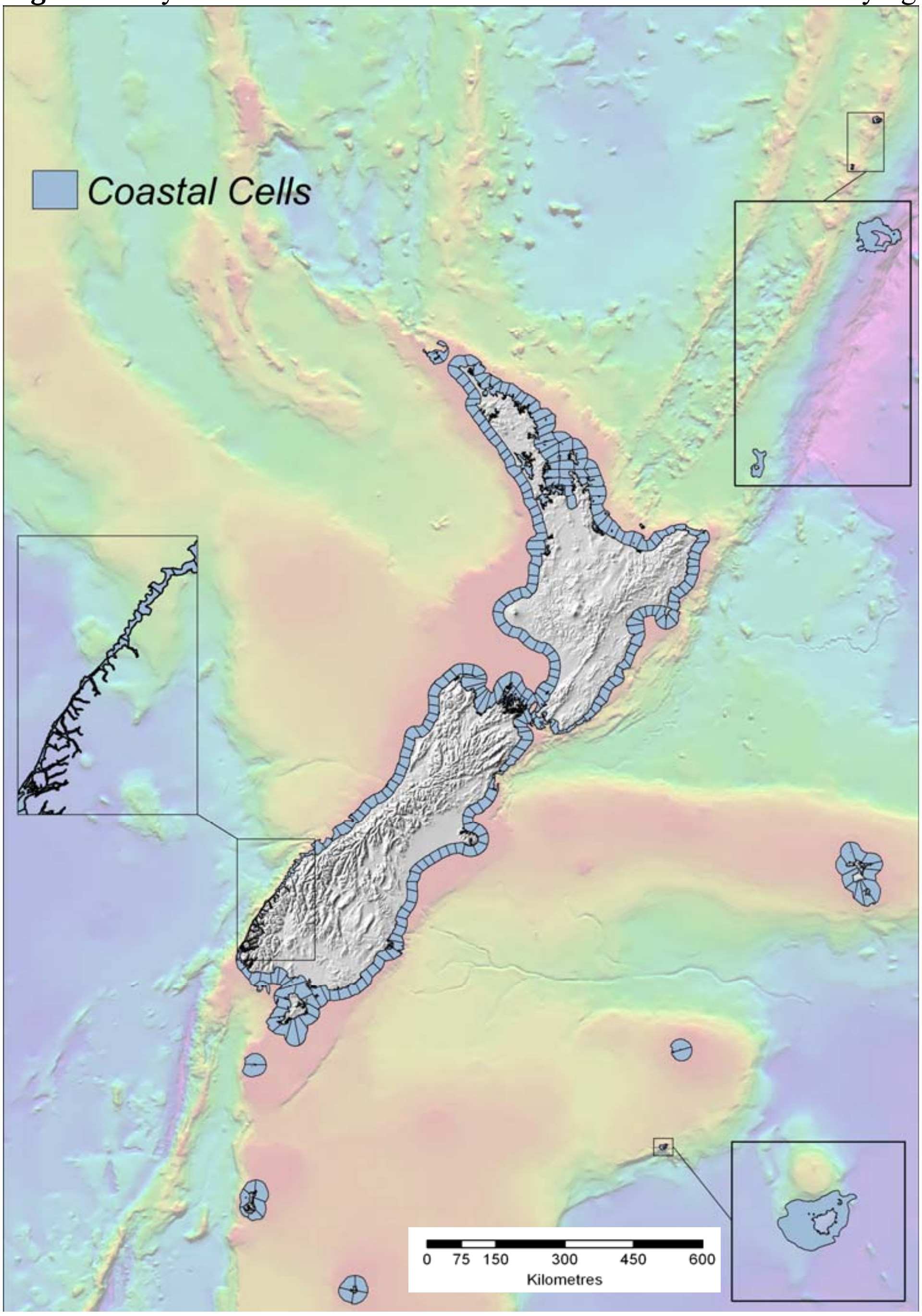
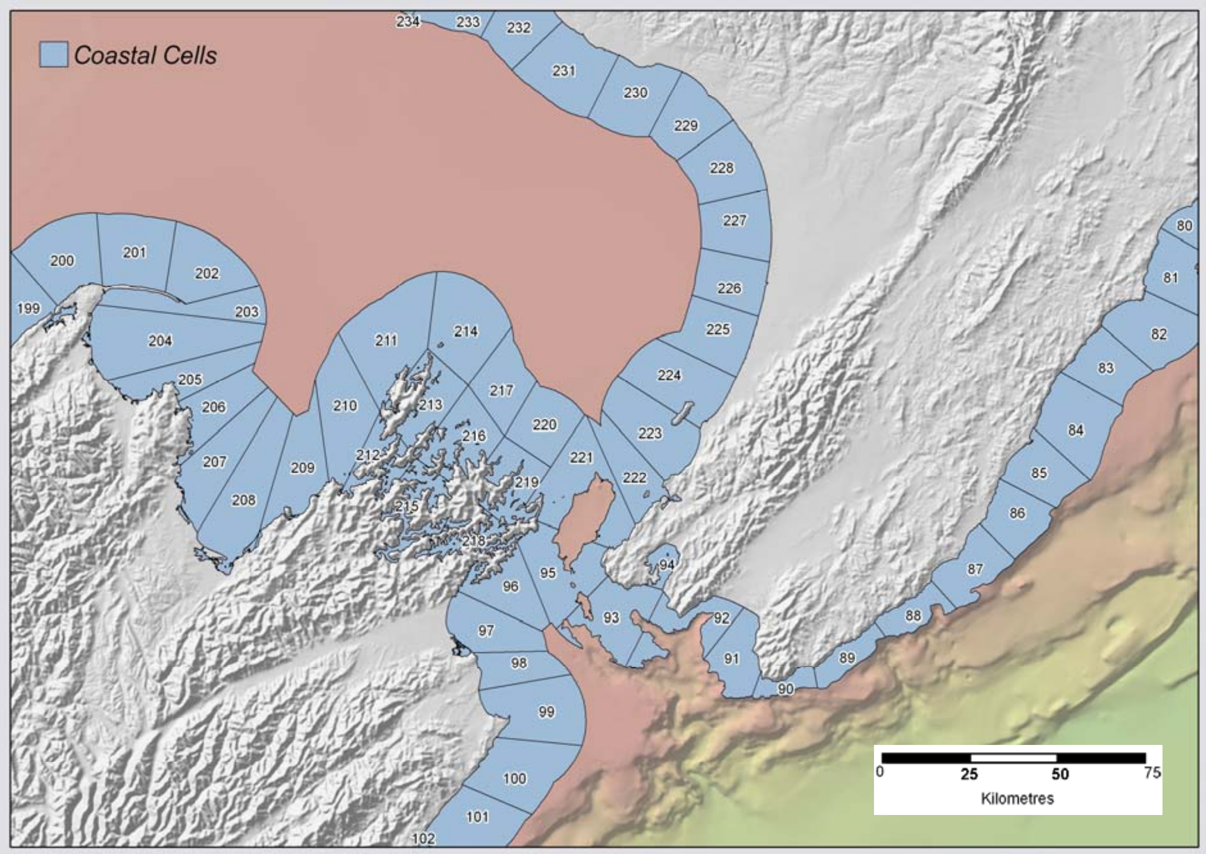


Figure 2 Detailed view of the arrangement of coastal cells in a complex area of the New Zealand coastline: Cook Strait and Marlborough Sounds.



2.1.2 Coastal areas

The taxon-specific datasets used in this study had very patchy distributions and as a result many coastal cells had few or no records associated with them. In data-sparse parts of the coastline it was, therefore, necessary to join neighbouring coastal cells together into "coastal areas" to enable analyses on these datasets to take place (Figure 3). In this way all coastal cells could have a value assigned to them. The joining of coastal cells into coastal areas was carried out manually to minimise the joining of cells with very different physical environments (i.e. exposed and sheltered). Cells with less than 20 records were considered to be data sparse and were joined to neighbours.

A GIS layer has been created for each dataset within the taxon-specific subcomponent (see section 2.3), where the data was patchily distributed, detailing the coastal areas used in the data analysis. These coastal area layers should be used, together with layers of derived values (e.g. species richness, species composition) and layers of total records, to determine the confidence in the value assigned to each coastal cell.

2.2 SUBCOMPONENT AND DATASET SELECTION

A Delphic process was used to identify subcomponents, associated datasets and suitable data analysis methods as well as to receive expert feedback on maps of measures of environmental value. An expert focus group was convened, as the first stage of this process, to select environmental subcomponents and their associated environmental values for mapping. Three groups of potential subcomponents were identified:

1. Species diversity, richness and rarity
2. Habitat distribution and characterisation
3. Areas of special biological / ecological significance.

A description and rationale for subcomponents selected from each of the three fields of environmental value is given in Table 1. Following a review of available data sources, 26 datasets were elected to populate these subcomponents (
Table **2**, Appendix I).

Figure 3 Coastal areas for algal data. An example of how coastal areas relate to coastal cells. Neighbouring coastal cells with the same colour have been joined into coastal areas. A coastal area data layer is available for each taxon-specific data set for which cells have been joined into areas.

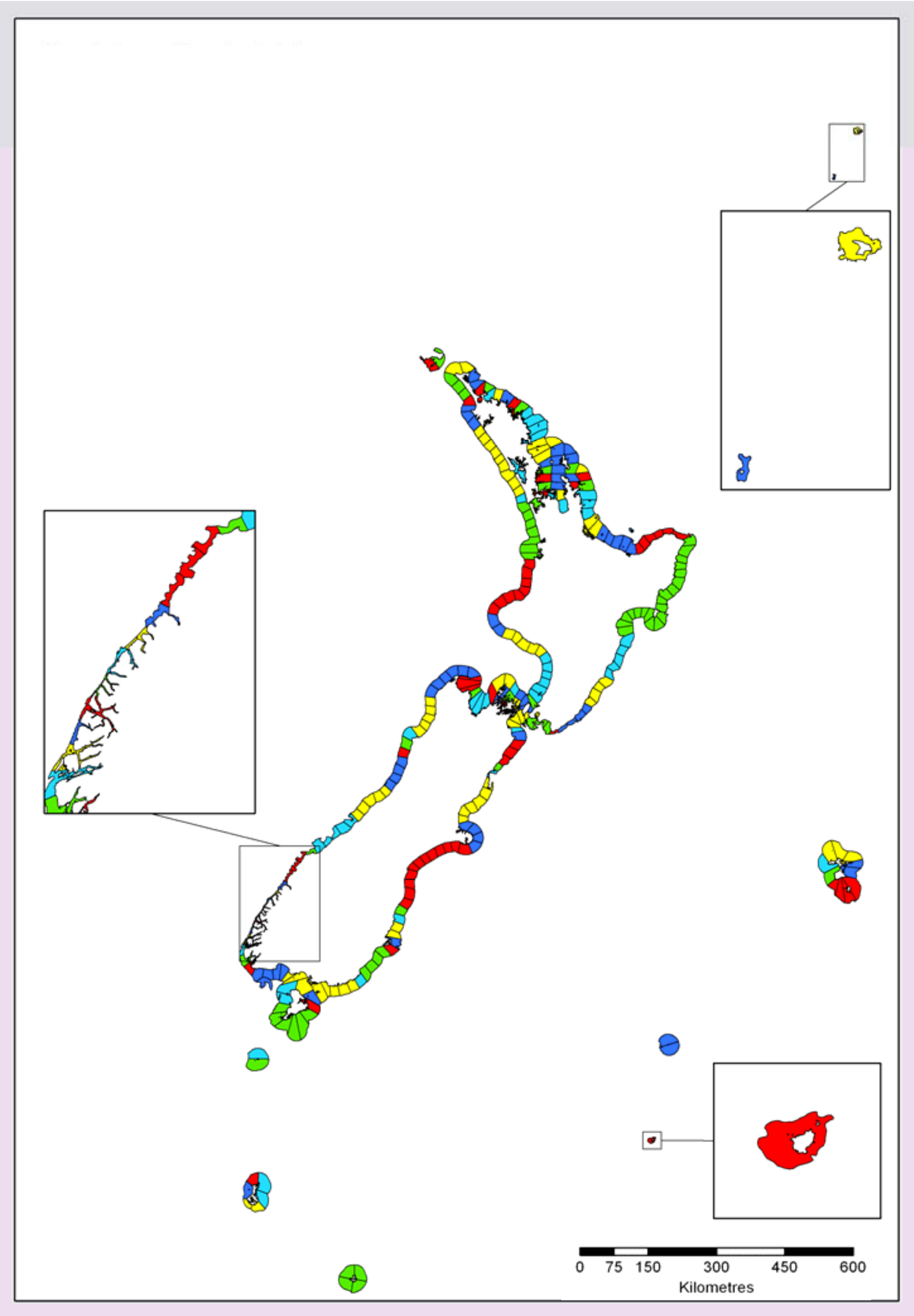


Table 1 Subcomponents of environmental value

Subcomponent	Description	Rationale
Species diversity, richness and rarity		
1. Taxon-specific diversity	Relative diversity of specific groups, e.g., macro-algae, bryozoans, polychaetes etc. within a coastal area. For each taxon group a range of diversity measures have been quantified, including species richness, Average Taxonomic Distinctness, species rarity, and species composition (see Table 2).	To identify areas of New Zealand coastline with high, low or average diversity of key taxa to aid in decision-making.
2. Overall marine biodiversity	Modelled species richness of rocky reef fish and rocky reef invertebrate communities for each coastal cell around New Zealand. Estimated overall diversity as derived from taxon-specific diversity.	To identify areas of New Zealand coastline with high, low or average biodiversity to aid in decision-making.
3. Non-indigenous species	Number of genera and proportion of national total of non-indigenous marine genera found within a coastal cell. Data only available for ports.	To identify the known distributions of existing non-indigenous species in New Zealand's ports.
4. At-risk or threatened marine species	Distribution of at-risk or threatened marine species occurring within a coastal cel	Species for which there is a Government mandate for protection.
Habitat distribution and characterisation		
5. Habitat area within NZ region	Area of specific biological habitat (mangroves, seagrass, biogenic reefs) and physical habitat categories (Marine Environmental Classification (MEC)) present within a coastal cell as a proportion of the total habitat area within NZ. Also includes a measure of estimated habitat diversity (using a proxy of coastline length to straight line ratio).	To highlight the known distributions of different coastal habitats. Different habitats support biological communities which may have varying degrees of resilience to incursion events.
6. Primary productivity	Annual average near-surface chlorophyll *a* concentration within a coastal cell.	Primary producers are a key trophic level within the marine ecosystem. Chlorophyll a concentration is a good proxy for local levels of primary production that drives the food chain.
Areas of special biological / ecological significance		
7. Marine mammal distribution	Distribution of marine mammals around the New Zealand coastline, including 100% range, 90% range, distribution hotspots and known colonies.	Marine mammals have an important role in marine ecosystems. They are also a charismatic group with high social and cultural value.
8. Area of Marine Protected Areas (MPAs), Sanctuaries and Restrictions	Proportion of NZ total area of fully protected marine areas (marine reserves, cableways, etc) and sanctuaries (e.g. whale sanctuary) occurring within coastal cell	Areas of ecological significance which have a protected status as well as areas where fishing is controlled/prohibited.

Table 2 Subcomponents and associated data sources, data owners and the values mapped.

Environmental value subcomponent	Data sources within each subcomponent	Data owners	Data type	Values mapped for each dataset
Taxon-Specific Diversity	1 Sponge dataset 2 Bryozoan dataset (OBIS) 3 Polychaete dataset (OBIS) 4 Mollusc dataset 5 Echinoderm dataset (OBIS) 6 Arthropod dataset (OBIS) 7 Algal database (KEmu) 8 Diadromous fish dataset (FBIS) 9 OSNZ Wader bird counts	NIWA NIWA NWIA Te Papa NIWA NIWA Te Papa NIWA OSNZ	Numerical presence Numerical presence Numerical presence Numerical presence Numerical presence Numerical presence Numerical presence Predicted probability of catch Raw counts	Total records Total species Species richness Average Taxonomic Distinctness (ATD) Variation in ATD Species rarity Species composition
Overall biodiversity (Modelled/interpolated data and derived values)	10 Rocky reef fish dataset 11 Rocky reef invertebrate communities 12 Vertical rock wall communities	DoC DoC/Nick Shears Franz Smith	Numerical counts Numerical counts Numerical counts	Species richness Biomass
	Derived value of overall invertebrate diversity (mean values of sponge, bryozoan, polychaete, mollusc, echinoderm and arthropod datasets)			Diversity indices (from Subcomponent: Taxon Specific Diversity)
Non-indigenous species	13 BIODS Port Surveys database 14 BIODS Surveillance database	BNZ BNZ	Numerical presence Numerical presence/absence	Total records Genera richness
At risk or threatened species	15 NZ Threat Classification system 16 Te Ara/NABIS bird and mammal distribution data	DoC Te Ara	Presence and absence / threat category TIF files	Species distributions
Habitat area within NZ region	17 Intertidal rocky reef 18 Subtidal rocky reef 19 Seagrass data 20 Mangrove data 21 Biogenic reefs dataset 22 MEC Physical habitat categories	LINZ DoC NIWA NIWA WWF NIWA	Shapefiles Shapefiles Expert knowledge Shapefiles TIF files Shapefiles	Habitat distributions (using normalised and non-normalised data) Proportion of habitat with each coastal cell
	Derived value: habitat diversity		Ratio	Derived value (ratio of cell length and coastline length)
Primary Productivity	23 MEC V2 (chlorophyll data)	NIWA	Shapefiles	Mean concentrations
Marine Mammal Distribution	16 Te Ara/NABIS bird and mammal distribution data 24 Incidental cetacean sighting	Te Ara Martin Cawthorn	TIF files Numerical presence	Distribution maps
Area of MPAs, sanctuaries and restrictions	25 Area based restrictions in the marine environment 26 Marine reserves	DoC/ MFISH WWF/ DoC	Digitised maps Shapefiles	Distribution maps

Abbreviations used: National Institute of Water and Atmospheric Research (NIWA), Ornithological Society of New Zealand (OSNZ), Ministry for Culture and Heritage (Te Ara), Museum of New Zealand (Te Papa), Department of Conservation (DoC), Biosecurity New Zealand (BNZ), Land Information New Zealand (LINZ), World Wildlife Fund New Zealand (WWF), Ministry of Fisheries (MFISH), Ocean Biogeographic Information System (OBIS), Freshwater Biodata Information System (FBIS), Marnie Biodiversity and Biosecurity Database (BIODS), Te Papa's database system (KEmu).

Valuation methods were selected, by expert focus groups, to make the best use of available data, taking into account the patchiness of many datasets as well as the great variation in sampling effort within datasets.

2.3 VALUATION METHODS FOR TAXON SPECIFIC DIVERSITY DATASETS

Nine datasets were selected to provide measures of taxon specific diversity: 1) Sponges, 2) Bryozoa, 3) Polychaetes, 4) Molluscs, 5) Echinoderms, 6) Arthropods, 7) Algae, 8) Diadromous fish and 9) Wading birds. Prior to analysis, data were groomed to remove inconsistencies and to ensure suitability. A proforma metadata record for each dataset detailing raw data providers, data ownership and grooming actions is provided in Appendix I.

Groomed data were entered into a Geographic Information System (ArcGIS) and joined to a coastal cells layer. Data were then exported with a coastal cell ID number assigned to each record. Records missing species names or unique identifiers were removed from analysis. In some cases, the nature and quality of the datasets necessitated a specific valuation approach and/or derivation process.

Few of the polychaete data records had unique species identifiers. As a result, these data were analysed to genus rather than species level.

The diadromous fish data, provided by NIWA, were modelled predicted probabilities of catch for each river within the North and South Islands of New Zealand (Leathwick et al., 2008). In order to generate mean values of predicted probabilities of catch per coastal cell for each of the 15 modelled species, all rivers intersecting the coastline were assigned a coastal cell ID number, corresponding to the coastal cell that was intersected, using GIS. This dataset is unique within this subcomponent in that the data are modelled rather than observed and the data are inferred abundances (from predicted catch) rather than presence data (species records at a location).

The wading bird data, purchased from the Ornithological Society of New Zealand (OSNZ), were collected during periodic surveys of the distribution of all birds in New Zealand throughout all habitats (undertaken between 1999 and 2004 by OSNZ) and data were supplied as the occurrence of species throughout a regular 10 x 10 km grid of sample locations throughout New Zealand and the Chatham Islands. It should be noted that the 10 x 10 km grid system used by OSNZ does not align perfectly with the system of coastal cells used in this project. Wading bird data were supplied as point locations at the centre of each 10 x 10 km survey grid. As such, all point locations were assigned to the coastal cells that they fell inside. No attempt has been made to adjust the data where the extent of the10 x 10 km grid cells surrounding each point location overlaps the boundary between coastal cells.

2.3.1 Total records

This data layer was calculated as the total number of records (species at a location) for each dataset occurring within each coastal cell. Not only does this highlight areas around New Zealand where data are sparse, but it gives the user an indication of the confidence in the value assigned to each cell. Confidence is higher in cells containing large numbers of records than for those containing few or no records.

Given the nature of datasets 8 and 9 (diadromous fish and wading birds, respectively; see above), the value of total records was presented as total number of rivers that intersected with the coastline within each coastal cell and the total number of sampling locations per coastal cell respectively.

2.3.2 Total species

This data layer was presented as a raw value of the number of species in each coastal cell. No account has been made for sampling effort or the size of the coastal cell. It is, therefore, likely that the trends shown in this layer reflect, or are influenced by, sampling intensity.

This value has only been mapped for those datasets for which species richness has been calculated as a value of deviation from expected (datasets1- 7). For datasets 8 and 9, which have been modelled or contain data that has been gathered in a consistent way, these values are represented within the species richness value.

