



Ministry for the
Environment
Manatū Mō Te Taiao

Getting Our Priorities Right

**The role of information in setting priorities for
management of New Zealand's ocean**

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Disclaimers

This report does not necessarily represent the views of the contributors listed above.

The maps contained in this report may not represent the best available information or the full range of information that might be useful for setting future national ocean priorities. They are illustrative only. Any errors or omissions in the maps are the responsibility of the Ministry for the Environment.

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Draft Marine Environments Classification – 9 Class Level

Draft Marine Environments Classification – 20 Class Level

Executive Summary

The draft Oceans Policy¹ identifies a fundamental need for co-ordinated national priority-setting on ocean issues to direct all our activities in the ocean so that we can manage threats to our ocean and maximise opportunities for its sustainable use. This report is a first step towards identifying a preferred, adaptive approach for setting future national ocean priorities, together with specific actions needed to build the information, tools and concepts that might underpin this approach.

Part 1 of this report explores the kinds of things we might need to know when setting priorities for ocean management. Any national priorities set under the Oceans Policy will need to address key threats and opportunities for managing our ocean – across social, cultural, economic and environmental dimensions of sustainable development. We can therefore expect the information needed to include both *values-based* information, so that we can understand people’s preferences for how the ocean should be managed, and *empirical* information, so that we can understand the complex nature of the ocean environment.

Values-based information has been gathered through the Oceans Policy consultation processes and has driven the overarching objectives and principles for ocean management. Over time, people’s preferences may change, so these may need to be reviewed.

Empirical data is being gathered through a number of projects, including the Ocean Survey 20/20 – a comprehensive exercise to survey New Zealand’s total ocean area and resources by the year 2020. This report scopes the range of information that could be collected as part of the Ocean Survey 20/20 and other complementary projects to assist with Oceans Policy priority setting, including information on:

- the full range of ocean environments and habitats
- human activities in and uses of the ocean
- the types of change that can occur in different environments and habitats, and as a result of different human activities and uses within them.

Tables 1 to 3 set out the information needs under these categories. However, to set management priorities we also need to understand the relationships between these factors; that is, we need to understand how the marine environment changes when different pressures (natural and human-induced) are applied. Figures 2 and 3 provide a useful model for classifying the full range of changes that could occur in the marine environment. However, further work is needed to develop these concepts further.

Section 1.2 looks at information we already have on hand and the gaps and barriers to accessing this information. It does this by summarising the range of marine data and information held by various agencies throughout New Zealand. Chief among these are:

- a review for the Ministry of Fisheries of data sets that may be incorporated into the National Aquatic Biodiversity Information System (NABIS) – a centralised decision-making tool containing layers of aquatic biodiversity information
- *Marine Research in New Zealand: A survey and analysis* (Chapman and Lough, 2003)

¹ At the time this report was printed, the draft Oceans Policy had not been approved by Cabinet.

- *Setting Course for a Sustainable Future: The management of New Zealand's marine environment* (Parliamentary Commissioner for the Environment, 1999)
- *Review of National Databases Relating to the New Zealand Marine Environment* (Froude, 2000)
- *Review of Existing Coastal and Estuarine Monitoring (excluding Regional Council monitoring)* (Froude, 1998)
- *Coastal Resources Database and GIS: A report to the NZ Maritime Safety Authority* (Tortell, 2001)
- an inventory of data sets listed in *Shining a Spotlight on the Biodiversity of New Zealand's Marine Ecoregion* (WWF-New Zealand, 2004), a report on the results of an experts workshop held in May 2003 to conduct an independent assessment of marine biodiversity in the New Zealand region.

The report adds to this body of knowledge by presenting easily available data in a series of maps. This exercise illustrated that there are significant gaps in, and barriers to obtaining and accessing, information, including:

- intellectual property issues
- availability of data in electronic geospatial format
- lack of a consistent definition or standard for particular data sets
- wide distribution of data among diverse agencies
- unclear responsibility for the collection of the data
- lack of technology to collect the information
- lack of resourcing to collate and manage data
- lack of protocols for the use of information.

These issues will need to be resolved before the full range of necessary information can be collated.

However, simply collecting data is not enough without some means to analyse it. In section 1.3 we explore:

- 'access tools', which allow decision-makers to directly access key information and data layers
- 'sourcing tools', which provide an overview of the range of available data and information sources throughout the country, and information such as where they are held, by whom and in what format
- 'interpretive tools', which can be used to evaluate and extrapolate from existing information.

We describe existing tools such as NABIS, the draft Marine Environments Classification the Near-shore classification, Marlin, and the draft marine environmental performance indicators, and conclude that there still remains a need for a comprehensive national meta-database of marine information sources, and a common portal for accessing selected data.

Part 2 of the report explores methods we can use to select the management priorities we might want to set in place under a national Oceans Policy to direct all decision-making about our ocean. The three options described and assessed are:

- a map-based approach
- a risk management approach
- an expert-based approach.

In reality, a mixture of all three approaches would probably deliver the best method for priority setting.

Recommendations

The report concludes with the following actions that could be initiated to address the issues raised in this report.

- Ensure there are effective links between the Ocean Survey 20/20 project and the Oceans Policy project, so that priorities set under each can inform the other and a truly adaptive approach to ocean management can be instigated.
- Develop a full list of data that currently exists to ensure there is no duplication in effort, and, as part of this exercise, address the range of barriers to accessing and using existing information, including:
 - intellectual property issues
 - limited availability of data in electronic geospatial format
 - lack of a consistent definition or standard for particular data sets
 - wide distribution of data among diverse agencies
 - unclear responsibility for the collection of data
 - lack of technology to collect the information
 - lack of resourcing to collate and manage data
 - lack of protocols for the use of information.
- To ensure that any data collected or collated can be used effectively, assess the viability and costs and benefits of:
 - a comprehensive database of information and data about New Zealand’s ocean (it is anticipated that any database developed would draw from distributed information available from existing key tools already being developed, particularly the Marine Environments Classification, NABIS and the Marlin meta-database; Australia is already developing a similar system and we would initially investigate whether this could be transposed to the New Zealand situation)
 - a ‘portal’ for providing public access to selected marine data and information held in the public domain.
- Agree on a preferred approach to identifying national ocean priorities and develop a strategy for implementing it.

Introduction

Overview

New Zealand's jurisdiction extends much further than the islands we live on. Under the sea our land continues for more than 200 nautical miles beyond the shore. It is a frontier that is still being mapped and we are only just beginning to understand it. Our underwater scientists return from their expeditions with fantastic tales of mountains spewing gold, ice that burns and bizarre sea creatures that seem to belong more in science fiction than in real life.

Meanwhile, the pressures on this unique environment are increasing as people push out into the frontier. More than 99 percent by volume of our exports are shipped by sea and fishing is our fourth-largest export industry, with aquaculture set to expand once the international market becomes more favourable. Our submarine cables carry 90 percent of our communications. We have extracted billions of dollars worth of energy from the Maui gas field off Taranaki, and there is a high level of activity to seek out new energy resources and options. A number of mineral and other biological resources are also being investigated for extraction potential, such as the manganese nodules south of the Campbell Plateau. On top of all this is a broad expectation that 10% of our ocean should be protected in some way, a growing economic reliance on marine-based tourism, and increasing demand for the use of marine space and resources.

At the moment we manage all of these activities in an ad hoc way through a myriad of authorities and legislation. In some cases, especially beyond the territorial sea², we have no management system at all.

So how can we improve our management of this vast territory and all its potential? The draft Oceans Policy³ identifies a fundamental need for co-ordinated national priority-setting on ocean issues to direct our activities so that we can manage threats to our ocean and maximise opportunities for its sustainable use.

Any national priority-setting approach for managing our ocean will need to be able to adapt to changing trends and priorities. Adaptive management allows decision-makers to refine their management responses over time as knowledge of ecosystems and human impacts improves. By the term 'adaptive management' we mean a systematic and precautionary process for continually improving management policies and practices, which provides:

- a way to make decisions in the context of uncertainty, *with a view to*
- minimising the risk of adverse changes to ecosystems *and*
- responding quickly to adverse changes where they do arise along the way.

² The territorial sea extends from the coast to 12 nautical miles offshore.

³ At the time this report was printed the draft Oceans Policy had not been approved by Cabinet.

An adaptive approach for managing New Zealand's ocean is illustrated in Figure 1 on page 3. The main components of this approach are:

- improving the information base
- setting management objectives
- identifying management and research priorities
- applying management responses
- assessing performance against management objectives
- reporting back on trends and performance.

Good information is integral to an adaptive approach. Information about ocean processes and functions (and the impact of human activities on these) is needed to set relevant management objectives, priorities and responses. Information derived from assessing trends in the state of the marine environment, and the effectiveness of marine management measures, needs to be fed back into ongoing improvements in both management and outcomes. In combination, these components can add up to an integrated approach to improving ocean management over time, based on best available data, information and know-how.

This report looks at ways that we can optimise information resources to make smart decisions about the best future uses of our ocean. It's about making information work for us so that we can manage threats to our ocean and maximise opportunities for its sustainable use. It will complement and inform work underway on the recently announced Ocean Survey 20/20 project, a comprehensive national programme to survey New Zealand's total ocean area by the year 2020.

The report also explores methods we can use to select the management priorities we might want to set in place under a national Oceans Policy to direct all decision-making about our ocean. It therefore represents a first step towards identifying a preferred, adaptive approach for setting future national ocean priorities, together with specific actions needed to build the information, tools and concepts that might underpin this.

The ideas described in the report have been developed over a six-month period with assistance and ideas from a number of people from across central government, local government, industry, research agencies and non-government organisations through a series of discussions and informal workshops. We thank the contributors and we hope that this report will stimulate and inform subsequent thinking and analysis as a national Oceans Policy evolves.

Structure of the report

Part 1 of the report explores the issues relating to the collection and distribution of information for priority setting, and is divided into three sections.

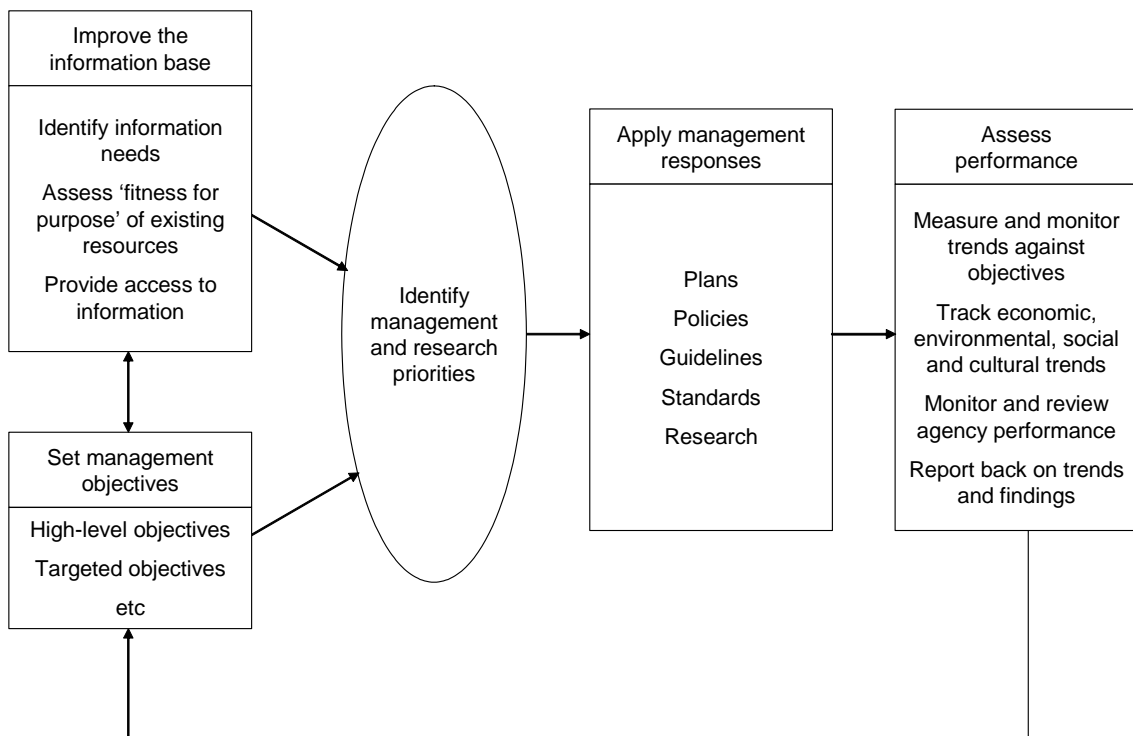
- Section 1.1 discusses what information we might need to inform our priority setting in the marine environment.
- Section 1.2 investigates how much information we already have to hand about the marine environment and where some of the key gaps might be. To illustrate this, we present some maps and discuss some of the issues faced in obtaining the information contained in the maps.
- Section 1.3 identifies the different types of information-based tools used to access, interpret and extrapolate the data we will need to assist with setting national ocean priorities, and describes some of the tools already available which we can build on.

