Shining a spotlight on the biodiversity of New Zealand's marine ecoregion

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Experts Workshop on Marine Biodiversity

27-28 May 2003
Wellington
New Zealand

Allison Arnold, Editor

WWF-New Zealand

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This report aims to be an accurate record of the discussions and material generated at the Marine Biodiversity Workshop held on the 27–28 May 2003, and during subsequent expert review. The content of this publication does not necessarily reflect the views of WWF or the workshop participants' employers, or other organisations that have supported this process.

Executive Summary

The distinctive nature of New Zealand's marine biodiversity has led to its identification by WWF as one of 238 ecoregions (collectively known as the Global 200) that are global priorities for conservation action. An ecoregion is a large area of land or water that contains a geographically distinct assemblage of natural communities that share a large majority of their species, ecological dynamics, and environmental conditions. Planning at the large scale of the ecoregion is consistent with an ecosystem-based approach to management. The ecoregion approach promotes conservation efforts in accordance with ecological processes and systems rather than along administrative boundaries, thereby creating new conservation opportunities.

With the long-term aim of contributing to marine biodiversity conservation, WWF-New Zealand established the New Zealand Marine Ecoregion Initiative in 2003, which is part of WWF's global approach to mobilise conservation efforts in priority regions of the world. In response to the need for an independent, scientific assessment of New Zealand's marine biodiversity, WWF-New Zealand convened marine scientists for an expert workshop that was held from 27-28 May 2003. The 22 workshop participants, who came from around the New Zealand region, hold expertise in taxonomy, ecology, oceanography, and conservation. They collectively have specialist knowledge across a wide range of marine organisms and habitats in New Zealand.

During the workshop participants divided into three subgroups that corresponded with the types of biota for which they had specialist knowledge: cetaceans, seals, and seabirds; fish; and benthic invertebrates, algae, and plants. Guided by a set of criteria that they had developed in the first session of the workshop, and furnished with bathymetric maps of the New Zealand region, the participants delineated key areas for the biodiversity of their respective biotic groups. Each area was coupled with a description of its physical and biological attributes, the state of information, and references to the literature. Biodiversity features that do not lend themselves readily to discrete geographic representation were reported, but were not illustrated on the maps. The oceanographers worked separately to report on the physical processes operating in New Zealand's marine environment.

Experts identified areas of deepwater emergence in Fiordland and Marlborough Sound where species are found at unusually shallow depths due to the unique physical characteristics of these environments. They noted the high productivity of the hydrographically complex Chatham Rise, the remarkable invertebrate diversity of Spirits Bay, and the expanding coverage of mangroves in northern New Zealand. Seabird experts highlighted the importance of the subantarctic and Chatham Islands as global hotspots for bird diversity, and the importance of migration corridors around New Zealand. Marine mammal experts marked the canyon and trench systems running from Kaikoura Canyon northwards as attractive foraging areas for deep-diving cetacean species, such as sperm whales. Overall, the work of the marine scientists shines a spotlight on key areas for biodiversity in New Zealand's marine environment, contributes to the greater body of knowledge of the ecoregion's marine biodiversity, and makes such knowledge available in a summarised and accessible form.

The results of the workshop are constrained by the limited biological sampling that has been conducted in New Zealand's marine environment. In addition to identifying areas that are thought to be important for marine biodiversity, workshop participants identified some of the gaps in the knowledge base. Much effort has been put into research on the spatial distribution of marine organisms, but there is still under-representation in sampling efforts, such as for all species and habitats deeper than 1,500m, and for specimens smaller than 2mm. Information deficiencies for ecosystem processes, such as trophic interactions, population dynamics, and recruitment are even greater. Participants expressed particular

concern about the challenge of addressing information gaps given the scarcity and declining number of specialists with taxonomic expertise in New Zealand. Concern about the state of marine biodiversity knowledge in New Zealand became the focus of a workshop statement.

During the workshop scientists also articulated ideas about what actions could be undertaken by the scientific community to promote conservation of marine biodiversity. Among the actions identified were: the need to train and recruit more competent taxonomists; the need to raise awareness of the marine environment among all New Zealanders; the need to better classify marine habitats; and the need for a well-supported national plan of marine exploration that better reflects New Zealand's oceanic status globally. They recognised that scientists have pathways to key audiences, to whom they can communicate their passion for the marine environment and translate it into action.

This report provides a foundation on which more detailed conservation strategies for New Zealand's marine biodiversity can be developed. WWF-New Zealand's role will include helping to identify the pressures placed on marine biodiversity through human activities, and developing conservation goals and targets in consultation with a wide group of stakeholders. WWF-New Zealand hopes that this report will serve not only as a useful information resource, but as a catalyst to more widespread, co-ordinated, and focused conservation of New Zealand's unique marine and coastal environment.

The workshop participants' statement on the state of knowledge for New Zealand's marine biodiversity:

We marine scientists of various specialisation, recognise New Zealand's oceanic environment and ecosystems as unique and highly regionalised, with a level of biodiversity of global significance.

A great deal remains unknown about New Zealand's marine environment; vast regions are unexplored, interactions between species and their environments are not understood, and we lack the expertise to recognise and document many of the components of the biota. Consequently, the capacity to use and manage marine resources, or even identify possible human impacts is limited.

If we New Zealanders are to live in a sustainable relationship with our oceanic environment and benefit from the use of the marine resources of our EEZ, we need more information. Our current lack of knowledge is alarming and does not represent a sound basis for reliable policy and management decisions.

We urge immediate action by the Government and other stakeholders to ensure the capacity of relevant institutions to address this situation.

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1.0 Introduction

1.1 The biological diversity of New Zealand's marine ecoregion

Marine biodiversity is among the great taonga (treasures) of Aotearoa New Zealand. The geological isolation, range and complexity of habitats, and number of major ocean currents that influence New Zealand have created diverse marine communities. New Zealand's marine environment spans over 30 degrees of latitude, from subtropical waters to the subantarctic, and extends from the shallows to the deep sea. Comprising more than 4.2 million km^2, the Territorial Sea and Exclusive Economic Zone (EEZ) are around 15 times the land area of New Zealand, making the country's jurisdiction predominately marine.

An estimated 22,000-23,000[1] species inhabit the marine environment of New Zealand, but to date fewer than 12,000 have been identified (Ministry for the Environment 2004). Among the known species are 126 seabirds, 50 marine mammals, more than 1,000 fish, 2,000 molluscs (e.g. snails, shellfish, and squid), 696 sponges, 615 echinoderms (e.g. kina, sea stars, sea cucumbers), 758 species of seaweed, and 700 species of micro-algae (Department of Conservation and Ministry for the Environment 2000; A. Stuart, personal communication, 2004). New species are being identified with almost every research sampling effort, some of which are known to occur only in New Zealand. Marine scientists estimate that as much as 80% of New Zealand's indigenous biodiversity is found in the sea (Department of Conservation and Ministry for the Environment 2000).

The wealth of New Zealand's marine life can be found living in such diverse habitats as mudflats, mangroves, seagrass and kelp beds, rocky reefs, seamounts, canyons, fiords, open water pelagos, and deep sea trenches. Some of these environments host unusual species assemblages that reflect the convergence of warm and cold waters or the influence of other physical forces. Conserving the fullest possible range of biodiversity – genes, species, communities, and ecological phenomena – at a scale that encompasses all of these environments is the ultimate goal of ecoregion conservation.

This document reports on the outcomes of an initial stage in New Zealand's Marine Ecoregion Initiative: a workshop in which marine scientists delineated and described key biodiversity sites and features in the ecoregion. The workshop served to summarise and synthesise biogeographic information on New Zealand's marine biodiversity, which is otherwise widely dispersed among various published and unpublished sources. The result is a collection of maps and descriptions of key biodiversity areas in the ecoregion that can serve as an information resource for those seeking a greater understanding of New Zealand's marine biodiversity.

[1] If the parasitic protozoans expected to live with multicellular hosts are considered, this estimate is increased to 54,600-75,700 species (D. Gordon, personal communication, 2004).

Southern Royal Albatross, Campbell Island

1.2 Scope of this report and relation to other information initiatives in New Zealand

This report outlines the scope of the ecoregion project and relation to other information initiatives in New Zealand, explains the methodology and criteria employed by workshop participants to identify key marine biodiversity sites and features, presents the participants' selected areas and their attributes, identifies gaps in marine biodiversity knowledge, and explores future steps for conserving New Zealand's marine biodiversity.

The contents of this report reflect information generated by a group of marine scientists during a two-day workshop. The outcomes of the workshop are meant to serve as a summary of marine biodiversity in New Zealand and an indication of those areas and features, such as habitats, species concentrations and assemblages, and unique ecological phenomena, that marine experts recognise as having special physical and biological attributes. Due to the large spatial scale at which the assessment was conducted, this report is not intended to be a directory to the specific locations of marine species or assemblages in New Zealand waters. References to more detailed information are provided where available for the key areas identified by workshop participants.

Expert workshops led by WWF in other ecoregions of the world have included an assessment of threats posed to biodiversity through human activities. In the New Zealand exercise threats to marine biodiversity were not formally assessed, nor were threats used as a major criterion for determining the key areas for marine biodiversity. A subsequent process will identify threats to New Zealand's marine biodiversity. Threat identification is likely to draw upon the outputs of the marine scientists' workshop, but is a process that will involve a wider group of stakeholders with interests in the marine environment.

The marine ecoregion project initiated by WWF-New Zealand complements other spatially based information initiatives underway to aid understanding of New Zealand's marine environment. Other projects operating in New Zealand include the National Aquatic Biodiversity Information System (NABIS), The Marine Environment Classification System (MEC), the Interim Nearshore Marine Classification (INMARC), and the Estuary Environment Classification (EEC). Lack of knowledge about the marine environment is a major impediment to effective management. Importantly, this collection of initiatives has potential to bridge those information gaps with the help of geographic information systems (GIS). A description of the projects is included in Appendix 2.

1.3 WWF and the ecoregion approach to conservation

WWF's mission is to stop degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving biological diversity, ensuring the sustainable use of resources, and reducing pollution and wasteful consumption. Scientists and conservationists worldwide have acknowledged that attainment of conservation goals requires thinking, planning, and acting at the appropriate spatial and temporal scales (IUCN, WRI, and WWF 1999). Adoption of the ecoregion as the spatial unit that best describes the patterns of biodiversity reflects increasing recognition of the need to expand the scale at which we address biodiversity conservation.

An ecoregion is "a large unit of land or water that contains a characteristic set of natural communities that share a large majority of their species, dynamics, and environmental conditions" (Olson *et al.* 2000: 2). Through identification of 238 terrestrial, freshwater, and marine ecoregions as priorities for conservation action, collectively known as the Global 200, WWF has taken a more comprehensive and representative conservation approach than has ever been attempted on a global scale. The ecoregions of the Global 200

are a focus for conservation efforts because "they harbour the most outstanding and representative examples of the world's diverse ecosystems" (Olson *et al.* 2000:1). Ecoregion conservation emphasises not only expansion of the geographic areas in need of consideration, but also the temporal horizon for planning, and engagement with a wide range of stakeholders. The methodology applied in selecting the Global 200 is outlined in Appendix 1.

Ecoregional planning embraces an ecosystem-based approach to management, which requires the ability and authority to plan in accordance with ecological processes and systems. Both ecoregion-based conservation and the ecosystem-based approach anticipate, plan, and act beyond political boundaries. Even in ecoregions that have a well-developed government infrastructure for conservation and sustainable use of the marine environment, responsibility for various marine management issues is often spread across departments with different, and sometimes conflicting, mandates. As a result, co-ordination challenges continuously arise for managing competing uses of the marine environment.

Planning at the ecoregion scale presents new conservation opportunities that might be neglected by approaches constrained by political units. At the ecoregional scale:

- Patterns of biodiversity can be contemplated along spatial and temporal parameters that reflect ecosystem processes rather than legal or jurisdictional boundaries and timelines;

Seahorse, Fiordland

- Participants in the process have the opportunity to exchange ideas independent of political and funding considerations;
- Resources for conservation can be drawn from a wide range of stakeholders at various levels; and
- Socio-economic issues that cross borders, such as international demand for a particular commodity, can be addressed.

WWF-New Zealand has initiated ecoregion conservation in the hope of realising new conservation opportunities in New Zealand's marine environment.

1.4 The New Zealand Marine Ecoregion

The marine environment of New Zealand was one of three Global 200 ecoregions selected among the temperate shelf and seas of the Southern Ocean[2]. The physical environment of New Zealand is best described as a large bathymetric platform where the Pacific and Indo-Australian plates collide. New Zealand intersects the general west to east flow of the subtropical and subantarctic surface waters, deflecting currents either northward or southward off the west coast, and creating permanent eddies off the east coast of the North Island. The Subtropical Front is the circumpolar boundary between the warm, nutrient-poor, and salty waters of the subtropics and the cold, nutrient rich, and less saline water of the subantarctic. To the west of New Zealand, the Subtropical Front generally lies at Fiordland's latitude, while to the east it follows the Chatham Rise.

The Deep Western Boundary Current is another major current that influences the region. It sweeps along New Zealand's south-east continental margin, flowing below 2000m depth, in consort with the overlying Antarctic Circumpolar Current (ACC)

[2] Other southern ocean ecoregions of the temperate shelf and seas habitat type are the Patagonian Southwest Atlantic and the Southern Australia Marine (Olsen *et al.* 2000).

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Scallop, Fiordland

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Half-banded perch and sponge, Poor Knights Islands

(L. Carter 2004, personal communication). The deep current then flows around the Chatham Rise, and along the Kermadec Ridge, infusing the Pacific with waters rich in oxygen and nutrients. The coincidence of these water masses contributes to the diversity of marine habitats found in the New Zealand ecoregion. New Zealand's currents are illustrated on page 14.

The great diversity and productive nature of New Zealand's marine environment among pacific south temperate and subpolar ecosystems led to its inclusion in the Global 200 (Olson *et al.* 2000). Biological attributes that distinguish New Zealand include a rich diversity of aquatic plants, fish, bivalves, bryozoans, seabirds, and a diverse community of marine mammals (Olson *et al.* 2000). The high levels of diversity, and possibilities for concerted conservation action in the New Zealand marine ecoregion make it a priority for WWF globally as part of a subset of Global 200 ecoregions for immediate action.

Compared with terrestrial ecoregions, marine ecoregions are considered to be more spatially and temporally dynamic ecological and biogeographic units. Thus, precise boundaries were not defined for marine ecoregions during selection of the Global 200. In New Zealand the 200 nautical mile boundary of the Exclusive Economic Zone has served as a proxy for the ecoregion, although delineation of key biodiversity areas during the workshop was not constrained by this jurisdictional border.

Extensive data has been collected and literature published for New Zealand's marine environment as a whole, however, there are still substantial gaps in the formal inventory of New Zealand's marine biodiversity. In their review of marine biodiversity research in New Zealand, Nelson and Gordon (1997) comment, "qualitative knowledge of the New Zealand marine biota is still very much in the discovery phase, even for macrobenthic organisms, and quantitative knowledge of distributions is restricted to very small areas of sea floor" (62). The dearth of scientific knowledge about the marine environment is attributed to inadequate sampling. There are more than 9,000 scientific sampling stations spread around New Zealand's sea floor (Nelson and Gordon 1997), but they are not representative of the full range of marine habitats. For accessibility reasons, 80% of all scientific sampling has been carried out in the 0–1000m depth range, which represents 28% of the sea-surface area of the Exclusive Economic Zone (Nelson and Gordon 1997). Furthermore, these stations do not include sampling of the water column above the sea floor, making the sampling effort seem even more insignificant (Nelson and Gordon 1997).

Compounding the difficulty of understanding New Zealand's marine environment is the relative inaccessibility of information that has been collected on biodiversity. In general, information about marine habitats and biodiversity is widely dispersed in the published and unpublished literature. Despite an active research community, biogeographical information for some marine areas has not been updated in decades (e.g. trenches).

In light of the current information deficiencies, WWF-New Zealand convened a group of marine scientists to convey their knowledge of the distribution of New Zealand's marine biodiversity. The aims of the workshop were to:

- Delineate key biodiversity areas in New Zealand's marine ecoregion through the consensus of scientific experts;
- Establish links with key experts on New Zealand's marine environment;
- Start a process of outreach to potential users of the information;
- Identify information gaps and other obstacles to assessing marine biodiversity;
- Agree on future steps for the assessment and conservation of New Zealand's marine biodiversity; and
- Formulate a common statement for the conservation of marine biodiversity in the New Zealand region.

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2.0 Methods

2.1 Defining and identifying key biodiversity areas and features

During this stage of the New Zealand Marine Ecoregion Initiative WWF-New Zealand sought the expertise of people involved with the gathering of formal information about the marine environment. Formal information originates from systematic, replicable research, while informal information comes from the accumulated experience and observations of people who interact regularly with the sea (Parliamentary Commissioner for the Environment 1999).

WWF-New Zealand sought to assemble an expert group that collectively held formal specialist knowledge across the wide range of marine organisms and habitats in New Zealand. The 22 participants had expertise in taxonomy, ecology, oceanography, and conservation, and were recognised as experts on New Zealand's marine biodiversity based on their academic qualifications, their publications, or their work in the field. Most participants worked for institutions with marine science capacity, but others were independent. Participants were asked to represent their own expertise rather than the views of the institution for which they worked.

Expertise in some taxonomic groups and habitats was not well represented at the workshop. For example, squid, echinoderms, bivalves, polychaetes, and hydrothermal vent communities were not the main areas of specialisation of any of the workshop participants. Although WWF endeavoured to cover all of the taxonomic areas at the workshop, some experts chose not to be involved, or were unable to attend. Substitute experts were generally not available because taxonomic expertise in New Zealand is in serious decline, resulting in only one, or in some cases no, expert available for some taxonomic groups.

A workshop format was preferred over other methods, such as surveys, to elicit information from experts. Workshops are interactive and may yield results that are superior to single step surveys, in terms of the quantity and quality of ideas produced (Gunton 2002). A potential flow-on benefit of workshops is the dialogue and knowledge sharing that they can foster among expert participants. Furthermore, the workshop approach is relatively inexpensive, can be conducted in a short time frame, and is a tool used by WWF in other ecoregions for gathering expert input on biodiversity.

A vulnerability of the workshop approach, however, is the potential for

certain personalities to dominate, thus overshadowing the input of other experts. To minimise the risk of this, a professional facilitator with experience in marine issues conducted the workshop and encouraged feedback from all of the participants. Participants also had the opportunity to independently revise their input after the workshop through a review process.

The workshop was convened at the offices of WWF-New Zealand in Wellington, New Zealand on 27-28 May 2003. The workshop began with presentations that reviewed the ecoregion concept and planning process and a participant discussion about how to best proceed with the assessment. The experts first developed a list of primarily biological criteria that could inform the delineation of key biodiversity areas and habitats. The following criteria contributed to the selection of key areas or habitats for biodiversity:

- Species diversity
- Species richness
- Endemism
- Dependency for other species
- Trophic/functional diversity
- Representation (i.e. across physical types)
- Conservation status/threat classification both nationally and globally
- Cultural values
- Extremities of range and adaptation to environment
- Degree of disturbance
- Special conditions and specialised organisms
- Species with a global distribution but New Zealand is a stronghold/significant
- Seasonal/migratory importance
- Unusual degree/proportion of biomass
- Aggregations
- Special phylogenetic grouping
- Relict/genetic lineages (i.e. "living fossils")
- Habitat complexity/diversity
- Meeting ground – overlap between biological regions (at national and global regions level)
- Links to global patterns

Some of the criteria were difficult to apply for some groups. For example, it is difficult to characterise many invertebrates as endemic because scientific sampling of this group is incomplete.

After developing the criteria the participants decided to break into three subgroups that roughly corresponded with the types of biota for which they had specialist knowledge. The oceanographers worked separately to report on the physical features of New Zealand's marine environment. The three biotic subgroups were:

- cetaceans, seals, and seabirds;
- fish; and
- benthic invertebrates, algae, and plants.

The experts from each subgroup worked through consensus to delineate key areas for biodiversity on bathymetric maps of the New Zealand region (see maps in results section for extent of the area) and recorded the justification for their selection on a standard form (Appendix 3). Selection and delineation of the areas was an iterative process that involved considerable deliberation. Each area identified was coupled with a description of its physical and biological attributes, the state of information, and references to the literature. Some biodiversity features of New Zealand's marine environment do not lend themselves readily to discrete geographic representation (i.e. special habitats, for which geographic locations are not comprehensively known). In such cases the information was recorded, but is not illustrated on the maps. At the end of the first day all of the workshop participants reconvened and a spokesperson from each group reported on their progress.

The morning of the second day was dedicated to further subgroup work. The participants then reunited for a final session to review the outputs of the workshop and discuss a way forward. During the afternoon the three spokespersons presented the maps from each subgroup to all workshop participants. The participants then superimposed the three maps to reveal the key biodiversity areas they had in common. A discussion ensued about the meaning and usefulness of this approach. Ultimately, participants decided that distillation of key areas across the three groups did not add value to the outcomes of the workshop. The general consensus among participants was that overlap between the identified areas was not sufficient reason to assign greater importance to the biodiversity of such locations.

Following the workshop WWF-New Zealand staff digitised the maps using geographic information systems (GIS) software and transcribed the notes made by participants about the attributes of the key biodiversity areas and features. The process of capturing this data included detailed verification with workshop participants to ensure that the end result matched the material generated during the workshop. The content of the workshop also underwent external review by other marine scientists in New Zealand who were recommended by the workshop participants.

2.2 Identifying information gaps and other obstacles to assessing marine biodiversity

During the afternoon session participants underscored the recognition that although they had contributed their best knowledge to the workshop, most of New Zealand's marine environment has not been sampled and remains unknown. The participants, based on their understanding of the literature, outlined gaps in the knowledge base both in terms of spatial distributions of organisms and the processes and interactions between them. The potential to fill these information gaps was a topic of concern among participants. They reported that the number of taxonomic experts who are able to interpret and catalogue marine biodiversity in New Zealand, and indeed globally, is diminishing rapidly.

2.3 Identifying future steps for the assessment and conservation of biodiversity; and formulating a statement from the workshop participants

The workshop concluded by generating suggestions from the experts on actions needed to proceed with further assessment and conservation of New Zealand's marine biodiversity. The participants endorsed the development of a statement of concern for New Zealand's marine environment. Several scientists volunteered to draft such a statement, which was circulated among participants for approval after the workshop.

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3.0 Results

Benthic assemblage

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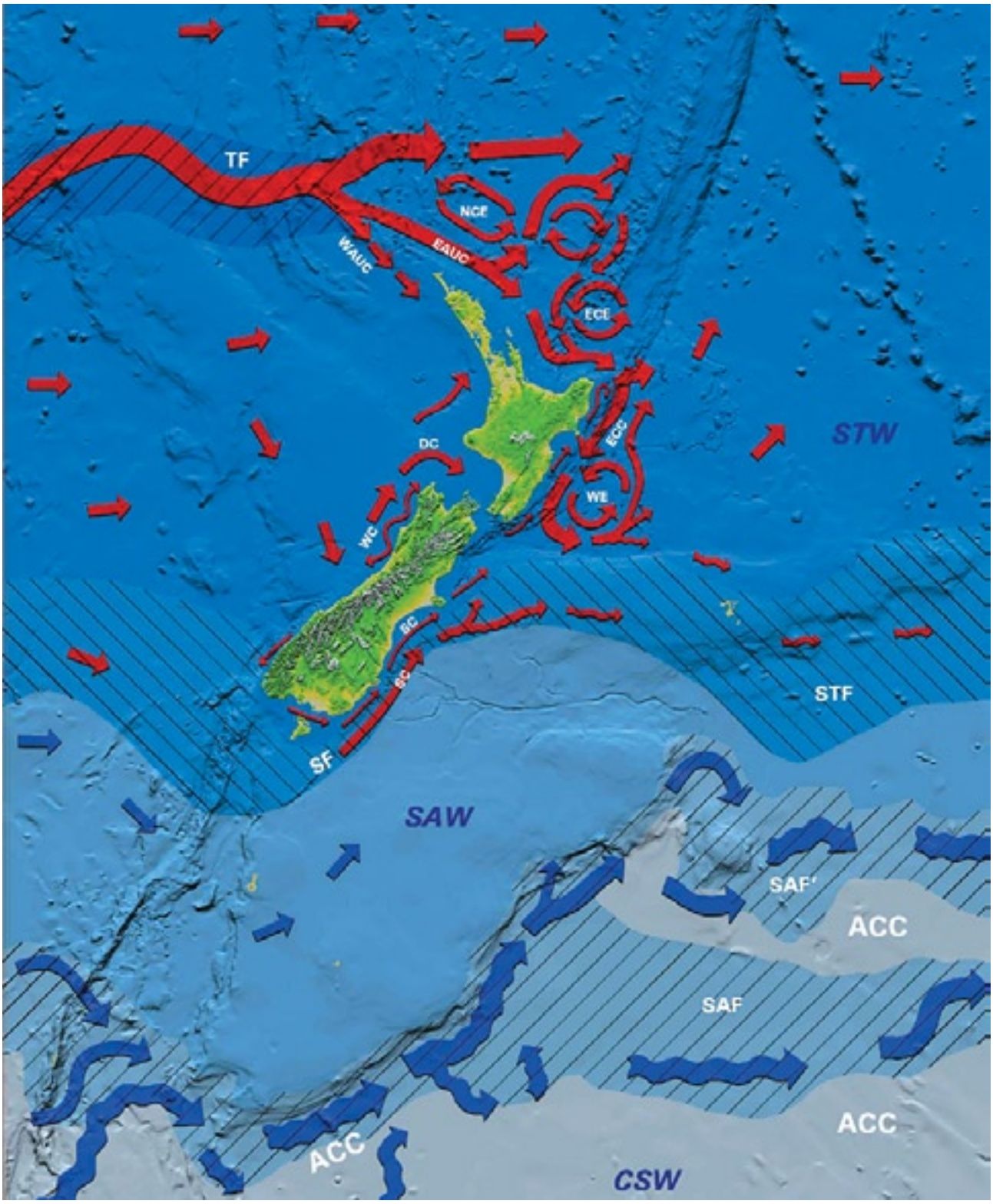
Surface currents in the New Zealand Region



Ocean surface currents in the New Zealand Region. The Tasman Front (TF), the Subtropical Front (STF), and the Subantarctic Front (SAF) approach New Zealand from the west. The STF represents the meeting of Subtropical Water (STW) and Subantarctic Water (SAW), while the SAF is formed by the meeting of SAW and Circumpolar Surface Water (CSW). The fronts contain or generate currents and there are several permanent eddies off the eastern North Island (EAUC, East Auckland Current; WAUC, West Auckland Current; ECC, East Cape Current; DC, D'Urville Current; WC, Westland Current; SC, Southland Current; ACC, Antarctic Circumpolar Current; NCE, North Cape Eddy; ECE, East Cape Eddy; WE, Wairarapa Eddy) There are also areas of tidal mixing in Foveaux Strait, between Stewart Island and the South Island, in Cook Strait, between the North and South Islands, and North of Cape Reinga. (Carter et. al 1998) Image provided courtesy of NIWA.

