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What if?

Future Seas Scenario Planning and the Establishment of a Marine Reserve Network

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Future Seas: Scenario Planning and the Establishment of a Marine Reserve Network

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ISBN 978-0-9582825-5-0

This publication should be cited as follows: Future Seas: Scenario Planning and the Establishment of a Marine Reserve Network. 2009. WWF-New Zealand, Wellington.

For the Future Seas project, WWF-New Zealand enlisted the scenario-planning expertise of consulting firm URS-New Zealand.

Letter from the Executive Director of WWF-New Zealand

In so many ways New Zealand is known as a country that punches above its weight – whether you're talking about our education system, our approach to business, providing aid to countries in need, and yes, our environment. For example, in 2008, New Zealand hosted International World Environment Day. We were chosen, in large part, because we were one of the first nations to commit to carbon neutrality and have continued to provide climate change leadership. Not bad for a country considered by many to be at the end of the Earth.

As an island nation, we are intuitively aware that "We live on planet Ocean rather than planet Earth", as Professor John Montgomery, director of Leigh Marine Laboratory, has said. Perhaps it is this awareness that has allowed New Zealand to also be a leader in marine conservation.

New Zealand was one of the first countries to establish a no-take marine reserve. Established in 1975, Cape Rodney – Okakari Point Marine Reserve was the first New Zealand marine reserve. A recent study commissioned by the Department of Conservation shows that the marine reserve contributes $19 million per annum to the Rodney district.[1] Thirty years on, the vision of a few has stood the test of time, benefitting the environment, the economy and the social fabric of the region.

New Zealand's marine environment is certain to play an important role in the country's social and economic development. There are currently concerns about the sustainability of seafood harvest and mineral extraction, pollution of marine habitats from land- and sea-based activities, responses to climate change, and questions of marine ownership. Many established and competing activities operate in New Zealand's marine environment, while others are emerging, and some are as yet unknown. With the increasing concentration and diversification of marine uses, it is critical that policies protect the values that people hold for the marine environment. How we choose to act – to lead – today will greatly influence our future.

WWF's mission is to build a future where people live in harmony with nature. Our vision is a future where our marine resources are managed for the benefit of people and nature. To look more closely at this issue, WWF-New Zealand initiated a scenario building project to spur long-term creative thinking and dialogue about New Zealand's marine environment. Future Seas explores two very different scenarios "Selling by the Litre" and "Acting Local". As becomes clear in reading through the scenarios, neither is a vision of utopia, rather they are just two possible ways of the future. What's equally clear, however, is that there are ways we can operate now – particularly in terms of marine protection – that may be of great consequence to our future.

Landcare Research has been involved in a comprehensive future scenarios planning process. They have even developed a game and a screenplay around the process. For me, the name of their screenplay says it all, "100% Pure Conjecture". That is all scenario planning can ever be, and yet, the process is a little like planning for your own retirement – you don't know what your personal future holds, but you probably have a good idea of how you'd like to spend the latter part of your life and to get there you need to plan for it. We need to think about our marine environment in similar terms.

For policy-makers, it's time to tackle the difficult questions and make choices that take the long view. It is up to today's leaders to take actions that will stand the test of time – no matter what that test brings.

Chris Howe, Executive Director
WWF-New Zealand
March 2009

Executive Summary

New Zealand's marine environment covers an area 15 times that of its terrestrial environment and our Exclusive Economic Zone (EEZ) is the fourth largest in the world. As such, New Zealand's marine environment already plays an important role in the economic, environmental and social well-being of our country and its people.

It's a role that is destined to grow. However, with increasing concerns about the sustainability of seafood harvest and mineral extraction, pollution of marine habitats from land- and sea-based activities, responses to climate change and questions of marine ownership, it's clear the future holds many challenges.

WWF-New Zealand's mission is to build a future where people live in harmony with nature. Our vision is a future where our marine resources are managed for the benefit of people and nature. We initiated the Future Seas scenario planning project to look beyond the current real or perceived costs and benefits of marine reserves and explore what this protection tool could offer New Zealand in the dynamic future ahead. The Future Seas project focused on marine reserves because they represent the most comprehensive means of protection for New Zealand's marine environment.

The Future Seas scenario planning project was devised to give us some understanding of three main questions:

1. How will biological, social, economic, and cultural aspects of the marine environment in New Zealand change over the next 50 years?
2. How will New Zealand's marine environment be used and protected in the future?
3. What role should marine reserve networks play in marine protection? How extensive should they be and how will their impacts and benefits change over time?

To make sure our fix on the future was grounded in reality, we invited a select group of fishers, scientists, energy experts, community leaders, eco-tour operators, and Māori and government representatives to two Future Seas scenario planning workshops. During the workshops we discussed a number of stories that could play out in relation to the New Zealand marine environment. We then chose to further investigate two possible scenarios: "Selling by the Litre" and "Acting Local".

Selling by the Litre

The Selling by the Litre scenario plays out in a world where climate change follows the most optimistic Intergovernmental Panel on Climate Change (IPCC) prognosis, one that allows people and the environment to gradually adapt to the new conditions. Although the effects of climate change on habitats are observed under this scenario, they do not affect human ability to derive value from the marine environment.

In Selling by the Litre, the first 15 years (2007–2022) are characterised by the gradually declining condition of the marine environment caused by lack of resources and little focus on its management and protection. In the following 15 years (2023–2038) the decline continues as a new property-rights dominated system takes shape. An increased level of industrial activity, especially methane hydrate mining, combined with weak environmental controls, leads to a higher number of pollution incidents and destruction of some key habitats. Pressure on water quality also increases as coastal and other marine activities intensify. Over time, as the economy improves, the government imposes national marine environmental standards and ensures strong enforcement, which results in a slow improvement over the next 20 years (2039–2059). Progress in marine sciences helps to restore and maintain remaining pockets of biodiversity.

Acting Local

The Acting Local scenario is overshadowed by the most pessimistic IPCC climate change outcome. Environmental change in this scenario is rapid and in many aspects devastating. Society's response to climate change initially provides an impetus for economic growth, which then collapses and a no-growth economy becomes a reality. Politics are focused on local issues with strong regional independence and diversity of policy approaches throughout New Zealand.

In the first 15 years (2007–2022), human activities in the marine environment are dominated by large-scale, publicly funded projects at the same time that climate change problems intensify with an increased number of 100 and 500 year events. In the following 15 years (2023–2038), the rate of sea level rise has accelerated beyond the pace of infrastructural adaptation and many coastal areas are flooded. The next 20 years (2039–2059) in many ways bring the greatest challenges as the temperature and pH levels in the 2040s cross the tipping point and the environment enters into a violent adjustment period following dramatic sea current changes and an ecological crash in the marine environment. But by 2060 people have returned to deriving sustenance from the oceans. Society adjusts

to the new situation with multinationals controlling activities in deep waters and the EEZ and local businesses and cooperatives operating in the near-shore environment. Genetically modified aquaculture is important, as is marine energy micro-generation and local shipping.

What we learned

During the Future Seas workshops we asked the participants to look at how society and decision-makers, living within each scenario world, would debate for and against the establishment of a marine reserves network. We considered what costs and benefits they would find more important considering the circumstance of their life, e.g. marine property rights debate or climate change and regionalisation.

Both scenarios highlighted that there is scope for much more extensive activity in the seas and that access to the ocean's resources could generate economic boom or recession. On the other hand, closer analysis of predicted climate change impacts showed that many marine species are likely to come under severe stress in the next 50 years and the stability of ecosystems is not guaranteed.

Through the scenario planning we also learned that marine reserves don't need to detract from the potential value of the marine economy. In fact, marine reserves can enhance a number of non-extractive activities and add value to activities undertaken outside of reserves, e.g. by providing scientific baseline information, enabling more informed exploration, or by conserving a pool of genetic diversity which could be used to enhance biodiversity elsewhere. In these two scenarios, at least, the opportunity costs of the reserves and costs of transformation (e.g. shift to other industries and retraining) were minimal compared to the eventual benefits and the costs of climate change. In fact, they were more like an insurance investment, which allowed the communities to prepare themselves for the changes that were inflicted by larger forces such as climate change, intensification of human activity in the sea, or change of property regime.

The idea of marine reserves being used as an insurance policy surfaced in both scenarios. In Acting Local the reserves provided a mitigation mechanism for some of the impacts of climate change. In Selling by the Litre the reserves provided insurance against political mistakes in marine planning and inappropriate environmental management. The effectiveness of this insurance policy depends on the design of the network and when the marine reserves are established.

Planning for the future

The point of scenario planning is simply to tell stories about the future that can help us to make better decisions today. With that in mind it is imperative that New Zealanders actively become involved in the dialogue about the future of our marine environment.

Through the Future Seas scenario planning project, WWF hopes to encourage the government to lead development of the agenda for establishment of marine reserves networks and other marine protected areas (MPAs). To do this we also need to build on our scientific understanding of our oceans and the potential impacts of climate change. It's also clear that fishing, mining and other industries aspiring to operate in the marine environment need to engage with all the stakeholders to develop visions and mechanisms to ensure a sustainable marine environment.

As both the Selling by the Litre and Acting Local scenarios demonstrate, our actions today have major implications for New Zealand's future.

Hydroid trees and other encrusting fauna, underwater cliff, Poor Knights Islands Marine Reserve.

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Cape Rodney-Okakari Point Marine Reserve.

What if?

Introduction

New Zealanders' quality of life is intimately linked to the quality of the marine environment. Marine ecosystems provide vital economic products, such as food and minerals, and may one day contribute other resources, such as a renewable energy supply. The marine environment is also the place many of us escape to whenever we can – we love to fish, spend time at the beach, sail, surf and swim in our ocean.

New Zealand's marine environment is certain to play an ongoing key role in the country's social and economic development, but what that future will look like is uncertain. There are currently concerns about the sustainability of seafood harvest and mineral extraction, pollution of marine habitats from land- and sea-based activities, responses to climate change, and questions of marine ownership. Many established and competing activities operate in New Zealand's marine environment while others are emerging and some are as yet unknown. With the increasing concentration and diversification of marine uses, it is critical that policies protect the values that people hold for the marine environment. The decisions and actions that we make today will influence that future.

New Zealand's natural and built marine environment is protected by a suite of tools that have developed largely in response to the needs of different sectors, and are thereby reflected in different laws. Such measures range from the establishment of individual transferable quotas to manage fish stock harvests, to zones that protect undersea cables and pipelines from damage, to establishing no-take reserves.

Over the past few decades the creation of marine protected areas (MPAs) has found increasing support in New Zealand and internationally.

Marine reserves afford marine life the highest degree of protection among MPAs in New Zealand because they are completely and permanently protected from uses that remove marine plants and animals or alter their habitats.

New Zealand has more than 30 years of experience with marine reserves. Biological studies indicate that like our national parks on land, marine reserves can be effective at protecting and restoring natural habitats in the sea.

While information is emerging on the biological benefits of marine reserves, there is little documentation of their social and economic benefits. Often there is resistance to marine reserve establishment by people who perceive the protection tool as having an immediate personal or societal cost.

WWF initiated this scenario building project to look beyond the current real or perceived costs and benefits of marine reserves and explore what this protection tool

could offer New Zealand in the dynamic future ahead. We approached the issue by asking:

1. How will biological, social, economic, and cultural aspects of the marine environment in New Zealand change over the next 50 years?
2. How will New Zealand's marine environment be used and protected in the future?
3. What role should marine reserve networks play in marine protection? How extensive should they be and how will their impacts and benefits change over time?

Purpose of this document

This document aims to promote long-term creative thinking and dialogue about New Zealand's marine environment. It uses scenarios, developed through the input of diverse marine users and experts, to help visualise what New Zealand's marine environment could look like by 2060.

It is an important time to consider the future of marine reserves in New Zealand because:

1. New Zealand has committed to developing a representative network of MPAs that are connected biologically and administratively. This commitment is reflected in the government's Biodiversity Strategy of 2000 and the MPAs Policy and Implementation Plan, released in 2006. Holistic consideration of MPAs as networks that protect biodiversity is a conceptual departure from historical practice which had seen the establishment of protected areas on an ad hoc or reactive basis. The policy recognises that "marine reserves are a core tool in the development of a representative network of MPAs".
2. The Government has the opportunity to consider a revised Marine Reserves Act. A draft new Marine Reserves Bill was introduced to Parliament in June 2002. The Bill had its first reading on 15 October 2002 and was referred to the Local Government and Environment Select Committee. The Select Committee received 165 submissions on the Bill and completed its hearings of submissions. In 2005 the Bill was carried over to the new Parliament after the election. The Select Committee was expected to report back on the Bill by 6 October 2008, but with the dissolution of Parliament on 3 October that did not happen. The Bill is now on the Select Committee's agenda. The current Government will now decide whether or not to consider the Bill.
3. Our international commitments to MPAs. These commitments include the Convention on Biological Diversity which was signed by world leaders at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, Brazil. The Commission on Sustainable Development was created that same year to ensure effective follow-up to the conference. The commission has a multi-year programme of work through to the year 2017.
4. Pressures on the marine environment are intensifying and becoming more widely recognised. About 30 per cent of our marine environment is thought to experience some degree of disturbance from human activities. Pressures we put on our marine environment include commercial fishing, which has the largest impact on the New Zealand marine environment; increasing land development, which has increased discharges of land-based pollution, stormwater, nutrients, and sediments to the sea; marine spills, which can put pressure on specific areas; and climate change, which is expected to have a significant impact on our oceans and coasts.[2]

Increased competition for marine space. Pressures of population growth and growing interest in activities such as marine farming have placed increasing pressure on near-shore space. The future will see increasing clashes of sometimes incompatible activities, ranging from recreational uses to commercial operations. The clash of activities could extend further offshore in the future, as near-shore space becomes crowded and technological advances enable new uses of the ocean environment.[3]

> The point of scenario planning is to help us suspend our disbelief in all the futures: to allow us to think that any one of them might take place.
>
> Peter Schwartz, *The Art of the Long View* (1991)

Using scenarios to describe possible futures

Management of human use of the marine environment is challenged by great levels of uncertainty. There is uncertainty not only about how marine ecosystems work naturally, but also how they respond to human intervention. Since there are limited examples of existing MPA networks, there is uncertainty about the costs and benefits that are expected to flow from such a system.

Scenario planning captures key elements of uncertainty in a system, provides insight into drivers of change, explores the implications of current trends, and illuminates options for action.[4] Scenarios are a tool to help us take a long-term view in a world of great uncertainty.[5] Although they may be informed by qualitative predictions or quantitative models, scenarios are not based on extrapolation of existing patterns. They are alternative, dynamic stories that present a powerful opportunity to look beyond current mind sets and reflect on how we can most effectively adapt to a changing world.

In Future Seas we broke down the scenario planning process into six interacting stages. Although they are presented in linear succession (Figure 1), scenario planning is an iterative process in which stages are frequently revisited and re-evaluated.[6]

The process began by defining a question: How will the marine environment be used and protected in

Karl Ringa Ringa, diver, Paterson Inlet, Stewart Island.

FIGURE 1. Scenario planning process

1.	2.	3.	4.	5.	6.
Define the question	Establish the baseline/ current state	Define key driving forces	Develop possible futures	Develop two story lines	Analyse options

the future? This focused the investigation of future possibilities along a central theme, but was defined broadly enough to engage the imaginations of the participants in the scenario planning process.

Before exploring future possibilities, the current state of the marine environment was investigated through a literature review and interviews with marine stakeholders. Definition of key driving forces, such as the impacts of market-based tools and environmental change, combined to form alternatives, which were then distilled into two different and challenging scenarios. The ideas of workshop participants were used to develop storylines to describe how the scenarios would unfold.

Scenario planning is most effectively conducted as an inclusive process through which people from different organisations and backgrounds can share their perspectives. For this project, WWF-New Zealand enlisted the scenario-planning expertise of consulting firm URS New Zealand and engaged the participation of people with experience and expertise in marine science, tourism, fisheries, marine transport, economics, customary use, conservation, and oil and gas exploration.[A]

Many people generously gave their time through interviews conducted by URS to gather information on the current state of the marine environment and identify key drivers of change. The participation of marine stakeholders was also vital during the two one-day scenario planning workshops. The first of these workshops was used to frame scenarios based on participants' identification of the drivers of change, which they then ranked according to perceived importance, and classified according to perceived certainty. A selection of the important, yet uncertain drivers became the basis of the two scenarios.