Once the information issues are addressed, we can begin to set priorities for ocean management with more confidence.

Part 2 of the report takes a preliminary look at some different approaches we might take to set robust national priorities for future ocean management. It describes three approaches that could be used – separately or in combination – and provides examples of how these have been applied in different contexts here and overseas.

Finally, the report makes suggestions for future work when Oceans Policy development recommences.

Figure 1: An adaptive approach to managing New Zealand’s ocean



Part 1: Information for Priority Setting

Because New Zealand's ocean is vast, complex and dynamic we will probably never have all the information we need to fully understand marine functions and processes or the effects of our activities on the ocean. However, with smart planning and investment we can build a robust information base and sound tools to help us make the best possible decisions about how our ocean is used and managed into the future. The question is: what steps are needed to achieve this?

In Part 1 we explore the issues relating to the collection and distribution of information for priority setting, asking:

- What information might we need to inform our priority setting in the marine environment?
- How much of the necessary information do we already have available, and where are some of the key gaps?
- What are the different types of information-based tools we will need to assist with setting national ocean priorities?

1.1 Information needs for ocean management

Current information needs are determined by a diverse range of existing management priorities and objectives, based on guidance set out in legislation, policies, strategies and plans. Many of these objectives have been determined without reference to an integrated set of priorities or objectives for national ocean management as a whole. Often they have been set without reference to:

- other agencies' priorities or objectives, and potential overlaps or duplication across these
- the best available information (from all sectors)
- an assessment of the cumulative impacts of various management responses in different areas or environments.

Any national priorities set under the Oceans Policy will need to address key threats and opportunities for the management of our ocean – across social, cultural, economic and environmental dimensions of sustainable development. We can therefore expect the information needed to set these priorities to include both values-based information and empirical information.

Values-based information is needed about people's preferences for the management of our ocean – what aspects of the ocean are important to people. A large part of the Oceans Policy exercise to date has been the collation of information about how people would prefer the ocean to be managed and what things they value about it. The potential scope is reflected in the vision and high-level objectives and principles contained in the draft Oceans Policy, which were drawn from the document *Healthy Sea, Healthy Society: Towards an Oceans Policy for New Zealand* (Ministerial Advisory Committee on Oceans Policy, 2001).

Over time these values may need to be reviewed as people change their preferred uses and values. There may also be a need for more detailed values-based information in relation to specific ocean management issues.

Empirical information will be needed about the nature of the environment itself, including:

- the full range of ocean environments and habitats
- human activities in, and uses of, the ocean
- types of change that can occur in different environments and habitats, and as a result of different human activities and uses within them.

The Ocean Survey 20/20 project is embarking on the ambitious task of developing a comprehensive set of empirical data about our marine environment. The remainder of this section scopes the range of information that could be collected as part of the Ocean Survey 20/20 project and other complementary projects, to assist with Oceans Policy priority setting. It does not delve into the criteria for deciding what information should be collected first and where, because this is part of the Ocean Survey 20/20 work programme development. However, we anticipate that in order to maintain an adaptive approach to management, the information needs driven by Oceans Policy and the information gathered through the Ocean Survey 20/20 project will inform each other over time.

A model for detailing specific information needs is provided by the approach adopted by the National Oceans Office of Australia (2002) as part of its impact assessment work. As part of the project leading up to this report, we convened two workshops to test ways of modifying the Australian approach to better reflect the New Zealand context. A panel of technical experts was convened to identify and agree on appropriate categorisations for:

- New Zealand ocean environments and habitats (coastal to the outer edge of the Exclusive Economic Zone)
- human activities in and uses of the New Zealand marine environment
- types of change that may occur in relation to these environments, habitats, activities and uses.

The categorisations were completed using expert professional judgement (and agency peer review) and did not involve assessing impacts *per se*, or evaluating actual changes in relation to specific environments, habitats, activities or uses.

The results of this process are set out in Tables 1–3 on pages 7–9. They provide a basic overview of the types of information that will be needed to make best use of our ocean in future. They could also provide the basis for future impact assessments, as part of a risk-based approach to setting national priorities.⁴ However further work will be needed to refine these lists.

⁴ A risk-based approach to setting national priorities is discussed further in Part 2.

Workshop participants recommended, in particular, that:

- benthic and pelagic zones of different environments/habitat types should be further subdivided to analyse different changes occurring in areas of hard versus soft substrate, and inter-tidal versus sub-tidal areas⁵ (where relevant)
- key plant and animal species should be detailed, perhaps using a checklist such as the one being developed by the Maritime Safety Authority in the context of its oil spill risk assessment, which includes algae, birds, amphibians, fish, invertebrates, mammals, plants and reptiles.

Refining these lists will provide us with an agreed checklist of ‘primary information needs’ for the marine environment – basic information about where activities occur, the nature of biodiversity in different marine environments, and the nature of different changes that occur in those environments. However, to identify priorities for management, managers will also need information about the *relationships* between these data sets. For example, what types of change can be expected to occur in any specific ocean habitat over time? How might different ocean habitats be affected by specific activities or events (both natural and human-induced) into the future?

A second expert workshop was convened in June 2004 to test the extent of our current knowledge and information about these key relationships. The idea was to attempt to summarise, for the whole of New Zealand’s Exclusive Economic Zone, the extent of current knowledge or information about where:

- different types of change can occur as a result of natural processes or events, across the range of marine environments and habitats
- different types of human-induced change can occur across the range of marine environments and habitats
- different types of change can occur as a result of different human activities and uses of the ocean.

Again, the workshop adopted a simplified version of the approach taken by the Australian National Oceans Office during development of the South-East Regional Marine Plan (see Australian National Oceans Office, 2002). Participants used the matrices shown in Figures 2 and 3 (on pages 10 and 11) in an attempt to summarise, for the entire Exclusive Economic Zone, the extent of knowledge about the relationships between each specific environment or activity, and each type of change. Participants were asked to colour-code the matrices to indicate:

- where a relationship is known to exist between a specific environment or activity, and a particular type of change
- where a relationship can be expected to exist despite a lack of any direct data to prove it)
- where a relationship is known *not* to exist
- where there is inadequate (or no) information to determine whether a relationship exists.

This exercise proved very difficult and was, on the whole, unhelpful because it confused two separate questions:

⁵ Inter-tidal areas are areas that are variously covered and uncovered by water during different stages of the cycle between low and high tides; sub-tidal areas remain permanently covered by water during all stages of the tidal cycle.

- Is there a known relationship between each specific environment or activity, and each particular type of change? (this question addresses the *scope* of our information needs)
- If so, do we have adequate knowledge and information about the nature of and trends in that relationship to make effective management decisions into the future? (this question assists with identifying key *gaps* in our existing information base).

A revised approach is therefore needed to distinguish between these questions. Participants also indicated that a revised approach should be designed:

- at appropriate management scales (not the Exclusive Economic Zone in its entirety)
- to distinguish between natural and human-induced change
- with clear temporal reference points (so that changes to environments or in relation to different activities and uses could be analysed according to appropriate temporal baselines).

Table 1: Environment and habitat types

Environment/habitat	Description	Example(s)
Enclosed water	A body of water bounded on at least three sides by land	Fiord, bay, lagoon, estuary, harbour
Near shore	The area of ocean within about 3 km of land, or where the seabed experiences wave energy sufficient to move sandy sediment during storms of normal annual frequency	
Shelf	A shallow submarine plain adjacent to the near-shore zone, of varying width, and typically ending at a depth of about 200 m with a steep slope to a plateau, rise or the oceanic abyss	There are wide shelves off the SW North Island (continuous with NW South Island) and off the Canterbury Bight, for example. The shelf is very narrow off the Kaikoura Coast and Fiordland.
Slope	A zone of steep gradient and generally irregular morphology (includes submarine canyons) between the shallower shelf and deeper plateau, rise or abyssal plain	On some transects there are both 'inner' and 'outer' slopes (eg, going SE from Stewart Island); elsewhere a single feature (eg, going NNE from the Bay of Plenty)
Plateau or rise	A deep submarine plain (generally 500 to 1000 m) of varying width and typically ending in a steep slope to the oceanic abyss	Campbell Plateau, Chatham Rise
Abyssal depths	The bottom waters of the ocean depths	

Table 2: Human activities and uses

Human activity/use	Description	Example(s)
Aquaculture	The human cultivation of natural marine organisms	Shellfish farms
Biosecurity	Prevention and management of the risks posed by pests and diseases to the economy, the environment and human health	Interception of invasion by non-endemic organisms; extermination or control of distribution or population growth of previously established pests and weeds
Defence	Activities undertaken to defend, or prepare to defend, a nation from invading forces	Training and manoeuvres
Environmental protection	Controls on human activities, or mitigation of their effects, to maintain or restore ecological conditions for conservation and/or education purposes	Marine protected areas (eg, sea mount closures for fishing); marine reserves; world heritage areas
Fishing and biological resource extraction	Harvesting of fish and other biological resources from the ocean for commercial, recreational or customary purposes	Deep sea game fishing; trawling; harvesting pipi; bioprospecting (extraction)
Historic heritage protection	Protection afforded historic features	Protection of a historic landing site or shipwreck
Land-based disposal	Point source or non-point source disposal of waste or other matter from land	Sewage outfall to a river or coast; agricultural run-off; urban storm-water run-off
Maori customary use	The traditional use and harvest of the ocean and its resources by Maori	Harvesting of shellfish for a tangi; imposition of rahui or other measures for cultural reasons
Mining and minerals (including petroleum)	The process of extracting raw, non-living materials from or beneath the seabed	Installation and operation of oil and gas production facilities, including pipelines; dredging of sand and aggregate for construction material; mineral sands such as iron sand
Ocean dumping	Dumping of waste and other matter from (or including) vessels, aircraft, platforms or other man-made structures at sea (as opposed to land-based disposal)	Dumping of dredgings; disposal of unwanted chemicals; waste disposal from cruise liners
Other land-based activities	Not disposal	Transport; agriculture; horticulture; forestry; urban development (eg subdivisions, marinas, flood control works)
Mineral and petroleum exploration	Activities undertaken for the purpose of sourcing usable non-living resources	Seismic and other geophysical surveys; offshore drilling for oil
Port & harbour operations	The activities that occur in a port or harbour for the purposes of operating or managing port and harbour facilities, including construction of new ports, expansion of existing ports; reclamation	Tug boat movements; shipping activity; port structures
Power generation	Generation of power from natural resources	Offshore windfarms; tidal current and wave generators
Recreational	Any activity or structure associated with recreation	Diving; swimming; fishing; boating
Research	Investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws	Sampling of marine species or organisms; sampling of non-living resources; measuring physical features such as temperature, salinity, currents, and interactions between ocean atmosphere and sea bed