3.1 The Oceanography of the New Zealand Marine Ecoregion

New Zealand is a relatively long, narrow archipelago that lies athwart the West Wind Drift and forms the western boundary to the South Pacific Ocean south of 34ºS. The position of New Zealand and the shape of the bathymetric platform ensure that currents are guided by the topography (Carter *et al.* 1998). This results in shelf edge currents, uplift over shallow features, and oceanic eddies that interact with coastal waters. Oceanic water maintains an intimate contact with coastal waters. Offshore currents are particularly important in maintaining shelf-break fronts, e.g. the East Auckland Current and the Southland Current/Subtropical Front.

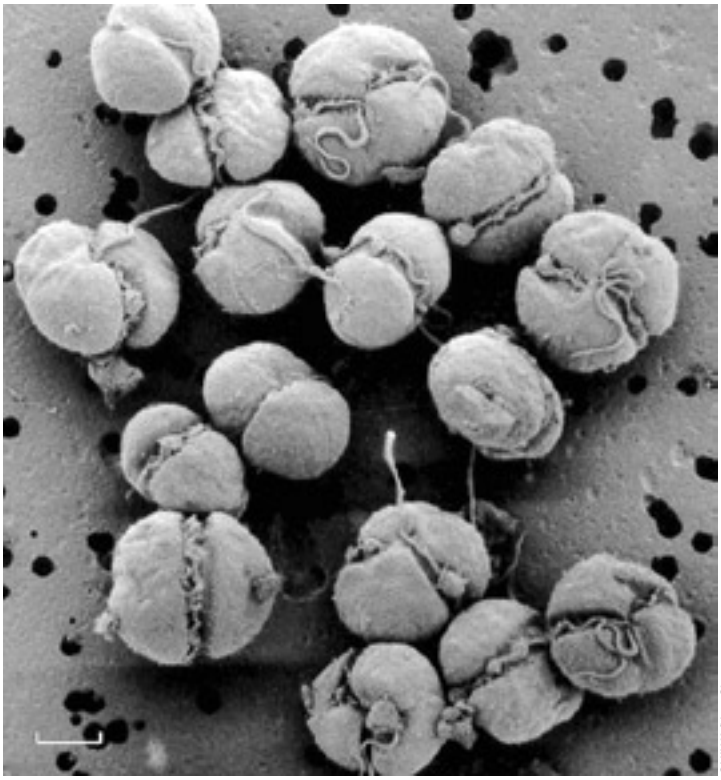
The South Pacific western boundary current, the East Australian Current, separates from the coast of Australia and a flow of water crosses the Tasman Sea forming the Tasman Front. A portion of this warm, salty Subtropical Water (STW) flows adjacent to the northeast New Zealand landmass to form the East Auckland Current, which transports water southwards along the north-east continental shelf (Stanton *et al.* 1997, Stanton and Sutton 2003). Most of this flow deflects south around East Cape as the East Cape Current before forming the northern side of the Subtropical Front (STF) (Tilburg *et al.* 2001, Carter *et al.* 1998, Heath 1985). Three permanent eddies lie offshore of this boundary current: the North Cape, East Cape, and Wairarapa Eddies (Roemich and Sutton 1998). Currents probably uplift over certain bathymetric features such as Mernoo Gap, East Cape Ridge, Puysegur Bank, and Three Kings Rise (e.g. Bradford and Roberts 1978, Bradford *et al.* 1991).

New Zealand intersects the circumpolar STF which separates the subtropical gyres from the Southern Ocean, i.e., warm, salty STW from cold, fresh Subantarctic Water (SAW). The STF passes south of Australia and Tasmania and approaches New Zealand at around 45ºS off Fiordland (Heath 1985). The front deviates south, along the continental margin, before following the shelf break northwards along the east coast of the South Island, where it is locally known as the Southland Front and has an associated current called the Southland Current. The Southland Current advects mainly SAW with peak surface speeds of 20–30cm per second (Chiswell 1996, Sutton 2003). The STF turns east along the crest of the Chatham Rise at 43.5ºS where it is constrained by the shallow bathymetry to a limited depth of 300–350m and a narrow width of approximately 100 km (Sutton 2001). Although the southern limits of the South Island are at latitudes normally associated with SAW, in fact the entire coastal region is bathed in water of STW origin, with the transition to SAW (i.e. the STF) occurring at the continental shelf break around the southern extreme of the South Island.

New Zealand's semidiurnal tides (M_2 and N_2) have a complete 360º range of phase around New Zealand (Walters *et al.* 2001). The semidiurnal tides have been characterised as a coastally trapped Kelvin wave travelling anticlockwise around the shelf. Tidal elevations increase towards the coast with a degenerate amphidrome situated at the centre of New Zealand (Heath 1985). A by-product of this geometry is that tides are always 180º out of phase through Cook Strait, resulting in very high tidal velocities through the strait. High tidal velocities also occur north of Cape Reinga and in Foveaux Strait. These areas of strong tides are associated with tidal mixing (Bowman *et al.* 1980).

New Zealand is located on the pole-ward boundary of the South Pacific subtropical gyre in the southwest Pacific Ocean. For this reason shelf edge (at 200m) nitrate concentrations are modest (about 5-15mmol m^{-3}) in comparison with many regions of the world (Conkright *et al.* 2002) and are similar in range to the northeast Atlantic Ocean, although this statement is based on very limited local data. The absolute concentrations of dissolved inorganic nutrients in oceanic water around New Zealand depend on the water mass involved. Coastal water is mainly of subtropical origin, although SAW lies adjacent to the southeast South Island slope. These two water masses have different nutrient characteristics that result in a north to south gradient in mean nitrate at 200m at the shelf break (Ridgway *et al.* 2002). The distribution of mean nitrate ranges from 10mmol m^{-3} in the northwest to 16mmol m^{-3} in the southeast. The distribution on the west coast ranges from 10mmol m^{-3} in the northwest to 12mmol m^{-3} in the southwest, with a minimum off the central west coast of ≤6mmol m^{-3}.

STW has a typical mix of nutrients (Tomczak and Godfrey 1994). Nitrate (NO_3) and dissolved reactive silica (DRSi) are depleted more or less together (Zentara



The dinoflagellate,** Karenia brevisulcata**, a New Zealand phytoplankton species that produces a potent toxin.

and Kamykowski 1981). SAW, as well as being low in iron and copper (Sedwick *et al.* 1997, Croot and Hunter 1998), has an excess of NO_3 relative to DRSi (Zentara and Kamykowski 1981). The interaction of SAW and STW at the STF, especially over the Chatham Rise, results in this region being highly productive (Bradford-Grieve *et al.* 1999). In addition, atmospheric transport of iron from arid and semi-arid parts of Australia may be a source of iron to surface seawater in this region (Kieber *et al.* 2001; Boyd *et al.* 2004). It is thought that freshwater is generally not an important source of nutrients on the open coast, given the degree of dilution (e.g. Hawke and Hunter 1992). Deep winter mixing and upwelling of deep waters are more likely to be dominant in enhancing nutrients in surface waters.

The nutrient content of the oceans has implications for ecosystem structure and function. For example, the Southern Plateau behaves like a system that is low in nutrients (despite high NO_3) and primary production, with phytoplankton dominated by very small cells. It is a low total biomass, low productivity system with high transfer efficiency (Bradford-Grieve *et al.* 2003). In this region there is very little organic matter arriving at the sea floor and most of the production occurs in the water column. This system is apparently tightly coupled. On the other hand, productivity is much greater in the STF over the Chatham Rise, phytoplankton cells are much larger, and there is much more sedimentation of organic matter to the sea floor (Nodder and Northcote 2001).

It is not only the water mass that has significance for nutrient supply to phytoplankton. Mesoscale processes that influence the supply of nutrients to surface waters and seasonal patterns of heating and cooling (as reflected in the depth of the surface mixed layer) are significant contributors to the patterns of phytoplankton distribution as seen from space as sea colour (Murphy *et al.* 2001).

The dynamical signature of the warm-core eddies down the east coast of the North Island results in deep, surface winter mixing (greater than would occur in the adjacent water from which the eddies formed (Bradford *et al.* 1982, Bradford and Chapman 1988). These eddies contribute to enhanced winter nutrient renewal, lower winter phytoplankton biomass, and are probably responsible for the generally extensive spring phytoplankton bloom in the region (Murphy *et al.* 2001). Not only do these eddies change the seasonal pattern of nutrient renewal but they can also retain larvae of coastal organisms (Chiswell and Booth 1999) or entrain coastal water taking it offshore (Bradford and Chapman 1988).

Winds are important in driving upwellings that bring nutrient-rich water to the surface. In the Southern Hemisphere winds blowing parallel to a coast cause surface waters to move to the left of the wind. Thus a northwesterly wind blowing along the coast north of Auckland (Sharples and Greig 1998) and a southwesterly wind blowing off the west coast of the South Island (Stanton and Moore 1992) will move surface water away from the coast and bring nutrient-rich deeper water to the surface inshore. A conspicuous summer feature of western Cook Strait is a large upwelling plume that originates from Kahurangi Point (Bradford-Grieve *et al.*

1986) that is responsible for considerable biological enhancement in the region.

The seasonal pattern of mixed-layer depth varies from north to south with water mass and with the large-scale circulation (Longhurst 1998). The seasonal pattern of mixed layer depth interacts with the nutrient characteristics of the water masses, freshwater inflow, and light penetration (mainly through the depth of the sunlit surface layer) to determine the seasonal patterns of primary production, nutrient depletion, and ecosystem structure.

A comprehensive overview of the distribution of plankton is available only for phytoplankton as observed from space through the time period 1997–2000 (Murphy *et al.* 2001). STW to the north and in the Tasman Sea has a classical cycle of spring and autumn chlorophyll blooms consistent with production being co-limited by nitrate and light. Chlorophyll-a concentrations varied annually between about 0.1 and 0.4mg m^{-3} to the north and in the Tasman Sea, but east of New Zealand the mean maximum was 0.8mg m^{-3}. SAW has a low-amplitude annual cycle of chlorophyll abundance that peaks in early autumn, consistent with production being limited predominantly by a combination of iron and light. SAW chlorophyll-a concentrations varied from 0.1 to 0.3mg m^{-3} and rarely exceed 0.4mg m^{-3}. Chlorophyll-a is generally greatest in the STF and has the greatest variability with concentrations varying from ≤0.1mg m^{-3} to ≥1mg m^{-3}. Through winter, elevated chlorophyll concentrations over the Chatham Rise often occur in a narrow band south of the Rise and tend not to extend as far as the Chatham Islands. At other times of the year there was a broader and more complex region of increased chlorophyll stretching across the whole length of the Rise and beyond the Chatham Islands. Chlorophyll concentrations were higher in the STF east of New Zealand (mean 0.6mg m^{-3}) with some evidence of a spring and autumn peak in the seasonal cycle compared with the STF to the west (mean of 0.4mg m^{-3}) and without a consistent seasonal pattern across the years analysed.

There is no similarly extensive picture of the quantities of zooplankton present in the New Zealand region. Bradford and Roberts (1978) show that, using limited data for the whole New Zealand region, there is a significant positive correlation between zooplankton biomass and surface chlorophyll-a. Nevertheless, no such relationship is evident for STW analysed separately. It is clear that the zooplankton biomass picture is much more complicated than can be interpreted from the limited data that we have for the New Zealand region. Any understanding of the spatial and temporal distribution of zooplankton in the New Zealand region will have to take into account the dynamics of the planktonic production system, ecosystem structure, and trophic relationships among plants and animals in the system.

Contributors:

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M.D. Ohman, Pelagic Invertebrates Collection, Scripps Institution of Oceanography

The copepod, *Neocalanus tonsus****, a common zooplankton species in New Zealand's offshore waters.***

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3.2 Cetaceans, seals, and seabirds

New Zealand's extensive coastline and inshore and offshore islands provide key habitats for seabirds and marine mammals. Three quarters of the world's albatross, penguin, and petrel species and half of shearwater and shag species occur here, as well as a number of other groups. The erect-crested *(Eudyptes sclateri)* and yellow-eyed *(Megadyptes antipodes)* penguins are among the eight endemic penguins of New Zealand. Nine species of endemic albatross are also found here. There are 16 endemic petrels, shearwaters, and storm petrels. Almost half of the world's cetaceans occur in New Zealand seas (Daniel and Baker 1986). The fauna includes the endemic Hector's dolphin *(Cephalorynchus hectori)*[3] and New Zealand sea lion *(Phocarctos hookeri)*.

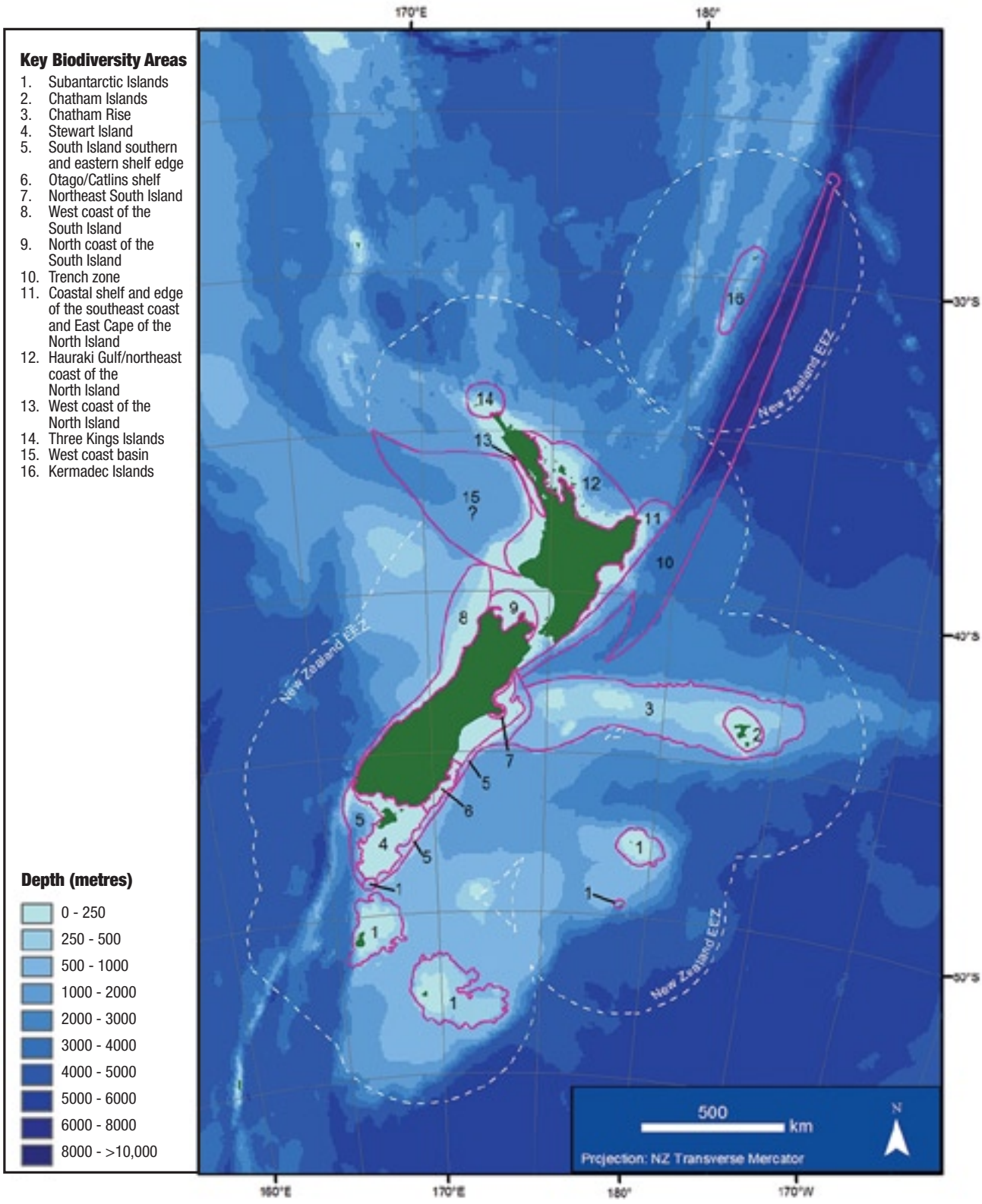
Workshop participants specialising in seabirds and marine mammals delineated 16 areas in New Zealand's marine environment that are known to be key locations for cetaceans, seals, and seabirds.

Contributors: Alan Baker, Mike Imber, Peter Moore, Chris Robertson, Anton van Helden, and Ian Wilkinson.

[3] Hector's dolphin is represented by two distinct subspecies. The populations of the South Island are known as Hector's dolphins (*Cephalorhychus hectori hectorii*) and the North Island population is known as Maui's dolphin, (*C. hectori maui*), which number around 100 individuals.

New Zealand Fur Seal

Key areas for cetacean, seal, and seabird biodiversity in the New Zealand marine ecoregion



Subantarctic Islands (and continental shelf areas to 500m depth)

Map ID number:

1

Location: Island groupings to the south and southeast of terrestrial New Zealand including Snares, Bounty, Antipodes, Auckland, and Campbell islands

Approximate area: 104,113km^2

Description of area:

The five subantarctic island groups are scattered across the Campbell Plateau and other submerged shelves of the southern New Zealand continental region. The plateau is a major feature that sits just north of the Subantarctic Front, at the northern boundary of the Antarctic Circumpolar Current that circles the Southern Hemisphere and connects all the large ocean basins. Despite there being plenty of phytoplankton nutrients, such as nitrates, the region has relatively low levels of phytoplankton biomass and primary production (Bradford-Grieve *et al.* 2003, Peat 2003).

Biological attributes:

The subantarctic islands are highly pristine and lack disturbance. Each island has a unique faunal assemblage because of their wide geographic spread and diverse and productive marine environment. Some islands have no introduced pests (e.g. The Snares, and Adams Island in the Auckland Islands group), and on others the pest mammals have been removed (e.g. from Enderby Island and Campbell Island). All islands provide excellent seabird nesting and marine mammal breeding locations that are close to major feeding areas. The Auckland and Campbell islands are a winter breeding ground for a remnant population of southern right whales (*Eubalaena australis*). The continental shelf is a productive area for inshore and shelf feeders, such as the yellow-eyed penguin (*Megadyptes antipodes*) and New Zealand sea lion (*Phocarctos hookeri*).

The islands are also good locations for albatrosses to access remote productive feeding areas in the subantartic. Forty seabird species (11% of the world total) breed in the New Zealand subantarctic and over 120 species have been observed at the islands or in the surrounding oceans. These include 10 (42%) of the world's 24 albatross species that breed in the New Zealand subantarctic (5 are endemic to the region), making the area a centre of biological diversity for albatrosses. Furthermore, 21 (30%) of the world's petrels, shearwaters, fulmars, and prions are observed in the subantarctic islands. Four penguin species breed (Snares crested (*Eudyptes robustus*) and erect-crested (*Eudyptes sclateri*) are endemic) and there are three endemic shag species (Campbell Island, Auckland Island, and Bounty Island shags). Table 1 indicates the number of seabird and marine mammal species that breed on each of the subantarctic islands.

Table 1. **Seabirds and marine mammals that breed on the subantarctic islands**

	Antipodes Islands	Auckland Islands	Bounty Islands	Campbell Island	Snares Islands
Albatross	4	4	1	6	2
Flightless duck	0	1	0	1	0
Penguin	2	2	1	3	1
Petrel	12	10	2	9	8
Tern/gull	3	4	1	4	2
Seal	2	2	1	3	0
Whale	0	1	0	1	0

Criteria applied:

Species richness; endemism; unusual degree/proportion of biomass (e.g. millions of seabirds occupy the Snares).

Status and management:

All islands are nature reserves and collectively are a World Heritage Site, and the Auckland Islands are surrounded by a marine mammal sanctuary and marine reserve. Several endemic species are considered to face a high threat of extinction under the IUCN and/or Department of Conservation threat classification schemes. For example, two penguin species (yellow-eyed penguin and erect-crested penguin) are currently listed as endangered under the IUCN classification.[4] Most albatross are classified as at least "vulnerable" because of large population declines and small breeding areas. More widespread species have also shown greater than 90% declines in population in the New Zealand region, such as the rockhopper penguin (*Eudyptes chrysocome*), grey-headed albatross (*Thalassarche chrysotoma)*, and southern elephant seal (*Mirounga leonine*).

State of information:

The breeding information for most species of birds and mammals in the subantarctic region is very good. Population assessments are, however, of variable quality and reliability, depending upon the species. Knowledge of species relationships is good. Information on foraging is limited, therefore niche separations are not as well understood. There is detailed information available for some species, such as the New Zealand sea lion. Extensive information is available from satellite telemetry of Buller's albatross (*Thalassarche bulleri*), Gibson's albatross (*Diomedea gibsoni*), and Antipodean albatross (*Diomedea anipodensis*) and to a lesser extent some other albatross species.

References and further reading:

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[4] The erect-crested penguin is also listed as endangered under the Department of Conservation's threat classification system.

Chatham Islands

Map ID number:

2

Location: 860 km east of New Zealand's south island on the Chatham Rise

Approximate area: 14,334km^2

Description of area:

The Chatham Islands are the most easterly island group in the New Zealand marine zone. They sit atop the Chatham Rise, a submarine plateau that extends eastward from the South Island. In this zone subantarctic and subtropical elements intermix. There are complex currents and eddies associated with the shelf edges and subterranean features of the area.

Biological attributes:

The habitat of this area provides island breeding locations close to productive feeding areas for seabirds. Many species feed close to the breeding islands. A mix of breeding species is found on the Chatham Islands, with feeding ranges extending to the subtropical waters in the north, the subantarctic waters in the south, and to the pelagic areas and over the submarine volcanic chains to the east. The islands are known for mass-strandings of whales and oceanic dolphins, indicating large populations in the surrounding waters. They are also the type-locality (the site where the specimen used to describe the species originated) for two beaked whales (*Mesoplodon grayi and M. traversii*). The ocean around the Chatham Islands is rich in marine life, supporting valuable fishing resources for people and animals. There are internationally significant populations of seabirds and nationally significant populations of whales, dolphins, and seals.

There is a high level of endemism in the seabird fauna of the Chatham Islands. Seven albatross species breed on the islands. One of the species (Chatham Island albatross) is a local endemic, and four are endemic to the New Zealand region – two of which have the vast majority of the population on the Chatham Islands (northern royal and Pacific albatrosses). The Chatham Islands blue penguin (*Eudyptula minor chathamensis*) is the islands' only penguin species, and is a subspecies endemic to the islands. The Chatham Island oystercatcher (*Haematopus chathamensis*) is endemic and classified as endangered. Thirteen petrel species live in the Chatham Islands, two of which (taiko or magenta petrel (*Pterodroma magentae*) and Chatham Island petrel (*Pterodroma axillaris*)) are endemic and endangered. The islands are home to 2 cormorant species (Chatham Island and Pitt shags), both of which are endemic, and 4 tern and gull species, one of which is endemic. The Chatham Islands also have a fur seal population that is recovering from significant human impact to be one of the major New Zealand groups of colonies.

Criteria applied:

Endemism; species richness; species diversity; conservation status/threat classification.

Status and management:

The Chatham Islands have the highest levels of endemism and greatest number of endangered seabird species of any New Zealand area. The endemism and endangered status of these seabirds is primarily related to modification of habitat and introduced predators combined with restricted breeding sites. About 50% of the bird species (land and marine) present at the time of European contact are today either extinct, endangered or severely reduced in numbers. Approximately 20% of New Zealand's threatened bird fauna occur on the Chatham Islands.

The main seabird fauna is confined to outer islands and islets after human modification of the two main islands. The three island groups with albatrosses are in private Maori ownership while other significant bird sites are mostly island reserves or part of the main island reserve. There are no marine mammals endemic to the islands. On the main Chatham Island there are predator control programmes to improve the productivity and survival of the endangered Chatham Island oystercatcher and taiko.

State of information:

There is much information available for endemic and endangered species currently under extensive conservation management (e.g. Aikman *et al*. 2001, Aikman and Miskelly 2004).

Chatham Island mollymawk on nest

References and further reading:

Aikman *et al*. (2001), Aikman and Miskelly (2004), Bell and Robertson (1994), Department of Conservation Canterbury Conservancy (1996), Department of Conservation (1996, 1999b), Holdaway (1994), Taylor (2000).

Chatham Rise

Map ID number:

3

Location: A submarine extension of the New Zealand Plateau that extends eastward of the South Island for 1400km

Approximate area: 189,185km^2

Description of area:

The Chatham Rise is a submerged platform of approximately 500–1000 m depth, located under the Subtropical Front, an intermixing area for subtropical and subantarctic waters.

Biological attributes:

The conditions associated with the Chatham Rise make it a diverse and productive habitat. The extensive area of the rise is characterised by high primary production. Of particular note is the large calanoid copepod (*Neocalanus tonsus*) which forms dense aggregations from late spring to early summer. Sei whales (*Balaenoptera borealis*), and broad-billed prions (*Pachyptila vittata*), are known to feed on this zooplankton species (Imber 1981). Other marine mammals known to forage on the Chatham Rise include sperm whales and beaked whales.

The rise is an important foraging area for seabirds from the Chatham Islands, southern New Zealand, and the subantarctic (e.g. the royal albatross). Particularly concentrated feeding spots are located around the Chatham Islands and close to the New Zealand mainland, but are also found on the slope areas. The Mernoo Bank, for example, is an important mixing area close to the mainland that is an important feeding ground for seabirds including Buller's mollymawk (*Diomedea bulleri*) and sooty shearwater (*Puffinus griseus*). The northern and southern slopes of the rise are subject to different hydrographic conditions, and therefore have different assemblages of foraging animals. The northern slope shows the effects of the subtropical current, while the southern slope shows the effects of the Subantarctic Front.

