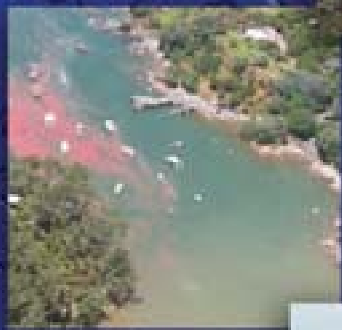
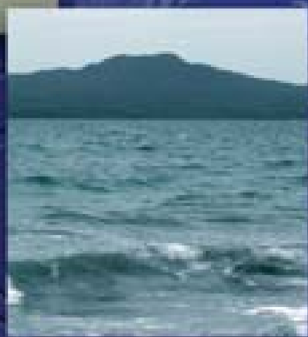
Hauraki Gulf Forum





The Hauraki Gulf State of the Environment Report

Vision for the Hauraki Gulf

It's a great place to be … because …

- … kaitiaki sustain the mauri of the Gulf and its taonga … communities care for the land and sea … together they protect our natural and cultural heritage …
- … there is rich diversity of life in the coastal waters, estuaries, islands, streams, wetlands, and forests, linking the land to the sea …
- … waters are clean and full of fish, where children play and people gather food …
- … people enjoy a variety of experiences at different places that are easy to get to …
- … people live, work and play in the catchment and waters of the Gulf and use its resources wisely to grow a vibrant economy …
- … the community is aware of and respects the values of the Gulf, and is empowered to develop and protect this great place to be[1].

[1] Developed by the Hauraki Gulf Forum

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Chairman's Foreword

No matter what people have called it – Te Moananui o Toi, Tikapa Moana or The Hauraki Gulf – the semi enclosed stretch of water east of present day Auckland has long been a special place for those who know it or have passed through it. The rich history of the Gulf reflects the value that our ancestors saw in it, and the reasons our early setters – both Maori and Pakeha – were drawn to its shores remain as strong today as ever.

In contemporary society people value the Gulf for all sorts of reasons. To tangata whenua the Gulf is a link to the past. It was the landing place for many of the migratory waka from Polynesia; the highway that connected people for centuries; and the location of major food sources. Many battles have been fought on its waters. Today the Gulf provides opportunities for the future prosperity of Maori in the fishing, aquaculture and tourism industries.

To holiday-makers the Gulf is a place to enjoy over long summer breaks, to weekend fishers the Gulf is a place to catch the "big one", to conservationists and researchers the Gulf is a place of fascinating biological diversity. To business the Gulf is an important trade route and place of abundant commercial opportunity. To many observant Kiwis, the Gulf is place of iconic landscape and an evocative expression of natural, social and cultural identity.

The Hauraki Forum was established to recognise these multiple values and multiple interests. One of its key functions is to prepare a state of the environment report in recognition that the many interests in the Gulf share one thing in common – a quality, sustainable environment.

The production of this report is the single-most important achievement of the Form to date. Not only does the report provide a snapshot of the state of the Gulf but it includes a stocktake of what the statutory agencies are doing in response to these issues.

The report provides a basis for the Forum to prioritise future action. It also provides a tangible example of what the Forum is all about – taking a holistic and integrated approach to the management of the Gulf: an approach that crosses statutory functions and deals with the Gulf as a single natural and social system.

Inevitably, some may suggest that the report could contain and present information to better advantage. To that I would simply say that this is a first effort at an extraordinarily complicated task. The Forum will continually search for better ways to tell the story of the Gulf. It will have its next opportunity in three years time when it produces its second State of the Gulf report.

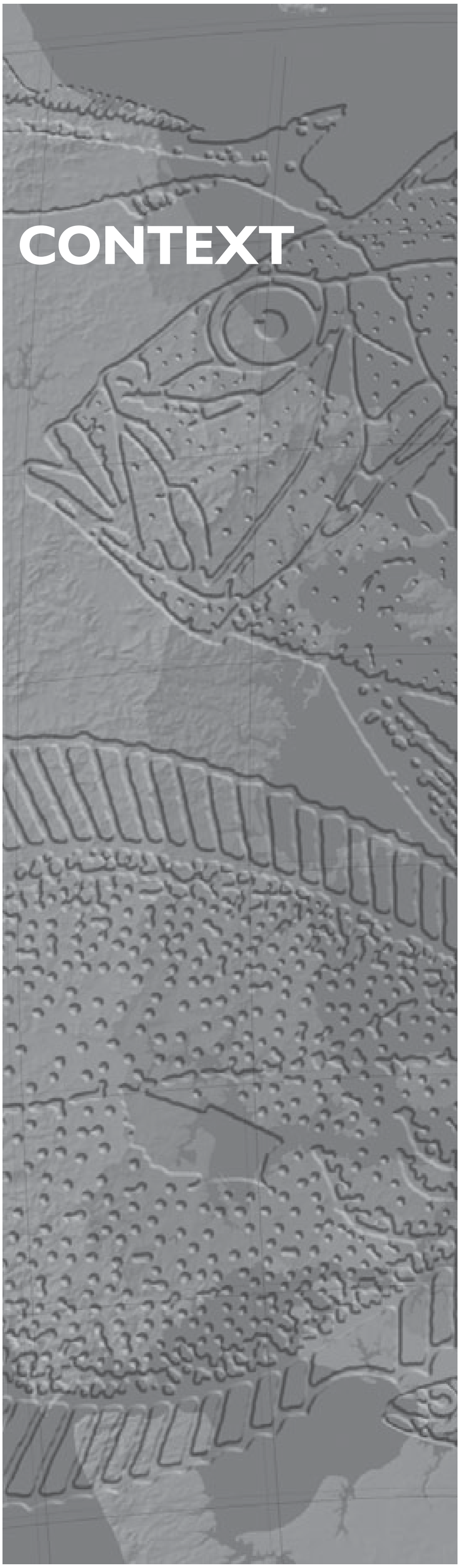
Finally, I would like to thank all those with contributed to the report's production and commend it to all those with an interest in the future of the Gulf.

Laly Haddon
Chair

Table of Contents

List of Figures

PART I CONTEXT



1 Introduction

1.1 Purpose of the Report

This is the State of the Environment report for the Hauraki Gulf ('the Gulf"). It is the first time that information on the environment of the Gulf as a whole has been brought together in one document.

The Hauraki Gulf is a special place. Its waters and islands are home to outstanding biological diversity, landscape quality, and economic and recreational opportunity. It is little wonder that the Gulf and its hinterland have a rich history of human settlement and use. The Gulf provides a sense of belonging for many New Zealanders, including Maori (see Box 1–2).

This report provides those with an interest in the Gulf with an understanding of its environment – what condition it is in, what is affecting it, and what is being done in response. The Hauraki Gulf Forum is required to produce a report such as this every three years under section 17(1)(g) of the Hauraki Gulf Marine Park Act 2000 (see Box 1–1). In fulfilling that obligation the Forum hopes the information in the pages that follow will:

- Raise public awareness about the state of the Gulf's environment, its vulnerability, and what constituent parties of the Forum and others are doing to safeguard it.
- Inform policy-makers, and assist them in prioritising actions, programmes and initiatives in the light of the information contained in this report.
- Provide a benchmark on the state of the Gulf's environment - one that can be reviewed on a regular basis, to identify emerging pressures, and to help determine the effectiveness of corrective actions.

Box 1–1

The Hauraki Gulf Marine Park Act 2000

The special nature of the Gulf has been formally recognised over many years - by government through the establishment of the Hauraki Gulf Maritime Park in 1967, by local Government through the *Vision Hauraki initiative*, and by iwi in 1992 through the Motutapu Accord.

More recently, the need to better understand and manage the complex interrelationships of the Gulf, its islands and catchments led to the enactment of the Hauraki Gulf Marine Park Act ("the Act") in 2000. The Act recognises the *national significance* of the Gulf

The purpose of the Act is to integrate the management of the Gulf through, (in particular):

- the creation of the *Hauraki Gulf Marine Park* encompassing the waters of the Gulf, the foreshore and seabed within the Gulf, and all publicly owned reserves located on the islands of the Gulf (see Chapter 2 for further explanation); and
- the establishment of a governing *Hauraki Gulf Forum* comprising representatives from iwi and from central and local government agencies with statutory responsibilities for managing use, development and conservation within the park and its *Catchment*.

The Forum works to co-ordinate action and better recognise the complex cause and effect relationships experienced in the Gulf. It respects both conservation and development needs and encourages management that crosses cultures, administrative jurisdictions and land/water boundaries (see Chapter 4 for further explanation).

1.2 Focus of this Report

References are made in Box 1–1 to – variously – the 'Hauraki Gulf', the 'Catchment' of the Gulf, and the 'Hauraki Gulf Marine Park' (see Figure 1.1).

To most people, the term *Hauraki Gulf* refers to the waters around the offshore islands to the immediate north and east of Auckland and the Firth of Thames. The Hauraki Marine Park Act ("the Act") defines the Gulf as the area seaward of mean high water springs to a distance of 12 nautical miles off shore and it extends the common understanding of the Gulf to include the waters east of the Coromandel Peninsula.

According to the Act's definition, the Gulf takes in the foreshore, which

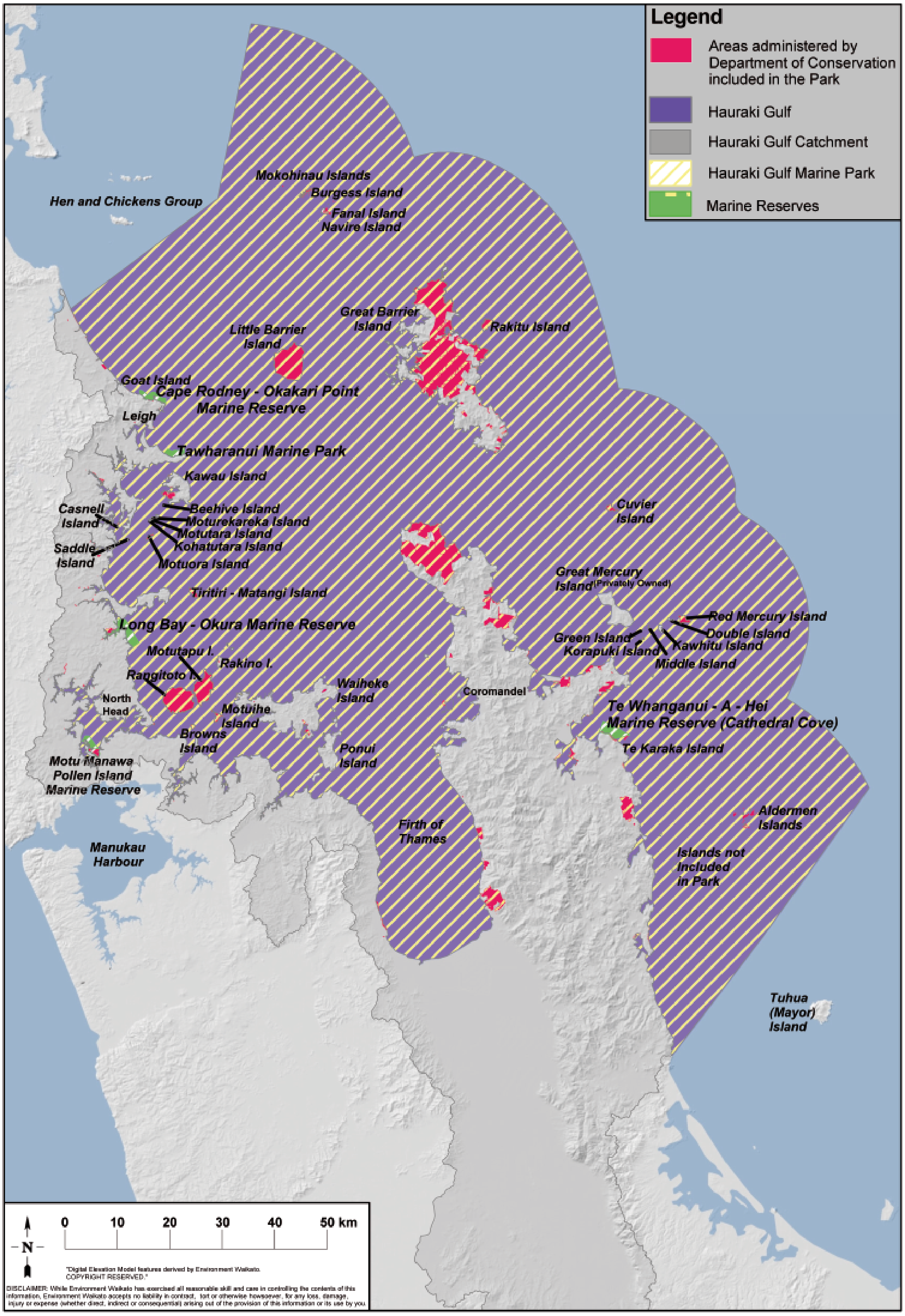


Figure 1.1 The Hauraki Gulf, the Marine Park, and the Catchments of the Gulf

comprises all parts of the bed, shore or banks of the sea and rivers that are covered and uncovered by the flow and ebb of the tide at mean spring tides. It includes the beaches, harbours, estuaries and the tidal parts of rivers and creeks of the east coast of North Island, extending from Mangawhai in the north, to Waihi Beach in the south. The Gulf covers approximately 13,900 km^2 and has a coastline of approximately 2550 kilometres.

The *Hauraki Gulf Marine Park* includes the Gulf *and* all public reserve lands located on islands and coastal areas within the Gulf, including Little Barrier Island, Cuvier Island, Tiritiri-Matangi Island, Rangitoto, Motutapu, and the Mokohinau Islands, and significant portions of Great Barrier and Kawau Islands and the Aldermen and Mercury Island groups. It also includes the public reserves located on the mainland at North Head, and at Mount Moehau and various other points on the Coromandel Peninsula.

The *Catchment* of the Gulf comprises all those areas of hinterland that drain to the Gulf.

The Act requires that a state of the environment report be prepared for the Hauraki *Gulf*. However, the Gulf is part of a wider environmental, social and economic fabric and it is necessary, in fulfilling the statutory requirement, to look at this broader context. For that reason, this report addresses relevant aspects of the Marine Park, Gulf Catchment and the immediate mainland coastal fringe.

The Gulf, Marine Park and Gulf Catchment are illustrated in Figure 1.1.

1.3 How this Report is Structured

This report is based around 6 key chapters included in Part 2 of the Report. Each chapter focuses on a dimension of the environment of keen interest to those who use, value and enjoy the Gulf.

These are:

- Water Quality (Chapter 5)
- Natural Heritage and Biological Diversity (Chapter 6)
- Natural Character and Landscape (Chapter 7)

Box 1–2

Maori and the Gulf

The Hauraki Gulf, known to Maori as Tikapa Moana, or Te Moana Nui a Toi, is integrally linked by whakapapa in a long chain of being back to the beginning of time: to Papatuanuku (Earth); to Ranginui (Sky); to Tangaroa (Sea); and to Te Kore (Nothingness).

The word *Hauraki* relates to the arid north winds that were said to frequent the geographic area. Tangata whenua traditions do not, however, refer to the Gulf as Hauraki. Although all the islands on the Gulf have their own stories and meaning to tangata whenua, the chain of islands across the outer end of the Gulf tend to be known to as Nga Poito-o-te Kupenga – a – Taramainuku – the floats of Taramainuku's fishing net.

To the Hauraki iwi, Polynesian hero Taramainuku stood astride far-off Hawaiki and cast his fishing net over the entire Pacific basin. The floats of his nets surfaced to form the islands of the oceanic archipelago of which the Hauraki offshore islands are a part.

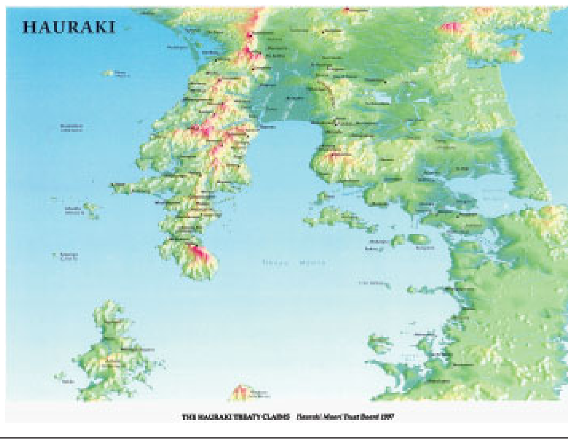
To the Hauraki iwi of Tainui, Te Arawa and Tohora tradition the Gulf itself is known as *Tikapa Moana*. Other names are given to the eastern Coromandel Peninsula including Te Tai Tamawahine and Nga Whakarewa Kauri, the latter referring to the kauri bearing tides of the Mercury Bay area.

In one Hauraki tradition the term *Tikapa Moana* takes its name from Tikapa (Gannet Rock) off the northeast of Waiheke Island. Tikapa means "sound of mournful sobbing" and refers to the sound made by the tidal action entering and emerging from a particular rock structure. It was on these islets that early Maori preformed specific rites – Uruuruwhenua – to claim lands. It is said that the Tainui and Te Arawa canoes performed ceremonies here when they first landed in Aotearoa. In another tradition the term *Tikapa Moana* refers to the way in which the inland sea gleams when sunlight is reflected off its surface.

To the Ngatiwai iwi of the northern Gulf it is known as Te Moananui a Toi. Ngatiwai tradition refers to Toitehuatahi's net being thrown from the southern Bay of Islands, and where it snagged on the shore defines the tribal rohe area of Ngatiwai. Ngatiwai refer to islands such as Hauturu as being poito of Toi's net.

Tangata whenua often refer to the Gulf as a "pataka kai" a food-basket in the literal and metaphysical sense; a place from which spiritual and physical sustenance is gained. The area was probably the earliest point of arrival for Polynesian visitors and retains important reminders of Maori association. The map adjacent provides a Maori perspective of the Gulf. In accordance with custom, the Gulf is viewed from the tail of Ika a Maui's (Maui's fish - the North Island) looking towards the head of the fish.

Tangata whenua identification with the Gulf remains strong today. In acknowledgement, representatives of the tangata whenua are involved in its management (see Chapter 4).



Box 1–3

Strategic Issues

The subject matter of the 6 key chapters is derived from the Strategic Issues identified by the Forum.

The Act (section 17 (1) (a)) requires the Forum to prepare, prioritise and review a list of strategic issues that are faced by the Gulf. This list was prepared in 2002. It includes that following matters.

- Water quality
- Natural heritage and biodiversity
- Natural character and landscape
- Cultural heritage
- Recreation, tourism and access
- Coastal hazards
- Soil erosion and sedimentation
- Biosecurity
- Fisheries and aquaculture
- Relationships with tangata whenua and community
- Knowledge and monitoring

As they stand the issues do not all fit neatly into a pressure – state – response framework. This report takes the first six issues as organising themes, while the other five are variously described in this report as either pressures or responses to those issues, and are reported on in that context (throughout the chapters that form Part 2).

- Cultural Heritage (Chapter 8)
- Access to the Gulf (Chapter 9)
- Coastal Hazards (Chapter 10)

The origin of the chapters is described in Box 1–3. Each of these chapters discusses:

- The *state* of that dimension of the Gulf and islands environment, including the Gulf's immediate coastal margin.
- The *pressures* being experienced on that state from within the Gulf and its catchment.
- The *responses* that the various agencies are making to those pressures.

In doing so, the report follows a pressure – state – response model. Although this is a widely accepted and recommended way for reporting environmental information, it is not without problems.

Environmental issues seldom fit into discrete boxes that can be discussed and understood in isolation from other issues. The environment and the pressures placed upon it are inevitably interconnected and interrelated. In particular, pressures on the environment can be identified broadly – such as increasing vehicle use, or more narrowly – such as the direct impact of vehicle emissions on water quality. There are, in other words, *pressures on pressures.* Similarly, some pressures arise from a specific activity but affect more than one dimension of the environment.

To deal with this problem this report defines, in Chapter 3, many of the *underlying pressures* faced by the Gulf. How those pressures manifest in specific terms is discussed in Part 2 of the report. The report also uses cross referencing liberally to draw readers' attention to relevant pressures discussed elsewhere in the report. An attempt is made to locate information where it is *most* relevant but, inevitably, the conscientious reader will need to refer to various parts of the report to gain a comprehensive understanding of any particular issue.

1.4 Quality and Reliability of Information Contained in this Report

The challenges associated with presenting a picture of the Gulf are considerable. No primary research was commissioned to assist in the preparation of this report. Monitoring of aspects of the environment in the Gulf is carried out by multiple agencies, for a whole host of purposes. Therefore, this report uses existing data, including, in particular those collected by:

- Local authorities, in meeting their own obligations to report on the state of environments that are defined by their own jurisdictions.
- The Department of Conservation, to assist in meeting its obligations to protect threatened species and manage the conservation estate.
- The Ministry of Fisheries, in meeting its obligations to manage the fisheries resource.
- Traditional environmental knowledge of tangata whenua.
- Research into specific aspects of the environment by crown research institutes and tertiary institutions.

Such issue, site and purpose specific information may not lend itself to collation into a state of the environment report for a particular environment, such as the Gulf.

Even in situations where neighbouring agencies do monitor similar aspects of the environment, data may not be collected in accordance with the same methodological, spatial or temporal parameters.

The Forum has used the best available information in preparing this report. Although that information may be patchy, taken together it does form a reasonable picture of the state of the Gulf's environment. It also serves to highlight those areas where better information would help to bring that picture into sharper focus.

The report uses both indicators and case studies to convey information about the environment. Box 1–3 describes what indicators are. As a general rule, the indicators of environmental health customarily used by tangata whenua have not yet been integrated into mainstream monitoring programmes. The opportunities for doing so are discussed in Chapter 1.6.

While every attempt has been made to ensure the accuracy of the data and information presented in this report, there may well be omissions or inaccuracies as a result of the difficulties in gathering information. It is the responsibility of the user to ensure the appropriate use of the data or information from the text, tables or figures.

1.5 What this Report Does Not Address and Why

Those activities that occur within the Gulf's catchment are covered in this report, but only where they affect the Gulf. The effects of activities that happen to be located in the Gulf, but that do not impact on the waters, seabed, foreshore and islands of the Gulf, are not dealt with in this report. Environmental issues, such as air quality, that have not been identified as strategic issues, are not discussed here. Information on these issues can be found in the state of the environment reports produced by individual members of the Forum[2].

Box 1–4

What are Indicators?

The environment is a very complex system. It is not possible to measure every aspect of it. There is only so much that can be monitored with resources available.

We need to pick certain things that give us a good indication of the state of the environment – we call these things *indicators*.

Indicators can take many forms. They can be something very specific like the amount of a particular contaminant in a sediment sample or something more general like the amount of fuel consumed.

Good indicators can be difficult to identify and develop but once they are agreed upon, and monitored consistently over time, they can give an important measure of whether action is required or, if action has been taken, how successful that action has been.

1.6 Matauraunga Maori

1.6.1 Scale of indicators relevant to the Gulf

The definition of "environment" in the Resource Management Act (RMA) includes "ecosystems and their constituent parts, including people and their communities … and the social, economic, aesthetic and cultural conditions …". In determining environmental indicators for the Gulf, all these factors need to be represented. The tangata whenua membership in the Forum, and recent decisions of the Forum, make the wider range of indicators more relevant and important. Unfortunately, because we are largely reliant on existing data, there are real constraints.

Work done by the Ministry for the Environment on national indicators does refer to the social dimension e.g., the "human uses and values". But the actual indicators used are defined in terms of biota and the physical details, such as degree of sedimentation. In other words, there are few tools available for anyone to apply to cultural and social dimensions necessary to represent many tangata whenua concerns.

1.6.2 The nature of matauranga Maori

Matauranga Maori is knowledge, understanding and interpretation of the creation and all that exists within it. It is knowledge based on fundamental truths, and the belief that everything in the universe is interconnected.

[2] For example, the *Waikato State of the Environment Report 1998*, Environment Waikato; *State of the Auckland Region Report 1999*, ARC

The spiritual link is embedded in the connections between the waters of the Gulf, the plants and animals within the Gulf, and the tangata whenua of the Gulf. In whakapapa terms, the earth, the sea, and the plants and animals of the earth and sea, are tuakana and hence have senior status to people. Kaitiakitanga therefore includes the respect and duties due to that seniority. Rahui tapu, by restricting use of resources, assures the interconnection between natural resources, people and nga atua.

Knowing these truths sets the guidelines on interaction with the natural and physical worlds. This is the very foundation on which tikanga Maori pivots. Tikanga Maori ensures that the truth manifests itself in exercising kaitiakitanga in the natural world.

Matauranga Maori contains information relating to methods of utilising and conserving natural resources (for example the use of medicinal plants, and the giving back to Tangaroa of the first first caught). Much of this knowledge has been lost, and there have been deliberate efforts to undermine its value.

1.6.3 Kaitiakitanga and rahui

Environmental integrity was maintained through the highly complex institution of tapu, which originated from the understanding that atua (gods) created all things in the universe, and all things were connected. Tapu then involved using natural resources in ways that ensured the connection between nga atua, the resource being exploited, and humankind remained intact. This was not only for human survival, but because all things in the universe have a purpose, and therefore a right to exist. Placating the atua was therefore paramount in assuring one's survival within a robust environment.

Rahui tapu involved imposing a ban on a resource when it was evident that the vital life force (mauri) was devitalised. Rahui tapu was systematically imposed for periods adequate to preserve or restore the mauri. Rahui tapu challenged individuals and groups integrity. To avoid violating tapu children were socialised in the principles and practice of rahui tapu. Tapu gave the Maori social, cultural, and economic systems a supernatural authority.

Maori believe that, since colonisation, in the drive to commercialise natural resources their institutions have not been respected and that this has led to today's environmental degradation.

Attempts to institutionalise rahui tapu today often fail because the whole community is not involved. In the case of fisheries resources, the responsibility now lies with the Ministry of Fisheries, and lacks the essential statutory degree of authority.

1.6.4 Matauranga Maori and Western science

There are some deep-seated aspects of European culture that pervade all its institutions and understandings. Two critical differences with Maori society and its conceptual frameworks are the Western emphasis on the individual, rather than the collective; and the separation rather than the synthesis of the physical and the metaphysical. In science, and specifically in environmental management, these differences have major impacts. Problems of cross cultural understanding, and hence the near impossibility of genuine partnerships in practice, are the common result.

> *"Matauranga Maori in a traditional context means the knowledge, comprehension or understanding of everything visible or invisible that exists across the universe ... This meaning is related to the modern context as Maori research, science and technology principles and practices.*
>
> *Accurate remembrance of large quantities of data required the use of sophisticated memory management techniques. The methodology used by Maori to achieve this end was to embed the knowledge base in a philosophical framework (or knowledge paradigm).*
>
> *Matauranga Maori not only contains potentially useful knowledge, but it also forms the basis of the Maori cultural paradigm ... The knowledge base underpinning the Maori cultural paradigm arises from an experience by Maori in the New Zealand environment. As such it contains jewels of information*

pointing towards methods of utilising and preserving the environment (for example, the traditional Maori medicinal use of plants). Such useful knowledge is expensive to create de novo. It is being rapidly lost for want of a strategy to preserve it."

"Both science and matauranga seek to codify knowledge in a useful manner. Both result in useful and unuseful concepts. Both rely on empirical observation and codifying that knowledge in a theoretical framework. The perspectives, however, are different. Science seeks to isolate the study matter from the real world under a set of very specific conditions, understand the topic in its isolation, and from there drawing observations about its place in the real world. Matauranga studies a topic in the real world, and from its interactions in the real world seeks to build a conceptual framework in which to codify that knowledge."[3]

1.6.5 Work on tangata whenua indicators

At a national level, the Ministry for the Environment attempted to determine a set of tangata whenua indicators, but has to date not managed to complete the task. While some useful information was collated, the underlying clash of paradigms – Western science, and matauranga Maori – was not sufficiently addressed.

Some direct empirical studies have been completed. These provide some useful information, but they are not able to be easily generalised to other iwi and other environmental studies.

Of more potential use in the context of our State of the Environment Report is the Hauraki Customary Indicators Report (Ministry for the Environment, June 1999). This report contains detail of traditional practices and indicators used historically, and to some extent into the present time, that guided customary fisheries and other activities. The focus for the report geographically is the Firth of Thames, the Waihou River, and Manaia Harbour.

1.6.6 Implications for the State of the Environment Report for the Gulf

In producing this first Hauraki Gulf State of the Environment Report the Forum is not able to solve the problems encountered by MfE and others in identifying and applying tangata whenua indicators. Nor can it achieve a comprehensive tangata whenua based investigation into the biodiversity values on the Gulf. Similarly, it will not find a satisfactory methodology for collection of social data. This report can merely recognise and record the current state of development towards tangata whenua indicators, and acknowledge the need for future work.

[3] *The Interface Between Matauranga Maori and Mainstream Science 1995* MoRST

2 The Gulf and its Catchment

2.1 How the Gulf was Made[4]

Basement rocks in the Gulf area were laid down some 140 to 250 million years ago. Much of the land was raised from the sea some 15 million years ago. Uplifted ocean sediments and ancient volcanoes form the backbone of the Waitakere, Hunua and Coromandel Ranges.

Around 3-16 million years ago, dry land extended from Auckland right across to the Coromandel Peninsula and Great Barrier Island. Around 3-5 million years ago, the Gulf area was forced upwards again, tilting the Coromandel region to the east and the Auckland region to the west. Following this up-doming of the Gulf area, it dramatically subsided about 2-3 million years ago to form the elongate, fault bounded Gulf, Firth of Thames and Hauraki Plains.

During the last ice age when sea levels were 110-120 metres lower than today, most of the Gulf was a broad, forested coastal plain intersected by meandering rivers, extending right out beyond the Coromandel Peninsula and Great Barrier Island.

At the end of the last ice age, the rising sea encroached over the land, and sand that had built up along the coast during the ice age was swept shoreward. Shallow valleys that had flowed out across the former coastal plain were drowned and rapidly filled with sediment. For several thousand years after the sea reached its present level about 6,500 years ago, vast quantities of sand were thrown up against the land to form beaches, barriers and dunes. Where there was a plentiful supply, whole valleys were filled or large sand barriers created, enclosing estuaries and shallow harbours, as at Mangawhai Heads, Omaha, Wenderholm and Orewa sand spits. Where there was less sand available, the river valleys were drowned to become our modern embayed coastline and harbours. The meandering and branching shape of these former river valleys is still recognisable in the extensive headwaters of places like the Mahurangi and Waitemata Harbours, and Tamaki Estuary.

Most of the cliffs around our modern coast are very young and have been eroded out of the sloping hillsides in the past 6,500 years. The Waitemata Sandstone cliffs around Auckland are eroding back at rates of 1 to 5 cm per year. The intertidal reefs in front of them, extending up to 100 metres out to sea, are an indication of the amount of cliff retreat since sea level rose. Today our youthful coast is still changing, in places eroding and elsewhere growing as nature continues to respond to the post ice age rise in sea level and to the variable patterns of winds, waves and currents.

2.2 The Gulf Today

2.2.1 Coastal Currents and Water Movements

The Gulf is a semi-enclosed coastal sea within a warm temperate region, influenced by the subtropical East Auckland Current, particularly around the island groups. The East Auckland Current flows towards the south east somewhat offshore of the continental shelf. The inner Gulf south of a line from Cape Rodney through Little and Great Barrier Islands exchanges water with the more open shelf regions via entrances to the north and south of Great Barrier Island. Water turn-over time is estimated at 60 to 80 days[5].

Whilst circulation on the open shelf, and to a lesser extent, the outer Gulf, are influenced by the East Auckland Current, circulation patterns within the Gulf are dominated by the influence of wind direction and strength upon surface water movements (see Figure 2.2). Surface

[4] Much of the physical description of the Gulf in this section is drawn from *A Field Guide to Auckland: Exploring the Region's Natural and Historic Heritage*, Cameron, E., Hayward, B. Murdoch, G., Godwit Publishing, 1997

[5] N. Broekhuizen (NIWA) pers comm., (citing Zeldis et al. in review; Zeldis and Smith 1999).

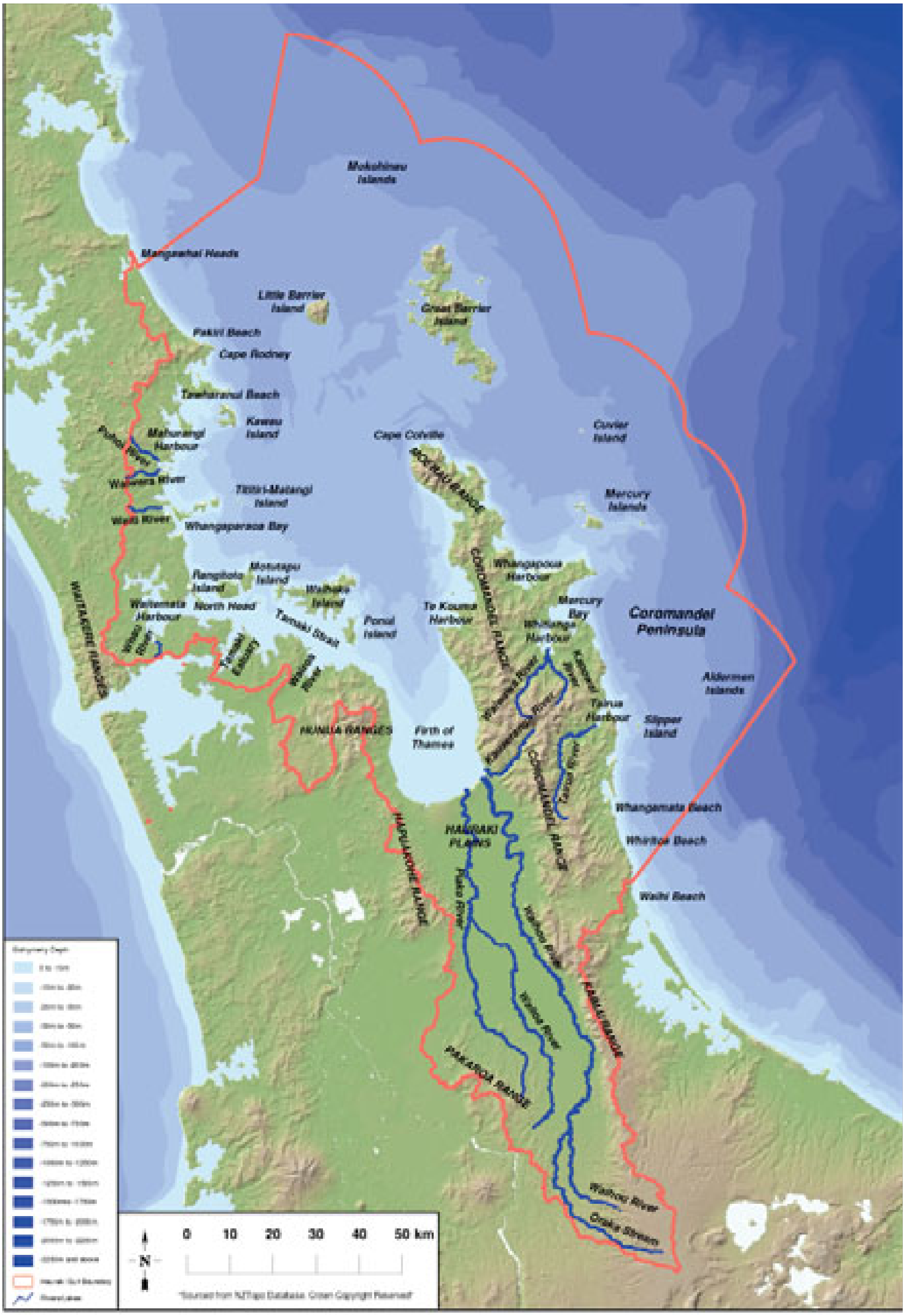


Figure 2.1 The Hauraki Gulf and its Catchment

waters tend to flow in the direction of the local wind and take some 12 to 24 hours to readjust themselves following a change in wind direction (N. Broekhuizen, pers comm.)