Human activity/use	Description	Example(s)
Shipping	The act or business of ship movements	Transit of all vessels through New Zealand waters; oil tanker movements; commercial trade cruise liners; research vessels; Cook Strait ferries
Submarine cabling	Installation and maintenance of telecommunications and power cables	Cook Strait power/telecom cables (may be either buried or laid upon the seabed)
Tourism	The guidance and management of tourists, including activities undertaken by the tourists themselves	Whale watching; kayaking; enjoyment of coastal vistas

Table 3: Types of change

Type of change	Description	Example(s)
Amenity change	Change in the natural or physical structure or appearance of the marine environment that affects people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes	Shoreline housing developments; oiling of a beach from oil spill
Biological change	Change in the biological make-up (ie, flora and fauna) of an environment or habitat	Reduced numbers of a fish species; reduced species richness; species displacement through a breach in biosecurity
Change in option, bequest or existence values	Change in the value of the use something may have in the future; knowing that something exists even if you never see or use it; knowing that something will be there for future generations	Reduced biodiversity leading to the erosion or removal of: <ul style="list-style-type: none"> • future options for drug development (eg, a cure for cancer) • enjoyment by future generations (eg, to view Antarctic species) • replacement of depleted resources of value to humans (eg, substitutes for current preferred seafoods).
Change in property rights	Change in rights (eg, a title, licence, or permit) to own or use a space or resource	Grant or surrender of a petroleum exploration permit; introduction of new species to the Quota Management System; revision of total allowable commercial catch for a species; change in conditions of a resource consent
Chemical change	Change in the chemical composition of the marine environment	Salinity increase or decrease; introduced pollutants (eg, oil)
Morphological change	Changes in the morphological structure of the ocean substrate	Dredging furrows; digging for submarine cables (eg, fibre optics, electricity)
Perception (metaphysical) change	A change in the way people perceive the ocean or part of it; changes affecting kaitiakitanga	Attitude to a location based on a drowning (eg, relating to tapu); national identity felt relating to the coastline and ocean; sense of wellbeing felt relating to the presence and health of the water in and around New Zealand
Physical change	A change in the physical nature of the substrate or water column of an environment (not morphological)	Turbidity (murkiness); sedimentation; inert contaminants (eg, plastic); temperature; solar penetration; artificial light; vibration
Wealth creation/loss	The creation or loss of wealth	Profit/loss resulting from commercial activities such as aquaculture, commercial fishing, mining, tourism operations

Figure 2: Matrix showing the extent of current knowledge about the relationships between environments/habitats and types of change

		Morphological change	Chemical change	Biological change	Physical change	Amenity change	Perception (metaphysical) change	Change in option, bequest & existence values	Wealth creation/loss	Change in property rights
Enclosed water	Benthic									
	Pelagic									
Near shore	Benthic									
	Pelagic									
Shelf	Benthic									
	Pelagic									
Slope	Benthic									
	Pelagic									
Plateau or rise	Benthic									
	Pelagic									
Abyssal depths	Benthic									
	Pelagic									

Figure 3: Matrix showing the extent of current knowledge about the relationships between human activities/uses and types of change

	Morphological change	Chemical change	Biological change	Physical change	Amenity change	Perception (metaphysical) change	Change in option, bequest and existence values	Wealth creation/loss	Change in property rights
Aquaculture									
Biosecurity									
Defence									
Environmental protection									
Fishing and biological resource extraction									
Historic heritage protection									
Land-based disposal									
Maori customary use									
Mining and minerals (including petroleum)									
Ocean dumping									
Other land-based activities									
Mineral and petroleum exploration									
Port and harbour operations									
Power generation									
Recreational									
Research									
Shipping									
Submarine cabling									
Tourism									

1.2 Gaps and issues associated with existing information

Once the range of data needs is identified, the next step is to document, using standard descriptions, the data sets that are currently available and identify where some of the gaps might lie. This section summarises easily available information and explores some of the gaps and issues relating to the collation of currently available information.

Existing information

There have already been a number of reports and projects undertaken over the past few years to summarise the range of marine data and information held by various agencies throughout New Zealand. Chief among these are.

- A review undertaken for the Ministry of Fisheries of data sets that may be incorporated into the National Aquatic Biodiversity Information System (NABIS) – a centralised decision-making tool containing layers of aquatic biodiversity information.
- *Marine Research in New Zealand: A survey and analysis* (Chapman and Lough, 2003) – this survey was carried out by the Ministry of Research, Science and Technology in 2003. It provides an overview of current and recent New Zealand marine research, both publicly and privately funded. It concludes that the major focus of recent marine research in New Zealand has been on understanding physical systems, but that if research on biological and ecological systems is grouped together it can be shown that research on understanding living systems is the largest area of focus. The report notes emerging signs of a greater focus on aquaculture and bioactives and a decreased focus on physical systems. It reports that the average figure spent annually on marine research in 2001/02 and 2002/03 was \$63 million. The majority of this (77 percent) was publicly funded.
- *Setting Course for a Sustainable Future: The management of New Zealand's marine environment* (Parliamentary Commissioner for the Environment, 1999) – this report notes that it is difficult to determine the extent of information on the marine environment because “information generated and held by different stakeholders is often not generally accessible to other stakeholders. This may be for cultural reasons, for reasons of commercial sensitivity and advantage, or as a consequence of the complexity of official management and reporting systems”. The report also identifies a number of examples of the diverse range of information collected about the marine environment, and gaps across these.
- *Review of National Databases Relating to the New Zealand Marine Environment* (Froude, 2000) – this review was commissioned by the Ministry for the Environment in August 2000 to assist with developing marine environmental performance indicators. It reviews the following types of national marine databases:
 - general biological databases (including various species and ecological databases, as well as an adventive biota database)
 - fisheries databases (this is an extensive set of databases, including catch-effort data, scientific observer data, and trawl, longline, aerial sighting and tag data)
 - wildlife databases (including the Ornithological Society of New Zealand's *Atlas of Bird Distribution*, and the national bird-banding scheme)

- physical databases (including Land Information New Zealand bathymetric and nautical charts; scientific data from surveys, climate, marine oil spills, ocean currents, salinity and temperature; satellite data, wave data and sediment data)
- integrated physical and biological databases (National Institute of Water and Atmospheric Research estuaries database)
- protected areas.
- *Review of Existing Coastal and Estuarine Monitoring (Excluding Regional Council Monitoring)* (Froude, 1998) – again, this report was commissioned by the Ministry for the Environment to inform development of marine environmental performance indicators. It summarises the monitoring of coasts and estuaries carried out by agencies other than regional councils, including broad-scale monitoring of dunelands, localised monitoring of beach and estuary dynamics, monitoring of inter-tidal and sub-tidal habitats, localised monitoring of general water and sediment quality, localised reporting on dredging and dumping, and monitoring of the effects of activities excluding discharges, and dredging and dumping.
- *Coastal Resources Database and GIS: A report to the NZ Maritime Safety Authority* (Tortell, 2001) – this report was prepared in 2001 to summarise data sets that might comprise a GIS-based tool to provide comprehensive coastal and marine resource information for the purpose of oil spill response, oil spill contingency planning and oil spill risk assessment.
- *Shining a Spotlight on the Biodiversity of New Zealand's Marine Ecoregion: Experts workshop on marine biodiversity, 27–28 May 2003, Wellington, New Zealand* (WWF-New Zealand, 2004) – this report contains the outcomes of an experts workshop convened by WWF-New Zealand in 2003 to carry out an independent assessment of marine biodiversity in the New Zealand region. The report summarises and references biogeographical information about New Zealand's marine biodiversity that is otherwise widely dispersed in the published and unpublished literature. It also cites gaps in the marine biodiversity knowledge base and makes recommendations on future actions for conserving New Zealand's marine biodiversity.

Illustrative maps of our ocean biodiversity and ocean-based activities

To add to this body of knowledge, we undertook a data collation exercise for this report culminating in a series of illustrative maps of biodiversity and activities in New Zealand's marine environment (see the maps at the end of this section). The maps were developed for this report to illustrate:

- some of the key information available about the biodiversity of, and human activities in, our marine environment
- some potential gaps in, and barriers to accessing, information that might be useful in setting future national ocean priorities.

The maps were compiled over a short period (about two months) using data sourced free of charge from a range of groups, organisations and individuals. They may not represent the best available information or the full range of information that might be useful for setting future national ocean priorities, but they are a start. In the future, better information might be aggregated from distributed sources (such as regional councils) or transformed from non-GIS formats (such as hard-copy charts). Section 1.3 of this report discusses the options for improving access and aggregating information already available.

Electronic copies of maps 1-20 are provided on the CD-ROM that accompanies this report. Further information about the data used in the maps, and where it was sourced, is contained in Appendix 1 (and in an electronic copy on the CD-ROM).

As noted above, other policy initiatives (such as development of the National Aquatic Biodiversity Information Strategy, Oceans Policy, and the proposed Coastal Resources Atlas) have revealed a number of key gaps in the availability of information for management purposes. The process of compiling the maps in this section also revealed a number of gaps in, and barriers to accessing, spatial information that might be needed to set future national ocean priorities. Table 4 below provides a full assessment of the issues we faced in collecting the data for each map, which can be summarised as follows.

- Some information cannot be readily accessed because of intellectual property issues, making the costs prohibitive, even though in many cases the data was collected with Crown funding in the first instance (eg, bathymetry data).
- Some data is available but there is no means yet to access it easily in electronic geospatial format (eg, data on submarine cables and mining exploration permits).
- There is no standard definition to inform particular data sets (eg, there are 15 different data sets on the position of the coastline).
- Data is distributed among diverse research agencies, from Crown to private, and a means to collate and depict data already collected needs to be developed (eg, marine research activities, marine pollution data and sediment loads from rivers).
- Responsibility for the collection of the data is unclear (eg, data on recreational uses).
- The right technology is not available, or required, to collect the information (eg, vessel-tracking technology for shipping is not required in New Zealand, though it is in other countries).
- An agency is collecting the information, but is not resourced adequately to maintain a comprehensive data set (eg, the New Zealand Water and Waste Association is keen to develop and keep up a national database on sewage outfalls).
- There are sensitivities relating to how some information could be used (eg, defence activities).

Table 4: Information gaps and barriers identified through map compilation

Information/data layer	What we found	Potential fix
Bathymetry	<p>Bathymetry data shows the location of natural features of the seabed (as topography does on land), and thus provides an essential spatial context for evaluating most other marine information. Responsibility for collecting and managing bathymetry data, and associated intellectual property rights, has been devolved by the Crown to Crown research agencies such as the National Institute of Water and Atmospheric Research (NIWA) and the Institute of Geological and Nuclear Sciences (GNS). Although much of this data collection is Crown-funded, the Crown and others wishing to access and use this data must buy it and the rights to use it for any new application. Due to the size of the data set, the costs of purchasing it are often prohibitive. The National Aquatic Biodiversity Information System does not contain a bathymetry layer for this reason. The completed Marine Environments Classification includes a modified version of the bathymetric grid that can be used independently from the classification as a whole.</p> <p>Land Information New Zealand (LINZ) has embarked on development of a hydrography information strategy which may address some issues relating to the management, access to and use of bathymetry data.</p>	<p>Develop a policy on access to and use of bathymetry data that:</p> <ul style="list-style-type: none"> • provides for 'core' bathymetric data to be held as a publicly accessible data set available at no more than the cost of transfer • contracts appropriate research agencies to collect and manage 'core' bathymetry data on behalf of the Crown, using public funds • ensures intellectual property in 'core' bathymetric data resides with the Crown.
Marine boundaries and jurisdictions	<p>LINZ is currently working on compiling, and making publicly available, an authoritative set of data layers describing key jurisdictional boundaries, such as the territorial sea, the Exclusive Economic Zone, and the extended continental shelf. Compilation of these data layers has been slowed, at least in part, by the need for trans-boundary negotiations (eg, with Australia over the boundaries of the extended continental shelf).</p>	<p>Support LINZ work (as necessary) to compile authoritative data sets of key marine jurisdictions, and to make these publicly available over the Internet.</p>
Coastlines	<p>There are at least 15 different data sets depicting New Zealand's coastline, based on different definitions of its boundary. No nationally complete and authoritative data set exists to depict mean high-water springs (a key boundary for management purposes; eg, it is the landward boundary of the coastal marine area as defined by the Resource Management Act 1991).</p>	<p>Develop a policy on the definition and use of coastline data, and make definitive data sets publicly available at no more than the cost of transfer.</p>
Marine research	<p>Data on the amount and spatial extent of historical research effort is essential in setting future national priorities for marine research. However, comprehensive data does not exist, and would be difficult to depict, because:</p> <ul style="list-style-type: none"> • it needs to be shown in three dimensions (ie, to show depth as well as aerial coverage) • it is distributed among diverse research agencies, including Crown research institutes, industry, non-government agencies. 	<p>Devise a means to depict data on the amount and extent of historical marine research effort, and contract a responsible agency to collate and maintain this information.</p>
Recreational uses	<p>Spatially formatted data on recreational uses of the marine environment often does not seem to exist and/or is not easily accessible. Responsibility for the collection and management of authoritative data sets is unclear. This makes it difficult to evaluate the actual or potential impact of recreational uses on the marine environment or other activities.</p>	<p>Develop a policy for the collection and management of, and access to, spatial data sets on recreational uses that would be useful for national priority-setting purposes.</p>