Criteria applied:

Species diversity; species richness (for seabirds and mammals as a result of highly productive oceanographic features). Focal point for foraging for a wide range of species that breed in subantarctic, New Zealand and the Chatham Islands.

Status and management:

The Chatham Rise is not managed specifically for seabirds or mammals which use the area for foraging, other than benefiting indirectly through the fisheries quota management system and observer programme. The fishing industry, conservation organisations, and government are working towards decreasing the level of non-fish mortality during fishing activities.

State of information:

Satellite-tracking of albatrosses is providing evidence of widespread foraging on the Chatham Rise. Information is inferred for cetaceans following reported sightings (Gaskin, 1968).

References and further reading:

Imber (1981, 1999), Nicholls *et. al* (2002), Waugh *et al.* (2002)

Stewart Island

Map ID number:

4

Location: Area includes Southland coast, Foveaux Strait, Stewart Island, Snares, and outlying islands. (The Snares are dealt with in the subantarctic section – map number 1)

Approximate area: 39,642km^2

Description of area:

Stewart Island lies on the shallow continental shelf of the South Island, separated from the mainland by Foveaux Strait, and surrounded by many offshore islands and stacks. Although there is a small human settlement the majority is uninhabited and forested.

Biological attributes:

Stewart Island has a major proportion of endemic and threatened species populations. It also has a high level of species richness with 3 species of penguin (yellow-eyed (*Megadyptes antipodes*), Fiordland (*Eudyptes pachyrhynchus*), and blue (*Eudyptula minor*)), 8 species of petrel, and 1 endemic shag (Stewart Island shag), which breed on islands and coasts. The New Zealand fur seal (*Arctocephalus forsteri*), and several cetaceans including pilot whales (*Globicephala melas*), beaked whales (*Mesoplodon* spp.), southern right whales (*Eubalaena australis*), and pygmy right whales (*Caperea marginata*), are known from the seas around Stewart Island. The Southland coast is an important mainland site for the endangered Hector's dolphin (*Cephalorynchus hectori*).

Criteria applied:

Species richness; species diversity; endemism; cultural values; habitat complexity/diversity (offered by large area under protection).

Status and management:

Much of the coast in this area is in pristine condition due to remoteness, climate, a low human population density and consequent lack of human disturbance. Stewart Island recently became a national park that includes pest-free nature reserves (e.g. Codfish Island), making it an important conservation area. Much of this major natural heritage area is accessible to the public. The area also has high cultural significance for local Maori. For example, the privately owned Muttonbird Islands are important for customary harvest of the sooty shearwater (*Puffinus griseus*).

State of information:

Good information for seabird breeding sites. Foraging areas are less well known.

References and further reading:

Bejder and Dawson (2001), Department of Conservation (1999c), DuFresne *et al.* (2001).

South Island southern and eastern shelf edge

Map ID number:

5

Location: Narrow zone of continental slope and edge from Fiordland to Kaikoura. Also includes the pristine small island group at The Snares (this is generally regarded as part of the subantarctic group of islands but has also been included in this section for its functional connection to these waters).

Approximate area: 42,844km^2

Description of area:

This area is strongly influenced by westerly drift and current in the south and subantarctic current in the east.

Biological attributes:

The shelf edges and slopes along the southern and eastern part of New Zealand's South Island provide major feeding zones for seabirds. This area serves as a linkage to other major foraging areas to the west and east of the subantarctic. The feeding route is one of the major seabird "motorways" of the world. For some seabirds it is the start and finish of migration paths to the Northern Hemisphere.

The area is part of the foraging range for at least 2 albatross species, one of which is a local breeding endemic (Buller's albatross), 8 petrel species, 1 endemic penguin species (Snares crested (*Eudyptes robustus*)) and 3 gull and tern species. There is also 1 gannet species that forms the most southern colonies for that species (*Morus serrator*). The biomass of small seabirds in this area is one of the highest in the world, especially those based at the Snares Islands where the largest regional colony of sooty shearwaters (*Puffinus griseus*) exists (2.75 million birds).

The area is important for marine mammals, such as New Zealand fur seals and sea lions. Shepherd's beaked whale (*Tasmacetus shepherdi*) and some Mesoplodon species are known from this area. This area (Te Wae Wae Bay) is also the 'home' to one of the four subpopulations of Hector's dolphin (*Cephalorynchus hectori*).

Criteria applied:

Unusual degree/proportion of biomass; trophic/functional diversity (as a foraging area link between the Snares and southern New Zealand for several species); extremities of range (birds); seasonal/migratory importance (birds).

Status and management:

The Snares, a subantarctic island unmodified by humans, is a World Heritage site. There are no introduced mammals.

State of information:

Bird species from The Snares Islands are well documented. Much distributional and behavioural data has been obtained from satellite tracking of albatrosses, and logger and satellite tracking of shearwaters.

References and further reading:

Miskelly *et al*. (2001), Pichler (2002), Stahl and Sagar (2000a, 2000b)

Sooty shearwater

Otago/Catlins Shelf

Map ID number:

6

Location: Coast of southwest South Island out to 200 m depth contour

Approximate area: 6,610km^2

Description of area:

A narrow (less than 35km) margin of continental shelf (mostly less than 80–120m deep) and slope borders the southeast side of the South Island.

Biological attributes:

The Otago/Catlins Shelf area is an important mainland breeding location for a number of species, given its proximity to highly productive water on the continental shelf and on the shelf's edge. The area provides habitat for 2 seal species (New Zealand fur seal (*Arctocephalus forsteri*) and New Zealand sea lion (*Phocarctos hookeri*)), Hector's dolphin (*Cephalorynchus hectori*), 2 albatross species (northern (*Diomedea sanfordi*) and southern (*D. epomophora*) royal albatrosses), 2 penguin species (yellow-eyed (*Megadyptes antipodes*) and blue penguins (*Eudyptula minor*)), 1 petrel species (sooty shearwater (*Puffinus griseus*)), and a variety of cormorants. There are important coastal wetlands in the area for wading birds, and migratory waders gather at these feeding sites at the southern end of their flyway. The Otago/Catlins area is an important breeding location for yellow-eyed penguins and New Zealand fur seals, and is the only mainland breeding site for New Zealand sea lion (*Phocarctos hookeri*) and royal albatross. It is the only location in the world where albatross species hybridise and are also viable (northern and southern royal albatross). Southern right whales (*Eubalaena australis*) migrate through this area in the spring.

Criteria applied:

Conservation status/threat classification; species diversity; and cultural (community) values.

Otago/Catlins shelf

continued

Status and management:

Some of the seabird and marine mammal species in the Otago/Catlins area are classified as threatened with extinction under the IUCN and/or DoC threat classifications. Under the IUCN classification, the northern royal albatross, yellow-eyed penguin and Hector's dolphin are endangered, while the southern royal albatross and the New Zealand sea lion are classified as vulnerable. Introduced terrestrial predators are a threat to penguins. Under the DoC classification the New Zealand sea lion and Hector's dolphin are classified as threatened.

The Otago Peninsula's proximity to a large urban centre makes it an accessible and popular ecotourism destination for viewing iconic species. Yellow-eyed penguins can be seen on the peninsula and albatrosses nest at Taiaroa Head. New Zealand sea lions also occur on the peninsula and in the Catlins.

State of information:

Information is good for the New Zealand sea lion and fur seal. Population and foraging information for albatrosses and yellow-eyed penguin is good.

Yellow-eyed penguin, Otago Peninsula

References and further reading:

Connel (ed.) (1999), Darby and Seddon (1990), DuFresne *et al*. (2001), Hitchmough (comp.) (2002), IUCN (2002), Moore (1999), Moore and Wakelin (1997), Robertson *et al.* (1998)

Northeast South Island

Map ID number:

7

Location: Coast and inshore coastal waters from Banks Peninsula to Kaikoura

Approximate area: 2,494km^2

Description of area:

Wide and shallow continental shelf and deep inshore trenches.

Biological attributes:

The northeast South Island is an important mainland New Zealand breeding site for several species of seabird, which are probably remnant of a larger distribution before human disturbance. For example, this area contains the only inland breeding site for Hutton's shearwater (*Puffinus huttoni*). Fur seal, gulls, terns, and penguins also breed on this coast. Estuaries on either side of Banks Peninsula are major national and international migratory wader feeding sites. The coast is also an important breeding and feeding area for Hector's dolphin (*Cephalorynchus hectori*), and is home to a small number of semi-resident sperm whales which feed in the deep local trenches.

Criteria applied:

Trophic/functional diversity; seasonal/migratory importance

Status and management:

A marine mammal sanctuary was declared around Banks Peninsula in 1988 with the specific purpose of protecting Hector's dolphin from fisheries bycatch. The sanctuary extends from Sumner Head to the Rakaia River, and out to a distance of four nautical miles – an area of 1,140km^2. There is a total ban on all set-netting from November to the end of February. During the rest of the year set-netting is permitted within the sanctuary area subject to some restrictions.

State of information:

Information on Hector's dolphin biology, breeding behaviour and distribution is good.

References and further reading:

Challies and Burleigh (2004), Childerhouse *et al.* (1995), Cuthbert *et al.* (2001), Cuthbert (2002a, 2002b), Dawson *et al*. (2000), Dawson and Slooten (1993).

Hutton's shearwater

West coast of South Island

Map ID number:

8

Location: out to the 500 m depth contour, from Dusky Sound in the south to western edge of Farewell Spit in the north

Approximate area: 50,506km^2

Description of area:

The west coast of the South Island has an open coast and continental shelf. The shelf widens toward the north. The southern end of the region includes fiord systems that are unique to New Zealand.

Biological attributes:

New Zealand's largest population of the endemic Hector's dolphin (*Cephalorynchus hectori*) is found on the west coast of the South Island. Bottlenose dolphins (*Tursiops truncatus*) are resident in the fiords. A significant proportion of New Zealand's fur seal (*Arctocephalus forsteri*) population lives on this coast, which is an important foraging area for this species. The Westland black petrel (*Procellaria westlandica*) also forages on the west coast and breeds there in the winter. The Fiordland crested penguin (*Eudyptes pachyrhynchus*) is a locally endemic species.

Criteria applied:

Conservation status/threat classification (Hector's dolphin).

Status and management:

There are minimal land-based human impacts on the west coast of the South Island due to the low level of development in this area. Some of the marine fauna, however, is at risk from human activities at sea. For example, the continental shelf is an important commercial fishing area for hoki, which has a bycatch of fur seals. In contrast, the fisheries appear to benefit Westland petrels which scavenge the discards of the harvest.

Fiordland crested penguin

State of information:

Population estimates of Hector's dolphins and fur seals north of Fiordland are good (e.g. Slooten *et al.* 2002). There are detailed studies of Fiordland bottlenose dolphins, but poor information on fur seal populations in the fiords. Distribution information on penguins is good, but abundance information for these birds is poor.

References and further reading:

Freeman *et al.* (2001), Freeman and Wilson (2002), Slooten *et al.* (2002), Bräger and Schneider (1999), Williams *et al.* (1993).

North coast of South Island

Map ID number:

9

Location: Whanganui Inlet to Cloudy Bay

Approximate area: 15,771km^2

Description of area:

Continental shelf with shallow seas.

Biological attributes:

The north coast of the South Island is home to many inshore species. The area is of major importance for wading birds, which congregate here in large numbers. Farewell Spit is a key wintering ground for Northern Hemisphere waders. Gannets are found along this coast, there are 6 petrel species, and a large fairy prion (*Pachyptila turtur*) colony. There is also a population of the rare and endangered king shag (*Leucocarbo carunculatus*), which is restricted to the Marlborough Sounds.

The area is habitat for a variety of small cetaceans, including Hector's dolphins (*Cephalorynchus hectori*), bottlenose dolphins (*Tursiops truncates*), and orcas (*Orcinus orca*). There have been a number of beaked whale strandings on this coast. Fur seals (*Arctocephalus forsteri*) breed in this area.

Criteria applied:

Endemism; conservation status/threat classification.

Status and management:

Takapourewa Island and others have iwi involvement in management. There is human disturbance on the islands as a result of fishing.

State of information:

Good.

References and further reading:

Schukard (1994), Clement *et al.* (2001).

King shag colony, Marlborough Sounds

Trench zone

Map ID number:

10

Location: Canyon and trench systems running from the Kaikoura Canyon in the south up the east coast of the North Island, taking in the Nicholson Canyon, Hikurangi Trench, and north-eastward following the Kermadec Trench up to 25ºS

Approximate area: 169,495km^2

Description of area:

Areas of deep water. Canyon and deep trench (up to 11 km deep) systems.

Biological attributes:

New Zealand's trench zone is an area of high productivity and consequently an attractive habitat for deep-diving species of cetacean, such as sperm whales. It is the primary New Zealand habitat for pygmy sperm whales (*Kogia breviceps*) and beaked whales (*Mesoplodon peruvianus*), which may use the trench as a north-south migration corridor. These whales forage in the trench zone, primarily for squid. There are at least 10 species of beaked whale in the area, which contribute to making New Zealand the richest country in the world in terms of beaked whale diversity (Baker 1999). Other offshore species of dolphins and whales found in the corridor include pilot whales, Risso's dolphins (*Grampus griseus*), and southern right whales (*Eubalaena australis*). In the north there are common (*Delphinus delphis*) and striped dolphins (*Stenella coeruleoalba*), and Dusky dolphins (*Lagenorhynchus obscurus*) in the south. The Hikurangi Trench has the greatest number of pygmy sperm whales in New Zealand waters. In warm water years there are strandings of short finned pilot whales (*Globicephala macrorhynchus*) and more tropical species such as striped dolphins, toothed dolphins (*Steno bredanensis*), and dense beaked whales (*Mesoplodon densirostris*).

Criteria applied:

Species diversity (whales).

Status and management:

Marine mammals have high cultural significance in New Zealand. Sperm whales in particular have great importance to Maori for bone carving and whale watching is culturally significant to most New Zealanders.

State of information:

Good.

References and further reading:

Baker (1999), Childerhouse *et al.* (1995), Jaquet *et al.* (2000).

Sperm whale

Coastal shelf and edge of the southeast coast and East Cape of the North Island

Map ID number:

11

Location: southeast coast of North Island

Approximate area: 29,860km^2

Description of area:

Continental shelf, edge, and slope with various current gyres influenced by subtropical currents.

Biological attributes:

The coastal shelf and edge off of the east coast of the North Island is a significant feeding area for a range of seabirds and marine mammals. The importance of this area for feeding is associated with areas of rich oceanic mixing. The mixing zones near the East Cape are foraging habitat for seabirds from the northern subtropical and east regions to the Chatham Islands. This zone is part of the seabird migratory route from the southern islands and east coast of the South Island to North Pacific wintering grounds.

Mammals found in the area include pygmy sperm whales (*Kogia breviceps*), beaked whales, sperm whales, common dolphins (*Delphinus delphis*), Risso's dolphins (Grampus griseus), long- and short-finned pilot whales (*Globicephala macrorhynchus* and *G. melas respectively*), oceanic dolphins, and orcas (*Orcinus orca*). There is possibly a small population of Hector's dolphins (*Cephalorynchus hectori*).

Criteria applied:

Seasonal/migratory importance.

Status and management:

No specific management measures other than protection afforded by the Exclusive Economic Zone.

State of information:

Information on seabirds and mammals in this area is poor except for gannet populations at Cape Kidnappers, bycatch species data, and beaching records of various whales in Hawke Bay.

References and further reading:

Adams (1992), Department of Conservation (2004), Robertson (1990).

Hauraki/northeast coast of North Island

Map ID number:

12

Location: Hauraki Gulf, islands and coastal region north to the Cavalli Islands out to 100 m depth contour

Approximate area: 14,878km^2

Description of area:

The northeast coastal area is deeply dissected by inlets, harbours, and bays with numerous inshore and offshore islands. Marine habitats range from oceanic to estuarine. Oceanic habitat is strongly influenced by warm tropical waters from the northwest and northeast. The main oceanographic influences are the East Australian current (south flowing), and adjacent deep water to 1000m. Promontories such as Cape Brett and Cavalli Island create eddying areas on their northern sides where food concentrates.

Biological attributes:

The Hauraki Gulf/Northeast coast provides habitat for common (*Delphinus delphis*) and bottlenose (*Tursiops truncates*) dolphins, orcas (*Orcinus orca*), beaked whales (*Mesoplodon* spp.), dwarf minke whales (*Balaenoptera acutorostrata*), Bryde's whales (*B. edeni*), and tropical vagrant and migrating species. Large baleen whales migrate through this area, foraging as they go. The high concentrations of prey species, especially fish, make the area attractive to many different marine mammals and seabirds, some of which breed there.

Seabirds found in the area include 10 species of tern and a concentration of gannets. It is also a major habitat for migrating wader birds. The area is characterised by species richness, including some diversity in the form of vagrant tropical species, and marked seasonal occurrence. Birds from north and south, such as albatrosses and petrels, visit the area to feed. There are 12 petrel species in the area, 11 of which have major colonies. A third of the petrel species are endemic.

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Bottle-nosed dolphin

Criteria applied:

Species richness; endemism; conservation status/threat classification.

Status and management:

The Bryde's whale population is resident and small and is therefore classified as nationally critical under the DoC classification. This area has significant human impacts through ship traffic, fishing, pollution, and other forms of disturbance. The Hauraki Gulf is designated as a marine park.

State of information:

Information for this area is moderately good. Species information is accurate, as is oceanographic information. It is one of the more researched areas of the New Zealand coast.

References and further reading:

Baker (1999), Imber *et al.* (2003a, 2003b, 2003c), O'Callahan (2002).

West Coast of North Island

Map ID number:

13

Location: Inshore coastal zone between North Taranaki and 90 Mile Beach out to approximately 10 nautical miles

Approximate area: 5,471km^2

Description of area:

The west coast of the North Island has exposed beaches with 4 bar-protected harbours including large areas of Manukau and Kaipara harbours. The area lies mostly within the 100m depth contour.

Biological attributes:

The west coast of the North Island is the only habitat for New Zealand's endemic Maui's dolphin (*Cephalorynchus hectori maui*), which is a subspecies of the endemic Hector's dolphin (*Cephalorynchus hectori*). The estuaries in the area also provide overwinter habitat for migrating waders.

Criteria applied:

Conservation status/threat classification.

Status and management:

The area has a wild, westerly impacted coastline with minimal land development and maritime use. Maui's dolphin, however, is critically endangered due to a small population that is threatened by human interaction. A ban on set-nets applies from the shore to 4 nautical miles and a ban on trawling applies from the shore to 1 nautical mile to protect Maui's dolphin.

State of information:

Information for this area is good, particularly with regard to accurate species information.

References and further reading:

Baker *et al.* (2002), Ferreira and Roberts (2003), Russell (1999).

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Maui's dolphin

Three Kings Islands

Map ID number:

14

Location: Offshore islands 25 nautical miles north of North Cape consisting of 3 main island groups and surrounding oceans

Approximate area: 12,479km^2

Description of area:

Environment influenced by cold water upwelling in a subtropical/warm temperature area.

Biological attributes:

The Three Kings Islands represent the limits of the range of several species. They are the most northern haul-out for the New Zealand fur seal (*Arctocephalus forsteri*), the most northern breeding ground in the Exclusive Economic Zone for Australasian gannets (*Morus serrator*), and the extremity of range for fluttering shearwater. The islands are the most northern breeding locality for Pacific albatross (*Thalassarche platei*), 3 petrel species, and fluttering shearwaters (*Puffinus gavia*).

Criteria applied:

Extremities of range and adaptation to environment

Status and management:

The land areas of the islands are in their natural state, with no mammals present. They are relatively undisturbed, although humans and goats historically occupied the islands.

State of information:

Information for this area is good, particularly with regard to accurate species and oceanographic information.

References and further reading:

Buddle (1949), Ramsay and Watt (1971), Wright (1984).

Australasian gannets

West coast basin

Map ID number:

15

Location: Offshore Basin system – particularly the southern end of New Caledonia Basin and inshore to Kaipara in the north to Wanganui in the south

Approximate area: 134,312km^2

Description of area:

The head of the New Caledonia Trough is a major re-entrant that leads directly to the continental margin off the west coast of the North Island. The ocean circulation is not well known, but the shallow rim of the trough may be affected by an ephemeral West Auckland Current. Sediments become progressively finer grained and carbonate enriched with distance and depth from the edge of the continental shelf, marking the rim of the trough. Thus, at 1,600m water depth, the predominantly muddy sediments contain about 50% biogenic carbonate composed mainly of planktonic foraminifers and possible coccoliths. This compares to less than 10% on the continental shelf and upper slope where the main carbonate contribution is from molluscan shells (L. Carter, personal communication 2004).

Biological attributes:

The west coast basin is likely to contain foraging and breeding grounds for rarely seen and unusual cetaceans. Species include pygmy right whales (*Caperea marginata*), Shepherd's beaked whale (*Tasmacetus shepherdi*) (type specimen from Wanganui), false killer whales (*Psuedorca crassidens*), long-finned pilot whales (*Globicephala melas*), Gray's beaked whale (*Mesoplodon grayi*), and Maui's dolphin (*Cephalorynhus hectori maui*). Globally the region is important for pygmy right whales.

Criteria applied:

Species diversity (indicative for cetaceans, not known to be a key area for seals or seabirds).

Status and management:

No specific management measures other than protection afforded by the Exclusive Economic Zone.

State of information:

From stranding data this was suggested as an important area for Shepherd's beaked whales and pygmy right whales, but is not supported with strong data. The ?-mark on Area 15 (p20, West Coast Basin) reflects this uncertainty.

References and further reading:

Department of Conservation (2004).

Shepherd's beaked whale

Kermadec Islands

Map ID number:

16

Location: 3 island groups along the Kermadec ridge

Approximate area: 23,565km^2

Description of area:

The subtropical Kermadec Islands are clustered in 3 groups along the Kermadec Ridge and span approximately 150 nautical miles from north to south.

Biological attributes:

Seven petrels breed on the Kermadec Islands, 2 of which are endemic. Many petrels and shearwaters that breed in the Kermadecs also breed elsewhere across similar latitudes of all southern oceans. Other seabirds found on the islands include inshore seabirds, such as terns, noddies, and boobies, and transient waders.

Migrating large whales are found over the deep waters of the Kermadec Trench seasonally. Also, beaked whales have been reported from the area, as have striped dolphins (*Stenella caeruloalba*). A small resident population of bottlenose dolphins (*Tursiops truncates*) lives around the main islands.

Kermadec petrel

Criteria applied:

Endemism (birds).

Status and management:

The two main islands of the Kermadecs are highly modified by pests.

State of information:

Poor

References and further reading:

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TO CONTENTS

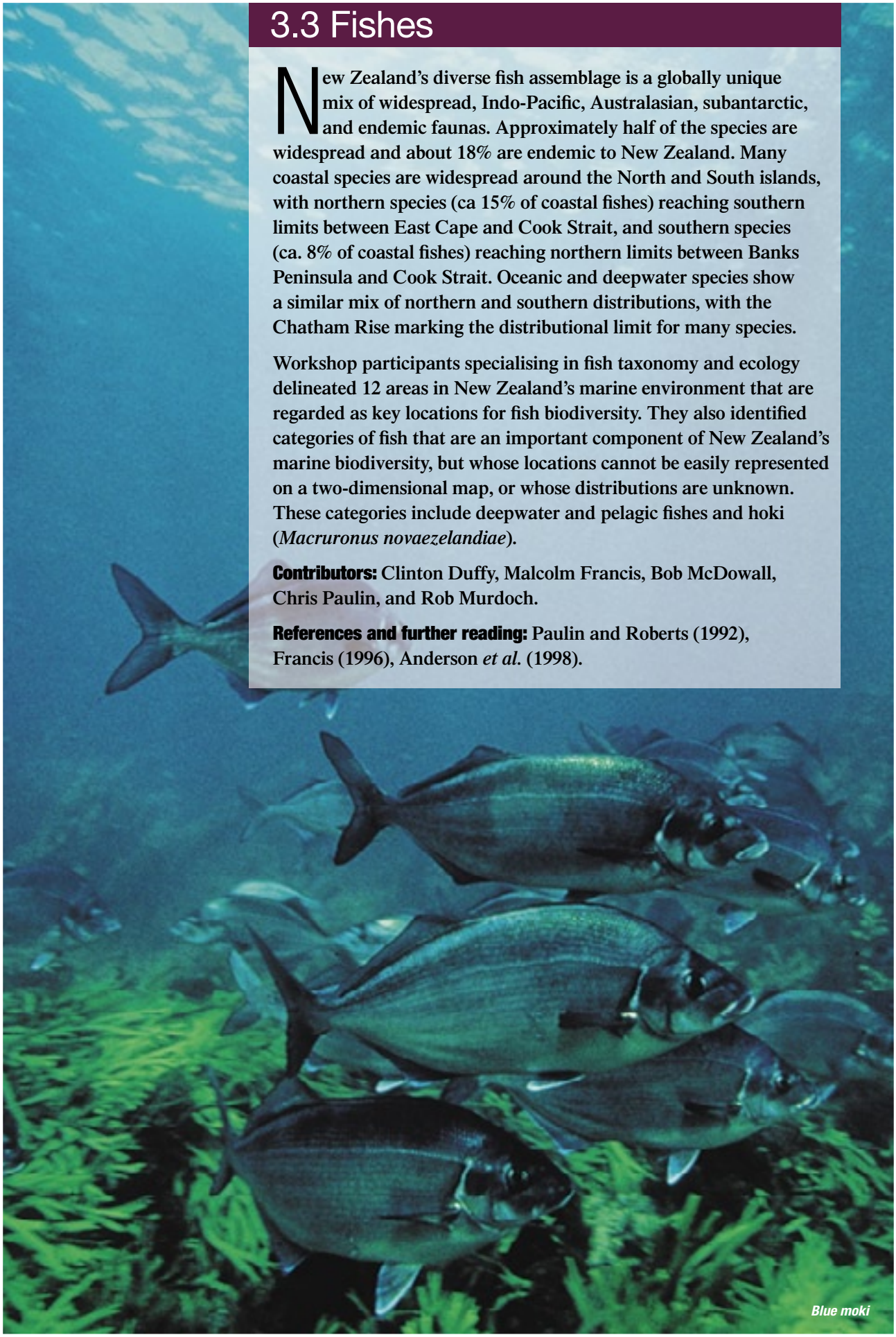
3.3 Fishes

New Zealand's diverse fish assemblage is a globally unique mix of widespread, Indo-Pacific, Australasian, subantarctic, and endemic faunas. Approximately half of the species are widespread and about 18% are endemic to New Zealand. Many coastal species are widespread around the North and South islands, with northern species (ca 15% of coastal fishes) reaching southern limits between East Cape and Cook Strait, and southern species (ca. 8% of coastal fishes) reaching northern limits between Banks Peninsula and Cook Strait. Oceanic and deepwater species show a similar mix of northern and southern distributions, with the Chatham Rise marking the distributional limit for many species.