2.3.3 Species richness

Species richness is a measure of the number of species present within a defined area. Unlike total species (above), species richness, in the context of the present study, is a relative estimate which can be meaningfully compared between coastal cells or areas to highlight areas of particularly high or low values of species richness within each taxonomic group.

Species richness is sampling-effort dependent (e.g. Ugland et al., 2003; Colwell et al., 2004). In order to assign a meaningful estimate of species richness to each coastal cell it was necessary to take into account the great variation in sampling density between cells. EstimateS software (Colwell, 2006) was used to create individual-based Coleman's rarefaction curves for each dataset for the whole shelf area of New Zealand (see Gotelli and Colwell, 2001 for an explanation of individual- and sample-based protocols). A rarefaction curve generates the expected number of species in a small collection of n individuals drawn at random from the large pool of N individuals. In this study, n individuals is the number of records of a taxon per coastal area (note that coastal areas and not coastal cells are used for this value) and N individuals is the total number of records for that taxon in the whole study area (New Zealand).

Using the generated rarefaction curves, residual values (the difference between the observed and the estimated number of species per individuals (n) according to the New Zealand-wide rarefaction curve) were calculated for each coastal area, resulting in an estimate of the species richness relative to the expected for New Zealand. The value represented in the data layer is, therefore, not an actual value of species richness, but a value representing the difference in species richness to that expected from the rarefaction curve (for all of New Zealand).

Not only was there great variation in sampling density between coastal cells, but despite best efforts in the creation of the coastal cell layer, cells also had physical differences which could influence the biological communities found in the cells, e.g., the area or the coastline length within each cell. These physical differences were particularly important when analyses were carried out using coastal areas which vary greatly in size. Data were, therefore, normalised for the size (area) of each coastal area (as a proportion of the total shelf area around New Zealand within each coastal area) before the residuals were calculated (i.e. both the number of species and the number of records in each coastal area were divided by the size of the coastal area (as a proportion of total NZ shelf area) prior to calculating residuals). In the case of the algal dataset, the data were normalised for the size (area) of coastal area as well as coastline length because algae only inhabit relatively shallow waters.

This method was used for datasets 1 – 7. In the case of the diadromous fish dataset (#8) species richness is presented as the number of fish species per coastal cell with a predicted probability of catch of greater than zero.

Due to the regular nature of the sampling locations within the wading bird dataset (#9), no rarefaction curves were created. The presented species richness value is the number of species observed within each coastal cell.

This value was calculated per coastal area for datasets 1 -7 and per coastal cell for datasets 8 and 9.

2.3.4 Average Taxonomic Distinctness (ATD):

ATD is a measure of the relatedness of the species within a sample. More specifically, it is the average taxonomic path length between any 2 randomly chosen species, traced though a Linnaean or phylogenetic classification of the full set of species involved (Clarke and Warwick, 1998). This measure has been shown to be independent of sampling effort or number of species present (Clarke and Warwick, 1998; Clarke and Gorley, 2006). This diversity measure is, therefore, well suited to the invertebrate and algal datasets which have been compiled over time using unstandardised and/or unknown degrees of sampling effort.

It is widely accepted that the Linnaean hierarchy system is inconsistently applied across Phyla. For this reason, ATD was calculated on the relatedness of species using taxonomic information from Order to Species (or Order to Genus in the case of Polychaetes). ATD was calculated within the multivariate software package PRIMER (Clarke and Warwick, 2001a).

This value was calculated per coastal area for datasets 1 -7 and per coastal cell for datasets 8 and 9.

2.3.5 Variation in ATD (VarATD)

This is a measure of the variance in the pairwise path lengths used to calculate ATD (Clarke and Warwick, 2001b) and reflects the unevenness of the taxonomic tree within a sample or, in this case, within a coastal area. This measure of diversity is also calculated using PRIMER.

It has been suggested that VarATD in combination with ATD may be used to identify degraded and pristine environments (Clarke and Warwick, 2001b). Degraded or polluted systems are often characterised by a reduction in higher taxa together with an increase in opportunistic groups which have relatively close taxonomic relationships. These systems would, therefore, be represented by a low ATD in combination with a low to normal VarATD. Conversely, a relatively pristine system could be expected to have a normal ATD and a high VarATD (Clarke and Warwick, 2001b). This use of ATD and VarATD may be most relevant to the overall invertebrate diversity measures (see below) where a range of taxa are included in the analysis.

This value was calculated per coastal area for datasets 1 – 7 and per coastal cell for datasets 8 and 9.

2.3.6 Species rarity

Rarity, in terms of distribution, was assessed for all taxon-specific datasets (except dataset 8; see below) in order to highlight coastal cells or areas around New Zealand that are particularly important with respect to rare species (in terms of distribution) of each taxonomic group. Cumulative distribution curves showed there to be many relatively rare species (species occurring in few cells) in many datasets. For the purposes of this study, the 5 percent of species with the smallest distribution, in terms of number of cells occupied, were classed as rare. In all taxa, this rare 5 percent were species that occurred in just 1 cell or coastal area. Therefore, a rare species for this study was defined as a species that occurs in just 1 coastal area around the New Zealand coastline. The value assigned is the number of these rare species occurring within each coastal area.

This rarity value is presented as both a raw value and normalised by the proportion of the total number of records in each coastal area. It was not possible to assign a value of rarity in terms of abundance as the data available were presence-only.

The rarity value calculated for dataset 8, diadromous fish, was based on the mean probability of catch and is, therefore, rarity in terms of occurrence rather than distribution. For the purposes of this study, those species with predicted probability of catch within the entire study area (New Zealand) of less than 0.0322 (which is 5 percent of the maximum probability of catch) were classed as rare. The rarity value assigned to each coastal cell is the mean predicted probability of catch of the rare species (in terms of occurrence) within this dataset. It is important to note that while the area sampled was standard amongst species it was not standardised between species.

2.3.7 Species composition

Species composition is a measure of the similarity of biological communities. This measure enables the identification of those cells or areas around New Zealand with unusual or unique species compositions.

Species composition was calculated within PRIMER software. A resemblance matrix was generated using the Sorenson's index on presence/absence transformed data (Clarke and Warwick, 2001a). In order to assign a relative value of species composition to each coastal area, the mean resemblance value for each coastal area was calculated. This gives an estimate of the distance of each coastal area from the mid-point (e.g. on a non-metric Multi-Dimensional Scaling (nMDS) plot).

A high mean resemblance value, therefore, represents a coastal area that is very similar to many other coastal areas in terms of species composition. Conversely, the smaller the mean resemblance value the more distinct the species composition. An example is given in Figure 4 and Table 3 where it can be seen that for the bryozoa data (dataset 2) those coastal areas with the lowest mean resemblance (e.g. 213, 233, 299 and 286) are spatially separated from the other coastal cells on the nMDS plot. Within an nMDS plot, data points that are close together are more similar to each other than to data points further apart. Therefore, the lower the mean resemblance value the more distinct the species composition of that coastal area is compared to the "normal" species composition of New Zealand.

Figure 4 non-metric Multi Dimensional Scaling (nMDS) showing the similarity/dissimilarity of coastal areas with respect to the bryozoa data. Sample labels are coastal areas. Data points that are close together on the plot are more similar to each other than data points that are far apart.

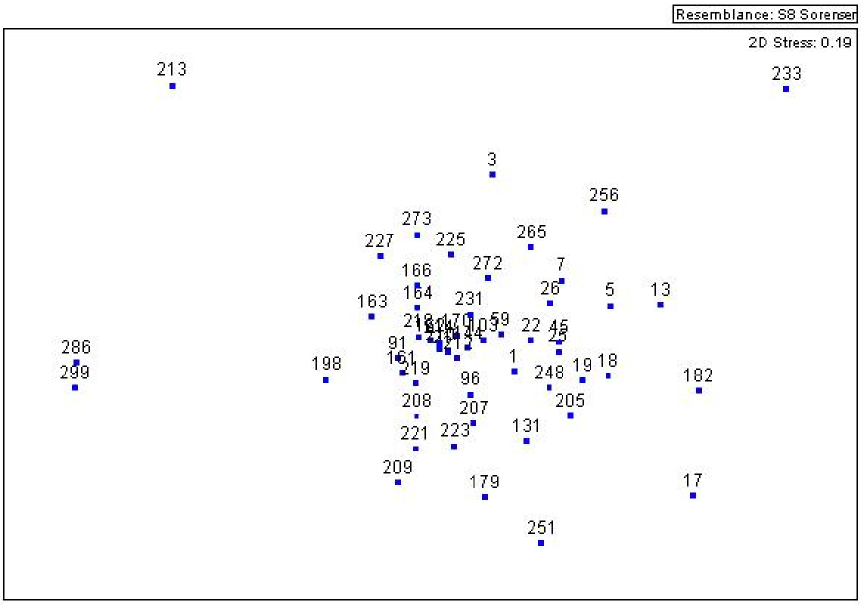


Table 3 Coastal areas sorted by ascending order of species composition (mean resemblance values).

Coastal area	Species composition (mean resemblance)
213	0.756831305
233	1.616664259
299	1.844528627
286	1.885242233
17	6.236099716
182	9.054882417
251	9.904559819
13	10.87248806
256	10.9151353
3	11.28105349
198	12.20768355
179	13.27377326
209	13.7049815
273	15.0273492
227	15.10500829
5	15.20056074
223	15.88216346
221	16.05279094

Diadromous fish (dataset 8): The mean predicted probabilities of catch for all rivers in each region were used to infer the relative abundance of each fish species. As relative abundance data were available for this dataset, resemblance matrices were generated within PRIMER using both the Bray-Curtis index (on mean predicted probabilities from which relative abundance can be inferred) and the Sorenson's index on pre-transformed (presence/absence) data. It is important to note that while the area sampled was standard amongst species, it was not standardised between species.

2.4 VALUATION METHODS FOR OVERALL BIODIVERSITY DATASETS

2.4.1 Modelled data

Three modelled datasets were used within this subcomponent: 10) Rocky reef fish, 11) Rocky reef invertebrate communities and 12) Vertical rocky reef invertebrate communities. A proforma metadata record for each dataset detailing raw data providers, data ownership and grooming actions is provided in Appendix I.

Dataset 10, Rocky reef fish (Adam Smith, NIWA): A Boosted Regression Tree method (e.g. De'ath, 2007) was used to fit models that predict species distribution and abundance as a function of environmental data (e.g. sea surface temperatures, dissolved and particulate organic matter, concentration of chlorophyll *a;* Marine Environmental Classification, Appendix I). For each of 72 species of reef fish, the model outputs were reviewed by experts in reef fish distributions. Predictions for some species were restricted to known distributional limits. The model outputs are presented as mean species richness per coastal cell based on a 1 km x 1 km grid (Smith, 2008).

Dataset 11, Rocky reef invertebrate communities (Franz Smith, Private Consultant): Generalised Additive Models and Generalised Regression and Spatial prediction were used to model the average biomass or average abundance of key rocky reef invertebrate species. Spatial predictions were made at 1 x 1 km resolution, trimmed to the 50 m depth contour and further constrained by the rocky reef layer (dataset 18).

Dataset 12, Vertical rocky reef invertebrates (Franz Smith, Private Consultant): Generalised Additive Models, Generalized Regression and Spatial Prediction were used to predict diversity indices and incidence measures of major taxonomic groups. Spatial predictions were made at a 1 x 1 km resolution, trimmed to the 50 m depth contour and further constrained by the rocky reef layer (dataset 18).

2.4.2 Derived values

A mean value (summed across all specific-diversity invertebrate datasets; molluscs, bryozoa, polychaetes, sponges, arthropods and echinoderms) for each environmental value described above has been calculated for each coastal cell. In addition, the total number of invertebrate records and species (in these datasets) per coastal cell are given.

2.5 VALUATION METHODS FOR NON-INDIGENOUS SPECIES DATASETS

Two datasets were available for this subcomponent: 13) BIODS Port surveys and 14) BIODS surveillance. A proforma metadata record for each dataset detailing raw data providers, data ownership and grooming actions is provided in Appendix I.

Records of the occurrence of non-indigenous species/genera were extracted from the BIODS port survey and BIODS surveillance datasets (Inglis, et al., 2006). BIODS is a database managed by NIWA for MFish and includes results of MFish funded biodiversity research projects together with marine biosecurity research projects initially funded by MFish and subsequently by MAF Biosecurity New Zealand.

The data are presented as: Total number of records per coastal cell, the proportion of total (within New Zealand) non-indigenous records within each coastal cell and the number of non-indigenous genera per coastal cell. It is important to note that data are only available from the ports that have been surveyed.

2.6 VALUATION METHODS FOR AT RISK OR THREATENED SPECIES DATASETS

Information on the distribution of at-risk and threatened species around the New Zealand coastline was sourced from the New Zealand Department of Conservation's Treat Classification System (dataset 15), and from data held jointly by the Ministry for Culture and Heritage (Te Ara) and the Ministry of Fisheries (dataset 16). These data include all the information currently held on the distribution of the nationally critical, nationally endangered or nationally vulnerable species. A proforma metadata record for each dataset detailing raw data providers, data ownership and grooming actions is provided in Appendix I.

Data have been mapped within GIS to show the distribution of the "at risk or threatened species" around the New Zealand coastline. The data are separated into three categories: 1) bird colonies – known areas of breeding colonies of at risk or threatened birds 2) distribution – known areas of the 100% range, 90% range and hotspots of distribution for at risk or threatened birds and mammals and 3) invertebrates – the known areas of distribution for at risk or threatened marine invertebrates to highlight particularly important areas or cells for these species.

2.7 VALUATION METHODS FOR HABITAT AREA WITHIN NZ REGION DATASETS

2.7.1 Habitat distribution

Five habitat distribution datasets were selected for this subcomponent: 17) Intertidal rocky reefs, 18) Subtidal rocky reefs, 19) Seagrass beds, 20) Mangroves, 21) Biogenic reefs. A proforma metadata record for each dataset detailing raw data providers, data ownership and grooming actions is provided in Appendix I.

Data were mapped as 1) the area of habitat within each coastal cell, 2) the area of habitat normalised by the shelf area of the coastal cell, 3) the area of habitat normalised by the length of coastline within each coastal cell (for those habitats whose presence is dependent on shallow/intertidal areas) and 4) the proportion of the New Zealand total shelf area of each habitat within each coastal cell.

The Biogenic reef layer has been created from expert knowledge following a workshop convened by WWF-New Zealand (Arnold, 2004). The Seagrass layer has been created from shapefiles of known seagrass distribution together with descriptions from experts as to where small patches of this important habitat exist. While it is believed that the area of seagrass within each coastal cell is representative of the actual distribution of seagrass, in many places the shapefile layer is not accurate on a fine scale. It is also important to note that there is great temporal variation in the spatial distribution of seagrass beds (Turner et al., 1999).

2.7.2 Marine Environmental Classification (MEC) Physical Habitat Categories.

The distribution of the different MEC classes around the New Zealand coastline has been mapped using dataset 22. The definitions of the classes are listed in Appendix V.

2.7.3 Derived value: Habitat diversity

A ratio of straight-line distance between intersection points of coastline and coastal cell boundary and the actual length of the coastline within each coastal cell has been used as a proxy for habitat diversity.

2.8 VALUATION METHODS FOR PRIMARY PRODUCTION DATASET

Primary productivity was derived from MEC chlorophyll data (dataset 23), in which mean annual near-surface chlorophyll *a* concentrations were generated from satellite imagery

(Appendix I). Chlorophyll *a* concentration is a good proxy for local levels of primary production that drives the food chain. A proforma metadata record for this dataset detailing the raw data provider, data ownership and grooming actions is provided in Appendix I.

2.9 VALUATION METHODS FOR MARINE MAMMAL DISTRIBUTION DATASETS

Information on the distributions of marine mammals (whales, dolphins and pinnipeds) was sourced from the Ministry of Culture and Heritage (Te Ara; dataset 16) and incidental cetacean sighting data (dataset 25). These data were mapped within a GIS and include the distribution of the 100 percent range, 90 percent range and hotspots of each species in addition to the location of important colonies. A proforma metadata record for each dataset detailing raw data providers, data ownership and grooming actions is provided in Appendix I.

2.10 VALUATION METHODS FOR MARINE PROTECTED AREAS (MPAs), SANCTUARIES AND AREA-BASED RESTRICTION DATASETS

Locations of marine restricted areas (dataset 25) and conservation sites (dataset 26) were sourced from the Department of Conservation. A proforma metadata record for each dataset detailing raw data providers, data ownership and grooming actions is provided in Appendix I.

Area-based restrictions were mapped to coastal cells, the attributes for each having information as to the type of restriction in place (e.g. scallop fishing prohibited, restriction on gear type etc.).

Conservation sites have been mapped to show the area of marine reserves within each coastal cell as well as a layer for each type of marine reserve or sanctuary. Data have been mapped as 1) the area of reserve or sanctuary within each coastal cell, 2) the area of reserve or sanctuary within each coastal cell normalised by the shelf area of the coastal cell and 3) the area of the reserve or sanctuary type within each coastal cell as a proportion of the total area of that type of reserve or sanctuary within New Zealand.

3 Results

Maps were created of each environmental value for each dataset for each subcomponent and were sent out to the participants of expert focus groups in December 2007 for comment. Experts reviewed the information on each map, in particular focusing on their own area of expertise as well as reviewing the habitat maps, and were asked to report back with information on outliers, unexpected results or with new data to enhance the database.

Following feedback from this delphic process, the value for each data source within each subcomponent was finalised and spatially explicit data layers were created.

3.1 SUBCOMPONENT: TAXON SPECIFIC DIVERSITY

Examples of Taxon-Specific Diversity are given using the algal dataset (dataset 7). Note that all of these environmental values with the exception of number of records (Figure 5) and number of species (Figure 6) are mapped using coastal areas (see Section 2.2.1) and not coastal cells due to poor data coverage in many areas. The same is true for datasets 1 - 6. Datasets 8 and 9, the diadromous fish and wading bird datasets are mapped using coastal cells.

The example given for the number of records (individuals at a location; Figure 5) shows there are large areas of both east and west coasts of both main islands of New Zealand which contain very few records. This is the case for many of the datasets within this subcomponent. An example of the raw number of species (Figure 6), not adjusted to allow for sampling effort (number of records) or normalised for the size of the coastal cell, shows high numbers of recorded algal species in locations such as the Three Kings Islands, the Chatham Islands and Fiordland. It can also be seen that the greatest number of species have been recorded in the coastal cells with the greatest number of records (see Figure 5). This highlights the potential problems of using the raw number of species to infer trends in species richness without taking into account the sampling effort.

A derived value of species richness (Figure 7) indicates where species richness is higher or lower than expected. A zero value reflects a coastal area with the expected number of species per record, and does not represent a cell with a species richness of zero. Normalised values remove the influence of differences in the size of the coastal area or the coastline length, in the case of algae, between coastal areas. In this example (Figure 7), normalised values, which remove the influence of between-area differences in coastal area size of shoreline length, shows areas such as the Three Kings, Fiordland, Waikato, Auckland and parts of the Chatham Islands and Otago coastline have a higher than expected richness of algal species (normalised to coastline length of the coastal area).

For many coastal areas in the north of the North Island, in the Marlborough Sounds area and in parts of the west coast of the South Island, algae demonstrates have a relatively high ATD (Figures 8 and 9). This means that the species in these areas are less related to each other than, for example, the areas in the south of the South island (e.g. Otago coastline) which have a relatively low ATD (Figure 8). Variation in ATD of algal species in New Zealand is relatively low in many coastal areas in the north of the North Island, Marlborough Sounds, Cook Strait and parts of the west coast of South Island (Figure 9). It is also relatively high in Fiordland, the south of the South Island (except for Foveaux Strait) and in parts of the east coast of the South Island and west coast of the North Island (Figure 9).

For rare species (in terms of distribution) (Figure 10), many coastal areas contain no or very few rare algal species. However, areas such as the Three Kings, Kermadec Islands, Snares Islands and the Bounty Islands had relatively high numbers of rare algal species (Figure 10). Within the database, the measure of rarity is also given as a value normalised by the number of records within each coastal area.

The species composition value shows how similar or distinct a coastal area is in relation to other areas with respect to the species present in each area. A high mean resemblance value represents a coastal area that is very similar to many other coastal areas in terms of species composition. Conversely, the smaller the mean resemblance value the more distinct the species composition. For the algal data (Figure 11), many of the outlying islands, Foveaux Strait, Otago, and parts of the northeast North Island have communities quite distinct from those in other parts of New Zealand. Conversely, the Marlborough Sounds, Cook Strait and Fiordland, amongst others, have algal communities very similar to many other areas.

Figure 5 Taxon specific diversity: Algal data (dataset 7). Total records (individuals at a location) per coastal cell.