2.2.2 Nutrient Upwellings and Marine Productivity

Winds along the shore (those from north west or south east) have particularly strong influences upon circulation patterns (Proctor and Greig 1989). Winds blowing from the north-west elicit upwelling along the open north east coast, whilst those blowing from the south-east induce downwelling along this coastline. During upwelling, the surface water tends to flow offshoreward, inducing a shoreward transport of deep, cold, saline, nutrient-rich water onto the shelf. Conversely, south-east winds cause onshore surface flow and offshore movement of water near the sea bed.

Overall, winds blow from the north-west sector for approximately 16% of the time, and from the south-east sector for approximately 12% of the time (N. Broekhuizen pers comm.). Upwelling introduces deep oceanic water from beyond the shelf-break into the coastal-shelf region near the sea-bed. This water is rich in nutrients, but has only a small resident plankton community. It is also cold (dense) and therefore tends to stay near the sea-floor. Light-intensities are lower near the sea-floor than they are close to the sea-surface and unless the water is mixed to the surface, the newly introduced nutrients are of little value to the local phytoplankton (plant) population.

The extent to which nutrient-rich oceanic water mixes with surface water and contributes to the nutrient pool in the Gulf depends on both extent of upwelling and strength of winds mixing the surface waters. The Gulf also receives nutrients from land based sources flowing into the Gulf from rivers and from discharges such as sewage.

In general terms the Gulf is a net source of dissolved inorganic phosphorus as more inorganic phosphorus is exported from the Gulf to the open shelf than is imported from the ocean. In contrast, the system is a net sink for dissolved inorganic nitrogen.

During the summer months, concentrations of dissolved inorganic nitrogen at the surface limit phytoplankton growth and if the nutrient-rich oceanic water becomes mixed to the surface it can have profound implications for plankton production and abundance. Phytoplankton are central to the productivity of any marine environment, as they are the primary prey of shellfish and also directly or indirectly of most other animals living in marine environments. Zooplankton transfer phytoplankton production to higher trophic levels such as fish and sea birds (Broekhuizen *et al* 2002).

Like the rest of north-east New Zealand, the Gulf has strongly seasonal hydrodynamic characteristics. In late winter and spring, westerly winds prevail in north-east New Zealand. Northwesterly winds favour upwelling of nutrient rich waters. This upwelling leads to high levels of nutrient availability and results in some of the highest spring chlorophyll a standing stocks on the New Zealand continental shelf (Chang *et al* 2003). In summer, predominant winds shift to easterlies, leading to downwelling and movement of warm, nutrient poor waters towards the coast

2.2.3 Coastal Dynamics

The Gulf is characterised by warm water flowing south, low to moderate wave conditions with occasional storm events, and displays a spectrum of coastal environments from sheltered harbours and estuaries to exposed rocky islands and beaches. Variations in physical coastal processes occur due to changes in exposure, from the moderate energy beaches such as Pakiri, Tawharanui, Whangamata and Whiritoa to the sheltered estuaries in inner harbours such as Tamaki Estuary, Upper Waitemata Harbour, Whitianga, Whangapoua and Tairua Harbours. In terms of physical coastal processes, this leads to great diversity in the levels of wave, tidal and current energies that shape and affect the coast and the rates of coastal erosion and accretion.

Figure 4.
Upper panels: This view up the coast to the north of the Hauraki Gulf shows two key wind driven current patterns – upwelling and downwelling. Winds are shown as feathered arrows, surface water is shaded light blue, and deepwater is shaded dark blue. The blue arrows depict water circulation. The orange symbols show the mooring sites near the Poor Knights Islands and in the Firth of Thames. Lower panels: These satellite images of sea surface temperature show that the cooling effects of upwelling (coloured green) in spring 1998 did not occur in spring 1999.

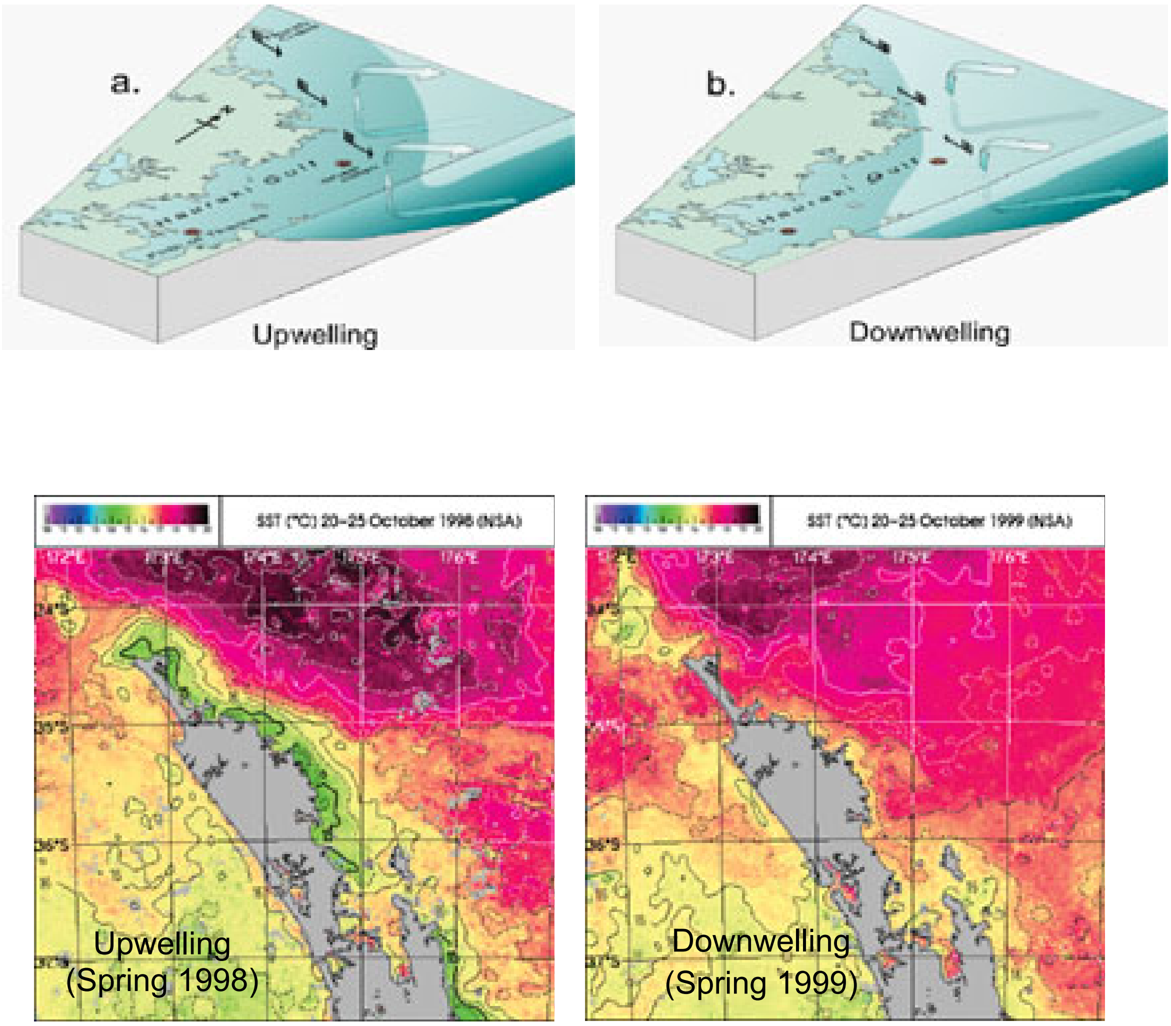


Figure 2.2 Wind, Current and Circulation Patterns in the Gulf
Source: Environment Waikato Technical report 02/09, ARC Technical Publication 182

Coastal landforms exist because hydrodynamic (waves, currents, tides) and aeolian (wind) processes erode, transport and deposit particles of sediment. The force of these processes wears down the coast in some places and builds it up in others, transports sand and shell, and shapes spits and bays. Waves, tides and currents that shape the coast are key components of the natural character of the Gulf..

Flood and ebb tidal currents in the Gulf are generally masked by wave energy, except in harbours and estuaries where tidal currents are generally more noticeable as large volumes of water are forced into and out of a narrow constriction during a tidal cycle.

Waves are the driving force behind all changes we see from day to day along the Gulf's coastline. Ocean and coastal waves are primarily the result of wind stresses upon the surface of the ocean. Open water swell waves, generated by winds blowing over very large distances or "fetch", affect much of the coast of the Gulf, but especially the more exposed east coast areas. Occasionally easterly storms, which can produce storm waves over 10 metres high in the outer Gulf, affect the east coast. When these waves reach the shore they can lead to significant coastal erosion and flooding[6].

Much of the Gulf's coastline is a lee-energy environment, which means it is generally sheltered from the predominant west to south-west winds. Wave heights are therefore generally low to moderate in the middle to outer Gulf and east coast of the Coromandel Peninsula, and low to very low in the inner Gulf, particularly in more sheltered situations such as estuaries and harbours where there is less fetch available for the development of swell.

Figure 2.3 illustrates the various wave environments that exist in the Gulf.

2.2.4 Sand and Sediment Transport and Deposition

The beaches of the Gulf are characterised by embayments that trap sand between headlands. Sand recirculates within the embayments mostly during large storm events, however there is little exchange of sand between the embayments and they essentially operate as closed systems.

Much of this sand originates from sand that was swept shoreward with rising sea levels at the end of the last ice age and built up along the coast to form beaches and dune systems. The Waikato River that once flowed out through the Firth of Thames and into the Gulf, was also an important source of sediment.

Twenty thousand years ago the Waikato River was diverted to the west coast, cutting off the coastal systems of the eastern coast of Auckland and the western coast of Coromandel from their original supply of sand. While there are small inputs of sand from streams, cliff erosion and bio-production, the embayed beaches of the Gulf essentially have as much sand as they are ever going to get.

As noted above, the Gulf's estuaries were created by the flooding of existing river valleys at the end of the last ice age. Since the sea level stabilised around 6500 years ago, the Gulf's estuaries have been in-filling with sediments (at various rates) to form the features we see today. Over time, estuaries naturally in-fill, both from sediments eroded from the land and sand driven in from the coast (see Box 2–1).

2.2.5 Freshwater Inputs

The Gulf is the receiving environment for freshwater inputs from a large catchment. This includes the watershed and tributaries of the Waiwera, Puhoi, Weiti, Whau, Tamaki and Wairoa Rivers located in the Auckland area; the Piako, Waitoa, Waihou, Oraka Rivers of the Hauraki Plains, and the Tairua, Waiwawa, Kapowai, and Kauaeranga Rivers of the Coromandel Peninsula.

The combined catchment of all areas draining to the Gulf totals approximately 8078 square kilometres.

The catchment drains the Waitakere and Hunua Ranges, the Auckland Isthmus volcanoes, the eastern side of the Hapuakohe Range and the Pakaroa Hills, the western side of the Kaimai Range, and most of the Coromandel Range.

[6] ARC, 1999, State of the Auckland Region Report 1999.

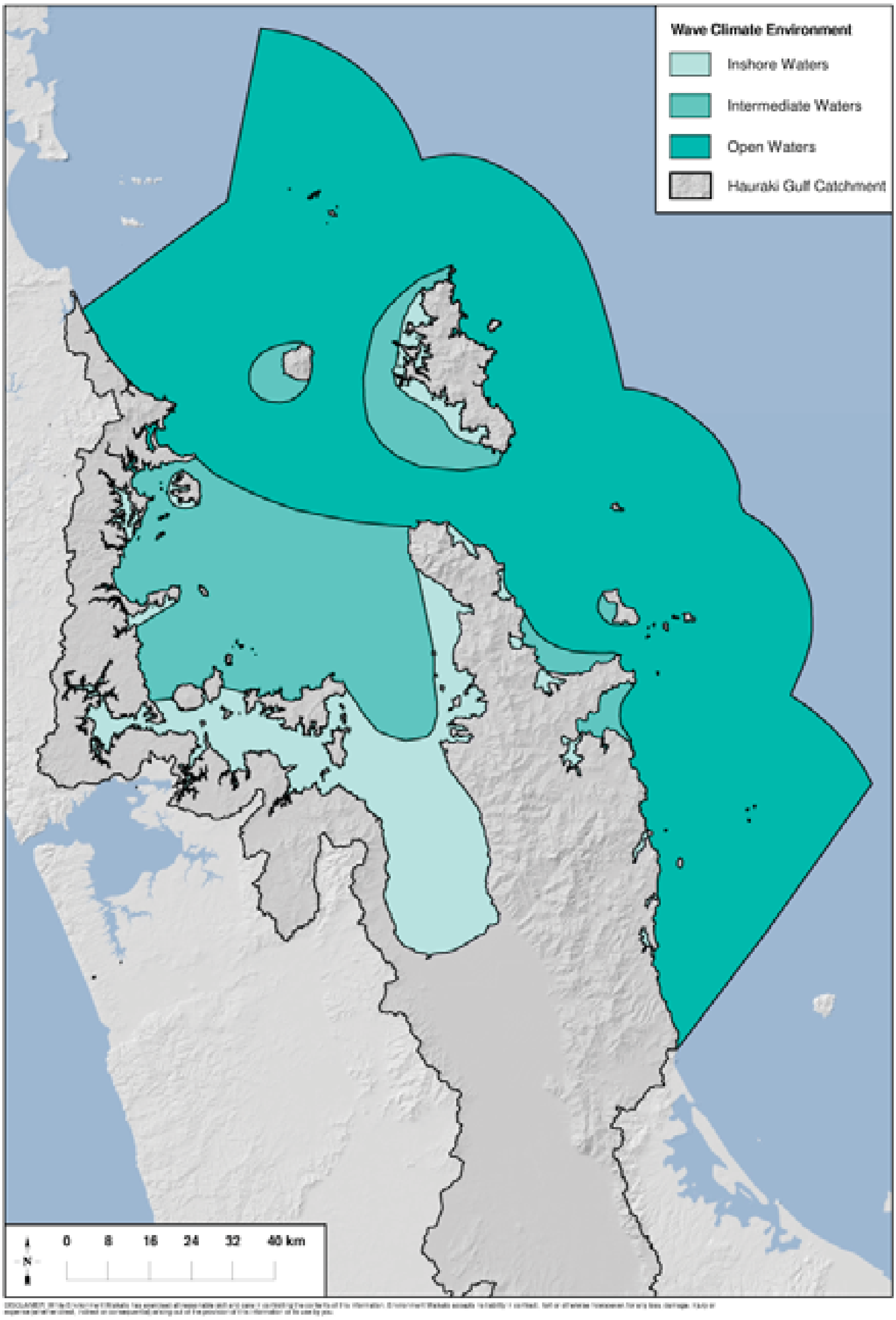


Figure 2.3 Wave Environments in the Hauraki Gulf

2.2.6 Climatic Features

The Gulf and its catchment is exposed to prevailing west and southwest winds from the Tasman Sea. Rainfall patterns and temperature are determined by those prevailing winds, the catchment's topography, its marine setting, and its northerly latitude (relative to the rest of New Zealand). This combination of factors gives rise to warm, humid summers and mild winters and, as a consequence, high biotic growth rates. Rainfall is higher in the rain shadow of the Waitakere and Coromandel Ranges. Coastal areas exhibit relatively small variations in temperature.

2.3 Marine Environments

The combined affect of different physical, climatic and biotic characteristics of the Gulf serves to create various "types" of environment within the Gulf.

Until recently there was no way of classifying and mapping different types of environment within the marine area.

However, the Ministry for the Environment has recently sponsored the development of a system known as Marine Environments Classification (MEC) (See Box 2–2).

MEC has been developed at a 1 km resolution for New Zealand's exclusive economic zone and adjacent waters. However, the system has been piloted at a much more precise scale (a 250 m^2 resolution) for the Gulf.

MEC has a number of applications. It is being developed primarily for its potential use in coastal and marine planning and conservation. However, MEC also has potential application for state of the environment reporting. It provides a framework within which information can be organised and reported.

Unfortunately, the way information is currently collected, collated and referenced within the Gulf has not permitted MEC to be used in this way in this report. It is hoped that subsequent state of the environment reports will be able to make better use of this tool.

Figure 2.4 maps 11 environment types (or "classes") within the Gulf. MEC can be used to make much finer grain distinctions and identify up to 290 different environment types. Although the MEC classes are not used to order the information that follows, the eleven classes and their descriptions do provide a useful introduction to biophysical characteristics of the Gulf.

Box 2–1

Sedimentation

An estuary is a dynamic environment in which many processes and sediment sources combine to influence the estuary's characteristics. The principal source of fine sediment entering an estuary system is from eroded soils transported into the estuary by rivers and streams from within the estuary catchment. These fine sediments then accumulate in the estuary. Current and wave action can remobilise sediments from the estuary bed and shunt them around and/or out of the estuary. An estuary may also fill with sand driven in from the coast to form ebb and flood tide shoals at the mouth, and within the middle reaches where fine sediment is winnowed from catchment-derived sediment to leave coarser sand-sized particles. This is particularly chacrateristic of the tidal lagoons which are common around the Gulf.

The ability of an estuary to mobilise sediment is determined by tidal, current and wave conditions. These conditions are dependent largely on the physical characteristics of the estuary.

The rate of in-filling is dependent on the balance of sediment entering and exiting the system. An estuary will start to in-fill if the balance of sediment entering and exiting the estuary changes. For instance, an increase in soil erosion within a catchment due to de-vegetation could cause in increase in sediment entering the estuary. Also, a decrease in current velocity or wave energy caused by a breakwater or causeway, which limits the amount of sediment mobilisation, could cause a decrease in sediment exiting the estuary. Both instances could cause a higher sedimentation rate and a part or whole of an estuary could start to in-fill. As an estuary becomes more in-filled, catchment-derived sediment entering the estuary will be exported to adjacent coastal waters.

The underlying physical type of an estuary plays an important role in determining how quickly it will be affected by in-filling. More enclosed estuaries (e.g. Whangamata and Whangapoua on the Coromandel Paninsula) are more susceptible to in-filling, which can result in channel filling and expansion of tidal flats. By comparison, tidal or 'fault-defined' embayments such as Te Kouma Harbour are less susceptible to in-filling.

Although sedimentation is a natural event, it can be rapidly accelerated by changes in land use and vegetation cover. The actual and potential effects of accelerated erosion and sediment deposition on the water quality, biodiversity, and natural character of the Gulf make sedimentation a Strategic Issue for the Gulf. Accelerated sedimentation is discussed in more detail in Chapter 5.

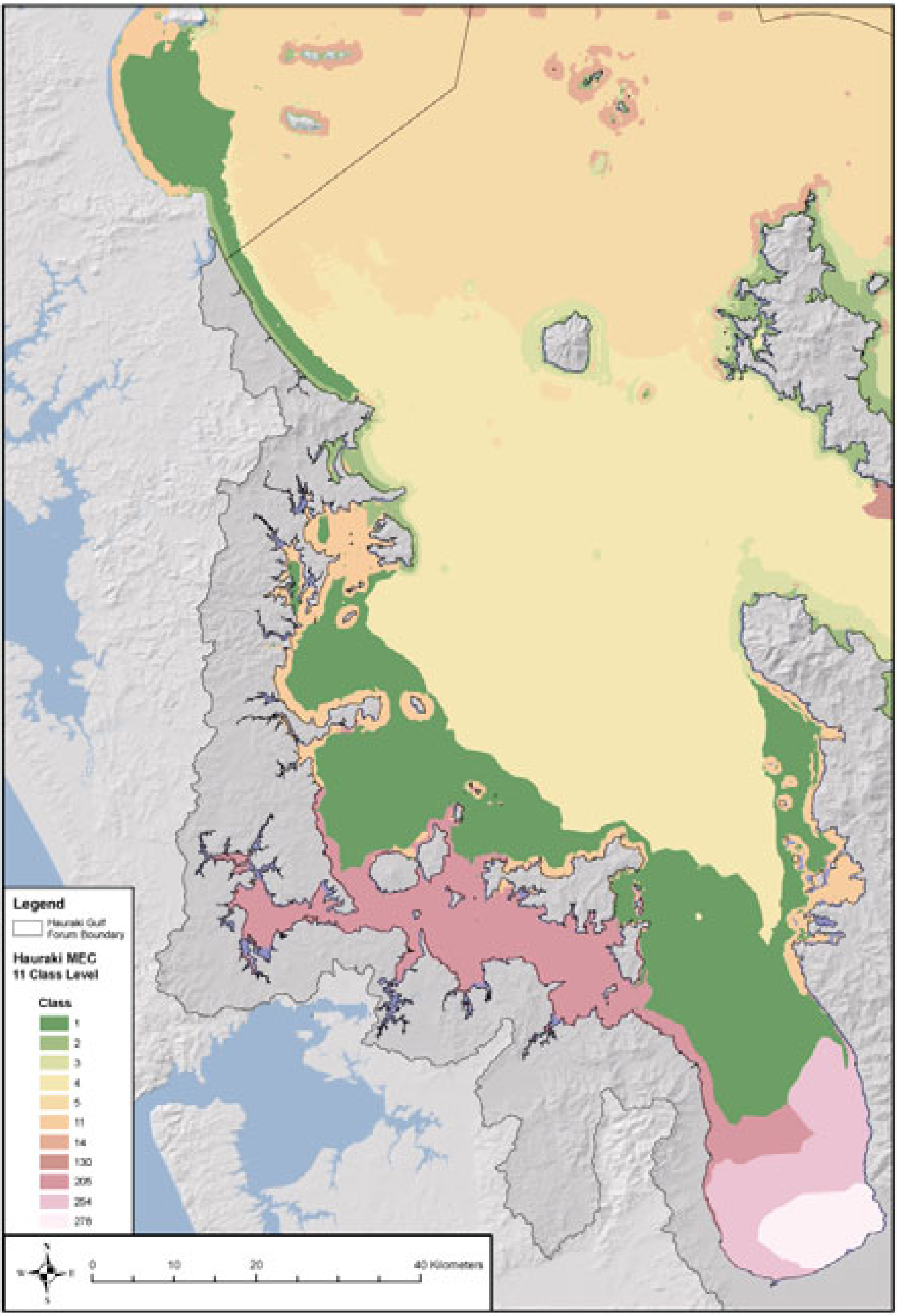


Figure 2.4 Marine Environments Classification for the Gulf

Description of Classes

Class 1 – Deeper water of the inner Gulf

Locations in this class have average depths of 22 metres with moderate tidal flows, and low orbital velocities. Freshwater fraction (a measure of the average freshwater influence) is only slightly elevated, indicating that the class is not strongly influenced by freshwater inputs. The SST variables indicate that this class is 'inshore' rather than oceanic in nature.

Biologically Class 1 is highly heterogeneous. It is characterised by a range of benthic communities including biogenic reef patches, dominated by large suspension feeding bivalues, scallops, sponges, byrozoans and red algae. It includes areas of important scallop habitat. At the southern tip of the class's extent (the Firth of Thames) the sediments are predominantly muddy sand/sandy mud. There are remnant green lipped mussel beds and highly productive sediments with burrowing crustacea and echinoderms. In the northern part of class 1's extent (Pakiri Beach) the substrates are coarser, being strongly influenced by extreme storm events, nevertheless biogenic reefs have been observed in this area. This variation within Class 1 is not captured at this level of the classification.

Class 2 – Shallow coastal water of the outer Gulf

Locations in Class 2 have average depths of eight metres with low tidal flows, but high orbital velocities. Freshwater Fraction is only slightly elevated indicating that the class is not strongly influenced by freshwater inputs despite its proximity to the shore. The SST variables indicate that this class is strongly influenced by the oceanic conditions of the outer gulf.

Biologically Class 2 has distinctive rocky reef habitats characterised by a mix of urchin barrens or Ecklonia kelp forest. In areas with sedimentary substrates, such as exposed beaches, substrates consist of well-sorted sand populated by a mosaic of shellfish beds that including different types of surf clam. There are significant biological differences of assemblages between locations within the class, for example between the east and west side of Great Barrier Island. Variation with respect to wave climate (note that the standard deviation of the orbital velocity variable in this class is large) may contribute to significant physical and biological variation within the class.

Class 3 – Deeper coastal water of the outer Gulf

Locations in Class 3 have average depths of 34 metres with moderate tidal flows and orbital velocities. Freshwater Fraction is low, indicating that the class is not strongly influenced by freshwater inputs despite its proximity to the shore. The character of Class 3 comprises distinctively steep areas, which means that patchy reef rocky substrate is a dominant habitat, as well as relatively deep unconsolidated sand flat and shell hash habitat. Because sediments in flatter areas are unconsolidated and mobile, they are moved along by currents producing mega ripples, particularly around headlands. The SST variables indicate that this class is strongly influenced by oceanic conditions.

Local quantitative information on the communities that occupy these habitats is rare. The rocky reef communities are likely to be dominated by filter feeding animals such as soft corals and sponges. These sediments can be highly diverse, while the sand flat areas on the south and western side of Little Barrier comprise a major scallop fishery.

Class 4 – Shallower offshore water of the outer Gulf

Locations in Class 4 have average depths of 45 metres with moderate tidal flows, very low orbital velocities and low freshwater fraction. Class 4 is characterised by very low slopes that are generally covered by muddy sediments. The class is relatively homogeneous with respect to slope, depth and orbital velocity. However, tidal currents are more variable reflecting some constrained tidal flows such as the Colville channel. The SST variables, and low freshwater fraction indicate that this class is dominated by oceanic conditions.

This class is a major snapper fishing area, despite this little is known of the seafloor ecology. It is however likely to have changes associated with trawling. Much

Box 2–2

Marine Environments Classification

Marine Environments Classification (MEC) is an *ecosystem-based spatial framework*. This means that it is a system of classifying and mapping the marine environment in a way that subdivides the marine environment into units that have similar biological and environmental characteristics.

It uses physical variables such as depth, slope, tidal current, freshwater concentration and temperature to classify areas in the belief that ecosystem properties are broadly determined by biophysical processes and physical factors in the marine environment.

The application of MEC enables division of the marine environment into areas where ecosystem properties are different and where effects of resource uses can be expected to differ. Conversely, it identifies areas that are considered to be physically similar, and where the biotic communities and effects of resource use could be expected to be similar.

In this way, MEC can act as a *predictor* of potential impacts of events and resource uses based on ecosystem characteristics and susceptibility.

of the class represents deep deposit feeder dominated soft-sediment communities dominated by heart urchins, burrowing crustaceans and brittle stars. In shallower and higher flow regions horse mussel beds may have been common in the past. The south, part of outer Firth is a major snapper spawning area supplying recruits to nursery areas closer to shore.

Class 5 – Deepest water of the outer Gulf

Class 5 is characterised by average depths of 85 metres with relatively homogeneous and very low tidal flows, orbital velocities, slopes and freshwater fraction. The SST variables, and low freshwater fraction indicate that this class is dominated by oceanic conditions.

There is little available biological information other than fisheries trawls (see Snelder et al. 2004 for information on demersal fish assemblages). However, these deep habitats include those at the shelf break which, given the upwelling along the shelf break, are likely to be highly diverse. Soft-sediment habitats are probably dominated by fine sediments and deep burrowing organisms as well as emergent epifauna such as seawhips and seapens. These habitats have probably been modified by fishing (see Cryer et al. 2002). Where rocky reefs are present, benthic communities are likely to comprise black corals, glass sponges, and diverse encrusting assemblages.

The class has good water quality, which is dominated by oceanic conditions. Pressure in this class is limited to fishing (commercial and recreational). There is intensive fishing in this class (snapper, trevally) and scampi in deeper waters as well as game fishing (marlin, kingfish). Sensitivities include the effects of drop line fishing around deep reefs.

Class 11 – Shallow water of the inner Gulf

Areas in Class 11 have average depths of 6.5 metres but the class covers areas from the shoreline to up to 12 metres deep. Orbital velocities are high but tidal flows are low. Freshwater inputs are moderate for the Gulf and tend be episodic although the class includes some relatively significant rivers (e.g. Orewa, Puhoi). The class is also characterised by relatively steep seabed slopes and includes rocky headlands such as Whangaparaoa Peninsula. The class has high variability with respect to orbital velocities, slopes and freshwater fraction (see appended Table 1). The SST variables indicate that this class is 'inshore' rather than oceanic in nature and the freshwater fraction indicates that freshwater inputs will significantly influence water quality.

The class is highly heterogeneous due in part to variation in substrates, and contains some diverse and productive habitats. However, the class is also characterised by some degradation of ecological values due to moderate turbidity and siltation. Areas of reef are common providing habitat for Ecklonia and shallow and sheltered water seaweeds. The class marks a transition zone between the outer and inner Gulf, with seaweeds such as Carpophyllum being replaced by increasing amounts of Ecklonia as conditions become more oceanic. There is some diversity of substrates in flatter areas due to large variation in orbital velocities. The class includes locations representing a very wide range of sediment types, from fine muds to medium sands and thus contains a diverse and heterogeneous array of benthic communities. In some locations orbital velocities are high and substrates are likely to comprise 80% sand and exposed shell material. These locations are good habitat for biogenic reefs and are likely to be dominated by horse mussel and scallop beds, as well as sponges, ascidians and soft-corals. Rocks, cobbles and exposed shell from living and dead sedentary molluscs provides an important primary settlement surface for encrusting organisms in these sedimentary environments and good flow provides good feeding conditions for suspension feeders.

Class 14 – Steep slopes in deep water of the outer Gulf islands

Areas in Class 14 have average depths of 52 metres and slopes of 2.2 0.01m-1. Orbital velocities and tidal flows are low. Freshwater inputs are low and the class is oceanic in nature.

The class is characterised by rock substrates and pinnacles, which provides a varied habitat with high biodiversity. Black coral dominates deeper areas. A key resource in this class is crayfish.

Class 130 – Water of southern tip of Great Barrier

There is not much known about this class, other than that the area is likely to be distinctive due to very strong tidal currents (the highest tidal velocities in the Gulf). The biota is likely to be characterised by Ecklonia forests and filter feeding animal such as feather stars, jewel anemones. Sediments are likely dominated by megaripples. The pressures and sensitivities of this class are not well known.

Class 205 - Sheltered shallow south-east bays of the inner Gulf

Locations in Class 205 have average depths of five metres with moderate tidal flows and low orbital velocities (although variability is high) due to sheltered conditions. Freshwater fraction is moderate, indicating that the class is influenced by freshwater inputs. The seabed within Class 3 is characteristically flat and comprises heterogeneous substrates, with patchy rocky reefs and areas with muddy sand substrates (except Firth of Thames where mud predominates). In areas with stronger currents (e.g., Rangitoto and Waiheke channels) the substrates are scoured with a predominance of surface shell. The proximity of the class to urban area and moderate freshwater influence means it is subject to sedimentation and contamination. A gradient in these pressures exists from the coast where effects are often high to more open areas where sediment and water quality are high.

The class has a complex and heterogeneous array of habitats. The shallow reefs are characterised by fringing seaweeds. In deeper soft-sediment areas with exposed shell, soft corals are found growing on fragments. Death assemblages in some locations have scallop shells and green lip mussels possibly indicating these areas may have been subject to change from siltation. In more sheltered areas mud communities dominate with intertidal flats providing important food resources and roosting sites for shorebirds. The class provides a significant recreational snapper fishery.

Class 254 – Sheltered upper reaches of the Firth of Thames

Locations in Class 254 have average depths of five metres with moderate tidal flows and orbital velocities. Freshwater fraction is high, indicating that the class is highly influenced by freshwater inputs from the agricultural hinterland. Water in this class tends to be turbid as a result of fine sediment resuspension (moderate orbital velocities and shallow depth) and fresh water inflows. The seabed within Class 254 is characteristically flat and comprises substrates that transition from shelly to muddy moving higher up the Firth.

Benthic assemblages are typical of soft bottom communities and include small amphipods, mud crabs, polychaetes, cockles and wedge shells. The class provides nursery habitat for shark and snapper and habitat for rays and flatfish. Benthic assemblages provide important food resources for shorebirds and flatfish.

Class 278 – Estuarine headwaters of the Firth of Thames

Locations in Class 278 have average depths of 1.8 metres with moderate tidal flows and orbital velocities. Freshwater fraction is very high (and higher than Class 254), indicating that the class is dominated by freshwater inputs. Water in this class tends to be turbid as a result of bed stirring (moderate orbital velocities) and fresh water inflows. The seabed within Class 278 is characteristically flat and comprises muddy substrates with some shell on eastern beaches.

The class is characterised by large areas of mangroves in the coastal fringes. Benthic assemblages are typical soft bottom and similar but less diverse than that represented by class 254. The class is a productive habitat for flatfish (rays, flounder).

3 Underlying Pressures on the Gulf Environment

As will be discussed in the following chapters, the environment of the Gulf faces a variety of pressures. It is important that these pressures be identified specifically so that proper, targeted and effective responses can be developed.

However, under-pinning many of these specific pressures are changes in the nature and shape of the society and economy that surrounds, uses and relies upon the Gulf. This chapter seeks to identify, at a broad level, some of those underlying changes.

It does so, principally, to provide the context within which the more specific pressures on the Gulf can be understood.

3.1 Land Use and Land Use Change within the Catchment

Land use in the Gulf Catchment is very diverse, and ranges from the intense urban development associated with the cities and ports of the Auckland Region, through small rural settlements and scattered coastal development, to horticulture, dairying and cropping, plantation forests, and natural wetlands, sand dune, harbour and rocky coastal habitats, and old-growth and regenerating coastal, kauri, and broadleaf-podocarp forest (refer Figure 3.1).

Much land use change within the past 150 years can be ascribed to agricultural and urban development. Wetlands have been drained and forests cleared and converted to pasture. The continued rapid urbanisation of Auckland's catchments has been well documented elsewhere.

Located in the catchment are North Shore City, almost all of Auckland City (excluding only those southern areas such as Blockhouse Bay and Onehunga, that drain to Manukau Harbour), and the eastern suburbs of Waitakere and Manukau Cities. Many other small centres of population are also located in the catchment, including Leigh, Warkworth, Snells Beach, Orewa, the Whangaparaoa Peninsula, Beachlands/Maraetai, Kaiaua, Miranda, Thames, Paeroa, Waihi, Te Aroha, Morrinsville, Waharoa, Matamata, Tirau, Coromandel, Colville, Whitianga, Tairua, Pauanui, Whangamata, part of Putaruru and the communities located on Waiheke and Great Barrier Islands.

3.2 Settlement and Population Growth

The population of the Auckland and Waikato regions increased by 22.7% between 1991 and 2001. Population growth in the Waikato region was significantly less than in Auckland (8.8% as opposed to 27.5%). The 2001 combined population of these two regions was 1,574,626.

The population of that part of the Auckland region within the Gulf Catchment increased 24% between 1991 and 2001. The population growth in the Waikato part of the Gulf Catchment was 2.5% over the same period. However, it is notable that population change within the Waikato portion of the Gulf Catchment is variable. Population growth within the Thames-Coromandel District increased by some 15.5% over the same 10 year period. Whereas, the inland areas of Hauraki Matamata-Piako recorded population decline. The net effect of all this is that by 2001, the total population living in the Gulf Catchment was 955,250, up from 782,557 in 1991.

Even taking into account population decline in inland areas of Waikato, the overall population growth rate (1991-2001) for the catchment was 18% – well above the national average for the period of around 11%. Strong growth is forecast to continue.