Workshop participants specialising in fish taxonomy and ecology delineated 12 areas in New Zealand's marine environment that are regarded as key locations for fish biodiversity. They also identified categories of fish that are an important component of New Zealand's marine biodiversity, but whose locations cannot be easily represented on a two-dimensional map, or whose distributions are unknown. These categories include deepwater and pelagic fishes and hoki (*Macruronus novaezelandiae*).

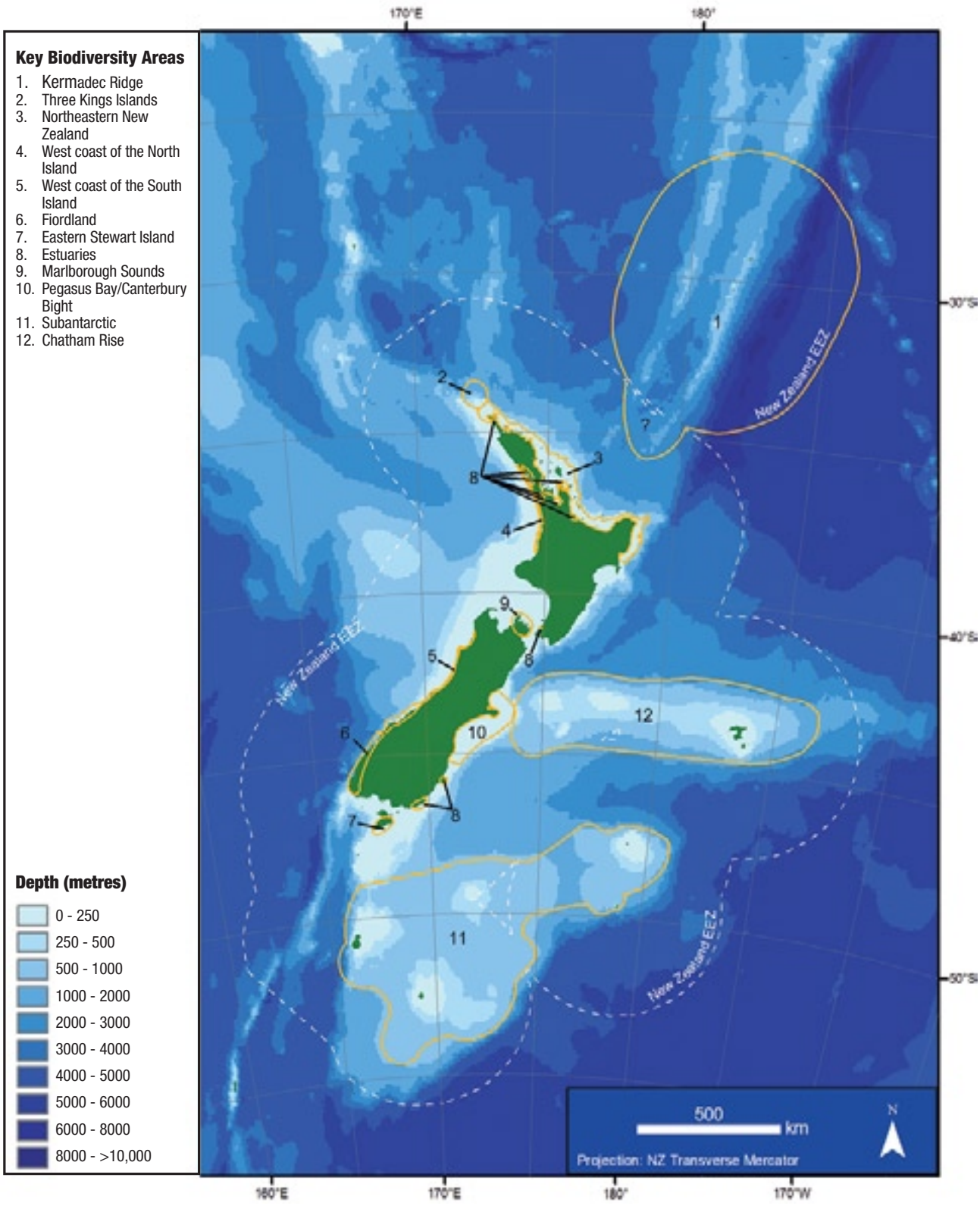
Contributors: Clinton Duffy, Malcolm Francis, Bob McDowall, Chris Paulin, and Rob Murdoch.

References and further reading: Paulin and Roberts (1992), Francis (1996), Anderson *et al.* (1998).



Blue moki

Key areas for fish biodiversity in the New Zealand marine ecoregion



Kermadec Ridge

Map ID number:

1

Location: Northeastern New Zealand

Approximate area: 661,885km^2

Description of area:

The Kermadec Islands are geographically isolated from New Zealand and other subtropical and tropical islands that may serve as source areas for planktonic larvae. The area is characterised by steep rocky islets and seamounts. The Kermadec Ridge connects the deeper waters of the New Zealand mainland with tropical waters to the north. The neighbouring Kermadec Trench is the deepest region in New Zealand's Exclusive Economic Zone, and one of the deepest in the world.

Biological attributes:

The Kermadec Ridge has a diverse fish fauna that includes several endemic species. The area is isolated from mainland New Zealand waters by the Tropical Convergence and there are biogeographic affinities with Norfolk Island and the Lord Howe Rise, with a large subtropical species component not found elsewhere in New Zealand. The Kermadec Islands are home to the world's largest population of spotted black grouper (*Epinephelus daemelii*), which is a protected species.

Criteria applied:

Species richness; endemism; representation; conservation status/threat classification both nationally and globally; extremities of range and adaptation to environment; special phylogenetic grouping; habitat complexity/diversity; meeting ground – overlap between biological regions (at national and global regions level); links to global patterns.

Status and management:

Spotted black grouper are vulnerable to exploitation because of their longevity and large size (up to 2 m), their sex-changing population dynamics, their existence in shallow water (to 50 m), and their territorial behaviour. They are protected by the Wildlife Act (1953). The waters around all the Kermadec Islands are protected by a marine reserve. The reserve extends out to 12 nautical miles and encompasses an area of 7,450km^2.

State of information:

The ?-mark on Area 1 (Kermadec Ridge) indicates uncertainty in placement of this boundary due to insufficient sampling to determine how far along the ridge the distinctive elements of the fauna extend. This boundary fluctuates with the seasonal movement of the convergence zone. Basic knowledge exists of the fauna, but the ecology is virtually unstudied.

References and further reading:

Cole (2001), Cole *et al.* (1992), Francis (1993, 1996, 2001), Francis *et al.* (1987).

School of trevally

Three Kings Islands

Map ID number:

2

Location: Northern New Zealand

Approximate area: 6,411km^2

Description of area:

Tidal mixing around the Three Kings Islands causes uplift of cold subsurface water. Steep rock faces, caves and archways are notable habitats found around the islands.

Biological attributes:

The Three Kings Islands have a moderate level of biological diversity. Blue-finned butterfish (*Odax cyanoallix*) is endemic to the islands except for a few stragglers recorded near Cape Reinga and on the east Northland coast. (This species has one of the most restricted geographical distributions of any fish species in the New Zealand region.) The protected spotted black grouper (*Epinephelus daemelii*) is more common here than anywhere else in New Zealand except the Kermadec Islands. The uplift of nutrient-rich subsurface water supports a rich community of plankton, pelagic fishes (e.g. trevally *Pseudocaranx dentex*) and seabirds (especially red-billed gulls).

Criteria applied:

Species richness; endemism; trophic/functional diversity; representation (i.e. across physical types); extremities of range and adaptation to environment; special conditions and specialised organisms; aggregations; special phylogenetic grouping; meeting ground – overlap between biological regions (at national and global regions level).

Status and management:

Populations of reef-associated fishes such as hapuku (*Polyprion oxygeneios*), bass (*P. americanus*), and king tarakihi (*Nemadactylus* sp.) are impacted by commercial and recreational fishing.

State of information:

Basic knowledge exists of the fauna, but the ecology is virtually unstudied.

References and further reading:

Brook (2002), Francis (1996), Hardy *et al.* (1987).

Northeastern New Zealand

Map ID number:

3

Location: North Cape to Poverty Bay

Approximate area: 37,240km^2

Description of area:

This northeastern quadrant of the North Island has many offshore islands and rock stacks. The warm East Auckland Current flows through the region. There is a high diversity of habitat types, from estuaries and sandy beaches to steep rocky cliffs, archways, caves, and islands.

Biological attributes:

The highest regional species richness for reef fishes is found in this area, especially around offshore islands and coastal headlands. A high proportion of the fishes found here are subtropical species. In the spring and summer there is an immigration of larvae and juveniles of subtropical and tropical species from areas outside New Zealand's Exclusive Economic Zone. Oceanic migratory species such as whale shark (*Rhincodon typus*), manta rays (*Manta birostris, Mobula japanica*), marlins, tunas, mako shark (*Isurus oxyrinchus*), and blue shark (*Prionace glauca*) are common in the area from mid to late summer.

Criteria applied:

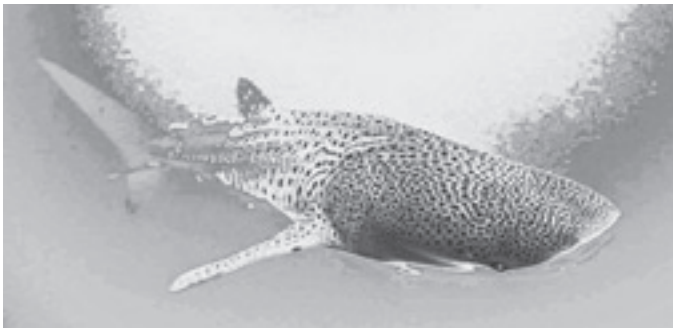
Species richness; trophic/functional diversity; representation (i.e. across physical types); degree of disturbance; seasonal/migratory importance; unusual degree/proportion of biomass; aggregations; habitat complexity/diversity; meeting ground – overlap between biological regions (at national and global regions level); links to global patterns.

Status and management:

Inshore waters are among the most heavily fished in New Zealand. The region supports several marine reserves and other protected areas. The presence of major ports and associated shipping routes in the region are contributing factors in alien species invasions.

State of information:

Probably the best-studied inshore fish fauna in New Zealand.



Whale shark

References and further reading:

Brook (2002), Francis (1996, 2001), Francis and Evans (1993), Francis *et al*. (1999), Kendrick and Francis (2002), Willis *et al.* (1999).

West coast of North Island

Map ID number:

4

Location: Tongaporutu (White Cliffs) to Maunganui Bluff (less than 30 m depth)

Approximate area: 1,937km^2

Description of area:

The west coast of the North Island has a mixture of volcanic and sedimentary rocky reefs on a high-energy shore, and the sea is usually turbid. Sedentary organisms are subject to burial by sand.

Biological attributes:

The benthic reef fish of this area are dominated by the giant triplefin (*Blennodon dorsale*) and the robust triplefin (*Grahamina gymnota*). Some species, such as sweep (*Scorpis lineolatus*), red moki (*Cheilodactylus spectabilis*), and snapper (*Pagrus auratus*), are more abundant here than they are in the cooler waters of the west coast of the South Island. Trevally (*Pseudocaranx dentex*) form large schools along this coast.

Criteria applied:

Trophic/functional diversity; representation (i.e. across physical types); degree of disturbance; special conditions and specialised organisms; unusual degree/proportion of biomass; aggregations.

Status and management:

There are large fisheries for snapper and trevally in inshore waters.

State of information:

Basic knowledge exists of the fauna, but the ecology is virtually unstudied.

References and further reading:

C. Duffy (unpubl. data), Francis (1996), King *et al.* (1985), C. Paulin (unpubl. data).

Red moki

West Coast of South Island

Map ID number:

5

Location: Kahurangi Point to Cascade Point

Approximate area: 5,167km^2

Description of area:

The west coast of the South Island is a high-energy shore with scouring by sand and cobbles, and high turbidity.

Biological attributes:

This area has low fish biomass and diversity. It is habitat for the giant triplefin (*Blennodon dorsale*), which is rare in other regions. A possibly endemic clingfish lives on this coast. The west coast has always had the biggest New Zealand whitebait (*Galaxias maculatus*) fishery, which has national importance, especially in the south. It also features large offshore winter spawning aggregations of hoki (*Macruronus novaezelandiae*).

Criteria applied:

Endemism; representation (i.e. across physical types); cultural values; extremities of range and adaptation to environment; degree of disturbance; special conditions and specialised organisms; seasonal/migratory importance; unusual degree/proportion of biomass; aggregations.

Status and management:

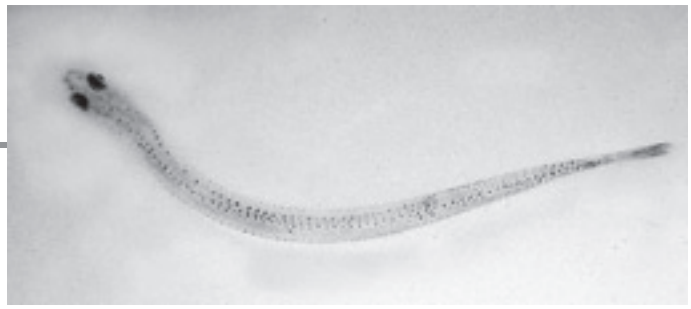
The pre-eminence of the whitebait fishery has probably been accentuated historically by the fact that the this coast remains relatively well covered by indigenous forest and has suffered less wetland damage than other areas of New Zealand. Major coastal and offshore fisheries targeting various fish species operate in the area.

State of information:

Moderately well studied, especially the fishes of the continental shelf and upper continental slope.

References and further reading:

Francis (1996), McDowall (1990), McDowall and Eldon (1980), Roberts *et al.* (2001).



Whitebait

Fiordland

Map ID number:

6

Location: Southwest New Zealand

Approximate area: 7,214km^2

Description of area:

Fiordland has deeply indented fiords with a surface freshwater layer that creates "estuarine" circulation. The fiords have deep inner basins protected by shallow sills near the entrances that isolate the fiords from each other and from the open sea.

Biological attributes:

Fiordland has fish assemblages typical of southern New Zealand but with "deepwater emergent" species: some deepwater species live at shallower depths than in other regions. The strong environmental gradients generate marked longitudinal and depth patterns in fish assemblages and abundance. Pelagic species, such as albacore tuna (*Thunnus alalunga*), butterfly tuna (*Gasterochisma melampus*), thresher sharks (*Alopias vulpinus*), and blue sharks (*Prionace glauca*) occur inside fiords. It is unusual to find these species in enclosed waters. There is limited recruitment in the waters of Fiordland, and limited exchange of recruits among fiords because of the water circulation patterns. The only fish known to be endemic to the fiords is the brotula, *Fiordichthys slartibartfasti*.

Criteria applied:

Species richness; endemism; trophic/functional diversity; representation (i.e. across physical types); extremities of range and adaptation to environment; special conditions and specialised organisms; habitat complexity/diversity.

Status and management:

Historically, there were large rock lobster (*Jasus edwardsii*) fisheries in the fiords, and associated fishing for bait. This fishery is now largely confined to the outer fiords. A management strategy for Fiordland prepared by The Guardians of Fiordland's Fisheries proposes a complete ban on commercial fishing within the inner fiords. Recreational fishing for blue cod (*Parapercis colias*) is common in the fiords. Two marine reserves occur in Fiordland.

State of information:

Good information on fish communities, some information on distribution and abundance, but little is known of fish ecology.

References and further reading:

Francis *et al.* (1989), Guardians of Fiordland's Fisheries (2001), Ryan and Paulin (1998), Teirney (2003).

Eastern Stewart Island

Map ID number:

7

Location: Stewart Island

Approximate area: 2,925km^2

Description of area:

Deeply indented bays and harbours, exposed rocky coastlines, and offshore islands. Pristine inlets and estuaries with large sea grass (*Zostera* sp.) and red algal (*Lenormandia chauvini*) beds.

Biological attributes:

Eastern Stewart Island has sand-dwelling fish species such as sand divers (*Tewara cranwellae, Limnichthys* spp.), and high population densities of blue cod (*Parapercis colias*), butterfish (*Odax pullus*), wrasses, blue moki (*Latridopsis ciliaris*), trumpeter (*Latris lineata*), and southern pigfish (*Congiopodus leucopaecilus*). Estuary headwaters have abundant galaxiids and smelt (*Retropinna retropinna*). Paterson Inlet, and possibly the other large inlets along the eastern side, appear to be important nursery areas for trumpeter – large schools of juveniles are a feature of rocky reefs inside the inlet.

Criteria applied:

Representation (i.e. across physical types); extremities of range and adaptation to environment; habitat complexity/diversity; meeting ground – overlap between biological regions (at national and global regions level).

Trumpeter, Paterson Inlet, Stewart Island

Status and management:

There is a low level of exploitation on this part of the island, with "pristine" unmodified catchments at the head of estuaries. A marine reserve and a mataitai have been declared in Paterson Inlet.

State of information:

Some fish survey work has been done in estuaries and coastal waters.

References and further reading:

Francis (1996).

Estuaries

Map ID number:

8

Location: Throughout New Zealand, except for the smaller offshore islands

Approximate area: 79,040km^2 (summation of the surface areas of all New Zealand estuaries at high water)[5]

Description of area:

Estuaries have been classified into eight categories (e.g. tidal lagoon, drowned valley, sound, coastal embayment) based on climate, oceanic and riverine conditions, and catchment characteristics.

Biological attributes:

Estuaries are critical habitat for diadromous fishes because they serve as conduits between freshwater and marine environments. Estuaries are a key habitat for spawning by diadromous species (species that migrate between fresh and salt waters). Some species deposit their eggs among terrestrial plants when spring tides flood this marginal vegetation. For juveniles of many commercial fish species, such as flounders (*Rhombosolea* spp.), mullets (*Aldrichetta forsteri, Mugil cephalus*), snapper (*Pagrus auratus*), rig (*Mustelus lenticulatus*), red gurnard (*Chelidonichthys kumu*) and others, estuaries are essential nursery habitat. They are the sole habitat for a range of mainly small species such as estuarine triplefin (*Grahamina nigripenne*) and gobies (*Favonigobius lentiginosus, F. exquisitus*), some of which are endemic.

Red gurnard

Criteria applied:

Endemism; dependency for other species; trophic/functional diversity; representation (i.e. across physical types); conservation status/threat classification both nationally and globally; cultural values; extremities of range and adaptation to environment; degree of disturbance; seasonal/migratory importance; aggregations; habitat complexity/diversity.

Status and management:

Many estuaries are heavily impacted by humans, but some that are nearly pristine include Parengarenga, Whanganui, Catlins, and several on Stewart Island. Catchment and estuarine development are major threats to this habitat type.

State of information:

Northern North Island estuaries and southern South Island estuaries have been studied in some detail.

References and further reading:

Hartill *et al.* (2003), Hicks *et al.* (2004), Hume *et al.* (2003), McDowall (1990, 1998), Morrison *et al.* (2002).

[5] Source for estuarine areas: http://finz.niwa.co.nz/NewZealand/viewer.htm

Marlborough Sounds

Map ID number:

9

Location: Cloudy Bay to Croiselles Harbour, Tasman Bay

Approximate area: 4,450km^2

Description of area:

The Marlborough Sounds are a complex drowned valley system spanning strong gradients in depth, tidal mixture, temperature, and wave exposure. As a result of these physical influences there are a wide range of habitats, including stream mouths and large estuaries, sheltered rocky shores with low algal biomass, shallow sand and mud habitats, and exposed eastern shores subject to high wave exposure and strong tidal currents.

Biological attributes:

Small pelagic fishes, such as sprats (*Sprattus* spp.), anchovy (*Engraulis australis*), and pilchards (*Sardinops neopilchardus*) are abundant in the Marlborough Sounds. These are important prey for seabirds such as shearwaters and gannets, and for bottlenose, dusky, and Hector's dolphins. Estuaries and streams in the area are important for diadromous fishes (fishes that migrate between fresh and salt waters). Bryozoan beds at Chetwode, Titi, Trio, and Rangitoto islands support diverse assemblages of small benthic fishes (including juvenile commercial species such as blue cod (*Parapercis colias*)). Large schools of planktivores (predominantly butterfly perch *Caesioperca lepidoptera*) also live among the bryozoan beds. Deepwater emergence is observed at Port Underwood where lantern fishes, rat tails, and dark ghost sharks (*Hydrolagus novaezealandiae*) are found shallower than in other regions. The inner Queen Charlotte and Pelorus Sounds are spawning grounds for elephant fish (*Callorhinchus milii*). The Marlborough Sounds are the southern range limit for pink brotula (*Brosmodorsalis persicinus*): Queen Charlotte Sound and Port Hardy are the only sites south of East Cape where this species has been recorded.

Criteria applied:

Dependency for other species; trophic/functional diversity; representation (i.e. across physical types); extremities of range and adaptation to environment; degree of disturbance; special conditions and specialised organisms; habitat complexity/diversity.

Status and management:

The Marlborough Sounds are major recreational fishing grounds, particularly for blue cod. However, rocky habitat is limited to a thin strip around the sides of most sounds, which means that overfishing is a problem. Allowable catches for both commercial and recreational fisheries have been reduced in response. In the outer sounds and Cook Strait there is an important commercial and recreational hapuku (*Polyprion oxygeneios*) fishery. There were historical fisheries for this species inside both sounds.

State of information:

Moderately well studied.

References and further reading:

C. Duffy (unpubl. data), Hurst *et al.* (2000b), Johnston (1983).

Pegasus Bay/ Canterbury Bight

Map ID number:

10

Location: Waitaki River to north of Waimakariri River

Approximate area: 22,288km^2

Description of area:

Long, exposed, soft-shore coastline with a major rocky headland, Banks Peninsula. There is high primary productivity at times in the Canterbury Bight.

Biological attributes:

Stokell's smelt (*Stokellia anisodon*) is endemic to the eastern South Island. It is the only diadromous freshwater fish species that does not have a New Zealand-wide range. The reasons for this restricted range are not understood, but may relate to enclosure of a triangular area of sea inside the current system that passes north from Otago and along the Canterbury coast. Interestingly, this is the same area inhabited by the introduced Chinook salmon (*Oncorhynchus tshawytscha*) population, which undergoes natural dispersion in the sea. Other notable species found in this area include basking shark (*Cetorhinus maximus*), elephantfish (*Callorhinchus milii*), and red cod (*Pseudophycis bachus*). Basking sharks are common in spring and summer from the edge of the shelf to the coast, and even in Lake Ellesmere. During this period elephantfish form spawning aggregations and lay their eggs in shallow water. Red cod also form large aggregations in some years.

Criteria applied:

Species richness; endemism; dependency for other species; trophic/functional diversity; representation (i.e. across physical types); degree of disturbance; seasonal/migratory importance; unusual degree/proportion of biomass; aggregations; habitat complexity/diversity; meeting ground – overlap between biological regions (at national and global regions level.

Status and management:

There are major fisheries along this coast, and some estuaries and bays are heavily impacted by human shore-based activities.

State of information:

The fish fauna has been intensively studied, especially on the continental shelf and upper continental slope.

References and further reading:

Beentjes and Renwick (2001), Beentjes *et al.* (2002), Francis (1997), Francis and Duffy (2002), Gorman (1963), McDowall (1990).

Subantarctic

Map ID number:

11

Location: Campbell Plateau and associated islands

Approximate area: 451,862km^2

Description of area:

Large plateau punctuated with extremely exposed rocky islands, some of which have sheltered bays and harbours.

Biological attributes:

There are few endemic fish species, but they represent a high proportion of the fauna overall. The area has low species diversity and abundance, but hosts a unique assemblage of reef fish species. Mesopelagic species such as southern blue whiting (*Micromesistius australis*) are abundant over the whole Campbell Plateau, and basking sharks (*Cetorhinus maximus*) and arrow squid (*Nototodarus* spp.) are abundant in aggregations on the western edge. The area is isolated from mainland New Zealand waters by the subtropical convergence zone.

Criteria applied:

Endemism; representation (i.e. across physical types); extremities of range and adaptation to environment; seasonal/migratory importance; unusual degree/proportion of biomass; aggregations; special phylogenetic grouping; habitat complexity/diversity; meeting ground – overlap between biological regions (at national and global regions level).

Status and management:

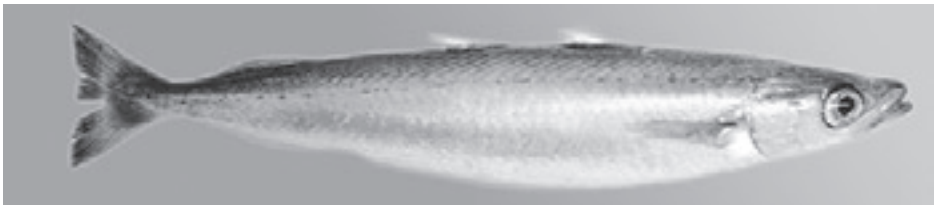
There are extensive fisheries for squid, southern blue whiting, and other species. A 12-nautical mile marine reserve around the Auckland Islands protects shallow inshore areas and also deep ocean environments down to 3000m deep. It encompasses an area of approximately 4,840km^2.

State of information:

The biological attributes are poorly known, although the southern blue whiting stock has been well studied.

References and further reading:

Anderson *et al.* (1998), Francis (1996), Francis and Duffy (2002), Kingsford *et al.* (1989), Hurst *et al.* (2000a, 2000b).