Information/data layer	What we found	Potential fix
Shipping activities	Because electronic tracking of vessel journeys is not required in New Zealand (as it is elsewhere eg, Australia), no comprehensive data exists on the concentration or spatial range of shipping activities. This makes it difficult to evaluate the actual or potential impact of shipping activities on the marine environment or other activities.	Consider the need for vessel-tracking technology to be used to generate data on the concentration and spatial range of shipping activities.
Submarine cables	The location of submarine cables for power and telecommunications is charted (the Maritime Safety Authority holds a hard copy), but it is not readily or freely available in electronic geospatial format. This data would be useful in evaluating the actual or potential impact of cabling on the marine environment or other activities.	Convert chart-based data on the location of submarine cables into electronic geospatial format, and make it publicly available at no more than the cost of transfer.
Marine pollution	We were unable to access useful information in the time available. Geospatial data on the concentration of pollutants in the coastal and marine environment such as heavy metals, chemical compounds and organic compounds would be useful in measuring trends in the state of the marine environment, and evaluating actual or potential activities in different areas. It is also a useful means for measuring land-based impacts on the marine environment. Some of this information is held by NIWA. Other data is likely to be distributed among a number of agencies, including regional councils and the Maritime Safety Authority.	Investigate the source of useful data sets on marine pollution, and evaluate options for integrating these into geospatial information layers for use in setting national ocean priorities.
Sediment loads from rivers	Estuarine and coastal marine habitats are vulnerable to ecological change resulting from sediments carried from the land by rivers. Information about sediment loads from rivers is available from NIWA. Aggregated information on sediment loads from rivers was not available for the purposes of this project.	Investigate the availability of river sediment load data and ways for this data to be made publicly available in geospatial format in future.
Sewage outfalls	In the time available we were able to source data (from the New Zealand Water and Wastes Association [NZWWA], with some additional analysis by URS New Zealand) on the location of major sewage outfalls to the sea from pumping stations and treatment plants. However, this provides only part of the picture: NZWWA is not adequately resourced to keep an accurate and up-to-date database, regional council data is apparently not always kept updated, and aggregated data was not available on: <ul style="list-style-type: none"> • non-reticulated sewage outfalls (eg, from septic tanks) • discharge of sewage to waterways flowing to the sea (eg, estuaries and rivers) • volumes and treatment quality of non-reticulated and indirect sewage discharges to the sea. Without more comprehensive data it is difficult to assess the overall volumes and treatment quality of sewage discharges to the sea – particularly from non-reticulated sources. This data is vital in evaluating the actual or potential impact of sewage discharges on the marine environment, other activities (eg, aquaculture), and spiritual/cultural values of people with connections to different areas of the ocean.	Work with NZWWA and local authorities to assess options for maintaining a regularly updated national database of all sewage outfalls (from both reticulated and non-reticulated sites), including data on the volumes and treatment quality of sewage discharges.

Information/data layer	What we found	Potential fix
Dumping	In the time available we were able to source data on permits issued by the Maritime Safety Authority for a two-year period only. More comprehensive data over a longer time-frame, including permits issued by regional councils, would be needed in future to provide a reliable picture of the locations, extent and types of dumping activities and their likely impacts on other activities.	Work with the Maritime Safety Authority and regional councils to assess options for compiling a more accurate picture of permitted dumping activities.
Introduced marine species	We were unable to source any data, in the time available, on the types and distribution of introduced marine species. These pose potentially significant threats to the ecological and economic value of New Zealand's marine resources, and need to be better understood if effective, prioritised action is to be taken to mitigate their impacts in future.	Work with the Ministry of Agriculture and Fisheries and regional councils to assess options for aggregating available data on the nature and extent of threats posed by introduced species on New Zealand's marine resources.
Defence activities	In the time available we were unable to source any data on the nature or extent of defence activities in the marine environment (eg, training areas and ammunition disposal sites). Clearly there are sensitivities around access to and use of this data, but some means for factoring defence activities into national priority-setting processes is nonetheless required.	Work with the Ministry of Defence and the New Zealand Defence Force to assess options for representing the nature and extent of defence activities as part of a national process for setting priorities for ocean management and use.
Emerging or future activities	We were able to source data only on some existing habitats, environments, activities and uses of the marine environment. However, it will be important for future national priority-setting processes to take account of research on emerging or future uses (eg, commercial bioprospecting opportunities that can be exploited as new technologies come online). This information is likely to be held by industry groups and independent researchers. Its use for national priority-setting purposes will require solutions to issues relating to intellectual property and the use of commercially sensitive information.	Carry out further work on the availability of information on future uses, and options for factoring it into future national priority-setting processes.

1.3 Building the right tools for managing information

The limitations of our information base, such as those discussed in section 1.2, mean that tools and models for interpreting and extrapolating from information that we do have are vital.

Three different types of information-based tools are needed in setting national priorities for ocean management:

- *access tools*, which allow decision-makers to directly access key information and data layers
- *sourcing tools*, which provide an overview of the range of available data and information sources throughout the country, and information such as where they are held, by whom and in what format
- *interpretive tools*, which can be used to evaluate and extrapolate from existing information.

A number of information-based tools have been, or are being, developed that can help decision-makers source, access and interpret existing marine data and information. These include the following.

- *The National Aquatic Biodiversity Information System (NABIS)* – development of this centralised decision-making tool is being led by the Ministry of Fisheries under the umbrella of the New Zealand Biodiversity Strategy. NABIS contains a number of different layers of aquatic biodiversity information. It is designed to enable decision-makers and planners to make informed decisions on the issues that affect aquatic biodiversity, by:
 - bringing together existing information to support decision-making processes that affect marine biodiversity
 - summarising key information for consideration in management decisions
 - making national-scale information about the marine environment freely available via the internet in GIS format
 - contributing to improved management of marine biodiversity information through the implementation and maintenance of common database and metadata standards.
- *Marine Environments Classification* – the Ministry for the Environment, in partnership with the Ministry of Fisheries and Department of Conservation, commissioned the National Institute of Water and Atmospheric Research (NIWA) to develop the Marine Environments Classification⁶. This classification is a Geographic Information System (GIS) based tool for mapping ecologically distinctive units ('marine environments'). The classification is derived from eight physical characteristics that influence the 'distinctiveness' of ecological systems. It is based on the principle that ecosystem properties are broadly determined by the interplay between biophysical processes and

⁶ The classification system is available from the Ministry for the Environment on DVD (Ministry for the Environment, 2005). The DVD contains GIS data that allows the marine environments classification to be displayed at any level of classification detail from 2 to about 300 environments, documents (maps) showing the classification at 5, 10, 20 and 40 classes for those who do not have a GIS, and all the data layers used during the classification development process (fifteen data layers). The fifteen data layers can be used independently of the classification as a whole.

physical factors in the marine environment. The classification generates maps that subdivide the marine environment into areas where ecosystem properties are different and where the effects of resource uses can be expected to differ. The maps also identify areas that are considered to be ecologically similar, and where the biotic communities and effects of resource use could be expected to be similar.

- *Near-shore classification* – the Department of Conservation is leading development of the interim near-shore marine classification (INMARC), a tool for use in identifying potential sites for protection in the near-shore area around New Zealand. The classification uses a biogeographical approach and comprises inventories of information covering the entire near-shore marine area of New Zealand. It comprises information at two scales: the meso-scale (100s to 1000s km), which describes marine biogeographic regions; and the micro-scale (10s to 100s km), which describes coastal, shelf and offshore island units. A report on the INMARC is due for publication soon, and will contain an inventory of information for use by those with an interest in the marine environment.
- *Marlin* – the purpose of the Marlin meta-database, being developed by the Ministry of Fisheries, is to make it easy for people to determine the existence, relevance, appropriateness and location of data which describes New Zealand's fisheries and marine biodiversity. Examples of such data include electronic databases, paper forms, specimens of marine organisms, and specimens collected for ageing purposes. Marlin is primarily a repository for metadata about Ministry of Fisheries funded research. However, it is anticipated that it may eventually become a 'one-stop shop' for people wanting to find any data about New Zealand fisheries or marine biodiversity. The first version of Marlin went live in July 2004, with further improvements planned over the next few years.
- *Draft marine environmental performance indicators* – these were identified under the Ministry for the Environment's Environmental Reporting Programme (1996-2002) as a useful tool for better co-ordination of marine data collection.⁷ Indicators allow measurement of key parameters of change using consistent monitoring and reporting methods, so that we can build a national picture of significant trends. A set of indicators for the marine environment was agreed, but these would require further development (eg, establishment of monitoring regimes by agencies) before they could be implemented and reported.

Together, these initiatives offer a valuable platform for future work.

Access tools

Data and information can be made available to those who need it in a number of formats: eg, reports and articles, spreadsheets, relational databases, lists, pictures, maps, and co-ordinates. And it can be conveyed in a variety of ways: in hard copy files, or in electronic files downloaded from discs, e-mails or the internet.

⁷ The Ministry for the Environment compiled technical reports on the development of the proposed indicators for the marine environment. Proposals included indicators for: fish stocks, fishing impacts, marine biodiversity, physical/chemical values and human health and values. The fish stocks indicators were further developed by the Ministry of Fisheries. Compiled reports are available under "Technical reports" online at <http://www.mfe.govt.nz/publications/ser/>.

A significant problem that often faces people wishing to access existing data is that they must approach a large number of different sources to obtain it – which poses considerable costs in terms of both time and expense. They then have to figure out how to aggregate data presented in a range of different formats and to a variety of standards – a technical exercise at best.

Geographic Information Systems (GIS) offer a powerful way around these problems. GIS essentially involves mapping different data layers (eg, species distribution, infrastructure, commercial activities) to provide a combined picture of information relevant to a specific management question. The maps at the end of section 1.2 provide examples using real data about New Zealand's marine environment.

GIS technology has not been widely or consistently used by government departments to date. This is due mainly to cost, data access constraints,⁸ and the fragmentation of ocean management functions.

However, several valuable GIS tools are being developed to provide access to existing data in formats that assist interpretation (ie, map formats). The National Aquatic Biodiversity Information System (NABIS) has recently been launched, and a number of other tools are under development, but not yet in place – including the proposed Coastal Resources Atlas and the Marine Environments Classification system. Also, the Department of Conservation is using GIS-based tools to map marine protected areas (see for example Froude and Smith, 2004), and a number of councils are in the process of mapping marine ecosystems⁹ using GIS.

These systems are being designed to meet a range of different purposes. For example, NABIS is designed mainly to assist fisheries management, the Coastal Resources Atlas to assist with planning for oil spill responses, and the Marine Environments Classification system has been designed as an environment-based tool for planning, environmental monitoring and reporting and management. Together, however, they comprise valuable layers of information for informing a range of management purposes. In combination they could provide a powerful system to draw information together and make it available to a range of decision-makers.