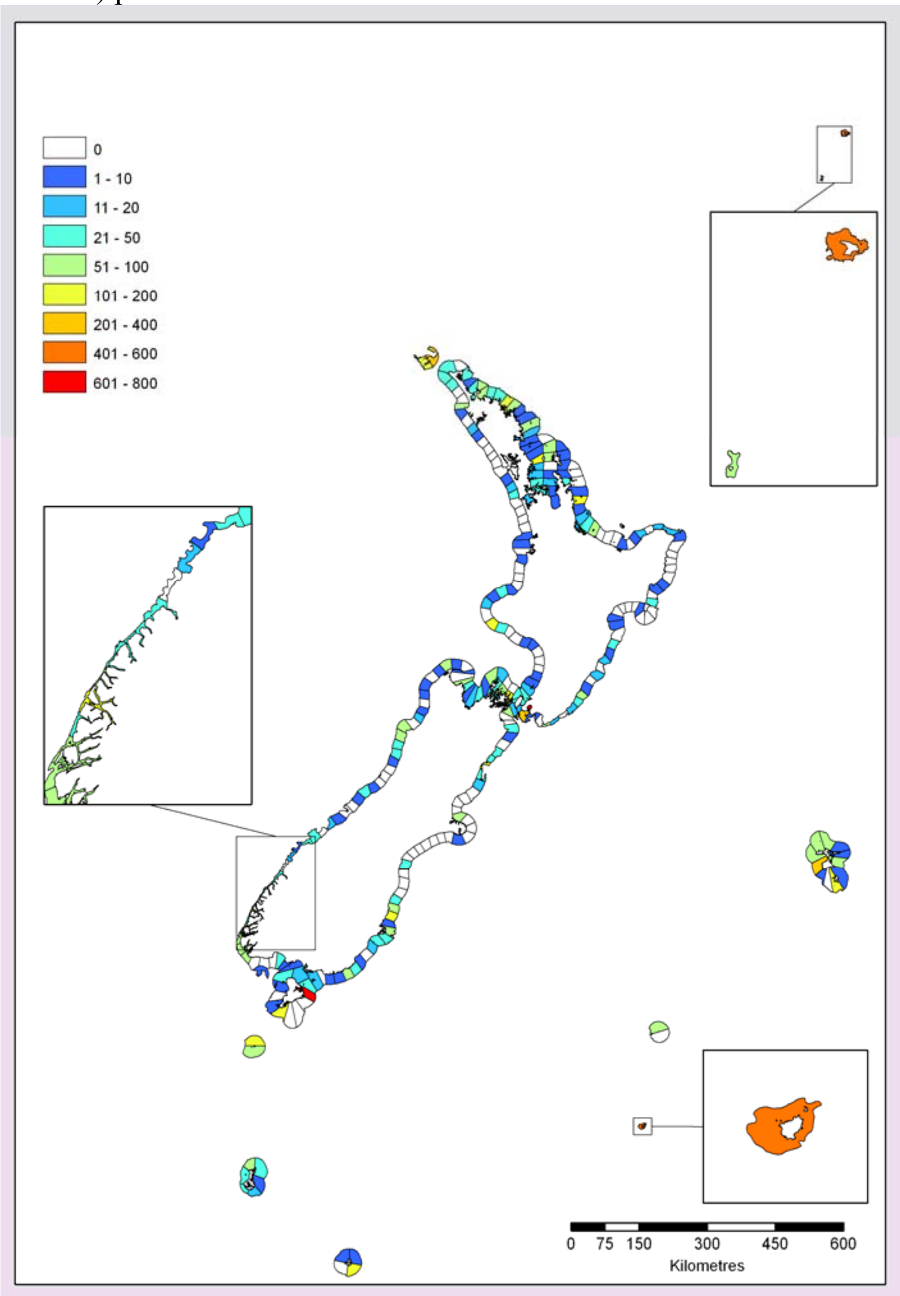


Figure 6 Taxon-specific diversity: No. of algal species per coastal cell (dataset 7). This is the raw value and has not been adjusted to allow for sampling effort (number of records) or normalised for the size of the coastal cell.

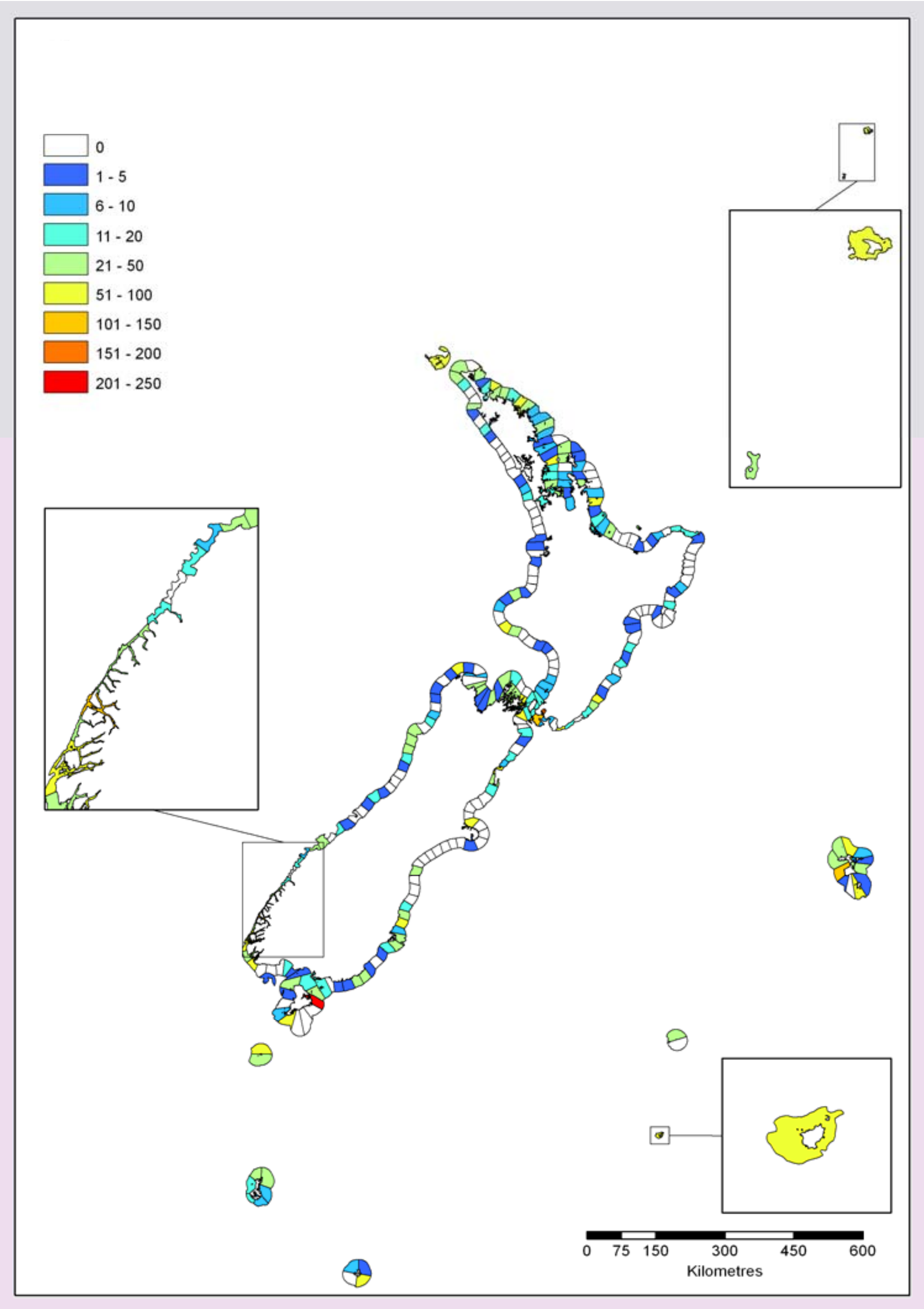


Figure 7 Taxon-Specific Diversity: Algal data (dataset 7). Species richness (deviation from expected). A zero value reflects a coastal area with the expected number of species per record; it does not represent a cell with a species richness of zero. These values were derived using a rarefaction curve (see methods) and are presented in the database as both a raw value and as normalised values; normalisation removes the influence of between-area differences in coastal area size and/or shoreline length.

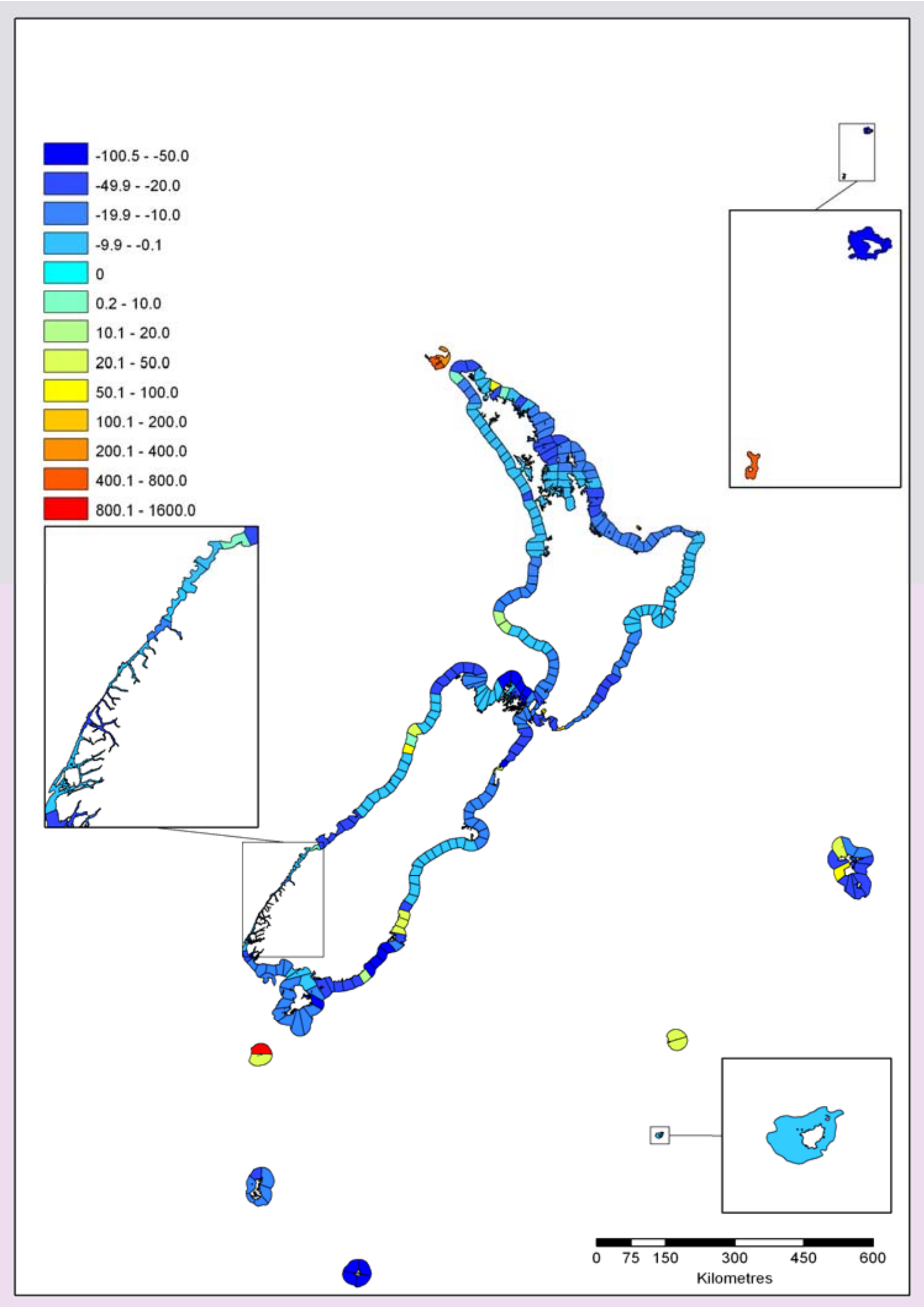


Figure 8 Taxon Specific Diversity: Algal data (dataset 7). Average Taxonomic Distinctness.

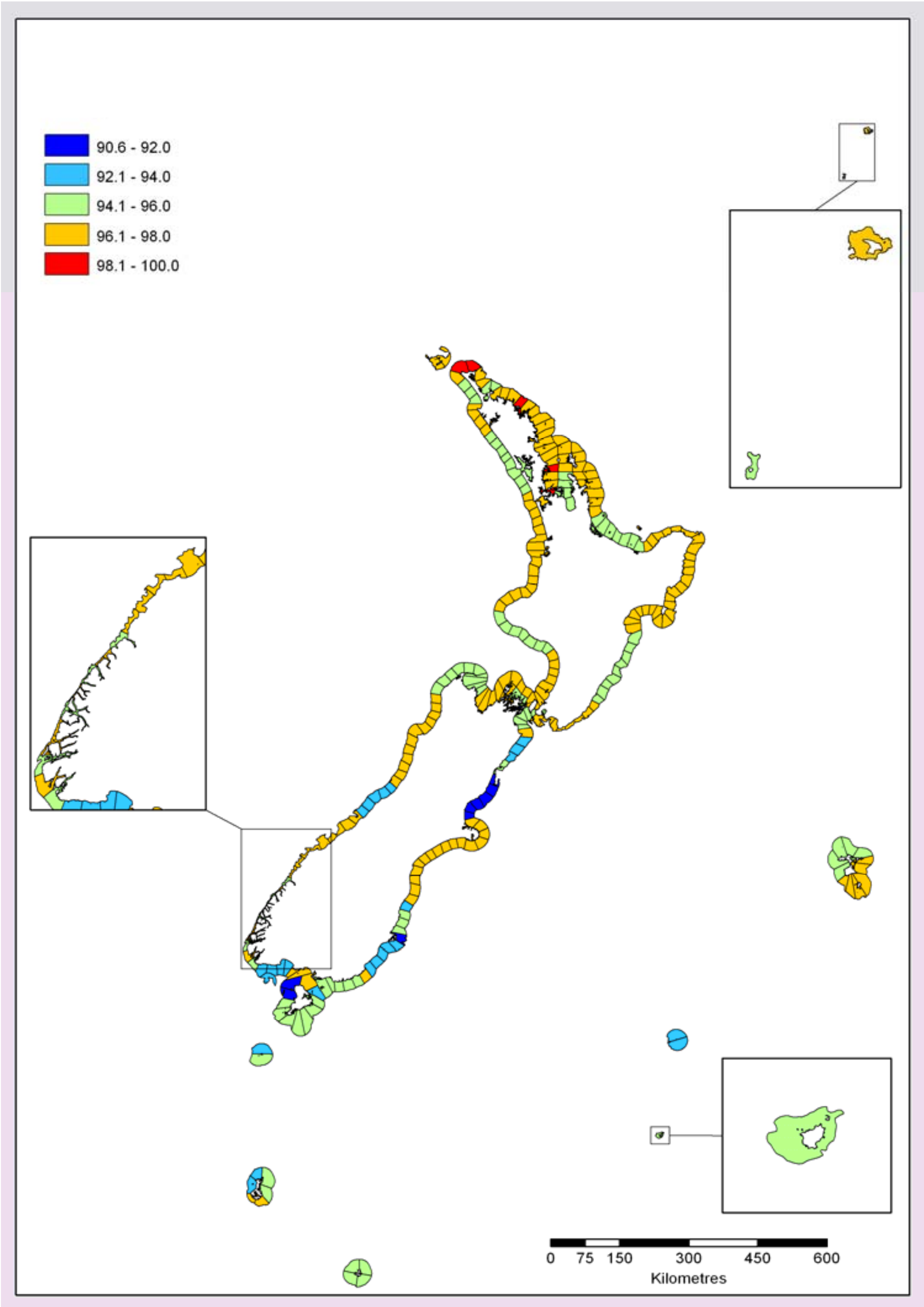


Figure 9 Taxon Specific Diversity: Algal data (dataset 7). Variation in Average Taxonomic Distinctness.

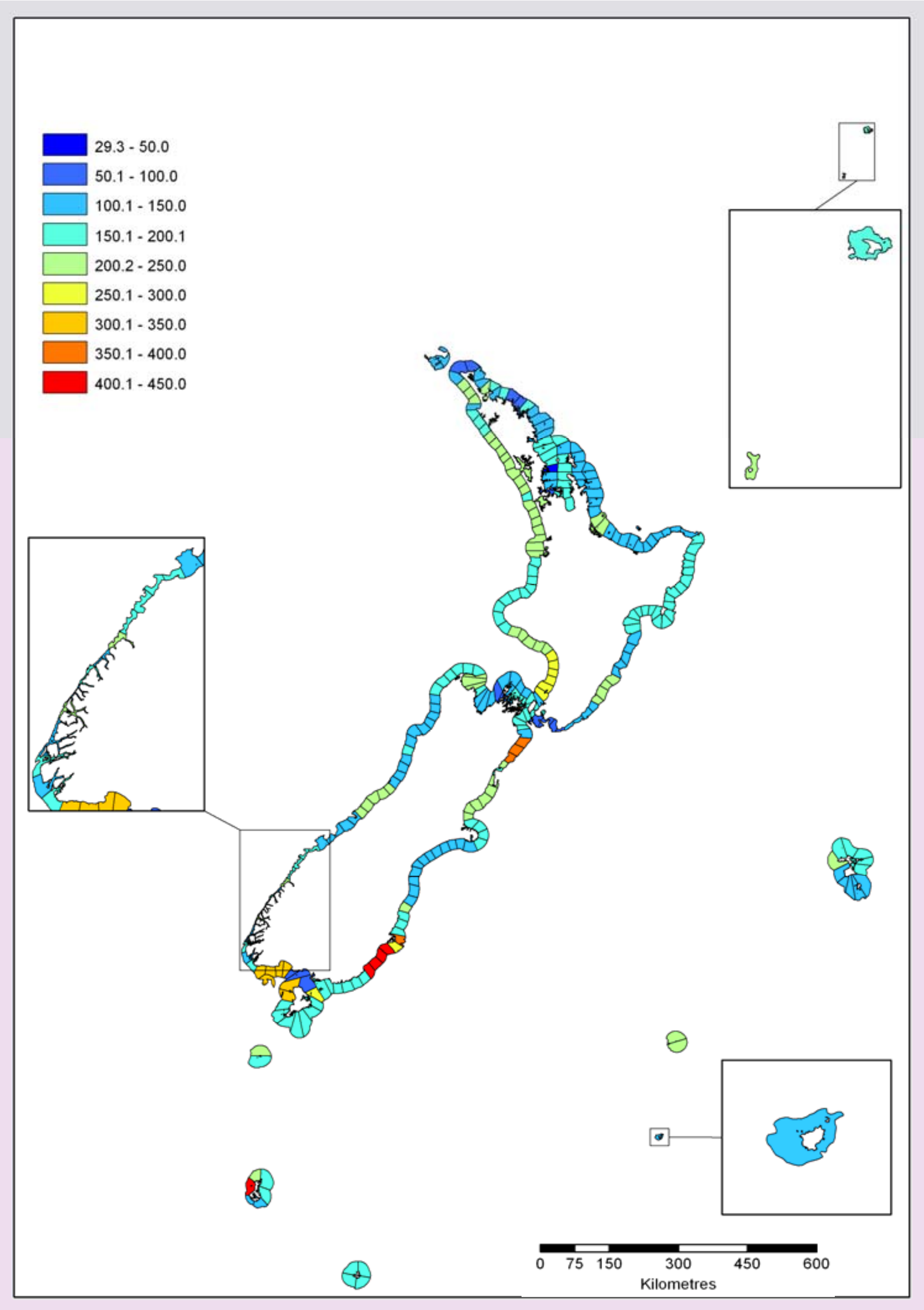


Figure 10 Taxon Specific Diversity: Algal data (dataset 7); Rarity. For this dataset rarity is defined as a species that occurs in just one coastal cell or coastal area around the New Zealand coastline. This value is presented in the database as a raw value and as a value normalised by the total number of records for that taxon per coastal area.