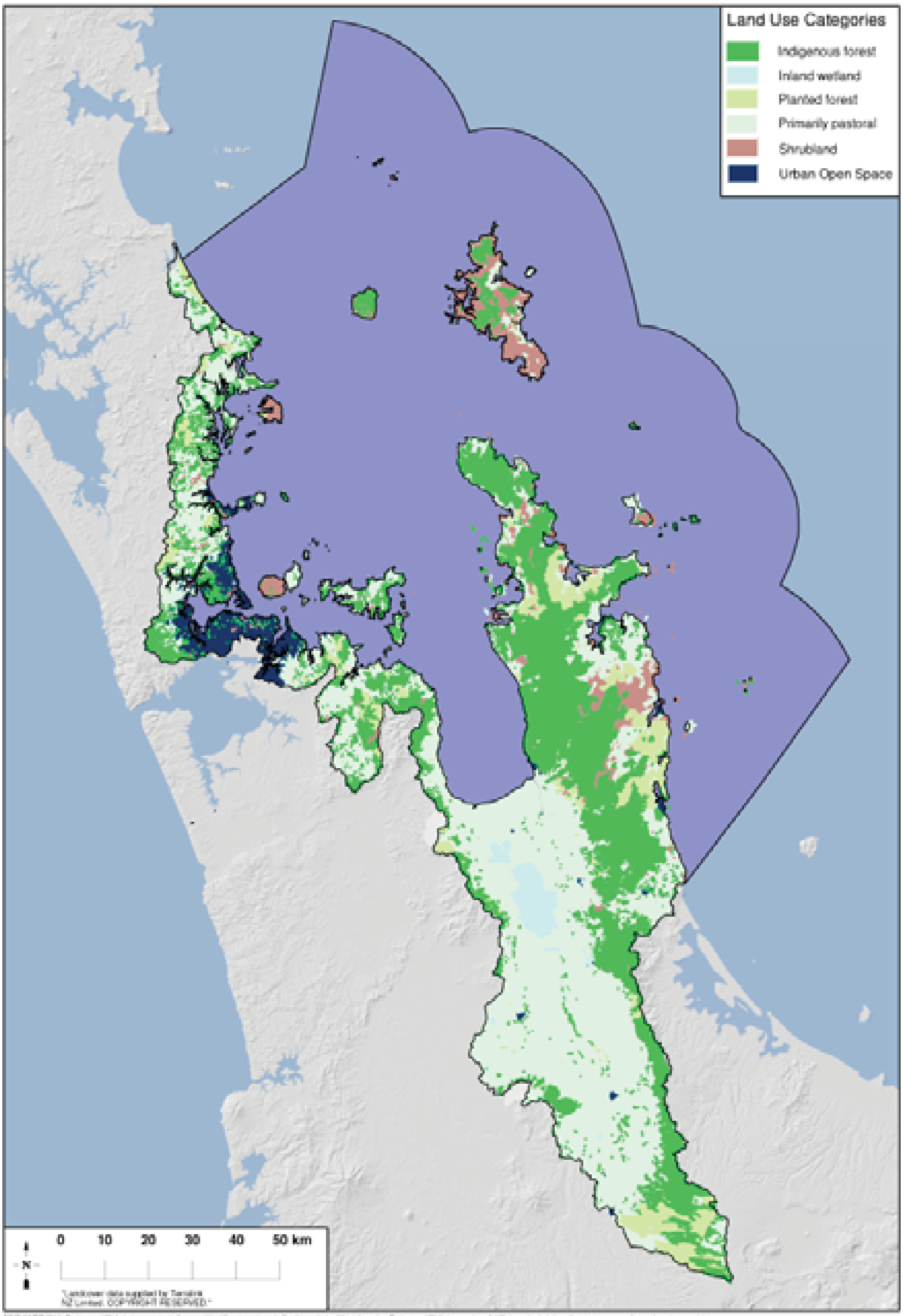


Figure 3.1 Land Use in the Gulf Catchment

The combined population of the Auckland and Waikato regions is forecast to grow by 474,700 people (33%) to more than 2 million people between 2001-2021. The population decline in inland areas of Hauraki and Matamata-Piako is forecast to continue (-12 and -9% respectively). Offsetting this, the population in those parts of the Auckland region within the Gulf Catchment, is forecast to grow between 2006 and 2010 marginally faster than for the region as a whole (15% as opposed to 14%)[7]. Growth in the Thames-Coromandel District is also expected to exceed the regional average. This pattern reflects a growing trend for urban and coastal intensification.

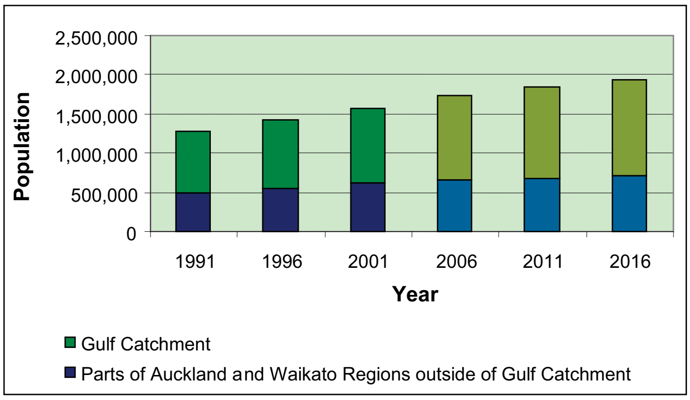


Figure 3.2 Population Growth

Settlement of the Gulf Catchment is dominated by the Auckland metropolitan area but there are many other coastal settlements (see Figure 3.3). Several of these have expanded rapidly in recent years, notably the commuter and retirement settlements of Orewa and Gulf Harbour north of Auckland and the holiday towns of Whangamata and Whitianga on the Coromandel Penninsula.

3.3 Increasing Affluence and Consumption

Mean household incomes in the Gulf Catchment have increased at a rate well above that of inflation during the period 1991 to 2001. During this period median incomes in the Waikato region generenally kept pace with national increases, posting a gain of around 30%. In Auckland, however, median incomes increased considerably more than the national average, growing 34% between 1991 and 2001. Moreover, median incomes in Auckland increased from just over 11% more than the national median incomes in 1991, to 14% more than above the national median income by 2001.

Increasing affluence has led to, amongst other things, more and greater use of motor vehicles. Between 1991 and 2001 the number of households in New Zealand with 2 or more cars rose 34.8%. In the Waikato region the growth was 36.2% over the same period and in the Auckland region the growth was almost 42%. Therefore, not only are there a lot more households around the Gulf and its hinterland, but those households typically have more cars than was the norm in 1991. Although the trend towards more vehicles per household is national, it is more pronounced in the Gulf and surrounding districts than it is for the nation as a whole.

Increasing wealth is manifest in many other ways (including, notably, the demand for second or holiday homes). As will be shown in the following chapters, this exerts pressure on the Gulf's resources in a variety of ways.

3.4 Increasing Development and Intensification

Traditionally, the growth of New Zealand's urban centres in the post-war period has been characterised by low-intensity residential, commercial and industrial areas on the outskirts of cities. In more recent years, the increasing cost of land and transport fuels, and the controls placed on peripheral urban development by local authorities, has led to an increasing density of population and dwellings within existing urban centres, characterised by the high rise apartments, terraced dwellings, and infill housing of Auckland City and elsewhere. Nevertheless, peripheral urban development (and associated earthworks and the creation of large expanses of hard surfacing) remains a strong characteristic of urban areas (particularly in Albany and East Tamaki).

Intensification of population and land development is not confined to Auckland.

[7] Note, all forecasts assume a medium growth scenario.

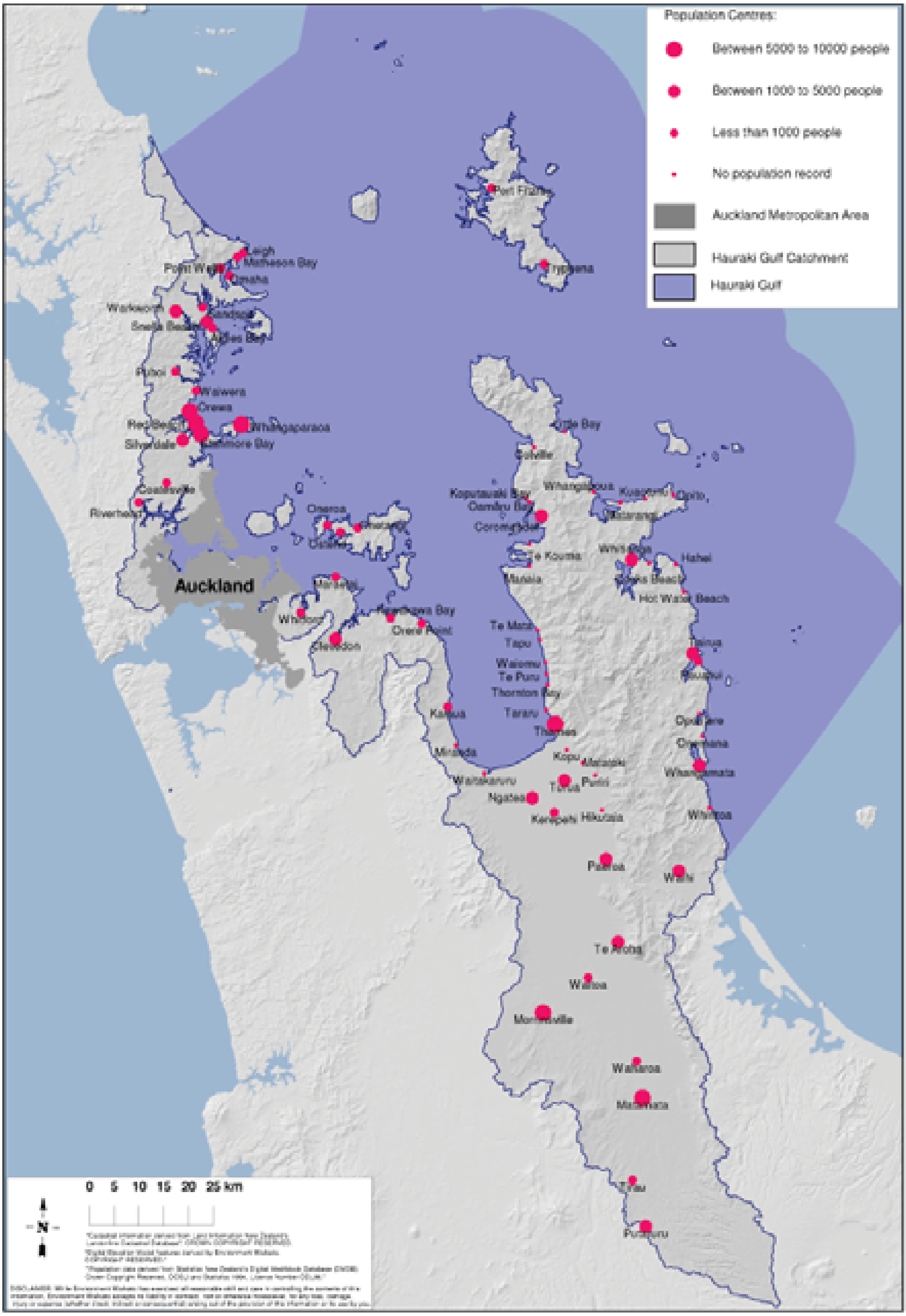


Figure 3.3 Centres of Population in the Hauraki Gulf Catchment

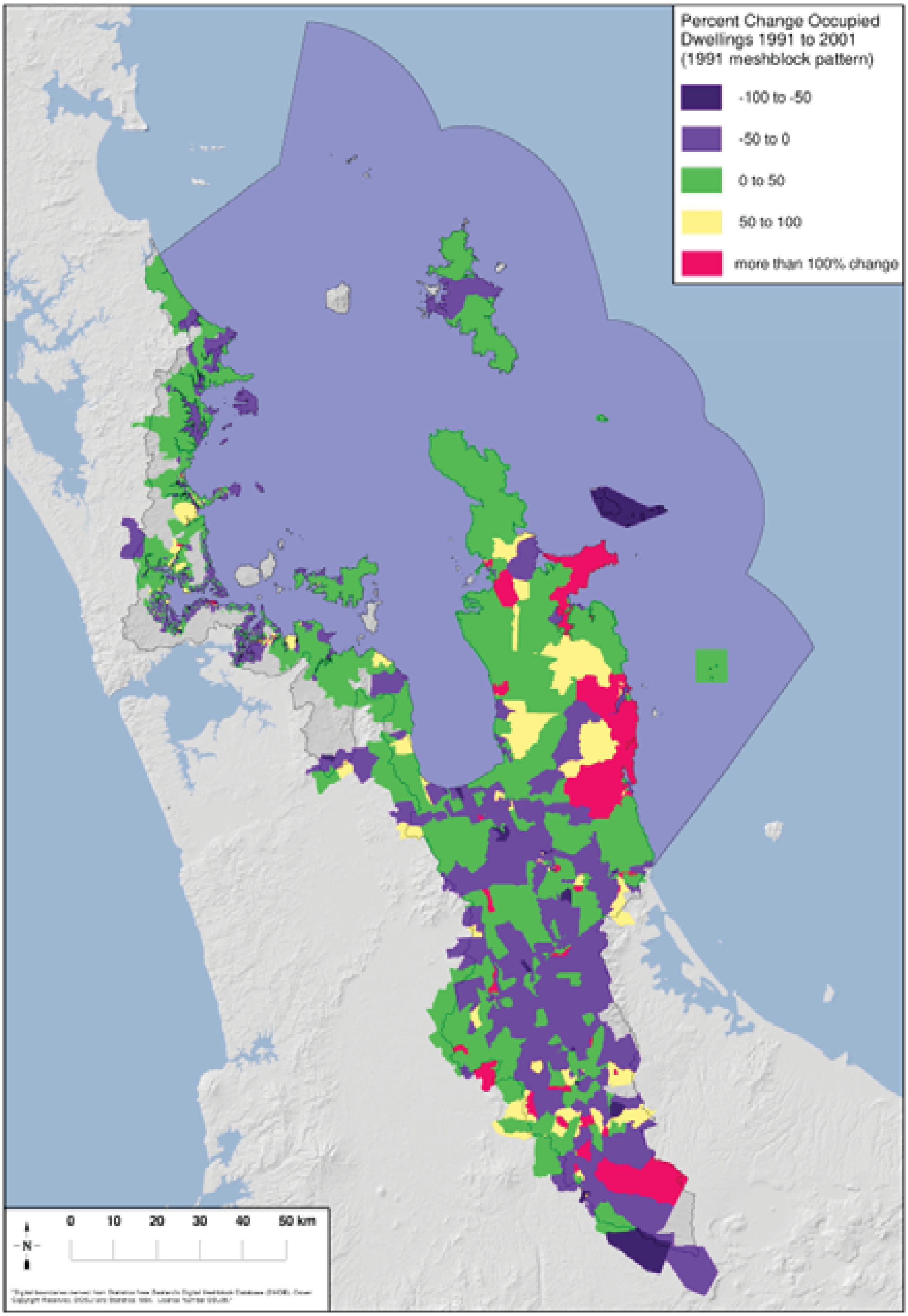


Figure 3.4a Percentage change in occupied dwellings 1991-2001

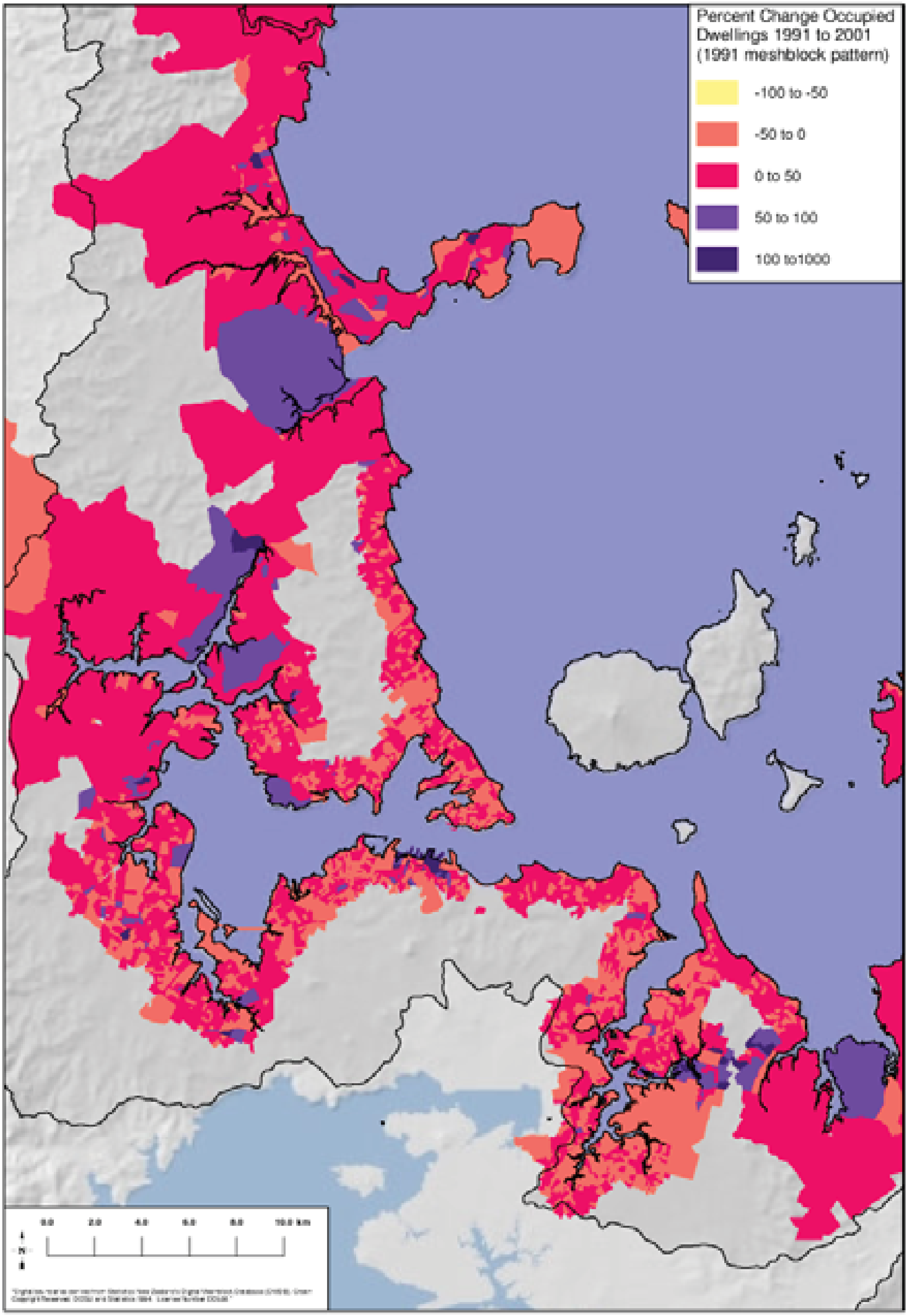


Figure 3.4b Percentage change for occupied dwellings 1991-2001 for the Auckland Metropolitan area

Figure 3.5 Land Values within the Auckland Region and Thames Coromandel District

Source: Real Estate Institute of New Zealand (REINZ). Note: Residential property sales information is not collected in a way that allows the relevant Waikato sales data to be reported.

The Coromandel Peninsula has also experienced significant development as an increasingly affluent population demands second, holiday or retirement homes.

Intensification also occurs in the rural environment, as extensive land use gives way to value added production systems. Demand for subdivision for rural lifestyle development continues.

This pattern of social and economic change around the Gulf's margin and in its hinterland is not new, but it as shown in Figures 3.4a and 3.4b, it continues to result in significant change in many parts of the Gulf's catchment and is particularly acute in sought after coastal areas.

3.5 Increasing Land Value

As indicated above, increasing affluence has been a driver of coastal development in the catchment. The demand for coastal land is directly reflected in the value people pay for it. Figure 3.5 shows the significant growth in median sale prices in the Auckland Region and the Thames Coromandel District. The growth in residential property values in and around the Gulf reflects a well reported national trend.

Residential property prices in Auckland/Coromandel areas have increased from a median of $234,500 to $322,800 in just 5 years (a 37.6% gain from mid-1999 to mid-2004). In absolute terms, that is a gain of $88,300 per residential property. Although the national median sale price has increased more in proportional terms (41%) over the same period, the absolute gain outside of Auckland/Coromandel has been just $69,375.

This means that, while in mid-1999 the median sale price in Auckland/Coromandel was $65,000 more than the national median sale price, by 2004 that had risen to $84,000 above the national median. This is reflected in the trend lines indicated in Figure 3.5.

This trend has placed considerable pressure on housing affordability, lifestyle choices and the demand for further land development (and associated impacts)[8].

[8] Witness the series of articles on increasing subdivision and development, section prices, the loss of the 'traditional bach', and capacity problems associated with state highways and wastewater treatment plants, in the New Zealand Herald during July 2004, under the byline *Coromandel – The Big Squeeze*

4 Environmental Management in the Gulf

4.1 The Gulf and Integrated Management

Many improvements have been made in resource and environmental management in New Zealand over the past 20 years which have a bearing on the Gulf. These include the establishment of the Department of Conservation, a major reform of local government, the enactment of the RMA and the development of a quota management system for fisheries administered by the Ministry of Fisheries.

Although improvements were made, there are still enormous challenges in getting management integrated – to get different agencies to work together and the environment managed as a whole rather than in individual parts. These challenges are particularly important in areas like the Gulf that are affected by a variety of activities in a variety of locations – spanning many different jurisdictions.

The Forum was established in 2000 to help promote integration in the way the Gulf's resources are managed by the agencies (and tangata whenua), to facilitate communication, co-operation, and co-ordination, and to recognise the relationship of tangata whenua with the Gulf.

4.2 The Hauraki Gulf Forum

As indicated in Chapter 2, the Forum draws on representation from three government departments (the Department of Conservation, Ministry of Fisheries and Ministry of Maori Affairs), six representatives of the tangata whenua of the Gulf (appointed by the Minister of Conservation after consultation with the tangata whenua and the Minister of Maori Affairs), and twelve local authorities (see Box 4–1).

The Forum is tasked with preparing a list of strategic issues and priority actions, and with regularly reviewing both. It is required to work with its constituent parties to:

- facilitate and encourage co-ordinated financial planning
- obtain, share and monitor information on the state of the environment
- promote and advocate integrated management
- encourage, share, and co-ordinate and disseminate educational and promotional material.

4.3 Administrative Boundaries of Local Authority Members

The various constituent members of the Forum have different functions and different jurisdictional and administrative boundaries. These boundaries bear little relationship to the Gulf and its catchment as a whole. This is one of the main justifications for having a forum where all those whose actions affect the Gulf, can communicate and be encouraged to co-ordinate and co-operate.

Box 4–1

Local Authority Members of the Forum

The following local authorities are members of the Forum:

- Auckland Regional Council ("ARC") and Waikato Regional Council ("Environment Waikato")
- Auckland, Manukau, North Shore and Waitakere City Councils
- Franklin, Hauraki, Matamata-Piako, Rodney, Thames-Coromandel and Waikato District Councils

Box 4–2

Main environmental management statutes implemented by constituent parties

- The Resource Management Act 1991 (the RMA) requires local authorities to plan for and address the environmental effects of land use, subdivision and development, and to monitor the state of the environment, and the effects of their management actions. It allocates a management role to the Minister of Conservation, in conjunction with regional councils, where the coastal marine area is concerned. The effects of aquaculture are addressed under the provisions of both the RMA and the Marine Farming Act 1971.
- The Fisheries Acts 1983 and 1996 allocate responsibility for the management of New Zealand's marine fisheries to the Minister (and hence Ministry) for Fisheries.
- The Conservation Act 1987 gives powers to the Minister (and hence Department) of Conservation to create and manage conservation estate, including forest parks, and advocate for conservation. The Department also administers the Marine Mammals Protection Act 1978 and the Wildlife Act 1953, among other conservation-oriented statutes.
- The Reserves Act 1977 gives local authorities and the Department of Conservation the power to create and manage publicly owned reserves for the benefit of their communities.
- The Marine Reserves Act 1971 gives public agencies the power to initiate and manage marine reserves in New Zealand's territorial waters.
- Both the Historic Places Trust and local authorities have responsibilities under the Historic Places Act 1993, relating to the protection of archaeological sites and heritage buildings.
- The Biosecurity Act 1993 devolves responsibility for the management of pests and weeds to the Department of Conservation, local authorities, and private landowners

The jurisdictional boundaries of constituent members are shown in Figure 4.1

All the public agencies who are members of the Forum have specific statutory responsibilities under other legislation. Tangata whenua exercise kaitiakitanga. The Forum itself has no specific authority to manage the Gulf through regulatory or other means.

The environmental management of the Gulf is undertaken by the individual Forum members under a raft of different statutes. The key environmental statutes (and commensurate responsibilities) are set out in Box 4–2.

However, the Hauraki Gulf Marine Park Act identifies, as a matter of national importance, both the interrelationship between the Gulf, its islands, and catchments, and the ability of that interrelationship to sustain the life-supporting capacity of the environment of the Gulf and its islands. The Act recognises that the Gulf's ability to support life extends beyond soil, air, water and ecosystems to the needs and well-being of people and communities, including tangata whenua.

The Act provides for *integrated management* to occur in a number of ways. First, through its effect on the application of other statutes. Second on the creation of the Marine Park. Third in Deeds of Recognition.

4.3.1 Relationship to Other Statutes

The Hauraki Gulf Marine Park Act applies across 21 statutes. It requires local authorities to ensure that the policy statements and plans they prepare under the RMA do not conflict with its purpose and management principles. The Act's purpose and management principles must also be given regard to by consent authorities, i.e., the local authorities and the Minister of Conservation acting in consideration of applications for resource consent under the RMA.

The Act gives its purpose and management principles the status of a New Zealand coastal policy statement under the RMA. Finally, it requires that the conservation management strategies and plans prepared by the Department of Conservation do not derogate from its purpose and management principles.

4.3.2 Marine Park

The Marine Park protects important areas with a lived-in, worked-in environment. Among other things, the purpose of the Marine Park is to protect in perpetuity the Park's natural and historic resources, including scenery, ecological systems and natural systems, for their intrinsic worth and for the benefit, use, and enjoyment of the people and communities of the Gulf and New Zealand.

The Act provides for additional public and private land to be included in the Marine Park at any time (the latter with the consent of the owner, and where the land concerned is covenanted for protection). One area of private land on Waiheke Island

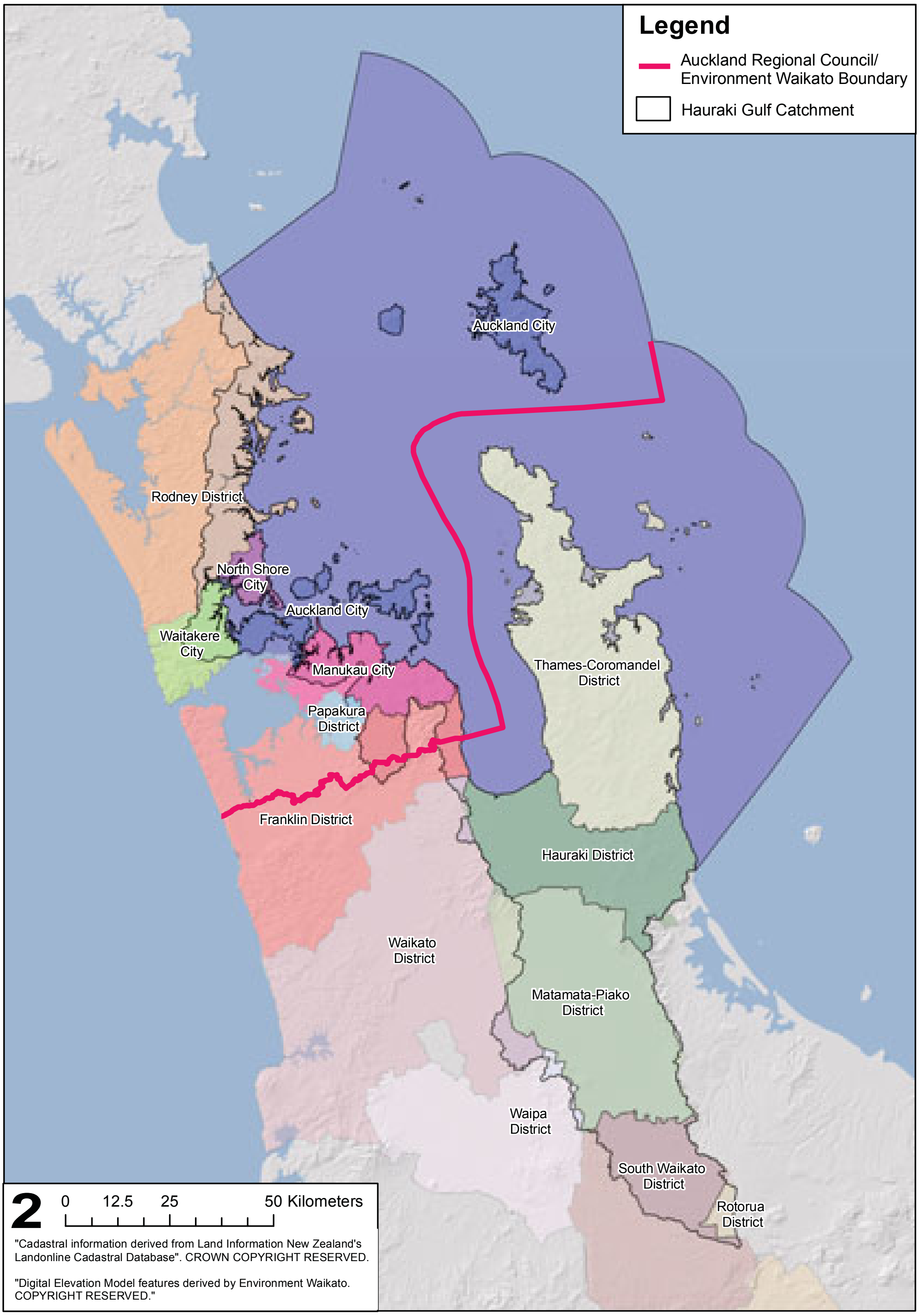


Figure 4.1 Jurisdictional boundaries of constituent parties

has been included within the Marine Park since enactment. The Act also provides for taiapure-local fisheries and mataitai reserves to be included in the Marine Park, with the consent of the tangata whenua.

4.3.3 Deeds of Recognition

The Act provides for the Crown or local authorities to enter into deeds of recognition with tangata whenua, for the purpose of acknowledging any aspect of a relationship that tangata whenua may have with any land, foreshore or seabed in the Marine Park. The purpose of such deeds is to identify opportunities for contributions by tangata whenua to the management of a particular area by the Crown or local authorities.

5 Water Quality of the Gulf

Key points

- Sediments are contaminated in harbours and estuaries with urbanised catchments, particularly those in the Auckland region with a longer history of settlement. Zinc concentrations are rising rapidly. Lead concentrations have fallen since lead was removed from petrol.
- Sediment has been accumulating at a greatly increased rate in estuaries and harbours of the Gulf as a result of land use changes over the past 150 years. This has potentially serious ecological consequences.
- Beaches in the Gulf are generally suitable for swimming most of the time. Some beaches may be temporarily unsuitable for swimming after heavy rain.
- Auckland's northern east coast waters are of good to excellent quality.
- Water in the outer Waitemata Harbour is of variable quality and is affected by urban contaminants. Mahurangi Harbour and the upper Waitemata Harbour have generally good water quality.
- Tamaki Estuary is one of the most impacted water bodies in the Auckland region. However, encouraging trends of improvement in some nutrients and other water quality measures have been observed over the last few years.
- Many rivers and streams in the Gulf Catchment are in poor condition.
- Information on both water quality state and pressures is not collected in a uniform way throughout the catchment. This makes it difficult to obtain an overall picture of water quality in the Gulf.
- Key pressures on water quality include stormwater, wastewater and agriculture. These are directly related to the underlying pressures of urbanisation, population growth and land use change.
- We do not have enough information to be confident about the effects of some pressures on water quality. For example, septic tanks are reported to be causing water quality problems in many areas, but few of these have been investigated.
- Agencies and communities are taking action on a wide range of fronts to improve water quality. The multi-million dollar approach to stormwater management in the Auckland region is a major project with the potential to reap long-term gains for water and sediment quality. Riparian protection and restoration works throughout the catchment can also have important water quality benefits and should continue to be supported.

5.1 Introduction

Through the processes of tides, currents, upwellings, downwellings and freshwater inputs from rivers the water of the Gulf is constantly changing, recirculating and replenishing.

This water is shared by many users, among them natural biota and humans, who use it in many ways. Good water quality is vital for healthy well functioning marine ecosystems.

The community benefits from the ability to sail on, swim in, fish, gather shellfish from, or simply admire the view of the Gulf's sparkling waters. These waters are also a vital economic resource. Maintaining the water quality of the Gulf is important for commercial fishing, aquaculture, tourism and for the general image of those businesses located around the Gulf's shores.

For these reasons, the Forum has identified water quality as a key value and a strategic issue for the Gulf (see Box 5–1).

Water quality in the Gulf is determined both by the activities in its catchment and natural ocean processes. Catchment activities can lead to pollution of streams and rivers and thus deterioration of water quality at estuaries, harbours and beaches.

Human activities over the past 150 years have extensively modified the Gulf Catchment. This has had major consequences for water quality. Loss of

Box 5–1

Strategic Issues and Objectives

The major issues identified by the Forum relating to water quality and sedimentation in the Gulf are:

- The waters of the Gulf are being locally degraded by the cumulative effects of many diverse uses.
- The effects of activities managed by different Forum members in and around the Gulf, and in its catchment, can be manifested beyond the jurisdiction of each management agency.
- Localised and cumulative effects of water quality are degrading mahinga mataitai and other taonga valued and used by tangata whenua.
- Activities occur in the catchments of the Gulf which result in accelerated erosion of soil and consequential accelerated sedimentation of estuaries and harbours.

The Forum identified the following objectives for water quality and sedimentation in the Gulf:

- The water quality of the Gulf continues to provide for a diversity of habitats and experiences, including the safe harvesting of kaimoana and exercise of customary rights, swimming, boating and aesthetic enjoyment.
- The waters of the Gulf do not receive inputs either directly or indirectly from human activities that exceed the assimilative capacity of natural processes.
- Communities in and around the Gulf are aware of and take responsibility for the effects of their activities on water quality and ecology in the waters and the catchment of the Gulf.
- The management of point source and non-point source discharges to the waters of the Gulf, including its catchment, is seamless with all management agencies and resource users working towards common water quality objectives.
- Erosion of soil and movement of sediment into waterways resulting from activities of people using the catchments of the Gulf is minimised.

large areas of forest cover has resulted in increased sediment loading to streams. This can result in increased siltation of harbours and estuaries.

The catchment for the Gulf is large, covering an area of 807,751 hectares[9] (8078 km2). It extends from Mangawhai in the north and south to Putaruru in the Waikato (see Figure 1.1).

The Gulf Catchment is diverse. Both rural and urban activities give rise to pollutants that enter waterways. These can then enter coastal waters.

Stormwater runoff carries sediment and contaminants from roads, residential and industrial areas into the waters of the Gulf. Large farming areas, particularly dairy farming, are located in the catchment. This includes the Hauraki plains and farming communities around Morrinsville, Matamata and Tirau (see Figure 3.1). Waste excreted by farm animals, including nutrients and bacteria, enters streams and rivers which flow into the Gulf. The Coromandel Peninsula, with its erosion-prone ranges and rapidly growing coastal settlements, has different water quality challenges. Increasing population places pressures on wastewater treatment systems. Poorly functioning septic tanks can overflow and cause localised pollution.

Water quality is not uniform across the Gulf. Many of these effects on water quality are localised. Estuaries and harbours in the Auckland urban area have a long history of development, and many show effects of this in their sediments. Some harbours outside the Auckland metropolitan area, including Mahurangi and Whangamata, are also showing the cumulative effects of a range of land use activities in their catchment. This is particularly obvious in terms of sediment build-up.

5.2 Maori Cultural Perspective

Water quality is of core importance to Maori. It is vital for sustaining life. Traditionally, each body of water was considered to have its own source of life, its own mauri (Durie 1994). If the mauri of one body of water comes into contact with another, both are placed at risk and the ecosystem equilibrium is disturbed (Durie 1994). The mixing of water or the separation or division of natural systems can markedly affect the mauri of many places. Rivers or streams flowing into one another, into a lake, into a harbour or estuary, are often assessed with different mauri. That mauri is often assigned either to specific parts of a river, stream, or lake, or applied to the whole ecosystem. Maori environmental concepts focus on keeping all parts of the natural environment pure, unpolluted and connected.

There is generally a belief that mauri can not be totally extinguished and that all systems have"a glimmer of hope" when it comes to sustaining life. It is also recognised that mauri can be enhanced to some extent

[9] Includes islands. Area calculation by ARC, July 2004

through the actions of kaitiakitanga and by the actions of other agencies.

Water quality is also key to maintaining the intregrity of the marine environment. Degradation of water quality may mean that shellfish can no longer be gathered in certain areas (e.g., because of pollution with human waste from septic tanks), or their populations may be diminished to the point that they can no longer be gathered. This has grave implications for the cultural needs of tangata whenua, including the mana of iwi in providing for guests.