A web-based portal

GIS technology is already sufficiently advanced that, in future, customised maps such as those at the end of section 1.2 could be generated through a web-based portal that draws on data distributed throughout New Zealand. Such a portal would be accessible to everyone, and provide a powerful means to integrate across a wide range of existing data held by various institutions nationwide. Further benefits would include the ability for:

- existing data custodians to retain their rights to hold and manage data, and to have a say in how it can be accessed through the GIS portal

⁸ For example, the Maritime Safety Authority has had a challenging and, at times, frustrating experience in trying to build a Coastal Resources Atlas to support planning and management of oil spills.

⁹ In a recent survey (Ministry for the Environment, 2004) the Ministry for the Environment asked councils whether they had mapped marine ecosystems on paper or using GIS. The results show that:

- fewer than a third (5/17) of regional councils/unitary authorities have mapped relevant marine ecosystems
- only three out of 69 territorial authorities have mapped relevant marine ecosystems
- overall, fewer than one in 10 (8/86) councils have mapped relevant marine ecosystems.

- data to be analysed at different scales (eg, from the whole of the Exclusive Economic Zone down to a particular estuary), depending on the resolution of available data
- data to be customised to different management needs (users could call on just the data they need)
- data to be accessed and analysed without any special software requirements (because the relevant software is all available as part of the web-based package)
- new or emerging data layers to be integrated into the system as they are generated
- New Zealand to contribute easily and effectively to – and perhaps even demonstrate best practice through its participation in – international programmes that are building a global picture of ocean systems, such as the Census of Marine Life¹⁰ and the related Ocean Biogeographic Information System (OBIS),¹¹ and the United Nations Global Marine Assessment.¹²

Preliminary work by the Australian National Oceans Office to build a national Oceans Portal provides a useful model for potential adaptation to the New Zealand context.¹³ Several issues would need to be addressed in order for the development of a national ocean portal to be feasible, however. These include the need for:

- agreed data quality, data management and metadata standards
- a common regulatory framework or policy on spatial information
- data-sharing protocols across government agencies, and between the government and key data custodians (such as Crown research institutes, councils, universities and museums)
- a marine cadastre (a registry of rights and obligations affecting the marine environment, such as petroleum exploration permits, or permitted marine farming sites)
- an agreed marine classification system, to provide an ecologically relevant base layer for the ocean portal, and to provide the ability for extrapolation across information gaps in similar environments.

Sourcing tools

Decision-makers often face difficulties in determining what data is available to assist them in making the best decisions about the use and management of the ocean. This can result in decisions being made in the absence of the best available information, or duplication of effort and cost to collate data that already exists elsewhere.

Meta-databases provide a solution to these problems. They index information about where existing data is held, by whom, in what format, and to what quality standards. They help

¹⁰ See <http://www.coml.org/coml.htm/>.

¹¹ See <http://www.iobis.org/>.

¹² See <http://www.mfat.govt.nz/foreign/env/oceans/gma.html> for an explanation of New Zealand's involvement in this proposal.

¹³ See http://www.oceans.gov.au/oceans_portal.jsp for more information about the Australian Oceans Portal proposal.

decision-makers identify which existing data is best suited to their purposes, and who they can contact to negotiate terms for its use.

An ocean meta-database

There is currently no comprehensive meta-database of information about New Zealand's marine environment and its uses. However, several initiatives do offer a platform on which a future marine meta-database could be built. These include:

- Marlin – a web-based tool being developed by the Ministry of Fisheries, which stores information about a range of existing data sources, with a focus on supporting fisheries management
- a database of marine research prepared for the Ministry of Research, Science and Technology (Chapman and Lough, 2003), which contains entries on current and recent New Zealand marine research – both publicly and privately funded
- inventories attached to the upcoming report by the Department of Conservation on its Interim Near-shore Marine Classification, and WWF-New Zealand's report on the results of an experts workshop that it convened in 2003 (WWF-New Zealand, 2004).

To provide a platform for a more comprehensive, web-based meta-database of marine data and information in future, these databases and inventories would need to be enhanced with other key data sources to support decisions across the full spectrum of ocean issues. A whole-of-government approach – and preferably co-operation from agencies outside government – would be needed to achieve this.

Interpretive tools

Interpretive tools provide the means for decision-makers to aggregate and analyse across a number of data and information sets, and to extrapolate from information-rich to information-poor areas or issues. They are therefore vital tools for managing in the context of uncertainty and limited information about the marine environment, how it functions and the impacts of human activities on it.

Key examples of interpretive tools being developed in the context of New Zealand's marine environment have been discussed earlier in this section, and include:

- the Marine Environments Classification system
- the Interim Near-shore Marine Classification
- draft marine environmental performance indicators.

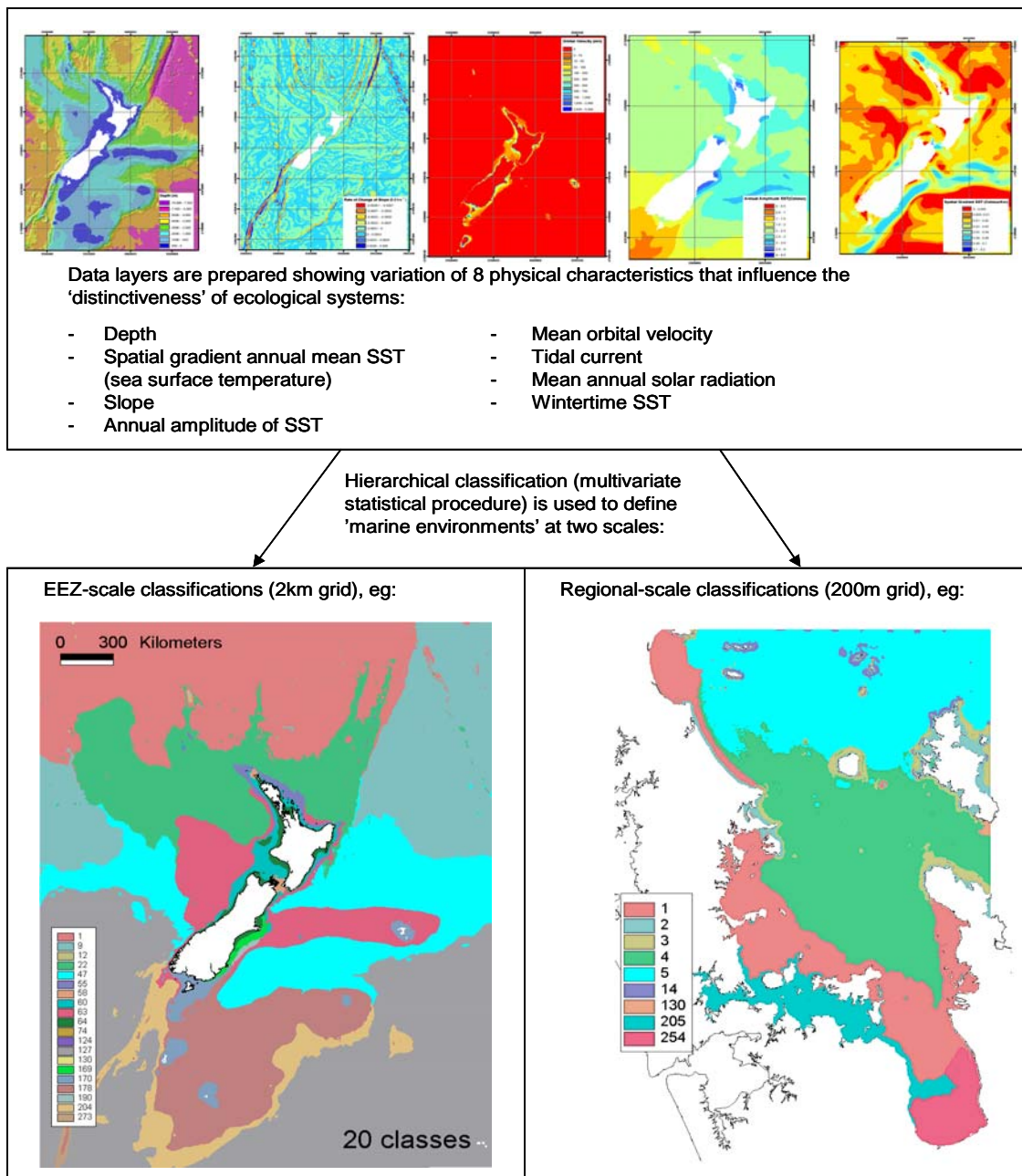
The Marine Environments Classification system

The Marine Environments Classification system is a valuable tool for marine ecosystem depiction. Figure 4 (page 24) illustrates the eight data layers used to derive the EEZ-scale classification, and illustrates the draft classification at the 20 group (EEZ) and regional (Hauraki) scales. Maps of the draft EEZ-scale classification are provided at the end of section 1.3; and a detailed explanation of those maps is contained in Appendix 2.

Since these draft maps were produced, the classification system has been completed, and is now available from the Ministry for the Environment in DVD format (Ministry for the Environment, 2005). It will be made available to marine managers and decision-makers for application across a range of management questions. A whole-of-government approach will be needed for any new work to further develop or improve the classification. A report on the potential for improving the Marine Environments Classification has been completed as part of the classification project to inform decisions about further work.

The Marine Environment Classification system could provide a valuable platform for the web-based national ocean portal proposed earlier in this section, due to the key data layers that comprise it and its power as a model for ecosystem depiction.

Figure 4: The draft Marine Environments Classification



Part 2: Approaches to Priority Setting for Ocean Management

Part 1 of this report explored the information needs that might underpin any priority setting in ocean management. This part outlines some preliminary research into approaches that could be used to set national priorities for managing New Zealand’s ocean. Three potential methods that could be used, separately or in combination, are discussed, together with examples of how these have been applied in different contexts here and overseas. The three options described are:

- a map-based approach
- a risk management approach
- an expert-based approach.

2.1 Map-based priority-setting approaches

A map-based approach to setting national priorities for ocean management draws on the application of Geographic Information System (GIS) technology. GIS supports several tools that enable mapping and identification of different environment types.¹⁴ It also allows us to visually represent different uses and activities within different environments.

Strengths and weaknesses of the map-based approach

Strengths	Weaknesses
<p>The maps-based approach:</p> <ul style="list-style-type: none"> • can build on existing GIS-based initiatives such as the National Aquatic Biodiversity Information System, the Marine Environments Classification system and the Coastal Resources Atlas • enables visual representation of issues, and links between them • allows comparison across different data sets • promotes resolution of some key issues relating to data ownership, management, spatial data and meta-data standards (etc) • is easy to edit and update, using new or improved data • can be easily customised to address varied and specific issues. 	<p>The maps-based approach:</p> <ul style="list-style-type: none"> • can be expensive • requires specialist expertise to develop • requires a range of contributing data formats to be converted into one • involves incomplete data sets, which can present a misleading picture, and their limitations can be difficult to convey to users • can make it difficult to represent issues in 3-D, such as in relation to a water column • can make it difficult to represent non-spatial issues • can make it difficult to compare issues and events occurring at different scales • can prompt misleading conclusions about complex relationships between data sets • does not generate priorities <i>per se</i>, but provides the information platform for subsequent decisions on priorities and management actions in response • is time-bound, which means it can be difficult to represent issues occurring over different periods and to analyse trends in issues over time.

¹⁴ This idea is discussed further in section 1.3 – see in particular the discussion on the draft Marine Environments Classification.

How the map-based approach can be applied

Figure 5 on page 27 shows how a map-based approach can be used to identify priorities for ocean management. In this example, wave activity and surface salinity have an influence on water clarity, which give a 'background' level of variation on which to evaluate the proposed activity. The model then allows expected changes resulting from the activity to be mapped, along with the spatial extent of the activity and overlaps with other activities or values in the area. This method could also be used to produce other maps showing socioeconomic values to identify areas that could serve as potential alternatives, if the activity is likely to pose an unacceptable environmental risk.