URS then facilitated a second workshop in which participants evaluated the options for marine reserve networks between the present and 2060 for each of the scenarios. The outcomes of the scenario planning process were synthesised in an earlier version of this report, on which workshop participants were able to comment prior to publication.

A Participants' contribution is greatly appreciated and they are acknowledged in the appendices.

It is a common belief that serious information should appear in tables, graphs, numbers or at least sober scholarly language. But important questions about the future are usually too complex or imprecise for the conventional language of business and science.

Peter Schwartz, *The Art of the Long View* (1991)

Hector's dolphins.

New Zealand's Marine Environment Today

Understanding of the future must start with agreement on where we are today. In this section we define the starting point of our scenarios by describing known aspects of New Zealand's marine environment today. There are still many gaps in our knowledge of the marine environment, but we have assembled a number of facts that help us define the beginning of our journey. We also look to the past to enhance our understanding of the scale of change that can take place within 50 years. In our analysis of the present and the past we take a closer look at marine reserves as they are central to our investigation.

1. Define the question	**2.** Establish the baseline/ current state	**3.** Define key driving forces	**4.** Develop possible futures	**5.** Develop two story lines	**6.** Analyse options

FIGURE 2: Timing of Significant New Zealand Marine Statutes and Policies 1965 to present

	Prior to 1965, New Zealand only controlled fishing within a three-nautical mile coastal limit
	Harbours Act 1950
	Wildlife Act 1953
	Continental Shelf Act 1964
1965	In 1965 a nine-nautical mile fishing zone outside the three-nautical mile territorial zone was established
	Marine Farming Act 1971
	Marine Reserves Act 1971 allowed for marine areas where all marine life is protected and fishing and the removal or disturbance of any living or non-living marine resource is prohibited, except for scientific research or monitoring
1975	The first statutory marine reserve was created in 1975 – the Cape Rodney to Okakari Point Marine Reserve that surrounds Goat Island
	In 1978 the 200-nautical-mile EEZ was created, increasing New Zealand's jurisdiction over marine resources
	Marine Mammals Protection Act 1978
	Many coastal fish stocks were heavily reduced in the 1970s
	QMS introduced in the mid-1980s
1987	Conservation Act 1987
	Crown Minerals Act 1987
	Resource Management Act 1991
	Driftnet Prohibition Act 1991
	From the late 1980s there has been increasing recognition of Māori customary rights in a fisheries context, which are encoded in the 1992 Treaty of Waitangi (Fisheries Claim) Settlement Act
1993	Biosecurity Act 1993
	Southern Ocean Whale Sanctuary created in 1994 covering most of the Southern Ocean south of 40 degrees south (International Whaling Commission)
	Maritime Transport Act 1994
	Submarine Cables and Pipelines Protection Act 1996
	Fisheries Act 1996 and later amendments provided important management tools to protect commercial seafood stocks and biodiversity values in the form of mataitai, taiapure and fishing exclusions
2004	In 2004 revision of legislation regulating aquaculture led to stronger controls of land run-off
	Maori Fisheries Act 2004
	Maori Commercial Aquaculture Claims Settlement Act 2004
2005	Foreshore and Seabed Act 2005
	Fiordland (Te Moana o Atawhenua) Marine Management Act 2005
	MPAs Policy Statement and Implementation Plan released by the Department of Conservation and the Ministry of Fisheries in January 2006
	The government and the fishing industry sign a Benthic Protection Area Accord which closes 17 areas to bottom trawling and dredging (total area 1.2 million km^2) in 2007, the Accord includes a clause that no new MPAs are to be established in New Zealand's EEZ until 2013
2008	New Zealand implements a set of interim conservation and management measures during negotiations to form the South Pacific Regional Fisheries Management Organisation in 2008 to ensure bottom trawling activity does not increase from current levels and that significant adverse impacts on "vulnerable marine ecosystems" are avoided
	Measures put in place to further protect Maui's and Hector's dolphins, including from 1 October 2008, set net and trawl fishing banned in more of the areas where the dolphins range. Some of the measures that are fishing related are currently being contested by the fishing industry.

Background

New Zealand has an extensive coastline with a wide variety of marine habitats and a great diversity of marine wildlife. Our marine environment covers an area 15 times that of its terrestrial environment.

Our Exclusive Economic Zone (EEZ) is the fourth largest in the world. It extends from 12 to 200 nautical miles offshore and covers an area of 3.93 million square kilometres.[7] The territorial sea covers 167,650 square kilometres and is situated between New Zealand's 12,000 kilometres of coastline and the inner, 12-nautical-mile boundary of the EEZ.[8]

Our marine environment is characterised by a great range of habitats extending from the subantarctic to the subtropical regions, and from the shallow continental shelf to abyssal depths. Marine habitats include mangroves, mudflats, seagrass and kelp beds, rocky reefs, seamounts, canyons, fiords, open sea and oceanic trenches. Scientists have formally identified almost 16,000 marine species in New Zealand waters and it's estimated that tens of thousands of species may still be undiscovered.[9] Scientists estimate that as much as 80 per cent of New Zealand's biodiversity occurs in the marine environment.[10]

Because of our geographic isolation, by international standards New Zealand's marine environment has a comparatively high level of endemism,[11] with 44 per cent of our known marine species endemic.[12] This high level of endemism means that New Zealand is an important contributor to the Earth's marine diversity.

How much can change in 50 years?

Since the first Pacific and European explorers and settlers voyaged by sea to reach New Zealand's shores, New Zealanders have depended on the marine environment to sustain themselves and to communicate and trade with the outside world.

The management of human interaction with the marine environment has changed significantly over the last 50 years. The majority of marine management legislation was introduced after 1965. The timeline (Figure 2) illustrates the timing of different statutes that govern the use of New Zealand's marine environment. Notable regulatory developments include the establishment of the first marine reserve in 1975 and introduction of the Quota Management System (QMS) which revolutionised the commercial fishing industry in the mid-1980s.

It is likely that substantial change in how we use and manage use of the marine environment will continue in the next 50 years.

Our marine environment is characterised by a great range of habitats extending from the subantarctic to the subtropical regions, and from the shallow continental shelf to abyssal depths.

The State of the Marine Environment

New Zealand's natural marine environment has been affected to varying degrees by human activities such as coastal development, pollution, harvesting of marine species, and introduction of exotic species.[13] These activities impact on the interconnected values of habitat health, biodiversity, and water quality in the marine environment.

Measurement and monitoring change in the marine environment is aided by indicators whose trends can reflect change in the wider system and alert managers to the need for intervention. Indicators that inform us about the state of the marine environment include: commercial fish stock levels, number of threatened species, abundance and distribution of exotic species, and water quality. Tracking quantitative change in these and others variables reflects New Zealand's performance in maintaining a healthy marine environment. Indicators are used in the scenarios presented later in this report as a quantitative snapshot of how ecosystem health could change over the next 50 years.

Commercial fish stock levels

Although our inshore and offshore marine areas are subject to different human-induced pressures, the largest single pressure on the marine environment in New Zealand is fishing.[14] Measuring fish stocks under the QMS is one of four national environmental indicators for oceans.[B] These indicators are used by the government to better respond to existing and emerging pressures on New Zealand's marine resources.

According to the Ministry of Fisheries, in 2006, 65 per cent by weight of all commercial catches were from fish stocks where enough information was available to assess the stock status (99 fish stocks). The remaining 35 per cent comprised 519 stocks, the status of which could not be assessed because of insufficient information.[15]

Of the 99 assessed fish stocks, 85 per cent were near or above target biomass levels. The remaining 15 per cent of assessed fish stocks were below target level and rebuilding strategies have been put in place for these fish stocks (e.g. the strategy to rebuild orange roughy numbers in the Puysegur area by closing the area to fishing since 1997).[16]

Numbers of New Zealand marine species nationally critical

Plants and animals listed as "nationally critical" by the New Zealand Threat Classification System are considered to have the highest risk of extinction in New Zealand. According to the 2005 New Zealand Threat Classification System list (published 2007), 11 marine invertebrates, four marine mammals, and 11 shorebirds and seabirds are listed as nationally critical.[17]

Abundance and distribution of exotic marine species

By 1998, more than 140 introduced marine species had been recorded in New Zealand waters. Since then, at least another 18 new species at 16 of New Zealand's high-risk ports and marinas have entered into our waters.[18]

The Ministry for the Environment's *State of the Environment Report 2007* notes that most of the marine invaders to date have probably arrived as a result of shipping activities, but changes to climate and ocean current patterns may bring more species to New Zealand's waters through natural processes.

Introduced and invasive species can have a detrimental effect on native marine species and habitats. Competition and predation by introduced species can lead to the loss of native species in some areas.

Water quality in coastal areas

Currently, New Zealand's marine water quality is high by international standards.[19] Harmful micro-organisms are relatively uncommon and shellfish from most locations can be safely eaten.[20]

In the 2006/07 summer, water quality at 80 per cent of the 380 beaches that the government monitors for recreational water quality met the New Zealand guidelines for contact recreation almost all the time. More beaches met the guidelines in the 2006/07 summer season than in the previous two summer seasons.[21]

The key impacts on water quality in the marine environment are sediment run-off from coastal, hillside, and riverbank erosion, and pollution of harbours, estuaries, and coastal waters from stormwater run-off, contaminated rivers, and sewage. Risk of coastal exposure to oil spills has been estimated between 2,000 to 20,000 tonnes per year with higher risk areas in Northland's East Coast, and the coastlines of the Coromandel Peninsula, Wairarapa, Marlborough, and North Canterbury regions.[22]

B The other three national environmental indicators for oceans include seabed trawling in deep waters, water quality at coastal swimming spots, and marine areas with legal protection.

Marine Reserves – Current State of Knowledge

The Future Seas scenario planning project focused on marine reserves as they represent the most comprehensive means of protection for New Zealand's marine environment. There is an extensive body of scientific literature on the effects of marine reserves, including many studies that have been conducted during New Zealand's 30-year history with this management tool. This means that scientists have been able to draw some important conclusions about the biological effects of marine reserves both in New Zealand and overseas.

Biological benefits observed

Marine reserves protect areas of the marine environment by permanently prohibiting removal or disturbance of any living or non-living marine resource, while still allowing for non-extractive uses such as research or tourism. Marine reserves in New Zealand are currently defined as "specified areas of the sea and foreshore that are managed to preserve them in their natural state as the habitat of marine life for scientific study. Marine reserves may be established in areas that contain underwater scenery, natural features, or marine life of such distinctive quality, or so typical, beautiful or unique that their continued preservation is in the national interest."[23]

As pressures on the marine environment from human use increase, marine reserves are also a tool that can help prevent, slow, or reverse negative change.[24] By protecting major portions of an ecosystem, marine reserves allow the environment, species and their interactions to function in a way that provides the ecosystem goods and services that support the well-being of humans and other species.

Other kinds of MPAs exist (e.g. limit or ban certain types of fishing or human activities). While these protected areas may provide some benefits, they do not produce the same outcomes as marine reserves because they do not afford as comprehensive protection of the overall marine environment.[25]

For example, long-term trends in spiny lobster abundance (1977–2005) were compared at two northern MPAs: Tawharanui Marine Park which is a no-take site and Mimiwhangata Marine Park which has partial protection (only restricted forms of recreational fishing are allowed). On average, legal-sized lobster were 11 times more abundant and biomass 25 times higher in the no-take marine park following park establishment, while in the partially protected marine park there has been no significant change in lobster numbers. Furthermore, no difference was found in densities of legal-sized lobster between the partially protected marine park and nearby fully fished sites.[26]

Over 30 marine reserves have been established in New Zealand waters. Today marine reserves cover 5.4 per cent of the territorial sea, or 0.2 per cent of the country's total marine environment. The largest reserves by far surround the remote Auckland Islands and Kermadec Islands, which comprise 99 per cent of the marine reserve area in New Zealand.[27]

Consistent with international trends, monitoring in New Zealand marine reserves has shown an increase in the size, density, diversity, reproductive output, and biomass of marine life:

- Increases in biomass of 5-10 per cent for every year of protection were modelled from a study of spiny lobsters in Leigh (Cape Rodney to Point Okakariki Marine Reserve), Hahei, and Mayor Island marine reserves and at Tawharanui Marine Park (a no-take protected area).[28]
- Monitoring has established that blue cod are more abundant and larger in the Kapiti Marine Reserve than in unprotected areas.[29]
- Results of monitoring show that butterfish and reef fish species are larger and more abundant within the Kapiti and Te Angiangi marine reserves since their establishment in 1992 and 1997 respectively. Findings also show that blue moki and pāua abundance has increased within Te Angiangi Marine Reserve.[30]
- Studies at Tonga Island Marine Reserve demonstrate the impact of a no-take reserve on particular species of reef fish, especially blue cod. In February 2005, large blue cod in reserve represented 43.5 per cent of the total compared to less than 3.3 per cent from all control sites.[31]

The data from studies of numerous marine reserves in temperate and tropical waters has been analysed by scientists to better understand their performance. These studies suggest that within the boundaries of most well-enforced marine reserves the density, size, diversity, reproductive output, and overall weight of marine plants and animals (biomass) has increased dramatically. The Partnership for Interdisciplinary Studies of Coastal Oceans reports that a global review of scientific documentation published in peer-reviewed journals found that fish, invertebrates and seaweeds had the following average increases inside marine reserves:

- Biomass, or the mass of animals and plants, increased an average of 446 per cent.
- Density, or the number of plants or animals in a given area, increased an average of 166 per cent.
- Body size of animals increased an average of 28 per cent.
- Species diversity, or the number of species, increased an average of 21 per cent in the sample areas.[32]

Genetic diversity

Marine reserves help to maintain genetic diversity of marine populations within and around their boundaries. A study undertaken by Hauser *et al.* into genetic diversity amongst snapper populations in New Zealand suggested that the number of fish in a population may be many times greater than the number of fish reproducing, contributing to the next generation and maintaining genetic diversity. [33]

Overfished marine populations are prone to lose their genetic diversity, putting their long-term viability at risk. In a study of the heavily fished snapper in Tasman Bay and the Hauraki Gulf it was discovered that genetic diversity declined once commercial fishing began in the Tasman Bay in the 1950s. The practice of continually harvesting the largest and oldest fish (as fishing regulations require) alters size and numerous other genetic characteristics that are harmful to the overall population – smaller fish have been shown to have lower reproductive capacity and a reduced ability to survive or respond to environmental change.[34]

The increased reproductive capacity exhibited by species in marine reserves and protection of age and size variability amongst species within marine reserves helps protect genetic diversity and resulting sustainability of different marine species. Genetic diversity in a population is critical to a species' ability to adapt to environmental changes and for the continued productivity of a fish species.

Spillover effect

While few studies have specifically examined the spillover effects of marine reserves (when organisms within marine reserves cross reserve boundaries), those that have concluded that animals from marine reserves may swim or crawl outside to supplement surrounding populations.[35]

Larvae, the microscopic young of fish and marine invertebrates, and plant shoots or seeds that disperse out of reserves, may seed and boost populations in surrounding areas.[36] For example, the spillover effect has been documented at Merritt Island National Wildlife

Long-term trends (1977-2005) at Tawharanui Marine Park, which is a no-take site, show that average, legal-sized lobster are 11 times more abundant following the park's establishment.