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Southern blue whiting

Chatham Rise

Map ID number:

12

Location: East of South Island

Approximate area: 261,904km^2

Description of area:

Long submarine ridge connecting the South Island and Chatham Islands.

Biological attributes:

The Chatham Rise is a highly productive area, which results in high abundance of many species, especially hoki (*Macruronus novaezelandiae*), orange roughy (*Hoplostethus atlanticus*), and oreos (*Oreosomatidae*). The northern and eastern margins of the rise are diversity hotspots. There is a strong north-south gradient in fish abundance across the rise. Some species occur only on northern and eastern margins, while some are only found on the southern margin.

Criteria applied:

Species diversity; species richness; trophic/functional diversity; representation (i.e. across physical types); degree of disturbance; species with a global distribution but New Zealand is a stronghold/significant; seasonal/migratory importance; unusual degree/proportion of biomass; aggregations; meeting ground – overlap between biological regions (at national and global regions level).

Status and management:

The Chatham Rise is one of the most heavily trawled parts of the New Zealand Exclusive Economic Zone.

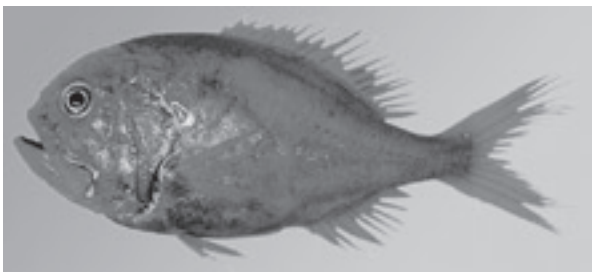
State of information:

The fish fauna has been intensively studied by research trawl surveys

References and further reading:

Anderson *et al.* (1998), Bull *et al.* (2001), Hurst *et al.* (2000a, 2000b), Livingston *et al.* (2003), O'Driscoll *et al.* (2003).

Orange Roughy



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Intertidal reefs

Not mapped during the workshop

Location: Throughout New Zealand

Approximate area: Not recorded during the workshop

Description of area:

Hard substrates adjacent to rocky land.

Biological attributes:

A high percentage of endemism (60%) has been recorded for intertidal fishes. Most species are widespread from North Cape to Stewart Island, but some are restricted to northern waters. The reef-dwelling clingfishes belong to endemic genera. For triplefins, New Zealand is the global "hotspot" of diversity, with around 30 species recorded (28 of these are endemic).

Criteria applied:

Species richness; endemism; representation (i.e. across physical types); cultural values; extremities of range and adaptation to environment; degree of disturbance; special conditions and specialised organisms; special phylogenetic grouping.

Status and management:

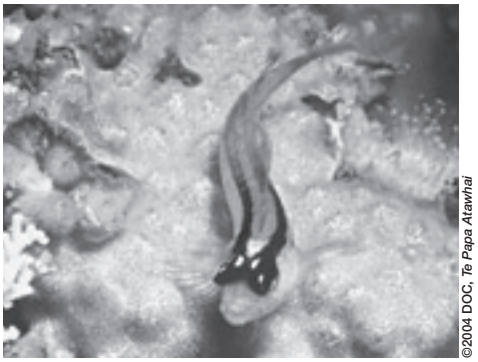
Vulnerable to land-based disturbance and fishing.

State of information:

Good knowledge in some parts of New Zealand but not others.

References and further reading:

Francis (1996, 2001), Paulin and Roberts (1992).



Yellow-black triplefin

Hoki

Not mapped during the workshop

Location: Throughout New Zealand except in the Kermadec Islands region; most abundant south of East Cape

Approximate area: Not recorded during the workshop

Description of area:

Not mapped during the workshop.

Biological attributes:

Hoki (*Macruronus novaezelandiae*) is the dominant fish species in depths of 200-800m. On the Chatham Rise, hoki biomass is equal to that of all other fishes combined. It occurs in around 97% of research trawl tows. There are massive hoki spawning aggregations off Hokitika Canyon, in Cook Strait, Conway Trough, and Mernoo Saddle. Adult and juvenile hoki are important prey for a variety of large marine predators including ling (*Genypterus blacodes*), hake (*Merluccius australis*), New Zealand fur seal (*Arctocephalus forsteri*) and dusky dolphin (*Lagenorhynchus obscurus*).

Criteria applied:

Dependency for other species; trophic/functional diversity; degree of disturbance; species with a global distribution but New Zealand is a stronghold/significant; seasonal/migratory importance; unusual degree/proportion of biomass; aggregations.

Status and management:

Hoki are heavily exploited and populations are currently declining. There has been a reduction in the allowable commercial catch from 250,000 tonnes/year in 2001 to 100,000 tonnes/year in 2004.

State of information:

Hoki are one of the most intensively studied New Zealand species.

References and further reading:

Anderson *et al.* (1998), Bull *et al.* (2001), Hurst *et al.* (2000a, 2000b), Livingston *et al.* (2003), O'Driscoll *et al.* (2003).

Hoki

Seamounts

Not mapped during the workshop

Location: Throughout the New Zealand Exclusive Economic Zone

Approximate area: Not recorded during the workshop

Description of area:

Over 500 submarine seamounts with an elevation greater than 250 m above the sea floor, and a further 300 between 100 and 250m, have been identified in the New Zealand region. These seamounts vary in shape and size and occur singly or in groups. Some have steep slopes with rugged tops, while others are more knoll-like with large, relatively flat tops.

Biological attributes:

Many seamounts have endemic species, but there has been insufficient sampling effort to confirm whether this endemism is confined to particular seamounts, or groups of seamounts. There are aggregations of some fish species around bathymetric features, especially Beryciform fishes including orange roughy (*Hoplostethus atlanticus*). Upwellings and tidal eddies concentrate phytoplankton biomass over seamounts and attract larger numbers of fish.

Criteria applied:

Species diversity; species richness; endemism; dependency for other species; trophic/functional diversity; representation (i.e. across physical types); conservation status/threat classification both nationally and globally; degree of disturbance; special conditions and specialised organisms; seasonal/migratory importance; unusual degree/proportion of biomass; aggregations; special phylogenetic grouping; habitat complexity/diversity.

Status and management:

Trawling is prohibited on 19 seamounts in New Zealand's Exclusive Economic Zone.

State of information:

Little information is available, but seamounts are a subject of increasing research.

References and further reading:

Clark *et al.* (2000), Tracey *et al.* (2004).

Deepwater

Not mapped during the workshop

Location: Throughout the New Zealand Exclusive Economic Zone

Approximate area: Not recorded during the workshop

Description of area:

Depths greater than 1500m.

Biological attributes:

There is a high diversity of deepwater fish species in New Zealand. They are often slow growing with high longevity. Fish sizes generally decrease from coastal waters to the lower continental slopes, however, at depths below 800-1000m there is an increase in the average size of demersal species. Below 1500 m there is a further decrease in the size of most demersal species, while some species take on gigantism (e.g. giant cods (*Lepidion* spp.), purple chimaera (*Chimaera lignaria*), sleeper shark (*Somniosus* sp.)). These deepwater species tend to be more specialised feeders, in part because of their morphological and functional adaptations to great depth, low light levels, and low food availability; populations have lower densities and communities with less diversity. These environments are more stable than the coastal environment, so they are less able to recover from anthropogenic disturbances. Diversity of sharks, rays, and chimaeras (*chondrichthyans*) is greatest over the continental slope (200-2500m depth). All but one of the 14 chimaera species normally occur below the shelf break. Fifteen species of sharks (20% of the fauna) inhabit the outer continental shelf and upper slope, and 32 species (44%) are found only on the continental slope (below about 200m depth). Twelve percent of rays inhabit the outer shelf and upper slope, and 56% are restricted to the slope. The latter include 15 species of skates and two small, blind electric rays (*Typhlonarke* spp.). Endemism is particularly high among the skates (94%), which includes 8 undescribed species of *Notoraja*.

Criteria applied:

Endemism; dependency for other species; representation (i.e. across physical types); extremities of range and adaptation to environment; special conditions and specialised organisms; species with a global distribution but New Zealand is a significant stronghold; special phylogenetic grouping.

Status and management:

There is no specific management for deepwater habitat, but see Seamounts above.

State of information:

New Zealand's deep waters are poorly sampled, especially below 1500m.

References and further reading:

Anderson *et al.* (1998), Francis *et al.* (2002), Merrett and Haedrich (1997), O'Driscoll *et al.* (2003).

Dark ghost shark ©NIWA

Epipelagic fishes

Not mapped during the workshop

Location: Throughout New Zealand's Exclusive Economic Zone

Approximate area: Not recorded during the workshop

Description of area:

Surface waters to depths of approximately 400m.

Biological attributes:

Numerous epipelagic fish species, especially southern bluefin tuna (*Thunnus maccoyii*), bigeye tuna (*T. obesus*), porbeagle shark (*Lamna nasus*), blue shark (*Prionace glauca*), albacore (*Thunnus alalunga*), skipjack tuna (*Katsuwonus pelamis*) and moonfish (*Lampris* spp.) migrate seasonally in and out of the New Zealand Exclusive Economic Zone. There are hotspots of abundance off East Cape and the southwest coast of the South Island.

Criteria applied:

Trophic/functional diversity; representation (i.e. across physical types); extremities of range and adaptation to environment; degree of disturbance; special conditions and specialised organisms; species with a global distribution but New Zealand is a stronghold/significant; seasonal/migratory importance; unusual degree/proportion of biomass; aggregations; links to global patterns.

Status and management:

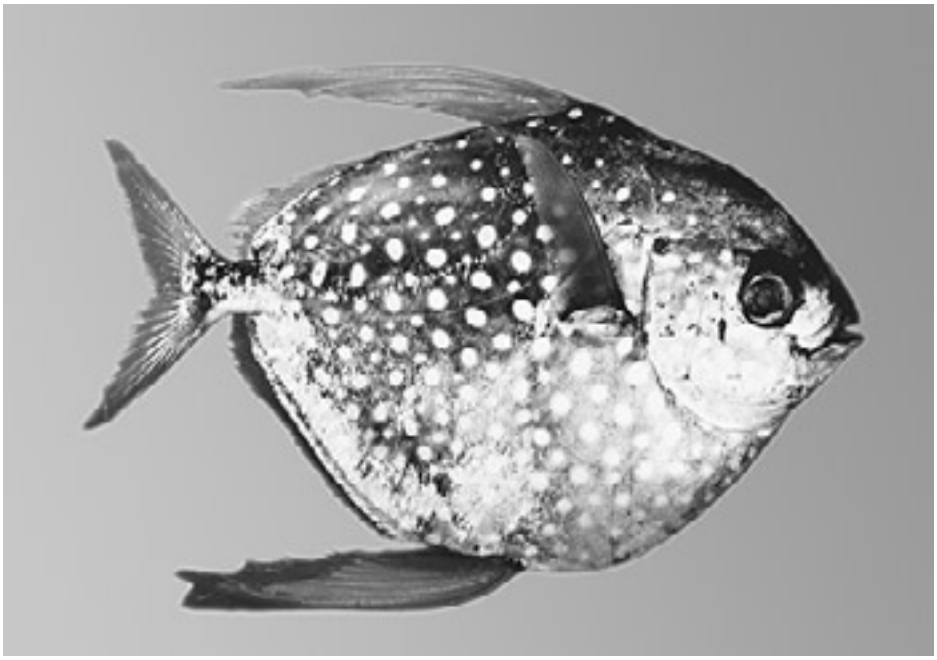
The southern bluefin tuna population is severely depleted and other pelagic fishes are being increasingly fished by the tuna longline fishery. Southern bluefin tuna is managed internationally through the Convention for Conservation of Southern Bluefin Tuna (CCSBT), which allocates quota for fishing nations. Many species will come under the Quota Management System in October 2004.

State of information:

There is good information on the tuna longline fishery, but not on population sizes and status.

References and further reading:

Bagley *et al.* (2000), Francis *et al.* (2000).



Moonfish

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3.4 Benthic Invertebrates, Algae, and Plants

The workshop group with expertise in marine invertebrates, algae, and plants arguably faced the greatest challenge in trying to summarise and highlight the biodiversity of New Zealand's oceans. The challenge stems from the fact that invertebrates make up 33 of the world's 34 animal phyla and have more species than all other domains and kingdoms combined (Ministry for the Environment 1997). There are an estimated 15,300-16,400 marine invertebrates in New Zealand, of which 7,462 have been described (D. Gordon, personal communication, March 2004).

For protista, algae, fungi, and plants, there are estimated to be 17,900-32,900 species, of which 2,700 have been described (D. Gordon, personal communication, March 2004). Many marine invertebrates, algae and plants are so small, or live in such obscure or isolated habitats that their existence has so far gone unnoticed. Sampling efforts are regularly uncovering new species. At the current rate of new species descriptions, it will take at least 90 years to complete an inventory of the New Zealand marine biota[6], not including unicellular organisms (D. Gordon, personal communication, March 2004).

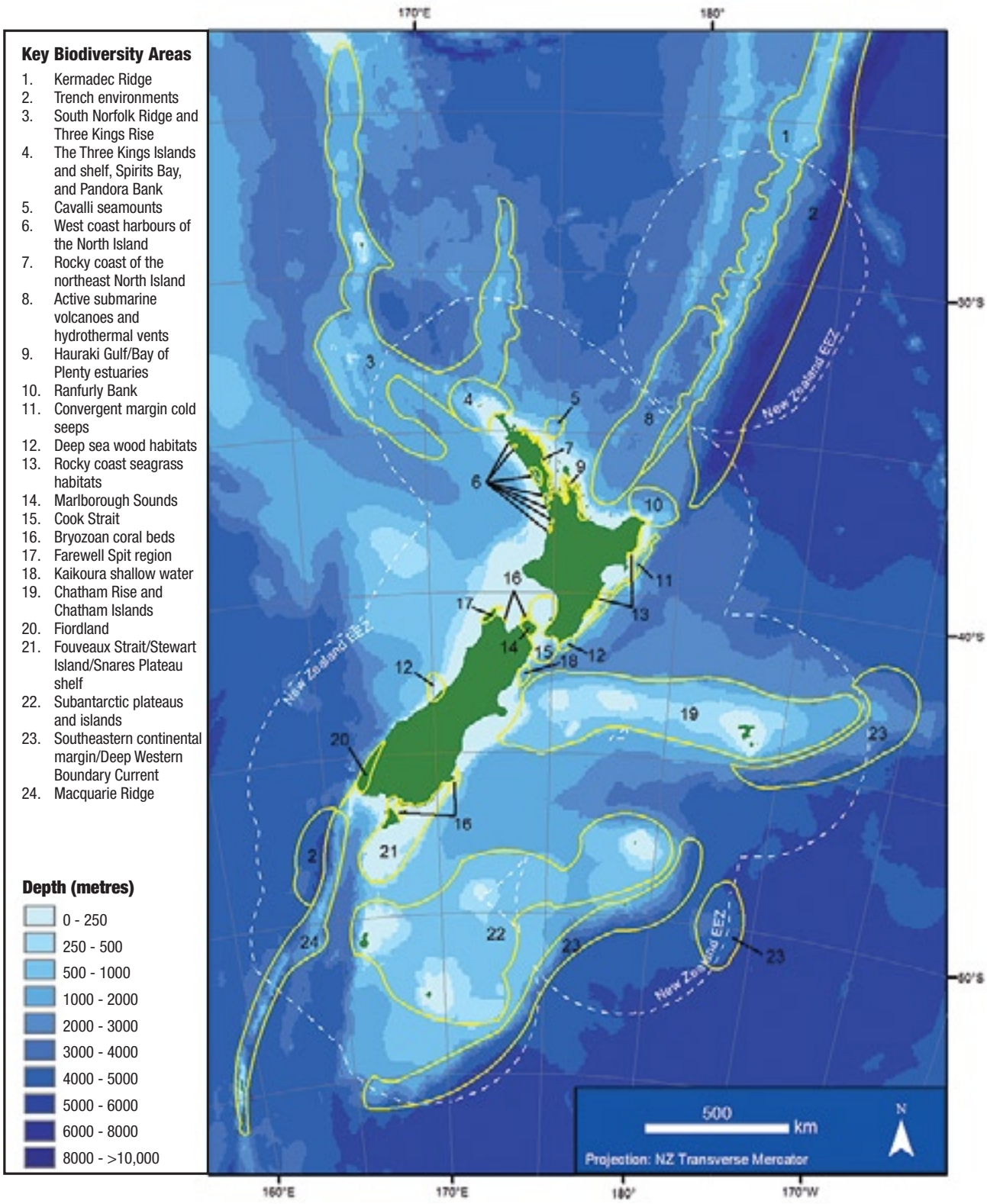
Marine invertebrates, algae, and plants occupy all marine habitats, from the sea floor to the sea surface, with the photosynthetic organisms restricted to the euphotic zone. The marine scientists at the workshop concentrated on benthic invertebrates and plants that dwell on, near, or are attached to the sea floor because their expertise centred on the benthic environment. During several work sessions the participants identified 24 important areas for marine biodiversity in New Zealand. While the group was able to delineate certain locations that are known to host special invertebrate, and algal, or plant communities, other important features of the marine environment were more difficult to represent geographically. These features include habitats such as kelp forests, mangrove forests, and rock wall suspension feeding assemblages, which are critical places for marine biodiversity, but have patchy distributions around the country. Participants decided to include these features as a list of "special habitats", which are represented in the last nine entries of this section, although all known locations for such habitats are not depicted on the map.

Contributors: Peter Batson, Dennis Gordon, Ken Grange, Michelle Kelly, Daphne Lee, Alison MacDiarmid, Patricia Mather, Wendy Nelson, Mike Page, and Stephanie Turner.

[6] Including the Protozoa (and prokaryotes) the task of inventorying New Zealand's marine biota could take up to 400 years (D. Gordon, personal communication, March 2004).

Bladder kelp

Key areas for benthic invertebrate, algal, and plant biodiversity in the New Zealand marine ecoregion



Kermadec Ridge

Map ID number:

1

Location: Ridge extends north from New Zealand's North Island

Approximate area: 197,998km^2

Description of area:

The Kermadec Ridge is composed of a string of volcanoes and vents, with associated bacteria and other components. Some of the volcanoes breach the summit to form four island groups, the Kermadec Islands. The area is flanked by the Kermadec Trench to the east (10km deep) and the South Fiji Basin to the west (4 km deep).

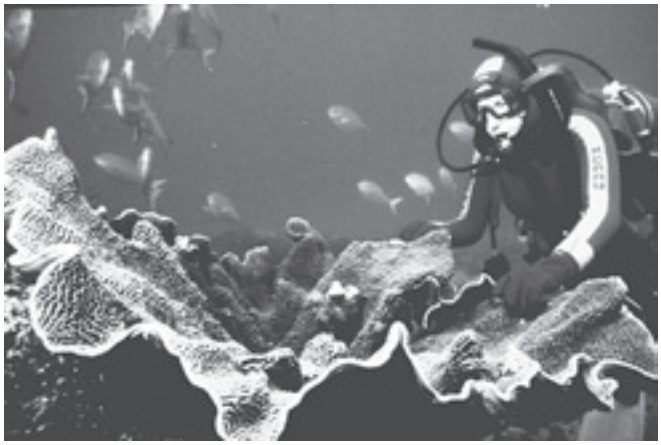


Plate coral

Biological attributes:

The Kermadec Ridge is New Zealand's window into the marine fauna of the Indo-Pacific in that it is the southernmost limit for many taxa. Marine invertebrates found on the ridge include brachiopods, corals, and sponges. The rocky reef fauna and macroalgal flora of the Kermadecs are distinct from that of the rest of New Zealand.

Criteria applied:

Species diversity; species richness; endemism; representation; extremities of range (southern limit of some tropical taxa); meeting ground; links to global patterns.

Status and management:

In 1990 a marine reserve was established around the Kermadec Islands, extending 12 nautical miles (22km) from each island group. Benthic fisheries are severely constrained in some parts of this area by nominal catch limits and special permit access provisions.

State of information:

Information for the Kermadecs is patchy. Some major taxa have been thoroughly studied; others have been little studied or not all. There is no information on bottom habitats beyond those at shallow diveable depths. Some bottom photographs exist for deeper habitats.

References and further reading:

Brook (1999), Cole *et al.* (1992), Gordon (1984), Nelson and Adams (1984), Schiel *et al.* (1986).

Trench (hadal) environments

Map ID number:

2

Location: Two trenches are located in the New Zealand region: the Kermadec and Puysegur, which lie to the northeast and southwest of the New Zealand landmass respectively

Approximate area: 381,424km^2

Description of area:

Trenches are massive linear depressions found throughout the world's oceans. They are formed at subduction zones, regions where one tectonic plate slides beneath another and is recycled into the earth's interior. Bottom sediments in trenches are dominated by muds and fine sands of mixed pelagic/terrestrial origin. The "hadal" zone is defined operationally by biologists as depths exceeding 6,000m; only trenches contain ocean this deep.

The Kermadec Trench trends northeast from East Cape. It is approximately 2,000km long, with a maximum depth exceeding 10km in places. The Kermadec Trench is narrow and steep in comparison with other trenches, being about 40km wide on average, with a wall gradient of about 1:6. The Puysegur Trench originates off southern Fiordland and trends southwest. The hadal portion of this feature is not as deep or as extensive as that of the Kermadec Trench.

Biological attributes:

Trench faunas, in general, exhibit a high degree of regional endemism, possess specialised ecological and physiological adaptations, and exist within a community structure that differs from adjacent areas of abyssal sea floor.

Trenches are widely separated from each other, and in geological terms are long-lived features. These characteristics have significant evolutionary and biogeographical implications for trench faunas, including the generation and maintenance of species endemic to a single trench. It is reasonable to expect trench endemism to be high among hadal benthic taxa. On this basis, New Zealand's trench habitats probably contain many species found nowhere else in the region.

Levenstein (1991) reviewed the world's known hadal polychaete fauna (120 species) and found that about 30% of species recorded from trenches were restricted to hadal environments (the rest co-occur in the

Trench (hadal) environments

continued

abyssal zone). Of this fraction, about half were endemic to a single trench. For hadal invertebrates found in multiple trenches, intra-specific differences among populations have been demonstrated (France 1993).

Trench organisms rely on particulate fluxes from the upper ocean as well as large food falls, including terrestrially derived plant matter. Deep camera and trap deployments indicate that highly mobile scavenging invertebrates adapted to exploit large food falls are an important component of the trench epifauna. Chemosynthetic communities are likely to be present in New Zealand trenches.

Trenches contain the ocean's deepest habitats. By definition they represent the lowest possible limits of depth distribution for aquatic life. Special conditions in trenches include extreme pressure and cold, and a highly variable food supply, which are conducive to chemoautotrophic organisms. Most higher metazoan taxa cannot survive deeper than mid-hadal depths, so deeper trench environments do exceed genuine biological endurance limits for many groups. Fishes, for example, have never been recorded deeper than 8.2km.

Physiological adaptations to extreme hydrostatic pressures have been documented for a number of trench bacteria, a number of which only survive under high environmental pressures (e.g. Yayanos and Dietz 1983). Other hadal microbes are reported to have extreme thermophilic or cold-optimised adaptations. Similar adaptations are hypothesised to exist for hadal invertebrate taxa.

No data exists for the New Zealand region about the proportion of biomass contained in trenches. Comparative evidence, however, indicates that trench communities generally differ considerably from surrounding deep-sea environments in this regard. For example, anomalously high concentrations of organic matter in the Atacama Trench contributed to meiofaunal densities an order of magnitude higher than those of the surrounding abyss (Danovaro *et al.* 2002).

Criteria applied:

Endemism; trophic/functional diversity; extremities of range and adaptation to environment; degree of disturbance; special conditions and specialised organisms; unusual degree/proportion of biomass.

Status and management:

Trenches are perhaps the most pristine of New Zealand's marine environments in terms of direct anthropogenic disturbance. Indirect impacts are harder to gauge, but potentially could be significant. For example, the removal of large epipelagic fish biomass from the world's oceans by fishing (cf. Christensen *et al*. 2003) could reduce the food supply to hadal scavengers, many of which appear adapted to exploit large natural food falls.

Hadal environments in the New Zealand region lie partly within, and partly outside the Exclusive Economic Zone. They are not spatially managed or protected by focused management plans, and have no commercial fishing potential. Presently there are no direct activities that pose a special risk to ocean trenches. In addition, benthic fisheries are severely constrained in some parts of this area by nominal catch limits and special permit access provisions.

State of information:

Poor. Hadal zone research in the New Zealand region has focused on the Kermadec Trench. The Danish Galathea and Soviet Vityaz Expeditions sampled fauna from this trench in 1952 and 1958 respectively, trawling to a depth of 10,000m. Hadal collections included many hundreds of specimens, among them polychaete worms, hydroids, gastropod and bivalve molluscs, echinoderms, crustaceans and fishes (e.g., Belyaev, 1966). An unpublished Australian Navy collection of bottom photographs of the Kermadec Trench to a depth of 10km may contain further ecological data.

References and further reading:

Belyaev (1966), Bourne and Heezen (1965), Christensen *et al.* (2003), Danovaro *et al.* (2002), France (1993), Galathea committee (1957), Levenstein (1991), Lewis and Marshall (1996), Nielsen (1964), Yayanos and Dietz (1983).

South Norfolk Ridge and the Three Kings Rise

Map ID number:

3

Location: Northwest of the New Zealand landmass

Approximate area: 269,180km^2

Description of area:

The South Norfolk Ridge and Three Kings Rise is characterised by numerous seamounts.

Biological attributes:

This area has an ancient sponge fauna that offers a window into the Cretaceous period. There is "a nest of living fossils" of marine invertebrates at mid-depth (400-700 m).

Criteria applied:

Species diversity; species richness; endemism; relict/genetic lineages (i.e. "living fossils"); special phylogenetic grouping; extremities of range and adaptation to environment; links to global patterns.

Status and management:

No specific management status known other than EEZ protection.

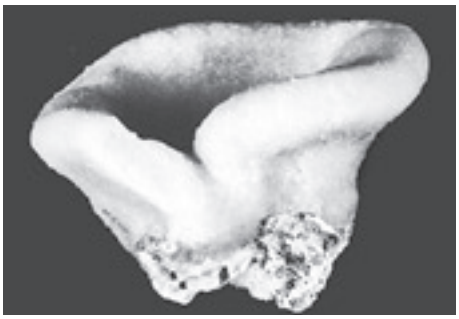
State of information:

Knowledge of sponge fauna of the area is current, relatively comprehensive, and based on examination of all recent and most historical NIWA and National Museum of New Zealand (NMNZ) collections. Information about this area increases substantially with each sampling effort.