The scenario illustrated in Figure 5 shows how:

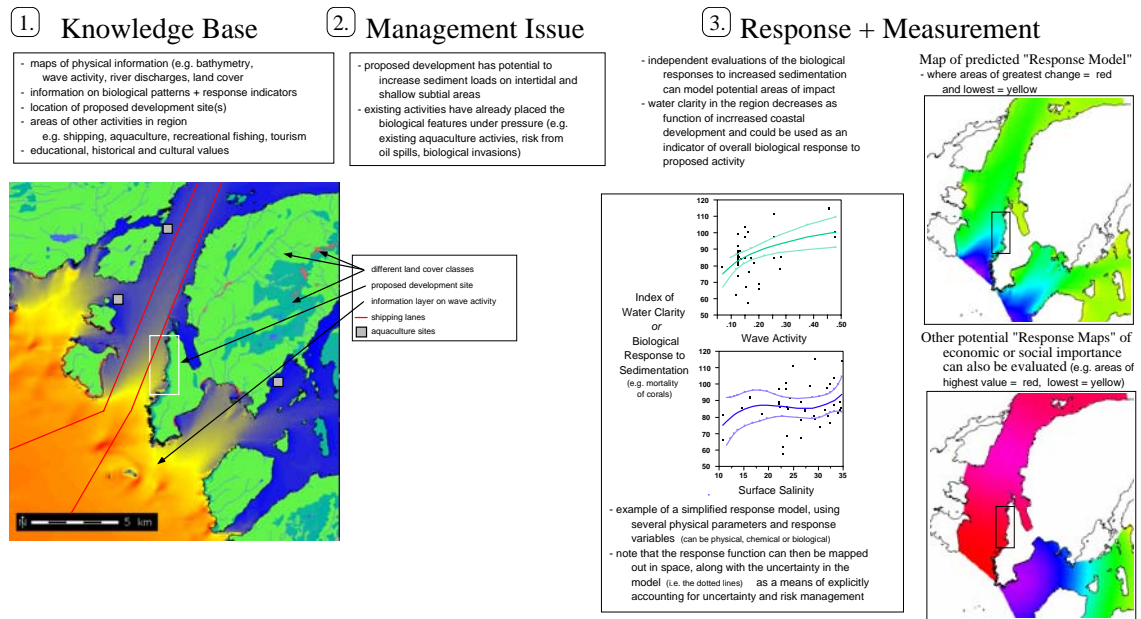
- information can be depicted in a GIS system – including physical and biological data and information, activities in the region, and sites of important educational, historical or cultural value
- existing and potential impacts from the activity can be identified as management issues arise – in this case, a proposed coastal development
- a response model can then be developed using empirical information and based on information underlying individual data layers.

The Australian National Oceans Office has applied a map-based approach during the information-gathering stage of development of the South-East Regional Marine Plan (the first in a series of plans for implementing Australia's Oceans Policy).¹⁵ The Australian National Oceans Office also recently published a *National Marine Atlas*, which brings together for the first time information from a wide range of sources about the use of Australia's ocean territory.¹⁶

¹⁵ The South-East Regional Marine Plan was released on 21 May 2004. See http://www.oceans.gov.au/se_implementation_plan.jsp for details.

¹⁶ See <http://www.oceans.gov.au/Non-fish%20Atlas.jsp>.

Figure 5: A hypothetical example applying the map-based approach



2.2 A risk management approach to priority setting

Ocean management is largely about managing risks, and ocean research is about improving our understanding of the situations of risk. Given that zero risk is unachievable, and that resources and information are limited, the challenge for ocean management is to target effort at the highest risks where returns will be greatest.

This section describes a possible risk management approach to setting national priorities for ocean management. It outlines (at a high level) some of the governance, management and implementation components of a risk management framework that could be used to guide decision-making by all agencies involved in ocean management and research in New Zealand.

Strengths and weaknesses of the risk management approach

Strengths	Weaknesses
<p>A risk management approach:</p> <ul style="list-style-type: none"> • is supported by well-developed techniques and tools (eg, the New Zealand/Australian Risk Management Standard) • does not depend on the availability of perfect information • is relatively quick • involves a multi-stakeholder approach that requires active participation • allows use of both qualitative and quantitative information • is a structured process for identifying, assessing and implementing management responses • therefore emphasises the accountability of agencies responsible for implementing management responses • allows the transparent identification of underlying values • is repeatable • promotes measurement of progress towards objectives or targets for risk management • is adaptive and future-looking. 	<p>A risk management approach:</p> <ul style="list-style-type: none"> • requires particular expertise that is not widely available in New Zealand • would rely on common or accepted understandings of appropriate scales and risk ratings applicable to the ocean, and these are not well developed • is contestable because it is value-dependent • requires a process for feeding learnings back into policy or values analysis (ie, it is not effective on its own) • can be subverted by participants representing agendas, not their expertise • can generate unreasonable expectations and be perceived as substituting for empirical data collection.

Current status of risk management

There are many decision-makers and decision-making agencies involved in ocean management. The integration of decision-making and allocation of funding is largely through the historical arrangements established for and between these agencies, which generally follow the processes established to carry out their core businesses. In most cases their core business is not the management of the ocean, and in some cases their core business may be in conflict with some of the values for ocean management.

While a number of agencies responsible for New Zealand's ocean management have embraced the concept of risk management, the application of risk management varies and many existing risk management processes are, for the most part, either informal or undocumented. Consequently we do not have a clear understanding of current risks in relation to the nation's ocean.

This means that it is difficult to evaluate existing and proposed management and research activities in an integrated and comprehensive way. However, there are a number of initiatives employing multi-agency risk management approaches. Examples include work relating to the National Biosecurity Strategy (currently at an early stage), and civil defence and emergency management (now in implementation). Examples of current risk management initiatives concerned with ocean management include the New Zealand Marine Oil Spill Risk Assessment (undertaken by Maritime Safety Authority) and the Ministry of Fisheries' Biosecurity Risk Management Framework.

A key overseas example is the approach being taken by the Australian National Oceans Office. Elements of this approach are further described and tested in section 1.1.

Developing an integrated risk management framework

Figure 6 on page 30 outlines an integrated risk management approach for ocean management that applies the guidelines of the Australian–New Zealand Risk Management Standard 4360. The national tools required to implement the approach are outlined below. The tools will need to be scoped in more detail at a later stage.

The draft Oceans Policy includes provision for some of the elements needed to develop and implement an ocean risk management framework. In particular, it provides guidance on a national outcome statement and a values framework for ocean management, which could provide a platform for developing a risk management framework. Such a framework would include:

- a framework for defining the risk management context
- an ocean risk management allocation model that allocates risk management roles, responsibilities and resources to other agencies
- a national ocean risk profile to provide the information for informed decision-making by all agencies involved in ocean management
- risk management guidelines to assist agencies to integrate risk information to derive the national risk profile, and to provide a platform for agencies that may not be currently conducting risk assessments.

In addition, a process will be required to ensure that agency and industry knowledge and learning are fed back to improve policy, refine values and establish viable performance measures.

The failure of many integrated risk management programmes can be attributed to confused roles and responsibilities, and abstract performance measures that are not verifiable or accountable. Hence, effective liaison that passes information between the agencies is fundamental to the successful management of risk to our ocean, and should result in:

- consistency and transparency, to the extent practicable, in risk management within and between agencies
- levels of ocean management and research activity appropriate to the situation of risk
- effective policy formulation, priority setting and resource allocation
- harmonisation of New Zealand's risk management processes, practices and standards with international obligations to the maximum extent practicable
- opportunities for active contribution by interested and affected parties at appropriate stages.

Figure 6: The risk management process



Source: Standard AS/NZS 4360: 1999 Risk Management.

2.3 An expert-based approach to setting priorities

Setting environmental priorities often draws on the knowledge and experience of a group of experts. The expert-based approach can be linked to the risk management approach and the map-based approach. For example, experts may be called upon to participate in a risk assessment, or the outcomes of their deliberations may be represented on maps. The results of an expert process will be influenced by how ‘expert’ is defined – as scientists with formal qualifications, as a group of local people with traditional knowledge, or as a combination of various expertise. Expert processes are not a substitute for the painstaking collection of empirical data and research, but do provide a way to summarise and prioritise both published and unpublished information for uptake by expert and non-expert audiences.

Expert input to environmental priority setting can be sought in various ways. One way is to construct a questionnaire comprising unstructured and structured questions that allow for the collection of qualitative and quantitative responses. The surveys can be followed up with interviews that allow experts to elaborate on or clarify their input. The advantage of such an approach is that it can provide respondents with anonymity, which may result in more candid responses. The survey format also assures each expert an equal opportunity for participation and expression.

Dynamic group processes, such as an expert workshop, can also be used to elicit information for priority setting. For this method experts are generally brought together in a facilitated workshop environment, during which consensus is sought on one or more environmental issues.¹⁷ Workshops are interactive and may yield results that are superior to single-step surveys in terms of the quantity and quality of ideas produced. A potential flow-on benefit of workshops is the dialogue and knowledge sharing they can foster among expert participants. Combining the survey and workshop methods can strengthen the approach. For example, a survey could be circulated among experts to establish priority-setting criteria, which would later be applied at a workshop.

Strengths and weaknesses of the expert-based approach

Strengths	Weaknesses
<p>An expert-based approach:</p> <ul style="list-style-type: none"> • can distill complex and dispersed information, making it more accessible to broad audiences (eg, when data is limited, uncertain or sensitive, experts can draw on their professional or personal experience to make assessments about an environment) • fosters dialogue and knowledge-sharing among expert participants • creates a forum that allows cross-fertilisation of ideas, creating synergies across diverse expertise and producing new ways of addressing well-rehearsed problems • is relatively inexpensive and can be conducted in a short timeframe. <p>In addition:</p> <ul style="list-style-type: none"> • the flexible workshop/survey format allows the collection of both qualitative and quantitative information • the perceived legitimacy resulting from expert knowledge can be politically powerful (ie, a distillation of the collective wisdom of people recognised as experts can usefully guide decision-makers). 	<p>An expert-based approach has weaknesses in that:</p> <ul style="list-style-type: none"> • outcomes are contestable • because the approach is based on sampling a segment of society, it is not necessarily representative, and may also be subject to bias, depending on how 'expert' is defined • there is the potential for certain personalities to dominate workshops and overshadow the input of other experts • in practice, the approach has tended to rely on Western scientific expertise and has overlooked matauranga Maori and other world views • the required expertise across an issue, discipline, or institutions may not always be available • there is the potential for participants to represent agendas and not their professional expertise • is not repeatable over time, i.e. experts change over medium to long term.

Many of the perceived weaknesses associated with the expert-based approach can be addressed through ensuring the process is well designed and facilitated, and by providing for transparent reporting of the process and results, including an indication of which experts were (or were not) involved in generating the information.¹⁸

¹⁷ The technique usually provides for divergent views to be recorded, where a consensus view cannot be achieved.

¹⁸ Government guidelines for expert group establishment and operation can be found in Ministry of Research, Science, and Technology, 1998.

WWF-New Zealand's use of the expert workshop approach

WWF uses expert workshops in ecoregions around the world to identify priority areas for terrestrial and marine conservation. WWF-New Zealand employed an expert-based approach in 2003, whereby experts with formal qualifications in marine science were invited to attend a facilitated workshop to identify key areas for marine biodiversity in the New Zealand region. Stakeholders with other forms of knowledge were involved through subsequent rounds of consultation on the workshop output.

A total of 22 marine scientists from New Zealand and Australia attended the workshop over two days at WWF-New Zealand's offices in Wellington. Most participants worked for institutions with marine science capacity, including NIWA, Te Papa, the Department of Conservation and universities, but others were independent. Participants were asked to represent their own expertise, and not the views of the institution for which they worked. Not all taxonomic groups and habitats were represented at the workshop (eg, squid, echinoderms, bivalves, polychaetes, and hydrothermal vent communities were not the specialist areas of any of the workshop participants). Also, some experts chose not to be involved or were unable to attend.