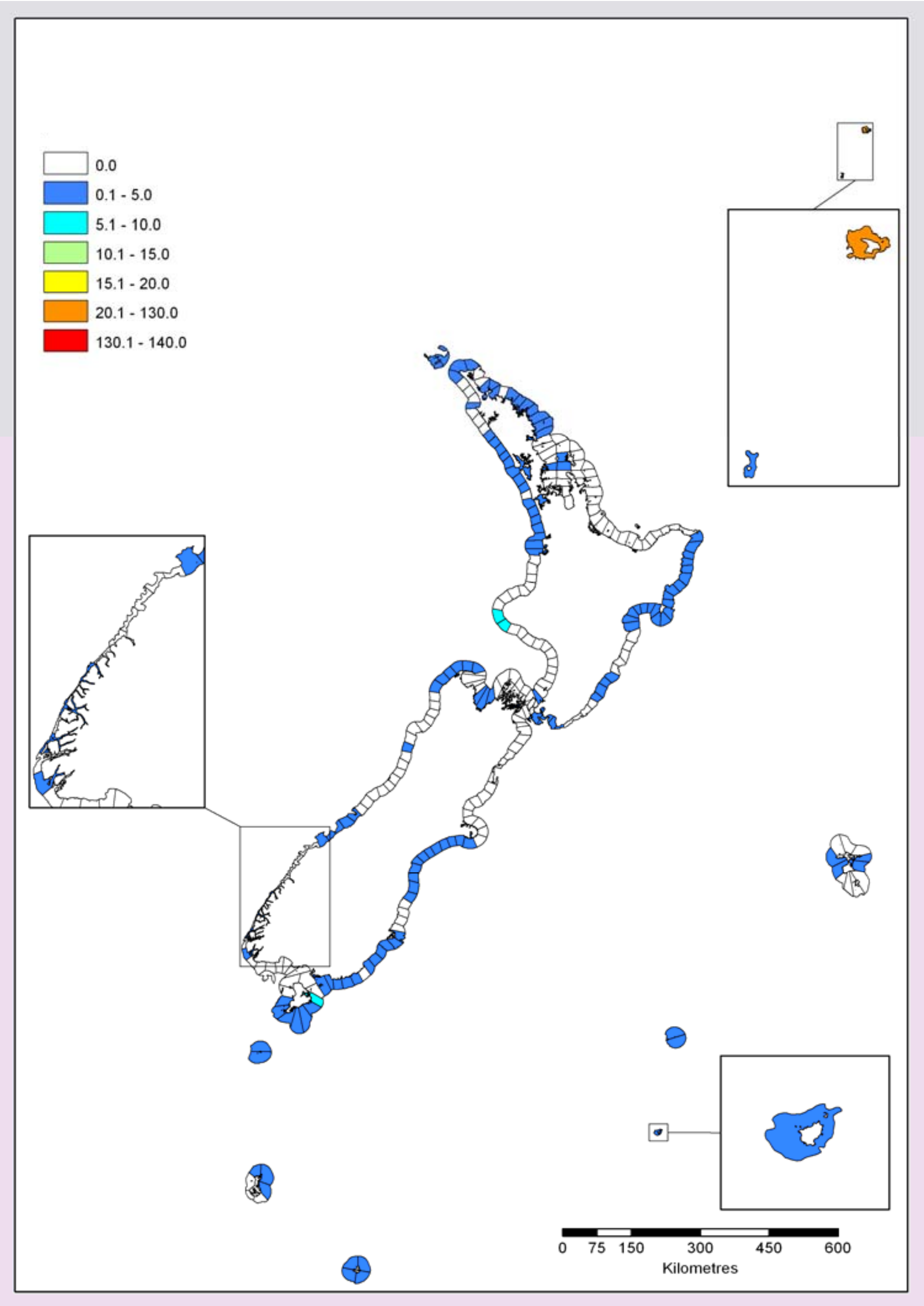
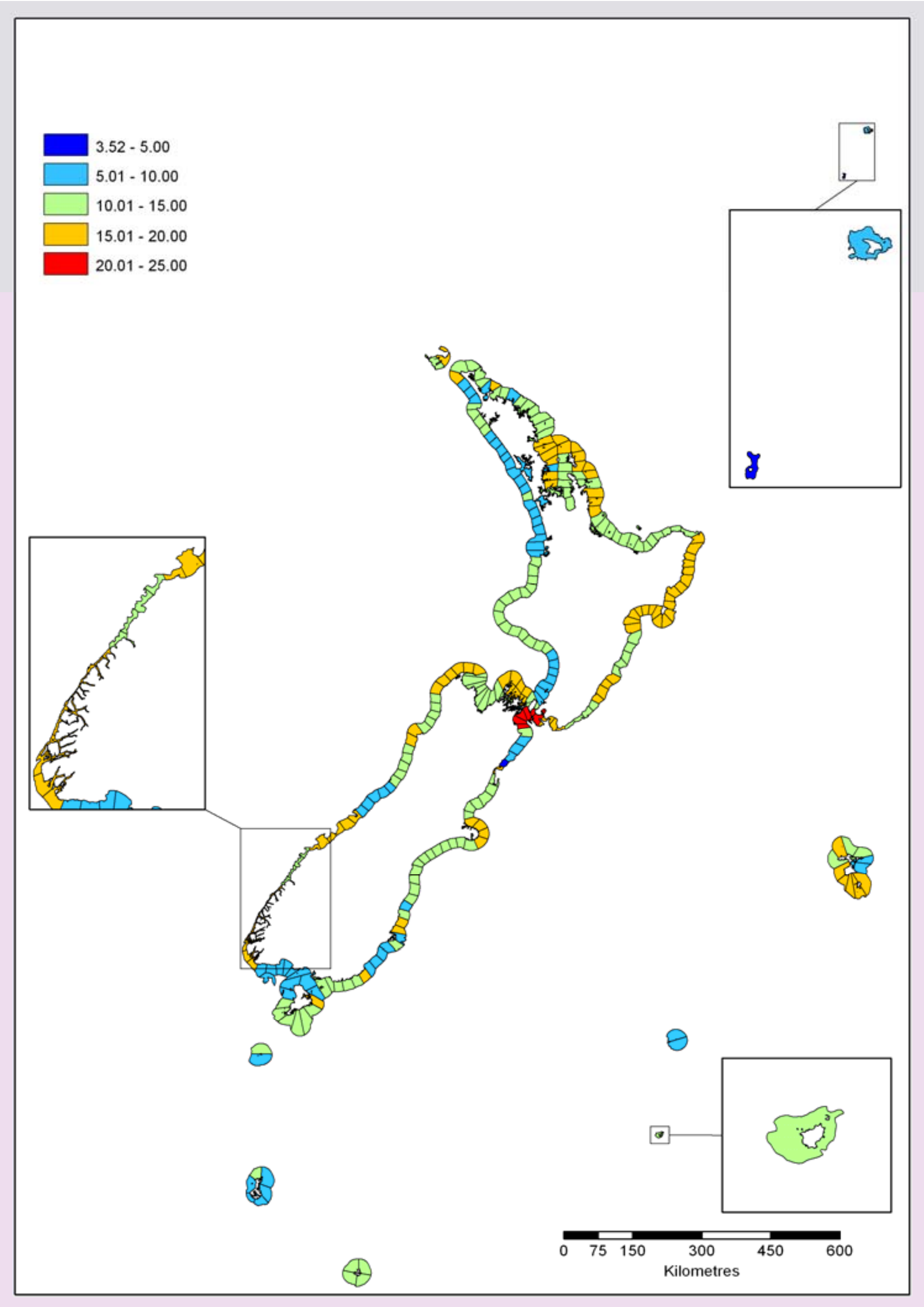


Figure 11 Taxon Specific Diversity: Algal data (dataset 7); Species composition. A high mean resemblance value represents a coastal area that is very similar to others in terms of species composition. Conversely, the smaller the mean resemblance value the more distinct the species composition.



3.1.1 Subcomponent: Overall biodiversity

These data layers created from modelled datasets (rocky reef fish, rocky reef invertebrate communities and vertical rock communities) are presented as GIS raster layers with a resolution of 1 x 1 km. A mean value per coastal cell has been mapped for key values from these data, calculated using the species richness values for each 1 x 1 km grid. In the case of mean estimated species richness of reef fish (Figure 12), species richness is predicted to be greatest in the north of the North Island and the north and northwest of the South Island.

In addition to the modelled datasets, overall biodiversity also encompasses layers of derived mean diversity values from selected benthic macroinvertebrate taxa (polychaete, mollusc, bryozoa, sponge, arthropod and echinoderm data; datasets 1-6) within the subcomponent Taxon Specific Diversity. These data are mapped per coastal cell and not per coastal area.

For the six invertebrate taxa listed above, the total number of records in each coastal cell are (Figure 13), indicate that the north of the North Island, the Bay of Plenty, the Marlborough Sounds and Fiordland have been highly sampled, and that the East and West coasts of both main islands have been less well sampled. It is also noteworthy that there are coastal cells (especially on the east coast of North Island and the south and southeast coast of South Island) where there are no records of any of these taxa.

Figure 12 Overall biodiversity: Modelled datasets; Mean estimated species richness of rocky reef fish.

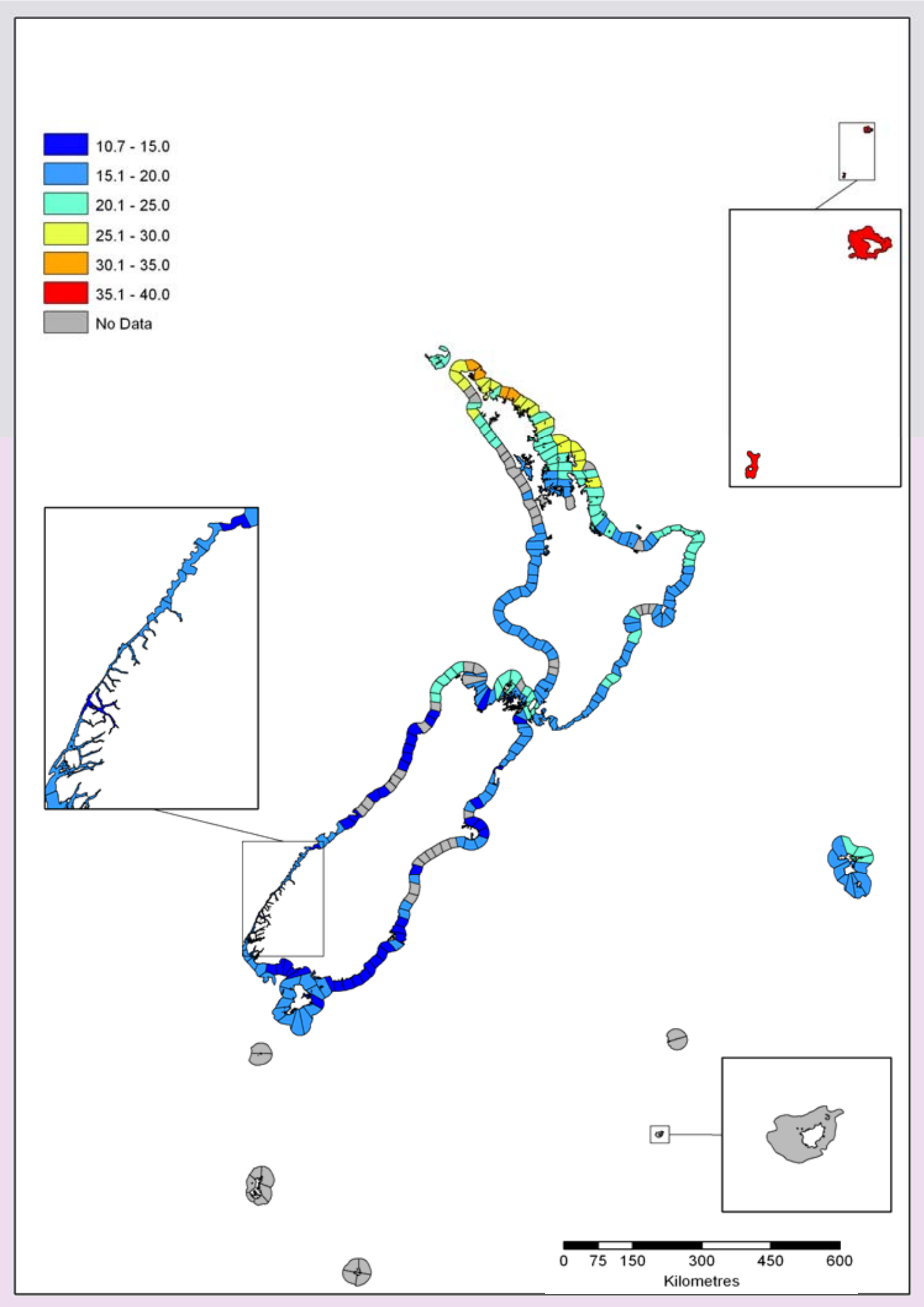
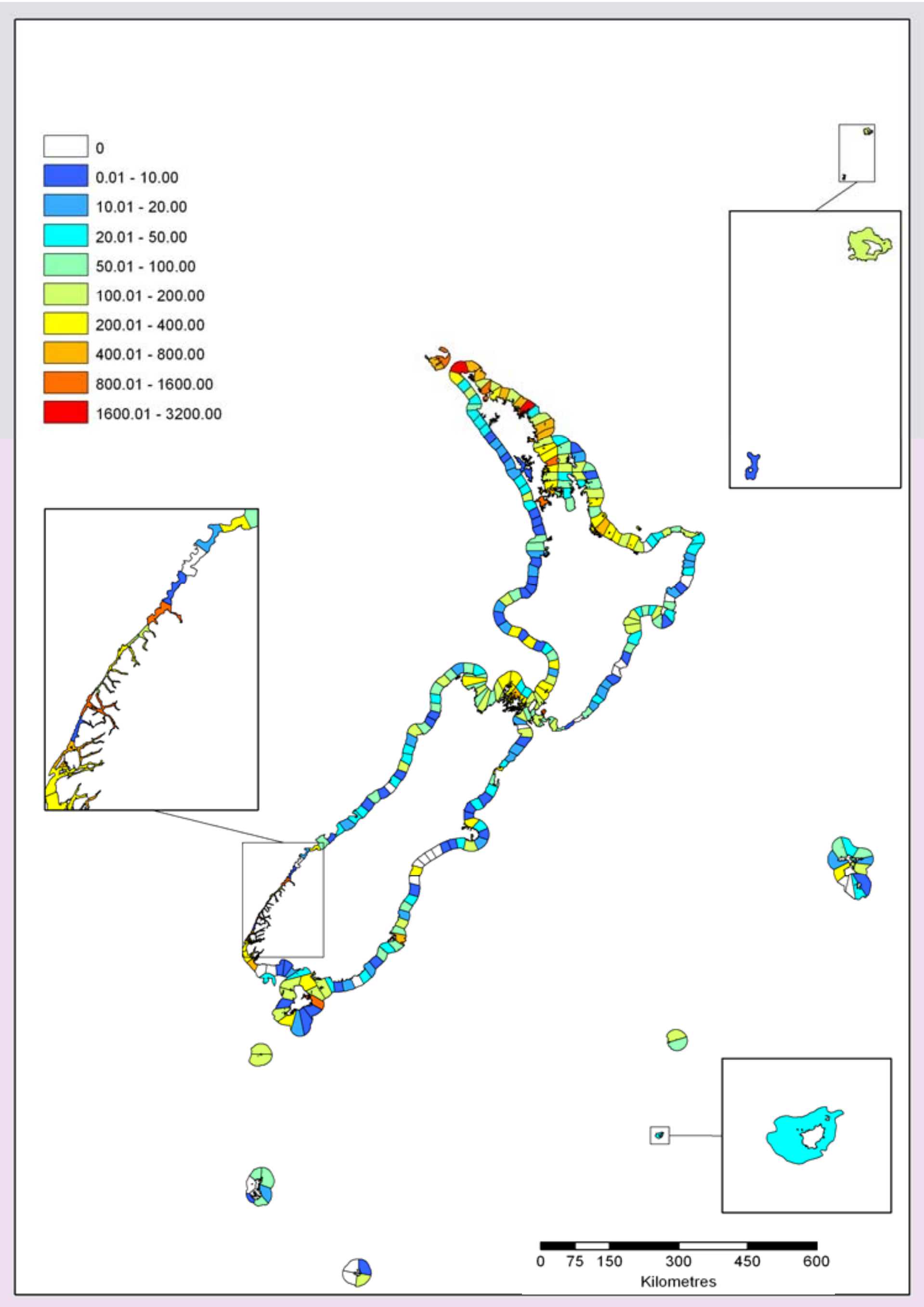


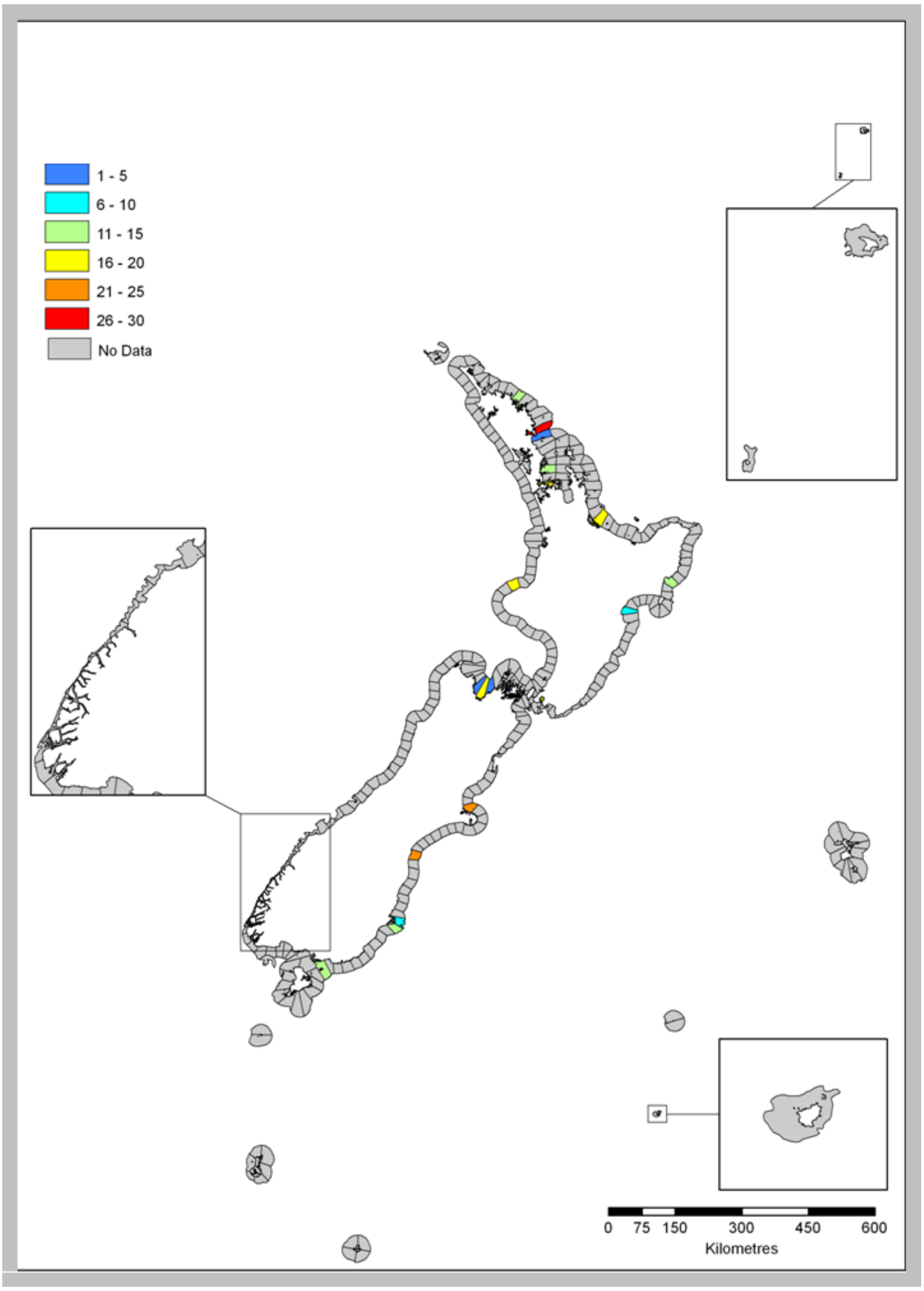
Figure 13 Overall biodiversity: Invertebrates (Derived data) total records per coastal cell for all of the selected benthic macroinvertebrate taxa (polychaete, mollusc, bryozoa, sponge, arthropod and echinoderm data) from the Taxon-Specific Diversity subcomponent.



3.1.2 Subcomponent: Non-indigenous species

The records of non-indigenous species from ports around New Zealand are presented as total number of records, the proportion of total records within each coastal cell and the number of non-indigenous genera per coastal cell. For the latter (Figure 14) ports with the highest number of non-indigenous genera are Lyttleton, Whangarei, Auckland and Timaru. It is important to note that data are only available from the ports that have been surveyed and are not available for all coastal cells.

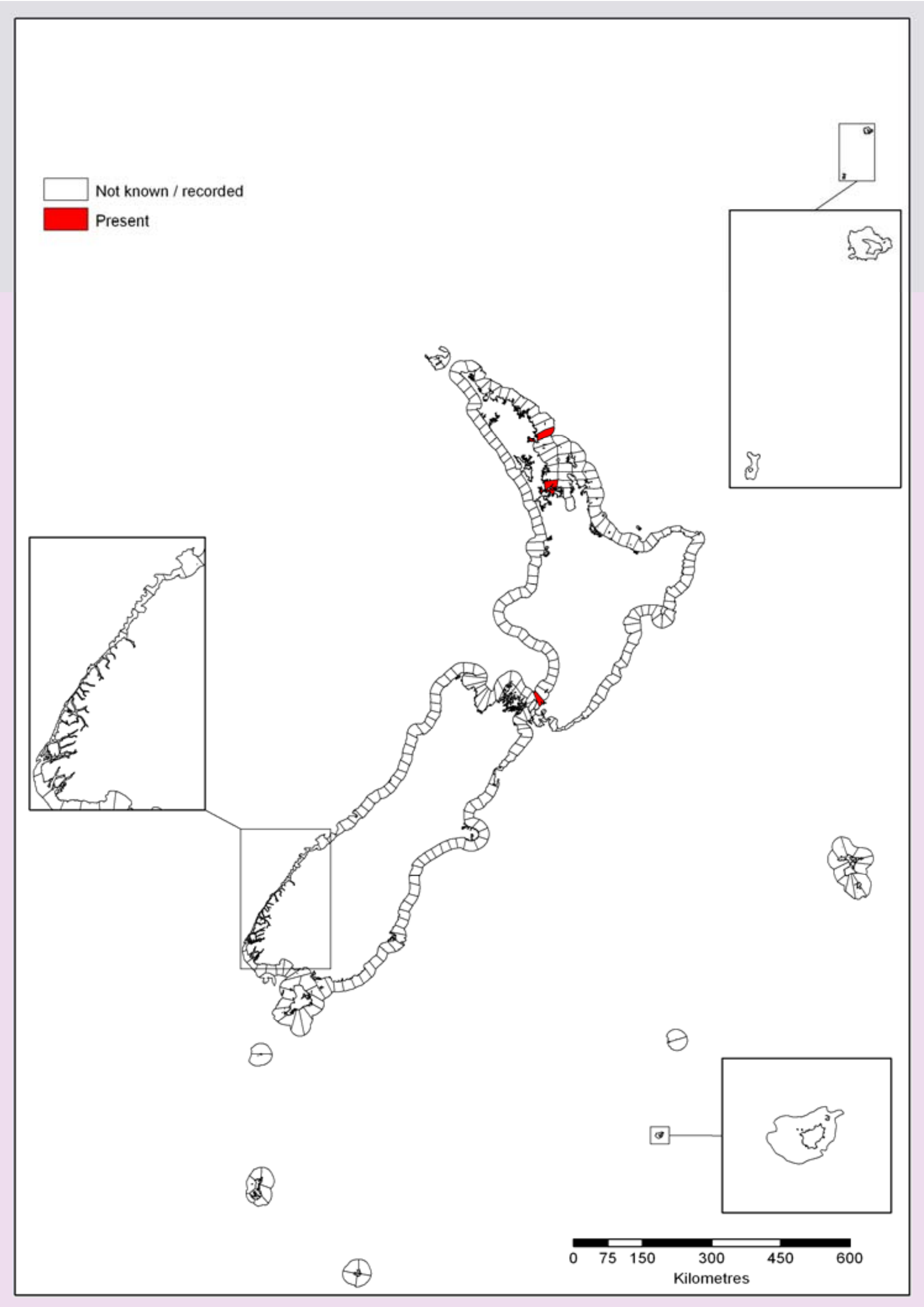
Figure 14 Non-indigenous species: Number of non-indigenous genera recorded in coastal cells. Note that data were only available from ports.