References and further reading:

The NORFANZ voyage explored deep sea habitats around seamounts and abyssal plains around Lord Howe and Norfolk Islands through to northern New Zealand. The joint Australia-New Zealand research cruise took place in May-June 2003. Findings are summarised at: www.oceans.gov.au/norfanz/
Kelly (2000b, 2001a, 2001b, 2003), Kelly and Buckeridge (2003), Kelly *et al.* (2003, in press), Pomponi *et al*. (2001).

Lithistid sponge, Three Kings Rise.



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The Three Kings Islands and shelf, Spirits Bay, and Pandora Bank

Map ID number:

4

Location: Immediately off the northwestern tip of New Zealand's North Island

Approximate area: 26,156km^2

Description of area:

The Three Kings Islands and the surrounding area provide a diversity of marine habitats. The islands have walls and shallow intertidal caves while the shelf has bryomol calcareous gravel.

Biological attributes:

This area is considered to be *the* New Zealand marine biodiversity hot spot. High diversity of suspension feeding taxa, such as molluscs and ascidians, has been observed here. Diversity is extraordinarily high for bryozoa and sponges. Endemism is high for bryozoans, sponges, ascidians, and other suspension feeders. Macroalgal diversity and endemism is high around the Three Kings Islands. Even within the area there are pockets of endemnicity. For example, the sponges found around the Three Kings Islands are distinct from those found in Spirits Bay.

Criteria applied:

Species diversity; species richness; endemism; relict/genetic lineages (i.e. "living fossils"); special phylogenetic grouping; extremities of range and adaptation to environment; links to global patterns; representation; habitat complexity/diversity.

Status and management:

Previously fished areas of Spirits Bay are presently under protections from scallop dredging (M. Cryer, NIWA Auckland, personal communication). No other specific management status is known other than EEZ protection.

State of information:

Knowledge of sponge fauna of the area is current, relatively comprehensive, and based upon examination of all recent and most historical NIWA and NMNZ collections. Information about this area increases substantially with each sampling effort.

References and further reading:

Adams and Nelson (1985), Cryer *et al.* (1999, 2000), Kelly (2000a), Kelly *et al.* (in press), Nelson and Adams (1990), Nelson (1999a), Nelson *et al.* (1999), Taylor and Gordon (2003).

Siliceous golfball sponge *(Tethya australis)* ***with buds, Three Kings Islands.***

©NIWA/Malcolm Francis

Cavalli seamounts

Map ID number:

5

Location: East of Northland on New Zealand's North Island

Approximate area: 3,817km^2

Description of area:

The Cavalli seamounts are formed from continental crust (as opposed to volcanic seamounts).

Biological attributes:

The Cavalli seamounts have a diverse suspension feeding fauna, including deepsea sponge and bryozoan assemblages. They have the richest fauna observed on New Zealand seamounts so far.

Criteria applied:

Species diversity; species richness; endemism.

Status and management:

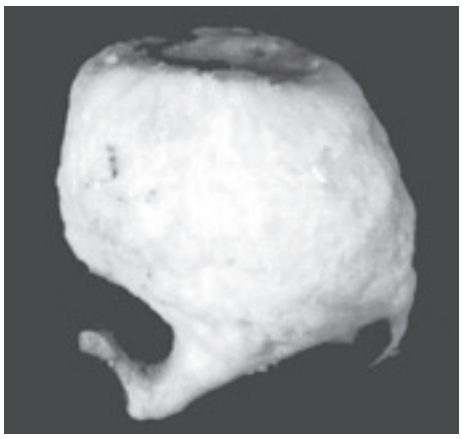
Cavalli seamount has been closed to trawling since 2001 under Ministry of Fisheries regulations. Five trawls occurred on Cavalli Seamount between 1992-1997, with a total orange roughy catch of 310 kg (Clark *et. al* 2000).

State of information:

No published information on taxa at the species level.

References and further reading:

Clark *et al.* (2000), Rowden *et al.* (2004).



Lithistid sponge, Cavalli seamounts.

West coast harbours of the North Island

Map ID number:

6

Location: Includes Whangape, Hokianga, Kaipara, Manukau, Waikato River, Raglan, Aotea, and Kawhia harbours and the adjacent coastline.

Approximate area: 1,375km^2 (summation of the surface areas of the above estuaries at high water)[7]

Description of area:

The west coast of the northern North Island is characterised by exposed, high energy, long open sand beaches often backed by extensive dune systems (e.g., Ninety Mile Beach, Hokianga North Head, Muriwai, Whatipu, Taharoa, Aotea Harbour), as well as cliffs and intertidal rock platforms which support a diverse range of marine algae and invertebrates (e.g. Muriwai to Karekare). The West Coast also has several large tidal estuaries which provide many important natural habitats for plants and animals.

Biological attributes:

The west coast estuaries are highly productive ecosystems, and are of significant environmental and economic importance. A range of habitat types are found in and around the west coast estuaries, including coastal shrublands and forest, freshwater wetlands, saltmarsh, mangroves, seagrass, sand and mud flats, rocky reefs and tidal channels. The extensive estuarine intertidal flats support abundant and diverse communities of benthic invertebrates, which are an important food source for many fish and birds, as well as having other significant ecological functions.

The intertidal sand and mudflats of the west coast harbours are important feeding grounds, and breeding and roosting sites for large numbers of wading birds and shorebirds – including internationally migratory and New Zealand endemic species and a number of threatened species. The vegetated margins of these estuaries also provide habitat for threatened coastal fringe birds, particularly where areas of adjoining terrestrial vegetation provides shelter for roosting and breeding.

The estuaries are important feeding and breeding areas for a number of fish species and are also important migration pathways between marine and freshwater habitats for a variety of native freshwater fish.

The dunes, open coast beaches and rocky cliffs and platforms also comprise important and complex habitat for a variety of plant and animal communities.

Criteria applied:

Species diversity; species richness; dependency for other species; trophic/functional diversity; conservation status/threat classification both nationally

Hokianga Harbour

[7] Source for estuarine areas: http://finz.niwa.co.nz/NewZealand/viewer.htm

West coast harbours of the North Island

continued

and globally; cultural values; degree of disturbance; special conditions and specialised organisms; habitat complexity/diversity.

Status and management:

The west coast harbours have come under significant threat as a result of catchment activities which, in particular, have been responsible for increased rates of sedimentation. These estuaries are also under threat from coastal development (reclamation and infilling, foreshore structures, roading, etc.), stock grazing, introduced species etc.

Many of the west coast harbours have been designated as "Areas of Significant Conservation Value" under regional council coastal plans.

Improved catchment management (minimising erosion, reducing runoff and nutrient leaching) will help to protect estuaries. Regional councils, in conjunction with the Minister of Conservation, are responsible under the Resource Management Act 1991 for the management of the effects of activities in the coastal marine area. Territorial authorities are responsible for managing land-use effects above mean high water springs.

State of information:

Variable for the different harbours. For example, there is considerable information available for the Manukau Harbour; but for some of the other harbours there is relatively limited information available.

References and further reading:

Auckland Regional Council (2003), Grange (1979), Pridmore *et al.* (1990), Turner *et al.* (1995)

Pukepuke Lagoon

Rocky coast of the northeast North Island

Map ID number:

7

Location: Reefs to about 30–50m deep around rocky headlands and offshore islands from North Cape to East Cape

Approximate area: 1,178km^2

Description of area:

Principally hard greywacke outcrops or softer mudstones, but outcrops of volcanic origin in some places, especially offshore islands. Limestone outcrops at Langs Beach near Waipu.

Biological attributes:

This coastal area of the North Island has a high diversity of suspension-feeding molluscs and a reasonably high diversity of tunicates. There is an abundance of shallow-water brachiopods. Occasionally, incursions of tropical and subtropical species are found here, at the southern limit of their range. The offshore islands are stepping stones for natural introductions of new warm water species. The islands are surrounded by deep reefs and have a high diversity of suspension-feeding rock wall invertebrates.

Criteria applied:

Species diversity; species richness; extremities of range and adaptation to environment.

Status and management:

Most species are not exploited or threatened. Some areas are protected within marine reserves at Poor Knights Islands, Cape Rodney Okakari Point (Leigh), Tuhua (Mayor Island), and Tawharanui Marine Park.

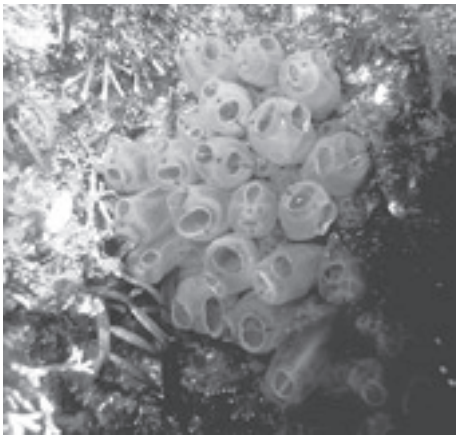
State of information:

Variable.

References and further reading:

Ayling and Babcock (2003), Ayling and Schiel (2003), Ballantine *et al.* (1973), Ballantine and Gordon (1979), Battershill and Stocker (1993), Gordon and Ballantine (1977), Grange (1986), Grange *et al.* (1992), Nelson and Adams (1987), Smith and Gordon (2003).

Large number of unpublished theses held by the University of Auckland and unpublished DoC reports.



Blue bell ascidians, Poor Knights Islands

Active submarine volcanoes and hydrothermal vents

Map ID number:

8

Location: Known features are north of North Island's Bay of Plenty, located in the Kermadec Ridge/Havre Trough area. Shallow-water hydrothermal venting also occurs on the Bay of Plenty continental shelf. Vent organisms have been collected from shelf depths, with offshore biological sampling concentrated between 200-2,500m on the Kermadec Ridge/Havre Trough.

Approximate area: 105,584km^2

Description of area:

Hydrothermal vents are zones of fluid expulsion from the sea floor, normally associated with sea floor spreading or tectonic plate subduction. Minerals contained within the expelled fluids are utilised as an energy source for vent bacteria. These specialised microbes form the basis of a unique class of ecosystem operating independently from the photosynthetically driven system that dominates the rest of the biosphere. In the New Zealand region, undersea volcanism and hydrothermal venting are associated with extensive back-arc basinal volcanism in the Kermadec subduction zone.

Biological attributes:

New Zealand hydrothermal vent ecosystems are in their early phase of investigation, but preliminary results indicate that their faunas are diverse and disparate (i.e. little overlap with the inhabitants of adjacent non-vent habitats). Endemism at New Zealand vents appears to be high, with recently published records of (apparently) regionally endemic vent polychaetes (*Branchipolynoes*); molluscs (the mussel species *Bathymodiolus tangaroa* and *Gigantidus gladius*, the latter a new genus); barnacles (*Neolepas osheai*); several new shrimp species (including *Alvinocaris niwa*), and a large and as-yet undescribed asteroid. The aforementioned taxa are mainly large, conspicuous organisms, and overseas experience suggests that a wealth of smaller, more cryptic, vent organisms are likely to be discovered at New Zealand hydrothermal vents.

At a fine scale, New Zealand vents have yet to be properly categorised. It is likely, however, that a range of vent environmental conditions will be found (e.g. variation in temperature and chemical composition of fluids), and that this habitat complexity will give rise to a small-scale variability in vent communities.

Vent organisms display unique and highly specialised physiological adaptations to a physical and chemical environment that would be lethal to most other forms of life. Due to the highly productive nature of vent ecosystems, local biomass of vent primary producers and consumers is usually elevated, sometimes to a level several orders of magnitude greater than the surrounding environment. Special phylogenetic groupings in vent ecosystems include particular polychaete, crustacean, and molluscan taxa.

Biogeographically, New Zealand's hydrothermal vents are significant, as demonstrated by several past and forthcoming international research expeditions intended to document the vents' geology and fauna. Subduction-related venting has been less studied than spreading-axis venting, and the comparison of regional faunas with global patterns of distribution is of great interest.

Given the unique nature of their chemotrophic ecosystem, vent faunas represent a significant addition to New Zealand's marine trophic and functional diversity. In terms of conservation status, vent habitats merit priority because of their uniqueness, restricted range and vulnerability (e.g. the potential commercial significance of the mineral deposits associated with venting sites).

Hydrothermal vents possess a cultural appeal that transcends their inaccessibility. Despite their limited distribution, vent ecosystems figure highly in the popular conception of the deep-sea environment, perhaps because of their inherent strangeness and aesthetic appeal.

Criteria applied:

Species diversity; species richness; endemism; trophic/functional diversity; conservation status/threat classification both nationally and globally; cultural values; extremities of range and adaptation to environment; special conditions and specialised organisms; unusual degree/proportion of biomass; special phylogenetic grouping; habitat complexity/diversity; links to global patterns.

Status and management:

Two areas of active hydrothermal venting were closed to commercial trawling in 2001: the Rumble 3 and Brothers Seamounts. These closures were framed in terms of seamount closures under the auspices of the 1996 Fisheries Act (as two of 19 seamounts closed). In this sense there is still no specific management of hydrothermal vent ecosystems. However, benthic fisheries are severely constrained in some parts of this area by nominal catch limits and special permit access provisions.

State of information:

Research is in its early stages. Offshore sampling of New Zealand hydrothermal vents has only been undertaken seriously in the last 15 years. At least seven active venting localities are known from Kermadec Ridge seamounts, in addition to the Brothers and Rumble sites. Upcoming submersible-based investigations will dramatically increase knowledge of the distribution, biodiversity and ecology of New Zealand vents.

References:

Buckeridge (2000), Clark and O'Shea (2001a, 2001b), de Ronde *et al.* (2001), Kamenev *et al.* (1993), Rowden *et al.* (2003), von Cosel and Marshall (2003), Webber (2004), Wright (1994).

Hauraki Gulf/Bay of Plenty estuaries

Map ID number:

9

Location: Includes Firth of Thames, Coromandel estuaries, and Bay of Plenty estuaries

Approximate area: 217km^2 (summation of the surface areas of the above estuaries at high water)[8]

Description of area:

The Firth of Thames is a large, shallow coastal embayment supporting a range of coastal habitats and plant and animal communities. There are four estuaries (Manaia, Te Kouma, Coromandel, and Colville) on the western coast of the Coromandel Peninsula and several on the eastern coast of the Coromandel Peninsula (e.g., Whangapoua, Tairua, Wharekawa, and Whangamata). There are a number of estuaries along the Bay of Plenty coast (e.g., Tauranga, Maketu, Whakatane, and Ohiwa)

Biological attributes:

The Firth of Thames, Coromandel estuaries, and Bay of Plenty estuaries are highly productive ecosystems, and are of significant environmental and economic importance. A range of habitat types are found in and around these estuaries, including coastal shrublands and forest, freshwater wetlands, saltmarsh, mangroves, seagrass, sand and mud flats, rocky reefs, and tidal channels. The extensive estuarine intertidal flats support abundant and diverse communities of benthic invertebrates – including extensive shellfish beds, which are an important food source for many fish and birds, as well as having other significant ecological functions.

The intertidal sand and mudflats are important feeding grounds, and breeding and roosting sites for large numbers of wading birds, coastal and freshwater birds, including a number of rare and threatened species. The Firth of Thames is one of New Zealand's most important coastal stretches for wading and shore birds. The area forms a key site for migratory birds from the Arctic Circle to Australasia (the "East Asian-Australasian flyway").

The estuaries are also important feeding and breeding areas for a number of fish species and are the subject of current Foundation for Research, Science and Technology (FoRST) funded research (conducted by M. Morrison, NIWA).

The Firth of Thames, Coromandel estuaries, and Bay of Plenty estuaries have come under significant threat as a result of catchment activities which, in particular, have been responsible for increased rates of sedimentation. These estuaries are also under threat from coastal development such as marinas and canal developments, subdivisions, aquaculture, reclamation and infilling, foreshore structures, roading, stock grazing, introduced species, and flood control works.

Whitianga Harbour

Criteria applied:

Species diversity; species richness; dependency for other species; trophic/functional diversity; conservation status/threat classification both nationally and globally; cultural values; degree of disturbance; special conditions and specialised organisms; habitat complexity/diversity.

Status and management:

The southern Firth of Thames is listed as a wetland of international importance under the Ramsar Convention. The site includes approximately 78km^2 of shallow estuarine waters, intertidal mudflats, mangrove and saltmarsh, and graded shell beach ridges. The Firth of Thames is considered to include nationally significant mangrove and mudflat communities.

The Firth of Thames and Coromandel estuaries are included within the Hauraki Gulf Marine Park which was established in 2000 with the aim of enhancing the integrated management of the Hauraki Gulf.

Many of the Coromandel and Bay of Plenty estuaries have been designated as "Areas of Significant Conservation Value" under regional council coastal plans.

Improved catchment management (minimising erosion, reducing runoff and nutrient leaching) will help to protect estuaries. Regional councils, in conjunction with the Minister of Conservation, are responsible under the Resource Management Act 1991 for the management of the effects of activities in the coastal marine area. Territorial authorities are responsible for managing land-use effects above mean high water springs.

State of information:

Variable for the different harbours.

References and further reading:

Auckland Regional Council (2002a, 2002b, 2003b, 2003c, 2003d), Brejaart and Brownell (2001), Cromarty and Scott (1996), Cole *et al.* (2000), Environment Bay of Plenty (1999, 2000), Hartill *et al.* (2003), Park (2000), Thrush (1993), Turner and Carter (2004).

[8] Source for estuarine areas: http://finz.niwa.co.nz/NewZealand/viewer.htm

Ranfurly Bank

Map ID number:

10

Location: Ranfurly Bank is located on the continental shelf, 17km east-north-east of East Cape.

Approximate area: 17,437km^2

Description of area:

The Bank rises from about 130m depth to a minimum of 25m and is bathed by the East Cape Current as it sweeps around the cape on its southward passage along the North Island margin. This stong flow, together with the tides, is liable to inhibit accumulation of muddy sediment discharged from the nearby Waiapu River – by far New Zealand's largest river in terms of sediment discharge (L. Carter, personal communication, 2004).

Biological attributes:

Sampling undertaken so far has revealed unusual/unexpected distributions. Observations of this area indicate that there are endemic species of algae. For example, *Adamsiella lorata* is known only from Lottin Point and *A. melchior* is known only from the Three Kings Islands.

Criteria applied:

Endemism.

Status and management:

Not recorded during the workshop

State of information:

Collections that have been made to date are few. The area warrants closer attention and a well-structured sampling programme.

References and further reading:

Phillips (2002).

Convergent margin cold seeps

Map ID number:

11

Location: Convergent margin cold seeps are found on the East Coast of the North Island and the southeast and southwest coasts of the South Island.

Approximate area: Not precisely known. Probably less than 300km^2 in total aerial extent for all 13 known sites. (Area 11 on the map is 6,534km^2)

Description of area:

Cold seeps are methanogenic and methylotrophic ecosystems. In buried sea floor sediments, organic compounds derived from marine life are chemically altered by heat, pressure, and bacteria. The compounds percolate upwards through the sediments to be released as organic-enriched fluids and gases, e.g. methane.

Biological attributes:

Methane-rich seeps are home to siboglinid tubeworms and highly adapted suspension-feeding bivalves, most of which are endemic.

Criteria applied:

Endemism; trophic distinctiveness; adaptation to extreme environment; special conditions and special organisms.

Status and management:

Not managed.

State of information:

Only the following paper has been published on New Zealand convergent-margin seeps.

References and further reading:

Lewis and Marshall (1996).

Deep sea wood habitats

Map ID number:

12

Location: Wairarapa and Hokitika Canyons (at 1000m)

Approximate area: Not precisely known; probably only a few hundred square kilometres in total aerial extent (Area 12 on the map is 6,219km^2)

Description of area:

A supply of riverine drift wood, which is contingent on land-based practices, supports a special assemblage of organisms.

Biological attributes:

Habitat-restricted fauna based on the bacterial decay of wood cellulose include Concentricycloidea (sea daisies), gastropods, and small crustaceans

Criteria applied:

Endemism; dependency for other species; special conditions and specialised organisms.

Status and management:

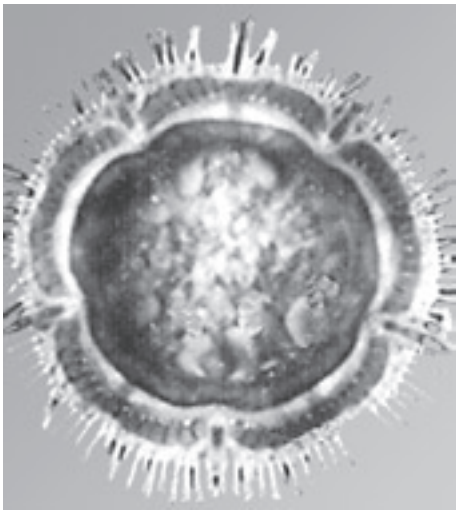
Not managed.

State of information:

No information has been published on the actual habitat in New Zealand waters, only the presence of unusual organisms.

References and further reading:

Baker *et al.* (1986), Rowe *et al.* (1988).



Sea daisy *(Xyloplax turnerae)*

Rocky coast seagrass habitats

Map ID number:

13

Location: East Coast of North Island between East Cape and Cape Turnagain. (South of Cape Turnagain the rock platforms tend to be lower on the shore, often at or just below low water and consequently they generally do not support extensive beds of seagrass (*Zostera capricorni*)).

Approximate area: 811km^2

Description of area:

A series of extensive siltstone intertidal platforms between about 70-120m wide, interrupted by extensive sand and gravel beaches in Poverty Bay, Hawke Bay, and at Porangahau. Each platform is typically backed by steep coastal hills of Tertiary siltstone, and topped by a narrow sand or boulder beach. All of the platforms are dotted with fissures, channels, and pools ranging up to more than 1,500m^2 surface area. In some places the seaward edges of the platforms are higher than the mid-sections.

Biological attributes:

These platforms are characterised by extensive turfs of coralline algae (*Corallina officinalis*), Neptune's necklace (*Hormosira banksii*), large beds of seagrass (*Zostera capricorni*), and the golden limpet (*Cellana flava*). These reef populations may form important connections for seagrasses in the isolated estuaries along this coast, and are important feeding areas for variable oystercatcher (*Haematopus unicolor*), white-faced heron (*Ardea novaehollandiae*), and bar-tailed godwit (*Limosa lapponica*).

Criteria applied:

Extremities of range and adaptation to environment; representation (i.e. across physical types).

Status and management:

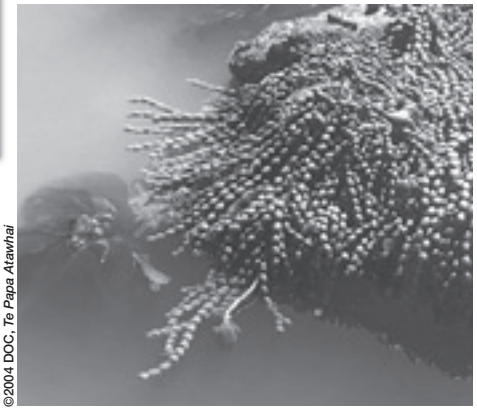
No exploitation, but some seagrass populations close to the high tide sand/gravel shelf are vulnerable to the increasing vehicular traffic on coastal reefs. Driving vehicles onto the platforms between Kairakau and Blackhead Point in Central Hawke's Bay is prohibited under the Hawke's Bay Regional Coastal Plan. Populations are protected within the Te Tapuwae o Rongokako Marine Reserve north of Gisborne and Te Angiangi Marine Reserve south of Cape Kidnappers.

State of information:

Seagrass populations in these habitats are generally poorly described or understood.

References and further reading:

Central Fishery Management Planning Team (1987), Creswell and Warren (1990), Department of Conservation (1994), Glassey (2002), Haddon (1993), Haddon and Anderlini (1993), Henriques *et al.* (1990), Morton and Miller (1968).



The algae, Neptune's necklace

Marlborough Sounds

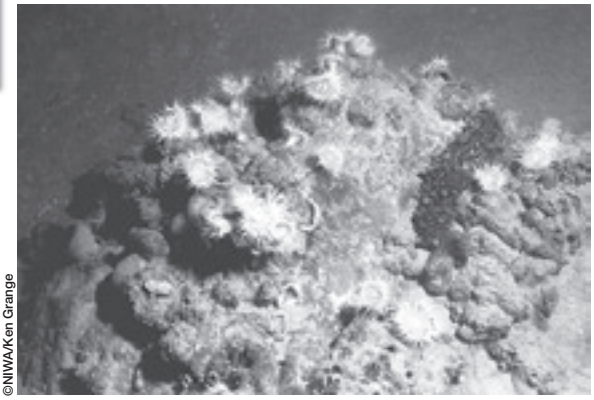
Map ID number:

14

Location: North coast of the South Island

Approximate area: 2,299km^2

Sea anenomes, sea cucumbers, and ascidians



©NIWA/Ken Grange

Description of area:

The Marlborough Sounds are formed from drowned river valleys resulting in a complex coastline with a large variety of habitats. High velocity semidiurnal tidal flows characterise the entrance of the sounds. In central New Zealand they represent the largest extent of sheltered harbour habitats.

Biological attributes:

The sounds have a reasonable diversity of native suspension feeders and muddy benthic communities in unmodified habitats. There is a mix of northern and southern brachiopod species and other invertebrates. Over their length the sounds show a strong transition in fauna and flora from that typical of exposed rock reefs and sandy sediments to those typical of sheltered shores. The sounds ecosystem also supports a large number of marine farms, which farm mainly suspension feeding mussels.

Criteria applied:

Representation (across physical types); meeting ground.

Status and management:

Some of the area is zoned for marine farming, which requires resource consent and fisheries permits. Sediment runoff from forestry operations and roads poses a threat to water quality.

State of information:

Not recorded during the workshop

References and further reading:

Bardsley (1976), Cole *et al.* (2001), Estcourt (1967), Farhey and Coker (1992), Grange (1991a), Nelson *et al.* (1992), Ogilvie (2000), Struik (1979).