Maori environmental concepts are holistic encompassing the human presence within the natural, spiritual and physical landscape. This holistic approach is used to identify where a problem originates and determine what is, or is not practical in terms of enhancing mauri. If the mauri is defiled or weakened, it is necessary to identify the source of the problem, define the stress or pressure placed on the system, and then work to remedy or remove that problem.

Box 5–2

Water in te Reo Maori

An indication of the extent of concern about water quality amongst Maori can be found in contemporary use of te reo Maori. Te Reo Maori uses two possessive particles 'a' and 'o'. 'O' is used for items of superior or tapu status. 'A' is used for inferior items. Traditionally water is assigned the 'o' category (superior or tapu). However, today there is discussion about whether water has become so degraded in general that it should be assigned to the 'a' category.

5.3 State of waters in the Gulf

Water quality is monitored for different reasons in different parts of the Gulf. Water quality indicators are not uniformly available or interpreted consistently across the Gulf. The choice of sites and indicators monitored depend on pollution sources known or suspected to be present.

At some sites monitoring is undertaken regularly over a long period of time providing long term information. In other areas monitoring might be undertaken for a specific time period for a particular purpose.

Water pollution is assessed by monitoring:

- *water quality:* for nutrients and contaminants in the water column (see sections 5.3.1 to 5.3.3). Stormwater contaminant concentrations (e.g., zinc) in sea water are highly variable, both spatially and temporally, and are generally low. These contaminants are therefore not measured in sea water. Instead, *sediment* and *shellfish* are monitored for these contaminants as integrators of water quality over time.
- *sediment:* for contaminants bound to sediment, which accumulate near the shore (see section 5.3.5)
- *shellfish:* for metals and organic contaminants (e.g. pesticides) which can build up in shellfish as they filter water during feeding over time (see section 5.3.6).

In some locations, indicator organisms and populations are also monitored as a means of detecting long-term changes in water quality and, importantly, assessing their ecological effects.

The presence of *algal blooms and biotoxins* is also a significant water quality issue and is discussed in section 5.3.7.

Water temperature is also monitored in the Gulf (see Box 5–3). Temperature changes can exacerbate the impact of pressures on water quality and marine ecology.

5.3.1 State of water at our beaches – is it safe to swim?

At times it may not be safe to swim at our beaches because of the presence of viruses, bacteria or protozoa which can cause illness. These can enter water from overflows of wastewater (either from blockages or faults in the wastewater system), entry of stormwater into sewerage pipes during wet weather, or from on-site wastewater treatment and disposal system failures. Runoff, during and after heavy rain, also carries contaminants from roads, other hard surfaces and pastures into rivers and stormwater systems and, ultimately, to beaches. Other sources of contamination include illegal wastewater connections to the stormwater system, and leakage of

Box 5–3

Getting warmer

Water temperature at Auckland's East Coast and Waitemata Harbour sites increased by an average of 0.24^{0}C per year (1991-2000). The same pattern was observed in streams – all except one stream monitored by ARC showed an increase in temperature of approximately 0.25^{0}C per year (ARC 2000).

Table 5.1 Beaches exceeding guideline action level from 2001 to 2004[11]

Beach	District	No. of routine sampling events 2001 – 04[12]	Exceedances of guideline action level (two consecutive samples > 280 enterococci/100mL)
Wenderholm	Rodney	70	1
Waiake Beach	North Shore City	70	1
Murrays Bay	North Shore City	70	1
Wairau Outlet	North Shore City	70	1
Soldiers Bay	North Shore City	70	1
Island Bay	North Shore City	70	2
Hellyers	North Shore City	46	1
Judges Bay	Auckland City	71	1

wastewater into the stormwater network (exfiltration) in areas with old leaky pipes.

To determine whether it is safe to swim, routine monitoring is conducted by five local authorities[10] at 86 beaches across the Gulf during the summer season.

- Rodney District Council – 14 sites
- North Shore City Council – 27 sites
- Auckland City Council – 15 sites
- Manukau City Council - 13 sites
- Environment Waikato - 16 sites

Results are used to inform the public about whether it is safe to swim, and to report on beach water quality over time. Monitoring results are analysed against the national guidelines outlined in Box 5–4. Water is *unsuitable* for recreational use when the *'action'* level is exceeded.

Most of the time, it is safe to swim at Hauraki Gulf beaches. From 2001 to 2004, national guidelines for bathing suitability were exceeded on only nine occasions during routine monitoring (see Table 5.2)

It is important to note that these results are for routine weekly monitoring only. Beaches may be unsuitable for swimming on a greater number of occasions than routine monitoring indicates. As monitoring is conducted just once a week, and only during the summer season, it will not detect all occasions on which beaches are unsafe for swimming.

In particular, beaches may sometimes be unsuitable for swimming because of wastewater overflows, especially during heavy rain. For this reason, most local authorities advise against swimming for 24 to 48 hours after heavy rain, depending on the beach.

Faecal contamination of beaches can occur during heavy rain because:

- rainfall washes contaminants (e.g. animal wastes) into stormwater, which then drains to beaches;
- stormwater can enter the wastewater system during heavy rain, leading to sewer overflows.

Enterococci levels are closely related to rainfall. In the Auckland region, for example, the alert guideline level was reached far more often in 2003-04, which was relatively wet, than in the much drier 2002-03 season.

It is not currently possible to obtain comprehensive information on the number of occasions on which beaches were unsuitable for swimming because of wastewater overflows. However, it is likely that many urban beaches are unsuitable for swimming because of wastewater overflows on more occasions that routine monitoring indicates. In North Shore City, for example, more warning signs were erected at beaches because of wastewater overflows than because of guideline exceedances detected during routine monitoring between 2001-2004 (North Shore City 2004a).

Single exceedance data

Another important factor to consider in assessing suitability of beaches for swimming is that not all local authorities monitor beaches in a way that allows comparison with national guidelines. National guidelines require a second sample to be taken within 24 hours of the first exceedance of 280 enterococci/100mL. The action level is triggered only if this second sample also exceeds 280 enterococci/100mL.

However, many local authorities do not take this second sample. This can be because of limited resources, practical difficulties, understanding of individual beach dynamics gained from years of monitoring, differences in applying guidelines, or differences in reasons for monitoring (e.g., state of the environment reporting vs public health alerts). This

[10] Data for Waitakere City Council has been excluded from this report because (i) only two of the council's beach monitoring sites are in the Gulf and (ii) electronic data was not available for 2001-2003.

[11] Data on exceedance of action levels is only available for those local authorities which take follow-up samples after single exceedances of 280 enterococci/100mL

[12] Excludes follow-up sampling events within 24 hours of initial exceedance of 280 enterococci/100mL

Box 5–4

What are the guidelines?

Monitoring of bathing beaches uses enterococci, a type of bacteria, as an indicator of the potential presence of faecal material. Enterococci is used as it is more closely correlated with health effects than other indicators (Ministry for the Environment and Ministry of Health 2003). However, enterococci can also originate from non-human sources, including birds, dogs, stock and decomposing seaweed.

The most recent Ministry for the Environment Microbiological Water Quality Guidelines (2003) set three 'modes' for bathing beach waters, depending on the level of enterococci present in a water sample.

- **Surveillance/Green mode:** no single sample greater than 140 enterococci/100ml (continue routine weekly sampling).
- **Alert/Amber mode:** single sample greater than 140 enterococci/100ml (increase sampling to daily).
- **Action/Red mode:** two consecutive samples greater than 280 enterococci/100ml within 24 hours (erect public warning signs).

The Ministry for the Environment has also developed national indicators for recreational beach water quality. However, it has not yet determined how these should be calculated.

The indicators chosen by the Ministry are:

- the percentage of monitored beaches in each beach grade.
- the percentage of the season beaches or coastal areas were suitable for bathing or shellfish gathering.

The first indicator cannot be used in this report as most local authorities have not yet graded beaches. The Ministry has not yet determined how the second indicator (percentage of the season beaches or coastal areas suitable for bathing) should be calculated. It is not clear whether a single exceedance of the 280 enterococci/100 mL level is sufficient, or whether two consecutive exceedances are required, or how calculations should be performed for local authorities which do not conduct follow up sampling. Work is ongoing, both at a national level and by individual local authorities, to agree on the most effective way of reporting bathing beach water quality for state of the environment purposes.

means that exceedances of the action level cannot be reliably compared across the Gulf, as results are not available for all areas.

To allow some comparison of all beaches across the Gulf, single exceedances of the 280 enterococci/100mL are set out in Table 5.2. A single exceedance does not mean that a beach is unsuitable for swimming. This can only be determined by follow-up sampling. Single exceedances are reported here because of the absence of any other universal indicator that can be applied across the whole Gulf.

Analysis of single exceedance data also found that water quality at bathing beaches in the Gulf is generally very good. For the past three years, water quality at beaches across the Gulf has been below 280 enterococci/100mL at least 96% of the time[13]. There are some differences in beach water quality between different locations in the Gulf (see Table 5.2 and Figure 5.1). However, in most cases any elevated percentages are related to localised causes at just a few beaches.

The small number of occurrences of consecutive exceedances in areas where follow-up sampling is conducted (see Table

Table 5.2 Single exceedance of 280 enterococci/100mL at bathing beaches in the Gulf 2001-2004

Notes: Data for Waitakere City Council are excluded as (i) only two of this council's beach monitoring sites are in the Gulf and (ii) electronic data were available only for 2003/04. Data for Auckland City includes Waiheke and Great Barrier Islands. Monitoring was not conducted on the Coromandel Peninsula and Firth of Thames in 2002/03.

Area	**% of sampling occasions**			
	01/02	02/03	03/04	All seasons (01/02, 02/03 and 03/04)
Coromandel Peninsula and Firth of Thames	3.1%	-	1%	2.2%
Auckland (Rodney, North Shore, Manukau, Auckland City)	1.1%	4.5%	5.2%	3.8%
Rodney	0.4%	3.0%	0.6%	1.6%
North Shore	1.9%	3.2%	5.2%	3.7%
Auckland	0.8%	3.0%	1.7%	1.8%
Manukau	4.4%	7.0%	13.5%	8.3%

[13] All data pooled for 2001/02, 2002/03, 2003/04; calculation based on single exceedances of 280 enterococci/100mL

Box 5–5

Is it safe to swim?

It is difficult to give an overview of suitability for swimming in an area as large as the Gulf. This is because (i) monitoring of beaches for swimming is organised differently across the Gulf, and (ii) not all agencies apply guideline values in the same way.

Who monitors beaches?

Monitoring of beaches in the Auckland region is performed by territorial authorities. Rodney District Council, North Shore City Council and Auckland City Council cooperate through the Safeswim programme. Waitakere City and Manukau City undertake monitoring separately for their areas. Franklin District Council does not monitor any beaches in the Gulf. Firth of Thames and Coromandel beaches are monitored by Environment Waikato, rather than by territorial authorities. This is done primarily for state of the environment monitoring purposes[1].

Monitoring period

Different local authorities monitor their beaches for different periods of time. Auckland beaches are monitored for over 20 weeks of each summer season (approximately October to April). However, beaches on the Coromandel and Firth of Thames are only monitored for 12 weeks every second year. This means it is likely there will be less exceedances recorded at Coromandel and Firth of Thames beaches, than if they were monitored as frequently as Auckland beaches.

Results are reported for the 2001/02, 2002/03 and 2003/04 seasons. This period of time was chosen because this is the earliest period for which data was available for most local authorities in a fairly consistent format.

It is recognised that beach water quality monitoring results, like any environmental data set, vary considerably from year to year, and that the longer the monitoring period, the more reliable the results. Also, bathing water quality data are particularly susceptible to climate influences (particularly rainfall) and can vary substantially. Only limited analysis was practical in preparing this report. Descriptions of some longer-term trends observed from longer monitoring periods are included where available.

Applying guidelines

Not all agencies in the Gulf apply guideline values in the same way to determine whether beaches are suitable for swimming. Crucially, not all agencies conduct resampling within 24 hours of a single sample exceeding 280 enterococci/100mL. Some may issue a warning at a beach on the basis of a single exceedance. Others have observed over many years that enterococci levels drop within 24 hours at particular beaches, so only conduct resampling at beaches where elevated enterococci levels are an unusual event. Even for local authorities which do undertake resampling, results of follow-up sampling were not always available when compiling this report.

Earlier guidelines defined a single exceedance of 277 enterococci/100mL as the action/red mode, requiring erection of warning signs (Ministry for the Environment and Ministry of Health, 1998). To date, Manukau City Council has used the 277 enterococci/100mL level rather than 280 enterococci/100mL.

These differing approaches make it difficult to compare beach water quality across the Gulf.

5.1) indicates that in the majority of cases, contamination does not persist.

Rodney District

Rodney District Council undertakes beach water quality monitoring in accordance with the national guidelines as part of the regional Safeswim Programme with Auckland City and North Shore City Councils. Monitoring is undertaken at 14 sites around the district.

In the three years of monitoring, there has been only one exceedance of the guideline action level during follow-up sampling. This exceedance was thought to be due to extremely heavy rainfall combined with strong onshore wind gusts driving land runoff back to the beach (Wenderholm).

There have been a small number (11) of single exceedances of 280 enterococci/100mL, but these did not result in warning signs being erected because enterococci levels returned below health guidelines within 24 hours. These elevations may have been due to many factors including runoff after heavy rain, large amounts of seaweed, high tides and tidal movement, large numbers of seabirds or the presence of boats (Rodney District Council 2002, 2003, 2004). They were not considered by council officers to indicate a long-term trend of deteriorating water quality.

North Shore City

North Shore City Council undertakes beach water quality monitoring in accordance with the national guidelines as part of the regional Safeswim Programme with Auckland City and Rodney District Councils. Monitoring is undertaken at 27 sites around the city.

In the past three years of monitoring, there have been six exceedances of the guideline 'Action' level after follow-up sampling. This is a low proportion considering the large number of sites monitored. All of these exceedances were due to heavy rainfall on or the day before monitoring took place. Heavy rainfall in North Shore City can trigger overflows from the city's wastewater system and can also result in elevated bacteria levels in stormwater that enters the beaches via pipe outlets and streams.

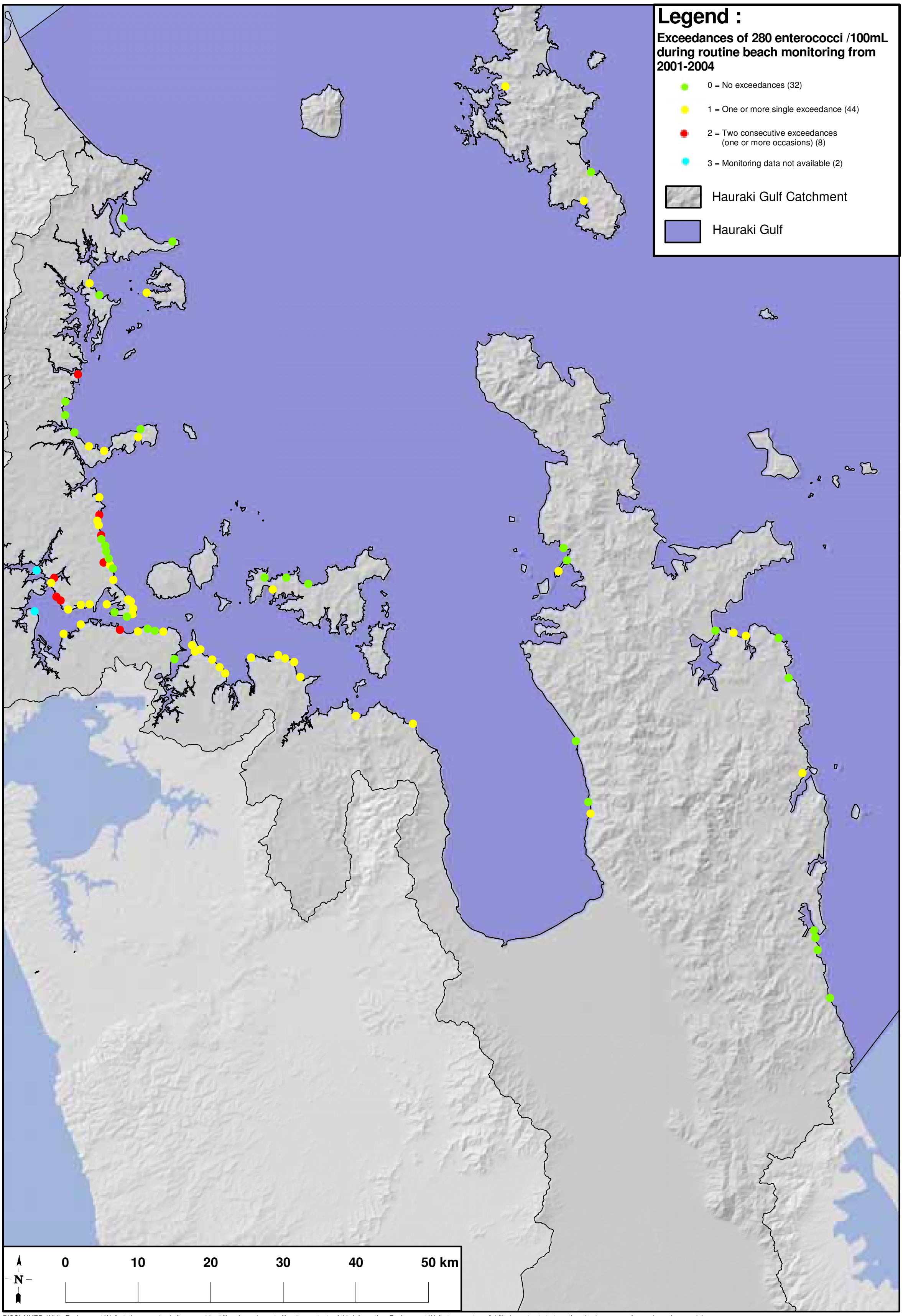


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Figure 5.1 Bathing beach locations and monitoring results

Single exceedances occurred on 65 occasions. The majority of these returned below health guidelines within 24 hours.

Auckland City

Auckland City Council undertakes beach water quality monitoring in accordance with the national guidelines as part of the regional Safeswim Programme with North Shore City and Rodney District Councils. Monitoring is undertaken at 15 sites - eight around the city, four on Waiheke Island and three on Great Barrier Island.

Auckland City's water quality can be affected by heavy rainfall, but any elevated bacteria levels usually return below health guideline levels within 24 hours.

In the past three years of monitoring, there has been only one exceedance of the guideline 'Action' level after follow-up sampling. The exceedance at Judges Bay was thought to be due to tidal and weather conditions. The water quality returned below health guidelines within 72 hours and it was not considered by Council officers to indicate a long-term trend of deteriorating water quality.

19 single exceedances occurred during the three years of monitoring.

Manukau City

Manukau City Council generally undertakes beach water quality monitoring in accordance with the national guidelines. The national sampling methodology is however modified due to local research and a developed understanding of how the city's beaches behave in particular weather conditions. Monitoring is undertaken at 13 sites in the Gulf.

Many beaches in Manukau City are shallow and poorly flushed. Also, northeasterly winds resuspend sediments. This may account for the comparatively high number of exceedances at some beaches. However, recreational water quality has been 'very good' at most beaches for the nine years that monitoring has been in place (Franks 2004). 65 single exceedances occurred during the three years of monitoring.

Catchment assessments at Howick, Mellons Bay and Cockle Bay indicate that elevated levels of enterococci are most likely to be derived from stormwater.[14] Several other beaches have gullies in their catchments which can be a source of non-human enterococci (e.g., birds, possums).

As for most locations in the Gulf, rainfall is the most common factor contributing to elevated levels of enterococci in the Manukau beaches (Franks 2002).

Coromandel Peninsula and Firth of Thames

Environment Waikato undertakes water quality monitoring every two years at 16 sites around the Coromandel Peninsula and Firth of Thames. This monitoring is undertaken primarily for State of the Environment reporting rather than for public health protection.

On the Coromandel Peninsula, water quality is generally considered to be 'excellent'. Water quality is particularly high at open coastal beaches. However, enclosed waters (e.g., estuaries/harbours) can have poorer water quality, especially after rain.

Beaches on the Coromandel Peninsula and Firth of Thames are monitored every second year. Therefore, there is less data available for these beaches compared with those in other parts of the Gulf.

There were eight single exceedances at Coromandel and Firth of Thames beaches during the two years of monitoring. For the 2003/2004 season, single exceedances of the 280 enterococci/100mL occurred only at the Pepe Stream (Tairua Harbour). As in other parts of the Gulf, bacterial levels in the Pepe Stream are often elevated after heavy rain.

Monitoring in previous years has also found occasionally high levels of bacteria at Wyuna Bay, Thornton Bay and Pepe Stream (Environment Waikato 1999).

5.3.2 State of water in the Gulf's harbours, estuaries and coastal areas

In addition to assessing safety for swimming purposes, water in some parts of the Gulf has been monitored for a range of other variables since the early 1990s. Most of this monitoring has occurred in the Auckland region. There has been very little monitoring of coastal waters[15] in the

[14] Franks, Manukau City, pers comm. 2004, and Franks 2004.

[15] Coastal water means seawater within the outer limits of the territorial sea and includes—
(a) Seawater with a substantial fresh water component; and
(b) Seawater in estuaries, fiords, inlets, harbours, or embayments.
(Resource Management Act 1991)

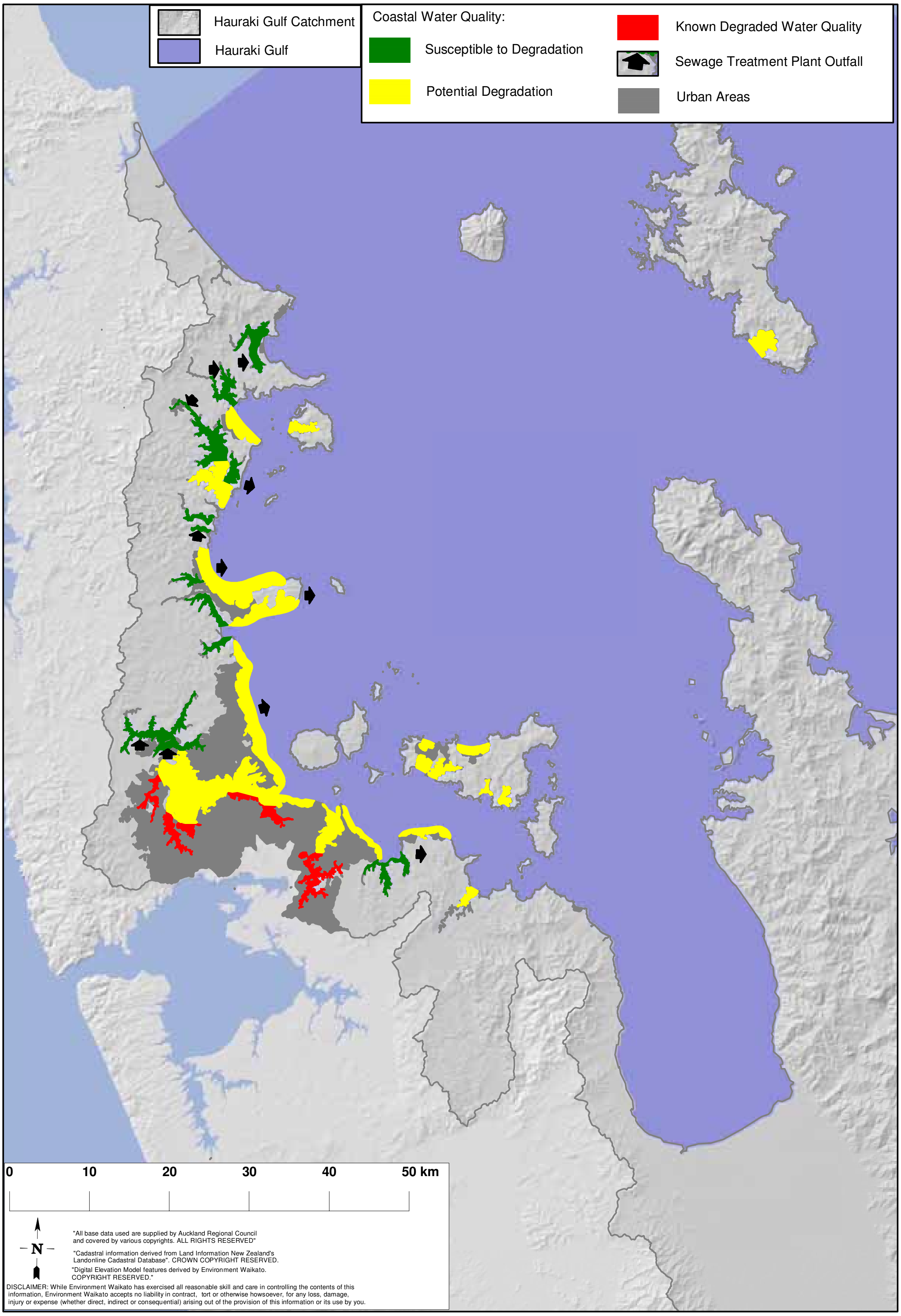

Figure 5.2 Coastal water quality in the Auckland region

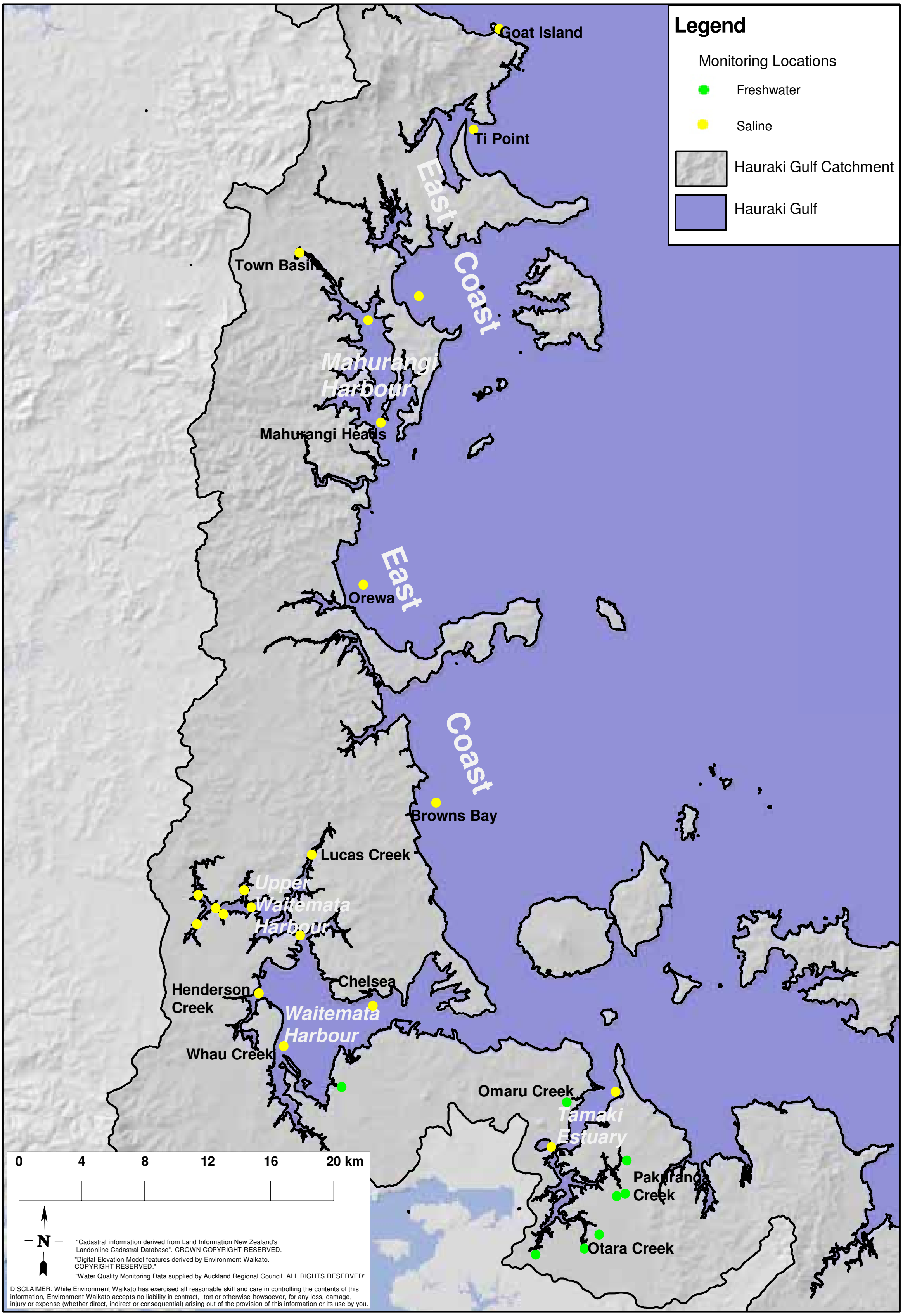

Figure 5.3 Water quality monitoring locations in northern Gulf

Waikato region, other than at bathing beaches.

An overview of water quality in the Auckland region is provided in Figure 5.2. The map includes areas of actual or potential water quality degradation. Key contributory factors include existing and future land use and susceptibility of receiving environments. While it is only broadly indicative, it shows that water quality is poorer closer to urban areas, and where dilution or dispersion is low (ARC 2002).

In Auckland, sea water has been monitored in the Waitemata, Mahurangi and Tamaki Harbours and along the East Coast since the early 1990s (see Figure 5.3). The indicators monitored are used to assess the effects of many human pressures on coastal waters, from both point and non-point sources.

Trends from long term baseline monitoring are presented from the early 1990s to 2000 in this report. Results for 2001 and 2002 have not been incorporated into long term trend analysis, as this only occurs every five years. However results for 2001 and 2002 were broadly similar to those from previous years (ARC 2002b, ARC 2002c). An explanation of water quality monitoring indicators is provided in the glossary.

Mahurangi Harbour

Mahurangi Harbour has generally good water quality (ARC 2002b, ARC 2003a). Water clarity is moderate to good, except during storms when sediments are mobilised (ARC 2003b). Suspended solids and turbidity are generally low. Suspended solids showed little change between 1992 and 2001 (ARC 2003a). Clarity is best at Mahurangi Heads.

Biochemical oxygen demand (BOD) levels were generally low in Mahurangi Harbour and are not changing, although occasional high levels were recorded. Waters in the Mahurangi Harbour are well oxygenated, though bacterial levels vary greatly and are much higher in the inner harbour. High levels in the Warkworth town basin are likely to be related to waste from ducks, rather than humans[16].

Nitrate-N values in the harbour were moderate to low and showed a downward trend over time. Levels were higher in the upper parts of the harbour than at the Heads. Phosphorus levels were also much higher in the upper harbour. Chlorophyll a levels have been monitored at Mahurangi and also at Browns Bay since 1993. However, insufficient information is available for trend analysis.

East Coast

Analysis of water quality trends from the early 1990s to 2000 found that Auckland's east coast waters are generally of good to excellent quality (ARC 2000). Results for Secchi depth, suspended solids and turbidity consistently show that water on the East Coast is twice as clear as waters in the Waitemata Harbour. Turbidity is decreasing at most east coast sites, and not changing at others.

Waitemata Harbour

Water in the Waitemata Harbour is of variable quality and is affected by urban sources. Analysis of results from 1991 to 2000 found that clarity in the Waitemata Harbour was similar to that in the Manukau Harbour (ARC 2000). Clarity was poorest at Henderson Creek. Turbidity is not changing significantly.

Some sites in the Waitemata Harbour have occasional elevations of faecal coliform concentrations, indicating urban runoff or movement of wastewater into stormwater drains during heavy rain. Enterococci concentrations were highest at Henderson and Whau Creeks. Increases in faecal coliforms were found at Chelsea and Henderson. Five sites in the Waitemata harbour had trends of decreasing dissolved oxygen (DO) concentration (approximately 0.10 mg/L per year; ARC 2000).

Upper Waitemata Harbour

The Upper Waitemata Harbour has generally good water quality (ARC 2003a). Most sites in the Upper Waitemata are well oxygenated. BOD levels are generally low, although occasional high levels have been recorded.

Long term median faecal coliform levels were elevated at two sites in the Upper

[16] Pers comm., Shane Kelly, ARC, August 2004

Box 5–6

Whangamata Harbour

Community concerns about the effects of treated wastewater on the Whangamata Harbour prompted Environment Waikato to investigate water quality in the harbour in 1999-2000.

During fine weather, water quality in most of the harbour was generally good (Vant 2000). This reflects the fact that the harbour is well-flushed, with the majority of water emptying to the sea during each tidal cycle. Bathing beaches were suitable for swimming, with very low levels of enterococci at both harbour and open coast bathing sites. However, freshwater flow volumes were below average during the time of study. It is suspected that water quality in the harbour could be worse in times of high rainfall or flooding.

Water quality was poorer, with elevated levels of bacteria and nutrients, where moderately contaminated freshwater inflows entered the harbour from rivers or streams. Likely sources of nutrients and bacteria entering the harbour included livestock and leakage of wastewater effluent spray-irrigated to forest (Vant 2000).

Subsequent investigations in 2001 confirmed that contaminant loading was much lower in dry than in wet weather (Vant 2001). For example, during the highest storm event, the total load of faecal coliforms was approximately 60 times greater than that observed during dry weather. Total phosphorus and nitrogen were 80 and 40 times higher, respectively, during high flow conditions.

Contaminant levels were measured in major streams and rivers entering the harbour. Most of the contaminants were found to be entering from diffuse runoff from pasture, pine forest and native bush. Leakage from spray irrigation of wastewater was also a major source of nitrogen entering the harbour (Vant 2001).

Disproportionately high loads of contaminants were found to enter from stormwater outfalls. The combined loads of faecal bacteria from two outfalls were approximately 20% of those from all streams, while turbidity and total phosphorus loads were 25-40% of those from streams (Vant 2001).

Foams and scums observed on the harbour could have a variety of possible origins, including naturally occurring estuarine foams resulting from wind and wave action on natural surfactants released by coastal plants (e.g., microalgae), and algal blooms of photosynthetic algae leading to aggregations of diatoms. The scums observed in Whangamata Harbour are likely to have been derived from natural processes, not wastewater (Vant 2000).

Waitemata. The Upper Waitemata had trends of decreasing suspended solids from 1993-2001. Nitrogen and phosphorus concentrations were low at all sites in the Upper Waitemata.

Tamaki Estuary

Tamaki Estuary is one of the most highly impacted water bodies in the Gulf (ARC 2003a). Water quality has been monitored since 1985. Water quality in the Tamaki Estuary is worse than that in the Mahurangi and Upper Waitemata Harbours. This reflects the land uses within its catchment. Several sites in the Tamaki Estuary have high faecal bacteria concentrations, probably derived from human sources. Low values of dissolved oxygen (DO) were recorded at Pakuranga Creek, Omaru and Otaki creeks in the Tamaki Estuary.

At times, total ammonia levels have greatly exceeded values harmful to fish (particularly at Otara Creek, Pakuranga Creek and Omaru Creek; ARC 2003a). Since 1998 levels have decreased markedly, and are now not considered to pose a risk on the basis of medians and trend analysis (ARC 2003a). Nitrite-N levels show similar trends, with previously elevated levels now decreasing. These changes may be due to improved reticulation and treatment of wastewater and stormwater (ARC 2003a). Nitrate-N levels in some parts of the Tamaki Estuary are high enough to potentially stimulate nuisance algal growth. These levels have changed little since monitoring began.

On the positive side, there are trends of improvement in suspended solids, dissolved oxygen, ammonium-nitrogen and phosphorus concentrations (ARC 2003a). BOD levels were generally low in the Tamaki Estuary and trending down. Very high levels have previously been recorded in the Pakuranga Creek. Suspended solid levels are also decreasing.

Coromandel Peninsula and Firth of Thames

There is no marine water quality monitoring programme in this part of the Gulf, other than the bathing beach surveys. Some localised studies have been done, particularly of Whangamata Harbour (see Box 5–6).

5.3.3 Nutrients

A recent study investigated sources of nutrients for the Firth of Thames and the open waters of the Hauraki Gulf, out to a line between Cape Rodney and Cape Colville (Zeldis 2004)[17].

During the time of the study (2000/2001), 65% of the dissolved inorganic nitrogen (DIN) entering the Firth of Thames came from rivers. Mixing between the Firth and the Gulf contributed the other 35%.