3.1.3 Subcomponents: At-risk or threatened species

Distributions of nationally threatened invertebrate and bird species as well as the distribution of marine mammals have been mapped within this subcomponent. The example given in Figure 15 shows the three coastal cells where the polychaete worm, Large Egged *Boccardiella*, is known to be present.

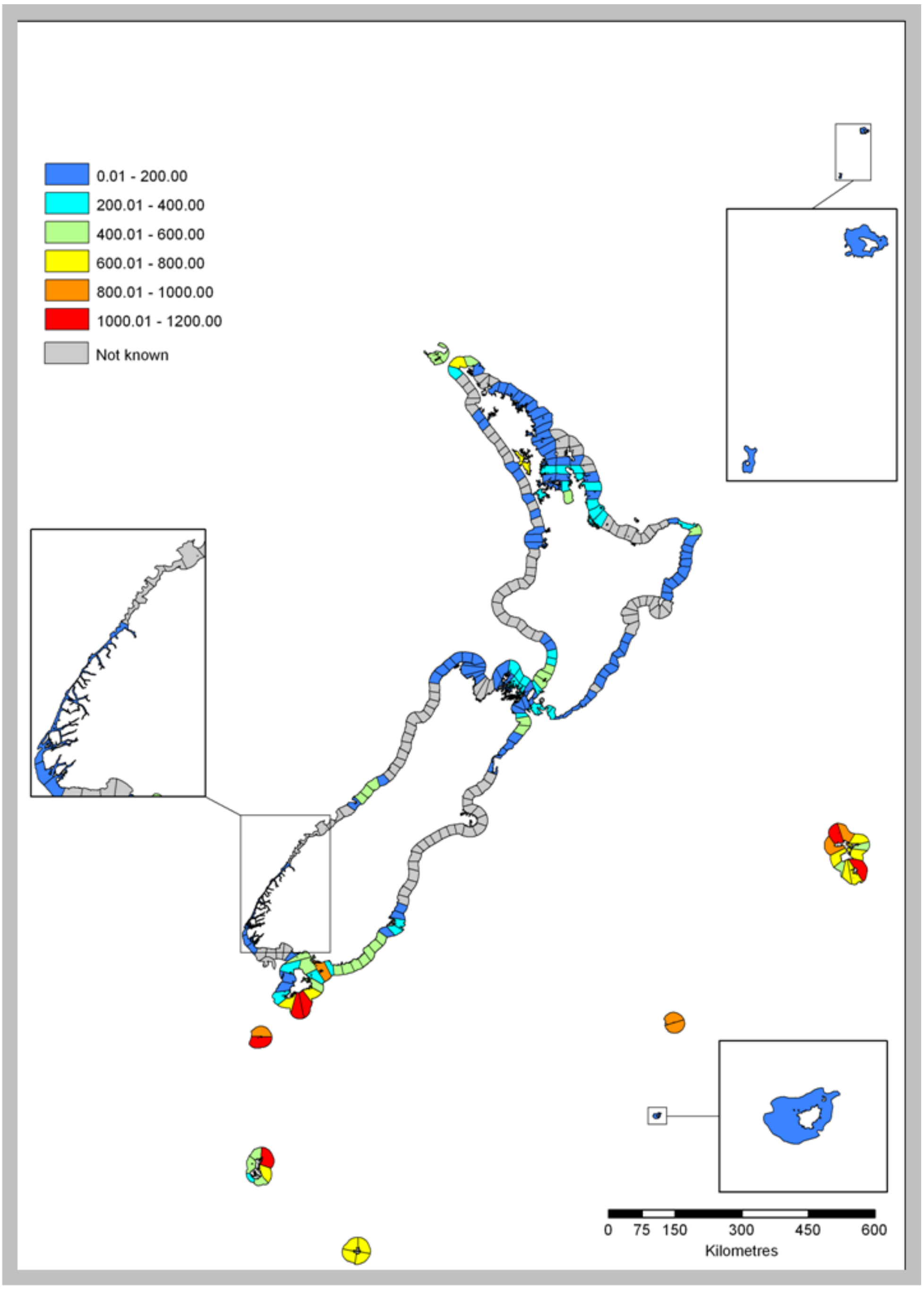
Figure 15 At-risk or threatened species: The very limited distribution of *Boccardiella magniovata*, the Large Egged Boccardiella (polychaete worm).



3.1.4 Subcomponent: Habitat area within New Zealand

Data layers showing the distribution of key marine habitats (mangrove, seagrass, biogenic reefs etc.) have been created to show 1) the area of habitat per coastal cell (e.g. Figure 16), 2) the area of habitat normalised by the size (area) of the coastal cell (and normalised by the length of coastline per coastal cell for habitats such as mangrove, seagrass and intertidal rocky reef) and 3) the area of habitat per coastal cell as a proportion of the total area of that habitat in NZ. It is important to note that some habitat maps, such as the seagrass and biogenic reefs, have been created using expert knowledge and reflect the best information available rather than being accurate on a fine scale.

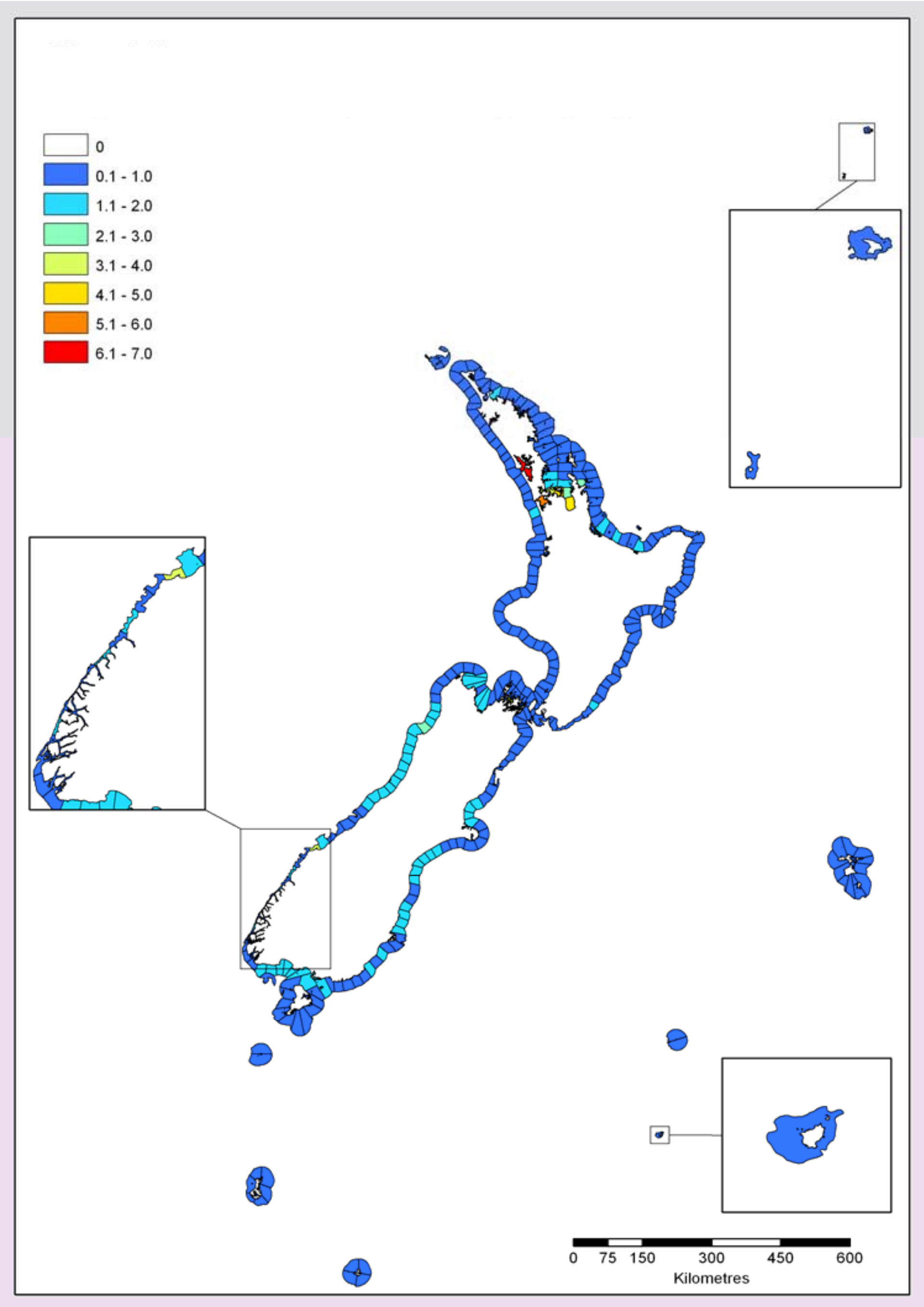
Figure 16 Habitat area within NZ region: Biogenic reefs.



3.1.5 Subcomponent: Primary productivity

Mean annual near-surface Chlorophyll *a* concentrations have been mapped around the New Zealand coastline (Figure 17). Primary productivity, in terms of the concentration of Chlorophyll *a*, is very high on the west, south and south-eastern coasts of the South Island, and in the Hauraki Gulf and Bay of Plenty in the North Island. In contrast, the offshore islands around New Zealand have relatively low mean concentrations of Chlorophyll *a*.

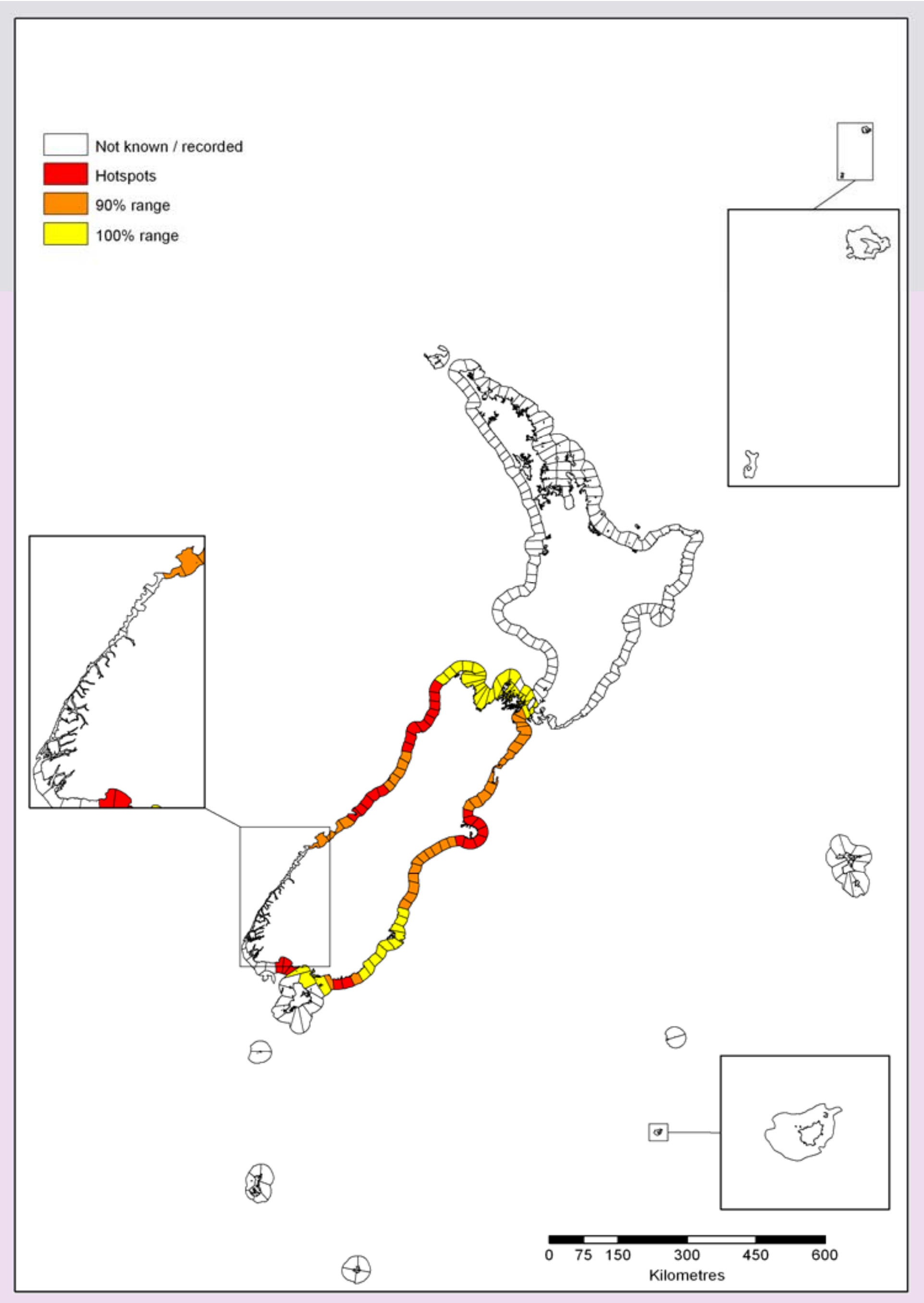
Figure 17 Primary productivity: Mean annual concentration of Chlorophyll *a* per m^3 calculated from SeaWIFS ocean colour data.



3.1.6 Subcomponent: Marine mammal distribution

The distribution of marine mammals have been mapped to show the 100% range, the 90% range and the hotspots of each species. For example, the known range of Hectors Dolphins is limited to the South Island of New Zealand, excluding Steward Island and Fiordland (Figure 18).

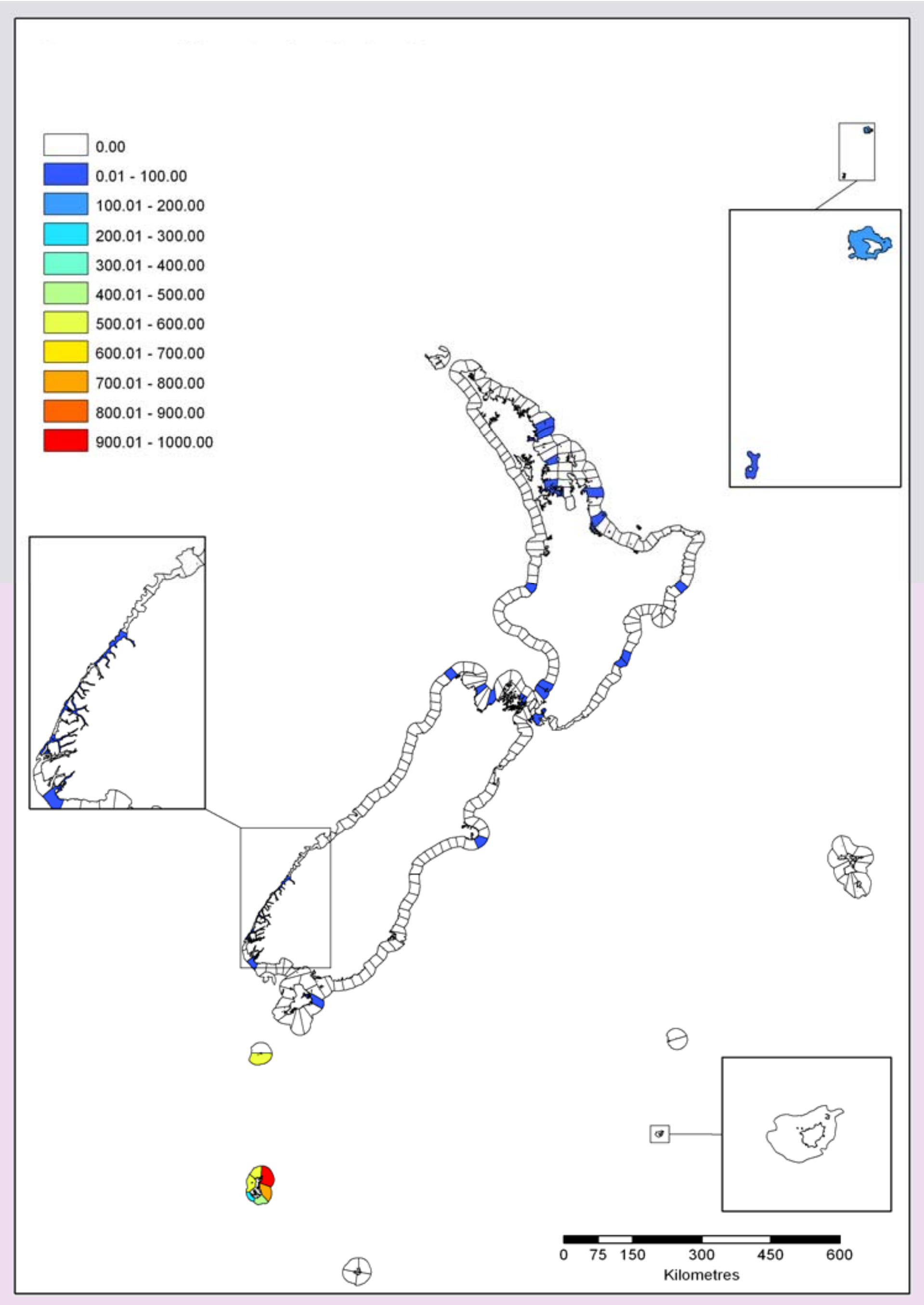
Figure 18 Marine Mammal Distributions: Hector's Dolphin (*Cephalorhynchus hectori*). Data are presented to highlight the 100% range, 90% range and hotspots of distribution.



3.1.7 Subcomponent: Areas of MPAs and Sanctuaries and area-based restrictions

The area of marine reserves, marine mammal reserves, cultural areas (Mataitai and Taiapure) together with areas closed to fishing as a result of submarine cables have been mapped within this subcomponent. Outputs from these datasets include the area of reserve/sanctuary per coastal cell (Figure 19) as well as the area of reserve/sanctuary per coastal cell as a proportion of the New Zealand total area of reserves/sanctuary. The occurrence of area-based restrictions within coastal cells has also been mapped. Within the GIS layer, the attributes for each coastal cell have information as to the type of restriction in place (e.g. scallop fishing prohibited, restriction on gear type etc.)

Figure 19 Area restrictions and marine reserves. Area of marine reserves within each coastal cell.



4 Discussion

Many measures of marine environmental value have been successfully quantified and mapped, using a NIWA-generated coastal cells layer, into spatially explicit data layers within a Geographic Information System.

4.1 FOCUS GROUP MEETINGS AND THE DELPHIC PROCESS

The Delphic process is a mechanism used "to develop fact-based decisions and strategies, reflecting expert opinion on well-defined issues" (Anon, 2008). This process has been used previously in biological valuation in the marine environment (Derous, et al., 2007) and consultation with select groups of experts was critical to the success of this project. Initial focus group meetings generated key ideas for identifying subcomponents of environmental value and available datasets. A follow-up focus group meeting provided invaluable discussion as to data limitations and suitable methodologies.

4.1.1 Valuation methods

Measures of environmental value and suitable methods to value these measures were discussed at a focus group meeting of selected experts from around New Zealand. Measures of environmental value had to be both useful and appropriate with respect to the scope of the project and be quantifiable in order to make comparisons between different coastal cells or areas.

Valuation methods were chosen to make best use of the available data, taking into account the patchiness of many of the datasets as well as great variation in sampling effort within datasets. Many of the datasets acquired for use in this study (particularly those within the taxon-specific diversity subcomponent) contained records that had been collated over time through a combination of detailed surveys and opportunistic collection of species of interest by scientists and members of the public. The inconsistencies inherent within such datasets - both in sampling methods, intensities and densities - created difficulties in the analysis of these data with respect to biodiversity measures. One of the greatest challenges was estimating the species richness for each coastal area from data that were both patchily distributed and inconsistently sampled

It is important to note that the value assigned to each dataset/subcomponent is not a monetary value but on a quantitative scale so that comparisons can be made between coastal cells. No attempt has been made to rank these values in terms of importance.

4.1.2 Feedback using the Delphic Process

In the final stages of the project, experts reviewed preliminary values of the mapped environmental measures. Experts were asked to focus their attentions on their own area of expertise as well as the habitat maps such as seagrass and biogenic reefs. The level of feedback received from experts varied greatly depending on the relevance of their individual expertise to the project. The majority of feedback related to the distribution maps rather than the mapped measures of taxonomic diversity.

Valuable feedback was received on the known distributions of habitats such as seagrass and biogenic reefs as well as the presence of marine reserves and sanctuaries around New Zealand. An inconsistency between distribution maps and maps of taxonomic diversity was also picked up by several experts and has now been resolved. New data was provided as a result of the feedback process for both the bryozoa and seagrass datasets. Data for the distribution of maerl/rodolith beds around New Zealand also came to light however within the constrains of this project it was not possible to include this data. It should be noted that this habitat was already included in the biogenic reef distribution dataset. Very useful comments were received about the usefulness of measures such as ATD to value the distribution of non-indigenous taxa. As a result, only the number of genera, the total number of records of non-indigenous species and the number of records as a proportion of the total number of records of non-indigenous marine species in New Zealand were mapped.