At the workshop a list of criteria was developed and used to determine whether a location was a key area for biodiversity. Criteria included species richness, endemism, and other biological attributes. The experts opted to divide into three groups according to their broad area of expertise (ie, fish, marine mammals and seabirds, and benthic invertebrates and plants). Having been supplied with maps and standardised reporting forms, they delineated areas that are known to be key areas of marine biodiversity and recorded the physical and biological attributes of the areas and habitats.

The three resulting maps were then superimposed to reveal which areas had been commonly identified as key biodiversity locations. However, participants ultimately decided that the maps had more value when left as distinct representations of fish, marine mammals and seabirds, and benthic invertebrates and plants.

After the workshop the outputs were circulated among the participants and peer reviewers for verification and revision. The tangible result of the workshop is a report that identifies key biodiversity areas, habitats and features in New Zealand's marine environment in a form that is accessible to a broad audience (WWF-New Zealand, 2004). The less tangible outcomes of the workshop were the new biodiversity insights and information-sharing derived from the forum.

2.4 Choosing a preferred approach

As we have seen, there are strengths and weaknesses associated with each of the three approaches described above. These are summarised in Table 5 below.

Table 5: Summary of the strengths and weaknesses of different priority-setting approaches

	Map-based approach	Risk management approach	Expert-based approach
Cost-effective		✓	✓
Draws on existing available tools and expertise	✓	✓	
Participative and promotes consensus		✓	✓
Time-efficient		✓	✓
Generates accessible products and results	✓		
Generates new information	✓		✓
Allows use of both qualitative and quantitative data		✓	✓
Transparent underlying values and assumptions	✓		
Repeatable and easily updated	✓	✓	
Adaptive and future looking		✓	
Inclusive of different societal value bases		✓	✓

Further work is needed to assess how these approaches and the tools they comprise could be adapted – separately or in combination – into an approach best suited to setting national priorities for managing New Zealand’s ocean.

Conclusion

This report has scoped a number of tools and approaches for future national priority setting for adaptive ocean management. It has been developed to contribute to the Ocean Survey 20/20 project and to provide a platform for future work on priority setting under an Oceans Policy.

The key conclusions reached through this study are presented here as a series of possible steps along a pathway to making the best use of existing and new information in setting national priorities for ocean management. The five steps are:

1. Refine our information needs for setting national ocean priorities.
2. Build a comprehensive index of what we already know.
3. Begin work to address key information gaps and barriers.
4. Further evaluate information-based tools and models that can assist with setting national ocean priorities.
5. Design a preferred approach to identifying national ocean priorities (based on the information, tools and models identified above), and develop a strategy for implementing it.

Step 1: Refine our information needs for setting national ocean priorities

To set national priorities for ocean management we need information about:

- the range of marine environments and habitats, the human uses and activities within them, and the types of change occurring within them ('empirical information')
- society's preferred uses and values for the ocean ('values-based information').

Some analysis of empirical information needs has been carried out in developing systems such as the National Aquatic Biodiversity Information System and the proposed Coastal Resources Atlas. Significantly, the Ocean Survey 20/20 project is now embarking on the ambitious task of developing a comprehensive set of empirical data about our marine environment. The initial work programme for this project is being identified by seeking expert advice from people working in this area on the key areas of knowledge that need to be filled now. However, a comprehensive statement of empirical information needs is still required.

Over time, as Oceans Policy priorities are developed, we would anticipate that the needs driven by Oceans Policy would begin to inform the Ocean Survey 20/20 work programme and that the two projects will be linked more closely.

A significant amount of values-based information has already been identified through Oceans Policy consultation processes to date. The potential scope is reflected in the high-level objectives contained in the draft Oceans Policy. Over time these values may need to be reviewed as people change their preferred uses and values. There may also be a need for more detailed values-based information in relation to specific ocean management issues.

Step 2: Build a comprehensive index of what we already know

This report has summarised the sources of a wide variety of existing information about New Zealand's ocean. A tiny subset of this information is illustrated in the maps contained in this report (see section 1.2). Previous summaries of existing information include the Ministry of Research, Science and Technology survey of marine research (Chapman and Lough, 2003); Marlin; the report from the experts workshop convened by WWF-New Zealand in 2003 (WWF-New Zealand, 2004); and for development of the proposed National Coastal Atlas (Tortell, 2001). Also, a number of tools are being developed that draw together some key data layers (eg, the National Aquatic Biodiversity Information System and the Marine Environments Classification system).

Despite this work, and due mainly to the lack of any co-ordinating agency, a comprehensive overview of the actual information held by all relevant agencies remains to be compiled. To ensure that effort is not duplicated, a full summary of the data contained in these different sources – and elsewhere – needs to be developed.

Step 3: Begin work to address key information gaps and barriers

Building on work under steps 1 and 2 above, a gap analysis is needed to analyse the 'fit' between existing empirical information and our information needs.

In some cases gaps in information and knowledge exist simply because the information does not yet exist; for example, in the preparation of this report we were unable to source comprehensive data on the type and distribution of introduced marine species.

In these cases, the gaps in information can be addressed through the Ocean Survey 20/20 and other complementary projects over time. However, in our compilation of data for this report we also identified a number of barriers to accessing existing information, which would need to be addressed as part of an overall strategy to collect a full data set on the ocean environment and the resources and activities within it. These barriers include:

- some information cannot be accessed because of intellectual property issues, making the costs prohibitive, even though in many cases the data was collected with Crown funding in the first instance (eg, bathymetry data)
- some of the data is available but there is no means yet to easily access it in electronic geospatial format (eg, submarine cables and mining exploration permits)
- there is no standard definition to inform particular data sets (eg, there are 15 different data sets on the position of the coastline)
- data is distributed among diverse research agencies, from Crown to private, and a means to collate and depict data already collected needs to be developed (eg, marine research activities, marine pollution data and sediment loads from rivers)
- responsibility for the collection of the data is unclear (eg, data on recreational uses)
- the right technology is not available, or required, to collect the information (eg, vessel-tracking technology for shipping is not required in New Zealand, though it is in other countries)

- an agency is collecting the information but is not resourced adequately to maintain a comprehensive data set (eg, the New Zealand Water and Waste Association is keen to develop and keep up a national data base on sewage outfalls)
- sensitivities relating to how the information could be used (eg, defence activities).

Step 4: Further evaluate information-based tools and models that can assist with setting national ocean priorities

A number of information-based tools are needed in setting national priorities for ocean management:

- ‘access tools’, which allow decision-makers to directly access key information and data layers
- ‘sourcing tools’, which provide an overview of the range of available data and information sources throughout the country, and information such as where they are held, by whom and in what format
- ‘interpretive tools’, which can be used to evaluate and extrapolate from existing information.

Key access tools already under development include the National Aquatic Biodiversity Information System. Key sourcing tools that have already been developed, or are under development, include the Ministry of Fisheries’ Marlin meta-database, the Ministry of Research, Science and Technology’s recent survey of marine research (Chapman and Lough, 2003), and reports compiled for the development of environmental performance indicators (eg, Froude, 1998 and Froude, 2000) and for the proposed Coastal Resources Atlas (Tortell, 2001). Key interpretive tools include the Marine Environments Classification system and draft environmental performance indicators.

Despite these developments, many data and information sources remain to be indexed, most are fragmented and difficult to access, and tools for their analysis have been developed on an ad hoc basis.

There is therefore a need for:

- a means for informing people about the range of data and information held throughout the country – such as an ocean meta-database
- a means for co-ordinating access to important publicly held data sets – such as a web portal
- further development of useful tools for interpreting information and trends relating to the marine environment – such as NABIS or other GIS-based systems.

Step 5: Design a preferred approach to identifying national ocean priorities and develop a strategy for implementing it

An approach for applying the best available information and tools for setting national ocean priorities needs to be developed for New Zealand. A number of priority-setting approaches have been, or are being, tested in different priority-setting contexts both here and overseas. This report presents an initial evaluation of three approaches: map-based priority setting, risk management and an expert-based approach.

All three have been found to offer a useful way forward and could be used in combination to develop national ocean priorities. A preferred approach that draws on some or all of these needs to be agreed before we can begin on the path of setting national priorities for ocean management.

Recommendations

As discussed above, this paper has been prepared as a think-piece to explore:

- ways to improve New Zealand's marine information base – especially as an input into the Ocean Survey 20/20 project
- methods for setting national priorities for future ocean management.

The following actions could be initiated to address the issues raised in this report.

- Ensure there are effective linkages between the Ocean Survey 20/20 project and the Oceans Policy project, so that priorities set under each can inform the other and a truly adaptive approach to ocean management can be instigated.
- Develop a full list of data that currently exists to ensure there is no duplication in effort, and, as part of this exercise, address the range of barriers to accessing and using existing information, including:
 - intellectual property issues
 - limited availability of data in electronic geospatial format
 - lack of a consistent definition or standard for particular data sets
 - wide distribution of data among diverse agencies
 - unclear responsibility for the collection of data
 - lack of technology to collect the information
 - lack of resourcing to collate and manage data
 - lack of protocols for the use of information.

- To ensure that any data collected or collated can be used effectively, assess the viability and costs and benefits of:
 - a comprehensive database of information and data about New Zealand’s ocean (it is anticipated that any database developed would draw from distributed information available from existing key tools already being developed, particularly the Marine Environments Classification, the National Aquatic Biodiversity Information System and the Marlin meta-database; Australia is already developing a similar system and we would initially investigate whether this could be transposed to the New Zealand situation)
 - a ‘portal’ for providing public access to marine data and information held in the public domain.
- Agree on a preferred approach to identifying national ocean priorities and develop a strategy for implementing it.

Appendix 1: About the Maps in this Report

	Source	Description/comments
Map 1: Administrative and jurisdictional boundaries		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by the Institute of Geological and Nuclear Sciences.
Key towns and cities	Land Information New Zealand – NZ Topo	
Fisheries management areas	GeographX Ltd	Digitised from legal descriptions of the areas.
Regional council boundaries	GeographX Ltd	
Territorial sea	GeographX Ltd	
Exclusive Economic Zone boundary	GeographX Ltd	
Map 2: Seabed, rivers and estuaries		
Seabed depth	GeoSphere Exploration Ltd	Based on data sourced from the Ministry of Economic Development.
Shaded relief (topography)	GeographX Ltd	
Key towns and cities	Land Information New Zealand – NZ Topo	
Rivers	GeographX Ltd	Based on NZ Topo source data.
Major estuaries	http://www.mfe.govt.nz/publications/ser/ser1997/chap7-1-3.pdf	Digitised from 'The State of New Zealand's Environment 1997', Ministry for the Environment and GP Publications, Wellington, 1997, Figure 7.6 page 7.29: 'Some of New Zealand's major estuaries and harbours'. Original source: Crisp and Walsby (1986).
Map 3: Inshore marine protected areas		
Bathymetry	GeoSphere Exploration Ltd	Based on data sourced from the Ministry of Economic Development.
Marine reserves	Department of Conservation	See also Froude VA (in press) 'Location-based restrictive provisions in the New Zealand marine environment', report to Department of Conservation. Pacific Eco-Logic Ltd, Wellington.
Mataitai	Department of Conservation	See also Froude VA (as above).
Taiapure	Department of Conservation	See also Froude VA (as above).
Marine mammal sanctuaries	Department of Conservation	See also Froude VA (as above).
Map 4: Seamounts closed to trawling		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by the Institute of Geological and Nuclear Sciences.
Seamounts closed to trawling	GeographX Ltd	Digitised from legal descriptions of the closed areas.