Cook Strait

Map ID number:

15

Location: Between North and South Island

Approximate area: 17,022km^2

Description of area:

The Cook Strait has high velocity semi-diurnal tidal flows. There are deep canyons at the Strait's eastern end bringing deep water faunas close to one of New Zealand's largest urban areas. Vertical mixing of the water column and associated increased productivity in and around the canyons helps to sustain a more varied and abundant mid-water and bottom dwelling fauna than the adjacent shelf.

Biological attributes:

The Cook Strait is a mixing zone for fauna and flora of northern and southern waters. The rocky reefs of the area have high algal diversity. The largest known rhodolith beds (free-living crustose coralline red algae), are found in Cook Strait. Dense aggregations of brittle stars are found at the head of the Cook Strait Canyon.

Criteria applied:

Species diversity; meeting ground; representation.

Status and management:

Most benthic species are not exploited but may be subject to bycatch in bottom trawling operations. A protected area of shallow waters lies within the Cook Strait power cable zone.

State of information:

Not recorded during the workshop.

References and further reading:

Foster (2001), Nelson *et al.* (1992).

Intertidal organisms, Cook Strait

Allison Arnold

Bryozoan coral beds

Map ID number:

16

Location: Tasman Bay/D'Urville Island, Otago Shelf, Foveaux Strait

Approximate area: Originally patchily distributed over around 410km^2, now probably less than 140km^2 in extent off Abel Tasman National Park. Other areas exist off D'Urville Island and Otago Shelf in which the bryozoan habitat is probably patchily distributed over several hundred square kilometres in a number of areas. (Area 16 on the map is approximately 2,289km^2.)

Description of area:

The bryozoan coral beds comprise erect bryozoan growths and molluscan shell, associated with a high diversity of sessile and mobile epibiota, forming a nursery ground for juveniles of commercial fish.

Biological attributes:

Celleporaria agglutinans ("Tasman Bay coral") and *Hippomenella vellicata* are the predominant habitat-forming species off northern South Island. *Cinctipora elegans* is the predominant habitat-forming species on the Otago Shelf, but *H. vellicata* is common there too. The Cinctiporidae is an endemic bryozoan family having gigantism – i.e. exhibiting the largest zooids in the class Stenolaemata.

Criteria applied:

Species diversity; species richness; dependency for other species; aggregations; threatened habitat; habitat complexity.

Status and management:

Only the area off Abel Tasman National Park is protected from bottom trawling (since 1980) but regeneration of the bryozoan habitat appears to be slow.

State of information:

Some published papers and a report to the Ministry of Fisheries have been produced.

References and further reading:

Bradstock and Gordon (1983), Gordon *et al.* (1994).

Bryozoan colony, Stewart Island

Farewell Spit region

Map ID number:

17

Location: Northwest corner of the South Island including the Karamea Estuary and Parapara Inlet.

Approximate area: 1,372km^2

Description of area:

The Farewell Spit Region is influenced by nutrient-rich cold water upwellings off Kahurangi Point. The area has a highly productive shallow-water soft-bottom habitat that yields food for migratory birds.

Biological attributes:

Extensive areas of sand and mud, including extensive areas of seagrass habitat characterise the Farewell Spit Region. The area is a Ramsar site, which is a wetland of international significance. For example, it is internationally important for migratory birds.

Criteria applied:

Dependency for other species; representation (of a physical type), seasonal/migratory importance; aggregations.

Status and management:

The area is a Ramsar site, which is a wetland of international significance.

State of information:

Not recorded during the workshop.

References and further reading:

Cuddihy (1992), Foster and Battaerd (1985), Nelson *et al.* (1992).

Eel-grass, Farewell Spit Ramsar site

Kaikoura shallow water

Map ID number:

18

Location: Northeast coast of South Island

Approximate area: 2,022km^2

Description of area:

Limestone base rock.

Biological attributes:

Kaikoura's shallow water environment has high algal diversity, some of which have cultural uses. It is a locality for the relict red seaweed of the order Bangiales. Between the coastal siltstone reefs there are localised areas of seagrasses. Kaikoura shelf and subtidal reefs are highly productive areas subject to periodic upwelling of deep nutrient-rich water. Steep reef walls, varied topography and high currents offshore support diverse communities of sessile filter feeders, including ascidians and sponges. The area has rich ascidian diversity (43 recorded species) and represents the southern limit of at least eight, and the northern limit of at least three described endemic species.

Criteria applied:

Species richness; extremities of range; habitat complexity/diversity.

Status and management:

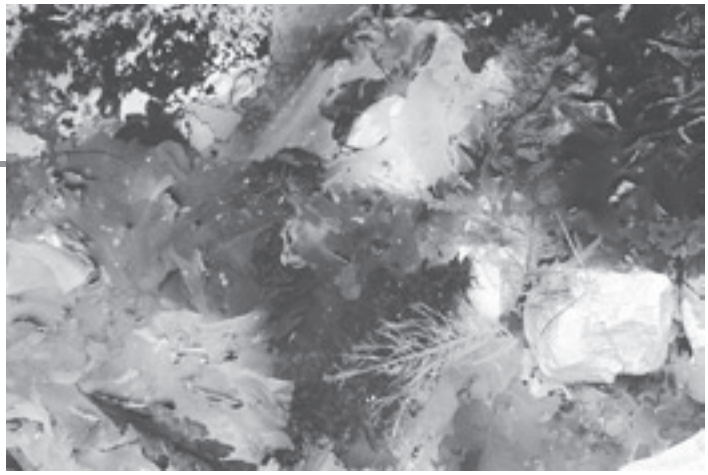
Some commercial trawling for sea perch (*Heliocolenus percoides*) occurs from 40-100m on the shelf approximately 1km southeast of Kaikoura Peninsula. Trawling is localised to sea floor areas between scattered low reef outcrops. This activity impacts ascidians and sponges growing on shell and cobble substrata.

State of information:

Ecology of subtidal sessile benthic invertebrates is not well studied. A large amount of unpublished data exists from extensive subtidal collections of ascidians and sponges made by the University of Canterbury Marine Chemistry Group between 1992 and 1997 in the Kaikoura region. This information should be published in a biogeographic context. However, there is need for taxonomic revision and more extensive collections to interpret with certainty faunistic relationships in the New Zealand ascidiacea.

References and further reading:

Broom *et al.* (2004), Chiswell and Schiel (2001), Millar (1982), Nelson *et al.* (1990), Page (1993), Stocker (1985), Woods and Page (1999), Schiel and Hickford (2001).



Seaweeds, Kaikoura

Chatham Rise

Map ID number:

19a

Location: A submarine extension of the New Zealand Plateau that extends eastward of the South Island for 1400km.

Approximate area: 248,955km^2

Description of area:

The Chatham Rise occurs underneath the Subtropical Convergence, a major oceanic front with high surface productivity. It is a classic mixing zone of north and south biogeographic elements.

The crest of the rise is of geologic interest. It is a locality for nodules of the mineral phosphorite, as well as areas of glauconite. The crest is the northernmost settling ground for iceberg-rafted rocks from Antarctica.

Biological attributes:

The Chatham Rise is the southern limit in New Zealand for stony sponges ("lithistids"). There are thickets of stony corals on the crest of the rise. Seamounts found on the Rise have variably diverse assemblages of deep-sea biota.

Criteria applied:

Species diversity and richness; trophic functional diversity; aggregations; meeting ground.

Status and management:

The Chatham Rise supports commercial fisheries for a considerable number of species, each of which is controlled by the Quota Management System. Six seamounts are closed to trawling on the Chatham Rise.

State of information:

The rise has been the focus of considerable research focus by NIWA and other research providers.

References and further reading:

Dawson (1984), Haywood *et al.* (2002), Nodder *et al.* (2003), Probert *et al.* (1996), Probert and McKnight (1993, 1997), Probert *et al.* (1997), Rowden *et al.* (2002).

Chatham Islands

Map ID number:

19b

Location: The Chatham Islands are at the eastern end of the Chatham Rise and are an intermixing zone of subantarctic and subtropical elements. They are the most easterly island group in the New Zealand marine zone.

Approximate area: Not delineated by benthic group during the workshop.

Description of area:

The Chatham Islands has a complex marine habitat of intermixing currents and eddies associated with shelf edges and subterranean features.

Biological attributes:

The islands have a good diversity of seaweeds and crustose coralline algae species. There is reasonably high endemism of ascidians, molluscs, and seaweeds.

Criteria applied:

Endemism; species richness; representation; extremities of range; meeting ground; habitat complexity/diversity.

Status and management:

The low human impact on some shores allows protection of crustose coralline habitat and delicate fossil sponges.

State of information:

Not recorded during the workshop

References and further reading:

Hay (1989), Knox (1957), Nelson *et al.* (1991), Schiel *et al.* (1995), Schiel and Hickford (2001).

Chatham Island

Fiordland

Map ID number:

20

Location: Southwest region of the South Island

Approximate area: 5,196km^2

Description of area:

This area contains New Zealand's only fiords. There are a variety of physical gradients among them. Notable features of the area include a very narrow continental shelf and a near-permanent, low-salinity surface layer within the fiords.

Biological attributes:

Fiordland is a special marine environment in that species normally found in deep water, such as sea pens, glass sponges, and certain corals, emerge in shallow water. The area has high cnidarian faunal diversity including habitat-forming black corals (*Antipatharia*) and red corals (*Stylasteridae*). Bryozoan thickets (*Adeonellopsis*) are found on entrance sills of the fiords. Fiordland also has high algal diversity, a fact that has been largely overlooked until recently. Crustose coralline algae are important in the rock wall communities.

Criteria applied:

Species diversity; special conditions and specialised organisms.

Status and management:

There are two marine reserves, one in Milford Sound and the other in Doubtful Sound. A comprehensive management strategy has been developed to protect the fisheries resources and marine environment, but this has yet to be formally approved in legislation.

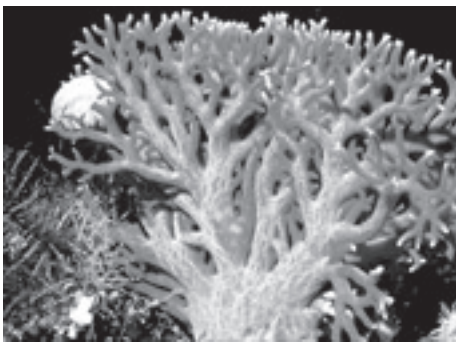
State of information:

Large number of scientific papers. University of Otago holds a living bibliography of studies.

References and further reading:

Glasby (1978), Grange (1985, 1988, 1990, 1991b), Grange and Goldberg (1992, 1993a, 1993b), Grange and Singleton (1988), Nelson *et al.* (2002), Schiel and Hickford (2001), Skerman (1964), Wing (2003).

Red coral, Fiordland



Foveaux Strait/ Stewart Island/ Snares plateau shelf

Map ID number:

21

Location: South of the South Island

Approximate area: 52,014km^2

Description of area:

The area encompassing Foveaux Strait/ Stewart Island/Snares plateau shelf is rich in biogenic carbonate (shell gravel). There is low sedimentation from Stewart Island rivers and the area includes "pristine estuaries".

Biological attributes:

The shell gravel biogenic carbonate is produced by abundant Stewart Island rock wall suspension feeders, especially by bryozoans and molluscs, along with serpulid polychaetes and brachiopods on the shelf. The three-dimensionality of the habitat is created by bryozoans, sponges, ascidians, and cnidarians. In shallow water some macroalgal species are habitat formers. A high diversity of fish is associated with such three-dimensional habitats.

There are high levels of local endemnicity across many taxa. There is high algal diversity, productivity, and biomass, with significant endemics. The area has some major estuaries with extensive seagrass beds.

Criteria applied:

Species diversity; species richness; endemism; trophic/functional diversity; representation; unusual proportion/degree of biomass; habitat complexity/diversity.

Status and management:

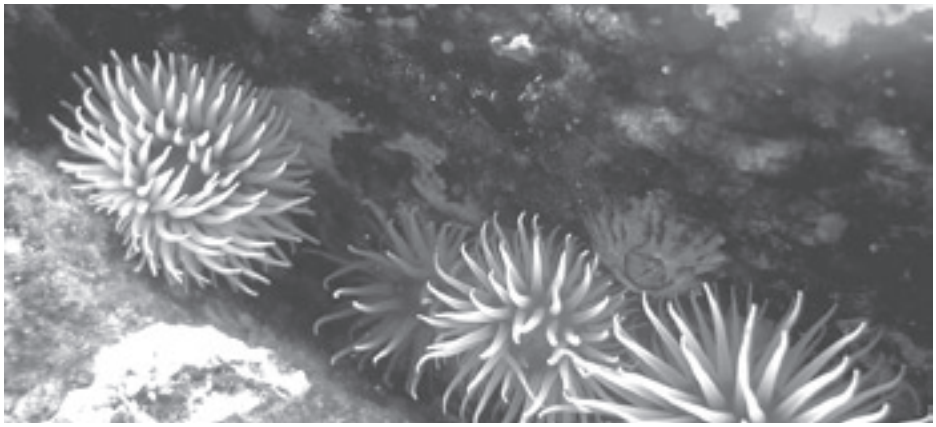
The Foveaux Strait oyster fishery and Snares Plateau fishery are managed in terms of "stock" but not yet from a holistic ecosystem perspective.

State of information:

See references below.

References and further reading:

Cranfield *et al.* (1999, 2001, 2003), Head (1985), Willan (1981)



©Sean Cooper

Anenomes, Stewart Island

Subantarctic plateaus and islands

Map ID number:

22

Location: South of New Zealand land mass

Approximate area: 342,544km^2

Description of area:

The subantarctic plateaus and islands have extensive areas of deep continental shelf. In places it is rich in biogenic shell gravel.

Biological attributes:

The area has high algal productivity and biomass with significant endemics. There are rock wall faunas associated with emergent islands, deep canyons, and seamounts.

Criteria applied:

Endemism; trophic/functional diversity.

Status and management:

The Southern Plateau supports commercial fisheries for a considerable number of species, each of which is controlled by the Quota Management System. Fishing is banned within the 4,840km^2 of the Auckland Islands Marine Reserve.

State of information:

There are large areas in which the benthos has not been adequately sampled or documented.

References and further reading:

Anderson *et al.* (1998), Bradford-Grieve *et al.* (2003), Hay *et al.* (1985), Nelson (1999b).

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Paua, Campbell Island

Southeastern continental margin/ Deep Western Boundary Current

Map ID number:

23

Location: The margin of the Campbell Plateau off the southeast coast of the South Island

Approximate area: 269,762km^2

Description of area:

Along the southeastern continental margin there is an abrupt transition from deep shelf to abyssal sea floor. The margin constrains the flow on its northern side of the Deep Western Boundary Current, which is the biggest "river" in the world.

Biological attributes:

Biologically unexplored.

Criteria applied:

Representation (across physical types); biologically unknown.

Status and management:

Bollons Seamount and Seamount 401 are among the 19 seamounts that were closed to trawling in 2001 under the Fisheries Act 1996.

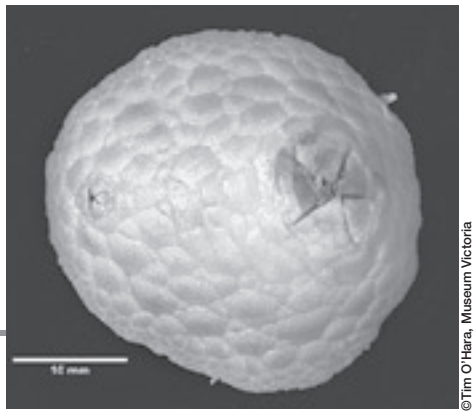
State of information:

Biologically unexplored.

References and further reading:

No benthic biological references in NIWA's library.

Sea cucumber *(Psolus neozelanicus)*



©Tim O'Hara, Museum Victoria

Macquarie Ridge

Map ID number:

24

Location: South of the South Island

Approximate area: 73,550km^2

Description of area:

The Macquarie Ridge is a tectonically generated volcanic ridge. It acts as a barrier to the Antarctic Circumpolar Current because of its north-south trend.

Biological attributes:

The ridge is a transition zone between neozelanic and Antarctic biotic elements. It is variably and locally rich in echinoderms and bryozoans.

Criteria applied:

Representation (across physical types); extremeties of range; biologically unknown.

Status and management:

The northern section of the Macquarie Ridge lies within New Zealand's Exclusive Economic Zone, while the southern section is part of Australia's marine jurisdiction. The Australian Government established the Macquarie Island Marine Park in 1999, which comprises 162,000km^2 of Commonwealth waters to the southeast of Macquarie Island. The state waters immediately surrounding the island are a marine reserve. The marine park is part of the National Representative System of Marine Protected Areas, which aims to maintain ecological processes and protect Australia's marine biodiversity. The island and surrounding waters out to 12 nautical miles were listed as a World Heritage Area in December 1997. Furthermore, the Macquarie Island Nature Reserve, which includes the marine and terrestrial environments, is one of 12 UNESCO "biosphere reserves" in Australia, and the only one in the Southern Ocean (Australian Department of the Environment and Heritage 2004).

Bottom midwater trawling to target Patagonian toothfish occurs along the western edge of the ridge west of Macquarie Island and Judge and Clerk Islands. Fishery operations are subject to environmental standards (Australian Department of the Environment and Heritage 2004).

State of information:

The Macquarie Ridge is not yet adequately characterised biologically.

References and further reading:

Australian Department of the Environment and Heritage (2004), Butler *et al.* (2000), Dawson (1970, 1988), Cairns (1991), McKnight (unpublished).

Biogenic carbonate/ bryozoan habitats

Map ID number:
16, 4, 21, for example.

Location: Chief areas are the Three Kings Shelf and Snares Plateau for extensive bryomol (Bryozoan-Mollusca) shell gravel. Large bryozoan colonies forming habitat occur in Tasman Bay, Otago Shelf, and parts of Foveaux Strait. Smaller areas include Mernoo Bank on the eastern Chatham Rise, Stephens Hole in Cook Strait, Otago Shelf, and parts of Foveaux Strait and the Campbell Plateau.

Approximate area: 10,000km^2

Description of habitat type:

Bryomol gravel environments are rich in three-dimensionality created by erect bryozoans, corals, hydroids, sponges, and ascidians. This three-dimensionality is co-associated with high diversity of mobile epibiota and fish. The highest macrobenthos diversities are found in these habitats, with nurseries for commercial fish associated with at least some of them.

Biological attributes:

New Zealand's currently known marine biodiversity hot spot, Spirits Bay, is associated with bryomol habitat. Of all known bryozoan localities in the world, Spirits Bay has the highest bryozoan diversity per unit area. The 300 species found in just the 200km^2 region of the bay are equivalent to the diversity of the entire bryozoan fauna of the British Isles. Spirits Bay, and other areas in the world, can have high local endemism at species and even genus level.

One habitat-forming bryozoan species, *Cinctipora elegans*, and the related north-restricted *Attinopora zealandica*, are the only living species of the endemic family Cinctiporidae. This family has giant zooids – the largest in the entire Stenolaemata class. The endemic, habitat forming bryozoan corals of Tasman Bay, *Celleporaria agglutinans* and *Hippomenella vellicata*, have existed in the northwest region of the South Island since the early Miocene period.

Criteria applied:

Species diversity; species richness; endemism; representation; unusual degree/ proportion of biomass; habitat complexity/ diversity.

Status and management:

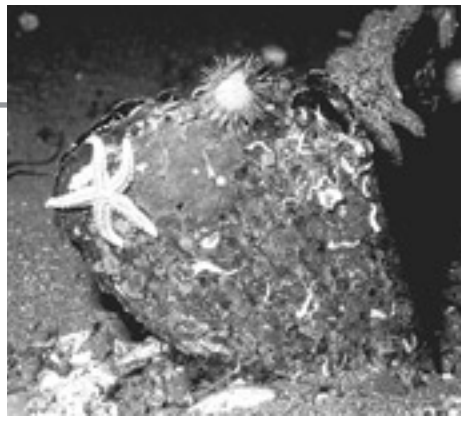
One small area off Spirits Bay is protected from bottom trawling.

State of information:

See references below. The state of information for bryozoan taxonomy is good, but the "ecology" is only partially described (i.e. for places like Spirits Bay).

References and further reading:

Battershill *et al.* (1998), Bradstock and Gordon (1983), Carter *et al.* (1985), Head (1985), Nelson *et al.* (1982, 1988a, 1988b), Probert *et al.* (1979).



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Horse mussel and soft-sediment refugia, Fiordland

Topographic generated soft-sediment refugia

Not mapped during the workshop

Location: Bay of Plenty and potentially throughout the Exclusive Economic Zone at various depths

Approximate area: Not recorded during the workshop

Description of habitat type:

This habitat is comprised of remnant areas of shelf slope sediments that have remained free of bottom trawling by virtue of their proximity to topographic features. The areas are undisturbed and unfished, but are otherwise representative of shelf and slope sediment habitats. The sizes of the refugia exist on a range of scales, from less than 1 km to tens of kilometres. Such areas are likely to occur throughout the New Zealand Exclusive Economic Zone at various depths. Examples of features that prevent trawling include rocky outcrops or canyons, cableways, and explosives dumping grounds.

Biological attributes:

Soft sediment refugia have high species diversity (including muricid gastropods) and the full range of population size and age structures.

Criteria applied:

Degree of disturbance; unusual degree/ proportion of biomass.

Status and management:

The refugia are probably now the only sites in northeastern New Zealand that contain unmodified slope fauna and are likely to be uncontested areas for conservation status. If not conserved, these refugia are likely to decrease in number and size as fishing technology develops to allow trawling in areas with some rocky outcrops.

State of information:

The fisheries trawl database (owned by the Ministry of Fisheries, administered by NIWA) has good records of trawling intensity on scampi grounds on different areas. Interrogation of this database in combination with the latest NIWA swath map should identify the exact location of refuges from trawling.

References and further reading:

Cryer *et al.* (2002).

Non-geniculate coralline algae

Not mapped during the workshop

Location: Non-geniculate coralline algae are widespread from the intertidal to the deep subtidal. They are found throughout New Zealand, from the Kermadecs (to approximately 200m) to the subantarctic islands.

Approximate area: Not recorded during the workshop

Description of habitat type:

Coralline algae encrusts rock walls and cobbles, and other marine plants and animals (epiphytic and epizoic). It is also found in a free-living form as rhodoliths, which are also in fossil deposits.

Biological attributes:

Coralline algae are implicated in the settlement of invertebrates, particularly paua (abalone) species and kina (sea urchins). Algae release materials that result in the settling of planktonic phases. Rhodolith beds are recognised internationally as significant (and vulnerable) habitat for fish juveniles and invertebrate hot spots of diversity.

Criteria applied:

Species richness; endemism; representation; habitat complexity/diversity.

Status and management:

Rhodoliths are vulnerable to disturbance/harvest as bycatch from trawling or other fishing activities. Coralline algae are slow-growing, which makes it them vulnerable to human impacts such as modification of coastal environments through sedimentation and nutrient enrichment. Removal of particular species may have a significant impact on recruitment of particular invertebrates.

State of information:

Information on non-geniculate coralline algae is very poor, but an initial study was started in 2002 with funding from the Ministry of Fisheries. Very little is known about the distribution of rhodolith beds. Only one rhodolith bed is well identified between Kapiti Island and mainland New Zealand, although others have been recorded, predominantly from northeastern North Island sites.

References and further reading:

Nelson and Farr (2001), Nelson (2002), Woelkerling and Nelson (2004).

Kelp forests

Not mapped during the workshop

Location: Different kelp species have specific distributions:

Ecklonia radiata is found around mainland New Zealand and Stewart Island, but not the Chatham Islands. This alga is found elsewhere in the world[9], but the New Zealand populations represent the eastern and southern limits of the species.

Macrocystis pyrifera is found around the northern Cook Strait to the subantarctic and on the Chatham Islands.

Lessonia variegata is found around the North, South, and Stewart Islands. *L. adamsiae* is restricted to the Snares Islands, *L. tholiformis* is found only on the Chatham Islands, *L. brevifolia* is found in the New Zealand subantarctic islands – Bounty, Antipodes, Auckland, and Campbell. The *Lessonia* species found in New Zealand are all endemic to New Zealand, and some species are unique to particular island groups, such as the Snares and the Chathams.[10]

Durvillaea, known commonly as bull kelp, is an iconic genus with southern hemisphere distribution. New Zealand is the world centre of *Durvillaea* diversity with four species:

- *D. antarctica* – found around mainland New Zealand to the subantarctic and Chatham Islands;
- *D. enchathamasis* – found only on the Chatham Islands;
- *D. willana* – found on the South Island and Stewart Island; and
- *D.* sp. – found on Antipodes Island.

Approximate area: Not recorded during the workshop.

Description of habitat type:

The presence of a particular kelp species indicates a particular environment type. For example, *Macrocystis* is found on the open coast where there is current/water exchange, but not in wave-exposed areas. *Durvillaea*, by contrast, is found in areas with extreme wave exposure.

Biological attributes:

Kelps are major components of coastal systems. They provide three-dimensional structure and shape coastal rocky reef environments. Both invertebrates and fish depend on the kelp canopy and the shade it provides. *Macrocystis*, commonly known as "giant kelp", is recognised as a major "forest-forming" taxon globally. Kelps are also major sources of productivity in the coastal environment. Macrocystis has the highest growth rate measured for any seaweed.

Criteria applied:

Species richness; endemism; representation; habitat complexity/diversity

Status and management:

Kelps are vulnerable to human impacts. For example, research conducted at Leigh Marine Lab demonstrates cascades between top predators, herbivores, and forest cover with very significant shifts in vegetation cover within the no-take marine reserve.

Commercial exploitation of kelp is developing. It has been proposed that four genera (*Ecklonia*, *Lessonia*, *Macrocystis*, and *Durvillaea*) be introduced into the Quota Management System. Such commercialisation would have implications for associated species and habitat change.

D. antarctica is used to make poha titi (storage bags for mutton birds) and has cultural significance for Māori, particularly Ngai Tahu.

State of information:

The data that are currently available are very local and restricted. Little is known about *Lessonia* ecology. *Ecklonia* data are available for New Zealand's northeast North Island and Fiordland, but little elsewhere.

References and further reading:

Durvillaea: Hay (1979a, 1979b, 1994), Hay and South (1979), Kelly and Brown (2000), South and Hay (1979).