For the open Gulf waters, however, rivers supplied only 8% of the DIN, and sewage (mainly from Auckland) accounted for another 5%. The great majority came from ocean inputs, as Gulf waters mixed with offshore shelf water through the wide entrance between the two Capes.

The study found that very little DIN was mixed from the Firth out into the Gulf, or from the Gulf out into the open ocean because both the Firth and the Gulf are net consumers of DIN. This occurs through the process of 'denitrification', which converts the DIN to nitrogen gas, causing it to be released to the atmosphere. Denitrification is driven by bacterial communities, mainly in sediments, and is a very important process in preventing the build-up of high levels of nutrients in marine systems.

The percentage of nutrients supplied from ocean and river sources are likely to vary from year to year depending on upwelling of nutrient rich water over the continental shelf outside the Gulf. In the year of Zeldis' (2004) study, nutrient concentrations in both the Firth and the Gulf were relatively low, because upwelling was infrequent. However, other data have shown that nutrient concentrations have been much higher in other years, often for months on end, due to long periods when upwelling is strong and frequent. Such changes in upwelling can cause nitrate concentrations near the bed of the Gulf to vary two to three fold, as this water is mixed into the Gulf from off-shore.

At times when nutrient concentrations are low, rivers contribute most DIN to the Firth, as ashown above. However, average nutrient flows from rivers vary relatively little from year to year, compared with the much greater degree of variation in nutrient supplies from ocean sources. This means that during phases of upwelling, more DIN which enters the Firth comes from ocean sources and that over the long-term, variation in DIN supply to the Firth is influenced more by changes in ocean upwelling than by river flows.

5.3.4 Off-shore monitoring

There is no routine monitoring programme for the outer waters of the Hauraki Gulf (beyond 1-2 km off-shore). The only information is from occasional studies measuring water quality for a particular purpose (e.g., earlier investigations for disposal of dredged material; investigations of nutrient and chlorophyll a levels for aquaculture studies).

Information on chlorophyll a concentrations, which provide an indication of phytoplankton levels, has been collected over a number of years.

Figure 5.4 shows levels of the algal pigment chlorophyll a in the Hauraki Gulf in years of strong and weak upwelling (1998 and 1999, respectively). See section 2.2.2 and 5.3.7 for discussion on the link between upwellings, nutrient supply and algal growth.

5.3.5 Sediment contamination

Stormwater entering estuaries and harbours often carries contaminants, including heavy metals (e.g. zinc, lead) and organic pollutants. Only a small proportion of these contaminants are dissolved in the water column. Most enter waterways bound to fine sediment particles. These particles settle out in the inner zones of harbours and estuaries, where wave and current energy is insufficient to keep particles in suspension. These particles then build up in fine mud sediments. Over time, contaminants in these sediments can accumulate to toxic concentrations.

Organisms can be exposed to these contaminants either by ingesting sediment, or by taking up contaminants that have dissolved into seawater. At high concentrations, these contaminants can have adverse effects on the plants and animals living in or on these sediments.

Levels of these contaminants are now being monitored in the sediments of

[17] Note: the definition of Hauraki Gulf used in this study differs from that in the the Hauraki Gulf Marine Park Act and in this State of the Environment Report.

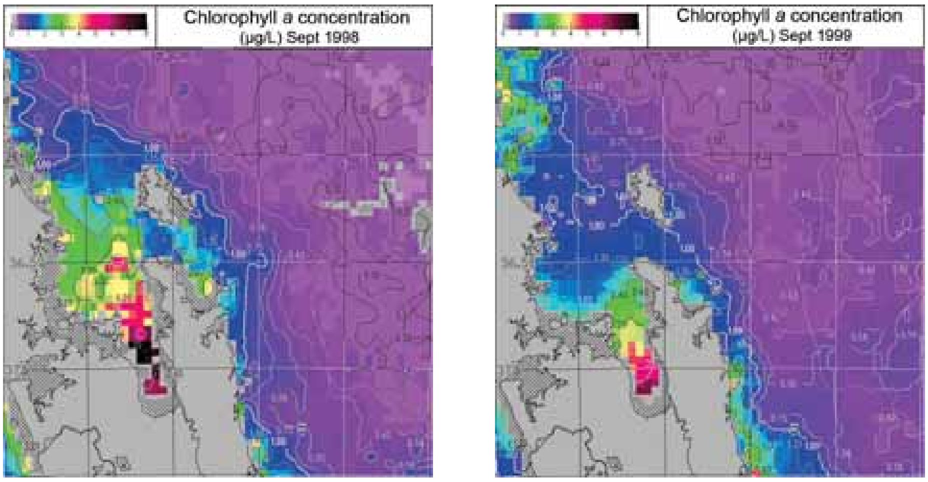

Figure 5.4 Chlorophyll a concentrations (µg/L)
Note: levels of chlorophyll a in the Firth of Thames are probably significantly overestimated, as it is difficult to distinguish between clorophyll a and other material (such as sediment) when generating these maps for near-shore environments.

Table 5.3 Environmental response criteria for sediment contaminant concentrations for the Auckland region
Source: ARC 2003d

Traffic light colour	Zinc (mg/kg)	Lead (mg/kg)	Copper (mg/kg)	PAH (mg/kg)
Green	<125	<30	<19	<0.66
Amber	125-150	30-50	19-34	0.66-1.7
Red	>150	>50	>34	1.7-3

urbanised estuaries and harbours in the Auckland region because of concerns about their possible effects on marine organisms. The primary stormwater contaminants of concern for Auckland are the heavy metals zinc, copper, lead, and polycyclic aromatic hydrocarbons (PAHs) (Kelly 2003).

Heavy metals can have a range of acute or chronic toxic effects on aquatic organisms. These effects include increased mortality and effects on growth and reproduction (ANZECC 2000, Grant and Hay 2003, Kennish 1997). Toxicity varies considerably between species and also depends on the form and concentration of the metals. Many effects are not immediately lethal, but over time may affect the ability of organisms to survive in their natural environment (Grant and Hay 2003).

Lead is toxic to aquatic life at very low concentrations, and accumulates in shellfish. Zinc is quite toxic to aquatic organisms, and can accumulate to high levels in many species. The toxicity of copper varies between species. Algae are particularly sensitive to copper.[18]

PAHs have been found to adversely affect marine life. PAHs have been linked with tumours in fish (ANZECC 2000). Effects vary widely depending on the bioavailability of PAHs and sensitivity of different organisms (Kennish 1997).

Some of these contaminants can also have effects further up the food chain. Shellfish and other organisms living in sediments are eaten by fish and birds. Some contaminants which have built up in sediment dwellers can thus enter other species, and may have toxic effects on these species also.

The ARC has monitored concentrations of zinc, copper, lead and PAHs in sediments since 1998. The primary purpose of monitoring is to determine trends of contaminant concentrations in estuarine areas affected by stormwater. Monitoring these contaminants is also useful for improving understanding of the relationship between contaminants and receiving environment and contributing catchment characteristics, identifying broad spatial patterns of contaminant distribution, and providing information on the effectiveness of stormwater management (Kelly et al. 2003).

Environmental response criteria have been developed for marine sediments to assist in determining the level at which contaminants may pose a risk to aquatic life. These criteria are based on recommendations in the ANZECC Water Quality Guidelines (ANZEEC 2000) and other internationally recognised guidelines (ARC 2003d). Concentrations are classified as green (low), amber (elevated) and red (high) (see Table 5.3). These concentrations

[18] Summary information on lead, copper and zinc toxicity supplied by Shane Kelly, ARC, 2004.

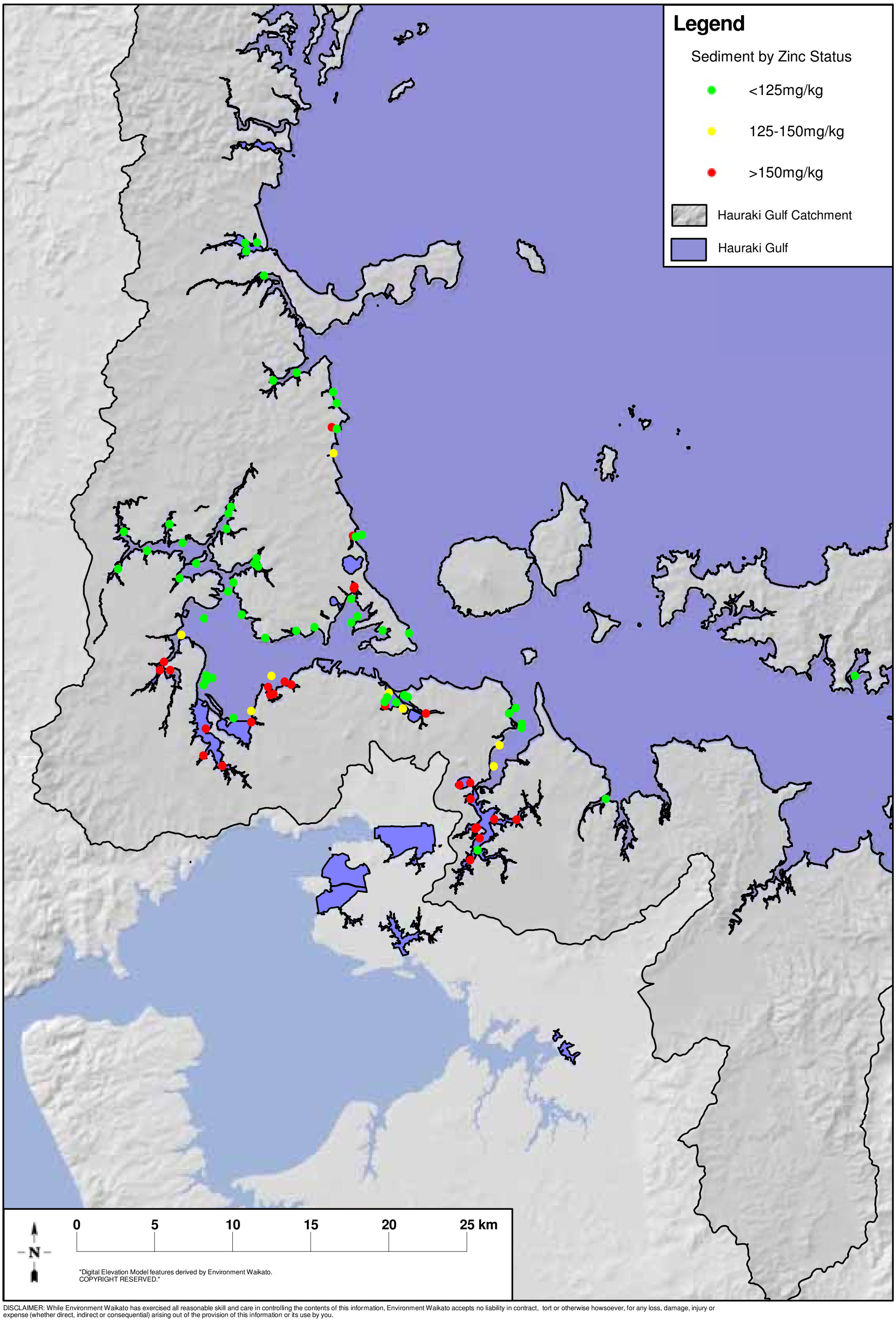

Figure 5.5 Zinc levels in sediment in the Auckland region

Box 5–7

Summary of sediment contamination issues in Auckland's harbours and estuaries

Note: The 'settling zone' is the area where most contaminants from the catchment settle and accumulate. The 'outer zone' is the area beyond the settling zone. The outer zone is still affected by contaminants from stormwater, but to a lesser extent.

- **Tamaki Estuary:** highest levels of contamination in settling zones of older parts of the catchment (Middlemore, Otahuhu, Panmure basin). Levels are also high near Pakuranga. Contamination is higher at the upper reaches than at the mouth.
- **Hobson Bay:** elevated contamination across the muddy deposition areas and in parts of the outer zone.
- **Waitemata Harbour:** overall, there is some serious contamination of intertidal areas in the Waitemata harbour, with clear warning signs of increasing contaminant levels in some areas.The muddy areas of the southern Waitemata shores are some of the most contaminated in Auckland. This is in keeping with the general observation of elevated sediment contamination in areas with older urbanised catchments. The highest concentrations are found in the Whau estuary, and around Motions and Meola Creeks. Some of this may be due to historical industrial pollution.
- **Upper Waitemata Harbour:** contamination levels are low in most parts of the upper harbour, presumably because there is limited urbanisation in the catchment. The Kaipatiki Arm, which has the most urbanised catchment in the upper harbour (including Beachhaven and Birkenhead), has amber levels of zinc and copper. Zinc and copper levels are increasing in Lucas Creek, which receives runoff from Albany, a relatively new urban area. More detailed studies indicate that zinc concentrations are likely to reach amber and red levels in the Lucas Creek sub-estuary in a relatively short period of time under current development scenarios.
- **East Coast Bays:** contaminantion levels are generally low in sediments in the near shore coastal zone, although occasionally there are higher levels near settling zones. Increases in zinc and copper are occurring at Cheltenham, and small muddy estuaries with urban catchments are contaminated (Deep Creek, Wairau estuary). Further north, Orewa and Weiti are relatively clean, either because of lower levels of urbanisation or a relatively large estuary size compared with catchment area. Copper and zinc levels are increasing at Weiti.

(Source: ARC 2003d).

are used as a tool by the ARC's Regional Discharges Project for deciding the required level of further investigation of benthic ecology, contaminant accumulation and contaminant sources and potential remedial upgrade response.

Sheltered estuaries are particularly vulnerable to contamination, because low wave and current energy result in rapid deposition of sediments. The Auckland area of the Gulf has many sheltered side arms and tidal creeks which are vulnerable to contaminant accumulation. Small sheltered muddy estuaries are particularly susceptible to rapid contamination (e.g., Deep Creek, Torbay).

Contaminant concentrations are highest in estuaries with longer histories of catchment urbanisation (Williamson 2003). However, even some more recently developed catchments have relatively high contaminant concentrations, such as Pakuranga and Henderson (Williamson et al. 2003). Contaminant concentrations are lower in water bodies surrounded by less intense urbanisation, or rural land use (ARC 2003d).

Zinc and copper concentrations in sediment have increased significantly in the Auckland region over a relatively short period of time (ARC 2002c). Many sites in the Waitemata Harbour and Tamaki Estuary have concentrations of zinc, lead and copper that could adversely affect marine life (Kelly et al 2003). See Figure 5.6 and Box 5–7 for more detail.

Zinc is the contaminant most likely to exceed red environmental response criteria in Auckland Harbour and estuary sediments (Williamson 2003). Zinc concentrations are higher than those of lead or copper, reflecting both higher background concentrations and greater inputs from human sources (Kelly et al. 2003). Zinc is accumulating rapidly in sediments (see Figure 5.6). If accumulation continues at current rates, zinc concentrations will:

- double in 13 years at Whau Estuary in the Waitemata Harbour.
- double in 17 years at some locations in the Tamaki estuary (ARC 2002c)[19].

Copper is accumulating in a similar manner to zinc, although both the concentrations and rate of increase are lower. If accumulation continues at current levels, contaminant concentrations will exceed toxic thresholds in many estuaries within the next 50 years (Kelly et al. 2003).

It is not possible to definitively state what the consequences of such increases in metal concentrations would be for benthic communities. However, the higher the concentrations, the greater the likelihood of adverse effects. Concentrations at many sites already exceed red environmental response criteria. If concentrations continue to rise, consequences may include adverse effects on fish health and shellfish quality, to a much greater extent and over a wider area than already occurs. Major

[19] From about 250 to 500 mg/kg for Tamaki sites and 300 to 600 mg/kg for Whau sites.

degradation of sandflat and mudflat ecosystems is also likely, particularly in sheltered estuaries with highly urbanised catchments.

On the positive side, lead concentrations in sediments are decreasing, presumably as a result of removing lead from petrol; see Figure 5.6 (Kelly et al. 2003). This is encouraging as it demonstrates that estuarine sediment quality can improve when pollution sources are removed.

PAH levels were green except at some sites with a longer history of urbanisation in their catchments (Hobson, Motions and Meola), and sites near historic gas works (Chelsea, Little Shoal Bay; ARC 2003d).

There has been little monitoring of sediments for contamination in the Firth of Thames and Coromandel, reflecting the different pressures in this part of the Gulf compared with Auckland. With no large coastal urban centres, the sources of major contamination by heavy metals that are present in Auckland are largely absent from the Coromandel and Firth of Thames fringe. A recent analysis of surface sediments from the Firth of Thames found that element levels were below those at which any adverse effects are anticipated[20].

There have been concerns that historic mining activities on the Coromandel could have contaminated sediments in estuaries and harbours around the peninsula. A study of heavy metals in Coromandel estuaries in 1992 found that typical background concentrations prior to human settlement were similar to those in other New Zealand estuaries, despite the presence of natural sources of heavy metals in Coromandel rock (Hume and Dahm 1992). However, after human settlement, lead, copper, zinc and occasionally arsenic, were elevated above background levels at five of six sites (typically, 1.5 to 3 times above pre-settlement levels). The increases appeared to be primarily attributable to historical mining activity. Levels were highest close to the mouth of the Waihou River, which historically received large volumes of mine waste via the Ohinemuri River. However, in most cases, metal concentrations were similar to those found in studies of estuaries elsewhere in New Zealand at the time of the study (Hume and Dahm 1992).

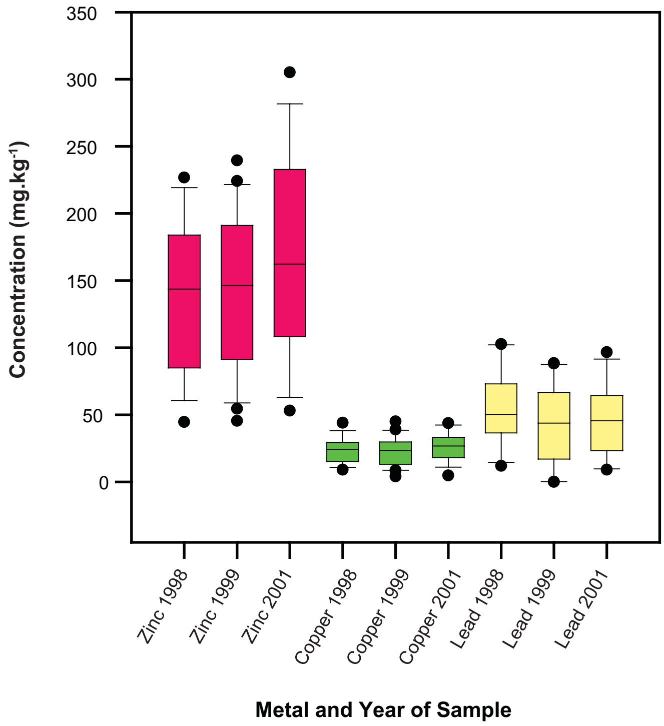

Figure 5.6 Concentrations of zinc (red), copper (green) and lead (yellow) at sediment monitoring sites in the Hauraki Gulf (Auckland).

A study of the Coromandel Harbour found that heavy metal concentrations had risen approximately ten-fold after gold mining began (Leipe and Healy 1992). This coincided with increased sedimentation rates. Concentrations were not considered to represent an acute environmental risk (Leipe and Healy 1992), though possible chronic effects cannot be discounted.

The Tui Stream in the Coromandel is contaminated with metals from historic mining activity and natural erosion (Webster 1995) but does not appear to contribute a significant mass load to the Waihou River[21]. A study in 1995 found that metal concentrations in sediments of the Waihou River estuary were elevated compared with levels further up the river (Webster 1995). All sediment levels were below the lowest ANZECC sediment quality trigger guidelines[22].

There are numerous minor discharges from historic mines throughout the Coromandel peninsula. From time to time,

[20] ANZECC 2000 Interim Sediment Quality Guideline (ISQC)-Low values. Pers comm. Nick Kim, Environment Waikato, 2004. Preliminary assessment of results only.

[21] Pers comm., Nick Kim, Environment Waikato

[22] ISQC-Low, ANZECC 2000

Box 5–8

Why use shellfish?

It can be difficult to obtain a reliable measure of contaminant levels in seawater alone. This is because the concentrations of contaminants in seawater at any one time are often very low and may be below laboratory detection limits. Also, contaminant levels in seawater vary greatly from time to time and place to place, depending on movement of water and location of contaminant inputs. Therefore, routine monitoring of water (e.g. once a month at the same sites) is unlikely to provide sufficient information. However, because shellfish are always present at the same location and filter large volumes of water, contaminants accumulate in their tissues over time. This means shellfish can be used as an indicator of contaminant levels in a surrounding water body over time.

these may have small, localised effects on streams. There is no strong evidence that either past or present mining activities are having an ongoing effect on the Hauraki Gulf[23].

5.3.6 Shellfish contaminant accumulation

Metal and organic contamination

Shellfish are filter feeders and process large volumes of seawater. Contaminants present in seawater accumulate in shellfish tissue. Shellfish can therefore be used as an indirect measure of seawater quality, as they reflect the presence of contaminants in water over time (see Box 5–7). Information on accumulation of contaminants over time can be used to detect changes in seawater quality, and relate these to changes in land use, stormwater and control of contaminant sources.

Deployed mussel rigs have been monitored for contaminant levels in the Waitemata Harbour and Tamaki Estuary since 1999. The programme primarily assesses contaminants likely to arise from urban activities (e.g. heavy metals from stormwater), but also includes analysis for some contaminants that can originate from agricultural activities (e.g. pesticides).

Mussels are obtained from 'clean' sites in the Coromandel and placed on mussel ropes at monitoring sites in Auckland waters (see Figure 5.7). The mussels are left at the monitoring sites for three months between September and December to allow contaminants to accumulate in their tissues. Four sites are monitored in the Gulf: Upper Tamaki, Upper Waitemata, Chelsea, and Illiomama (Rangitoto), a reference site. Oysters were also sampled during a one-off survey in the Waitemata Harbour in 1998.

Organic contaminant levels are relatively high in the Upper Tamaki Estuary, compared with other Auckland sites (ARC 2004a). Copper, PAH, chlordane, dieldrin and PCB concentrations were highest at this site (compared with other Gulf sites). Organic contaminant concentrations were lowest at the Illiomama (Rangitoto) site.

Oysters in the Waitemata Harbour had relatively high levels of copper and zinc, compared with international levels. Copper levels were approximately two to four times higher than international thresholds considered to be indicative of contamination[24]. Zinc concentrations were also substantially higher than international thresholds. In fact, zinc levels exceeded mean concentrations reported in oysters at highly contaminated sites in the Russian port of Vladivostok (ARC 2004a). These results were all obtained from just one year's sampling and further investigations are needed to determine whether these elevated concentrations have persisted.

The condition of oysters and mussels was consistently better at the cleanest sites, and worst in sites affected by urban or industrial development but, the extent to which contaminant levels were responsible for poor condition is unknown. A number of other factors can also affect shellfish condition, including physical habitat type and levels of suspended sediment.

There is no regular monitoring programme for contaminants in shellfish in the Waikato region (Coromandel Peninsula and most of the Firth of Thames). Again, this reflects the different land use profile of the Waikato region compared with metropolitan Auckland, posing a lower risk of contamination by metals and organic contaminants.

During the summer of 1996, a single survey for metal contamination in mussels was undertaken around the Coromandel Peninsula (Coffey 1996). Mussels were collected from three sites on the west of the peninsula and eight sites on the east coast,

[23] Pers comm., Dennis Crequer, Nick Kim, Environment Waikato

[24] The 85th percentiles from world-wide data were considered to be indicative of contamination (Cantillo 1998, cited in ARC 2004a)

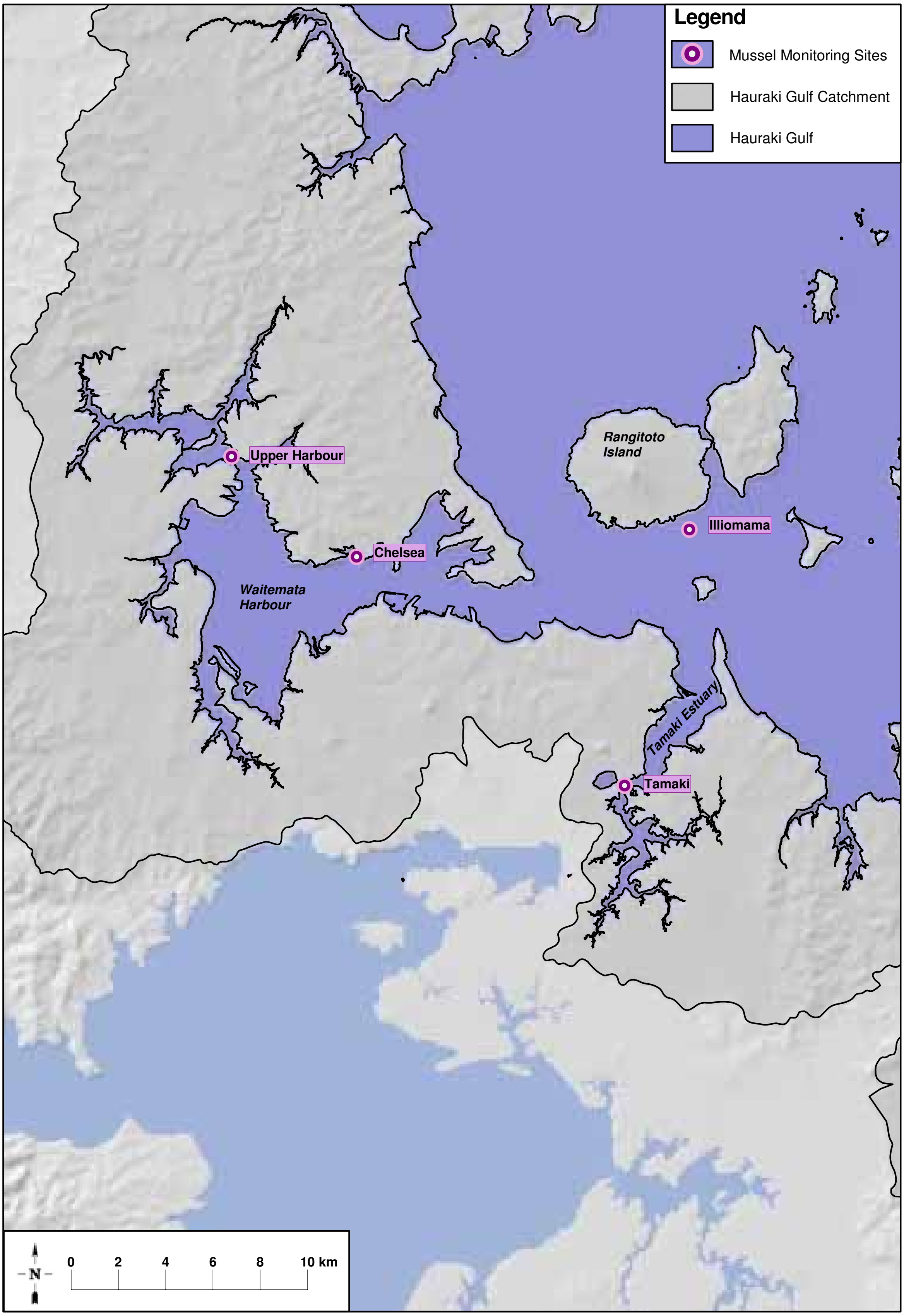

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Figure 5.7 Location of mussel monitoring sites for the Shellfish Contaminant Monitoring Programme

Table 5.5 Emergency closures of commercial shellfish harvesting areas in the Hauraki Gulf 2000-2003[26]

Location	Date	Days closed	Reason
Mahurangi Harbour	April 2001	3	?
Mahurangi Harbour	February 2002	5	Sludge spill to Mahurangi River
Mahurangi Harbour	June-September 2002	77	Malfunction of Warkworth sewage treatment plant due to entry of oil
McGregor Bay and Preece Point		9	Spillage from a pumping station in the Coromandel sewerage system.
McGregor Bay and Preece Point	March-May 2003	54	Spillage from a pumping station in the Coromandel sewerage system.

including islands. Cadmium levels at some open coast and offshore island sites off the east coast were above the relevant health standard. The source of cadmium at the East Coast sites is not known. There have been other reports of high cadmium levels at other apparently uncontaminated sites in New Zealand (cited in Coffey 1996).

Copper, mercury and zinc levels were well below applicable health guideline levels[25], and no lead was detected. Mercury levels at Thames and Te Puru, while still below health guideline levels, were elevated compared with other sites in the Waikato. The highest zinc levels were at Tairua Harbour and were presumed to derive from sacrificial boat anodes.

Microbiological contamination

Regular monitoring of water and shellfish for pathogens is performed at commercial shellfish farms throughout the Gulf, to ensure that shellfish are safe for human consumption. Farms are closed for harvesting when pathogen levels exceed relevant criteria. Sampling is carried out by independent contractors, under the direction of district health boards.

Protocols are in place to stop harvesting from farms after specified rainfall levels, because of the risk of contamination of shellfish from runoff washed into the sea during rain. Farms are also closed to harvesting if exceptional events in the surrounding catchments pose a risk of microbiological contamination (e.g., sewage treatment plant malfunction).

From 2000-2003, there were a number of these emergency closures of marine farms because of events in their catchments, other than routine rainfall closures (see table 5.5).

In addition, many commercial shellfish harvesting areas around Waiheke and Great Barrier Islands are routinely closed during and after holiday weekends because of the risk of contamination by sewage from boats. This results in a substantial number of additional closures. For example, all commercial shellfish harvesting areas at Waiheke Island except one are closed for 42 days each year as a precautionary measure to prevent contamination by boat sewage during holiday weekends.

Around the Coromandel Peninsula, the marine farms in Te Kouma Harbour are also routinely closed during holiday weekends as a precautionary measure to prevent the harvesting of shellfish which may be contaminated by sewage from boats.

There is no routine microbiological monitoring programme of either shellfish or water quality for recreational harvesting of shellfish in the Gulf. Environment Waikato has previously suggested that such a programme be established in conjunction with the district health board (Turner and Vant 2000). To date, this has not been established.

Although sampling is not conducted specifically for the purposes of assessing suitability for shellfish harvesting, analysis of 2003/04 bathing beach water quality results for the Coromandel Peninsula showed that 15 of 16 sites met one of the guideline values for shellfish gathering water (the seasonal median shall not exceed a Most Probable Number (MPN) of 14 faecal coliforms /100 mL)[27]. However, only nine of 16 sites complied with the other

[25] New Zealand Food and Drug Regulation 1984, cited in Coffey et al. 1996

[26] This should not be considered an exhaustive list.

[27] Pers Comm. Bill Vant Environment Waikato 2004.

guideline (not more than 10% of samples should exceed 43 MPN/100 mL; Ministry for the Environment and Ministry of Health, 2003).

The Pepe Stream site in Tairua Harbour did not meet either guideline, while five of six sites in the Firth of Thames did not meet the upper decile guideline. By contrast, eight of ten sites on the east coast of the peninsula met both guidelines. This supports previous findings that sites on the open coast are likely to have lower levels of faecal bacteria, and therefore to be more suitable for shellfish-gathering, than those in enclosed locations (Environment Waikato 1999). Refer to Figure 5.8.

In Auckland, consideration has been given to sampling shellfish to assess suitability for recreational harvest, though a number of factors have prevented this to date. One reason is depletion of shellfish at many popular beds. For example, a researcher wished to investigate viral contamination of shellfish, but shellfish stocks in common recreational harvesting areas were so low that reliable numbers of shellfish were not available for regular sampling[28]. For further information on shellfish depletion, refer to the biodiversity chapter.

5.3.7 Algal blooms and shellfish biotoxins

When marine algae build up in massive numbers, they are said to form 'blooms' (see Figure 5.9). Algal blooms have been highly visible in the Gulf from time to time over the past decade.

Blooms occur when algae receive high light intensity, plentiful nutrients and favourable water temperatures. Over the past 50 years, a relatively large number of irregular but widespread algal blooms have been recorded in New Zealand (Chang and Mullan 2003). These can result in:

- discolouration of water
- foams or slimes
- fish kills or death of other marine life
- adverse human health effects (e.g., poisoning from eating shellfish).

Algal blooms in the Gulf appear to be driven by influxes of nutrients from oceanic waters. Nearly all of the major harmful algal blooms observed over the

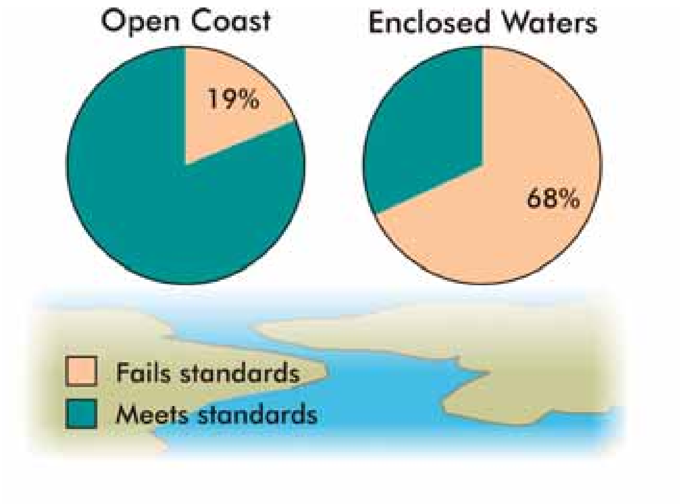

Figure 5.8 Coastal sites in the Waikato Region meeting bacterial guidelines for shellfish gathering.

Figure 5.9 'Red tide' Leigh Harbour, December 2002. (Photo: Miriam Godfrey)

[28] Pers comm. Leslie Breach, Auckland Regional Public Health Service, 2004

Box 5–9

Shellfish biotoxins in the Gulf

There are five main toxin groups found in New Zealand shellfish. These toxins, or the algal species that produce them, have all been found in the Gulf at various times since monitoring began. However, none of these have resulted in major health events since 1993.

- **Paralytic Shellfish Poison (PSP):** PSP poisoning can potentially be fatal. Symptoms of PSP are numbness and tingling, progressing to headache and dizziness. In more severe cases, there is difficulty in swallowing, breathing and speaking. This can progress to paralysis and ultimately, cessation of breathing. PSP has not been found in any significant quantity in Gulf shellfish over the past ten years. However, low numbers of the toxic phytoplankton species that cause this illness have been found. It is likely that at some point a bloom of one of these toxic species will result in levels of toxicity requiring public warnings to be issued. Most of the North Island apart from the Gulf has been affected by significant PSP toxicity over the past few years.
- **Neurotoxic Shellfish Poison (NSP):** This toxin affects the nervous system. Symptoms include difficulty in swallowing, double vision, unsteadiness and tremor, nausea, diarrhoea, vomiting, numbness, tingling of the mouth, lips and extremities. There have been widespread blooms of some species over the past few years which can cause NSP toxicity in shellfish in the Gulf. Some of these have caused fish kills and low level toxicity resulting in public warnings being issued. However, none have resulted in a repeat of the events of 1993.
- **Diarrhetic Shellfish Poison (DSP):** Symptoms are diarrhoea, nausea, vomiting and abdominal pain. Although the species usually associated with DSP have been found in the Gulf, no significant quantities of these toxins have been found to date in shellfish in the Gulf.
- **Amnesic Shellfish Poison (Domoic Acid):** This toxin mostly causes gastrointestinal illness. However neurological problems (including memory loss) occur in about a quarter of cases. These can be significant and permanent. Blooms of the species that cause this illness are common in the Gulf, usually occurring in spring and summer. Domoic acid toxicity in shellfish associated with these events has not occurred in significant levels except in scallops which accumulate and retain this toxin much more so than other shellfish species. Scallops are tested for this toxin weekly throughout the Gulf through the period of most risk from October through to the end of the scallop season in mid-February. The toxin is mainly in the scallop gut and skirt which is why public health units always advise consumers to only eat the adductor muscle and roe of these shellfish and to dispose of the gut and skirt where it cannot be consumed by animals.
- **Yessotoxin (YTX):** Yessotoxin is thought to have the potential to cause serious long term harm if consumed. YTX has been found at a few sites in the Gulf and this has resulted in public warnings being issued at Great Barrier Island.

past 50 years have coincided with El Nino Southern Oscillation events (ENSO; Chang and Mullan 2003). ENSO is therefore likely to be affecting algal bloom activity around New Zealand.