Refuge at Cape Canaveral, Florida, USA. The refuge contains two areas that total 40 km². In 1962 the area was closed to public access and fishing due to security concerns for the nearby Kennedy Space Center.[37] An additional 60 km² area was closed to motorised vessels in 1990. Prior to protection, the area was intensively fished by recreational fishers. Studies show the protected zone now produces enormous game fish such as black drum (*Pogonias cromis*), red drum (*Sciaenops ocellatus*), spotted sea trout (*Cynoscion nebulosus*) and common snook (*Centropomus undecimalis*) that live in and move outside the refuge and into the fishing grounds nearby. Many of these individuals are record-breaking sizes.[38] The changes at Merritt Island have occurred over a period of decades after protection, because the game fish are slow growing and long lived.[39]

Marine reserve networks

A tension exists between making reserves large enough to support self-sustaining fish and invertebrate populations and minimising the economic constraints larger protected areas may pose on extractive activities, such as fishing. Economic impacts can be reduced without compromising conservation and fisheries benefits by establishing networks of several smaller marine reserves. Marine reserve networks provide more protection for species and habitats than individual, unconnected reserves.[40]

Historically, marine reserves in New Zealand and elsewhere have been established individually to protect particular habitats or special places. Mathematical models and knowledge of the life history and ecology of marine species has led scientists and policy-makers to consider how marine reserves link with the wider marine environment. Worldwide the idea of networking marine reserves has been embraced as an effective protection strategy that has the potential to provide synergistic benefits exceeding the sum of the network's individual reserves.[41] There are few international examples of marine reserve networks to date,[C] but many countries, including New Zealand, have made commitments to establish representative and comprehensive MPA networks.[D]

Other benefits observed

Ecosystem goods and services – Marine ecosystem services such as flood and storm protection, wave and tidal energy, water quality maintenance and shoreline maintenance are often taken for granted but are nonetheless under threat from changes induced by direct human activities and climate change. Marine reserves increase the resilience of the marine systems and are therefore likely to increase their ability to provide the ecosystem regulating services.[44]

Scientific research – By providing natural areas that are protected from most human impacts, many no-take areas have an important role in scientific research. These areas provide research opportunities for long-term ecological and population studies that will enhance our understanding of marine ecosystems. They can also be used to study the effects of human activities by comparing an area that has little impact from humans to nearby areas that allow a range of activities, including fishing, as evidenced by the articles cited in this section of this document. Understanding our impact on the marine environment is essential to achieving sustainable management of its resources.[45]

Potential benefits to fisheries – Reserves contribute to the understanding of fisheries management through greater understanding of fish ecology and can provide information to improve management elsewhere, e.g. measures of natural mortality, reproduction and maximum size.[46]

Marine reserves complement protection provided by the QMS by protecting fish of all ages and their habitat. The QMS results in removal of virtually all large animals and fished populations tend to be dominated by smaller, younger animals – many just over the minimum legal size.[47] Reserve populations could be used as genetic pools to strengthen the QMS populations.

Education – Marine reserves are of key importance for education purposes as they are the only areas of the marine environment that provide an experience close to that which may have been experienced prior to human disturbance. Informal education opportunities are also created by marine reserves as visitors appreciate the natural state of the marine environment and become more mindful of the need to preserve it through their future actions.[48]

Economy – Marine tourism relies on clear water and opportunities to view marine life to attract visitors,[49] elements provided by marine reserves. The Australian national economy has been estimated a benefit of $1.4 billion from tourism associated with the Great Barrier Reef Marine Park.[50] The Commonwealth Department of Environment and Heritage identified that the quality of visitor experiences "…depends on the ability to see large fish and the diverse life of algal beds, rocky seabeds and reefs undisturbed and undamaged in their natural environment and free from the debris of lost fishing gear, discarded plastic and drink containers".

C Notable examples of recently established MPA networks, which include a substantial marine reserve component, include the 2004 rezoning of the Great Barrier Reef Marine Park, the establishment and expansion in 2002, 2006 and 2007 of MPAs, including 11 marine reserves, around California's Channel Islands, and the 2006 establishment of an MPA network along California's central coast.

D New Zealand's commitment to an MPA network is documented in the Government's Biodiversity Strategy of 2000, the Marine Protected Area Policy and Implementation Plan, 2006, and the Marine Protected Areas Classification, Protection Standard and Implementation Guidelines published February 2008.

Making the connection: Great Barrier Reef

The Great Barrier Reef is the largest natural feature on earth, stretching more than 2,300 km along the north-eastern coast of Australia. The Great Barrier Reef Marine Park covers an area of 344,400 km² and is the largest managed marine area in the world.[42] The Great Barrier Reef ecosystem faces increasing pressure from a diverse range of impacts causing wide ranging effects on the biodiversity of the park.

Prior to a 2003 initiative called the "representative areas programme" being established, only 4.5 per cent of the park was zoned as no-take areas. Since the rezoning under the representative areas programme in 2004, 33 per cent is now zoned as no-take areas and these areas cover at least 20 per cent of each of the described bioregions in the park.[43] The programme aims to enhance the resilience of the natural system to cope with global scale change, and responds to issues for coral reef management such as increasing sea temperatures and sea level rises.

Establishment of the reserve included the most comprehensive process of community involvement and participatory planning for any environmental issue in Australia's history, including over 31,500 public submissions with the majority in support. Stakeholder involvement in planning and management is assured through public participation in zoning, the Great Barrier Reef Consultative Committee, geographically focused Local Marine Advisory Committees and issue-focused Reef Advisory Committees. Indigenous communities are working with the Great Barrier Reef Marine Park Authority to ensure sustainable traditional use of marine resources, especially the traditional use of turtles and dugongs in the marine park.

Protecting the marine environment can also be expected to go hand in hand with protecting New Zealand's clean green image and its associated economic impact through our tourism markets. Tourists are attracted to New Zealand because of the real nature experience and have high expectations about scenery and landscape. As a result, worsened perceptions of our marine (or terrestrial) environment would result in a loss to the nation's economy.[51]

Cultural and spiritual – Our natural environment is a key defining feature of New Zealand. Our rich natural and cultural heritage and connecting with our heritage through conservation and enjoyment is an important component of our national identity and sense of belonging.

Many of the stakeholders interviewed during this project talked about the enjoyment and inspiration from the marine reserves experience contributing to their health and well-being. People may experience a sense of well-being when in coastal areas or on the ocean owing to a feeling of connecting with nature, the feeling of solitude and being far from other humans and civilisation. Whether or not people experience a marine reserve directly, they are likely to feel an enhanced sense of well-being from existence of marine reserves that will help protect the marine environment for the benefits of future generations.

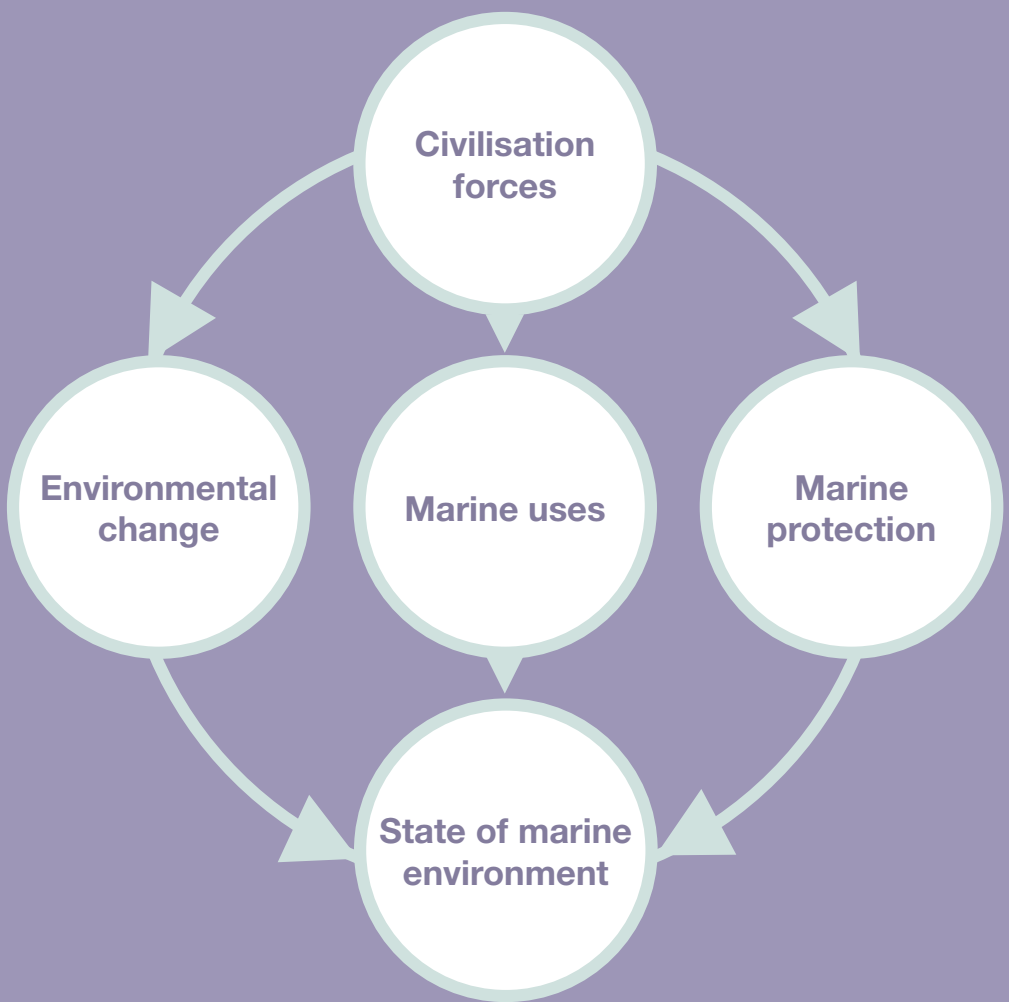
Our stakeholders also mentioned that the involvement of the local community and in particular Māori in the management of their marine environment and especially reserves helps people to feel more empowered, and as a result capable of exercising guardianship/kaitiakitanga over their marine environment to a greater extent than previously. The protection of indigenous values such as seafood gathering on the outskirts of the marine reserves often provides further benefit to tangata whenua.[52]

Connections between Driving Forces of Change

New Zealand's marine environment is a dynamic system in which change is driven by internal and external forces. Some driving forces are characterised by a high degree of uncertainty, and thus have greater potential to influence future scenarios. Modelling different combinations of driving forces yields alternative ways that the system could evolve. In this section we identify and describe forces that are likely to shape the future of New Zealand's marine environment.

1.	2.	3.	4.	5.	6.
Define the question	Establish the baseline/ current state	Define key driving forces	Develop possible futures	Develop two story lines	Analyse options

FIGURE 3. Key driving forces for the marine environment and main directions of impacts



Defining the Key Driving Forces

Discussions with many stakeholders and an extensive review of current literature have led us to conclude that we are operating in a framework of four key forces:

- Civilisation forces – the totality of political and management systems and styles that influence any decisions in regards to the marine environment.
- Marine uses – the way and the reasons for which we consciously interact with the marine environment.
- Environmental change – the natural cycles and human induced changes like climate change.
- Marine protection – our efforts to protect and conserve marine species and habitats.

These forces interact in many different ways and determine the state of the marine environment, which in turn, through feedback loops, influences society and our interaction with the seas.

What follows is a review of the current state of these forces. The framework is then used to construct some possible futures for New Zealand's marine environment.

Civilisation Forces

The way we interact with the marine environment is influenced by the wider social and political systems that organise our society. They impact indirectly on marine ecosystems as the root causes of change. Stakeholders who have been involved in this scenario planning process identified a number of civilisation forces that influence change in the marine environment.

These can be categorised as economic forces; the policy, planning, and management regime; science and technology; and society and culture.

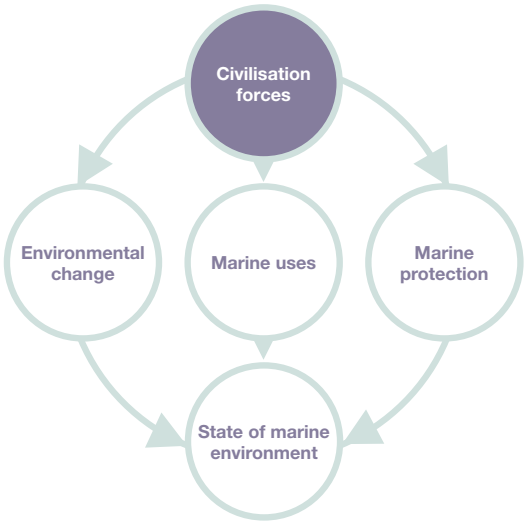
Economic forces

The overall state of the domestic and global economy can have significant impacts on the marine environment. These impacts are expressed by our willingness to pay the opportunity cost or actual costs of protecting the marine environment. The state of the economy also influences the amount of pressure placed on the marine environment from extraction, production, consumption and transportation of goods.

Prices and demand for marine resources are a major factor contributing to increasing pressure on the marine environment. If prices or demand increase new fisheries may be explored, new types of aquaculture established, and more oil areas may become viable for exploitation.[53] Increases in tourism may place additional pressure on the marine environment from increased infrastructure to support tourists and increased recreational activities in the marine environment. Resources available for research and protection of the marine environment also depend on a prospering economy. Conversely, the rise in price of some resources could make some commercial activities less viable, leading to a lower level of activity in the marine environment.

Policy, planning, and management regime

The type of regulatory framework and management that apply to the marine environment will have a significant influence on its use and protection. Today the marine environment is managed through a combination of statutes and policies (see Figure 2 on pg 10). Major activities such as fisheries and mineral extraction are covered by sectoral legislation and there is coordination between agencies to manage these activities. The level of coordination has an obvious impact on how the specific marine uses evolve.



New Zealand: Fiordland Marine Reserve Network

In recognition of the Fiordland marine area's unique marine environment, distinctive biological diversity, outstanding landscape and cultural heritage, the government passed the Fiordland Marine Management Act 2005.[54]

Current marine management in Fiordland stems from a package proposed by the Guardians of Fiordland. The guardians include representatives from commercial and recreational fishing interests, tour operators, dive clubs, and conservationists associated with the area. The 2005 Act seeks to facilitate and promote cooperation between the guardians and management agencies, to assist in achieving the integrated management of 8,820 km^2 of the Fiordland Marine Area.[55]

A process has been developed to encourage cooperation between different stakeholder groups – "gifts & gains" terminology was used to discuss contributions from various groups. The facilitation and funds from the government assisted discussion and articulation of the shared vision.

The agreements reached under the Act include:

- commercial fishers would only fish in the open sea and outer fiords;
- recreational fishers would limit their daily bag to three blue cod a catch;
- Ngāi Tahu agreed to not continue to fish under its limitless customary rights.

Founding Fiordland Marine Guardian, John Steffens, shared with WWF-New Zealand key lessons from the process:

- Look for what needs to be protected and how best to achieve it instead of trying to fit existing tools.
- Gather as much information and knowledge as possible – good monitoring programmes and robust baselines are essential.
- A bottom up approach works best, but support from the government is critical. Provide regular communication and opportunities to engage.
- Legislation is key to address free riders [those who consume more than their fair share of a resource].

Management of our marine environment is a mixture of national and local regulation and management. For example, in June 2008 the government agreed to the drafting of an Exclusive Economic Zone Environmental Effects Bill. The purpose of this legislation is to safeguard the integrity of New Zealand's ocean ecosystems in the EEZ through monitoring and managing the environmental effects of various activities in the EEZ.

Fisheries, which represent one of New Zealand's largest industries, are managed at a national level through the QMS, which involves industry, scientists and government agencies working together to assess the abundance of all quota-managed species. Industry codes of practice are one way that some fisheries, including aquaculture, work to improve environmental sustainability.

Property rights are an institution that could have significant influence on the use of the marine environment. In New Zealand the marine environment, including the foreshore and seabed, is the property of the government. Access and use rights, including customary uses, allow individuals to undertake certain activities on certain areas within certain periods. Unlike on land, zoning of areas for different use has been a concept little used in the marine environment, possibly due to the relative lack of knowledge about the marine environment. Changes to this system could lead to development of new uses and different management styles.

Science and technology

The application of scientific knowledge and new and existing technologies in the marine environment is likely to be a key driver of change in the marine environment that could have both positive and negative effects. While greater scientific knowledge and new technologies can help us better protect the health of the marine environment, some technologies create further risks for the environment. Emerging technologies likely to change the marine environment in the future include:

- increased use of the sea for energy generation through operations such as wave energy, offshore wind farms and tidal current energy harvesters
- more sustainable and efficient seafood harvesting with more species exploited through use of satellite tags, computer chips and other new technologies allowing us to observe the migrations of fish, mammals and other marine life[56]
- more extraction of minerals as technology reduces environmental impact and costs and intensified exploitation could contribute to higher levels of habitat change and pollution incident rates
- new tourism opportunities such as underwater hotels
- increased exploitation of marine biodiversity for pharmaceutical purposes
- increased coastal and offshore aquaculture development.

Society and culture

New Zealand society is made up of a number of diverse cultural groups who have different values regarding the marine environment. Those diverse values influence people's choices in regards to how they interact with and use the marine environment.

For many New Zealanders a connection to the ocean environment and especially the coast is an essential element of life. A 2005 WWF survey found that many New Zealanders placed a high value on the marine environment and would support a greater level of protection than is currently in place. The majority of respondents believed that the marine environment is under threat, yet many were optimistic about its future.[57]

From an indigenous perspective, Māori have a strong relationship with the sea that is an extension of their close relationship with the physical and natural environment.

Links to scenarios

The participants of the scenario planning workshop believed that changes to the property regime, distribution of power between local and national authorities and the state of the economy were the strongest factors likely to influence the future of the marine environment.