Detailed responses were received from two experts concerned that the measures of species richness (deviation from expected) that had been mapped within the taxon-specific diversity subcomponent did not agree with the experts' intuitive conceptions of the marine communities around the coast of New Zealand. As a result a new measure, number of species, was added to the list of measures valued within that subcomponent (see section 4.2.1 below).

4.2 DATA LIMITATIONS AND CONFIDENCE IN ASSIGNED VALUES

Although confident that the best use has been made of the data available for the purpose of mapping environmental values around the New Zealand coastline, there are some issues with the type of data used that must be noted.

The spatial distribution of many datasets in this project was highly heterogeneous with high numbers of records in a few coastal cells and with very few or no records in most coastal cells. As a result, it was often necessary to join neighbouring coastal cells together into coastal areas in order to assign a value to all cells. This was carried out manually to minimise joining cells with very different physical environments (i.e. exposed and sheltered). In all cases, the total number of records per coastal cell for each taxon has been included in the database, together with a data layer detailing which coastal cells have been joined into coastal areas. These data layers should be used to determine the confidence in the value assigned to each coastal cell or area. For example, the confidence in the value assigned to a coastal cell with 200 records is far greater than for that of a coastal cell which had one original record and has been joined to six neighbouring coastal cells in order to generate a value.

Many of the coastal habitats that have been mapped within the Habitat Area subcomponent require further comment. With the exception of the intertidal rocky reef layer, where data on the distribution of the habitat was generated from aerial photography, all habitat layers are a best estimate of distributions. Data sources range from the digitisation of hydrographic faring sheets (subtidal rocky reef layer) through to personal communications on the existence of small patches of habitat. Distributions of many biogenic habitats (seagrass, mangroves, biogenic reefs) are also known to have temporal variation. As such, the fine-scale accuracy of habitats is only as good as the available data and cannot be relied upon.

4.2.1 Biodiversity measures

Many of the taxon-specific datasets available for use in this study contained historical/ museum records i.e. presence at a location. These records come from qualitative sampling and have not been collected using any standardised protocols. Records have instead been collated over time through a combination of detailed surveys and opportunistic collection of species of interest by scientists and members of the public. The inconsistencies inherent within such datasets - in sampling methods, intensities and densities - created difficulties in the analysis of these data with respect to biodiversity measures. One of the greatest challenges was estimating species richness for each coastal area from data that were both patchily distributed and inconsistently sampled. Nevertheless it is safe to assume that for those cells with records, these synoptic, temporally integrated data will be giving a minimum value. It is acknowledged that we cannot provide certainty about the differences between diversity metrics between cells with high and low sampling densities.

The use of such data meant it was necessary to use individual- rather than sample-based rarefaction curves which, it has been suggested, "inevitably overestimates the number of species that would have been found with less effort" (Gotelli and Colwell, 2001). For all taxon-specific datasets, many coastal areas had a low number of records and, as such, were placed on the left-hand side of the rarefaction curve, which equates to "low sampling/low effort". This could explain the large number of coastal areas with negative scores for estimated species richness. It is, therefore, important that the end-user is aware that the species richness of coastal areas with a low total number of records may have been underestimated.

Although differences in the size of the coastal areas were taken into account during the calculation of derived values, through normalisation of data, the trends in species richness were sometimes counter-intuitive to experts' intuitive impressions. Surprisingly, it was the raw number of species per coastal cell, regardless of sampling intensity, which reflected the experts' knowledge (W. Nelson and M. Kelly, NIWA, *pers. coms.*). This measure could be expected to be heavily influenced by both sampling intensity and patterns of data collection.

There are several explanations for this. It is possible that the experts' impressions of areas of high species richness have been biased by their own sampling patterns. It is also possible that because of the type of data used, the results of any analysis will reflect the number of records/collections rather than reflect the actual communities present. This is in addition to the issues discussed above whereby coastal areas/cells with a low number of sample records may have underestimated values of species richness. As a result, it is important, especially when using taxon-specific diversity indices, that all relevant data layers are consulted, including those data layers such as the number of records per coastal cell and the layer detailing the relationship between coastal cells and coastal areas, to give an indication of the confidence in any assigned value.

The inclusion of records gathered as "specimens of interest" in many of the datasets may have resulted in an overestimation of the occurrence of rare species and underestimation of the occurrence of the more common or better known species. The impact of this on measures of rarity has been minimised in this study through the use of presence/absence data rather than numerical abundance data for many analyses. However, it is important to note that through the use of these data types, rare species may have been overestimated relative to the more common species.

4.2.2 Intellectual property

All derived values and raw data have been provided to Biosecurity New Zealand with the exception of the raw data for the algal, mollusc and wading bird datasets. The intellectual property rights for these remain with Te Papa (algal and mollusc data), and the Ornithological Society of New Zealand (the wading bird data).

4.3 RECOMMENDATIONS

The values that have been mapped are, in some instances, a best estimate using the data available. It is strongly recommended that these data are ground-truthed in the near future through the use of a standardised sampling regime at key locations around the New Zealand coastline. These key locations should include areas with a range of diversity values (high, low and medium values) as well as areas lacking in data.

This database has been collated to assist in biosecurity management. It will also be useful to identify areas around the New Zealand coastline that have been poorly sampled to-date so that they may be targeted in future collections/surveys. However, the raw database would be enhanced through further analysis to identify trends and hot- and cold- spots of biodiversity around New Zealand.

5 Acknowledgements

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6 References

Anon, 2004. How much is an ecosystem worth? Assessing theh economic value of conservation. IUCN / The Nature Conservancy / The World Bank, Washington DC, p. 33pp.

Anon, 2008. Retrieved from http://www.hc-sc.gc.ca/ahc-asc/pubs/public-consult/2000decision/4-tech-delphi_e.html

Arnold, A., 2004. Shining a spotlight on the biodiversity of New Zealand's marine ecoregion, Experts workshop on marine biodiversity, 27-28 May 2003. WWF New Zealand, Wellington, New Zealand.

Beaumont, N.J., Austen, M.C., Atkins, J., Burdon, D., Degraer, S., Dentinho, T.P., Derous, S., Holm, P., Horton, T., van Ierland, E., Marboe, A.H., Starkey, D.J., Townsend, M., Zarzycki, T., 2007. Identificaion, definition and quantification of goods and services provided by marine biodiversity: Implications for the ecosystem approach. Marine Pollution Bulletin In press.

Clarke, K.R., Gorley, R.N., 2006. PRIMER v6: User manual/tutorial. PRIMER-E Ltd, p. 190.

Clarke, K.R., Warwick, R.M., 1998. A taxonomic distinctness index and its statistical properties. Journal of Applied Ecology 35, 523-531.

Clarke, K.R., Warwick, R.M., 2001a. Change in marine communities: an approach to statistical analysis and interpretation. 2nd ed., Plymouth: PRIMER-E.

Clarke, K.R., Warwick, R.M., 2001b. A further biodiversity index applicable to species lists: variation in taxonomic distinctness. Marine Ecology Progress Series 216, 265-278.

Colwell, R.K., 2006. EstimateS: Statistical estimation of species richness and shared species from samples, Version 8 ed.

Colwell, R.K., Mao, C.X., Chang, J., 2004. Interpolating, extrapolating, and comparing incidence-based species accumulation curves. Ecology 85, 2717-2727.

De'ath, G., 2007. Boosted trees for ecological modeling and prediction. Ecology 88, 243-251.

Derous, S., Agardy, T., Hillewaert, H., Hostens, K., Jamieson, G., Lieberknecht, L., Mees, J., Moulaert, I., Olenin, S., Paelinckx, D., Rabaut, M., Rachor, E., Roff, J., Steinen, E.W.M., Van Der Wal, J.T., Van Lanker, V., Verfaillie, E., Vincx, M., Weslawski, J.M., Degraer, S., 2007. A concept for biological valuation in the marine environment. Oceanologia 49, 99-128.

Emerton, L., Bos, E., 2004. Value. Counting ecosystems as an economic part of water infrastructre. IUCN, Gland, Switzerland and Cambridge, UK, p. 88pp.

Gordon, D. (Ed.), in press. The New Zealand Inventory of Biodiversity: A Species 2000 Symposium Review. Canterbury University Press, Christchurch.

Gotelli, N.J., Colwell, R.K., 2001. Quantifying biodiversity: procedures and pitfalls in the measurement and comparison of species richness. Ecology Letters 4, 379-391.

Hanley, N., Wright, R.E., Adamowicz, V., 1998. Using choice experiments to value the environment. Environmental and Resource Economics 11, 413-428.

Inglis, G., 2001. Criteria for selecting New Zealand ports and other points of entry that have a high risk of invasion by new exotic marine organisms., Final research report for Ministry of Fisheries research project ZBS2000/01A, objectives 1&2. . NIWA, Wellington, p. 27.

Inglis, G., Gust, N., Fitridge, I., Floerl, O., Woods, C., Hayden, B., Fenwick, G., 2006. Dunedin Harbour (Port Otago and Port Chalmers). Baseline survey for non-indigenous marine species (Research project ZBS2000/4), Biosecurity New Zealand Technical Paper No: 2005/10. NIWA, Wellington, p. 99.

Leathwick, J., Julian, K., Elith, J., Rowe, D., 2008. Predicting the distributions of freshwater fish species for all New Zealand's rivers and streams, NIWA Client Report. NIWA, p. 22.

Mack, R., Simberloff, D., Lonsdale, W., Evans, H., Clout, M., Bazzaz, F., 2000. Biotic invasions: causes, epidemiology, global consequences and control. Ecological Applications 10, 689-710.

MacKinnon, K., Bonnardeaux, D., Luz, K., Sobrevila, C., 2004. Ensuring the future. The World Bank and biodiversity. The World Bank, Washington DC, p. 65pp.

McCracken, J.R., Abaza, H., 2001. Environmental valuation: A worldwide compendium of case studies. Earthscan, London.

Murphy, R.J., Pinkerton, M.H., Bradford-Grieve, J.M., Boyd, P.W., 2001. Phytoplankton distributions around New Zealand derived from SeaWIFS remotely-sensed ocean colour data. New Zealand Journal of Marine and Freshwater Research 35, 343-362.

Navrud, S., Ready, R.C. (Eds.), 2002. Valuing cultural heritage: applying environmental valuation techniques to historic buildings, monuments and artifacts. Edward Elgar, Cheltenham.

Nunes, P.A.L.D., Van den Bergh, J.C.J.M., 2001. Economic valuation of biodiversity: sense or nonsense? Ecological Economics 39, 203-222.

Pagiola, S., von Ritter, K., Bishop, J., 2004. Assessing the economic value of ecosystem conservation. The World Bank Environment Department papers. Paper No. 101, p. 57 pp.

Ruiz, G., Fofonoff, P., Hines, A., Grosholz, E., 1999. Non-indigenous species as stressors in estuarine and marine communities: assessing invasion impacts and interactions. Limnology and Oceanography 44, 950-972.

Smith, A., 2008. Predicting the distribution and relative abundance on fishes on shallow subtidal reefs around New Zealand, NIWA Client Report WLG2008-9. NIWA, Wellington.

Turner, S.J., Hewitt, J.E., Wilkinson, M.R., Morrisey, D.J., Thrush, S.F., Cummings, V.J., Funnell, G., 1999. Seagrass patches and landscapes: The influence of wind-wave dynamics and hierarchical arrangements of spatial structure on macrofaunal seagrass communities. Estuaries 22, 1016-1032.

Ugland, K.I., Gray, J.S., Ellingsen, K.E., 2003. The species-accumulation curve and estimation of species richness. Journal of Animal Ecology 72, 888-897.

Wilcove, D., Rothstein, D., Dubow, J., Phillips, A., Losos, E., 1998. Quantifying threats to imperiled species in the United States. Bioscience 48, 607-615.

7 Appendices

7.1 APPENDIX I: PRO-FORMAS OF FUNDED DATASETS

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Sponges data set (1)
	RAW DATA HOLDER:	Ashley Rowden, NIWA, Wellington
	DESCRIPTION:	This is a rich dataset of over 800 species from 3000 stations from New Zealand's EEZ.
	SELECTION RATIONALE:	This dataset is currently being groomed for another NIWA project. A small cost will be required to extract the data once it becomes available early in 2007. The high rating reflects the limited distribution of many species, the very high level of endemism (97% are not found outside NZ waters) and their vulnerability to overgrowth from invasive benthic species.

BOX B	EXTRACTION	
	Undertaken by:	Ashley Rowden, NIWA, Wellington
	Date sourced/details of contact:	Data requested 17 Jul 07 Deadline – Oct '07 Received Feb 08 but some grooming still required
	Values/Data extracted:	Genus, species, latitudes, longitudes, depth (where available), family, common name
	Rationale for extraction:	SUBCOMPONENT: Taxon specific diversity
	QA/QC:	NIWA's standard protocols were followed together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING	
	Undertaken by:	Ashley Rowden, Jenny Beaumont & Peter Notman NIWA, Wellington
	Date:	April 08
	Grooming actions:	Taxonomy of sponge data checked Locations of records without latitude and longitude information determined
	QA/QC:	NIWA's standard protocols were followed together with feedback on preliminary data maps using the Delphic process

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	Coastal cells/areas

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	**Bryozoan data set (extract from OBIS) (2)**
	RAW DATA HOLDER:	Steve Massey, NIWA Christchurch
	DESCRIPTION:	Data on the distribution of bryozoans around New Zealand are comprehensive and named species are included in the OBIS regional node. They have been previously checked and groomed. Another ~300 as yet unnamed species are available from a spreadsheet maintained by Dennis Gordon. A small cost is required to extract the data in the required format, especially from the spreadsheet.
	SELECTION RATIONALE:	The high rating reflects the limited distribution of many species, the high level of endemism (62%) and their vulnerability to overgrowth from invasive benthic species.

BOX B	EXTRACTION	
	Undertaken by:	Steve Massey, NIWA Christchurch
	Date sourced/details of contact:	Data requested 10/7/07. Data received 13/7/07 (csv files) Deadline Jul '07
	Values/Data extracted:	Genus, species, latitudes, longitudes, depth (where available), family, common name
	Rationale for extraction:	SUBCOMPONENT: Taxon specific diversity
	QA/QC:	NIWA's standard protocols were followed together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING	
	Undertaken by:	Dennis Gordon, NIWA Wellington
	Date:	Groomed prior to inclusion in OBIS
	Grooming actions:	Groomed prior to inclusion in OBIS Additional data from Wellington Harbour, the Auckland and Campbell Islands and Foveaux Strait have been added to the dataset (March 08)
	QA/QC:	NIWA's standard protocols were followed together with feedback on preliminary data maps using the Delphic process

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	Coastal cells/areas

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Polychaete data set (extract from OBIS) (3)
	RAW DATA HOLDER:	Steve Massey, NIWA Christchurch
	DESCRIPTION:	Data on the distribution of polychaetes or bristle worms around New Zealand are comprehensive and included in the OBIS regional node. They have been previously checked and groomed.
	SELECTION RATIONALE:	The high rating reflects their relatively large biomass (40 – 50% of benthos) and the vital role they perform in all marine communities, affecting everything from sediment size to sediment macrostructure.

BOX B	EXTRACTION	
	Undertaken by:	Steve Massey, NIWA Christchurch
	Date sourced/details of contact:	Data requested 10/7/07. Data received 13/7/07 (csv files) Deadline Jul ‘07
	Values/Data extracted:	Genus, species, latitudes, longitudes, depth (where available), family, common name Polychaete records from ASB and Specify were combined and duplicate records removed. Polychaete data were analysed to genus level rather than to species level as a result of great numbers of missing species identifiers.
	Rationale for extraction:	SUBCOMPONENT: Taxon specific diversity
	QA/QC:	NIWA’s standard protocols were followed together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING	
	Undertaken by:	Geoff Read, NIWA Wellington
	Date:	Groomed prior to inclusion in OBIS
	Grooming actions:	Groomed prior to inclusion in OBIS
	QA/QC:	NIWA’s standard protocols were followed together with feedback on preliminary data maps using the Delphic process

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	Coastal cells/areas

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A		
	DATA SOURCE:	Molluscs dataset (4)
	RAW DATA HOLDER:	Te Papa, Patrick Brownsie Ph. (DD) 3817135 Email : PatB@tepapa.govt.nz
	DESCRIPTION:	A large, high quality database of mollusc records from all around New Zealand. Records are presence at a location.
	SELECTION RATIONALE:	Location data for all mollusc species within the 250m depth contour

BOX B		
	EXTRACTION	
	Undertaken by:	Te Papa, Patrick Brownsie
	Date sourced/details of contact:	Patrick informed of funding decision 6/7/07 NIWA/Te Papa contracts prepared 27/8/07 Deadline Oct '07
	Values/Data extracted:	Class, Family, Genus, Species, latitudes, longitudes
	Rationale for extraction:	SUBCOMPONENT: Taxon specific diversity
	QA/QC:	Quality assurance undertaken by the data provider

BOX C		
	GROOMING	
	Undertaken by:	Te Papa, Bruce Marshall
	Date:	31.10.07
	Grooming actions:	All foreign mollusc records and all NZ terrestrial mollusc records eliminated. All records beyond 250m depth eliminated. Records of uncertain taxonomic identity eliminated. Distributional dot maps generated from database and obviously incorrect dots checked and verified. Latitude/longitude added for as many records as possible where these were absent in the database. Feb 08. Records without unique species identifiers were removed from the dataset.
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX D		
	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E		
	GROOMED DATA RESOLUTION	Coastal cells/areas

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Invertebrate data (Southwest Pacific Regional OBIS Node) (datasets 5 & 6)
	RAW DATA HOLDER:	Steve Massey, NIWA Christchurch
	DESCRIPTION:	This regional node (http://nzobis.niwa.co.nz) is hosted through New Zealand and includes some of NIWA's invertebrate and coralline algae biodiversity data as well as MFish/NIWA presence/absence data on marine bony fishes and elasmobranches (sharks and rays and their kin), but does not yet include a number of other important groups including seaweeds and kelp, crustaceans, molluscs, ascidians or sponges. The number of species presently represented on this node is 11,628. The data are numerical presence at a small scale, are of high quality and give national coverage. The invertebrate data are less well represented in depths <50m depth.
	SELECTION RATIONALE:	The dataset contains a large number of high quality records (currently 11,628) of numerical presence at a small scale and with national coverage.

BOX B	EXTRACTION	
	Undertaken by:	Steve Massey, NIWA Christchurch
	Date sourced/details of contact:	Extraction commissioned 10/7/07. Data received 13/7/07 Deadline Jul '07
	Values/Data extracted:	Genus, species, latitudes, longitudes, depth (where available), family, common name csv files
	Rationale for extraction:	SUBCOMPONENT: Overall marine biodiversity / taxon specific diversity. Difficulties associated with measuring overall biodiversity resulted in the Echinoderm and Arthropod data being analysed separately for Subcomponent: Taxon Specific Diversity.
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING	
	Undertaken by:	The data stored in OBIS was groomed by taxonomists prior to inclusion in the data base. The extracted echinoderm and arthropod data were groomed by J. Beaumont
	Date:	April 08
	Grooming actions:	Records without unique species identifiers were removed from the dataset. Data were checked for taxonomic consistency between records
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	N/A
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	Coastal cells/areas

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Algal Database (KEmu) (7)
	RAW DATA HOLDER:	Te Papa, Patrick Brownsie Ph. (DD) 3817135 Email : PatB@tepapa.govt.nz
	DESCRIPTION:	The database contains approx. 20,000 high quality algal records (specimen at a locality) around New Zealand.
	SELECTION RATIONALE:	The algal database has national coverage though with some gaps where collections have not yet been made.

BOX B	EXTRACTION	
	Undertaken by:	Te Papa, Patrick Brownsie
	Date sourced/details of contact:	Patrick informed of funding decision 6/7/07 NIWA/Te Papa contracts prepared 27/8/07 Deadline Oct '07
	Values/Data extracted:	Order, Family, Genus, Species, latitudes, longitudes
	Rationale for extraction:	SUBCOMPONENT: Overall marine biodiversity
	QA/QC:	Quality assurance undertaken by the data provider

BOX C	GROOMING	
	Undertaken by:	Te Papa, Jenn Dalen, Sunita Mahat
	Date:	31.10.07
	Grooming actions:	All foreign marine algal records and all NZ freshwater algae eliminated. Records of uncertain taxonomic identity eliminated Distributional dot maps generated from database and obviously incorrect dots checked and verified. Latitude/longitude added for as many records as possible where these were absent in the database.
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	Coastal cells/areas

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Diadromous fish (8)
	RAW DATA HOLDER:	John Leathwick, NIWA, Hamilton
	DESCRIPTION:	The Diadromous fish dataset contains predicted probabilities of catch for each of 15 diadromous fish species for each river within the North and South Islands of New Zealand (Leathwick, et al., 2008). This dataset was generated using statistical models combined with environmental data for all New Zealand rivers and streams to predict the likely probability of capture for each individual fish species.
	SELECTION RATIONALE:	Several species of fish spend part of their life cycle in freshwater and the other part in the marine environment. This makes them vulnerable to both freshwater and marine incursion events and as 71% are endemic are thus rated high for inclusion in the project. The existing NIWA database of numerical presence in estuaries is well groomed and available for use.