The influx of nutrient-rich waters (see section 2.2.2) appears to be strengthened during El Nino events. During the El Nino phase of the southern oscillation, northwesterly winds are strengthened (Chang and Mullan 2003). This drives greater upwellings of nutrient-rich water from offshore, increasing nutrient availability in surface waters. It is suggested that these additional nutrients promote algal growth, eventually resulting in algal blooms.

Algal blooms are important from a public health perspective, as some algal species produce harmful biotoxins which can cause illness (see Box 5–9). In extreme cases fatalities can occur.

Monitoring

Monitoring of harmful algal blooms and their associated shellfish toxicity commenced in the Gulf in early 1993 when what is believed to be a bloom of a Karenia species resulted in people reporting symptoms consistent with neurotoxic shellfish poisoning (NSP) after eating shellfish from a variety of areas. Respiratory irritation syndrome was also reported from the coastal community at Orewa where algal cells became aerosolised and caused respiratory problems for beach users and nearby residents[29].

Shellfish and water in commercial growing areas are regularly monitored for toxin-producing algae. When toxic algal species are detected above pre-set trigger levels, sampling of shellfish for toxins is initiated. The safety of non-commercially harvested shellfish with regard to harmful marine biotoxins is also monitored.

District Health Boards issue warnings to the public about the risks of consuming non-commercial shellfish when toxic bloom events occur. This includes opening and closing commercial growing areas and domestic market product recall where required. Monitoring of water for toxic phytoplankton species now occurs routinely at 12 sites in the Gulf. Shellfish samples are taken routinely at 12 sites, five of which are seasonal scallop beds.

Unlike much of the rest of the North Island, the Gulf has largely escaped harmful algal bloom events leading to significant shellfish toxicity since the initial event that led to the establishment of the marine biotoxin monitoring programmes.

[29] The assistance of the NZ Food Safety Authority (NZFSA) in providing this information is gratefully acknowledged.

The reasons for this remain unknown and ongoing monitoring is necessary as most of the organisms responsible for significant toxicity elsewhere in New Zealand are present in the Gulf.

Since monitoring commenced, two events have occurred on the Coromandel Peninsula:

- July 1994: the western side of the Coromandel Peninsula was closed following a positive test result. However, there was no evidence of a bloom of a recognised species at this time.
- June 1999: high levels of an algal species known to produce PSP were detected at Tairua, leading to closure from Kennedy Bay to Waihi Beach.

Sedimentation

Accelerated sedimentation is one of the most pervasive issues facing the Gulf. Sediment affects the quality of the Gulf's waters, its biodiversity values, its natural character, and people's potential use and enjoyment of the Gulf.

For these reasons *Soil Erosion and Sedimentation* has been identified as a strategic issue by the Forum (see Box 5–10). Actual and potential accelerated sedimentation poses a major risk to the quality of the Gulf environment. It is one of the core reasons why the Hauraki Marine Park Act acknowledges the Gulf *catchment* and why the Forum includes representation from local authorities responsible for land use activities within that catchment.

In this chapter, sediment is reported on as an indicator of the *state* of water quality. It can equally be viewed as a *pressure* on the Gulf and is reported as such in chapters 6, 7 and 9.

5.3.8 Sedimentation

In-filling of estuaries is a natural process, (see Box 2–1). However, in-filling can be dramatically hastened by human activities in catchments. Any process that increases sediment run-off from a catchment (e.g., earthworks or vegetation disturbance associated with development or forest harvesting) can result in an increase in sedimentation in an estuary. There is a substantial amount of evidence that urbanisation of catchments increases sediment loading in the marine environment, particularly in estuaries (Grant and Hay 2003). This leads to accelerated sedimentation of estuaries and harbours. Changes in sedimentation over the past 150 years for many estuaries in the Gulf have been dominated by increased accumulation of fine sediments derived from erosion of local catchments (ARC 2002d).

Changes in the sediment regime (e.g., turbidity, sedimentation rate, water depths, water coverage, nature of sediment) in estuaries are associated with ecological changes. These include changes in vegetation and biological communities. Most sediment is deposited in the inter-tidal zone (Vant et al 1993). This means that inter-tidal species are more likely to be exposed to the risks associated with increased sedimentation and changes in sediment particle size (Grant and Hay 2003) (see Chapter 6).

Estuarine areas most at risk from increased sediment load are those relatively enclosed parts of the coast that are:

- undergoing modification in land use that increases run-off (such as removal of vegetation, and particularly urban sub-division)
- have a small size relative to catchment area
- have poor flushing (Swales, 1989).

Typically, these tend to be the upper reaches of estuarine and harbour areas.

Sedimentation in Auckland estuaries and harbours

Core sampling of estuarine sediments in the Waitemata Harbour shows increasing sedimentation rates over a long time scale. Prior to human settlement, sedimentation rates in the harbour were 0.03-0.1 mm/year (Grant and Hay 2003). This increased to an estimated rate of 1 mm/year after Maori settlement, as a result of small-scale land clearance and vegetation burn-off (Hume and McGlone 1986, cited in Grant and Hay 2003). Sedimentation rates increased to 2-3 mm/year with European settlement, associated with land clearance, logging and agriculture. Higher sedimentation rates have been found in other harbours. Post-European sedimentation rates of 3.2-21.0 mm/year were found in the Mahurangi Harbour (ARC 2002d).

Box 5–10

Strategic Issues

The major issues identified by the Forum relating to soil erosion and sedimentation in the Gulf is:

- Activities occur in the catchments of the Hauraki Gulf which result in accelerated erosion of soil and consequential accelerated sedimentation of estuaries and harbours.

Objective

The Forum identified the following objective for soil erosion and sedimentation in the Gulf:

- Erosion of soil and movement of sediment into waterways resulting from activities of people using the catchments of the Hauraki Gulf is minimised.

Table 5.4 Post- European settlement sedimentation rates in Coromandel harbours
(Source: Turner and Riddle 2001)

Investigators	Harbour	Sedimentation rate (mm/yr)
McGlone (1988)	Whangapoua, Whitianga	1.0
Sheffield (1991)	Whangamata	6.0-11.0
Hume and Dahm (1992)	Firth of Thames, Coromandel, Whangapoua	0.3-2.8
Swales and Hume (1994)	Whangamata	5.0
Swales and Hume (1994	Wharekawa	0.3-5.0

Since the 1950s, intensive agriculture and urban development have resulted in further increases in sedimentation rates, estimated at 2-9 mm/year (ARC 2002d). Extremely high sedimentation rates have been found in some estuaries. In the Wairoa Estuary, sedimentation rates of up to 34.5 mm/year were found (ARC 2002d). The period from 1950 to the present is of particular interest as it was a time of rapid urbanisation in many Auckland catchments. A study of estuaries in the Auckland region[30] found that sedimentation rates after 1950 are an order of magnitude higher than before catchment deforestation, at rates of 2.7-5.8 mm/year (ARC 2002d).

In that study, sedimentation rates differed little between estuary types, and muddy estuaries did not necessarily infill more quickly. Sediment accumulation rates were significantly higher on intertidal flats than subtidal flats. Over the past 50 years, the height of intertidal flats in estuaries studied have increased by approximately 0.5m (ARC 2002d). This is a substantial rise, given that the average water depth at high tide in many Auckland estuaries is less than 1m. The rate of estuary infilling from sedimentation has only partly been offset by sea level rise, as sedimentation rates are two to three times higher than the average rate of sea level rise in Auckland since the early 1900s. Infilling of estuaries is expected to continue at a rate of several mm/year (ARC 2002d).

Of particular concern is that sedimentation rates have increased even at remote estuaries with no apparent risk factors (such as Te Matuku at Waiheke Island). Sedimentation rates in Te Matuku Bay have increased at a similar rate (4-9 mm/year) as those in estuaries with large developed catchments, despite the relatively small amount of catchment runoff. The Wairoa River, located across the Tamaki Strait from Te Matuku, is considered to be the most likely source of the majority of sediment entering Te Matuku Bay. As the Wairoa Estuary has now largely infilled, sediments from the large Wairoa catchment are thought to now be transferred to subtidal areas of the adjacent Tamaki Strait, to neighbouring estuaries and the inner Gulf (ARC 2002d). Similar processes may be occurring in other bays on the south side of Waiheke Island, and adjacent to the Wairoa Estuary. Export of catchment-derived sediment from infilled estuaries could also be occurring in other estuaries in the Gulf.

A case study of the effects of accelerated sedimentation on the ecology of the Mahurangi Harbour is presented in Chapter 6, see Box 6–7.

Sedimentation in Coromandel estuaries

Estuaries on the Coromandel Peninsula are particularly susceptible to the effects of land use changes. This is because catchments are typically steep, with highly erodible soils (Turner and Riddle 2001). Localised high intensity rainfall events are relatively common in the Coromandel, particularly in the upper catchments, and can lead to erosion of these soils. Major land use changes have occurred on the Coromandel since human settlement, including deforestation, gold mining and exotic forestry plantations. Studies have shown greatly increased sedimentation rates after European settlement, largely attributed to deforestation.

Investigations in harbours on the Coromandel Peninsula show that sedimentation rates were very low prior to human settlement (0.1-0.2 mm/year) (Turner and Riddle 2001). These rose only slightly following Maori settlement, however sedimentation rates rose markedly after European settlement. Estimates of post-European sedimentation rates vary between studies and harbours, but are commonly in the range of 0.3-5 mm/year (up to 11 mm/year in one study; see Table 5.4). Researchers suggest that these increases are likely to be due to land use change, including deforestation, mining, farming and forestry.

Environment Waikato is monitoring sediments in the southern Firth of Thames to assess changes in the surface sediment particle size and rates of sediment deposition. As monitoring only began in 2001, there is not yet sufficient data available to draw conclusions on sedimentation trends in the Firth. However, it seems that sediment distribution patterns may vary greatly from time to time, depending on predominant wind direction and local estuary dynamics in different parts of the Firth[31].

Monitoring is ongoing in the Whangapoua harbour to assess possible effects of sedimentation from forestry operations in the catchment. Results

[30] Estuaries studied included Mahurangi, Puhoi, Okura, Henderson Creek, Waitemata Harbour, Te Atatu, Whitford, Wairoa and Te Matuku.

[31] Pers comm., Rick Liefting, Environment Waikato 2004

suggest that sedimentation may be adversely affecting sensitive benthic fauna but the design of the monitoring programme makes it difficult to conclusively determine the source of sediment[32] .

5.4 Pressures on the Gulf's Waters

The state of coastal waters in the Gulf is determined to a large extent by activities in its catchment, particularly near the coast. Ocean circulation currents, tidal flushing and physical geography are also important factors.

Both point source discharges (e.g., wastewater treatment plants) and diffuse runoff from urban and rural land uses can contribute to deterioration of water quality. This is briefly discussed in section 5.1 of this chapter.

5.4.1 Discharge consents

There are 1170 consented discharges to land and water in the Gulf Catchment (see Figure 5.10). The largest proportion of these are discharges from dairy farms, the majority of which (420) are located on the Hauraki plains. Wastewater discharges, from wastewater treatment plants, commercial premises and private homes, comprises the next largest proportion of discharges. A variety of other activities comprise the remainder of discharge consents[33].

The total figure needs to be treated with considerable caution as:

- It does not include approximately 2000 individual stormwater consents located in the Auckland region, as:
  - it is not currently possible to distinguish between those located within the Gulf Catchment, and those located outside it.
  - their inclusion would tend to obscure the number (and relative significance) of other discharges.
- Conversely, it does include stormwater discharges for the part of the catchment within Waikato region, as wastewater and stormwater discharges are grouped together in Environment Waikato databases.
- It provides no information on the volume or quality (as opposed to the number) of discharges from different sources, or their relative impacts on receiving water quality. Consent databases are not currently set up in a way which allows easy extraction of this information.

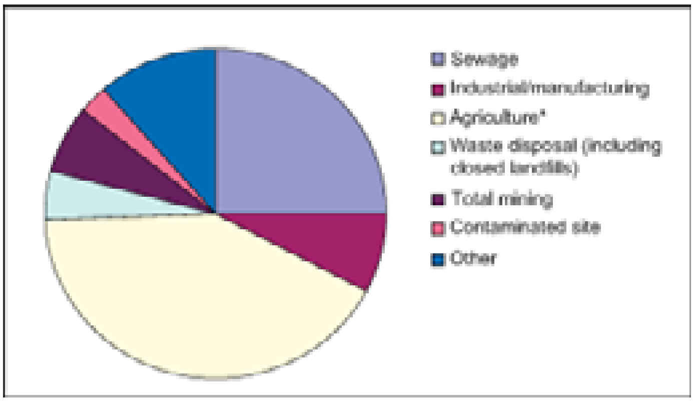

Figure 5.10 Relative numbers of discharge consents in the Gulf Catchment (excluding stormwater)

5.4.2 Wastewater treatment plants

Wastewater treatment plants, if not functioning adequately, have the potential to adversely affect water quality because of discharges of nutrients and pathogens. Discharge of wastewater effluent directly to water is offensive to Maori spiritual and cultural values.

There are 37 wastewater treatment plants in the Gulf Catchment, ranging from the large Rosedale plant on Auckland's North Shore, to small treatment plants on the Coromandel (see Figure 5.11).

Discharges from wastewater treatment plants are regulated by the relevant regional council.

Both Rodney and Thames-Coromandel Districts have numerous small wastewater treatment plants. Some of these plants are older and function below modern expectations, or do not have the capacity to deal with the increase in population in coastal areas. Some plants can become overloaded during peak season or are chronically overloaded (e.g., Whangamata). The Waiwera wastewater treatment plant is not permitted to discharge during the peak holiday period because of the potential for adverse effects on swimmers and shellfish gatherers.

[32] Felsing. File note, environment Waikato 2004

[33] Landfill and waste disposal consents include discharges from a number of closed landfills. Contaminated site discharge consents do not represent all contaminated sites in the catchment, just those that have been identified and for which discharge consents are in place.

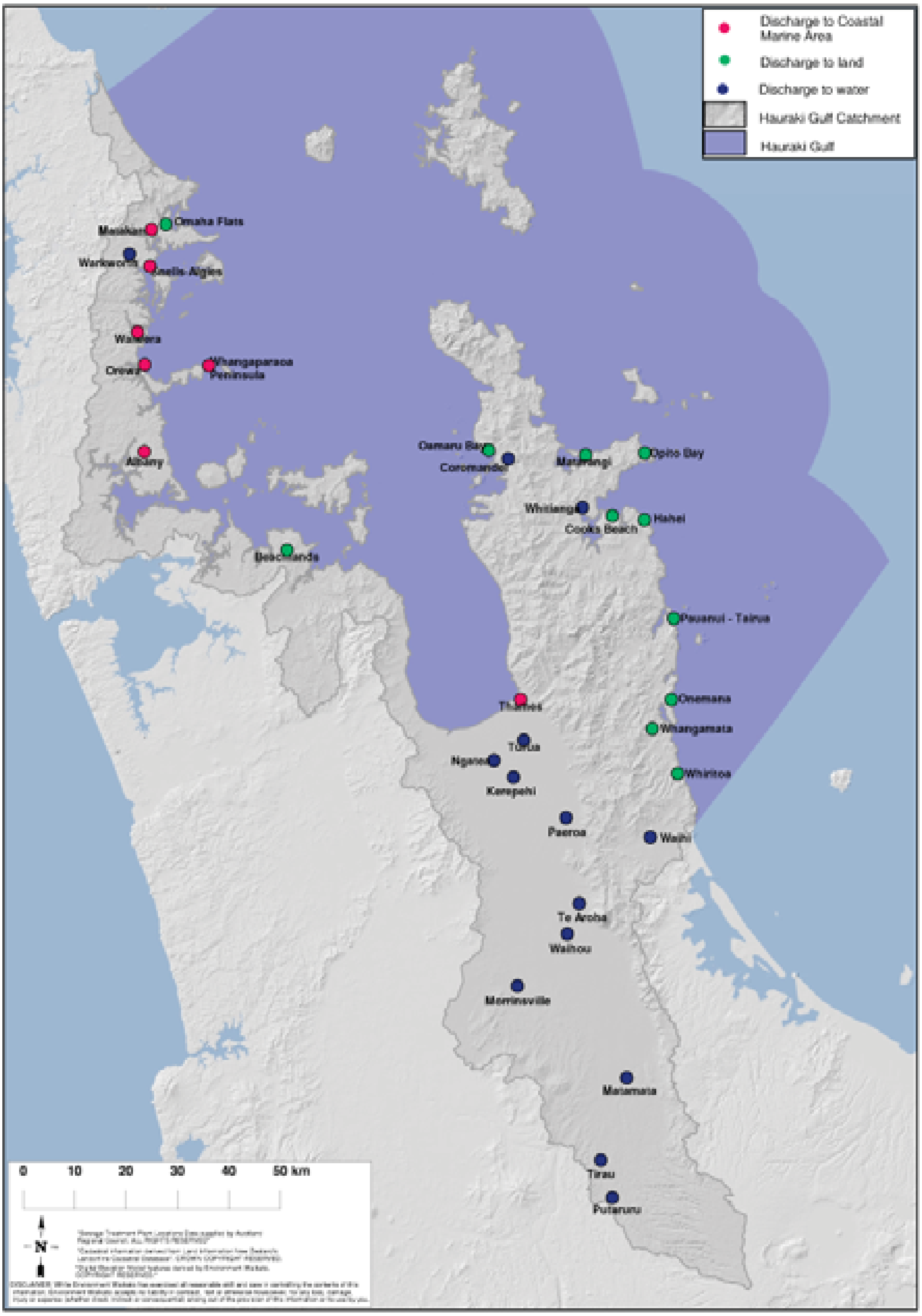

Figure 5.11 Wastewater treatment plants in the Gulf Catchment

In some parts of the Gulf Catchment, lack of adequate wastewater treatment capacity is limiting further development (e.g., Hahei, Tairua/Pauanui). Some areas have had wastewater treatment plants installed because of the inadequacy of septic tanks managing wastewater as the population has increased (e.g., Beachlands/Maraetai).

Further inland, there are a number of wastewater treatment plants serving towns on the Hauraki Plains and the upper Waihou and Piako catchments. A significant proportion of the phosphorus entering the Firth of Thames comes from these plants (see section 5.4.9). Several of these plants are due for upgrading as part of their resource consent process.

The largest wastewater treatment plant discharging to the Gulf is Rosedale on Auckland's North Shore, which serves an effective population of 205,000. The plant discharges to the coastal marine area from an outfall 650 metres offshore, but a new outfall is to be constructed further offshore (see section 5.5.2).

5.4.3 Septic tanks

Many smaller settlements in the Gulf Catchment have individual household septic tanks rather than community wastewater treatment plants. Septic tanks can treat domestic wastewater adequately if soil types are suitable and land area sufficient for tanks to function correctly. Where soil types are not suitable or lot sizes are too small, septic tanks may function inadequately and lead to water quality problems. In these situations, untreated or inadequately treated effluent can seep from properties into waterways, through groundwater or overland flow. Manitenance and particularly regular sludge removal is also important for effective septic tank performance.

At times of heavy use, such as holiday periods at beachside settlements, effects can be particularly severe. This is increasingly becoming a problem in coastal areas as small beachside communities, which were once holiday areas or had only a small number of permanent residents, swell in population due to the coastal development boom. Many houses now being built in coastal settlements are not the traditional summer bach with limited water supply and facilities. Large modern dwellings are being built (refer to the Coromandel case study in Chapter 7), often on small lots, with modern conveniences using large volumes of water. Information on septic tanks at locations in Rodney District and Manukau City, and on the Coromandel Peninsula, has been compiled for the purposes of this report.

Rodney District

Approximately one third of all properties in Rodney District, including 10% of those in towns, have septic tanks[34] (Rodney District Council 2003). Settlements using septic tanks include Riverhead, Coatesville, Point Wells, Matheson Bay, Leigh, Puhoi, Sandspit and Kawau Island.

No surveys of the adequacy of performance of septic tanks have been performed in the Rodney District to date, complaints relating to inadequately functioning septic tanks are reasonably common in towns (Rodney District Council 2003). Effects include septic tank effluent seeping across properties from neighbouring properties, and sewage odours after wet weather. These effects can result from leaking septic tanks and overflow of drainage fields during wet weather. Poorly performing septic tanks in towns can pose significant risks to the environment and public health, because of (i) the close proximity of houses to each other and (ii) cumulative effects of many small discharges in a relatively small area.

Many of these overflows run into stormwater systems, and can thus enter streams, rivers and the Mahurangi Harbour (Rodney District Council 2003).

Manukau City

Kawakawa Bay: Until comparatively recently, Kawakawa Bay was a holiday and farming community with most dwellings occupied predominantly during holiday periods. In the past 15 years, this pattern has changed and many people now live in the area year-round. This has resulted in increased pressure on the septic tanks which previously only had to cope with short-term occupancy.

[34] There are approximately 12,400 residential properties in the Rodney district that are not on a public wastewater system. Rates data indicates 3,400 residential properties in townships are on private wastewater systems and 9,000 in rural areas. It cannot be readily determined from the data how many are within the Gulf Catchment.

Investigations by Manukau City Council found elevated levels of ammonia, phosphate and faecal coliforms in a drain receiving stormwater from a residential area (26 properties, with very little inflow from agricultural areas (Franks 1997). Levels of ammonia and faecal coliforms approached those expected in untreated wastewater effluent. The results indicated that septic tanks were not containing effluent on-site. Subsequent investigations found a high level of unsatisfactory performance of septic tanks at Kawakawa Bay (Franks 2002).

Orere Point: A study at Orere Point found that septic tanks were inadequate to treat domestic wastewater (Meyer, 1998). The investigation concluded that high levels of faecal coliforms in waterways receiving stormwater discharge were due to discharges from septic tanks, and that this could affect water quality and recreational use of the beach and river area.

Coromandel Peninsula

A large number of communities (over 25) on the Coromandel Peninsula are served by on-site systems[35]. For some of these communities, on-site systems are thought to be functioning reasonably well. For many others, however, on-site systems are known or suspected to be functioning inadequately. This has the potential to adversely affect water quality or cause a public health nuisance[36].

Communities where septic tanks are suspected to be functioning inadequately include: Hikutaia, Matatoki, Puriri, Thornton Bay, Te Puru, Waiomu, Tapu, Te Mata, Manaia, Kikowhakarere Bay, Koputauaki Bay, Oamaru Bay, Little Bay, Whangapoua, Kuaotunu West, Opito, Hahei, Hot Water Beach and Opoutere . At most of these locations, soil conditions are not suitable for on-site disposal from traditional septic tank systems[37].

5.4.4 Wastewater discharges from boats

Under the Marine Pollution Regulations[38], boats are permitted to discharge untreated wastewater in waters more than 500m from shore, 500m from marine farms and mataitai reserves, 200m from marine reserves and in waters more than 5m deep.

There are also a limited number of wastewater pump-out facilities for boats in the Gulf. These include:

- Gulf Harbour Marina
- Westhaven Marina
- Bayswater Marina
- Viaduct Harbour
- Pine Harbour (chemical toilet only)
- Down Town Ferry Terminal
- Whitianga Marina
- Pauanui Waterways.

Anecdotal reports suggest that usage of these facilities on the Coromandel is very low. It is suggested that this is because discharge off-shore, which is permitted under the regulations, is an easier option.

See section 5.3.6for discussion of the possible effects of sewage from boats on shellfish.

5.4.5 Stormwater

Stormwater is a major source of contaminants in urban areas. Section 5.3.5 provides information on the contamination of sediments in Auckland estuaries and harbours by pollutants derived largely from stormwater. Stormwater runoff washes contaminants from roads and other hard surfaces into waterways and ultimately to the sea. Stormwater can also enter the wastewater system, leading to wastewater overflows.

Stormwater can carry both microbiological and other contaminants (e.g., metals). Microbiological contamination of stormwater occurs in two ways:

- stormwater runoff picks up contaminants from roads and other sources (e.g., dog and bird faeces).
- entry of stormwater to the wastewater network.

Stormwater can enter the wastewater network in several ways:

- in older parts of Auckland, stormwater and wastewater run through a common pipe (combined sewer).
- stormwater can enter sewerage pipes through cracks and joints (infiltration), and also from cross-connections between stormwater and sewerage pipes.

[35] Communities with at least 20 on-site systems and average lot size < 4000m2. Source: information supplied to Environment Waikato by Thames-Coromandel District Council for a questionnaire on effects of on-site systems.

[36] Pers comm., Thames-Coromandel District Council 2004, various staff.

[37] Pers comm., Ian Feasey, Thames Coromandel District Council 2004.

[38] Resource Management (Marine Pollution) Regulations 1998

Sewerage can also leak directly to surface and groundwater through cracks and joints in sewerage pipes (see Box 5–12).

Sewer networks are designed to handle a certain amount of rainfall. However, during heavy rain, overflows occur at designated 'relief points', discharging sewerage to stormwater networks, land, streams or the sea. In some parts of Auckland, wet weather flows in the separated sewerage network may be 10 to 20 times greater than dry weather flows (ARC 2004b). As sewerage pipes are generally designed to accommodate only four times the dry weather flow, overflows occur during heavy rain. The frequency of overflows in separate networks varies from almost never to approximately 10 times per year (ARC 2004b).

In the combined sewer network in central Auckland, there are approximately 400 designed combined sewer overflow points. Some of these hardly ever overflow; others overflow frequently. At the worst of these points, overflows occur approximately 50 times per year (ARC 2004b).

Modelling indicates that during wet weather in North Shore City, local wastewater overflows typically account for up to 80% of microbiological pollution impacts on an individual beach (North Shore City 1999). Stormwater accounts for the other 20%.

In addition to microbiological contamination, stormwater carries other pollutants. These include metals, petrol and oil, organic contaminants such as pesticides, and nutrient-rich sources such as plant material and fertilisers. See Box 5– 9 for a list of major contaminants.

Many of these contaminants originate from road runoff. It is estimated that 70 per cent of stormwater pollution originates from vehicles (Auckland City Council, 2004).

Roof runoff is an important contributor to stormwater volume. Roof areas in New Zealand cities are at least equivalent to or greater than trafficked road surfaces. Roofs make up 40% of total impervious area, and 20% of the catchment area, in urban catchments (Kingett Mitchell Ltd and Diffuse Sources Ltd, 2004). For catchments with a long history of development, roof runoff is probably the main source of zinc in stormwater, because of the large number of galvanised iron roofs in poor or unpainted condition (Kingett Mitchell Ltd and Diffuse Sources Ltd, 2004).

High zinc concentrations have also been found in roof runoff in industrial areas. This is thought to be due to dry deposition of road dust and industrial emissions on roofs. A recent study suggested that industrial areas may be a significant source of reactive zinc above that expected from road runoff and galvanized roofs (Kingett Mitchell Ltd and Diffuse Sources Ltd, 2004).

In Auckland, sediment quality is used to assess stormwater impacts (see section

Box 5–11

Contaminants in stormwater

Contaminants in stormwater, and their major sources, include:

- **Zinc:** tyre wear, roof runoff.
- **Copper:** brake linings.
- **Lead:** vehicle exhaust emissions (prior to removal of lead from petrol), paints, batteries.
- **Polycyclic aromatic hydrocarbons (PAHs):** motor vehicle emissions, oil, tar, coal and wood burning fires.
- **Nitrogen:** plant litter, animal faeces, organic litter, vehicle emissions, wastewater contamination, soil runoff.
- **Suspended solids:** soil particles (e.g., from earthworks, construction, roadworks, streambank erosion), organic material. Other contaminants (e.g., metals) can adsorb to sediment particles and transported with them.
- **Organochlorines:** (e.g., chlordane, dieldrin, DDT, lindane) pesticides.

(Sources: Le Fevre and Silyn Roberts 2002, ARC 1995).

Box 5–12

Exfiltration

Leakage of sewage from sewer pipes into the surrounding area (exfiltration) is another source of microbiological contamination of water, including beaches. Exfiltration occurs mainly during dry weather. Cracks in sewer lines cannot only lead to entry of stormwater to sewers during wet weather, but also allows sewage to seep into the surrounding area during dry weather. Tree roots, fat and other substances which block pipes can also cause exfiltration. Exfiltration is more likely in areas where the sewer network is old and leaky and has had little or no renewal over the years.

5.3.5) because there is well-documented evidence that contaminants from stormwater are found in marine sediments (ARC, 2002e).

5.4.6 Erosion and earthworks

As discussed in section 5.3.7, sedimentation is a major issue for the Gulf. The processes by which sediment enters waterways are discussed in detail in that section. Natural or accelerated erosion of stream banks and hill country, and earthworks (e.g., for subdivision and roading) contribute the majority of sediments to our waterways.

Sediment from land disturbing activities is the single largest contaminant by volume in the environment in the Auckland region[39]. ARC research has indicated that earthworks have the potential to release 66 tonnes of sediment per hectare per year, on average, to our streams, estuaries and harbours[40]. Table 5.3 shows the area of earthworks consented for the Auckland region as a whole from 1999 to 2003.

5.4.7 Oil spills

All marine oil spills in New Zealand are reported to the Maritime Safety Authority (MSA), which records information on spills in a national database. Information is recorded only at regional level. This means that information on the exact location of spills cannot be extracted. Therefore the total numbers of oil spills in the Gulf cannot be reported.

Since records began in 1995, 379 spills (a total of nearly 23 tonnes) have been recorded in the Auckland region. It is not possible to state how many of these spills occurred in the Gulf part of the region. Just 12 spills occurred over the same time period in the Waikato. Again, it is not known how many of these occurred in the Gulf.

The majority of spills were relatively small (< 100L), with only 21 spills of 100L or more. Of these, at least 15 occurred in the Gulf. Most were from boats, but some were from land-based sources (e.g., storage tanks leaking into streams and then entering the sea).

There are oil spill response teams in both the Auckland and Waikato regions.

5.4.8 Dredging

Dredging is carried out in some parts of the Gulf to improve navigability of ports and access channels, and to create and maintain marinas. Dredging activities have the potential to result in temporary adverse effects on water quality and to disrupt benthic communities (both from dredging areas and from deposition of sediment at disposal sites). The environmental effects of dredging and disposal vary depending on the site.

In Auckland, there has been a history of public concern about the effects of dredging and the subsequent disposal of dredged material at sea. These concerns have led to a change in disposal practices, so that most dredged material is no longer disposed of within the territorial sea.

Sediment from the Pine Harbour Marina approach is dredged from time to time and deposited at the end of the approach channel. There is no evidence to date of adverse ecological effects from this activity[42].

Dredging occurs at a number of locations on the Coromandel Peninsula and Firth of Thames, including:

- Whangamata boat launching ramp.
- Pauanui Waterways access channel.
- Whitianga Waterways access channel.
- Whitianga marina entrance and around wharf.

Dredgings are mostly disposed to coastal waters off nearby beaches. Dredging also occurs at several river mouths as part of flood management schemes.

Table 5.5 Area of earthworks consented per annum, and length of stream disturbed/piped per annum (all of Auckland region)[41]

Financial Year	Area of Earthworks Consented (ha)
1 July 1999 – 30 June 2000	614
1 July 2000 – 30 June 2001	703
1 July 2001 – 30 June 2002	802
1 July 2002 – 30 June 2003	1570

[39] Pers comm., Paul Metcalf, ARC, June 2004

[40] Pers comm., Paul Metcalf, ARC, June 2004

[41] It was not possible to obtain figures for the Gulf Catchment only.

[42] Pers comm. Dominic McCarthy ARC 2004

5.4.9 Nutrient inputs from river systems

Three billion cubic metres of water enter the Firth of Thames from the Waihou and Piako rivers every year. These are the main freshwater sources for the Gulf (Broekhuizen et al. 2002). Figure 5.12 shows the catchments of these rivers, along with major estuary catchments on the Coromandel Peninsula.

The Piako, Waitoa and Waihou rivers together deliver a total of more than 10 tonnes of nitrogen per day to the Firth of Thames, along with one tonne of phosphorus (Vant 1999).

The majority of this nitrogen comes from non-point source land use, largely agriculture (see Table 5.6). By contrast, the majority of phosphorus comes from point sources, including wastewater treatment plants, dairy factories and meatworks.

Runoff from agriculture is a major source of nutrients entering the Firth of Thames, particularly nitrogen. Half a million dairy cows are estimated to be farmed in the Waikato portion of the Gulf Catchment alone (see Table 5.7)[43]. Stocking densities vary across the catchment but are estimated to average 2.68 stock per hectare for dairy cows. Many of these animals are located on the Hauraki Plains (see Figure 5.13).

Although the amount of water entering the Firth of Thames from rivers is relatively small compared with mixing from continental shelf waters (total mixing rate 580 billion m3/year), river waters have a higher nutrient concentration (see section 5.3.3for discussion of nutrients in the Firth).

Table 5.6 Mass flows of nitrogen and phosphorus in the lower reaches of three Hauraki rivers during 1993-1997

(Source: Vant 1999)

	Nitrogen (g/s)			Phosphorus (g/s)		
	Piako	Waitoa	Waihou	Piako	Waitoa	Waihou
Overall	32.8	22.6	66.4	2.56	6.34	5.52
Point sources	1.3 (4%)	6.3 (28%)	6.5 (10%)	1.59 (62%)	5.77 (91%)	1.72 (31%)
Background	3.5 (11%)	2.8 (12%)	10.1 (15%)	0.34 (13%)	0.28 (4%)	0.98 (18%)
Land use	28.0 (85%)	13.5 (60%)	49.8 (75%)	0.63 (25%)	0.29 (5%)	2.81 (51%)

Table 5.7 Estimated stock numbers in the Waikato portion of Gulf Catchment

Notes: Weighted stocking density was derived by calculating stock species as a percentage of total stock for each farm classification. Land area for each stock species was estimated based on the calculated percentage. For example, dairy cows = 97% of total animals on a dairy farm, therefore 97% of total land area is allocated to dairy cows.

	Beef	Dairy	Deer	Sheep
Weighted Land area (Ha)	37085	196106	3749	60603
Estimated Total Stock Numbers	85982	525132	14054	211249
Weighted Stocking Density (Stock per Ha)	2.32	2.68	3.75	3.49

5.4.10 Quality of other rivers and streams

Information on the quality of rivers and streams in the Gulf Catchment provides a general overview of the nature of freshwater entering the Gulf.

Many streams and rivers in the Gulf Catchment are in poor condition.

Monitoring from 1992 to 2000 found that most Auckland streams were turbid and had poor visual clarity[44] (Wilcock and Stroud 2000). None of the streams met the criterion for 'clear water' (median black disk clarity of 3m or more).

Increases in percentage dissolved oxygen saturation were found at the majority of streams (12 of 16) monitored in the Auckland region[45]. Dissolved oxygen levels were lowest at the Otara and Lucas Creek sites.

Coliform concentrations (both presumptive and faecal) were uniformly high with the exception of one native forest site. Ammonia-N concentrations were generally low. Levels of nitrate-N varied with land use: the lowest levels were found in native bush sites, the highest in market gardening areas. Dissolved reactive phosphorus levels were mostly very low. Total phosphorus levels were a little higher, but were not a major pollutant. All streams except one showed an increase in temperature of about 0.25

[43] ARC advises that information on stock numbers is not able to be readily obtained for the Auckland region.

[44] Median Secchi disk depth values less than 1.6m, which is the recommended guideline value for recreational use

[45] This is for all streams, not just those in Hauraki catchment.