Māori hira and tikanga

The Māori culture developed through an interdependency and close relationship with all aspects of the physical environment. This is expressed through whakapapa/genealogy; the "genealogical descent of all living things [including rocks and ocean creatures] from the gods to the present time,"[58] which defines the Māori worldview. Māori have genealogical links to the god of the sea Tangaroa, and thus consider themselves to have family ties with the marine environment leading to the right to derive sustenance from it and the responsibility to protect it. This relationship with the sea permeates all aspects of traditional marine management and influences tikanga/Māori laws surrounding the harvest of kaimoana/seafood.

Today, Māori apply elements of tikanga in their involvement with management of the marine environment through mataitai and taiapure and through the increasing use of tohu/signs or indicators. An environmental tohu includes smell, taste and abundance of kaimoana and tells us what state the environment is in and what might be happening over the short or longer term.[59]

Iwi leaders can have a great impact on the state of the marine environment through commercial and customary fishing rights and possibly reintroducing traditional ways of marine management.[60]

Red coral being observed by a diver, Branch Rock, Fiordland Marine Area.

Uses of the Marine Environment

"Healthy oceans deliver a range of important environmental benefits: they absorb and transfer nutrients and sediments from the land, absorb carbon, and regulate heat transfer from the atmosphere. These functions are critical to sustaining life."

State of the Environment Report 2007, Ministry for the Environment

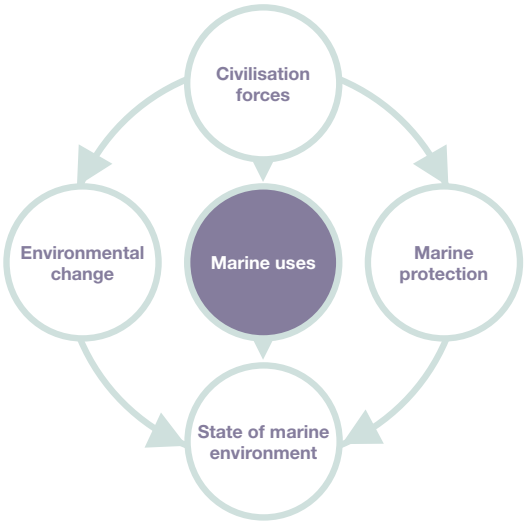
Beyond life-sustaining benefits, New Zealanders also benefit from the marine environment through tourism and recreation, resource extraction (e.g. seafood or minerals), energy production, as a medium for transport and communication, and research and scientific purposes. The marine environment also plays a critical role in fulfilling many of our cultural, educational and spiritual needs.

These varied and sometimes conflicting uses obviously impact our marine environment. Below we have described some of our direct uses of the marine environment. In this report we do not discuss the pros and cons of each use, but instead give an overview of each activity in order to highlight just some of the pressures our marine environment is under.

Tourism recreation and community use

The coast and sea are important natural tourist and recreational resources. In fact, the most popular nature-based activity for both domestic and international tourists is going to beaches. For international tourists the second most popular activity is taking a scenic boat cruise and for domestic tourists it is fishing (sea/river/lake).[61] Recreational fishing is an activity enjoyed by as many as a million people each year.[62]

International tourists who take part in nature-based tourism activities tend to stay longer and spend more on average per trip than those who don't.[63]



Other marine-based tourism activities include sailing, fishing, scuba-diving, surfing, dolphin and whale watching, to name just a few.[64]

Wild fisheries and aquaculture

In the September 2007 year the calculated asset value of New Zealand's commercial fish resource under the QMS was $3.8 billion. This represents a 39 per cent increase since 1996 when the asset value was calculated at $2.7 billion.[65] The commercial seafood industry employs more than 26,000 people (10,000 directly) and is New Zealand's fourth largest export earner.[66]

Aquaculture is New Zealand's fastest growing primary industry. Currently worth about $300 million each year to the national economy, New Zealand's aquaculture industry is working to become an environmentally sustainable billion dollar business by 2025.[67]

Marine mining

Oil and gas have been produced from New Zealand's EEZ from the oilfields in Taranaki. The Great South Basin off the coast of Southland and South Otago is currently being explored.[68]

The extraction of minerals from the sea floor is relatively new in New Zealand, however, several prospecting licences to mining companies have been granted for areas on the Kermadec Ridge.[69]

Renewable energy

There is currently a focus on devising technologies to harness wave and tidal energy. The previous government set up a Marine Energy Deployment Fund to encourage the deployment of marine energy generation devices in New Zealand. The fund was part of the government's initiative to look to marine energy to help reach the target of 90 per cent renewable electricity for New Zealand by 2025.[70]

Shipping and communication

In 2006, 99.5 per cent of New Zealand's exports were transported by sea, making New Zealand's 13 major commercial ports and shipping lanes vital to the economy.[71] An important aspect in shipping is the risks it poses to New Zealand's biosecurity. In 2008, the government declared its intention to join an international convention controlling ships' ballast water discharges. Ballast water is one of the main

ways pests can be introduced into New Zealand's marine environment. Nearly three-million metric tonnes of ballast water, coming from places outside of New Zealand, are discharged into New Zealand's waters each year.[72]

New Zealand has submerged cables in the EEZ as part of the Southern Cross Cable Network for communication purposes. These submarine cables carry 90 per cent of our communication.

The most important submarine pipelines are those servicing the Maui gas field. Transpower operates the Cook Strait electricity link (3 x 350,000 volt direct current cables and two fibre optic cables).

Scientific exploration and biotechnology

New Zealand spends about $60 million per year on marine research.[73] Some of this research is focused on topics such as coastal processes, climate change, affects of land-based activities, biological interactions, and status of fish stocks.

New technologies are also allowing scientists to go below the surface to gain a greater understanding of our marine environment. This information can be used to contribute to the sustainable management of our marine resources.

Indigenous uses

"Māori have a particular and unique standing as the Crown's Treaty partner, and the depth of connection between Māori and the sea must not be ignored. The Māori connection with the ocean permeates many aspects of Māori life – it is cultural and spiritual, as well as practical and economic." – Māori and Oceans Policy, Oceans Policy Secretariat, Working Paper Three, 14 March 2003.

Māori are important players in commercial, recreational and customary fishing, as well as aquaculture. Māori control over a third of New Zealand's commercial fisheries. This is primarily due to two Waitangi Tribunal settlements: a 1989 interim agreement that awarded Māori 10 per cent of the fishing quota and a cash settlement, and in 1992 a final settlement that granted Māori a 50 per cent share in Sealord and a guarantee of 20 per cent of all new species brought into the QMS.[74]

The Maori Fisheries Act 2004 disbanded the Treaty of Waitangi Fisheries Commission, which had mainly been created to develop an allocation of model for the assets of the Māori fisheries settlement. In November 2004, Aotearoa Fisheries Limited and Te Ohu Kaimoana were formally established. Aotearoa Fisheries Limited manages the commercial aspect of certain settlement assets while Te Ohu Kaimoana serves as the governance body for Māori interests in the marine environment.[75]

In terms of aquaculture, the Maori Commercial Aquaculture Claims Settlement Act 2004 provides iwi with access to aquaculture space to develop their marine farming interest. The settlement requires the government to provide iwi with 20 per cent of all new aquaculture space. The government is also required to provide iwi with the equivalent of 20 per cent of space created between 21 September 1992 and 31 December 2004.[76]

As new resources and industries emerge, Māori interests will need to be considered in two ways: 1) as an indigenous right that was not fully dealt with under the settlement, or 2) as an opportunity to promote economic development for Māori. [77]

Our oceans are important to New Zealand's economy. Here participants take part in a 'mussel relay' as part of the Havelock Mussel Festival.

Environmental Change

There are many natural cycles which impact on marine ecosystems, species and populations. As scientific knowledge grows we will understand more about the impact and interconnections of these cycles and the role human activity plays. Emerging evidence identifies climate change (perturbated and accelerated by human activity) as a force that will have a significant impact on the state of the marine environment in the future.

The major predictions associated with climate change include: increased global average temperature, a rise in sea level, increased frequency of El Niño events, changes to rainfall patterns, changes to ocean circulation, and acidification arising from increased CO_2 concentrations in the ocean.[78] The implications of these predicted modifications to the marine environment pose a significant risk to the survival of many marine species and habitats.

The Intergovernmental Panel on Climate Change (IPCC) has predicted a wide range of impacts resulting from climate change based upon several different scenarios that assume different levels of future CO_2 emissions.[79] When building the Future Seas scenarios we used the IPCC's most pessimistic and most optimistic predictions in 2001.[F]

The German Advisory Council on Global Change (WBGU) developed the concept of determining and setting guard rails,[80] a threshold level, beyond which the change that will occur will have severe consequences for human kind, and below which effects are maintained at a level that is considered to be acceptable by society. These guard rails include:

Sea surface temperature: the mean global rise in near surface air temp must be limited to a maximum total increase of 2°C above the pre-industrial level and a rate of 0.2°C per decade.[81]

Potential impact if guard rail breached: dangerous climate changes that will detrimentally alter the state of the ocean.

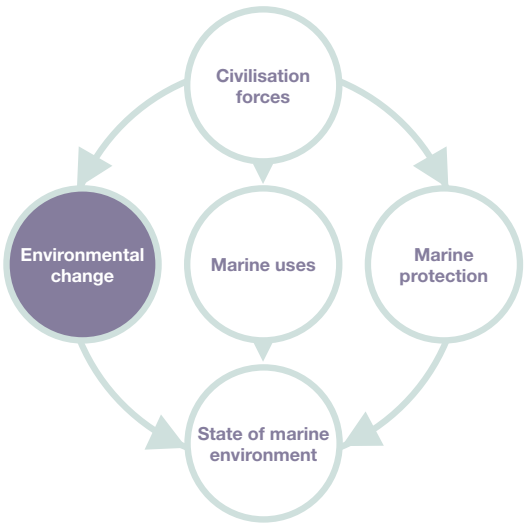
Near surface water acidity (pH level): the pH of near surface waters should not drop more than 0.2 units below the pre-industrial average value in any larger ocean region.[82]

Potential impact if guard rail breached: disruption of calcification of marine organisms and resultant risk of fundamentally altering marine food webs.

Marine ecosystems: at least 20 to 30 per cent of the area of marine ecosystems should be designated for inclusion in an ecologically representative and effectively managed system of protected areas.[83]

Potential impact if guard rail breached: significant reduction in marine biodiversity and weakening resilience of the marine ecosystem to the impacts of climate change.

F Since the scenarios were developed and scenario planning exercises held the IPCC has released its Fourth Assessment Report. In this 2007 report they state that warming of the climate system is unequivocal and observational evidence from all continents and most oceans show that many natural systems are being affected by regional climate changes, particularly temperature increases.



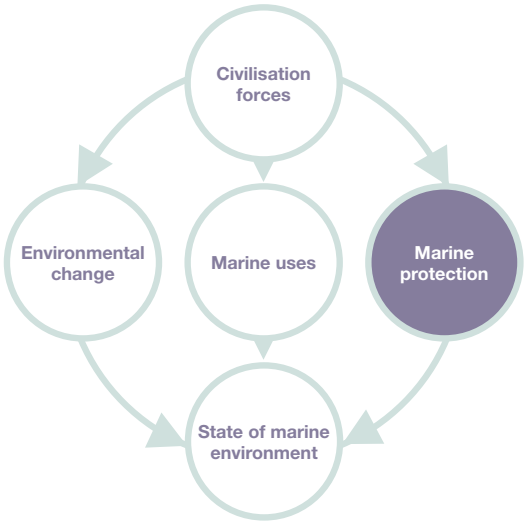
Marine Protection

Marine protection mechanisms available in New Zealand include marine reserves, fisheries protection, and marine mammal sanctuaries. They influence the future of the marine environment by protecting ecosystems and their dependent life forms from human activities. The adoption, development and enforcement of marine protection mechanisms will have a significant impact on the value (social, environmental, cultural and economic) of our marine environment over the next 50 years.

Marine reserves are no-take zones that are closed to all direct extractive or harvest activities, but are usually still open for non-extractive or low-impact activities, such as tourism or research.

Marine reserves provide the most comprehensive means of protection in New Zealand's marine environment. Marine reserves are clearly defined as no-take zones that are closed to all direct extractive or harvest activities but are usually still open for non-extractive or low-impact activities, such as tourism or research. A marine reserve network is defined as a set of marine reserves within a biogeographic region, connected by larval dispersal and juvenile or adult migration.[84]

Fisheries management includes the QMS, permitting, fishing restrictions, closed seasons, gear restrictions and size limits. Mataitai, taiapure and temporary closures provide for customary Māori use and management practices in areas traditionally of importance to Māori. Within mataitai reserves, tangata whenua manage all non-commercial fishing by making bylaws. Taiapure areas are established to give local Māori the ability to recommend regulation to manage all types of fishing.[85]



Marine mammal sanctuaries place restrictions on activities in sanctuaries in order to protect marine mammals. There are currently two marine mammal sanctuaries in New Zealand. One is around Banks Peninsula to protect Hector's dolphin and the other is the Auckland Islands to protect the main breeding areas of the New Zealand sea lion and southern right whale. In 2008, the Acting Minister of Conservation Mahara Okeroa announced the intention to establish four new marine mammal sanctuaries and to redefine the existing Banks Peninsula Marine Mammal Sanctuary. The Notices of Intention were published in the New Zealand Gazette on 26 June 2008.

Other protected areas include marine parks, seamount closures, wildlife refuges, and submarine cable and pipeline protection zones. The Resource Management Act 1991 also allows for regional councils to identify marine areas within the 12-nautical-mile zone of significant conservation value and protect them through zoning and other regulations.[86]

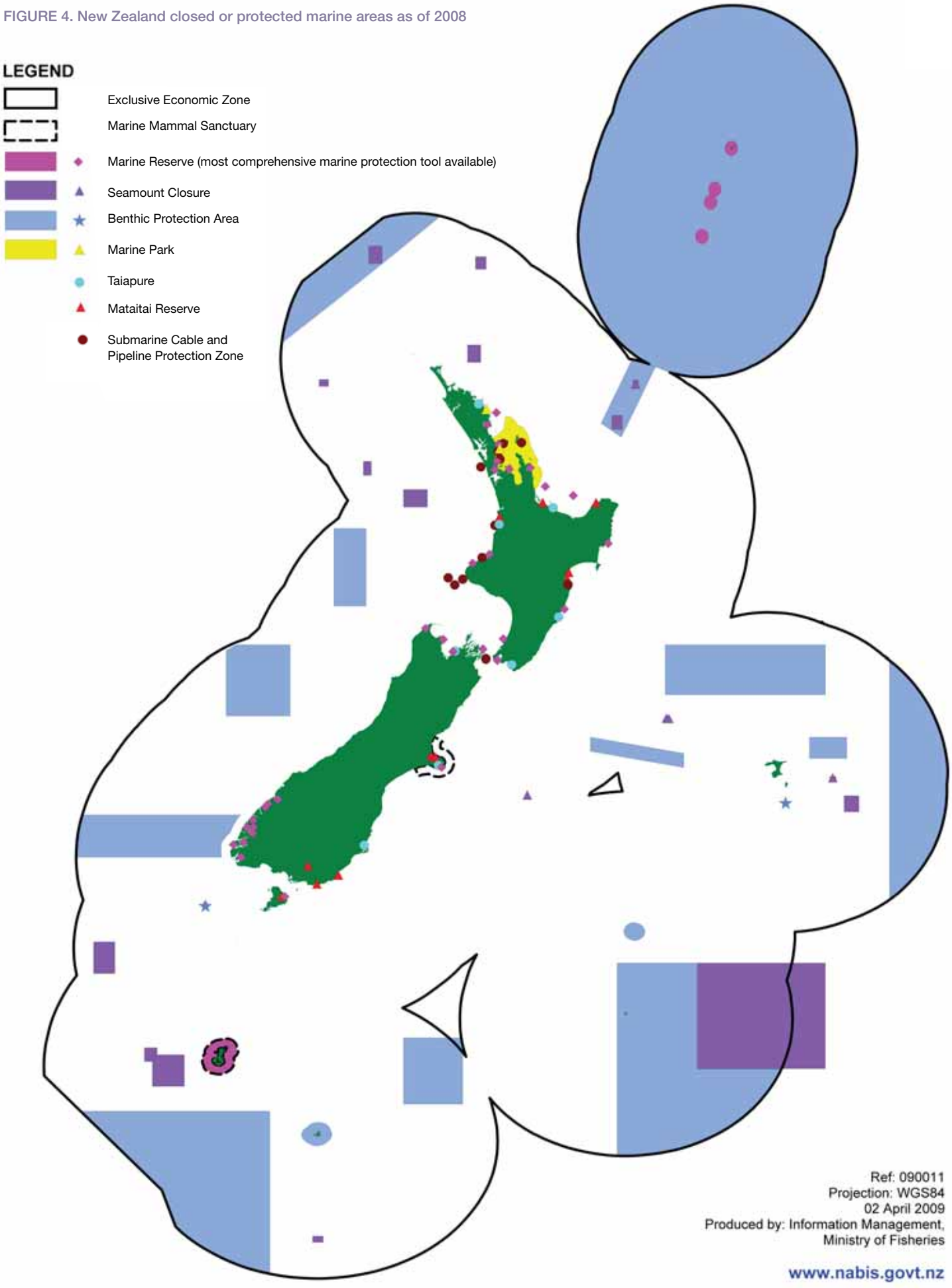
Current area-based protection in New Zealand's marine environment

	Mainland Territorial Sea	Territorial Sea surrounding Offshore Islands	Total Territorial Sea	EEZ	Total Marine Environment
Current total km^2	144500	35180	179680	3914000	4093680
Area protected in square km					
Marine reserves					
Marine reserves (35)	328	9421	9749	–	9749
Marine mammal sanctuaries					
Marine mammal sanctuaries (2)	4170	5064	9234	–	9234
Marine parks					
Marine parks (3)	12290	–	12290	300	12590
Marine protected areas					
Marine protected areas (1)	7	–	7	–	7
Fisheries management					
Mataitai (11)	185	–	185	–	185
Taiapure (8)	393	–	393	–	393
Seamount closures (18)	–	–	–	80890	80890
Benthic protection areas (17)*	–	13690	13690	1252000	1265690
Other protected areas					
Submarine cables and pipeline protection zones (12)	1580	–	1580	151	1731
Percentage of area protected					
Marine reserves	0.2%	26.8%	5.4%	–	0.2%
Areas other than marine reserves	12.2%	53.3%	20.3%	30.6%	30.1%
All areas	12.4%	53.4%	20.4%	30.6%	30.1%

*BPAs are closed to bottom trawl fishing methods, including dredging, in perpetuity. Other methods of fishing are still permitted in BPAs.