BOX B	EXTRACTION	
	Undertaken by:	John Leathwick, NIWA, Hamilton
	Date sourced/details of contact:	Deadline – Sept '07 Reminder to JL 11/9 Data received 18/9/07
	Values/Data extracted:	
	Rationale for extraction:	SUBCOMPONENT: Overall marine biodiversity
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Grooming actions:	No grooming required.
	QA/QC:	

BOX D	MODELLING/INTERPOLATION	
	Undertaken by:	John Leathwick, NIWA, Hamilton
	Date:	August/September 2007
	Modelling/interpolation actions:	Predicted probabilities of capture
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX E	GROOMED DATA RESOLUTION	Coastal cells

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	OSNZ Wading bird data (dataset 9)
	RAW DATA HOLDER:	Ornithological Society of NZ, Chris Robertson Ph 027 6027947 100244.1012@compuserve.com
	DESCRIPTION:	The wading bird data were collected during periodic surveys of the distribution of all birds in New Zealand throughout all habitats (undertaken between 1999 and 2004 by the New Zealand Ornithological Society) and data were supplied as the occurrence of species throughout a regular 10 x 10 km grid of sample locations throughout New Zealand and the Chatham Islands.
	SELECTION RATIONALE:	The Ornithological Society of New Zealand (OSNZ) carries out a regular survey of wading birds in 150 estuaries nationwide. The high rating reflects that all these species feed in shallow, often sheltered waters and they all nest onshore and are thus vulnerable to both terrestrial and marine incursion events.

BOX B	EXTRACTION	
	Undertaken by:	Ornithological Society of NZ, Chris Robertson
	Date sourced/details of contact:	Chris informed of funding decision 6/7/07. No confirmation received yet. NIWA/OSNZ contracts being prepared Deadline Oct '07 Data on disc received 29/10/07
	Values/Data extracted:	Genus, species, northings, eastings Omitted seasonality, habitat type
	Rationale for extraction:	SUBCOMPONENT: Number of pupping, calving, spawning, roosting or feeding grounds. Subcomponent changed to Taxon Specific Diversity
	QA/QC:	It should be noted that the 10 x 10 km grid system used by NZOS does not align perfectly with the system of coastal cells used in this project. Wading bird data were supplied as point locations at the centre of each 10 x 10 km survey grid. As such, all point locations were assigned to the coastal cells that they fell inside. No attempt has been made to adjust the data where the extent of the10 x 10 km grid cells surrounding each point location overlaps the boundary between coastal cells.

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Grooming actions:	
	QA/QC:	

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	Coastal cells

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Rocky reef fish data set (10)
	RAW DATA HOLDER:	Ian West/Clinton Duffy, Department of Conservation
	DESCRIPTION:	This is a dataset collected by Clinton Duffy of DoC over many years. It covers 400 sites nationally where transect counts of fish have been assigned into logarithmic abundance classes for 20-40 species of fish per site. Although the number of sites is high there are gaps in national coverage. The MEC will be used to model the distributions of reef fish species based on physical correlates to provide interpolated data nationally. These will be of lower reliability than the direct observations and will be flagged as such in the project database.
	SELECTION RATIONALE:	The high rating assigned to this data set reflects the probability that reef fishes are among the most likely of all New Zealand marine fishes to be affected by incursion events.

BOX B	EXTRACTION	
	Undertaken by:	DoC
	Date sourced/details of contact:	Alison MacDiarmid asked to co-ordinate July 10th. Need timeline from Clinton. Deadline Jul '07 – more likely to be Oct 07
	Values/Data extracted:	Abundance and species richness
	Rationale for extraction:	SUBCOMPONENT: Overall marine biodiversity
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Grooming actions:	
	QA/QC:	

BOX D	MODELLING/INTERPOLATION	
	Undertaken by:	Adam Smith of NIWA, contracted by DOC
	Date:	December 2007
	Modelling/interpolation actions:	This dataset was interpolated by statistical modelling. A model was created for each of the 72 species of reef fish, in turn. A method called Boosted Regression Trees was used to fit a set of models that predicted the abundance of fishes according to a suite of environmental variables. Environmental data were extracted for a 1km grid of points spread over all known shallow subtidal reefs around New Zealand (from Steward Island north). These data were then fed into the models, resulting in predicted spatial distributions and abundance for each species.
	QA/QC:	Resulting layers were inspected by experts in reef fish distributions. Predictions for some species were restricted to specific known latitudinal limits appropriate to the species.
	GROOMED DATA FILE NAME/FORMAT:	NZ_VMEn_README_cur.doc NZ_VMEn_RRFSRichStat_cur.dbf NZ_VMEn_RRFSR.aux NZ_VMEn_RRFSR.rrd NZ_VMEn_RRFSRich_cur.dbf NZ_VMEn_RRFSRich_cur.prj NZ_VMEn_RRFSRich_cur.sbn NZ_VMEn_RRFSRich_cur.sbx NZ_VMEn_RRFSRich_cur.shp

		NZ_VMEn_RRFSRich_cur.shp.xml NZ_VMEn_RRFSRich_cur.shx

BOX E	GROOMED DATA RESOLUTION	1 x 1 km

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Rocky reef invertebrate communities data set (11)
	RAW DATA HOLDER:	Dr Nick T. Shears Present address: shears@msi.ucsb.edu, Marine Science Institute, University of California, Santa Barbara, California 93106
	DESCRIPTION:	These data were collected by Dr Nick Shears as part of DoC contracts and supplemented by his own research. The data are observer counts per unit area, are stored electronically and of high quality but the data require grooming. Similar to the rock wall community database these data are from many localities around New Zealand but some regions are not well represented. Franz Smith under contract to DoC has used the MEC to model the distributions of the rock wall species based on physical correlates to provide interpolated data nationally. These would be of lower reliability than the direct observations and would be flagged as such in the project database. Franz Smith has already demonstrated to BNZ the usefulness of this approach Broad-scale survey of 247 shallow subtidal reef sites throughout mainland NZ, where 2-15 replicate sites were sampled within 42 locations. At each site, biological assemblages were sampled in five haphazardly placed 1m^2 quadrats at four fixed depth strata (0-2, 4-6, 7-9 and 10-12 m below mean low water). For all macroalgal species (> 5 cm) the numerical abundance and size (large brown algal species), or percent cover (foliose and turfing species), was quantified in each quadrat. In addition, the abundance of all conspicuous mobile macroinvertebrates (> 1 cm) was counted in each quadrat. Reference: Shears, N.T., and R.C. Babcock. In press. Quantitative description of mainland New Zealand's shallow subtidal reef communities. Science for Conservation.
	SELECTION RATIONALE:	Shallow rocky reef invertebrate communities are one of the habitats most susceptible to species incursions originating from biofouling on ships hulls and from ballast water and so are of high importance in this study. Although the original data are patchy, the modelled data, estimating species richness and abundance, will have national coverage.

BOX B	EXTRACTION	
	Undertaken by:	Dr N. T. Shears
	Date sourced/details of contact:	Alison MacDiarmid asked to co-ordinate July 10th. Need timeline from Franz. Meeting with Franz 1/8/07. Deadline Aug - Oct '07
	Values/Data extracted:	Depth-averaged biomass/abundance for 106 macroalgal taxa, 47 mobile invertebrate taxa, 29 structural groups (biomass), 23 macroalgal functional groups (biomass), values from principle coordinate axes
	Rationale for extraction:	SUBCOMPONENT: Overall marine biodiversity Extractions, data analysis, and modelling were conducted to evaluate the relevance of the Marine Environment Classification to explain observed biological patterns for coastal rocky reefs (Smith et al. in prep.)
	QA/QC:	Files were complied and explored jointly with Dr Shears and Dr Smith to identify outliers or any consistencies in data

BOX C	GROOMING	
	Undertaken by:	Franz Smith, Private consultant
	Date:	04/08/2007 10.50PM
	Grooming actions:	Omitted 10 sites from Long Bay, selected key species/community metrics for predictive modelling. 3 km buffers around each sampling site used to extract physical data from the Marine Environmental Classification (Snelder et al. 2004). Variable description PC1 (106 Algal Species) First axis of the Principle Coordinate Analysis (PCoA) conducted by Shears & Babcock in press, based on presence-absence data from 106 macroalgal species PC1 (29 functional groups) First axis of the PCoA conducted by Shears & Babcock in press., based on fourth-root transformed ash-free dry weight of 29 functional groups of macroalgae and invertebrates PC1 (41 mobile invertebrates) First axis of the PCoA conducted by Shears & Babcock in press., based on presence-absence of 41 mobile macroinvertebrate species, including sea urchins, sea stars, gastropods, and sea cucumbers Species richness (Observed) Number of macroalgal species observed at each site (Should also screen data of Chao 2 (Estimated species richness) from Nick) Red Foliose Depth averaged biomass of foliose Rhodophyta, including species of Osmundaria colensoi, Euptilota fomosissima etc. Small Browns Depth averaged biomass of smaller Phaeophyta, including species of Carpomitra costata, Zonaria turneriana etc. Massive sponges Depth averaged biomass of massive sponges, such as Ancorina alata Bryozoans Depth averaged biomass of encrusting bryozoans, including Membranipora Ecklonia radiata Depth averaged biomass of Ecklonia radiata Carpophyllum flexuosum Depth averaged biomass of Carpophyllum flexuosum Lessonia variegata Depth averaged biomass of Lessonia variegata Pterocladia lucida Depth averaged biomass of Pterocladia lucida CCA_All Depth averaged biomass of Crustose Coralline Algae Xiphophora chondryophylla Depth averaged biomass of Xiphophora chondrophylla Codium convuluta Depth averaged biomass of Codium convoluta Anotrichium crinitum Depth averaged biomass of Anotrichium crinitum Evechinus chloroticus Depth averaged abundance of kina or common sea urchin Stichopus mollis Depth averaged abundance of the sea cucumber, Stichopus mollis

		Cookia sulcata Depth averaged abundance of Cookia sulcata Patiriella regularis Depth averaged abundance of Patiriella regularis
	QA/QC:	Exploratory data analysis used to identify potential outliers/errors in data matrices Errors were found in the dataset and Franz Smith is investigating. (Feb 08) Problems with model have been resolved and corrected models were with NIWA by the end April 08
	GROOMED DATA FILE NAME/FORMAT:	NZ237_topmodels_01.jmp

BOX D	MODELLING/INTERPOLATION	
	Undertaken by:	Franz Smith, Private consultant
	Date:	11 April 2008
	Modelling/interpolation actions:	Generalised Additive Models, GRASP (Generalised Regression and Spatial prediction (Lehmann et al 2002), gaussian link function, DF = 3. Spatial predictions made at 1km resolution, trimmed to the 50m contour and further constrained by the Department of Conservation rocky reef layer provided by NIWA. Intersection of predictive layer with the DoC rocky reef layer were exported from GRASS as ESRI Ascii Grid format. Projection information are not included in output, although original NIWA has been maintained (i.e. Projection: Mercator, Spheroid: Clarke 1866).
	QA/QC:	Overlay of DoC rocky reef layer and underlying bathymetry were visually inspected. N.B. No attempt was made to alter model predictions or constraints according to the DoC rocky reef layer (e.g. Ecklonia radiata predictions for Chatham Islands) as no systematic protocol was provided to be able to do this consistently across species groups and the entire spatial extent of the model predictions.
	GROOMED DATA FILE NAME/FORMAT:	Raw output files are provided as ESRI Ascii grids 1_pc1_106spp_x.grd 2_pc1_29fg_x.grd 3_pc1_41spp_x.grd 4_macroalgalrichness_xc.grd 5_redfoliosealgae_xc.grd 6_smlbrownalgae_xc.grd 7_msvsponges_xc.grd 8_bryozoans_xc. grd 9_ecklonia_xc.grd 10_cflexuosum_xc.grd 11_lessonia_xc.grd 12_pterocladia_xc.grd 13_cca_sc.grd 14_xiphophora_xc.grd 15_codium_xc.grd 16_anotrichium_xc.grd 17_evechinus_xc.grd 18_stichopus_xc.grd 19_cookia_xc.grd 20_patiriella_xc.grd

BOX E	GROOMED DATA RESOLUTION	Predictive models cover shallow water areas (i.e. < 50 m depth) constrained by the Department of Conservation rocky reef layer. Maximum resolution of grids 1 km.

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Vertical rock wall communities data set (12)
	RAW DATA HOLDER:	Dr. Franz Smith, Private Consultant Present address: franzinho@actrix.co.nz, 108 Glenmore Street, Thorndon, Wellington
	DESCRIPTION:	The vertical rock wall dataset has been collected by Dr Franz Smith as part of his PhD in Fiordland and subsequent research around New Zealand over the last 15 years. The source data are photo-quadrats from which he has extracted numerical data from about 80%. The existing data-set though from many localities around NZ does have large gaps where no collection has taken place. It is desirable to use the Marine Environment Classification (MEC) to model the distributions of the rock wall species based on physical correlates to provide interpolated data nationally. These would be of lower reliability than the direct observations and would be flagged as such in the project database. Ledge surveys were conducted at 202 sites across 14 geographic regions, where 15-17 random 0.25m2 photoquadrats were taken along 25 m transects at ~15 m depth (± 3 m) following methodology of Witman (1985). Analysis of photographic images was done by counting species per quadrat of sessile suspension-feeding invertebrates to the lowest taxonomic level possible – keeping identifications consistent within a site. Maximum detectable resolution of species from images is > 3 mm. Species incidence data were used to calculate 4 diversity metrics and the incidence (i.e. frequency of occurrence) of major taxonomic groups was also calculated. References: Smith and Witman 1999; Smith 2001; Smith, unpublished data
	SELECTION RATIONALE:	Shallow vertical rocky wall communities are one of the habitats most susceptible to species incursions originating from biofouling on ships hulls and from ballast water and so are of high importance in this study. Although the original data are patchy, the modelled data, estimating species richness and abundance, will have national coverage.

BOX B	EXTRACTION	
	Undertaken by:	Franz Smith
	Date sourced/version of raw data:	File Name: ledges_14Dec07.xls Date/Time: 14 December 2007, 12:09 PM
	Values/Data extracted:	Site location, geographic position, date, number of replicate quadrats, species density, variation of species density, turnover diversity, observed species richness, estimated species richness, variation of species richness estimator, 3 measures of rarity, incidence of 12 major taxonomic groups.
	Rationale for extraction:	SUBCOMPONENT: Overall marine biodiversity Extractions, data analysis, and modelling were conducted to use multi-regression modelling techniques to establish relationships with physical environmental variables as a basis for predictive modelling for Biosecurity NZ environmental value mapping project.
	QA/QC:	Files were compiled and explored by Smith to identify outliers or any consistencies in data.

BOX C	GROOMING	
	Undertaken by:	Dr. Franz Smith

	Date:	12 December 2007 21:32 PM
	Grooming actions:	3 km buffers around each sampling site location were used to extract physical data from the Marine Environment Classification (Snelder, et al. 2004). Approximately 20 sites were located off the grids of physical data at the 1 km scale and not included in the modelling. Variable Description 1_density Average species density per 0.25 m2 2_variation Average variation of species density per 0.25 m2 – expressed as the standard deviation of density 3_turnover Change in community composition from one quadrat to the next, calculated using Routledge's beta – I (Magurran 1988: 163) 4_chao2 Estimated species richness according to the Chao 2 index (Colwell and Coddington 1994). 5_rarity The total number of species occurring in 1 or 2 quadrats along a 25 m transect 6_porifera_c Proportion of sponges from the total number of species recorded at a site 7_ascidiacea_c Proportion of seasquirts from the total number of species recorded at a site 8_bryozoa_c Proportion of lace corals from the total number of species recorded at a site 9_actinaria_c Proportion of anemones from the total number of species recorded at a site 10_prin1_c First axis of principal coordinate analysis based on the proportion of major taxonomic groups (i.e. 12) – explaining 43.63% of the total amount of observed variation 11_prin1_i First axis of principal coordinate analysis based on the average incidence (i.e. frequency of occurrence) of major taxonomic groups (i.e. 12) – explaining 26.80% of total amount of observed variation.
	QA/QC:	Exploratory Data Analysis used to identify potential outliers/errors in data matrices
	GROOMED DATA FILE NAME/FORMAT:	Ledges_14Dec07.jmp – JMP5.0.1.2 statistical discovery software (SAS Institute, Inc.)

	MODELLING/INTERPOLATION	
	Undertaken by:	Dr. Franz Smith
	Date:	11 April 2008
BOX D	Modelling/interpolation actions:	Generalised Additive Models, GRASP (Generalized Regression and Spatial Prediction (Lehmann, et al. 2002), gaussian link function, DF = 3 for diversity indices and binomial link function, DF = 3 for incidence measures of major taxonomic groups. Spatial predictions made at 1 km resolution, trimmed to the 50 m depth contour and further constrained by the Department of Conservation rocky reef layer provided by NIWA. As the DoC rocky reef layer did not extent to the Subantarctic Islands, a 1 km buffer from the NZTM coastline (included within the NIWA MEC) was used to extract data from these areas. Intersection of predictive layer with the DoC rocky reef layer and the 1km buffer from the Subantarctic Islands were exported from GRASS as ESRI Ascii Grid format. Projection information were not included in output, although original NIWA has been maintained (i.e. Projection: Mercator, Spheroid Clarke1866).

	QA/QC:	Overlay of DoC rocky reef rock layer and underlying bathymetry were visually inspected. N.B no attempt was made to alter model predictions or constraints according to DoC rocky reef layer of coastal buffer for the Subantarctic Islands as no systematic protocol was provided to be able to do this consistently across species groups and the entire spatial extent of the model predictions.
	GROOMED DATA FILE NAME/FORMAT:	(Consider requirement for unique identifier) Raw output files are provided as ESRI ASCII grids. 1_density_xc.grd 2_variation_xc.grd 3_turnover_xc.grd 4_chao2_xc.grd 5_rarity_xc.grd 6_porifera_xc.grd 7_acidiacea_xc.grd 8_bryozoa_xc.grd 9_actinaria_xc.grd 10_prin1_c_x.grd 11_prin1_i_x.grd

BOX E	GROOMED DATA RESOLUTION	Predictive models cover shallow water areas (i.e. < 50 m depth) constrained by the Department of Conservation rocky reef layer. Maximum resolution of grids 1 km.

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A		
	DATA SOURCE:	**BIODS Port Surveys and Surveillance Database (datasets 13 & 14)**
	RAW DATA HOLDER:	Graeme Inglis, NIWA Christchurch BNZ/MFish
	DESCRIPTION:	The Baseline database (BIODS: port survey) contains data based on surveys of selected harbours throughout New Zealand, targeted because of their probable susceptibility to invasive species. A wide range of organisms are surveyed included wharf piling fouling species, infaunal species and planktonic species. The Surveillance database (BIODS: surveillance) contains data on the presence / absence of specific targeted invasive species at specific sites within selected harbours around New Zealand. Data on invasive species presence would need to be extracted from both databases and compiled into a dataset suitable for use in this project.
	SELECTION RATIONALE:	The high rating reflects the relevancy of this factor to the project.

BOX B		
	EXTRACTION	
	Undertaken by:	Graeme Inglis, NIWA, Christchurch
	Date sourced/details of contact:	Deadline – Sept '07
	Values/Data extracted:	Order, Family, Genus, Species, latitudes, longitudes
	Rationale for extraction:	SUBCOMPONENT: Non-indigenous species
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process. Data only available for ports

BOX C		
	GROOMING	
	Undertaken by:	J. Beaumont, NIWA, Wellington
	Date:	Feb 08
	Grooming actions:	Records of non-indigenous species were extracted from both datasets.
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX D		
	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E		
	GROOMED DATA RESOLUTION	Coastal cells.

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	NZ Threatened Species Classification System (dataset 15)
	RAW DATA HOLDER:	Department of Conservation
	DESCRIPTION:	The data relevant to species in the three highest threat categories need to be digitized. The scale is large compared to the grid cells likely to be used in this project. However, these species have been given a high rating for inclusion in the project because of their threatened status.
	SELECTION RATIONALE:	Government mandate to protect these threatened species.

BOX B	EXTRACTION	
	Undertaken by:	This data has recently been entered into NABIS and may be able to be extracted easily by NIWA, rather than having to be digitised as thought earlier.
	Date sourced/details of contact:	Deadline – Oct'07 The threat classification for invertebrates is currently being updated and will not be available from NABIS until Oct end. Maps of distribution and breeding sites for 20 birds species transferred to database on 30/8/2007 Maps of distribution for 15 invertebrate species transferred to database on 8/10/2007
	Values/Data extracted:	Map-info files
	Rationale for extraction:	SUBCOMPONENT: At-risk or threatened marine species
	QA/QC:	Quality assurance undertaken by DoC before sourcing

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	NA
	Date:	
	Grooming actions:	
	QA/QC:	

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	
	GROOMED DATA FILE NAME/FORMAT:	

BOX E	GROOMED DATA RESOLUTION	Coastal cells

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	**Te Ara marine mammal distribution maps (dataset 16)**
	RAW DATA HOLDER:	Te Ara – Ministry of Culture and Heritage
	DESCRIPTION:	TIF files of maps showing the distribution of marine mammal calving, pupping and feeding grounds. Data are available from the Ministry of Culture & Heritage for a small fee. Areas of interest need to be digitized and GIS referenced.
	SELECTION RATIONALE:	Te Ara – the online encyclopaedia of New Zealand has good maps showing marine mammal calving, pupping and feeding grounds.