	Source	Description/comments
Map 5: Marine mammals and seabirds		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by the Institute of Geological and Nuclear Sciences.
Exclusive Economic Zone boundary	GeographX Ltd	
Key areas for seabird and marine mammal biodiversity	WWF-New Zealand	Based on a map produced by a marine science experts workshop held in Wellington in May 2003. For the workshop report, see WWF-New Zealand (in prep) 'Shining a Spotlight on the Biodiversity of New Zealand's Marine Ecoregion: Marine Biodiversity Experts Workshop 27–28 May 2003', Wellington.
Whale migration routes	Department of Conservation	Digitised from a poster published by the Department of Conservation entitled 'Threats to Marine Mammals', 2003.
Southern Royal Albatross foraging locations	Susan Waugh	Sites where satellite-tracked Southern Royal Albatrosses were recorded foraging for food on two days during the period 12 January–11 February 1999 (actual dates unknown). See also Waugh S, Troup C, Filippi D and Weimerskirch H, 'Foraging Zones of Southern Royal Albatrosses' in The Condor, 104: 662–7, 2002.
Fur seal breeding colonies	Department of Conservation	Digitised from a poster published by the Department of Conservation entitled 'Threats to Marine Mammals', 2003.
Hector's Dolphin sightings	Department of Conservation	Digitised from a poster published by the Department of Conservation entitled 'Threats to Marine Mammals', 2003. Shows sites where the dolphins are frequently seen.
Southern right whale sightings	Department of Conservation	Digitised from a poster published by the Department of Conservation entitled 'Threats to Marine Mammals', 2003. Shows sites of known sightings.
Map 6: Benthic invertebrate, algal, and plant biodiversity		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by the Institute of Geological and Nuclear Sciences.
Key areas for benthic invertebrate and plant biodiversity	WWF-New Zealand	Based on a map produced by a marine science experts workshop held in Wellington in May 2003. For the workshop report, see WWF-New Zealand (in prep) 'Shining a Spotlight on the Biodiversity of New Zealand's Marine Ecoregion: Marine Biodiversity Experts Workshop 27–28 May 2003', Wellington.
Map 7: Fish biodiversity		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by GNS.
Key areas for fish biodiversity	WWF-New Zealand	Based on a map produced by a marine science experts workshop held in Wellington in May 2003. For the workshop report, see WWF-New Zealand (in prep) 'Shining a Spotlight on the Biodiversity of New Zealand's Marine Ecoregion: Marine Biodiversity Experts Workshop 27–28 May 2003', Wellington.

	Source	Description/comments
Map 8: Recreation – boating and diving		
Bathymetry	GeoSphere Exploration Ltd	Based on data sourced from the Ministry of Economic Development.
Slipways	Land Information New Zealand – NZ Topo	
Wharves	Land Information New Zealand – NZ Topo	
Boat launching ramps	Land Information New Zealand – NZ Topo	
Dive sites	http://www.divespots.co.nz	Based on data sourced from Aquanaut brochure, "Best Dive Sites in New Zealand".
Map 9: Ocean discharges and dumping		
Bathymetry	GeoSphere Exploration Ltd	Based on data sourced from the Ministry of Economic Development.
Ocean sewage outfalls from treatment plants/pumping stations	Data sourced mainly from the New Zealand Water and Wastes Association; analysis and additional data sourcing by URS (NZ) Ltd	Shows outfalls from sewage treatment plants/pumping stations that flow directly to the coast or offshore – not into rivers or estuaries. Treatment types can be defined as follows: ¹⁹ <ul style="list-style-type: none"> • Primary treatment consists primarily of physical processes (screening, settling or skimming) that removes a significant percentage of the organic and inorganic solids from wastewater. • Secondary treatment applies biological action to remove fine suspended solids, dispersed solids, and dissolved inorganic solids. • Tertiary treatment uses biological or chemical treatment, or filtration equipment to reduce nutrients (phosphorous and nitrogen), organic matter, and residual solids and pathogens. Nearshore outfalls are defined as those within 600 m of the shoreline; offshore outfalls are those beyond 600 m of the shoreline.
Ocean dumping permits: <ul style="list-style-type: none"> • dredge spoil and sediments • derelict vessels • organic fish and fish waste materials • mortal remains 	Maritime Safety Authority	Ocean dumping permits issued by the Maritime Safety Authority and regional councils for exercise in 2001 and 2002. The permit register does not show whether the materials were actually dumped.
Map 10: Petroleum industry seismic surveys		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by the Institute of Geological and Nuclear Sciences.
Seismic survey tracks	Ministry of Economic Development	Surveys conducted for oil and gas exploration. Approximately 95% of surveys were conducted by the petroleum industry.

¹⁹ Summarised from the US Local Government Environment Assistance Network.

	Source	Description/comments
Map 11: Mining, petroleum and undersea cables		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by the Institute of Geological and Nuclear Sciences.
Petroleum permits: • exploration • mining	Ministry of Economic Development	
Gas/oil wells: • active • plugged/abandoned	Ministry of Economic Development	
Undersea cable exclusion zones	GeographX Ltd	Digitised from legal descriptions of fishing/anchoring exclusion zones around undersea cables. Digitised for the National Aquatic Biodiversity Information System.
Map 12: Mining and petroleum in Taranaki		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by Institute of Geological and Nuclear Sciences.
Petroleum permits: • exploration • mining	Ministry of Economic Development	
Gas/oil wells: • active • plugged/abandoned	Ministry of Economic Development	
Maui pipelines	Ministry of Economic Development	
Map 13: Shipping		
Bathymetry	GeoSphere Exploration Ltd	Based on data sourced from the Ministry of Economic Development.
Recommended domestic shipping routes	Land Information New Zealand	Shipping routes represented are not authoritative. The routes are currently being surveyed by the Maritime Safety Authority.
Annual cargo volumes	Land Information New Zealand	Cargo volumes processed at New Zealand's 12 busiest ports for the year ending June 2001.
Coastal limits	Maritime Safety Authority	Digitised from Appendix 2, Maritime Rule Part 20 – Operational Limits.
Inshore limits	Maritime Safety Authority	Digitised from Appendix 1, Maritime Rule Part 20 – Operational Limits.
Map 14: Commercial fishing – snapper catch		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by GNS.
Snapper catch	Ministry of Fisheries	Estimated catch by statistical area for all fishing methods from October 1990-October 2003. Constructed as a data layer for the National Aquatic Biodiversity Information System.

	Source	Description/comments
Map 15: Commercial fishing – orange roughy catch		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by Institute of Geological and Nuclear Sciences.
Orange roughy catch	Ministry of Fisheries	Estimated catch by statistical area for all fishing methods from October 1990 – October 2003. Constructed as a data layer for the National Aquatic Biodiversity Information System.
Map 16: Commercial fishing – snapper distribution		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by the Institute of Geological and Nuclear Sciences.
Snapper distribution	Ministry of Fisheries	Based on best known data to June 2003. Constructed as a data layer for the National Aquatic Biodiversity Information System. Full range = the range within which virtually 100% of snapper distribution is found; normal range = the range within which approximately 90% of snapper distribution is found.
Map 17: Commercial fishing – orange roughy distribution		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by the Institute of Geological and Nuclear Sciences.
Orange roughy distribution	Ministry of Fisheries	Based on best known data to June 2003. Constructed as a data layer for the National Aquatic Biodiversity Information System. Full range = the range within which virtually 100% of orange roughy distribution is found; normal range = the range within which approximately 90% of orange roughy distribution is found.
Map 18: Commercial fishing – red rock lobster distribution		
Bathymetry	Institute of Geological and Nuclear Sciences	Image derived from a picture file provided by the Institute of Geological and Nuclear Sciences.
Red rock lobster distribution	Ministry of Fisheries	Based on best known data to June 2003. Constructed as a data layer for the National Aquatic Biodiversity Information System. Full range = the range within which virtually 100% of red rock lobster distribution is found; normal range = the range within which approximately 90% of red rock lobster distribution is found.
Map 19: Commercial fishing industry employment		
Bathymetry	GeoSphere Exploration Ltd	Based on data sourced from the Ministry of Economic Development.
Commercial fishing industry employment	Seafood Industry Council	Commercial fishing industry employment data for 2003, shown for each territorial authority area as a percentage of total employment for the area.

	Source	Description/comments
Map 20: Title extending below mean high water		
Bathymetry	GeoSphere Exploration Ltd	Based on data sourced from the Ministry of Economic Development.
Title extending below mean high water	Land Information New Zealand – New Zealand Foreshore Database (CD-Rom published November 2003)	Land parcels which have a legal boundary extending below the NZ Topo mean high water coastline. Mean high water is defined as the average level of all high tides. Excludes partially- or fully-eroded parcels; and excludes land owned by the Crown (e.g. as marine reserves).

Appendix 2: Detailed Explanation of Draft Marine Environments Classification Maps at 4-class, 9-class and 20-class levels

The maps at the end of section 1.3 of this report show the draft Marine Environments Classification at the Exclusive Economic Zone scale at three different hierarchical levels: 4-class, 9-class and 20-class levels. The following text further explains the environmental variation at these successive hierarchical levels of the classification. It has been adapted from text supplied by Ton Snelder of the National Institute of Water and Atmospheric Research (NIWA), who is project manager for the Marine Environments Classification development.

4-class map

The main subdivision shown in this map is between the relatively ‘coastal’ environments and the deeper ‘oceanic’ environments. Within the oceanic environments, further divisions are associated with differences in the mean annual solar radiation and sea surface temperature (winter). These subdivisions approximately define the subtropical, shelf and subtropical front, and subantarctic waters.

9-class map

The 9-class level further subdivides the subtropical waters into deep and abyssal, the shelf and subtropical front waters into the deep subtropical front, and central continental shelf and southern continental shelf. The 9-class level also subdivides the coastal environment into three classes that are associated with differences in the mean annual solar radiation and sea surface temperature winter; northern, central and southern continental shelf.

20-class map

The 20-class level further defines variation in the shallow coastal environments. The following environments are discriminated:

- class 58 – high tidal current
- class 60 – middle mid-depths
- class 64 – middle shallows
- class 124 – high wave energy coastlines
- class 130 – Marlborough Sounds
- class 169 – Southland Current
- class 190 – Southland front.

This series of subdivisions is summarised in Table A below.

Table A: The average value of each of the eight defining environmental variables in each class of the 20-class level of the EEZ classification

Class	Area (km ²)	Depth	Slope	Orbital velocity	Radiation mean	SST amplitude	SST gradient	SST winter	Tidal current	2-class level	4-class level	9-class level
1	1,416,048	3001	1.40	0	18	2	0.01	20	0.06	Oceanic	Subtropical	Deep
22	853,888	1879	1.54	0	15	2	0.01	16	0.11			Abyssal
9	1,028,896	5345	1.39	0	15	3	0.01	16	0.03		Shelf and subtropical front	Deep
47	960,848	2998	1.03	0	12	2	0.01	12	0.07			Central
55	35,408	334	1.62	0	16	2	0.02	15	0.20			Southern
63	426,016	754	0.88	0	13	2	0.02	12	0.18			
74	1232	15	0.62	0	14	2	0.02	12	0.11		Subantarctic	
178	629,760	750.47	0.41	0.01	9.46	1.34	0.01	7.61	0.15		Coastal	Central
127	2,477,856	4799	0.60	0	10	1	0.01	8	0.05			
204	292,432	2044	2.99	0	9	1	0.01	8	0.08			
273	12,880	2550	9.11	0	8	1	0.03	4	0.05			
12	2384	94	0.95	113	18	2	0.01	19	0.30	Northern		
58	6304	117	0.71	57	15	2	0.03	13	1.09	Central		
60	65,344	112	0.33	21	14	2	0.02	13	0.26			
64	43,024	38	0.28	272	14	3	0.02	13	0.19			
124	1088	8	0.41	836	13	2	0.02	13	0.00			
130	224	10	0.37	353	14	2	0.09	12	0.21			
169	14,912	66	0.19	113	12	3	0.04	10	0.21			
190	5424	321	1.90	3	12	2	0.06	9	0.10			
170	83,328	129	0.31	99	10	1	0.02	9	0.55	Southern		

Note: The divisions within the table show how environmental variation has been differentiated at the 2-, 4- and 9-class levels. The total area of each class at the 20-class level is shown in the second column and can be summed to derive the area in classes at the 2-, 4- and 9-class levels.

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