Source: Ministry of Fisheries, NABIS, 2008 (nabis.govt.nz)

FIGURE 4. New Zealand closed or protected marine areas as of 2008



The point of scenario planning is simply to tell stories about the future that can help us to make better decisions today. With that in mind it is imperative that New Zealanders actively become involved in the dialogue about the future of our marine environment.

Waikanae beach

Two Scenarios

In this section we tell the story of two possible futures that might play out in the New Zealand marine environment. They were selected by the workshop participants based on investigation of the strongest driving forces (e.g. climate change, economy, property rights, and distribution of power between local and central government) and their most pressing questions. What results is not a prediction; it is an exploration of the question “what if”. We encourage you to allow the scenarios to challenge your current thinking and to use them to test your own questions about the future of the marine environment.

1. Define the question	**2.** Establish the baseline/ current state	**3.** Define key driving forces	**4.** Develop possible futures	**5.** Develop two story lines	**6.** Analyse options

Overview

During the scenario planning workshop we discussed a number of stories that could play out in relation to the New Zealand marine environment, based on the drivers identified by workshop participants. We have chosen to investigate two of them – those that, apart from being internally consistent, plausible, credible and relevant, also in our opinion posed the most intriguing challenges. The purpose of developing those stories was not to predict the future but to better understand what drives it and to create a tool that we could use to make decisions about marine reserves today, to prepare for whatever the future might bring.

The starting point – 2006

Both stories start at the same point at the end of 2006, when Al Gore's film *An Inconvenient Truth* has moved the topic of climate change to the mainstream. The economy is doing well. Security of energy supply is a big discussion topic as New Zealanders watch their gas reserves shrink. The prime minister wants New Zealand to be the first carbon-neutral nation. Marine issues are not in the centre of the political debate and some long-awaited actions are being delayed. Kiwis are proud of their unique seas and have a strong connection with them. The state of the marine environment is largely unknown. Scientists call for more research.

Overview of 2015

Climate change	
Atmospheric CO_2 concentrations	380 ppm
Temperature	0.2˚C increase relative to 1990 level
Near surface acidity (pH)	0.11 drop since onset of industrialisation
Sea level rise	2.5 cm increase relative to 1990
Oceanic current conditions	Stable
Marine uses	
Fisheries	600,000 t per year
Aquaculture	50 km^2
Energy & mining	Dominated by oil and gas
Shipping	3,300 international calls a year
Tourism & recreation	Booming
State of the marine environment	
% of fishstocks with unknown status	72%
% of fishstocks below BMSY*	3%
Beaches suitable for bathing	78%
Number of known marine extinctions	1 in 20th century
Number of nationally critical marine species	25
Marine protection	
% of mainland territorial sea protected	2.57% (including 0.21% as reserves)
% of offshore territorial sea protected	50.01% (all as reserves)
% of total territorial sea protected	9.62% (including 7.61% as reserves)
% of EEZ protected	0.03% (no reserves)
% of total marine environment protected	0.42% (including 0.31% as reserves)

*Biological Maximum Sustainable Yield

From this point our two scenarios diverge

A synopsis of the two selected Future Seas scenarios

Selling by the Litre		Acting Local
Slower than humanity's and nature's ability to adapt	Environmental change	Faster than humanity's and nature's ability to adapt
Energy-related crisis turned into entrepreneurial growth	Economy	Public spending boom crashing into long-term recession
Nationally led planning and strong private property rights	Political and management systems	Local decision making with variety of systems including communal cooperatives
Very high level of marine uses starting with energy projects moving to variety of high-tech innovations	Dominant marine uses	Initial intensification of energy and infrastructure projects followed by a widespread crash and then slow rebuild around micro-generation and genetic modification aquaculture
Maintained at the maximum sustainable yield level	Commercial fisheries	Crash and replacement by opportunistic and exotic species
Initial decline followed by improvement	Quality of beaches	Destruction due to sea level rise and remediation of small areas
Severely restricted	Public access to foreshore	Unrestricted
Small number of extinctions, large number of threatened species, but in the end further extinctions eliminated	Biodiversity	Extremely large number of extinctions leading to highly modified, low-diversity ecosystem

Our glimpse into the two possible futures includes a look at potential statistics, news briefs, and insights from three people who will witness much change within their lifetimes. The three characters – Julie D. from Auckland, Aroha M. from Gisborne, and Peter S. from Christchurch – all meet in 2006 while earning degrees in marine science at Victoria University. Although their tertiary education may be similar, their responses to what the future holds will be quite different.

Giant kelp, Ulva Island, Paterson Inlet, Stewart Island

Selling by the Litre – Key Developments 2007–2060

Environmental change takes place slowly, allowing gradual adaptation to new conditions. The global economy initially enters a period of stagnation due to an energy crisis, to be later revitalised by strong growth with marine property rights well defined and in private hands. National issues dominate and decision making shifts away from the territorial authorities.

Environmental change

The Selling by the Litre scenario plays out in a world where climate change follows the most optimistic IPCC prognosis of 2001 and allows people and the environment to gradually adapt to the new conditions. The effects of climate change on habitats (especially on calcareous organisms like coral and shellfish) are observed, but do not affect human ability to derive value from the marine environment. By 2060 the marine biome has changed significantly but humanity and nature adapt accordingly.

Civilisation forces

The global economy initially enters a period of recession with fast growing demand for land and marine resources, but the supply side is restricted by energy challenges. National issues dominate the attention of decision makers with power diverted away from the territorial authorities. Use of marine energy is initially limited by a perception of risk resulting from the current planning and property system in the marine environment. The implementation of the Marine Resource Management Act (MRMA), a new planning/regulatory regime with strong user rights, and the creation of an Oceans Ministry has led to an expansion of activities in the EEZ and the territorial sea.

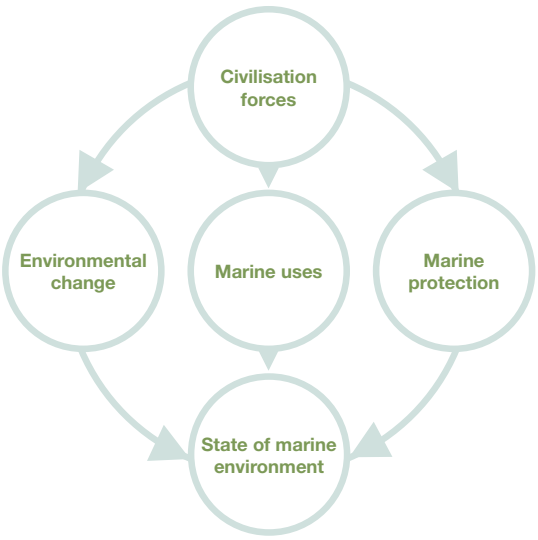
This in turn provides the expected trigger for economic development and technological innovation. On the other hand, this privatisation of the marine environment leads to social conflict and reduced government control over environmental quality. Strong property rights enable Māori and other minorities to incorporate traditional values in some of their private enterprises.

Marine uses

The level of human activity in the marine environment initially remains stable as poor economic conditions restrict any response to the growing demand for seafood and energy resources. After the implementation of the MRMA, the economic climate proves ideal for an explosion of marine activities with little concern for environmental consequences. In the initial years large scale investment and energy projects dominate. As the system matures the level of activities remains high but the balance shifts towards more innovative, low impact enterprises. By 2060 the scientific knowledge of the marine environment reaches levels comparable to that of terrestrial systems and strong environmental standards are enforced by the Oceans Ministry.

State of the marine environment

The first 15 years (2007–2022) are characterised by the gradually declining condition of the marine environment caused by lack of resources and little focus on its management and protection. In the following 15 years (2023–2038) the decline continues as the new property-rights dominated system introduced by the MRMA takes shape. An increased level of industrial activity, especially methane hydrate mining, combined with weak environmental controls, leads to a higher number of pollution incidents and destruction of some key habitats. Pressure on water quality also increases as coastal and other marine activities intensify. When the economy improves and the MRMA matures the government imposes national marine environmental standards and ensures strong enforcement, which results in a slow improvement over the next 20 years (2039–2059). Progress in marine sciences helps to restore and maintain remaining pockets of biodiversity.



Selling by the Litre – Marine Protection

2007	2015	2030	2045	2060
• Economic recession • Energy shortages • Private investment pulls out from the energy projects	• MRMA introduced • Population at 4.6 million • Methane hydrates exploration • Oceans fencing riots	• Cook Strait tidal generator • Advanced marine system for modelling & monitoring • Marine Department of Conservation established	• Population at 5 million • Multi-use sublease system introduced • First underwater hotel chain	

When is the marine reserves network introduced?

Economic recession, increasing pressure on terrestrial resources, and debate about unlocking the economic potential of the marine environment leads to a low focus on marine reserves in the first 10 years with very few new reserves in place by 2015.

In 2020 the development of the MRMA and the related debate about property rights in the oceans lead the government to make a commitment to develop a comprehensive network of reserves to be held in trust for society. This commitment is used as a political lever to get society's approval for intensification of activities in the marine environment and allocation of property rights.

Initially the decisions about where the reserves are located are based on political drivers – in less productive areas and where they are visible with easy access for the public. As a result, many are located in the mainland territorial sea.

When the MRMA matures and the knowledge of marine environment improves, a buy-back scheme is initiated and a more biologically driven network is attempted. This is limited by the existing property rights and the scope remains limited. Nonetheless, a number of cases of rights being revoked and repossessed by the government take place, giving an opportunity for a few big public-funded marine regeneration schemes.

Conservation organisations assist the project by buying the rights for the biodiversity hot spots and setting up private marine reserves.

What other marine protection options are applied?

An MPA network in the key biodiversity areas protecting 5 per cent of EEZ is established before 2020. Existing MPA policy is further clarified under the MRMA, where property rights are limited in relation to the exploitation of specific species or activities, leading to a centrally planned network of areas with various types and levels of protection. As the MRMA matures and the first property right revocations take place, marine operators take their environmental responsibilities more seriously. Some ensure compliance of their operations with more stringent environmental standards while others go beyond the minimum standards by taking additional measures to protect and enhance marine biodiversity. The businesses in key biodiversity areas are under more pressure to operate in sustainable ways that protect or enhance local biodiversity.

Private reserves are developed to benefit from demand for marine tourism. Game parks are created – they are sometimes available for restricted fishing and sometimes only for diving and other marine sports.

How are the reserves managed?

The key network of reserves created in the 2030s is owned and administered by a central agency, the Marine Department of Conservation (MDOC). They cooperate with local-elected boards who manage day-to-day operations. The Oceans Ministry is responsible for ensuring that biodiversity objectives are reflected in marine planning, leading to the development and maintenance of appropriate protection levels throughout MPAs.

Customary fishing is formalised and limited to mataitai, taiapure and the areas owned by Māori businesses.

Research into the marine environment is extensive and carried out both by private entities and public research institutes funded by a marine activity tax.

Private reserves are sometimes operated by owners and sometimes given in trust to MDOC to manage in the same way as public terrestrial reserves.

Selling by the Litre – 2015

Economic recession fuelled by an energy crisis sets in and the level of economic activity in the marine environment is low. While climate change impacts are apparent, the main cause of the marine environment's degradation has been caused by direct impacts of its use. These impacts are, in part, due to a lack of resources for enforcement and conservation efforts.

Overview of 2015

Climate change	
Atmospheric CO_2 concentrations	395 ppm
Temperature	0.3°C increase relative to 1990 level
Near surface acidity (pH)	0.12 drop since onset of industrialisation
Sea level rise	3 cm increase relative to 1990
Oceanic current conditions	Stable
Marine uses	
Fisheries	Maintained at 600,000 t per year
Aquaculture	Increased to 100 km^2
Energy & mining	Dominated by oil & gas
Shipping	Reduced to 2,500 international calls a year
Tourism & recreation	Focus on local activities and tourists
State of the marine environment	
% of fishstocks with unknown status	Reduced to 65%
% of fishstocks below BMSY*	Maintained at 3%
Beaches suitable for bathing	Reduced to 65%
Number of known marine extinctions	2 since 2006
Number of nationally critical marine species	Increased to 30
Marine protection	
% of mainland territorial sea protected	10% (including 1% as reserves)
% of offshore territorial sea protected	50% (all reserves)
% of total territorial sea protected	15.94% (including 8.28% as reserves)
% of EEZ protected	5% (no reserves)
% of total marine environment protected	5.68% (including 0.35% as reserves)

*Biological Maximum Sustainable Yield

12.03.2015 News – Energy crisis keeps the country in recession

While annual energy consumption continues to grow at 4 per cent, the security of New Zealand's energy supply is of grave national concern. Seen as a possible "quick fix" by some researchers, methane hydrates and other marine energy sources are still considered a risky investment and environmental questions remain. In fact, international investors continue to shy away from investing in New Zealand's gas hydrate mining. To stimulate international interest, the government is currently developing an allocation regime that balances the protection of the resource with the development of a gas hydrates industry in New Zealand.

02.11.2015 News – Slower climate change not an excuse for lowering of environmental standards

WWF-New Zealand, hosts of an international climate change conference being held in Wellington, have released figures showing that New Zealand is not moving toward low-carbon technologies quickly enough and the current energy recession has caused a worrying reduction in environmental standards.

02.11.2015 Staff Newsletter – People on the move

Julie D. has been appointed manager of marine exploration. Prior to taking this role, Julie served as team lead on a project to further develop technologies for the sustainable exploitation of methane hydrates. As team lead, Julie was able to successfully broker a number of international collaborative research partnerships that may play a role in the development of New Zealand's methane hydrate resources.

Selling by the Litre – 2030

Climate change is still below the tipping point. The economy is booming due to increased activity in the marine environment. Large energy projects dominate. The MRMA has been implemented with strong user and property rights throughout the EEZ and the territorial sea. Social discord and further destruction of the natural marine environment follows.