Ecklonia: Andrew and Choat (1985), Andrew and MacDiarmid (1991), Babcock *et al.* (1999), Choat and Ayling (1987), Choat and Schiel (1982), Cole and Babcock (1996), Jones (1984, 1988), Novaczek (1984a, 1984b), Schiel (1981, 1982, 1988, 1990), Schiel and Hickford (2001), Schiel and Nelson (1990), Shears and Babcock (2002), Trenery (1985).

Lessonia: Choat and Schiel (1982), Hay (1987, 1989), Schiel and Hickford (2001), Schiel *et al.* (1995).

Macrocystis: Brown *et al.* (1997), Hay (1990), Kain (1982), McCleneghan and Houk (1985), Moore (1942), Nyman *et al.* (1990, 1993)

[9] *Ecklonia radiata* is also found in South Africa, Australia, and Oman upwelling zones.

[10] The *Lessonia* genus is also in Tasmania and South America, but the species are different to those of New Zealand.

Mangroves

Map ID number:
Examples include 6, 9

Location: Mangroves occur in many estuaries and shallow-water coastal areas north of 38°S. (This corresponds with Raglan/Whaingaro on the west coast of the North Island and Ohiwa on the east coast.) There is some evidence from analysis of pollen samples that mangroves have occurred further south in the past (e.g. Mildenhall 1994).

Approximate area: Unknown – there is some historical information available (e.g. Crisp *et al*. 1990) and more recently, mangrove extent has been mapped at a number of individual locations by different agencies/organisations.

Description of habitat type:

The mangrove (*Avicennia marina* subsp. *australasica*)[11] is a broadleaf evergreen tree that flourishes in estuarine and sheltered coastal areas. The trees grow between mid-tide and high spring tide levels on sheltered accretive shores with low energy wave action. They have a number of physiological adaptations that aid survival in these areas.

Biological attributes:

Mangroves are highly productive in terms of litter production (e.g. May 1999). They are thought to contribute substantially to the organic material available to estuarine/coastal food chains. Mangroves provide habitat structure for high and mid-intertidal areas, but there is little information on the biodiversity value of mangrove habitat in New Zealand. Mangroves also contribute to prevention of shore erosion and act as sediment and contaminant retainers.

In many New Zealand localities mangroves are reported to be increasing in spatial extent, which is a unique phenomenon globally. This expansion is generally considered to be a consequence of catchment activities. In some areas the expansion of mangroves is considered by some to be having undesirable consequences, conflicting with other estuarine resources and values, both natural and human.

Criteria applied:

Trophic/functional diversity; conservation status/threat classification both nationally and globally; extremities of range and adaptation to environment; special conditions and specialised organisms; habitat complexity/diversity.

Status and management:

The 1994 New Zealand Coastal Policy Statement identifies the protection of areas of significant indigenous vegetation as a national priority for the preservation of natural character of the coastal environment.

Some areas of mangroves currently receive some level of protection (e.g. mangroves in the southern Firth of Thames Ramsar site). With the increase in the spatial extent of mangroves in a number of estuaries there has been an increased demand for active management of mangrove areas.

State of information:

There is some historical information on mangroves. Currently there is a demand for increased information related to the biodiversity of mangrove forests and the changes in estuarine biodiversity associated with the increase in extent of mangroves in New Zealand.

References and further reading:

Crisp *et al.* (1990), May (1999), Mildenhall (1994).
The Mangrove Steering Group has compiled a bibliography of New Zealand mangrove publications.

[11] The New Zealand variety is considered to be the same as species found between Adelaide and southern Queensland.

Mangrove

Seagrasses

Map ID number:
Examples include
6, 9, 17, 18, 21

Location: Around mainland New Zealand and Stewart Island

Approximate area: Unknown

Description of habitat type:

Seagrass (*Zostera capricorni*)[12] is mainly intertidal in New Zealand, forming extensive monospecific beds on estuarine sandflats. The beds may extend as subtidal fringes into the shallow subtidal areas of estuaries. Permanently submerged beds of seagrass have been recorded around offshore islands (e.g. Grace and Grace 1976). Seagrass beds also occur on open coast intertidal platform reefs (e.g. Woods and Schiel 1997, Ramage and Schiel 1998, 1999).

Biological attributes:

Seagrasses are flowering plants which are restricted to shallow coastal and estuarine waters because they have high light requirements. Seagrasses possess morphological adaptations unique for submerged marine plants such as linear grass-like leaves and an extensive root-rhizome system.

Seagrasses are generally considered to be highly productive, with their high biomass

[12] There is currently considered to be one species of seagrass in New Zealand, *Zostera capricorni* Asch (Les 2002).

Seagrasses

continued

and production directly linked to the important roles they play in coastal and estuarine ecosystems. Recent studies have established the importance of New Zealand estuarine seagrass habitat to benthic macrofauna communities (e.g. Turner *et al.* 1999, van Houte-Howes *et al*., under review) as well as recreationally and commercially important fish species (e.g. Morrison and Francis 2001).

Criteria applied:

Species diversity; species richness; dependency for other species; trophic/functional diversity; conservation status/threat classification both nationally and globally; cultural values; degree of disturbance; special conditions and specialised organisms; habitat complexity/diversity.

Status and management:

Seagrasses are vulnerable to human impacts such as changes in sedimentation, coastal modification, increased nutrients, and direct physical disturbance. The 1994 New Zealand Coastal Policy Statement identifies the protection of areas of significant indigenous vegetation as a national priority for the preservation of natural character of the coastal environment. Limited areas of seagrass currently receive some level of protection (e.g. Whanganui (Westhaven) Inlet and Te Angiangi marine reserves include areas of seagrass).

State of information:

Information on seagrass in New Zealand is relatively limited – in particular for permanently submerged beds. There is some information on the physiology and ecology of seagrass and some information on associated biological communities.

References and further reading:

Grace and Grace (1976), Inglis (2003), Les *et al.* (2002), Morrison and Francis (2001), Ramage and Schiel (1998, 1999), Turner *et al.* (1999), Turner and Schwarz (under review), van Houte-Howes (under review), Woods and Schiel (1997).

Photic zone rock wall suspension feeding assemblages

Not mapped during the workshop

Location: Rock wall assemblages are widespread in northeast New Zealand, offshore islands, and Fiordland. Other examples along the rest of New Zealand's coastline include rock stacks, pinnacles, and similar formations.

Approximate area: Not recorded during the workshop

Description of habitat type:

The photic zone, or the depth to which light penetrates, is up to 200m. Rock walls have a vertical relief or a very high gradient. They are typified by strong to moderate currents.

Biological attributes:

Rock walls are home to many iconic taxa including black corals, red coral, and brachiopods. They have a high biomass and surface cover of benthic species and a high biomass of planktivorous fishes. Such biomass is sustained by energy transfer from the surrounding ocean ecosystem. The habitat is characterised by very high feeding upon pelagic energy sources – by benthic/demersal species such as sponges, tunicates and/or bryozoans, brachiopods, hydroids, soft and hard corals, and a variety of planktivorous fishes. The environment is also a carbonate sediment "factory" for surrounding soft bottoms (Nelson *et al.* 1988).

Non-geniculate coralline algae are particularly important as they cover very large areas of rock walls and are implicated in invertebrate settlement and recruitment.

Criteria applied:

Species diversity; species richness; endemism; dependency for other species; trophic/functional diversity; representation (i.e. across physical types)

Status and management:

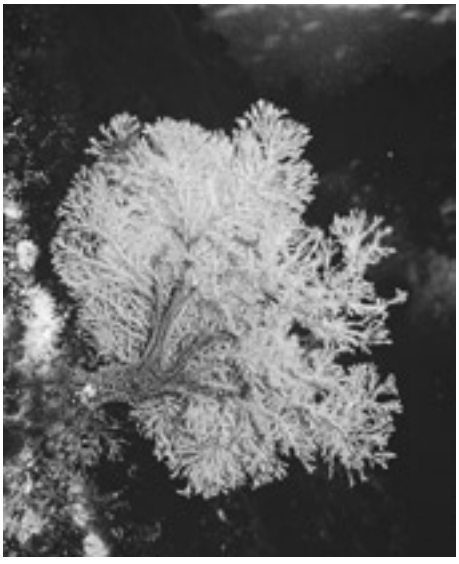
Most species are not exploited or directly threatened. Rock walls have high human appeal (e.g. for scuba divers). Populations are protected in New Zealand's marine reserves.

State of information:

Some rock wall sites are very well known, especially in northeast New Zealand and Fiordland. Other sites are only locally known. They are best known within SCUBA range, but other deeper rock walls are known to occur.

References and further reading:

Battershill and Stocker (1993), Grange (1986).



Hydroid, Cape Karikari

Deep rock wall/high gradient hard bottom habitats deeper than 200m

Not mapped during the workshop

Location: This habitat type is located throughout the New Zealand Exclusive Economic Zone, but is especially associated with continental margins, seamounts, ridge features, submarine canyon walls, and fiord walls.

Approximate area: Not recorded during the workshop

Description of habitat type:

Steep gradient areas with a rocky substratum beyond the photic zone, from 200m to kilometers in depth. This environment experiences a range of current conditions, from weak to very strong.

Biological attributes:

Biodiversity on deep rock walls can be high, and differs significantly from surrounding communities. A wide range of sub-habitats are encompassed by the category, including coral communities and boulder fields. Many long-lived species are attached to rock walls at these depths including the giant bubblegum coral (*Paragorgia arborea*), and Gorgonian corals, including bamboo corals, Antipatharians, Scleractinians, and hydrocorals.

©NIWA

Deep-water coral thicket and orange roughy

Status and management:

Coral communities are susceptible to even light trawling, with recovery time measured in centuries. Such communities have become iconic globally. These areas are becoming increasingly impacted with advances in fishing technology. Trawling is moving from "flat" features to adjacent hills and seamounts and is able to access progressively deeper sites.

State of information:

The location of deep rock walls is increasingly better known through swath-mapping exercises, but biological characteristics have been investigated only in a small subset of seamounts and canyons. Taxonomic work is required by many specialists.

References and further reading:

Clark *et al.* (2000), Rowden *et al.* (2004).

Brachiopod communities

Not mapped during the workshop

Location: Brachiopod communities are widespread in New Zealand from shallow depths to beyond 2000m.

Approximate area: Not recorded during the workshop

Description of habitat type:

Brachiopods are usually attached to hard substrates, such as rock, other brachiopods, and dead shells, although one species (*Neothyris*) is free-living as an adult.

Biological attributes:

Brachiopods are sessile suspension feeders that range in size from less than 1mm to 50mm. They are solitary animals, and are probably long-lived. They are abundant in the New Zealand fossil record. In fact, the brachiopod record for the past 40 million years is the best in the world.

There are several other reasons why New Zealand brachiopods are particularly significant in a global context. New Zealand has high brachiopod diversity and richness, a high proportion of brachiopod species are found in shallow water (intertidal less than 20m), and brachiopods account for a large portion of the biomass in many areas. For example, they are a dominant or conspicuous member of the benthic communities in the fiords, the Marlborough Sounds, Paterson Inlet on Stewart Island, and in patches on the Otago Shelf and subtidal eastern Northland.

Criteria applied:

Species diversity; species richness; unusual degree/proportion of biomass; relict/genetic lineage; endemism; special phylogenetic grouping.

Status and management:

Brachiopods are not protected as a species, but communities of brachiopods are included within marine reserves such as Poor Knights, Long Island, Milford Sound, and Doubtful Sound.

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Brachiopod community, Stewart Island

State of information:

Not recorded during the workshop

References and further reading:

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TO CONTENTS

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3.5 Information gaps and other obstacles to assessing marine biodiversity

Experts identified multiple deficiencies in spatial information about the marine environment and the challenges of filling such gaps. These include: significant gaps in the distribution of intertidal organisms; under-representation of sampling for all species and habitats deeper than 1,500m; a sampling bias for specimens larger than 2 mm, since smaller organisms can escape from the net; the ability of nekton to avoid sampling efforts by swimming away, resulting in under-representation in sampling; only recent knowledge of deep-sea features; a fisheries bias in the information source, resulting from a large portion of data that is generated through commercial fishing activities and research; and virtually complete ignorance about trench environments.

Deficiencies in information about ecosystem process and interactions that workshop participants identified include: very sparse interactive studies; limited understanding of trophic interactions; gaps in population dynamics and recruitment studies; incomplete information on ocean currents; and ignorance about the history of marine processes and floral/faunal composition, particularly how the environment has changed since human settlement.

Workshop participants voiced a high level of concern about the scarcity of specialists with taxonomic expertise in New Zealand. Taxonomy is the integrative basis for understanding, use, and management of marine biological resources. Fundamentally, taxonomic capacity dictates the speed at which organisms can be identified and classified. The taxonomic deficiency is particularly severe for the benthic environment. Amelioration of the taxonomic specialist shortage is not foreseen in the near future because the subject is not a fundamental component of the biology curriculum at tertiary institutions. The shrinking level of taxonomic expertise has implications for New Zealand at a national level because taxonomy has wide application in areas such as biosecurity, biotechnology, fishing impacts, and conservation.

3.6 Future steps for the assessment/ conservation of biodiversity; and a common statement for the conservation of New Zealand's marine biodiversity

During the discussions concerning the identification of future steps for the assessment and conservation of biodiversity, the following actions were widely supported by all workshop participants: train and recruit more competent taxonomists; raise public/government awareness of marine environment and promote an ethic for its care; make greater use of geographic mapping techniques to identify areas of ecological importance; increase the amount of the marine environment scheduled for protection; develop and fund a national plan of marine exploration; effectively direct adequate and appropriate biological information to government science-funding agencies; appraise appropriate national authorities of the results of the present workshop; harness the passion that scientists and others have for the marine environment and translate it into action.

The workshop participants' statement on the state of knowledge for New Zealand's marine biodiversity:

We marine scientists of various specialisation, recognise New Zealand's oceanic environment and ecosystems as unique and highly regionalised, with a level of biodiversity of global significance.

A great deal remains unknown about New Zealand's marine environment; vast regions are unexplored, interactions between species and their environments are not understood, and we lack the expertise to recognise and document many of the components of the biota. Consequently, the capacity to use and manage marine resources, or even identify possible human impacts is limited.

If we New Zealanders are to live in a sustainable relationship with our oceanic environment and benefit from the use of the marine resources of our EEZ, we need more information. Our current lack of knowledge is alarming and does not represent a sound basis for reliable policy and management decisions.

We urge immediate action by the Government and other stakeholders to ensure the capacity of relevant institutions to address this situation.

4.0 Discussion

Ecoregion conservation is a process that requires stakeholder collaboration and action at ambitious spatial and thematic scales. The compilation of data provided by marine scientists during this workshop is an important step in the effort to conserve New Zealand's marine biodiversity. Experts identified areas of deepwater emergence in Fiordland and the Marlborough Sounds where species are found at unusually shallow depths due to the unique physical characteristics of these environments. They noted the high productivity of the hydrographically complex Chatham Rise, the remarkable invertebrate diversity of Spirits Bay, and the expanding coverage of mangrove forests in northern New Zealand. Seabird experts highlighted the importance of the subantarctic and Chatham Islands as global hotspots for bird diversity, and the importance of migration corridors around New Zealand. Marine mammal experts marked the canyon and trench systems running from Kaikoura Canyon northwards as attractive foraging areas for deep-diving cetacean species, such as sperm whales. Overall, the work of the marine scientists has helped to shine a spotlight on the most important areas and features of New Zealand's marine environment and contributed to the greater body of knowledge about the ecoregion's marine biodiversity.

The focus of the workshop on defining the key biological elements provides a platform for long-range dialogue, planning, and action among a range of stakeholders. The gaps that workshop participants identified in the marine biodiversity knowledge base, however, are a reminder that the workshop results are biased toward representation of the places that have been sampled and by the sampling methods that have been used. For example, the workshop results shine a brighter spotlight on areas shallower than 1,500m, since there are fewer observations of the deep. The continuous process of marine discovery will involve observation at larger spatial scales and depths and the use of different sampling techniques. As new information on marine biodiversity distribution comes to light, other places may be recognised as key areas for biodiversity within the ecoregion.

Knowing the biogeographic distribution of marine biodiversity, however complete, is only one dimension of understanding the marine environment. Equally important is understanding how biodiversity functions, and how dynamic temporal processes, both geological and hydrologic, created the patterns that are observed today. One workshop participant pointed out that 20,000 years ago, many of New Zealand's marine habitats did not exist. Historical baselines for the marine environment are unknown, but would be immensely valuable for setting conservation and management targets. Such baselines are also critical for anticipating how changes in environmental conditions (e.g. those associated with climate change) will shape the distribution of marine organisms in the future.

The next steps for the New Zealand Marine Ecoregion Initiative will involve determination of how the sites and features deemed important for marine biodiversity intersect with human uses of the marine environment. Spatial representation and characterisation of human activities that impact on the oceans would likely help to identify the pressures on marine biodiversity. This process would involve not only scientists, but stakeholders with expertise in the human uses of the environment including tourism, fishing, shipping, mining, bioprospecting, and other uses.

WWF-New Zealand is committed to making information on marine biodiversity more accessible to stakeholders and the larger public, and to promoting conservation action in the region. Achievement of conservation success in New Zealand's marine ecoregion will require collaboration between many partners – communities, Māori, research institutes, environmental managers, and resource users. As the ecoregion consultation process develops, goals, objectives, and targets for marine biodiversity will be defined in consultation with stakeholders. Such benchmarks are central to ecoregion conservation for measuring the performance of conservation strategies, plans, and partnerships. WWF-New Zealand hopes that this document will be a useful information source for other organisations and individuals and will help to catalyse further interest in and support for conservation in the ecoregion.

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Appendix 1

WWF Methodology for selection of the Global 200 ecoregions

Ecoregions were derived using a hierarchical methodology in which biodiversity was stratified by the terrestrial, freshwater, and marine realms, major habitat types, and biogeography. In the terrestrial realm 14 major habitat types were identified, such as mangroves, flooded grasslands and savannas, temperate coniferous forests, and tundra. Among the seven major freshwater habitats types are large rivers, small lakes, and xeric basins. The marine realm includes a total of nine major habitats types: polar, temperate shelf and seas, temperate upwelling, tropical upwelling, tropical coral, pelagic trades, pelagic westerlies, abyssal, and hadal (Olson *et al*. 2000).[13]

In order to represent the unique biota on different continents or ocean basins each major habitat type was further subdivided by biogeographic realm, such as nearctic, southern ocean, Indo-Malayan, or Afrotropical. Consultation with regional experts, supplemented with extensive literature reviews led to the identification and evaluation of ecoregions. Ecoregion boundaries are intended to encompass an area within which important ecological and evolutionary processes strongly interact. Compared with the terrestrial realm, marine ecoregions are considered to be more dynamic ecological and biogeographic units both spatially and temporally. Thus, the ecoregion boundaries for the marine environment were not as clearly defined.

Of the ecoregions identified, 238 were considered to be globally outstanding in terms of their biological distinctiveness and were selected as the subset known as the Global 200. The parameters used to define biological distinctiveness were species richness, endemism, higher taxonomic uniqueness, extraordinary ecological or evolutionary phenomena, and global rarity of the major habitat type (Olson *et al.* 2000). Inclusion of ecoregions in the Global 200 based on these criteria estimates the "urgency" for action in these areas based on opportunities for conserving distinct units around the world.

[13] Although nine major habitat types were identified for the marine realm, four were not assessed for the Global 200 marine analysis: pelagic trades, pelagic westerlies, abyssal, and hadal habitats. These habitat types differed in scale from other Global 200 ecoregions and have particularly limited biodiversity information.

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Appendix 2

Information-based initiatives underway for New Zealand's marine environment

National Aquatic Biodiversity Information System (NABIS)

The National Aquatic Biodiversity Information System (NABIS) is a website application using GIS (geographic information system) tools to provide spatial and visual representation of New Zealand's marine biological and fisheries management data. The system displays geographic distributions of various marine organisms on a species-by-species basis, including an indication of where species are concentrated. NABIS also provides access to maps showing the boundaries of the areas used in the management of New Zealand's living marine resources and displays some commercial catch effort. Information sources for NABIS include Ministry of Fisheries databases, field collections, published and unpublished reports, museum holdings, and expert discussion. NABIS is administered by the Ministry of Fisheries and can be accessed at www.nabis.govt.nz.

The Marine Environment Classification (MEC) System

The Ministry for the Environment has been leading the development of a marine environments classification system. The MEC system development is based on the principle that ecosystem properties are broadly determined by the interplay between biophysical processes and physical factors in the marine environment. The classification groups the physical factors and maps them as ecologically relevant environmental units, or areas with similar biophysical characteristics that are likely to reflect different ecological communities. Some of the physical factors that have been mapped are depth, slope, tidal current, and mean annual solar radiation.

The end result of the classification will be maps that represent areas of similarity or difference for marine ecosystem properties, and as such infer how the effects of resource use could correspond with the characteristics of the areas. The Exclusive Economic Zone has been classified on the 1km scale. Pilot classifications on a finer scale, such as 200m in the Hauraki Gulf, are being developed to test the ecosystem relevance of the classification through biological ground truthing. Ultimately, the MEC system will be applied to measure the effectiveness of marine policies and manage marine issues at the regional council level.

The Interim Nearshore Marine Classification (INMARC)

Development of the interim nearshore environment classification scheme has been led by the Department of Conservation to provide a spatial framework of large marine biogeographic regions and smaller units. The INMARC focuses on relatively shallow water (approximately 50–100m depth) where sampling of the marine environment is most concentrated. It comprises an inventory of physical and biological information relating to New Zealand's nearshore marine environment.

The classification comprises information at two scales, the mesoscale (100–1000km) which describes eight marine biogeographic regions and the micro-scale (10–100km) which describes coastal, shelf, and offshore island units. The marine biogeographic regions and units were determined using relevant information from the literature and the advice of specialists with expertise on the distribution patterns of marine invertebrates, fish, and algae. The INMARC information is represented in a geographic information systems (GIS) format.

The Estuary Environment Classification (EEC)

The Estuary Environment Classification has been developed by scientists at the National Institute of Water and Atmospheric Research Ltd (NIWA) as a new method of classifying estuaries. The classification is based on the "factors" or broad scale environmental circumstances such as climate, oceanic and riverine conditions, and catchment characteristics that cause or "control" differences and similarities in the physical and biological characteristics of estuaries. The EEC is based on a model of the processes that determine estuarine characteristics, which makes it applicable to broad scale environmental management applications. For example, the Exclusive Economic Zone can be used to extrapolate the results of studies between estuaries, to stratify environments according to their susceptibility and vulnerability to the effects of development, and to develop broad-scale management strategies and policy (Hume *et al.* 2003).

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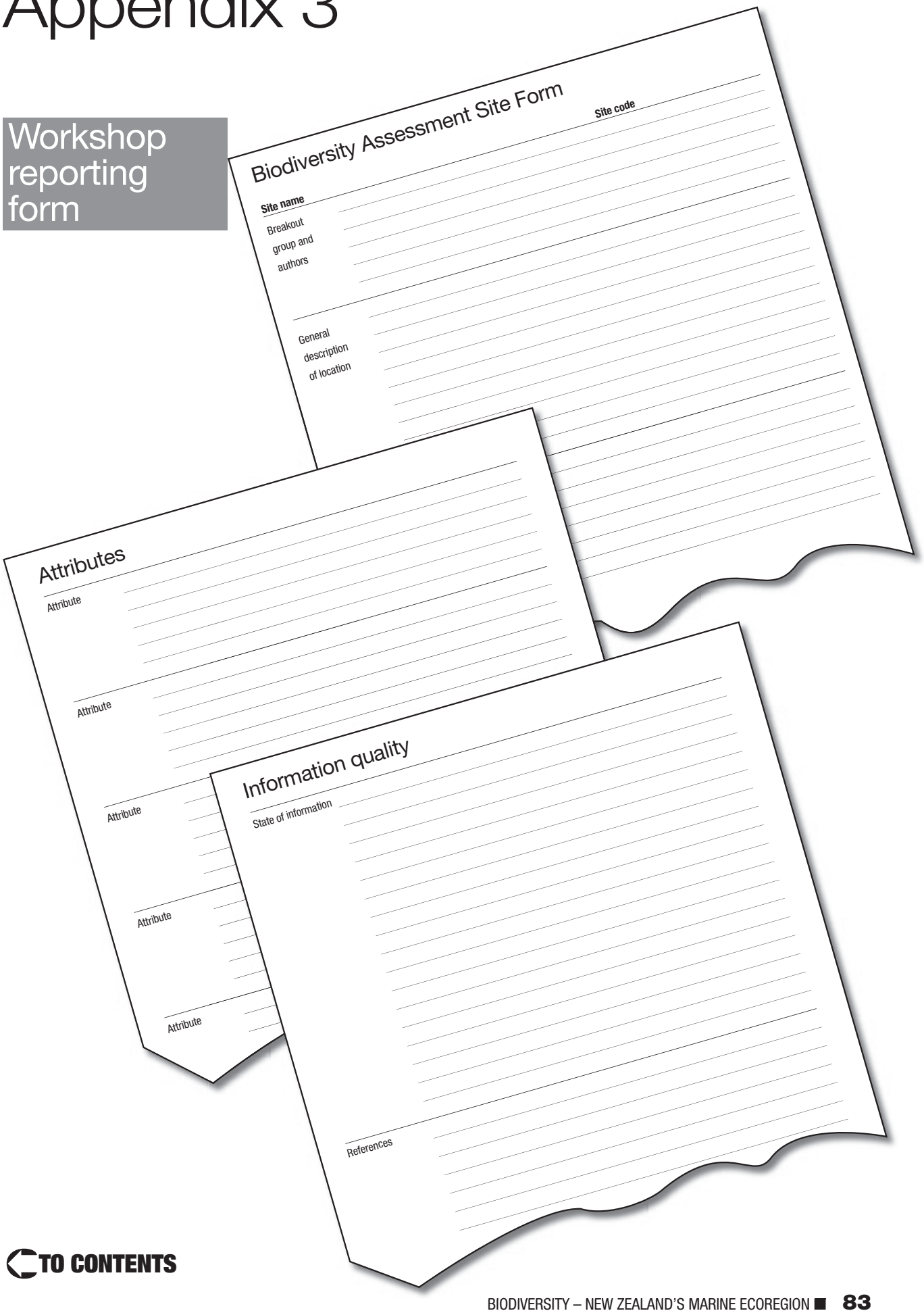
Appendix 3

Workshop reporting form



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