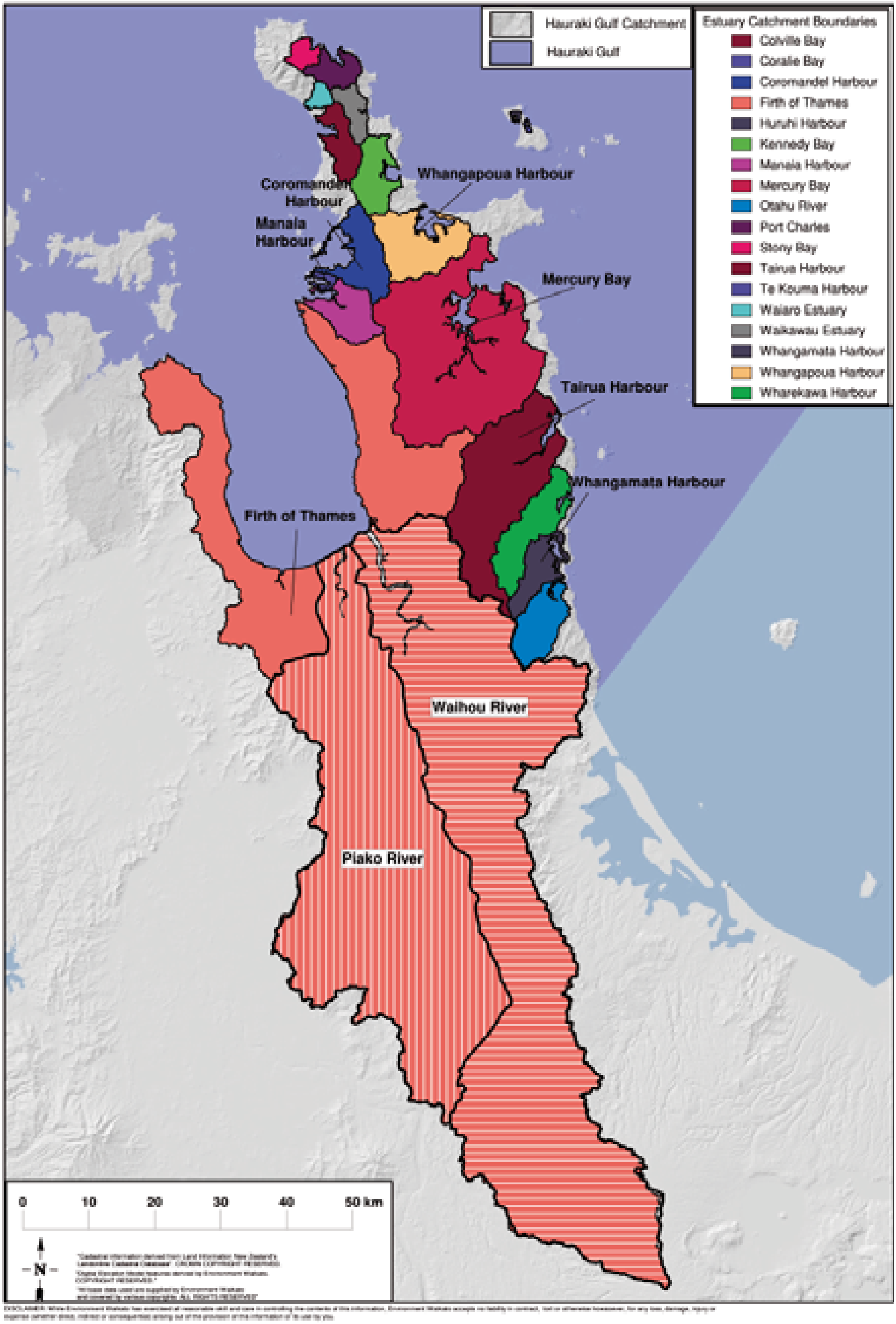

Figure 5.12 Catchments for the Firth of Thames and major Coromandel Peninsula estuaries

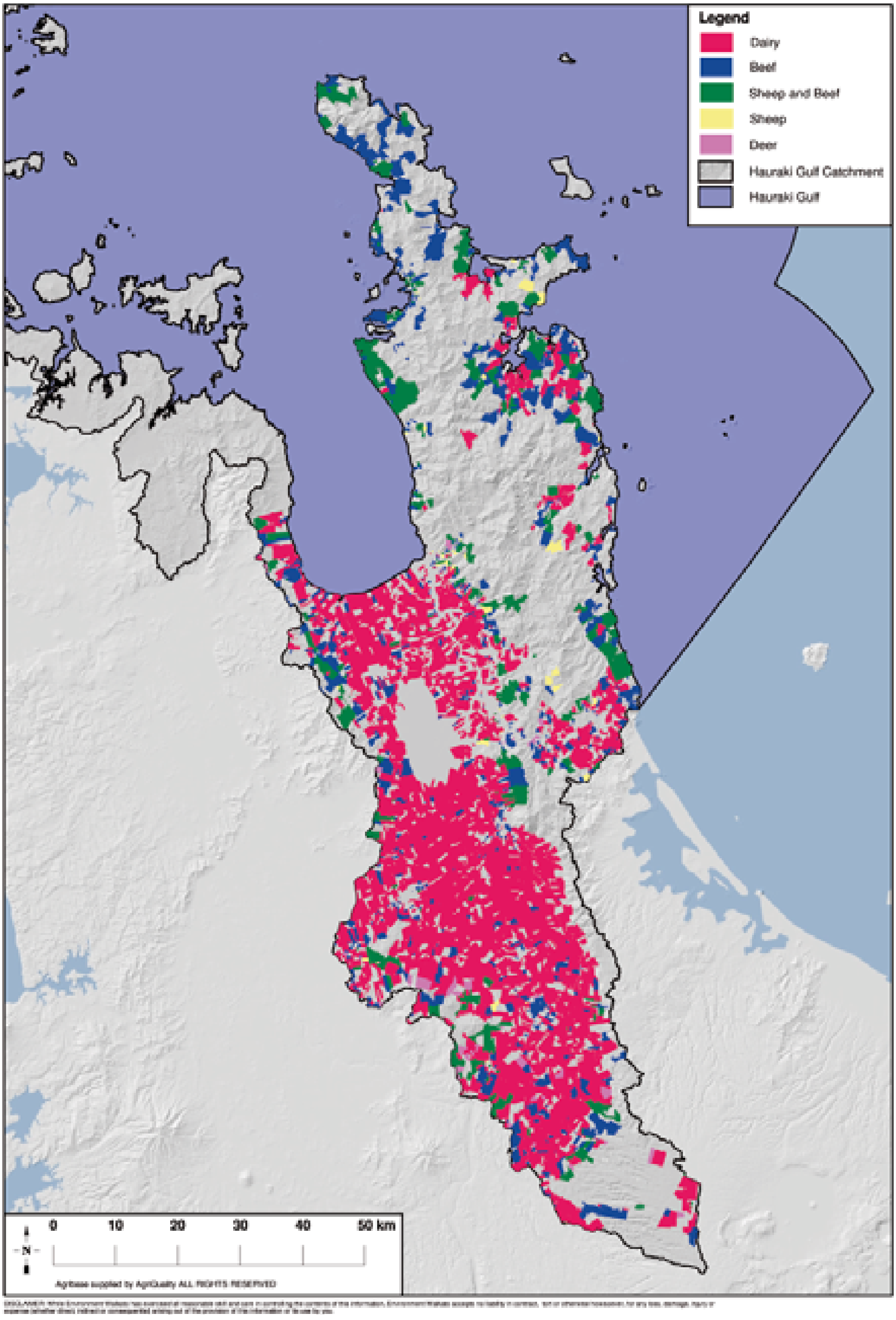

Figure 5.13: Location of livestock in the Hauraki and Coromandel portion (Waikato Region) of the Gulf Catchment

degrees per year, which is consistent with increases in temperature found in saline water monitoring (see Box 5–3).

Heavy metals were not detectable in most samples, with the exception of zinc. Zinc levels in urban Auckland streams monitored often exceeded criteria for protection of aquatic life (Wilcox and Stroud 2000).

Water quality was poorest at urban sites, or sites with large proportions of urban uses in their catchments. Inadequate riparian management (e.g. lack of vegetation buffer zones to filter runoff during storm events) may be contributing to the turbidity of streams (Wilcock and Stroud 2000). The high clay content of Auckland soils may also contribute to the elevated turbidity and poor clarity of streams (Wilcock and Stroud 2000).

Many streams and rivers in the Hauraki and Coromandel areas have shown deterioration in some variables over 12 years of monitoring. However, the pattern varies from stream to stream. It is difficult to determine clear trends for all rivers and streams in the Gulf Catchment, as trend analysis has not been conducted for these streams in isolation from other rivers and streams in the Waikato region.

Analysis of trends in river water quality from 1990 to 2002 showed significant decreases in pH in the majority of rivers and streams monitored in both the Coromandel Peninsula and Hauraki areas[46] (Vant and Smith 2004). The majority of Hauraki rivers and streams showed a trend of decreasing dissolved oxygen concentrations. On the Coromandel Peninsula, streams were more likely to show an increase in dissolved oxygen.

Significant increases in conductivity were found in the majority of Coromandel streams and rivers, and at nearly all Hauraki sites. This is in keeping with a trend observed across the Waikato. This probably indicates deterioration in water quality. This trend seemed to be associated with land use, but the nature of processes is unclear.

On the positive side, decreases in turbidity were found at most sites in the Coromandel. These results were supported by findings of increased visual clarity at a majority of sites. Similar findings were observed in Hauraki rivers and streams. This is also in keeping with overall trends for the region.

Nutrient concentrations did not show a clear pattern, with increases at some sites and decreases at others.

Analysing the types of invertebrates that live in streams is another way of determining stream health. Some animals are more tolerant of poor water quality than others. The types of invertebrate communities found in waterways can therefore be used as another indicator of water quality.

As Figure 5.14 shows, many streams in the Waikato portion of the Gulf are classified as 'unsatisfactory' using these biological indicators (Taylor 2001). Streams in the ranges of the Coromandel Peninsula, which were likely to be undeveloped, were mostly satisfactory. In the Hauraki area, however, all sites were in developed catchments and most streams were classified as 'unsatisfactory' using biological indicators.

Given present knowledge, it is not possible to quantitatively state the extent to which these rivers and streams are affecting the Gulf as a whole. There is no doubt that freshwater pollution can affect coastal water quality. The question is the degree to which this occurs, and where. Links can be demonstrated between freshwater inputs and coastal water quality. However, to do so in a quantitative manner requires understanding of all inputs to a water body and sufficient monitoring to determine the effect of freshwater sources on coastal waters. Where this information is not available, definitive statements cannot be made.

The effects of freshwater inputs are influenced by the nature of the coastal environment. Poor quality freshwater inputs are more likely to adversely affect sheltered harbours and estuaries than open surf beaches, where wave action and currents can more readily disperse pollutants. The degree of tidal flushing also determines whether pollutants will build up in a harbour or estuary. Also, nutrient inputs from ocean sources are substantial.

It is difficult to state whether nutrient inputs from land sources are having an

[46] The Hauraki area referred to here includes the Hauraki Plains and upper catchment of the Piako and Waihou rivers.

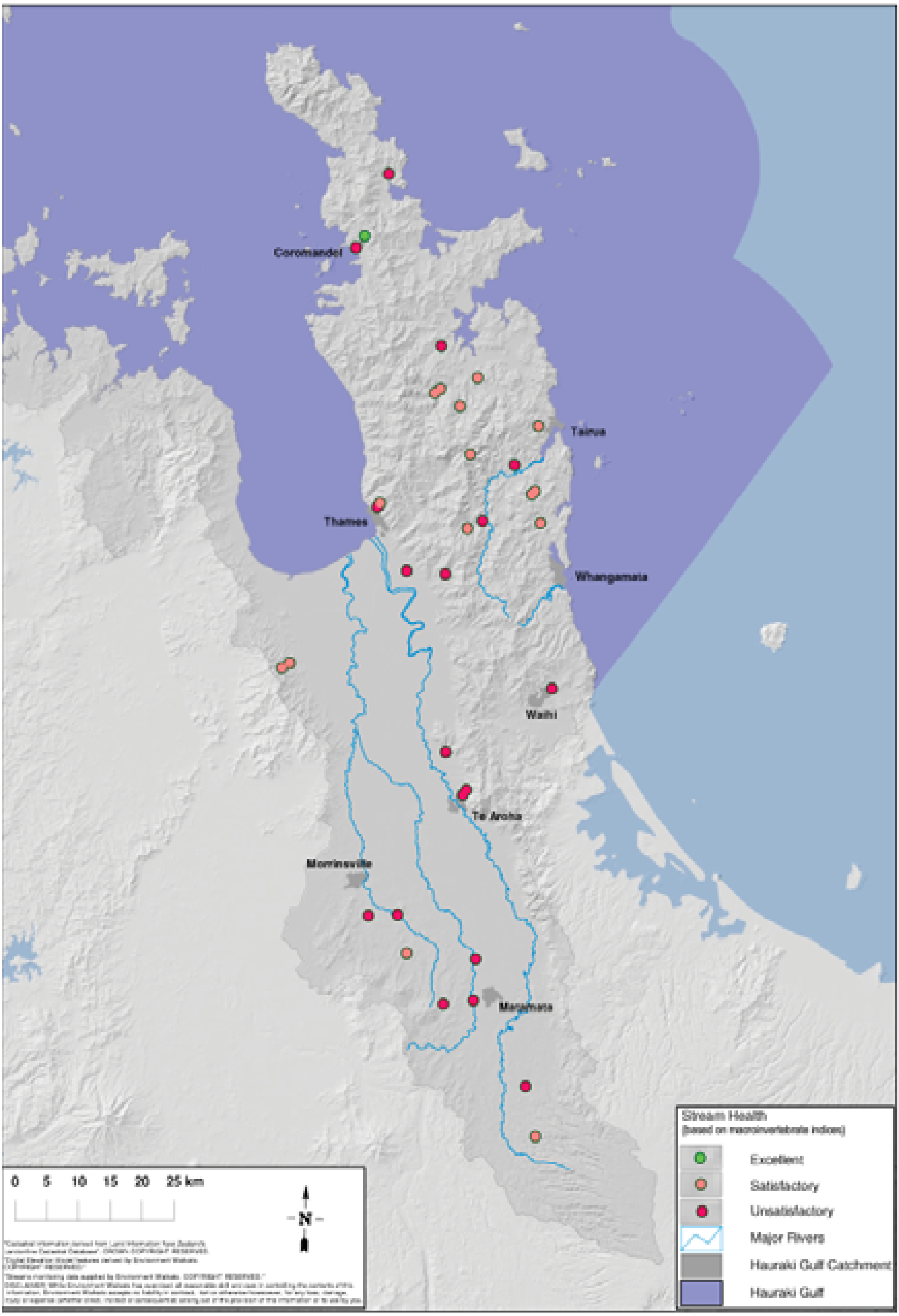

Figure 5.14 Stream health, assessed using several macroinvertebrate indices, in Hauraki and Coromandel streams of the Gulf Catchment

(Source: Taylor 2001)

adverse effect on the marine environment without studying nutrient fluxes in more detail, particularly in the Firth of Thames. A recent review of available water quality information suggested that the level of nutrient enrichment (nitrogen and phosphorus) is generally low in the Gulf (Grant and Hay 2003). The potential for eutrophication is greater in upper estuarine areas than in outer estuaries or along the coast.

5.4.11 Other sources

There are other sources of contaminants which can affect water and sediment quality, for which quantitative information was not able to be collected. These include:

Antifouling paints

Organotins used historically for antifouling, including tributyl tin (TBT), are one of the most toxic substances known for aquatic life (Grant and Hay 2003). Organotin antifoulants were banned in New Zealand in 1993. As there are eight to ten large commercial ships in the Port of Auckland at any one time, this could be a significant source of TBT in some parts of the Gulf (de Mora 1995). However, organotins can persist in sediments for many years.

Disturbance of sediments can remobilise organotins back into the water column. New inputs of TBT to the Gulf originate largely from commercial ships entering the Auckland Port area (Grant and Hay 2003). However, inputs from this source may decline in the future, as there are proposals for international bans on TBT on ships' hulls by 2008 (Maguire 2000).

TBT contamination is localised and is highest in marinas, around wharves and at other facilities with high levels of boating activity. In a study of the Waitemata Harbour, De Mora et al. (1995) found that the majority of TBT contamination was present in marinas. Levels decreased within a short distance (250-500m) from point sources such as dry docks and marinas (Stride 1998, King et al. 1998). No recent data on levels of TBT in sea water were available for the Gulf (Grant and Hay 2003). A study of whelks in 1998 found that growth of male sex organs on females, an indicator of the presence of TBT, was slightly reduced in some east coast Auckland populations (Playfair 1998). This may indicate a decrease in TBT levels. No more recent data were available (Grant and Hay 2003).

Since the banning of TBT, copper is the main active ingredient in antifoul paints (Voulvoulis et al. 2002). Organic booster biocides are used in conjunction with copper to improve antifouling efficacy (Grant and Hay 2003). A study of levels of organic booster biocides in coastal waters, including the Gulf, was completed recently.

A recent study detected the organic booster biocide diuron in seawater at Gulf Harbour, Westhaven and Whitianga marinas (Stewart 2003), though concentrations did not exceed marine environmental protection guidelines[47]. Levels in sediments were low or below detection limits at all sites.

High levels of copper and zinc can originate from the antifoul paints currently in use. Levels will be highest in the water column and sediments near marinas, dry docks, slipways, swing moorings and wharves (Grant and Hay 2003). These are scattered throughout the Gulf.

Contaminated sites

These could be a source of localised water pollution in some parts of the Gulf if close to water bodies, particularly the coastal marine area. There is a lack of comprehensive information about the location of sites however, and doubt about the extent of potential environmental risk. For many sites in Auckland, comprehensive information is available primarily for those sites which have already been remediated and therefore pose little environmental risk. For the Waikato, it was not possible to obtain relevant information, and again there was doubt about whether there were significant discharges associated with known sites.

Other sources of heavy metals (other than stormwater)

Such sources include the sediments found below commercial ports and wharf areas,

[47] Diuron1800ng/L, New Zealand Environmental Exposure Limit, proposed by ERMA New Zealand, December 2002. Diuron 430ng/L, Netherlands Maximum Permissible Concentration

wastewater treatment plants and septic tanks, and agricultural runoff (e.g., cadmium in fertilisers).

5.5 Responses to Pressures on Water Quality

A large number of actions are being undertaken by agencies and individuals in the Gulf Catchment that will have direct or indirect benefits for water quality and erosion and sedimentation rates in the Gulf. These range from multi-million dollar sewerage and stormwater upgrades, to stream monitoring by schoolchildren and riparian planting by landowners.

This section reports progress on strategic actions identified by the Forum, as well as major activities by individual Forum members. The actions that the Forum encourages its members to take are set out, with examples of actions taken. The list of actions should not be considered exhaustive.

Progress on Forum actions

- **Undertake joint research initiatives to better understand the cumulative effects of discharges on the Gulf.**

Preparation of the Shellfish Depletion Report (Grant and Hay 2003), which includes information on cumulative effects on shellfish of contaminants in discharges.

- **Promote awareness of the localised and cumulative effects of activities on mahinga mataitai and other taonga values and uses by tangata whenua.**

No action to date.

- **Promote awareness of the extent and relationship between activities on land and in the Gulf through consistent signage indicating entry into the Gulf Catchment.**

To be addressed in forthcoming communications strategy.

Other Progress

In addition to the projects and programmes the Forum undertakes, individual Forum members have undertaken a range of initiatives.

5.5.1 Stormwater Management

Improving management of stormwater is a high priority in the Auckland region, and will be vital to improving water quality in coastal waters of the Gulf near urban Auckland (see Box 5–14).

Waitakere City Council has developed the Comprehensive Urban Stormwater Management Strategy and Action Plan. This is a 20-year strategy for managing stormwater. The strategy aims to prevent future stormwater problems through careful design of new development. It also sets out to improve existing stormwater management in areas that have already been developed. The Strategy uses total catchment management practices for both rural and urban areas. An important component is the recognition of the need for involvement of all sectors of the community to improve stormwater management in the long term. The Twin Streams Project (see Box 5–13) is one aspect of the Strategy.

ARC and Manukau City Council are working on a joint project to predict the effects of development in Whitford catchment, using work by NIWA modelling the effects of development on sediment runoff and biota. This work will be used to develop policy for a plan change for this area to determine future growth.

Box 5–13

Project Twin Streams

Project Twin Streams is a major riparian restoration project that aims to restore some of the major streams in Waitakere City. The project focuses on the Oratia, Opanuku, Waikumete, Swanson and Pixie Streams, and Henderson Creek. Together, these streams drain a catchment of over 10 000 hectares, and ultimately flow to the Waitemata Harbour. These streams and their catchments have a history of flooding, erosion, siltation and pollution.

The project aims to improve water quality by planting stream margins and introducing stormwater control devices. Riparian vegetation reduces stormwater pollution and sedimentation, as it traps sediment and slows flows before they enter waterways. Riparian planting also stabilises stream banks and reduces erosion.

In partnership with the community, riparian margins will be weeded and planted with indigenous vegetation. Stormwater control devices such as wetlands, infiltration basins and swales will also be built to remove pollutants from stormwater and decrease the volume and speed of water entering streams.

Community education is also an important part of the project. Involvement of community groups is seen as crucial to its success (Woodward 2004).

Funding assistance for the project has been received from Infrastructure Auckland.

Box 5–14

Stormwater Management – Key to Improving Water Quality

It is not feasible to route stormwater through wastewater treatment plants before being discharged into the sea, due to the highly variable volumes involved. Regulating volumes and reducing contaminants at source is the best approach. The most efficient way to protect stormwater quality is through management practices to ensure that contamination of hard surfaces, soil loss from construction sites, and overflows from the wastewater network are reduced. This requires an integrated management approach by the regional and territorial authorities of the Gulf's catchment. A selection of projects carried out by city councils in the Auckland Region are described below.

Auckland City: Metrowater, which manages Auckland City's wastewater and stormwater networks on behalf of the City Council, has set a target of reducing wastewater overflows by 50% by 2005. Separation of combined sewers is the main method being used to reduce overflows. Current initiatives are underway in Upland, Orakei and Point Chevalier (Metrowater 2004a). Improved maintenance and management are also important in achieving this goal.

Auckland City also aims to reduce loads of suspended sediment in stormwater. The Council has set a target of removing 27% of suspended sediment, in 70% of catchments, over a 20 year period. This is being achieved by street sweeping, catchment cleaning (using catch pits with silt traps) and installation of treatment devices (e.g. stormwater detention ponds). Dredging of port sediments is also part of achieving this goal. (Patterson 2004).

Metrowater and Auckland City are working together to plan for the extra demand and pressures on infrastructure from urban intensification. An infrastructure contribution scheme has been introduced to ensure that the costs of development-related capital expenditure is not met by existing consumers, but by the developers of such projects (Metrowater 2004b).

North Shore City: Project CARE is a 20-year project by North Shore City Council to improve beach water quality by reducing wet weather sewer overflows and improving stormwater quality. In consultation with residents of North Shore City, a target of a 65% improvement in beach water quality was set in 2001. Significant capital works (including pipe renewals and the containment of overflows in underground storage tanks) aim to reduce wet weather overflow events from an average of 12 per year to two per year.

The "Kokopu Connection" – a programme for gathering information to support the Council's consent applications for discharges from stormwater and wastewater networks and preparation of seven integrated Catchment Management Plans (see Regional Discharge Project below), is now largely complete. The work has included:

- Documenting the condition of 26 urban streams in a series of comprehensive individual stream reports;
- Assessing the condition of the marine ecology all around the city's coastline;
- Multi-faceted investigations of the effects of wastewater overflows on the environment;
- Documenting the levels of contaminants in marine sediments and comparing to the condition of the local ecology; and
- Investigations of uses of the North Shore aquatic environment.

The Kokopu Connection also includes a campaign to increase public awareness of the ecological value of urban streams and engage the community in water quality issues and initiatives including stream enhancement programmes.

The Council has established a cross-divisional team to develop appropriate policies for particular aspects of environmental management and integrated catchment management plans, including individual stream management plans. The process will link land use planning, wastewater, stormwater, transport and parks activities and is being overseen by a Steering group at General Manager level, which reports directly to the Council's Chief Executive and Executive Team.

As part of Project CARE, North Shore City Council's long-term project to improve beach water quality, it is inspecting both public and private sewers in various areas throughout the City. Ongoing maintenance aims to renew, repair and reline pipes to prevent both leakage of sewage and entry of stormwater. Works have been targeted to occur in areas where sewage leakage from (and stormwater entry to) pipes is greatest, so that the maximum benefit for investment in the sewer network is obtained.

Regional Discharges Project: The initiatives described above all fall under the umbrella of ARC's Regional Discharge Project (RDP). This project requires all territorial authorities to apply for permits for discharges from the stormwater networks that they own and manage. The requirement to do so is set out in the Proposed Auckland Regional Air, Land and Water, and Coastal Plans. Territorial authorities and local network operators such as Metrowater are obliged to prepare integrated catchment management plans that:

- characterise the catchments,
- document the water quality and ecology of streams and receiving coastal waters,
- document contaminant levels in marine sediments,
- identify sources of contamination and flooding, and
- describe in detail a programme setting out how stormwater and water quality issues will be monitored and addressed.

Consents are expected to be granted in 2005. This is the first time a comprehensive, holistic approach to stormwater management in the Auckland Region has been undertaken (Stormwater Facts, ARC, June 2004). Along with community concern over particular pollution problems (such as on the North Shore beaches), it has helped to galvanise interest in stormwater, wastewater and water quality issues.

Box 5–15

Waiheke Wastewater Treatment

Most of the permanent residents on Waiheke Island live in small towns such as Oneroa, Onetangi, and Surfdale and on relatively small rural-residential properties, close to streams and coastal waters. Most dwellings and commercial premises on Waiheke rely on on-site systems to treat and dispose of their wastewater. Most of these comprise septic tanks (where the effluent is discharged to ground soakage). Some properties have more sophisticated systems with sand filters and aeration plants. Septic tank sludge is disposed of at commercial facilities on the Island. The City Council maintains a back-up disposal area at Man-O-War Bay.

While the majority of on-site wastewater systems appear to be performing satisfactorily, the streams on Waiheke that pass through densely populated areas often fail to meet standards for contact recreation. Similar problems occur with beach water quality after rainstorms. The effectiveness of soakage-type systems on Waiheke seems to be constrained by the poor soakage characteristics of soils, and there appears to be a direct link between pollution events and this particular source of contamination (WRCG Ltd 2004a).

Auckland City Council constructed the Owhanake wastewater treatment plant in 2001 to serve the commercial area of Oneroa and the Matiatia Wharf facility. The plant discharges effluent into the Matiatia wetland, which in turn flows into the sea at Matiatia Bay. The original proposal sought to cater for residential as well as commercial development at Oneroa. However, the community opposed any servicing of residential properties and indeed any capacity for additional reticulation, fearing this would create pressure for further development. It was the community's wish that there be no further reticulation until a need was "proven".

The debate at Oneroa emphasised the lack of formal, detailed studies of water quality issues on Waiheke (the receiving environment studies referred to above notwithstanding). Auckland City carried out a walkover survey of on-site systems in June 2000. This survey found that 16% of those systems surveyed were considered to be failed systems, with another 11% indicating potential problems. However, the survey elicited an estimated 33% response rate from property owners, which is likely to have biased the results.

In May 2004, Auckland City commenced a new survey in attempt to quantify the 'problems' associated with septic tank use. The return of pump-out reports remains voluntary until May 2007, when the requirement to respond becomes mandatory. The survey is being carried out in conjunction with the distribution of an instruction manual for properly maintaining tanks.

Discharges from septic tanks serving normal domestic situations are made a permitted activity by the ARC (under the Resource Management Act). Building consents for new septic tanks are required from Auckland City, as part of the construction of any new dwelling. On Waiheke, compliance with an Auckland City tank maintenance bylaw has been mandatory since 1998. The bylaw requires property owners to have their tanks pumped out once every three years. The removal of settled solids assists in maintaining the efficiency of the tank's operation, and avoids overflows of suspended solids to ground and water sources, thereby causing drain blockages, and exacerbating pollution problems. The current survey referred to above is having the effect of raising community awareness about water quality issues, the bylaw, and the requirement to comply with it.

Metrowater has now assumed responsibility for the Owhanake plant. Metrowater has stated:

> *"Our involvement on Waiheke is about providing the best wastewater services for the community and we will not be doing any further development in the area without understanding and consulting with the community. We want to provide solutions that are right for this particular area – not transpose mainland processes to an environment that is quite different from Auckland City. However, Waiheke people will be very aware that traditional ways of managing wastewater are less and less practicable as the population increases, which does not mean that options like the Owhanake plant are necessary."* (Metrowater press release, 30 June 2004).

5.5.2 Wastewater Treatment

Rodney District

Rodney District Council is developing an onsite wastewater treatment management strategy. For septic tanks in towns, connection to existing wastewater treatment plants could be an option if these plants are upgraded or their capacity expanded. Wastewater service investigations are currently underway in the following areas:

- Riverhead.
- Warkworth.
- Waiwera.

North Shore City

A new outfall is to be constructed for effluent from the Rosedale Wastewater Treatment Plant. The new outfall will discharge 2.5km offshore from Mairangi Bay. The current outfall is much closer to shore (650m off Red Bluff near Campbells Bay). Construction of the new pipe is being undertaken because (i) the existing pipe is getting old and (ii) piping further offshore will allow greater dispersal of effluent[48]. Monitoring will be taken at both the new and old outfall locations, as well as at beaches.

Manukau City

Manukau City Council has a work programme for sanitary and environmental surveys of rural settlements without reticulated wastewater. This includes Kawakawa Bay, Orere Point and Clevedon. Studies at Kawakawa Bay have found significant problems with septic tanks in this area (Franks 2002). A sewage treatment plant has been designed and is awaiting approval and then construction for Kawakawa Bay. This is thought to be not necessary at Orere Point.

Coromandel Peninsula

Upgrades are planned over the next couple of years for wastewater treatment plants at Thames, Coromandel, Matarangi, Whitianga, Tairua/Pauanui and Whangamata.

Hauraki

A new wastewater treatment plant is proposed for Waitakaruru. The previous plant serving this small community achieved little or no treatment of effluent, which was then discharged to a nearby canal. Hauraki District Council has obtained partial funding from the Sanitary Works Subsidy Scheme for a new reticulation and wastewater treatment system. The scheme will also serve households currently on septic tanks. The Council hopes to have the scheme installed by mid-2005.

Waikato Region

Over the next few years, Environment Waikato will be reviewing rules for on-site wastewater.

5.5.3 Agricultural Discharges

The Proposed Waikato Regional Plan contains detailed provisions for managing nutrient inputs from agriculture. There is a focus on reducing the adverse effects of non-point source discharges, promoting the use of streamside management and managing the adverse effects of livestock access to water bodies. This is achieved using a range of non-regulatory methods and permitted activity rules for the discharge of fertiliser and for livestock access to water bodies.

5.5.4 Other Planning Responses

District and regional plans contain numerous provisions with direct or indirect benefits for water quality. Some examples are outlined below.

Regional Growth Strategy

The Regional Growth Strategy has identified areas for targeted population growth and development in the Auckland Region. For each of these areas, in-depth catchment management and structure planning is done prior to development commencing. It is hoped that this process will reduce impacts on water quality in new development areas.

Long Bay Structure Plan

This is a plan change to create a new residential area at Long Bay (North Shore City). Part of this work has involved planning how to lay out residential areas across the site in a way that protects natural streams and minimises the effects

[48] Kylie Falconer, ARC, pers comm. 2004

of stormwater on both streams and the marine environment.

Local Area Coastal Plans

Environment Waikato has provided budget in this financial year for the development of Local Area Coastal Plans under the provisions of the Regional Coastal Plan. These will be statutory plans (under the RMA) to cover all aspects of the harbour and catchment from an environmental point of view.

5.5.5 Discharges from Vessels

There have been complaints in Auckland for a number of years about discharges of wastewater from ferries. Until recently, ferries discharged all wastewater into the Gulf.

Under the Marine Pollution Regulations, ferries were not breaking the law by discharging wastewater. However, smells associated with discharge of untreated wastewater on ferry trips have been a source of offence for ferry passengers and other harbour users.

Pump-out facilities were recently installed in the new Auckland ferry terminal. Fullers Ferries have upgraded their vessels and are now able to pump out wastewater at the Auckland Downtown terminal[49].

Related actions include joint production by ARC and EW of a pamphlet on the Marine Pollution Regulations and installation of a wastewater pump out facility at Auckland Ferry Terminal (encouraged by ARC).

5.5.6 Sustainable Land Management

There are several soil conservation schemes for rivers in the Gulf Catchment, including the Piako and Waihou schemes (administered by Environment Waikato). These have the potential to benefit water quality by reducing entry of sediment, nutrient and animal waste to streams. Work to maintain and improve these schemes is ongoing.

Waihou Valley Scheme

This scheme has protected 1783 ha of indigenous forest[50], 500 ha of riparian area and 28 ha of wetland. It includes 477 km of fencing and 60 erosion control structures (Environment Waikato 2003).

Piako River Scheme

To date, there have been no land management works in this scheme, with the exception of some recent work under the Clean Streams project (see below). Works in the scheme currently consist of flood and river management structures. However, it is recognised that water quality in the Piako catchment is generally poor and that erosion is contributing to entry of sediment to waterways, ultimately contributing to sedimentation in estuaries (Environment Waikato 2001). Catchment management approaches have the potential to reduce the amount of sediment in waterways.

Clean Streams

Clean Streams is a new Environment Waikato project to encourage and support farmers in reducing the impacts of farming on waterways. Under this programme, landowners can apply to receive up to 35% of the funds needed for fencing and planting to exclude stock from riparian areas, including wetlands and estuaries.

The programme was established in 2002 and will run for 10 years, with total funding from Environment Waikato of up to $10 million. The Coromandel Peninsula and upper Hauraki catchment have been identified as being of high priority for riparian management.

91.7 km of fencing to protect streams had been completed under the Clean Streams programme in the Gulf Catchment by the end of the 2003/04 financial year, at a total cost of $163,625[51].

Table 5.8 shows the length of fencing and area planted in the Hauraki and Coromandel Peninsula parts of the catchment under the above programmes. Note that the accuracy of these figures is unknown, so numbers should be considered approximate only.

Peninsula Project

The Peninsula Project has been established by Environment Waikato and the Thames-

[49] Alan Moore, ARC, pers comm, July 2004

[50] This figure does not include large areas of Crown land in forest parks adjacent to properties, which have also been effectively 'retired' by fencing works in this scheme.

[51] 29,394m on the Coromandel, 54,808m on the Upper Hauraki, 7,550m on the Lower Hauraki. Cost is the total amount of grant provided by Environment Waikato.

Table 5.8 Soil conservation and riparian protection works in the Hauraki Gulf catchment (Waikato region figures only; to February 2004. Includes Clean Streams and soil conservation in Paiko and Waihou Scheme)

Area	Fencing[52] (m)	Planting (ha)
Coromandel	35,144	208
Piako and Waihou	539,358	561
Total	574,502	769

Coromandel District Council to improve management of rivers and streams on the Coromandel Peninsula. It is a 20-year project which aims to improve land and water quality, reduce flooding, improve biodiversity and reduce sediment build up in estuaries and harbours. The project aims to achieve this by:

- Pest control to reduce forest damage by goats and possums. Improved vegetation cover reduces soil erosion and thus sedimentation. The project provides for pest control on private land. Central Government has approved additional funding for pest control on land administered by DOC in response to a business case presented to central government by Environment Waikato. The work is coordinated with DOC to achieve the best outcomes. DOC administers approximately 40% of the catchment.
- River and catchment management, including riparian planting and preventing stock access to waterways. River management works include removal of debris and gravel blocking the river systems and causing channel instability. It also includes provision for supporting erosion protection works.
- Flood protection works for particularly at-risk communities.

Improved biosecurity and stream management are expected to have water quality benefits by reducing soil loss and thus decreasing sedimentation. This will have benefits for estuaries and harbours.

The Hauraki Maori Trust Board has been consulted during the development of the project. Current arrangements include ongoing consultation on annual works programmes and where new flood protection works are initiated.

Riparian Management in the Auckland Region

ARC has a riparian management project and runs workshops around the region for both rural and urban areas. The project provides information on riparian management, planting guidelines and pest control. Workshops have been run for the past three years.

Soil conservation officers are employed by ARC. Their function is primarily to educate and provide advice. The only source of funding by ARC to assist financially with riparian protection is the Environmental Initiatives Fund (see below).

Data on total stream margins fenced and areas protected were not available from ARC. However, staff estimate that approximately 20km of streamside have been protected over the past year (including lakes and wetlands).