Overview of 2030

Climate change	
Atmospheric CO_2 concentrations	420 ppm
Temperature	0.4˚C increase relative to 1990 level
Near surface acidity (pH)	0.14 drop since onset of industrialisation
Sea level rise	4 cm increase relative to 1990
Oceanic current conditions	Stable
Marine uses	
Fisheries	Drop to 400,000 t per year
Aquaculture	Increased to 200 km^2
Energy & mining	Methane hydrates & aggregates dredging, some wind
Shipping	Increased to 4,000 international calls a year
Tourism & recreation	Focus on higher value activities
State of the marine environment	
% of fishstocks with unknown status	Reduced to 45%
% of fishstocks below BMSY	Reduced to 2%
Beaches suitable for bathing	Reduced to 60%
Number of known marine extinctions	2 since 2015
Number of nationally critical marine species	Increased to 40
Marine protection	
% of mainland territorial sea protected	40% (including 10% as reserves)
% of offshore territorial sea protected	75% (all reserves)
% of total territorial sea protected	45.2% (including 19.66% as reserves)
% of EEZ protected	15% (including 10% as reserves)
% of total marine environment protected	16.24% (including 10.4% as reserves)

*Biological Maximum Sustainable Yield

17.10.2030 Editorial – Seas for Sale!

Today, Parliament passed the controversial Marine Resource Management Act (MRMA), marking a new era in the management of human use of the ocean. The MRMA introduces a tradable allocation regime for all uses of marine space. Allocations will be tendered out by the new Oceans Ministry for all areas in the EEZ and the territorial sea. Each allocation will be related to specific types of uses, e.g. fisheries, mining, tourism, recreation and transportation. All applicants must submit a business plan evaluating quadruple bottom line of the venture: impact on New Zealand economy, culture, society, and environment. The Oceans Ministry will consider applications under the national marine plan, which includes special management zones that separate conflicting uses. Analysts predict stiff competition for the allocations.

14.03.2033 Speech notes from Peter S., Chief Executive, Oceans Ministry

The recent release of The State of the Marine Environment Report should be a wake-up call for all New Zealanders that we need to take drastic measures if we're going to protect our finite marine resources. Over 40 endemic marine species are now reduced to populations smaller than 100 individuals surviving in fringe areas protected by MDOC. The report suggests that unless actions are taken immediately some of these species will be added to the growing list of marine species already lost in the 21st century.

The government is now implementing a stronger property rights regime to reverse what has become the "tragedy of the commons" in our oceans. Through this regime there is also a strong desire to provide quality public access to the marine environment through marine reserves and other MPAs. After all, access to the marine environment is considered a birthright by many Kiwis – a birthright and a responsibility.

Selling by the Litre – 2060

The acidity of the ocean crossed the tipping point in the 2040s causing widespread mortality among coral and shellfish. The MRMA system matured and wealthy New Zealand society invested in protection of the remaining marine life. Taxes on marine profits provide funds for extensive research and monitoring of the marine habitats. The Oceans Ministry and MDOC spend large sums on detailed management of the oceans, and no further extinctions are allowed. The remaining oases of natural marine habitats are preserved and some areas are restored to their pre-human settlement state.

Overview of 2060

Climate change	
Atmospheric CO_2 concentrations	500 ppm
Temperature	0.8˚C increase relative to 1990 level
Near surface acidity (pH)	0.2 drop since onset of industrialisation
Sea level rise	6 cm increase relative to 1990
Oceanic current conditions	Increased El Niño events
Marine uses	
Fisheries	Remain at 400,000 t per year
Aquaculture	Increased to 300 km^2
Energy & mining	Dominated by wind, thermal, and tidal schemes
Shipping	Increased to 4,500 international calls a year
Tourism & recreation	Renaissance through new submarine technologies
State of the marine environment	
% of fishstocks with unknown status	Reduced to 1%
% of fishstocks below BMSY*	Reduced to 2%
Beaches suitable for bathing	Increased to 80%
Number of known marine extinctions	None since 2040
Number of nationally critical marine species	Maintained at 40
Marine protection	
% of mainland territorial sea protected	60% (including 20% as reserves)
% of offshore territorial sea protected	80% (including 75% as reserves)
% of total territorial sea protected	62.97% (including 28.17% as reserves)
% of EEZ protected	40% (including 20% as reserves)
% of total marine environment protected	40.94% (including 20.33% as reserves)

*Biological Maximum Sustainable Yield

01.10.2059 Tourism e-magazine

A popular destination with visitors and locals alike is a private marine park near Gisborne. Here you can scuba-dive, kayak, or just explore the rocky shore. In part of the park you can still even gather kaimoana for your evening meal.

“People tell us that coming to the marine park is like stepping back into their own childhoods,” says Aroha M. “That is how it should be, for we are carrying on the traditions of our whanau. Our marine environment is part of our past, present and future – part of who we are.”

23.11.2059 Obituary in Victoria University’s alumni e-newsletter – Written by Julie D.

Peter S., ONZM died peacefully on 10.11.59 after a brief illness. He was surrounded by his family and many close friends. Known as the behind-the-scenes architect of the Marine Resources Management Act, Peter worked tirelessly to ensure a solid management regime was put in place maintain the health of our oceans. Peter felt that his greatest accomplishment – aside from raising three beautiful children – was his work to protect thousands of hectares of marine habitat. Although a great accomplishment, perhaps his greatest legacy was his ability to inspire those who had the privilege of knowing him. Through each of us his unswerving commitment to protect the health of our oceans lives on.

Caulerpa flexilis, Cable Bay, Northland

Acting Local – Key Developments 2007–2060

Environmental change in this scenario is rapid and in many aspects devastating. Society's response to climate change initially provides an impetus for economic growth, which then collapses and a no-growth economy becomes the reality. Politics become dominated by local issues with strong regional independence and diversity of policy approaches throughout New Zealand.

Environmental change

The Acting Local scenario is overshadowed by IPCC's most pessimistic climate change outcome. By 2015 climate change problems intensify with an increased number of 100 and 500 year events. A violent cyclone called *Xena* devastates Auckland. By 2030 the rate of sea level rise has accelerated beyond the pace of infrastructural adaptation and many coastal areas are flooded. In the 2040s the temperature and pH levels also cross the tipping point and the environment enters into a violent adjustment period following dramatic sea current changes and an ecological crash in the marine environment.

By 2060 the new biome starts emerging but it is much more fragile and species poor than before. The North Island is affected by climate change to a greater extent than the South Island.

Civilisation forces

In 2015 the economy is booming. It is fuelled by a fast-increasing demand for marine protein and energy as well as large-scale, expensive, national and international climate change response programmes. Already in the 2020s it is clear that the response programmes are failing to allow humanity to adapt to quickly changing conditions, and in many cases the programmes have negative impacts on local interests. The economy finally crashes in the 2030s and 2040s after New Zealand fails to adapt to suddenly inflated population levels, caused by the influx of environmental refugees from countries worst affected by sea flooding – Bangladesh and India.

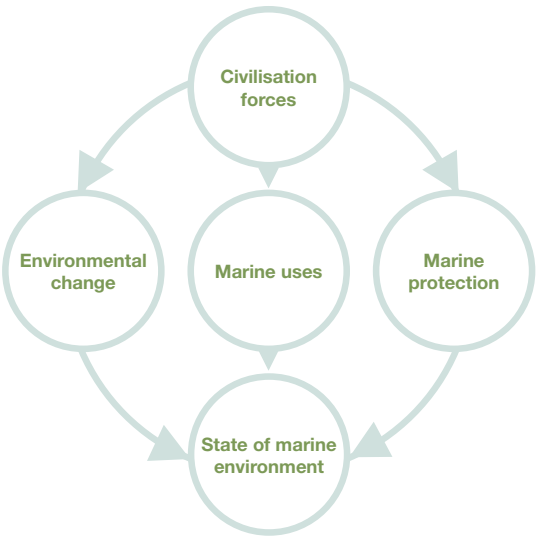
Local decision making increasingly dominates management issues. Regions cooperate initially, but differences in conditions and social structures lead to conflicts and the emergence of a variety of systems throughout New Zealand. The North Island struggles under immigration pressures; the South Island becomes increasingly insular and conservative; and other regions either become playgrounds for the wealthy or experiment with minority-inspired community ownership systems. In the low-growth economy multinationals prevail, while small, innovative businesses occupy local niches.

Marine uses

Human activities in the marine environment are initially dominated by large-scale, publicly funded projects. Coastal infrastructure is being redeveloped to address sea level rise, and CO_2 sequestration in the oceans is developed against mainstream scientific advice. Energy to fuel these projects is derived from methane hydrates. The level of marine activity drops dramatically following the environmental and economic crash in 2040s. By 2060 people have returned to deriving sustenance from the oceans. Society adjusts to the new situation with multinationals controlling activities in deep waters and the EEZ and local businesses and cooperatives operating in the near-shore environment. Genetically modified aquaculture is important, as is marine energy micro-generation and local shipping.

State of the marine environment

The marine environment is foremost impacted by climate change, which causes large scale extinctions and population collapses. Whole ecosystems disappear. Human activity in the marine environment reduces following the economic crash, but the biome remains unstable. Some regions manage to preserve remaining fragments of habitats and strongholds of biodiversity. Others develop highly modified environments, which provide a source of marine protein. The ongoing problem is lack of cooperation between regions. The recovery of the wider system is questionable.



Acting Local – Marine Protection

2007	2015	2030	2045	2060
• Cyclone *Xena* • Methane hydrates mining and CO_2 sequestration • Territorial offices in Wellington	• Sea level rise – refugees enter NZ • Auckland Party and South Island Party coalition government	• Economic and environmental crash • Kaitiaki community system in East Cape • Crime soars in Auckland	• New biome emerges • Genetic modification aquaculture • Micro-scale tourism and renewables generation	

When is the marine reserves network introduced?

A strong economy and increasing intensity of climate change provide great impetus for the implementation of MPA policy between 2006 and 2020. This policy provides the framework for the development of new reserves and a suite of MPAs in the territorial sea and EEZ. As part of the national response strategy to climate change adaptation, funds are made available for research into the state of the marine environment, location and extent of key habitats, and impact of climate change on the marine environment. A network of marine reserves is mapped out through a participatory stakeholder process (informed by research and following the expanded principles of the MPA Policy) and staged implementation initiated. The majority of the reserves are located in the offshore territorial sea to reduce any conflict with large scale mining projects. By 2020 the reserve network is in place.

The process is hindered in 2030 when sea levels rise and the influx of environmental refugees leads to an economic crash, instigating more localised decision making. Throughout the 2030s and 40s no new reserves are implemented, but the level of activity in the marine environment reduces and some areas remain untouched by human activity. At a later stage these areas are given reserve status by international agreements, although many argue that this approach leads to reserves located in unsuitable areas.

The reserves set up in the mainland territorial sea are slowly reconfigured by regional governments. There are some new reserves established in more eco-conscious regions, e.g. East Cape.

What other marine protection options are applied?

The core network of marine reserves is supplemented by a suite of MPAs. Fisheries restrictions and property rights in some regions also limit the scope of activities within the marine environment. All MPAs prohibit oil, gas, and mineral extraction. Some of them also prohibit commercial, customary and recreational fishing.

How are the reserves managed?

The Marine Reserves Bill, which includes provisions for reserve establishment outside the 12 nautical miles limit, is approved by Parliament. Marine reserves management is reorganised and set up within the wider programme of MPA implementation. The reserves are initially managed by Department of Conservation (DOC) in cooperation with local communities, but the decision making is based on national priorities.

After 2030 the regionalisation of decision making leads to diversion of reserve management responsibilities away from DOC and to conservation divisions of regional governments. In some regions community-based systems of marine protection areas evolve.

For example, on the East Cape a complex of MPAs is established that includes marine reserves, mataitai, and taiapure. This “Tangaroa suite”, as it is known locally, is managed by kaitiaki/guardians nominated by the community. In other regions marine protection is based on regional coastal plans or is privately outsourced, where marine biodiversity is preserved for recreation purposes. The offshore territorial sea reserves are also managed by respective regional governments. Reserves and MPAs in the wider EEZ are managed by international agreements (e.g. a renegotiated Convention on Biological Biodiversity) and administered by an internationally funded organisation.

Acting Local – 2015

By 2015 climate change is intensifying. The international community including the New Zealand government launch large-scale response programmes – including redevelopment of coastal infrastructure and carbon sequestration. Public funds are allocated to allow for mining of methane hydrates – an urgently needed source of energy. In the process some local interests are affected and regional governments become increasingly active in Wellington. A violent cyclone called *Xena* devastates Auckland. Fishing levels are increased in response to growing demand. The marine environment deteriorates quickly.

Overview of 2015

Climate change	
Atmospheric CO_2 concentrations	400 ppm
Temperature	0.8°C increase relative to 1990 level
Near surface acidity (pH)	0.13 drop since onset of industrialisation
Sea level rise	9 cm increase relative to 1990
Oceanic current conditions	Increased El Niño events
Marine uses	
Fisheries	Increased to 700,000 t per year
Aquaculture	Increased to 100 km^2
Energy & mining	Methane hydrates and sequestration
Shipping	Increased to 4,000 international calls a year
Tourism & recreation	Increased importance local tourism and recreation
State of the marine environment	
% of fishstocks with unknown status	Maintained at 72%
% of fishstocks below BMSY*	Increased to 10%
Beaches suitable for bathing	Reduced to 60%
Number of known marine extinctions	6 since 2006
Number of nationally critical marine species	Increased to 40
Marine protection	
% of mainland territorial sea protected	15% (including 2% as reserves)
% of offshore territorial sea protected	50% (all reserves)
% of total territorial sea protected	20.2% (including 9.13% as reserves)
% of EEZ protected	20% (including 3% as reserves)
% of total marine environment protected	20.01% (including 3.22% as reserves)

*Biological Maximum Sustainable Yield

17.09.2015 News – Southern regions oppose government plans for hydrates mining expansion

Three of New Zealand's southern regions joined forces and opened an office in Wellington today. Southern regions spokesperson Peter S. said the South Island will now be able to more effectively oppose the government's plans to expand methane hydrates mining. Peter S. says the regions question the long-term financial benefits of the mining and contend that it puts the regions' fishing industry at risk.

20.01.2017 News – The north still struggling to recover from cyclone *Xena*

Two weeks after cyclone *Xena* hit Auckland, many areas are still without water and electricity. The disruption in services has been compounded by an increase in robberies and other crime.

24.02.2017 News brief

WWF-New Zealand today issued a statement saying that the dead Maui's dolphin found on South Raglan Point signals a black day for New Zealand. According to scientific research, there are now too few Maui's dolphins remaining to viably breed. The loss of this single dolphin may be the death knell for the entire species.

Acting Local – 2030

As climate change reaches the tipping point, low-lying countries are thrown into chaos from sea flooding and New Zealand is forced by the international community to accept large numbers of environmental refugees. At the same time the marine environment is crashing – global circulation patterns change, acidity crosses limits for most shellfish, coral reefs dissolve and a number of fisheries collapse. As regional parties are elected to parliament, New Zealand evolves into a federation of more independent regions, each pursuing a vision chosen by its electorate.

Overview of 2030

Climate change	
Atmospheric CO_2 concentrations	480 ppm
Temperature	1.8˚C increase relative to 1990 level
Near surface acidity (pH)	0.19 drop since onset of industrialisation
Sea level rise	17 cm increase relative to 1990
Oceanic current conditions	Reduced circulation between tropic and temperate seas
Marine uses	
Fisheries	Reduced to 80,000 t per year
Aquaculture	Maintained at 100 km^2
Energy & mining	Reduced exploitation of existing installations
Shipping	Reduced to 1,000 international calls a year
Tourism & recreation	Virtual tourism and elite activities
State of the marine environment	
% of fishstocks with unknown status	Reduced to 65%
% of fishstocks below BMSY*	Increased to 30%
Beaches suitable for bathing	Reduced to 40%
Number of known marine extinctions	15 since 2015
Number of nationally critical marine species	Increased to 85
Marine protection	
% of mainland territorial sea protected	15% (including 2% as reserves)
% of offshore territorial sea protected	70% due to lack of use (including 50% reserves)
% of total territorial sea protected	23.17% (including 9.13% as reserves)
% of EEZ protected	40% (including 20% as reserves)
% of total marine environment protected	39.31% (including 19.52% as reserves)

*Biological Maximum Sustainable Yield

04.06.2029 Email from Julie to Peter

Peter – Hope you're well. So how many of your friends have come out of the woodwork and told you that they need your help? Guess what? I'm now one of them. I'm hoping to forge an agreement between the Auckland Party and the Southern Regions on fishing quotas and you seem like the man to help me. Unfortunately, up here in Auckland we don't have the luxury of worrying about conservation as much as how we're going to contend with the next wave of refugees who land on our shores, so there will need to be compromises on both sides. It would be a very pragmatic agreement, but one that might just get both parties what they need. Talk soon, *Julie*

PS Saw Aroha over the last school holidays and she's as staunch as ever. She's left the "malaise" of central government behind and has moved up to the East Cape where she's quickly becoming a voice for protecting Tangaroa's taonga.