BOX B	EXTRACTION	
	Undertaken by:	This data has been entered into NABIS and can be more easily extracted in digital form than previously thought. Pinniped distribution data being updated, however which will delay entry into ZBS database. – updated maps not available by deadline so existing maps used.
	Date sourced/details of contact:	Deadline – Oct '07 Data transferred to database 8/10/2007 for Southern Right whale, Bryde's whale, and Hector's, Maui's, dusky and bottlenose dolphins No maps available for sperm whales or common dolphins
	Values/Data extracted:	Map info files
	Rationale for extraction:	SUBCOMPONENT: Number of pupping, calving, spawning, roosting or feeding grounds – renamed Marine Mammal Distribution.
	QA/QC:	Quality assurance undertaken by Te Ara before sourcing NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Grooming actions:	No grooming required
	QA/QC:	

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	Coastal cells

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Rocky reef (intertidal proxy) data set (17)
	RAW DATA HOLDER:	LINZ
	DESCRIPTION:	Shapefiles of the distribution of intertidal rocky reefs from aerial photography.
	SELECTION RATIONALE:	In this habitat live many organisms vulnerable to invasive species that arrive as fouling species on ships hulls. The detailed extent of underwater rocky reefs is well described for only that tiny portion of the New Zealand coastline where detailed acoustic mapping has taken place. Full coverage of the New Zealand coastline may take many decades. However, a useful proxy is the intertidal reef areas that are available through a LINZ database. The high rating for inclusion in the project reflects the vulnerability of many reef species to invasive fouling and mobile species.

BOX B	EXTRACTION	
	Undertaken by:	Eagle Technology Ltd
	Date sourced/details of contact:	Data received Jul 07 (version dated May 2000)
	Values/Data extracted:	Shapefiles of rocky reef distribution (9101 polygons)
	Rationale for extraction:	SUBCOMPONENT: Habitat area within NZ region
	QA/QC:	Quality assurance undertaken by LINZ before sourcing. NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	NA
	Date:	
	Grooming actions:	No grooming required
	QA/QC:	
	GROOMED DATA FILE NAME/FORMAT:	"LINZ rocket reef"\TopoNZRocks, ESRI shape file.

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	1 km^2

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	DoC Subtidal Rocky Reef layer (18)
	RAW DATA HOLDER:	Department of Conservation (Clinton Duffy)
	DESCRIPTION:	Shallow subtidal rocky reefs, to a maximum depth of 50m, have been mapped, by DoC, from historical hydrographic farings sheets.
	SELECTION RATIONALE:	Many organisms vulnerable to invasive species, particularly those that arrive as fouling species on ships hulls, inhabit shallow subtidal reefs. This habitat layer is currently the best information available on were this shallow subtidal reef habitat exists around the New Zealand coast.

BOX B	EXTRACTION	
	Undertaken by:	Department of Conservation
	Date sourced/version of raw data:	2007
	Values/Data extracted:	Shapefiles of rocky reef distribution
	Rationale for extraction:	Subcomponent: Habitat area within NZ region
	QA/QC:	Quality assurance undertaken by DoC before sourcing NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Grooming actions:	
	QA/QC:	

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Seagrass data set (19)
	RAW DATA HOLDER:	Mark Morrison, NIWA, Auckland
	DESCRIPTION:	Unfortunately the records of seagrass distribution are not yet digitized and come from a wide variety of time periods; in some areas records have not been updated since the 1960's. The distribution of seagrass is highly likely to have changed since then. In recent years Dr Mark Morrison has been undertaking related work in many New Zealand harbour and estuarine seagrass beds. The only practical way of generating estimates of seagrass distribution is to use his expert knowledge. The data will be of a coarse scale (~10km2) but smaller than the proposed grid cells size of 400km2.
	SELECTION RATIONALE:	This is a shallow water habitat, often with harbours and estuaries, that contains a variety of species vulnerable to typical invasive species. The high rating for inclusion in the project reflects the vulnerability of many reef species to invasive fouling and mobile species.

BOX B	EXTRACTION	
	Undertaken by:	Mark Morrison, NIWA, Auckland
	Date sourced/details of contact:	Data requested 25/7/07 Deadline – Sept/Oct '07
	Values/Data extracted:	Printed maps with seagrass bed boundaries drawn on them. Will need to be digitised. Shapefiles Word document detailing location of small seagrass beds not yet digitised Shapefiles from Environment Waikato.
	Rationale for extraction:	SUBCOMPONENT: Habitat area within NZ region
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING	
	Undertaken by:	J. Beaumont / A-L. Verdier, NIWA, Wellington
	Date:	March 2008
	Grooming actions:	New information (chapter in Seagrasses of New Zealand) available from G. Inglis (NIWA, Christchurch) and added to database.
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process.

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	Fine scale resolution of small seagrass beds is not accurate. Seagrass beds are known to have great temporal variation. In addition, many of the seagrass habitat patches that have been mapped were from personal communications or from experts notes e.g. "small patches, 10s of meters scale". Use as maximum resolution of coastal cells.

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Mangroves data set (20)
	RAW DATA HOLDER:	Mark Morrison, NIWA, Auckland
	DESCRIPTION:	An existing GIS database details the aerial extent of mangrove forests in North Island Harbours. A small cost is required to check the data and extract it in a format suitable for inclusion in this project.
	SELECTION RATIONALE:	This is a shallow water harbour and estuarine habitat dominated by a single species of mangrove, Avicennia marina. Because of vulnerability to frost mangroves occur only in the northern half of the North Island but in this area can form distinctive and extensive forests. These contain a wide variety of fish and invertebrate species. The high rating for inclusion in the project reflects that many vessels, potential vectors of incursion species, originate in tropical and subtropical ports and harbours that have their own mangrove habitats and regularly call at northern New Zealand harbours and ports.

BOX B	EXTRACTION	
	Undertaken by:	Eagle Technology Ltd
	Date sourced/details of contact:	Data received 25 Jul 07 as shapefiles (48 polygons) Needs to be converted to one map layer of polygons by GIS person Deadline – Aug '07
	Values/Data extracted:	Shapefiles
	Rationale for extraction:	SUBCOMPONENT: Habitat area within NZ region
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Grooming actions:	
	QA/QC:	
	GROOMED DATA FILE NAME/FORMAT:	under folder Mangroves, all ESRI shape files Auckmangrove_bdy,Auckmangrove_poly,Auckmangrove_seed, ECMangrove_bdy,ECmangrove_poly, ECmangrove_seed, NLmangrove_bdy, NLmangrove_poly, NLmangrove_seed, Waimangrove_bdy, Waimangrove_poly, Waimangrove_seed,

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	**Biogenic reefs data set (21)**
	RAW DATA HOLDER:	Chris Howe, WWF, Wellington
	DESCRIPTION:	Areas containing biogenic reefs have already been identified by an expert group for another project. Twenty-two marine scientists identified, described, and mapped key biodiversity areas and features for marine plants and animals at a workshop convened by WWF-New Zealand (Arnold, 2004). The TIF files describing these distributions need to be digitized and GIS referenced. No differentiation between types of biogenic reef has been made in this dataset.
	SELECTION RATIONALE:	This is a highly specialized habitat that characteristically occurs in areas of strong water movement. Here reefs made from colonial tube worms, corals, bryozoans or coralline algae can form extensive areas of three dimensional structure up to 1 or 2 m tall. They often contain a suite of associated species that use the reef structure for shelter and feeding.

BOX B	EXTRACTION	
	Undertaken by:	Chris Howe, WWF, Wellington
	Date sourced/details of contact:	Date requested from WWF 25/7/07 Data received 25/7/07 Deadline – Aug '07
	Values/Data extracted:	Shapefiles
	Rationale for extraction:	SUBCOMPONENT: Habitat area within NZ region
	QA/QC:	Quality assurance undertaken by dataprovider before sourcing

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Grooming actions:	
	QA/QC:	

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	Not accurate on a fine scale. These habitats have been mapped following expert discussion groups rather than from data from systematic sampling.

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	MEC Physical habitats categories (dataset 22)
	RAW DATA HOLDER:	Katie Dey, NIWA, Christchurch
	DESCRIPTION:	Nine environmental variables have been used in the Marine Environmental Classification (MEC) system to define up to 290 classes of habitats in the New Zealand EEZ. These classifications were tuned with biological data sets on demersal fishes, chlorophyll-a and benthic invertebrates and showed only modest improvement once the number of environmental classes exceeds 75. Some of these occur at depths irrelevant to this project. The subset that occurs on shelf areas to depths of 250m will each need to be extracted from the MEC. These data will then be used to calculate the area of each environmental class within a grid square as a proportion of that habitat found at depths <250 m nationally.
	SELECTION RATIONALE:	The MEC models habitat distribution nationally to a scale of 1km2 making it ideal for inclusion in this project.

BOX B	EXTRACTION	
	Undertaken by:	Katie Dey, NIWA, Christchurch
	Date sourced/details of contact:	Deadline – Sept '07 Emailed Katie requesting 20 class level 11/09 Received 13/9/07
	Values/Data extracted:	Classes 1, 22, 55, 58, 60, 63, 64,124, 130, 169,170, 178, 190
	Rationale for extraction:	SUBCOMPONENT: Habitat area within NZ region
	QA/QC:	NIWA's standard protocols were used.

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Grooming actions:	No grooming required
	QA/QC:	

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	1km2

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	MEC Version 2 (dataset 23)
	RAW DATA HOLDER:	Matt Pinkerton, NIWA, Wellington
	DESCRIPTION:	Data have been generated using SeaWIFS satellite imagery (http://seawifs.gsfc.nasa.gov/SEAWIFS.html). SeaWIFS measures normalised water-leaving radiance in six visible bands (400-700nm) and this constitutes a single measurement of "ocean colour" from which surface concentrations of chlorophyll *a* are measured. See Murphy et al. (2001) for more information on the use of SeaWIFS in determining phytoplankton distribution. The data are available daily nationwide via satellite sensors and have been incorporated into the MEC version 2.
	SELECTION RATIONALE:	Near surface chlorophyll-a concentration is a good proxy for local levels of primary production that drives the food chain. This subcomponent indicates which of New Zealand's coastal areas are the most productive. The high rating reflects the importance of this basal part of the food chain to all other organisms and the potential for introductions of exotic micro-algal species in ballast water.

BOX B	EXTRACTION	
	Undertaken by:	John Leathwick/Matt Pinkerton, NIWA, Wellington
	Date sourced/details of contact:	Deadline – Oct '07 Matt on leave until 28th September. He must be notified immediately on his return of data requirement.
	Values/Data extracted:	Chlorophyll a concentrations, latitude, longitude
	Rationale for extraction:	SUBCOMPONENT: Primary productivity
	QA/QC:	NIWA's standard protocols were used together with feedback on preliminary data maps using the Delphic process

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Grooming actions:	No grooming required
	QA/QC:	

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	9km2

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A		
	DATA SOURCE:	**Incidental cetacean sightings data set (24)**
	RAW DATA HOLDER:	Martin Cawthorn, Private consultant
	DESCRIPTION:	Approximately 5,500 records of coastal and shelf cetacean observations in paper format. These records need to be entered into an electronic database to make them useful to this project.
	SELECTION RATIONALE:	New Zealand has a rich cetacean fauna, including some coastal threatened species. Twelve percent of the dolphin species are endemic. One species, Maui's dolphin, is the world's rarest cetacean. This dataset is the only nationwide dataset that includes coastal and shelf observations. Because of the rarity and vulnerability of some species this data is highly ranked.

BOX B		
	EXTRACTION	
	Undertaken by:	Martin Cawthorn, Private consultant
	Date sourced/details of contact:	Alison MacDiarmid asked to co-ordinate July 10th. Need timeline from Martin. Data is in paper form. Needs to be entered into electronic format. Deadline Oct '07
	Values/Data extracted:	Species name, latitude, longitude
	Rationale for extraction:	SUBCOMPONENT: Marine Mammal Distribution
	QA/QC:	NIWA's standard protocols were followed.

BOX C		
	GROOMING	
	Undertaken by:	NIWA (Sandy Black and Pauline Mills)
	Date:	Feb - April 2008
	Grooming actions:	Data digitised by NIWA (Sandy Black and Pauline Mills)
	QA/QC:	Queries with digitised data checked by Martin Cawthorn

BOX D		
	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E		
	GROOMED DATA RESOLUTION	Coastal cells

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	Area-based restrictions in the marine environment data set (dataset 25)
	RAW DATA HOLDER:	Felicity Wong, DoC; Juliane Sellers, MFish
	DESCRIPTION:	Shapefiles of area-based restrictions in the marine environment. Includes attribute information on the type of restrictions in place (ie prohibition or restriction of gear or catch)
	SELECTION RATIONALE:	Areas of the marine environment completely protected from extractive use have special significance because they contain a greater size range of individuals of many species than do fished areas. While marine reserves are typical of such areas, protected cableways are also included. This subcomponent indicates the proportion of the NZ wide total area of fully protected marine areas occurring within grid square. The high rating reflects the high conservation value of fully protected areas.

BOX B	EXTRACTION	
	Undertaken by:	Juliane Sellers, MFish
	Date sourced/details of contact:	Data requested from DoC 18/7/07 Approval for data to be used given 18/7/07. Data due from MFish w/e 27/7/07 Deadline Jul '07 Data received 27/7/07
	Values/Data extracted:	Shapefiles
	Rationale for extraction:	SUBCOMPONENT: Area of MPA's
	QA/QC:	Quality assurance undertaken by dataprovider before sourcing

BOX C	GROOMING (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Grooming actions:	No grooming required
	QA/QC:	

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	

PRO-FORMA TO MAP THE PROCESS FROM RAW DATA TO GROOMED DATA

BOX A	DATA SOURCE:	BNZ/MFISH 20X20 km grid square layers
	RAW DATA HOLDER:	MO/Andrew Bell
	DESCRIPTION:	This is a rigid 20 x 20 km grid square layer. The grid system has been used by the Maritime Safety Authority to map the New Zealand coastline in the development of an oil-spill response risk assessment framework. This grid system was initially to be used for all four of the value mapping projects (environmental, social, economic and cultural) to enable an overall estimate of value to be applied to each grid cell. However, as a result of the regular layout of the grids and the irregular coastline of New Zealand, there was great variation in the proportion of sea, coastline length and land within each grid. This variation would have made it unrealistic to compare measures of environmental value between grids. Following discussion with Biosecurity New Zealand, all four value mapping projects have adopted a mapping method to suit their particular data types.
	SELECTION RATIONALE:	The grid system has been used by the Maritime Safety Authority to map the New Zealand coastline in the development of an oil-spill response risk assessment framework. It was thought to be suitable for use in this project. However, this data layer was not suitable for the environmental data and so have been superseded with a NIWA-generated coastal cells layer.

BOX B	EXTRACTION	
	Undertaken by:	
	Date sourced/details of contact:	Data requested from DoC 18/7/07 Approval for data to be used given 18/7/07. Data due from MFish w/e 27/7/07 Deadline Jul '07 Data received 20/7/07
	Values/Data extracted:	Shapefiles
	Rationale for extraction:	
	QA/QC:	

BOX C	GROOMING	
	Undertaken by:	N/a
	Date:	
	Grooming actions:	Data layer not suitable for project. Replaced by NIWA-generated coastal cells. See section 2.2 of Technical report
	QA/QC:	n/a
	GROOMED DATA FILE NAME/FORMAT:	under "Grid square layer", ESRI shape files zipped in: NIWAAvmGISlayers.zip

BOX D	MODELLING/INTERPOLATION (NOT REQUIRED FOR THIS DATASET)	
	Undertaken by:	
	Date:	
	Modelling/interpolation actions:	
	QA/QC:	

BOX E	GROOMED DATA RESOLUTION	

7.2 APPENDIX II MEC PHYSICAL HABITAT CATEGORIES

The MEC models habitat distribution nationally to a scale of 1 km^2 making it ideal for inclusion in this project. The class definitions are listed below (taken from: http://www.niwa.cri.nz/__data/assets/pdf_file/0005/29507/mec_overview.pdf)

Oceanic subtropical environments:

Class 1 – is extensive in the far north, occurring in deep (mean = 3001 m) subtropical waters with high solar radiation and warm winter sea surface temperatures. Average chlorophyll a concentrations are very low, but there are insufficient trawl or benthic invertebrate records to provide descriptions of these components.

Class 22 – is extensive in moderately deep waters (mean = 1879 m) over a latitudinal range from about 33–38 °S. It is typified by cooler winter SST than the previous class. Chlorophyll a reaches only low average concentrations. Characteristic fish species (i.e. occurring at 50 percent or more of 20 sites) include orange roughy, Baxter's lantern dogfish, Johnson's cod, and hoki.

Oceanic, shelf and subtropical front environments:

Class 55 – is of restricted extent occurring at moderately shallow depths (mean = 224 m) around northern New Zealand and has high annual solar radiation and moderately high wintertime SST. Average chlorophyll a concentrations are moderate. Characteristic fish species (26 sites) include sea perch, red gurnard, snapper and ling, while arrow squid are also caught frequently in trawls. The most commonly represented benthic invertebrate families (i.e. occurring at 50 percent or more of 27 sites) are Dentallidae, Nuculanidae, Pectinidae, Carditidae, Laganidae and Cardiidae.

Class 63 – is extensive on the continental shelf including much of the Challenger Plateau and the Chatham Rise. Waters are of moderate depth (mean = 754 m) and have moderate annual radiation and wintertime SST. Average chlorophyll a concentrations are also moderate. Characteristic fish species (29 sites) include orange roughy, Johnson's cod, Baxter's lantern dogfish, hoki, smooth oreo and javelin fish. The most commonly represented benthic invertebrate families (14 sites) are Carditidae, Pectinidae, Dentaliidae, Veneridae, Cardiidae, Serpulidae and Limidae.

Class 178 – is extensive to the south of New Zealand occurring in moderately deep water (mean = 750 m) as far south as latitude 55 °S. It experiences low annual solar radiation and cool wintertime SST. Chlorophyll a reaches only low to moderate average concentrations. Characteristic fish species (26 sites) include ling, javelin fish, hoki and pale ghost shark. The most commonly represented benthic invertebrate families (eight sites) are Terebratellidae, Serpulidae, Pectinidae, Temnopleuridae, Veneridae, Carditidae, Glycymerididae, Spatangidae and Limidae.

Central coastal environments:

Class 58 – is of relatively restricted extent occurring in moderately shallow waters (mean = 117 m) around the northern tip of the North Island and in Cook Strait. Strong tidal currents are the dominant feature of this class. Some of the most commonly occurring fish species are red gurnard, snapper, leather jacket, spiny dogfish, barracouta, hoki and eagle ray, while arrow squid are also frequently caught in trawls. The most commonly represented benthic invertebrate families are Veneridae, Carditidae and Pectinidae.

Class 60 – is much more extensive than the previous class, occupying moderately shallow waters (mean = 112 m) on the continental shelf from the Three Kings Islands south to about Banks Peninsula. It experiences moderate annual solar radiation and wintertime SST and has moderately high average chlorophyll a concentrations. Some of the most commonly occurring fish species are barracouta, red gurnard, john dory, spiny dogfish, snapper and sea perch, while arrow squid are also frequently caught in trawls. The most commonly represented benthic invertebrate families are Dentaliidae, Cardiidae, Carditidae, Nuculanidae, Amphiuridae, Pectinidae and Veneridae.

Class 64 –occupies a similar geographic range to the previous class but occurs in shallower waters (mean = 38 m). Seabed slopes are low but orbital velocities are moderately high and the annual amplitude of SST is high. Chlorophyll *a* reaches its highest average concentrations in this class. Some of the most commonly occurring fish species are red gurnard, snapper, john dory, trevally, leather jacket, barracouta and spiny dogfish. Arrow squid are also frequently caught in trawls. The most commonly represented benthic invertebrate families are Veneridae, Mactridae and Tellinidae.

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Class 124 – although of limited extent, occurs around the entire New Zealand coastline occupying shallow waters (mean = 8 m) with very high orbital velocities. Some of the most commonly occurring fish species are leather jacket, snapper, red gurnard, eagle ray, trevally and john dory. The most commonly represented benthic invertebrate families are Veneridae, Mactridae, Carditidae and Terebratellidae.

Class 130 – occurs only in the Marlborough Sounds, occupying sites with a distinctive set of environmental conditions typified by very shallow water (mean = 10 m), minimal slope, moderate orbital velocities and tidal currents, and high gradients of SST.

Class 169 – is moderately extensive east of the South Island, occupying shallow waters (mean = 66 m) with low to moderate orbital velocities, moderately low annual solar radiation and wintertime SST, and moderate tidal currents. It supports high average concentrations of chlorophyll a. Some of the most commonly occurring fish species are barracouta, spiny dogfish, hapuku, red gurnard, ling and sea perch, while arrow squid are also taken frequently in trawls. The most commonly represented benthic invertebrate families are Veneridae, Terebratellidae, Mactridae, Pectinidae, Cardiidae, Amphiuridae, Nuculidae, Balanidae and Carditidae.

Class 170 – is extensive in moderately shallow waters (mean = 129 m) on the continental shelf surrounding the Chatham Islands, and from Foveaux Strait south, including around the Bounty Islands, Auckland Islands and Campbell Island. Annual solar radiation and wintertime SST are both moderately low, as is the annual amplitude of SST. Tidal currents are moderate and average concentrations of chlorophyll *a* reach moderate levels. Some of the most commonly occurring fish species are barracouta, spiny dogfish, hapuku and ling, while arrow squid are taken with very high frequency in trawls. The most commonly represented benthic invertebrate families are Terebratellidae, Serpulidae, Veneridae, Pectinidae, Temnopleuridae, Carditidae Cardiidae, Glycymerididae, Spatangidae and Limidae.

Class 190 – is of limited extent, occurring in waters of moderate depth (mean = 321 m) along the Southland Coast. It experiences moderately low mean radiation and wintertime SST, and high gradients of SST. It supports high average concentrations of chlorophyll *a*. Some of the most commonly occurring fish species are spiny dogfish, barracouta, ling, hapuku, hoki and sea perch. Arrow squid are also frequently taken in trawls.