08.07.2029 East Cape online news

Aroha M. has been asked by local community leaders to represent the East Cape at an upcoming UN Climate Change Conference. In an unusual move, the East Cape and several other regions have appealed to the UN to be allowed to send their own representatives to the conference, stating that New Zealand's current leadership has not responsibly represented their interests.

The UN's leadership had been unwilling to take a stand on the issue, but has agreed, in principle, that Ms M. and a delegate from the Southern Regions may attend the conference as observers.

Acting Local – 2060

By 2060 the economy is stable but stagnant. The changed climate poses difficulties for New Zealand society, with water shortages on the east coast and many areas affected by the rapid sea level rise over the last 50 years. The marine environment is significantly changed – niches emptied by collapsed populations are slowly being filled by opportunistic species. Ecosystems are very fragile and prone to sudden collapses. The connection between people and the marine environment varies between regions, which are operating as independent states under the diplomatic umbrella of central government. The EEZ is the domain of large multinationals operating under international law, while small, innovative businesses operate in the territorial sea.

Overview of 2060

Climate change	
Atmospheric CO_2 concentrations	650 ppm
Temperature	3.2˚C increase relative to 1990 level
Near surface acidity (pH)	0.31 drop since onset of industrialisation
Sea level rise	42 cm increase relative to 1990
Oceanic current conditions	Reduced circulation between tropic and temperate seas
Marine uses	
Fisheries	Increased to 100,000 t per year
Aquaculture	Increased to 200 km^2
Energy and mining	Mining in EEZ and micro-wind and tidal near shore
Shipping	Increased to 1,500 international calls a year
Tourism and recreation	Local recreation and high value elite playgrounds
State of the marine environment	
% of fishstocks with unknown status	Reduced to 40%
% of fishstocks below BMSY*	Increased to 40%
Beaches suitable for bathing	Increased to 60%
Number of known marine extinctions	15 since 2035
Number of nationally critical marine species	Reduced to 70
Marine protection	
% of mainland territorial sea protected	15% (including 4% as reserves)
% of offshore territorial sea protected	70% (including 50% reserves)
% of total territorial sea protected	23.17% (including 10.84% as reserves)
% of EEZ protected	40% (including 20% as reserves)
% of total marine environment protected	39.31% (including 19.63% as reserves)

*Biological Maximum Sustainable Yield

07.03.2059 Email from Peter to Aroha

Dear friend – I hope this email finds you surviving the severe water shortages in your region this year. Flooding last winter, drought this summer...Coleridge's Rime of the Ancient Mariner frequently comes to mind during these trying times, "Water, water every where, Nor any drop to drink…" Indeed it seems we have killed too many pious birds of good omens. Do I sound tired? Yes, but not too tired to now be teaching a course on "environmental advocacy". It has been worth coming out of retirement for, and the kids (they are 18 to 25 years of age, but they're like kids to me) remind me of the two of us so many years ago. I think perhaps I'm learning as much from them as they are from me.

04.08.2059 Letter to the Minister for the Environment from Aroha M., East Cape community rep.

On behalf of the East Cape cooperative, I would like to thank the ministry for the grant funds we recently received to assist us in our efforts to remove several different invasive species from sections of our coastline. As you know, the two marine reserves that the community had worked so hard to protect have been negatively impacted by two of these invasive species and we are gravely concerned about the survival of several native species within the reserves.

Children and the principal of Ngunguru School snorkel in Maroro Bay at the Poor Knights.

The Role of Marine Reserves

In this section we use the scenarios to enhance our understanding of the possible benefits of marine reserves networks. At the workshop, we asked the participants to look at how society and decision makers, living within each of the scenario worlds, would debate for and against the establishment of a marine reserves network. We imagined what costs and benefits they would find more important considering the circumstance of their life (e.g. marine property rights debate or climate change and regionalisation). Following that, we returned to the most likely scope of the reserves proposed by the workshop participants and tried to evaluate what impacts these sets of reserves would have on the scenario worlds and their marine environment. These analyses provided us with important lessons, which we share in the final "The Lessons Learnt" and "Next Steps" sections.

1.	2.	3.	4.	5.	6.
Define the question	Establish the baseline/ current state	Define key driving forces	Develop possible futures	Develop two story lines	Analyse options

Selling by the Litre – Benefits and Costs of Marine Reserves

Selling by the Litre

Extent of marine reserves and MPAs expected in New Zealand waters under Selling by the Litre scenario

		Mainland Territorial Sea	Offshore Territorial Sea	Total Territorial Sea	EEZ	Total Marine Environment
Current total km²		144500	35180	179680	3914000	4093680
2015	MR*	1%	50%	8.28%	0%	0.35%
	All MPA*	10%	50%	15.94%	5%	5.68%
2030	MR	10%	75%	19.66%	10%	10.4%
	All MPA	40%	75%	45.2%	15%	16.24%
2060	MR	20%	75%	28.17%	20%	20.33%
	All MPA	60%	80%	62.97%	40%	40.94%

*MR = marine reserves, All MPA = all marine protection areas including marine reserves

Benefits and costs that were considered in this scenario when the original decisions about the extent of marine reserves were made (2010–2020)

Political – The new property rights regime for the marine environment meets with opposition and the government responds with a programme of implementation of marine reserves and MPAs to reassure the public that they will be able to maintain access to the sea. Marine reserves will still be relatively accessible areas for pursuing non-extractive activities while access to other parts of the coast and marine areas might be severely restricted. The government is keen to show that the public will enjoy access to the marine environment through the reserves and so the new reserves are implemented mostly in the mainland territorial sea.

There is much public discussion regarding which marine areas should be sold to private investors and which should be maintained as public resources. Political risks are associated with these decisions and some fear that the whole scheme might fall apart. Others voice concerns that the government will eventually need to buy marine property rights back at market prices or that New Zealand's marine property rights may be transferred into foreign ownership. Finally, costs of maintaining and enforcing large areas of marine reserves are considered.

Economic – The reserves are seen as compensation to disenfranchised groups in society. The economic benefits associated with potential tourism operations and bio-prospecting (marine reserves offer opportunity to carry out research enabling bio-prospecting) are not discussed in detail. Instead the debate focuses on the economic benefits of private ownership leading to maximum utilisation and providing funds for public infrastructure. Benefits to fisheries from proximity of the reserves are mentioned. The costs of maintenance and enforcement of the reserves are discussed but seen as a justified price of avoiding long-term degradation.

Social and community – The key social benefits of marine reserves and MPAs (where recreational fisheries are allowed) are to provide access for New Zealanders unable to obtain property rights for the sea and to allow a basic level of public access to coastal waters. Reserves give the local communities an opportunity to maintain some of the personal freedom and control that is felt to be lost due to the reform. The loss of fisheries and traditional jobs is caused to a larger extent by the property rights regime, not by marine reserve restrictions.

Cultural – The new reserves and mataitai reserves are an inducement offered to Māori (alongside a percentage of a variety of marine property rights) to accept the new regime. Overall, society has been convinced that the reserves and network of MPAs will enable the marine environment to remain an important

part of their lifestyles, but many people feel that their rights have been disregarded through the process. There is an underlying sense that the reserves are too controlled by the government and do not provide sufficient scope for exercising traditional rights and a lifestyle closely connected to the sea.

Environmental – The environmental arguments point to the fact that the increased level of activity in the marine environment is likely to put marine life under additional stress and could lead to the collapse of some key habitats and species. The ability of reserves to encourage biodiversity, genetic diversity and functioning of key ecosystems is highlighted and reserves are seen as a key conservation tool. The ability to study the marine environment in an undisturbed state is seen as critical for conservation but also to inform the booming bio-prospecting industry.

Benefits and costs that were experienced by 2060 as a result of the establishment of the reserves network

It is difficult to discuss the actual benefits that the reserves in this scenario brought about based only on their size – in reality benefits and costs would need to be based on more details. Still, workshop participants identified a number of benefits and costs experienced within the Selling by the Litre scenario.

Political – The marine reserves network proved to be an important aspect of the new regime. It allowed the government to keep social discontent at a manageable level and carry through the reform. The reserves were portrayed as a gift from the government to society rather than a confiscation of people's rights. While mistakes were made in regards to location and the speed of implementation, these were slowly corrected as the system matured.

Economic – The key economic benefit of the reserves was that they allowed for the zoning reform to be implemented and indirectly contributed to the resulting economic growth. They also supported the aquaculture and wild fisheries industries through provision of genetic material extinct elsewhere and spillover for neighbouring fishing grounds. Indirectly, reserves contributed to the boom of bio-prospecting by providing suitable research grounds, and finally, they allowed tourism and recreation businesses to survive the initial period of property rights when small- and medium-sized enterprises were not able to compete for rights with large energy investment projects.

By 2060, 20 per cent of the marine environment was protected by reserves and over 40 per cent by other MPAs. The debate continued on whether this restriction limited the potential growth of the marine economy with some arguing that reserves and MPAs limited the scope of activities for fisheries and extractive industries and others stating that the protected areas kept the ocean biologically and economically productive.

Social and community – By 2060 marine reserves and other forms of MPAs were the only avenues through which the public could interact with the marine environment. A large proportion of the reserves were in the mainland territorial waters that the public had access to. They provided opportunities for small local eco-savvy businesses to find their niches and provided alternative employment options for those dissatisfied with the rule of large corporations.

Cultural – New Zealand society was changed through the zoning reform and strongly refocused on the sea.

> A lot of this new interaction was related to exploration of marine resources. More intangible were the traditional Pakeha and Māori ways of interacting with the sea – more of a spiritual or instinctive nature was enabled through access to reserves that preserved the marine environment in the natural, healthy state.

Environmental – The environmental objectives of the marine reserves met with mixed success. Only 10 per cent of the environment was protected in the early days of the MRMA and throughout the 30s and 40s the vast majority of the marine systems were affected by large scale energy projects and associated dragging and development of the seabed. Additionally, some of the already established reserves were affected by climate change and the increase of ocean acidity, others suffered from pollution and bio-invasion incidents in the neighbouring areas. Overall the 10 per cent of the marine environment protected as marine reserves was not sufficient. Due to low levels of replication some species and habitats believed to be protected in the reserves disappeared. By 2060 stronger environmental standards, enforcement and expansion of better designed reserves network started to allow for recovery. The reserves set up in the early stages provided the most benefits as they protected the marine life through the most intensive development period and preserved the genetic pool that could be used for rehabilitation of new areas assigned as reserves.

Acting Local – Benefits and Costs of Marine Reserves

Acting Local

Extent of marine reserves and MPAs expected in New Zealand waters under the Acting Local scenario

		Mainland Territorial Sea	Offshore Territorial Sea	Total Territorial Sea	EEZ	Total Marine Environment
Current total km²		144500	35180	179680	3914000	4093680
2020	MR*	2%	50%	9.13%	3% (legislation)	3.22%
	All MPA*	15%	50%	20.2%	20%	20.01%
2030	MR	2%	50%	9.13%	20%	19.52%
	All MPA	15%	70% (due to lack of use)	23.17%	40%	39.31%
2060	MR	4% (some only on paper)	50%	10.84%	20%	19.52%
	All MPA	15% (changed balance)	70%	23.17%	40%	39.31%

*MR = marine reserves, All MPA = all marine protection areas including marine reserves

Benefits and costs that were considered in this scenario when the original decisions about the extent of marine reserves were made (2010–2020)

Political – The key political driver is related to intensifying climate change and the central government attempting to demonstrate an appropriate response. Marine reserves are seen as an "insurance programme" and a measure of adaptation to climate change with politicians, scientists and environmental groups contending that the conservation of vulnerable, as well as representative habitats and species is an important way of offsetting some of the impacts of climate change. Beyond this, New Zealand recognises and takes seriously its international responsibilities in the face of the global challenge.

Reserve design and size trade offs are negotiated to mitigate some of the perceived costs – impact on economic growth and dissatisfaction of some local communities for which establishment of reserves is considered an act of confiscation and limitation of their rights.

Economic – The supporters of the reserves assert that marine reserves provide opportunities for local businesses and contribute to the national economy. Key areas discussed include: tourism which thrives in areas of high biodiversity; fisheries which can benefit from the spillover effect if designed appropriately; bio-prospecting – while no organisms can be removed from the reserves, knowledge gained from studying them in their natural environment could lead to discovery of new profitable applications for marine organism (pharmaceuticals and microbiology and genetics lead the way). The final argument is that of "option value" – the possibility that there are other uses that marine reserves will allow in the future that we don't know yet.

The opposition also uses economic arguments: calculating the costs of development and enforcement of the network and discussion about "opportunity cost" – the foregone value of the development of aquaculture and mineral extraction.

Social and community – Research shows that the majority of New Zealanders want to be assured that some pristine marine environment still exists. The educational benefits of marine reserves are well documented and scientists recognise the value of the reserves to provide baseline data against which to monitor changes within the wider environment.

On the other hand, NIMBYism continues to be an issue for some reserves and in some communities there is a concern that local fishing industries have been lost. There is an ongoing discussion around how to re-train ex-fishers.

Cultural – Being able to fish and gather shellfish is still seen as an important Kiwi value. Because of this, many people protest that the marine reserves take away traditional and customary rights.

Often the existing marine reserves provide an answer for these arguments. The local communities where reserves have been set up in the past showcase many success stories of increased catch in mataitai

or marine parks surrounding the reserves. In many areas where marine reserves are located there is a large increase in cultural tourism ventures. There also appears to be a qualitative benefit to marine reserves in that they encourage community cohesiveness through communal ownership and renewal of the stewardship/ kaitiaki values.

Environmental – Additional research sponsored by the government proves that the reserves increase local biodiversity, lead to greater abundance of numerous species, increase sizes of individual specimen, increase system resilience to climate change, and provide a genetic reservoir for humans and nature. What researchers are not yet able to determine is what exact marine reserve design maximises these benefits. Environmentalists call for restrictions on the numbers of visitors to the reserves to reduce degradation. Because there is often potential for marine reserves to replenish surrounding grounds through spillover, many conservationists argue that while marine reserves may displace fishing they do not necessarily limit catch volumes.

Benefits and costs that were experienced by 2060 as a result of the establishment of the reserves network

It is difficult to discuss the actual benefits that the reserves brought about in this scenario based only on their size, but the workshop participants identified a number of benefits and costs that reserves were likely to bring by 2060 within the Acting Local scenario.

Political – Regions operate as independent states under the diplomatic umbrella of central government.

Economic – The economy became localised and regions which managed to protect their reserves saw their economies slightly strengthen with marine tourism, reservoir of fish stocks for local fisheries, and support for aquaculture through an increased genetic pool and replenishment for farming. The costs of enforcement of the reserves were seen as minimal compared to the benefits. Under this scenario, however, only 4 per cent of the mainland territorial sea was protected.

The Southern Regions controlling offshore reserves at Auckland Islands were the winners – 50 per cent of the territorial sea was protected and the impacts of climate change closer to Antarctica were not as severe – these areas still maintained healthy squid fisheries and the spillover on the edges of the reserves provided productive grounds for the wild fisheries. Fishing quotas were sold to other regions at high prices. The remaining oasis of “life before climate change” attracted eco-tourists willing to pay a high premium to interact with the unspoiled marine environment. Those benefits came at a cost: the areas were remote so transport was expensive. The reserves were under threat from illegal activities by other regions and countries – to maintain integrity of the non-take areas the southern governments needed to carry the enforcement costs.

The 20 per cent of the EEZ protected by marine reserves mostly benefited the multinationals operating in this area. Only the reserves near the continental shelves and seamounts, where the nutrient mixing was not fully disturbed, maintained their biodiversity. The level of activity in the EEZ was fairly low and the 20 per cent of protected areas were not seen as competition for other uses.

Social and community – The regions which managed to preserve some of their reserves in territorial waters took great pride in them. The reserves were a source of educational, research and recreational benefits. The regions which had higher levels of reserves also had fewer problems with unemployment when the fisheries collapsed. Many fishers retrained in the 2020s with few new fishing careers starting since that time. Tourism and other activities related to the management of the reserves offered alternative livelihoods.

In some regions reserves had become playgrounds of the rich. The shortage of reserves also created wider social gaps, which led to tension and sometimes poaching.

Cultural – The loss of traditional and customary fishing areas used for reserves paled in comparison with the impact of climate change and fisheries collapse. Instead, areas near the reserves were the only remaining places where some species could still be fished or gathered and where the once emblematic Kiwi lifestyle could still be experienced. The reserves in the EEZ and offshore territorial sea provided fewer benefits as they were more difficult to experience. Nonetheless a concept of eco-pilgrims evolved and society appreciated the fact that some marine life survived climate change.

Environmental – Climate change impacts were more severe than what was forecast in 2010-2020. The scope of the marine reserves proved insufficient to avoid mass extinctions and destruction of many habitats. A large proportion of the reserves failed to protect their ecosystems as pH levels destroyed shellfish life and sea level increases dramatically altered conditions in many habitats.

Some of the reserves proved large enough for near shore life to adapt to sea level rise. These provided refuges, which might have saved some species from extinction and allowed parts of the ecosystem to continue to function. The reserves that were set up early tended to have better survival rates as their ecosystems were more intact. The species which were protected by multiple reserves escaped extinction.

Overconfidence that the marine reserves could mitigate climate change detracted attention from other tools that could have been applied.

One northern reserve collapsed because of the high numbers of visitors and illegal poaching activities.


Northland

The Lessons We Learnt

Key learning

Through the scenario planning process we came to two main conclusions:

- The marine environment could generate much greater economic value than it is currently.
- The marine environment is less resilient and more threatened than we realise.

Both scenarios highlight that there is scope for much more extensive activity in the seas, and that access to the ocean's resources could generate economic boom or recession. On the other hand, closer analysis of predicted climate change impacts showed that many marine species are likely to come under severe stress in the next 50 years and the stability of marine ecosystems is not guaranteed.

Marine reserves don't need to detract from potential value of marine economy

The two scenarios showed marine reserves are capable of enhancing a number of non-extractive activities and can add value to activities undertaken outside of reserves, e.g. by providing scientific baselines and enabling more informed exploration, or by conserving a pool of genetic diversity which could be used to enhance biodiversity elsewhere. It was anticipated that the majority of the costs associated with marine reserves were related to management and enforcement of the reserves as well as development of new activities and technologies that were compatible with the reserves. In our scenarios, at least, the opportunity costs of the reserves and costs of transformation were minimal compared to the eventual benefits and the costs of climate change.

Marine reserves could provide an insurance policy against future changes

The idea of marine reserves being used as an insurance policy surfaced in both scenarios. In Acting Local the reserves provided a mitigation mechanism for some of the impacts of the climate change. In Selling by the Litre the reserves provided insurance against political mistakes in marine planning and inappropriate environmental management. The effectiveness of this insurance policy depends on the design of the network and when the marine reserves are established.

There is need for parallel implementation and research

The level of benefit was clearly related to the timing of the reserves implementation in both scenarios. Marine reserves are able to provide insurance benefits including increasing the resilience of marine life by protecting them from some direct threats. Building up resilience, however, takes time. It is not uncommon for ecosystems protected through marine reserves to need tens of years to return to a healthy state. At the same time our marine ecosystems are contending with the effects of climate change. Reserves set up today have a much greater chance of mitigating the effects of climate change. By the same token, our understanding of marine systems is much less than that of terrestrial systems. In order to design an ideal reserve network from a biological perspective (to maximise the resilience of the marine systems and to effectively conserve species and habitats) an extensive amount of research is needed. In order to gather all of the facts, taking into account seasonal variations, years of study are still required.

These two needs – immediately establishing a comprehensive marine reserve network and more information – are in conflict with one another. The scenario planning process enabled us to investigate possible ways out of this impasse. We might not be able to fully estimate the risks and opportunities brought by the climate change and intensification of human activity in the seas, but we better understand what actions are likely to have a positive impact on our future. The conclusion drawn from the scenario planning is that parallel implementation and research will enable marine reserves to offer the best insurance policy.

Leadership by government agencies

During the scenario development we investigated the consequences of the decision-making focus shifting strongly either to national or local government. We concluded that both local and central governments have an important role to play in the successful implementation of the reserves. Local government is better positioned to work with local communities, generate goodwill and build on traditional knowledge. Central government has the ability to collate a big picture ensuring representativeness on a larger scale. Its key role is to provide leadership throughout the process. Provision of supportive legislation and appropriate resources is another facet of central government responsibilities. Any legislation set up to enable development of marine reserves and marine reserve networks should be flexible enough to allow for implementation of a suite of tools best suited for local biodiversity and the local community.

Role of stakeholder engagement

One of the key benefits of using scenario planning process in this project was the inclusion of a wide range of stakeholders. The scenarios provided a valuable platform for discussion even when the participants held opposing views. Everybody involved found it beneficial to hear the opinions and ideas about the future from groups they do not regularly interact with. Multiple perspectives combined in the development of our scenarios and allowed us

to investigate the futures that no single individual or organisation could have constructed alone. This again highlighted to us how important stakeholder engagement and public buy-in are to the establishment of marine reserves.

Intensification of human uses – potential opportunities and dangers

The discussions surrounding the Selling by the Litre scenario highlighted that there are a number of opportunities that could result from the intensification of the human activity in the oceans.

As the marine economy becomes more important and profitable, more funds will be available for research and therefore our understanding and ability to protect the environment could increase. A more permissive marine regime could also encourage more private research such as bioprospecting, and more intensive study and monitoring of the ecosystems.

New economic mechanisms operating in the marine environment could provide ways for society to participate more actively in marine protection. In the Selling by the Litre scenario we identified an opportunity for grassroots organisations to purchase marine rights and use them to support conservation objectives. But, the scenarios highlighted that the market forces are unlikely to account for non-market values of the oceans, e.g. existence value, ecosystem regulating services and intergenerational equity. Any opportunities arising from the intensification of human activities in the sea could very easily be overshadowed by large environmental costs, unless they were accompanied by a strong environmental management and planning regime, such as zoning to separate conflicting uses and ensure appropriate allocation. It became clear that any planning regime would have to account for and allocate areas for biodiversity and its environmental regulating services. Marine reserves, in particular, and other forms of MPAs could fulfil this role.

Reserves establishment process is likely to be influenced by many factors in addition to environmental and scientific advice

Our analysis of the benefits and costs that are likely to be discussed under both scenarios highlighted that a variety of factors other than just biological are likely to play a key role. In the Selling by the Litre scenario the key driver was securing public support for stronger rights in other areas. In Acting Local it was a trade-off between economic demands and the need to insure against climate change, as well as economic success of the communities benefiting from the very early implementation of reserves. But in both scenarios it became evident that good decision making needs to be informed by robust scientific research. It also became apparent that scientists, educators, and environmentalists need to clearly understand the political environment within which they operate to ensure that their recommendations are best suited for the context within which decisions are made.

Reserve location and design

The debate now moves towards the location and design of the reserves. A key learning from the scenario planning process was the realisation that the reserves could offer a variety of benefits apart from conservation, but that the design requirements for conservation and socioeconomic benefits don't always align. Community and recreational benefits for example depend on the reserves being located in accessible areas, i.e. mainland territorial sea, and any spillover effects require a design and location responsive to fisheries management systems and location of fisheries. Research should focus on providing sound biological and socioeconomic information to enable key design decisions.

Next Steps

Next Steps and Concluding Thoughts

Having gone through the scenario planning process WWF-New Zealand is now committed to the following actions:

- Discuss the contents of this report with key stakeholders.
- Support development of an action plan to develop a comprehensive network of marine reserves.

We realise that the marine environment is important to all New Zealanders and that its future should be guided by a collaborative approach. We therefore challenge:

- The government to lead development of the agenda for establishment of marine reserves networks and other MPAs in New Zealand, as well as play a leadership role in establishing MPAs in the southern ocean (e.g. the Antarctic and subantarctic regions).
- The government to fulfil international obligations, including actions under the Convention on Biological Diversity and the United Nations Law of the Sea Convention.
- The scientific community to align the academic schedule to best inform decision making – especially impacts of climate change and design principles for the reserves.
- DOC to propose a scope of marine reserves, based on the precautionary principle, that can be implemented before 2010.
- Government to identify and propose a comprehensive representative network of MPAs for the EEZ to be implemented in 2013, which is the earliest date new marine reserves in the EEZ can be established per the BPA Accord.
- Fishing, mining and other industries aspiring to operate in the marine environment to engage with all the stakeholders to develop visions and mechanisms ensuring a sustainable marine environment.
- The public to develop an opinion about marine reserves and to take an active part in the debate and the associated decision-making process.

We realise that there is still a lot of disagreement in regards to what role marine reserves could or should play. There is an urgent need to facilitate a wide stakeholder discussion to form a national agreement on what marine future is desired, how conflicting desires can be reconciled, and what tools should be used to encourage value-enabling but sustainable interaction between people and the marine environment.

We hope that the longer view provided by our scenarios will enable various stakeholders to overcome the limitations related to focusing on the current state alone. The scenarios are designed to free our imagination and give us the ability to identify actions needed to ensure a sustainable marine environment for today and the future.

Appendices

Appendix 1 – Acronyms and Abbreviations

List of Acronyms

DOC	Department of Conservation
BPAs	Benthic Protection Areas
EEZ	Exclusive Economic Zone
IPCC	Intergovernmental Panel on Climate Change
MPAs	Marine Protection Areas
NIMBY	Not in my backyard
NIWA	National Institute of Water & Atmospheric Research, New Zealand
QMS	Quota Management System
WGBU	German Advisory Council on Global Change

Acronyms developed as part of the scenario planning process

MDOC	Marine Department of Conservation
MRMA	Marine Resource Management Act

Abbreviations for measurements

ppm	part per million
km²	square kilometre
t	tonne
pH	measure of acidity or alkalinity
°C	degrees Celsius

Appendix 2 – List of Figures

Figures

Appendix 3 – Key Factors for Establishing Successful Marine Reserves

There are several key success factors that need to be considered in order to achieve the full benefits from marine reserves. As noted previously, there are also costs to implementing marine protection so it is important to ensure the greatest possible benefit for society in terms of economic, social and biological values is achieved.[87]

The no-take principle – Research that has compared no-take marine reserves with other forms of partial marine protection has concluded that little or no beneficial effects are obtained for populations of exploited species from areas under partial protection.[88] It is likely that other forms of marine protection will provide benefits to fisheries management and biodiversity conservation where non-exploited species are involved; however, this has not been well studied.[89]

Establishing clear objectives – Policy-makers need to have a clear understanding of what their objectives are in creating marine reserves and design reserves with these in mind in order to be successful.[90] The application of science to achieve these objectives can then be pursued. There is currently a good understanding of how to design marine reserves for certain objectives and how to identify the likely outcomes from the reserves. For example modelling has shown that increased yields for fisheries from marine reserves occur only when a fish stock has been fished past the point of maximum yield.[91] Hence marine reserves are a valuable tool for protecting heavily fished species.

Research suggests that meeting fisheries goals requires maximising larval dispersal which would be best achieved with small reserves over a large proportion of the coast. Conservation objectives, however, could be achieved with a few larger reserves although would ultimately benefit more from numerous smaller reserves over a larger geographic range.[92]

Networks and connectivity – Current understanding of successful marine protection has identified that one marine reserve or area of marine protection in isolation is less likely to achieve a wide range of benefits. While one reserve may increase the size, abundance and fecundity of the animal and plant life within its boundaries, it will require a network of marine reserves encompassing the diversity of marine habitats and ecosystems in order to meet goals for fisheries and biodiversity conservation.[93]

No one reserve can meet the size and location requirements to protect a given habitat type or marine community due to larval dispersion patterns. There is a need for reserves to span large distances and cover substantial areas to protect against catastrophes and provide stability for the long-term viability of marine communities. A network maximises the variety and number of connections available for aspects such as larval dispersion (distances and directions between reserves). Connections can be physical, for example current flows, or human, for example through connecting different forms of marine protection.[94]

In order for a marine reserve network to be effective the following principles have been established:[95]

- Representation – there needs to be a system of marine reserves, which includes at least one marine reserve in each biogeographic region (as different regions have different biota), and for each region, each ecosystem and habitat must be represented in at least one marine reserve (as different ecosystems and habitats have different unique species/ arrangements).
- Replication – more than one example of an ecosystem and or habitat needs to be protected.
- Large enough to be self-sustaining – the need for sufficiently sized reserves was demonstrated by Willis *et al.* who suggested that the Cape Rodney to Okakari Point marine reserve in New Zealand is not large enough to achieve a density of snapper that is unaffected by fishing at the reserve boundaries.[96]
- Maximum diversity of arrangements – as much diversity as possible should be contained in a network.

Accounting for larval dispersal patterns – Larval dispersal patterns play a key role in determining the success of marine protection.[97] Few models, however, developed to date to assess the likely outcomes of marine reserves fully account for larval dispersal patterns (e.g. the currents influencing larval dispersal and the distance over which different target species larvae can disperse).[98]

It is also important to ensure connections between reserves and exploited populations, and between reserves themselves,[99] for connectivity to be effective. Specifically, larval dispersal patterns will identify the required spacing between reserves and thereby the proportion of a coastline that needs to be protected to achieve effective larvae dispersal. Given the relatively short distances larvae can disperse over, marine reserves need to encompass a large fraction of the coastline or the reserve needs to be larger than the mean dispersal distance of a species targeted for protection.[100]

Every habitat will be unique in terms of species larvae dispersal, e.g. species in rocky habitats may have different dispersal mechanisms and potential compared with those in sandy habitats.[101]

Ongoing monitoring and evaluation – Monitoring marine reserves is necessary to better understand

their effect on their immediate environment and on the wider environment. Monitoring also assists managers in setting realistic marine protection objectives. Ongoing monitoring is also needed to better understand the natural variability of marine systems in order to inform management of potential changes associated with anthropogenic impacts.[102]

Managing visitor impacts on marine reserves – Careful management is required to ensure that benefits of marine reserves are not comprised by human activities within them. Diving in particular has been shown to create stress on coral reefs in the Bonaire Marine Park in Netherlands Antilles.[103] Lloret *et al.* advocate the use of mapping of different marine communities, together with an evaluation of different marine community vulnerabilities, as a complementary tool for managing scuba diving – again this proposes the application of available science to effectively manage marine reserves.[104]

Socioeconomic considerations – The marine reserve design process should give equal weight to social, economic and ecological factors while bearing in mind that meeting the goal of conserving biodiversity and ecosystem functionality will ensure ecosystem goods and services that benefit humans are protected.[105] Taking social and economic considerations into account to ensure the long-term viability of the marine reserve will create greater economic value from a marine reserve. For example, considering locating marine reserves in close proximity to tourists' existing destinations, in places where marine biodiversity is not the only attraction but is combined with interesting natural formations.[106]

Using local knowledge such as Māori tohu should also be considered a significant resource to the development of marine reserves alongside scientific assessment.[107] The incorporation of stakeholders at all phases of the design and establishment of marine reserves is characteristic of successful marine reserves.[108]

It is important to ensure that any proposed marine reserve is acceptable and sustainable from the local communities' perspective in order to have the marine reserve respected and the no-take policy observed, and to take advantage of local knowledge and opportunities as described previously.

Public involvement in the marine planning process in conjunction "…with information, communication and compromise were identified as strategies for reducing conflict between groups" associated with a proposed marine reserve or network was identified as an essential element of marine design by a survey of the public in different areas associated with existing marine reserves.[109]

Ecklonia forest

Acknowledgements

We were able to develop our scenarios and this document because of the people who were prepared to share their knowledge with us and were willing to embark on this journey into New Zealand's future.

WWF wishes to thank everyone who offered their time and expertise in developing the two scenarios for this report. Every effort has been made to accurately reflect the two scenarios as outlined by the workshop participants. We apologise for any inadvertent errors or omissions that may have occurred during the writing of this report. Please note that the views and opinions expressed within this report may not reflect the views and opinions of workshop participants or the organisations that they represent.

We would like to thank the following:

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George Clement, Clement & Associates Ltd.
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Jeroen Jongejans, Dive! Tutukaka
Mac Beggs, Geosphere
John Marshall, Maritime New Zealand
Alison Lane, Maritime New Zealand
Ginny McLean, Ministry for the Environment
Jonathan Peacey, Ministry of Fisheries
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Hone Taumaunu, Ngāti Konohi
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Other relevant WWF resources that you may be interested in regarding New Zealand's marine environment include *Treasures of the Sea* and *Shining a Spotlight on the biodiversity of New Zealand's marine ecoregion*. Both these resources are available at wwf.org.nz.

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Giant kelp growing at Paterson Inlet, Stewart Island

WWF thanks Spicers Paper for donating the paper for this report.

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