Financial Support

In addition to the projects listed above, financial support to assist with land management is available from a number of organisations. These have the potential to benefit water quality by protecting stream banks and reducing erosion in the Gulf Catchment. Environment Waikato offers financial support through:

- Environmental Initiatives Fund: This fund assists community organisations, agencies and individuals with environmental projects. It provides one-off grants for projects that directly enhance and/or benefit the environment or provide environmental education. This contestable fund provides $250 000 per year for environmental projects in the Waikato region.
- Natural Heritage Fund: Funded by a targeted rate, approximately $800 000 per year will be available for protection of important natural heritage areas in the Waikato region. This fund will be used to secure public interest in important areas (for example through purchase, leases, management agreements), contribute to community management and assist landowners to place conservation covenants on significant areas.

[52] Both conventional and electric fencing.

- Key Ecological Sites Programme: Regionally significant sites have been identified in ecological surveys across the northern Waikato region. 38 of these sites are on the Coromandel Peninsula. Works are currently underway on about a quarter of these sites. Under this programme, these sites are given priority by Environment Waikato for pest control work. The sites are mostly forest remnants and wetlands, ranging from a few hectares to several thousand. If the site is of high ecological significance, then Environment Waikato will fund the cost of initial pest control activity (e.g. possums, goats, weeds). A 33% subsidy is available for exclusion fencing. In most cases, landowners provide the labour for ongoing pest control works. As many sites are located on more than one property, landowner and community groups are working together on many of these projects. DOC is also involved as many sites border land administered by DOC. In addition to its benefits for biodiversity, this programme has the potential to improve water quality by stabilising catchments and reducing erosion.
- Rating relief: The Piako River Scheme Differential Rating System provides rate relief for forested areas greater than 10 ha. Rates remission is also available for land covenanted under the Queen Elizabeth II National Trust. Remission of biosecurity rates is available for areas greater than 10 hectares that are fenced against pests. Rates remission is also available for unoccupied Maori land not used for any economically beneficial purpose.

ARC also has an Environmental Initiatives Fund, which has been in place for approximately eight years. It is funded partly by ratepayer contributions and partly by sponsorship.

The Mahurangi Action Plan

Sedimentation in the Mahurangi Harbour has led to changes in the harbour's ecology (see Box 5–16). If sedimentation continues at current rates (see Box 6–9), marine life in Mahurangi Harbour will deteriorate further, water clarity will decline, and fishing, boating and marine farming will be affected as the harbour becomes shallower.

However, there is hope that the pattern can be reversed by improving land management so that less sediment enters the harbour. ARC and Rodney District Council are working together to develop the Mahurangi Action Plan, which aims to improve the harbour using a catchment management approach.

Community involvement is vital. There are many sources of sediment in the catchment, and all sectors of the community will need to be involved to achieve the necessary reduction in sediment inputs. Involvement of forestry and rural sectors will be particularly important.

Potential actions include riparian planting, targeted sediment and erosion control measures for farming and forestry, and low impact urban design. Measures will need to be targeted towards parts of the catchment that are particularly high risk erosion areas, but control of all sources is important. It is expected that a broad suite of measures will be developed over time in consultation with all stakeholders. It is also hoped that the action plan will provide a successful catchment management model which can then be transferred to improve the quality of estuaries elsewhere in the Auckland region.

5.5.7 Promoting best practice in disposal of trade wastes

Rodney District Council is consulting on a draft Trade Waste Bylaw to protect its wastewater and stormwater systems, its staff and the community from known instances of unacceptable trade waste discharge.

ARC has established an industry clean up programme in the Tamaki estuary - 'Environmental Champions' – in partnership with local industries.

5.5.8 Community involvement in water quality management

Community involvement is crucial for successful riparian and catchment management. Participation of individual landowners is essential. Examples of

Box 5–16

Whangamata Community Plan

Rapid population growth in Whangamata has resulted in increased environmental pressures. Concerns about a range of environmental issues in Whangamata led to the development of the Whangamata Community Plan. The community was already actively engaged in care groups addressing some of these issues (Harbourcare, Beachcare, and Rivercare).

The plan has several key areas of focus, including:

- Water: establishment of a community-based water working party to develop long-term management options for water supply, stormwater and wastewater.
- Harbour and Beach: ecological health and quality of the harbour and beach, including kaimoana and mangroves.
- Growth and development: manage growth and development to reflect community aspirations.
- Catchment management: to minimize adverse environmental effects (native vegetation cover, riparian protection, land management, pest management).
- Leisure and recreation.

The Plan was developed in consultation with the community in partnership with Environment Waikato, Thames-Coromandel District Council and Ngati Puu. Involvement of community-based care groups (e.g. Wentworth Rivercare, Beach Care, Clean Water Whangamata), private landowners and other agencies (e.g., DOC) is vital to the success of the plan.

While the plan does not have any statutory basis, progress on actions is ongoing.

The Plan is currently the subject of review by the Parliamentary Commissioner for the Environment.

large-scale programmes involving the community follow:

Landcare

ARC is closely involved with supporting Landcare groups. Landcare groups are set up by local communities wishing to address environmental issues in their area and promote sustainable land management. Issues addressed include soil erosion, weed and pest management and stream management. Activities can include revegetation, erosion prevention, community education and liaison, forest and wetland restoration, plant and animal pest control, fencing and signage.

Landcare groups in the Gulf Catchment include:

- Matakana Landcare Group
- Puhoi Landcare Group
- Whangateau Harbourcare
- Orewa Landcare Group
- Clevedon Landcare.

Trees for Survival

The Trees for Survival Programme is run by a charitable trust which promotes the growing and planting of native trees to help reduce soil erosion. The programme now runs nation-wide, with nearly 100 Plant Growing Units (PGUs) in schools from Northland to Southland. In the Auckland Region, 50 schools are growing trees for erosion control and riparian management[53]). 45,000 trees planted in 2004 were under the programme in designated areas on private land, identified by ARC.

The benefits at a local and regional level are significant. Not only do landowners and communities benefit from improved land and water quality, but also schools are able to impart important knowledge and skills to pupils who are involved in the nurture of native plants right through the process from propagation to planting.

The programme involves partnerships between school students who grow and plant the native trees, service groups who sponsor the schools, regional councils who select the planting sites and landowners who care for the trees.

The ARC supports the Trees for Survival programme through its rural land management team as part of its soil conservation and sustainable land management functions.

Wai Care

Wai Care is a community based monitoring, education and action programme tailored towards streams in urban Auckland. Community groups and schools participating in the programme monitor the health of a stream or other water body in their area on a regular basis. The groups can then identify actions to restore these water bodies.

A key component of Wai Care is learning about the effect of land use on water, and the actions that can be taken to improve water quality.

Wai Care began in 1999 and is jointly funded by councils in Auckland, together with ARC. Each council has a Wai Care coordinator, who works with groups and liaises with other coordinators across the region.

[53] Pers comm. Tony Thompson, ARC, 2004

47 community and school groups are currently involved in stream monitoring in the Gulf Catchment. Wai Care also has an active environmental education component and regularly gives presentations to clubs and schools.[54]

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6 Biological Diversity of the Gulf

Key Points

- The Gulf has a rich diversity of habitats and species including algae, zooplankton, invertebrates, fish, aquatic plants, estuarine plants, and terrestrial plant and animal species on islands.
- Diversity has declined and a range of plant and animal species are now threatened or extinct. Some aquatic habitats are significantly modified.
- There are important commercial and non-commercial fisheries for fish and shellfish in the Gulf, but a combination of quantities caught and adverse environmental changes mean that numbers of most species are likely to have fallen from what they once were. The Quota Management System recognises the requirement to manage fisheries in a sustainable manner.
- Much of the recent or current monitoring has inadequate baseline data to determine the full extent of habitat degradation or loss in species diversity. Trends of decreasing abundance are based on relatively few data or anecdotal evidence.
- Key pressures are commercial and recreational fishing, loss, degradation or modification of habitat, and introduction and spread of plant and animal pest species. It is clear that sedimentation and accelerated infill of estuaries is causing decline in diversity and changes in abundance of intertidal species.
- Programmes have been established to monitor changes in estuarine and harbour benthic populations in response to urban development and catchment use, but biodiversity as such is not monitored. Processes are underway to increase the marine area under protection.

6.1 Introduction

Biodiversity in the Gulf includes a diverse range of common and rare species and habitats which have natural beauty and worth, provide resources for tourism, recreational and commercial opportunities, and provide a range of ecological services including spawning and nursery grounds, nutrient recycling, waste treatment and genetic resources.

The Gulf reflects a worldwide trend in species decline. Human activities within the Gulf and within the catchment of the Gulf have placed pressure on plant and animal species such that some species no longer exist in the Gulf and others are seriously threatened in their ability to survive. The introduction of exotic species has further contributed to the decline in indigenous biodiversity.

Some habitats and species are protected in marine reserves and a key feature of the Gulf is the use of its islands to support populations of species restricted in habitat or no longer present on the mainland.

Box 6–1

What is Biodiversity?

Biological diversity (biodiversity) refers to the variety of life forms. It includes diversity within species, between species, and of ecosystems and the processes that maintain them.

Species diversity is the most common measure used to describe biodiversity because it encompasses most living things and describes individual species which can be recorded. Genetic diversity refers to differences in the gene structure, including variations in traits and genetic mutations in genes, within a population. Ecological diversity describes ecosystems, or assemblages of species that interact with each other and their physical environment in a particular way. Most ecosystems can be characterised by their features and dominant species, although there remains debate as to the ability to separate out ecosystems and their dependent species.

Biodiversity can be measured as species, genetic or ecological diversity (see Box 6–1). The information that is available on the Gulf is largely species and ecosystem based.

The Forum has identified diversity of habitats and features and the presence of rare and endangered species as values of the Gulf. Also associated with biodiversity is the value of high quality food production

Box 6–2

Strategic Issues and Objectives

The major issues identified by the Forum relating to biodiversity, natural heritage, fisheries and aquaculture management in the Gulf include:

- Restrictions on traditional relationships that tangata whenua have with biota.
- The threatened state of flora and fauna in the Gulf.
- Direct and indirect threats to flora and fauna.
- The lack of information about marine biological diversity and the most appropriate management.
- Acknowledgement of the national importance of the recreational and commercial fisheries.
- Threats to those and conflicts between customary, recreational and commercial uses.

The Forum identified the following objectives for biodiversity and natural heritage in the Gulf:

- The exercise of customary rights to biota and their habitats and ecosystems as guaranteed by the Treaty of Waitangi is actively protected.
- People recognise, understand and respect the value and benefits of natural heritage and indigenous biological diversity of the Gulf. They support and participate in widespread and co-ordinated activities to sustainably manage the use of biological diversity resources.
- The diversity of species, habitats and physical natural features are maintained for their intrinsic, scientific, recreation, tourism and commercial values and opportunities for sustainable use.
- There is a comprehensive knowledge base of the biota of significant indigenous areas and restorative or control programmes are therefore targeted and monitored effectively.

through both the harvest of species within the Gulf and aquaculture. The Forum has identified a series of strategic issues and objectives relating to biodiversity (see Box 6–2).

6.2 State of the Gulf's Biodiversity

6.2.1 Marine habitats and species

The Gulf has a rich diversity of marine species, including algae (phytoplankton and seaweeds), zooplankton, invertebrates, fish, and aquatic plants. These species live within a diverse range of hard and soft substrate habitats in the foreshore and marine environment within the Gulf. The Gulf includes rocky reefs and platforms, stacks, enclosed harbours, estuaries and tidal inlets, sandy beaches, extensive dune systems, coastal cliffs, and a substantial intertidal area in the upper Firth of Thames. These differ in oceanic and riverine influences and in catchment characteristics that influence the physical characteristics and biological communities present.

We do not know the total number of species present in the Gulf. Accordingly a list of known species has not been specifically compiled for this report.

The best inventory currently available for the Gulf is that provided by INMARC for the marine environment within 12 nautical miles of the coast (see Box 6–3 and Appendix 1). INMARC describes the landforms and geological characteristics that form the basis of the habitats and then describes the biota recorded or known to exist in the particular habitats found in each coastal unit. The Gulf is divided into 14 coastal units which differ in geological characteristics and habitats. Also included in the descriptions are tidal ranges and local influences from prevailing currents, as they influence the species found at different locations.

The INMARC inventory details the range of beach, intertidal, subtidal and deep water ecosystems that are present in the nearshore environments of each coastal unit. For example, the information provided for coastal unit 19, the Waitemata Harbour, Tamaki Estuary, Beachlands and Clevedon estuaries, is described in Box 6–4.

Similar descriptions are found for the other 13 coastal units (see Appendix 1). They highlight both common and rare species found in each area, in some cases detailing individual species and in others the species assemblages (or associations) that can be found. Many species, including mobile species such as fish, will be found in more than one coastal unit, but there are some species that are restricted in range and found in few locations.

6.2.2 Fish and shellfish

Most of the fish and shellfish species that live in the Gulf are part of populations with a wider distribution that extends over the north-east coast of the North Island.

Snapper, and scallops in areas commercially fished, are the only species where there is information on population size within the Gulf. For other species, trends

Box 6–3

Interim Nearshore Marine Classification (INMARC)

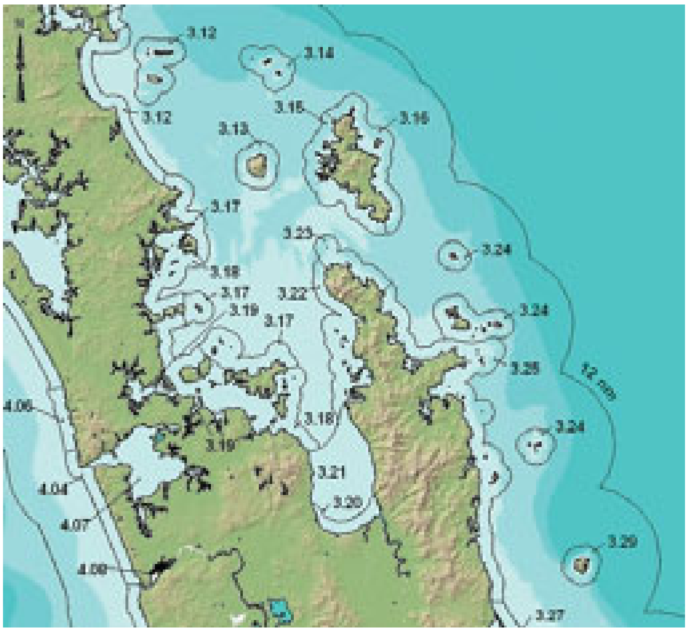
The INMARC system is being developed by the Department of Conservation (Walls 2004). It will assist the department in meeting objectives of the New Zealand Biodiversity Strategy and in implementing the New Zealand Marine Protected Areas Strategy, a joint initiative between the Ministry of Fisheries and Department of Conservation.

INMARC uses a biogeographic approach and provides information on the geological and oceanographic features of the coast as well as on the marine biota. It covers the entire nearshore marine area of New Zealand.

The classification deals with the nearshore marine environment because much of the information available is limited to the coast or to relatively shallow water (approximately 50 – 100m depth). It comprises information at two scales, the meso-scale (100s – 1000s km) which describes marine biogeographic regions and the micro-scale (10s – 100s km) which describes coastal, shelf and offshore island units. Eight broad marine biogeographic regions describing the New Zealand nearshore marine environment are identified. Within each region, coastal units are determined on the basis of broad changes in nearshore marine features, including bathymetry and biota, based on available information and local knowledge.

INMARC includes in its reporting a description of the geographic and biota information comprising each coastal unit. The Gulf includes 14 coastal units, being Units 12 to 25 contained within the Northeastern Biogeographic Region. The full descriptions and map of locations of Units 12 to 25 are provided in Appendix 1 to this report as they provide a comprehensive description of the geological and oceanographic features and species assemblages found in the nearshore marine environment of the Gulf.

It is envisaged that INMARC will contribute to a national marine classification that will be complemented by additional layers of information that characterise New Zealand's marine environment.



Box 6–4

INMARC Coastal Unit 19 (Waitemata Harbour, Tamaki Estuary, Beachlands and Clevedon Estuaries)

The Waitemata Harbour is a drowned river system consisting of deep bays and broad estuaries. Volcanic eruption craters flooded by the sea and infilled with muddy sediments are found at Panmure Basin, Orakei Basin and Northcote. Intertidal mudflats, sand/shell flats and mangrove habitats exist behind shellbanks at Pollen and Traherne Islands, and around rivers such as the Tamaki River estuary. The upper reaches join with freshwater habitats. There is an extensive area of sheltered rocky reef near Point Chevalier (Te Tokoroa Reef), formed from the distal end of a larval flow.

Sea surface temperatures range from 9˚C to 25˚C and maximum tidal range is 3.5 m, with tidal currents up to 3 knots near the harbour entrance.

Major habitat types in the harbour are based on a combination of substrate (basalt, tuff, sandstone, Pleistocene clay, shell, sand and mud), vegetation (mangroves, salt meadow and saltmarsh, seagrass and large seaweeds) and dominant visible animals (mud snails, hornshells, oysters, Asian date mussels, cockles, pipi and spionid worm tubes).

The softshores of Waitemata Harbour are dominated by the mud crab, cockle, wedge shell, nut shell, mud snail, horse mussel, mud whelk and mantis shrimp. Rock surfaces are inhabited by the rock oyster and the black top shell. Te Tokoroa Reef supports a diverse marine biota, particularly sponges and bryozoans and saltmarsh vegetation.

Mangroves cover about 951 hectares in the harbour. There are two main benthic associations around Pollen Island, one of which is dominated by an introduced bivalve *(Theora lubrica)*, and the other with large numbers of the small bivalve Nucula hartvigiana. Many fish species use the harbour for feeding and as a nursery ground, including flounder, snapper, yellow-eyed mullet and parore.

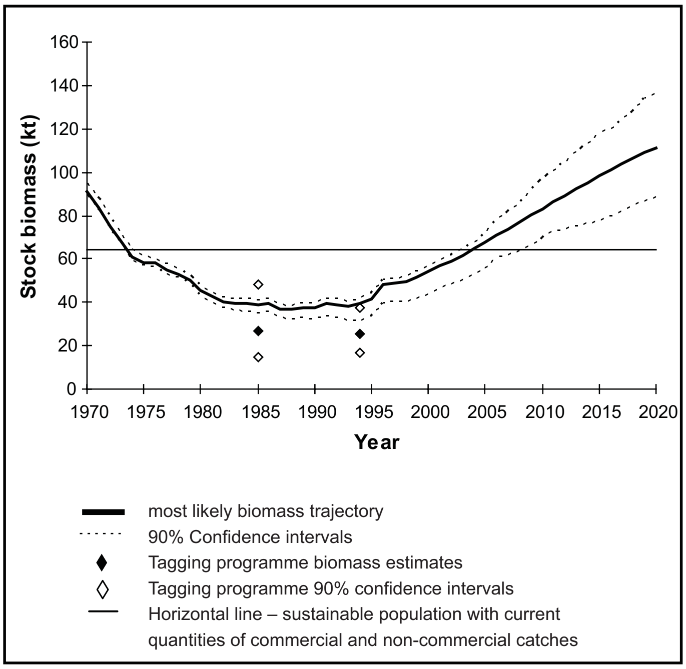


Figure 6.1 Gulf and Bay of Plenty snapper biomass

in the wider population should determine numbers in the Gulf. Information on the population status of the main Gulf species is provided in Appendix 2.

6.2.3 Fish

Trawl surveys of the Gulf have indicated four main fish assemblages associated with the Gulf habitat. These are (Kendrick and Francis 2002):

- shallow mud sites, where fish species such as snapper, john dory, sand flounder, spotted stargazer, rig, eagle ray, spott, trevally, red mullet, yellow-belly flounder, and soles are typically found.
- sandy and deep mud sites, where species such as red gurnard, arrow squid, lemon sole, blue mackerel, opalfish, scaly gurnard, skates, crested flounder, and blue cod are found.
- shallow mud and sand, where species such as porcupine fish, broad squid and leatherjacket are found.
- deep mud, where species such as tarakihi and school shark are found.

Of the species indicated in Appendix 2, snapper is the only fish species where there are population estimates that apply to the Gulf (and the Bay of Plenty), rather than over the wider north-east coast region. Figure 6.1 shows an assessment of this population. Population size (biomass) is measured by weight, rather than number of fish. The assessment shows that the snapper population in the Gulf and Bay of Plenty region reached a low point between 1985 and 1995. Reductions in catch limits since 1986 are thought to be why the population is now rebuilding.

The population status of most of the other Gulf fish species – including gurnard, kahawai, trevally, flounder, mullet, John Dory and rig is generally similar to snapper. Most of these species were subject to considerable fishing pressure during the 1970s and 1980s. Like snapper, there are now catch limits applied under the Quota Mangement System which should allow populations to rebuild. Appendix 2 provides more information on these species.

6.2.4 Shellfish

Sub-tidal and intertidal shellfish, including scallop, cockle, pipi, green-lipped mussel, Pacific and rock oyster, paua, tuatua, periwinkle, kina, crab, snails, cats eyes, and horse mussel are widely distributed around the Gulf. Harvesting and environmental changes affect populations of shellfish species.

There are regular biomass surveys of the scallop beds near Little Barrier Island, Cape Colville, Waiheke, Whitianga and Waihi that support commercial fisheries. Biomass at these beds rises and falls, sometimes significantly, from year to year (Figure 6.4). This is mainly due to biological influences. Scallops grow rapidly (although with much variation), have high natural mortality, and show highly variable recruitment[55]. Such a life history results in fluctuating biomass and catch.

There are signs that populations of shellfish species such as cockle and pipi are becoming depleted in the Gulf. In response, the Ministry of Fisheries and volunteer groups have regularly surveyed populations at some of the most popular shellfish gathering areas. As a further response, the Forum commissioned a report (Grant and Hay 2003) on shellfish issues. The report summarises the current state of knowledge related to depletion of some valued intertidal bivalve species.

[55] Recruitment is the quantity of fish that first become large enough to be allowed to be caught each year.

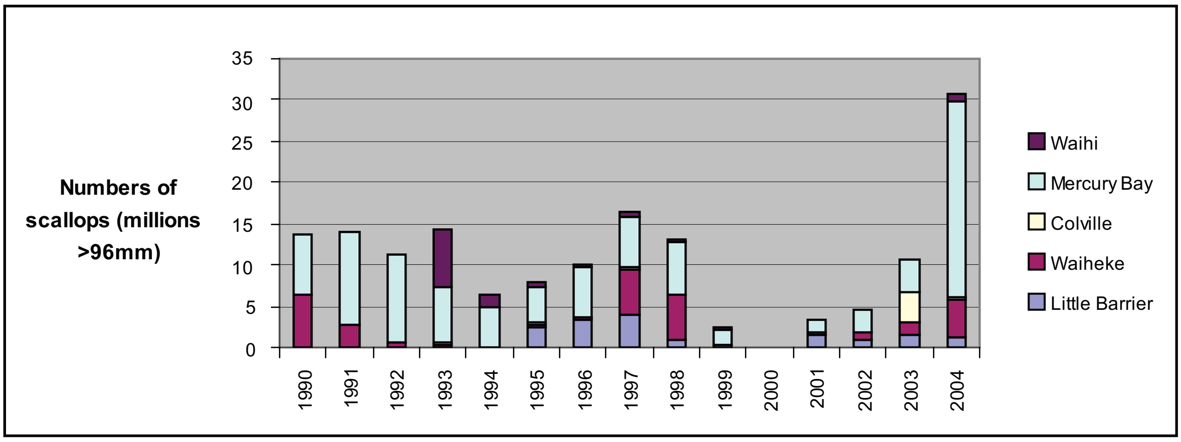


Figure 6.2 Estimated numbers of scallops in commercially fished beds since 1990

Note: There were no surveys in 1994 and 2000 and no surveys of some of the beds in years when numbers were thought to be too low

Grant and Hay (2003) concluded that research information from various studies shows trends of decreasing intertidal bivalve abundance at most sites surveyed. They caution that the small quantity of robust data available makes generalisation of their findings to the Gulf as a whole, inappropriate.

Grant and Hay (2003) also noted the large body of anecdotal evidence of depletion of intertidal shellfish stocks in the Gulf region. The Ministry of Fisheries and volunteer surveys support this finding for most of the places they survey.

6.2.5 Rock lobster

Research on the rock lobster (crayfish) population is recorded as catch per unit effort[56] rather than direct counts of population size. This information is used to estimate relative abundance and trends in the population size over time.

These estimates are for the rock lobster population in an area that extends from the Kaipara Harbour around the coast to Cape Runaway in the eastern Bay of Plenty. In theory, increases in catch per unit effort are signs of increases in population – the reverse applies to decreases. Figure 6.7 shows that catch rates (and probably population numbers) of rock lobster in the Kaipara Harbour – East Cape region fell from 1980 – 1992, and increased slightly from 1992-1998. Catch rates have declined since then. However, the present rates are still above low levels recorded in the late 1980s and early 1990s.

6.2.6 Degraded marine habitats

The inventory provided by INMARC indicates the diversity of habitats and species that currently exist within the Gulf, but does not detail habitats that have been lost or degraded, or species that have disappeared or are under threat. Much of the information available on the Gulf describes present state, and baseline data are inadequate or not available to determine the full extent of habitat degradation or loss in species diversity. Trends of decreasing abundance, for example of shellfish, are based on relatively few data or on anecdotal evidence.

Three habitats known to be damaged or low in abundance compared to pre-European levels are those of green-lipped mussel beds, seagrasses and biogenically structured soft sediment habitats (following details provided by C. Lundquist (NIWA) pers. comm.). Sub-tidal soft-bottom communities have also exhibited considerable change over an extended period.

Mussel beds

Green-lip mussel beds once covered much of the shallow habitats in the southern Gulf and Firth of Thames. Dredging in the early 1960s caused the mussel populations to crash and they have not recovered due to a lack of suitable habitat, breeding stock and

[56] The amount of catch taken per unit of fishing effort – for example number of fish per longline hook per month.

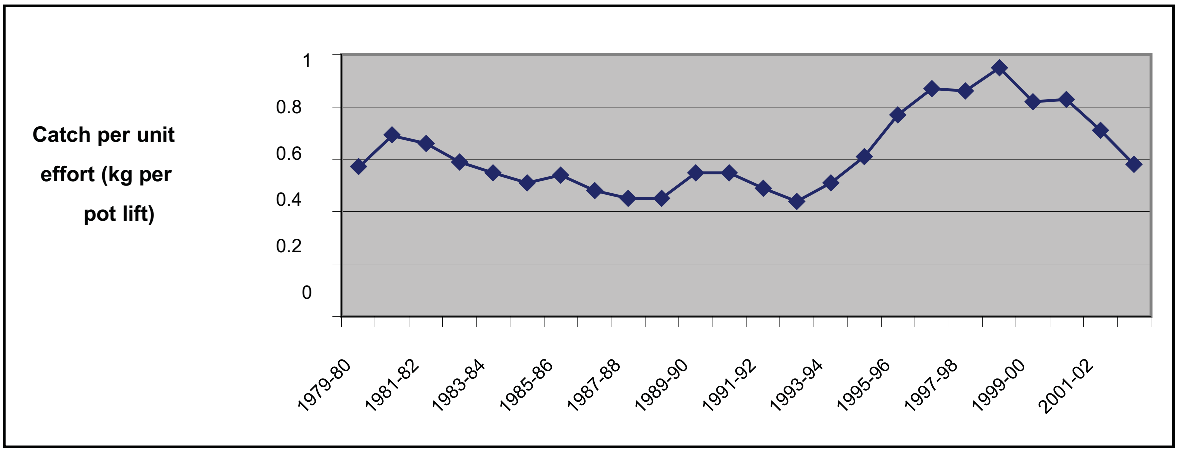


Figure 6.3 Catch per unit effort[57] for rock lobster in the area Kaipara Harbour – East Cape

a decrease in environmental quality. Only remnants of the original habitat remain. Native oysters were also once common in the Firth of Thames but are no longer present. Mussel and oyster beds provide an area of increased topographic complexity, settlement substrate and refuge areas from predation, and are associated with high biological diversity. These mussel beds were likely to have been associated with high abundances of fish and invertebrates, which no longer have this physical habitat to depend on as a nursery habitat or as refuge from predation.

Seagrass

Intertidal seagrass *(Zostera)* is another habitat which has declined substantially within most estuaries in the Gulf, with few extensive beds remaining. Seagrass is associated with high densities of fish, as the vegetation provides substrate and refuge from predation. Decline in seagrass in estuaries is likely to be associated with increased inputs of terrestrial sediments into estuaries. Increased sedimentation rates modify the sediment substrate, making it muddier, and increases suspended sediment concentration or turbidity within estuaries, making it difficult for enough light to penetrate shallow estuarine waters for these plants to grow.

Subtidal seagrass beds are an extremely rare habitat in New Zealand, with two such beds at Slipper Island and Great Mercury Island currently known. Subtidal seagrass may provide an even greater role than shallow beds for juvenile fish such as snapper and yellow-eyed mullet. Juvenile snapper are commonly associated with biogenic structure such as seagrass beds or other subtidal complex habitats such as sponge gardens and mussel beds, and are likely dependent on these complex habitats during the juvenile life stage. Possibly as these structures have been destroyed or modified through fishing and land use patterns, the carrying capacity of the environment for juvenile fish has been reduced as there are fewer habitats available for many species to utilise as a nursery.

Sponge gardens

Another important habitat within the Gulf is that of biogenically structured soft sediment habitats, such as sponge gardens, bryozoan reefs and other substrates comprised of living organisms that are present in muddy or sandy bottom habitats. These complex habitats have declined within the Gulf. Reasons for the decline are not fully understood but the biogenic reefs require long time periods (years to decades) to recover after they have been damaged or lost. These habitats are associated with high diversity of fish and invertebrates, including juveniles of many commercially important species such as snapper and scallops.

Sub-Tidal Soft-Bottom Communities

A study by Hayward et al. (1997) compared the subtidal soft-bottom communities in the Waitemata Harbour surveyed in the

[57] Catch per unit effort is a measure of the amount of effort used to catch a quantity of fish or shellfish – for example in rock lobster it is kg. per pot lift. It can be used as a measure of abundance, with less effort needed indicating greater abundance, and more effort indicating lower population numbers.

1990s with those found by Powell (1937) in the 1930s. Changes over the 60 year period showed that the gross pattern of fauna remained the same but 14 mollusc species had disappeared or suffered major reductions in abundance, while at least nine mollusc species and one crab species had colonised the harbour in that time. The most significant change was the colonisation of beds north east of North Head by the horse mussel *(Atrina)* and the abundance of three introduced molluscs (file shells *(Limaria orientalis)*, *Theora lubrica,* Asian date mussel *(Musculista senhousia))* that are now co-dominant in six of eight species associations in the harbour.

The difficulty with studies such as this is that they do not demonstrate causal effects and cannot differentiate between naturally occurring changes and progressions or changes due directly as a result of human activities. There is no doubt, however, that human activities have caused significant changes in the Gulf's marine environment. These activities include discharges of wastewater, stormwater and contaminants, dredging and construction, reclamations, commercial fishing techniques, and catchment-related activities such as deforestation which have resulted in accelerated inflows of sediment to estuaries.

Accelerated inflow of sediment has probably had the greatest impact on marine environments and will continue to impact on populations in the Gulf. (See Section 6.3.5).

6.2.7 Estuarine habitats and species

Mangrove and saltmarsh habitats are features of many of the Gulf's estuaries and harbours (see Appendix 1 for locations of these habitats). Estuarine vegetation complexes commonly consist of a sequence of zones, with seagrass beds occupying sand and mud on the seaward side, grading up the shore through mangrove forest into saltmarsh (Turner and Riddle 2001).

Mangroves are a natural and important part of estuarine ecosystems in the Gulf. They provide habitat for fish, birds and invertebrates, playing a key role as nurseries, feeding and breeding areas. Mangroves are highly productive and, together with other plant and algal species, form the base of estuarine food webs. Leaf litter from mangroves is an essential food source for numerous species in the estuarine food chain, including polychaetes, gastropods, bivalves, amphipods and crabs. These in turn are fed upon by fish and birds. Mangroves also have an important role in improving water quality in estuaries by filtering sediment, nutrients and other pollutants. They may also protect the shoreline from erosion and storm damage.

Saltmarsh typically has three sub-communities (Turner and Riddle 2001, citing studies by Graeme):

- Rush/sedge community (dominated by jointed wire rush or oioi *(Apodasmia similis)* and sea rush *(Juncus maritimus* var. *australiensis*))
- Salt meadow community (containing sea primrose or maakoako *(Samolus repens)*, selliera *(Selliera radicans)*, glasswort *(Sarcocornia quinqueflora)*, silver tussock *(Austrostipa stipoides)*, bachelor's button *(Cotula coronopifolia)*, sharp spike-sedge *(Eleocharis acuta)*, slender clubrush *(Isolepis cernua)* and arrow grass *(Triglochin striata)*)
- Saltmarsh-ribbonwood community (containing saltmarsh ribbonwood *(Plagianthus divaricatus)*).

6.2.8 Marine mammals

The Gulf is used by a number of cetacean (marine mammal) species. Some species appear to be resident, while others pass through the Gulf intermittently or while on migration.

The cetacean community of the Gulf is dominated by schools of common dolphins, but a number of species of whales are also observed. In a survey carried out from November 2000 to February 2001 (O'Callaghan & Baker 2002) six species were observed in the Gulf. The common dolphin *(Delphinus delphis)* was the most commonly sighted species with schools of 150 dolphins not uncommon. Bryde's whales *(Balaenoptera edeni)* were also relatively common, although in much fewer numbers. Other species observed included bottle nose dolphins *(Tursiops truncates)*, long-finned pilot whales *(Globicephala* *melas)*, Orcas *(Orcinus orca)*, and Arnoux's beaked whales *(Berardius arnouxii)*.

The survey indicated that most sightings of common dolphins and Bryde's whales were around the 40 m depth contour and predominantly in the middle of the inner Gulf. These two species were often in feeding aggregations, suggesting that distribution of prey may be an important factor in their distribution. Bottlenose dolphins and killer whales were generally seen closer inshore.

Killer whales number less than 200 in the waters of New Zealand, and are sighted most frequently in the winter months (Visser 2001). Rays are the most common prey, which can bring pods into estuaries as shallow as the Firth of Thames (Visser 2001, Brownell and Brejaart 2001).

Although much more common on the west coast of New Zealand, the New Zealand fur seal *(Arctocephalus forsteri)* is an occasional visitor to the Gulf.

6.2.9 Diadromous Fish

New Zealand has approximately 38 known native freshwater fish of which at least 18 spend a part of their lifecycle in the sea. These fish are 'diadromous';that is they need to go to sea to complete their lifecycle. A number of these species are found in the Gulf. Table 6.1 lists indigenous species and their known distribution within the Gulf based on their presence in streams and rivers which supply freshwater to the Gulf[58].

Four species found in the Gulf are in gradual decline or are sparse nationally. Five of the galaxiid species, inanga, koaro, banded kokopu, giant kokopu and shortjaw kokopu, and common smelt form the whitebait catch. These fish spawn in freshwater habitats during autumn, and the young larvae are washed out to sea on the autumn floods. The juvenile whitebait return to fresh water in the spring.

In contrast, the longfin eel migrates out of its freshwater habitat to spawn at sea. Female longfins become sexually mature around 35 years and can be 80 or more years of age before migrating downstream during autumn months, often triggered by flood events, and out to the Pacific Ocean to spawn. The young glass eels return to river mouths about eighteen months later in spring and the elvers (young eels) make their way back upstream, often over several years, seeking out suitable adult habitat in which to mature (Jellyman 1977; McDowall 2000).

It is likely that all populations of indigenous freshwater fish have declined throughout the Gulf Catchment and will continue to do so unless specific freshwater habitat requirements are addressed.

6.2.10 Wading and sea birds

The Gulf supports a diverse range of birds, including waders, seabirds and dwellers of estuarine wetland vegetation, and including indigenous, introduced and migratory species.

The distributions of some of the bird species observed in the Gulf are indicated for the coastal units described by INMARC in Appendix 1. They are typically found in all harbours, estuaries and beaches, which provide feeding, breeding and roosting habitats.

The area of the Gulf most known for its bird populations is the Firth of Thames Ramsar site, a wetland of international significance and one of only five wetlands nationally to be listed as a Ramsar site (see Box 6–5).

Of the indigenous species that have been observed in the Gulf, twenty-five are species which are listed as nationally threatened (see Table 6.3). These range from nationally critical, the most threatened state, to sparse. Factors which contribute to the decline in bird populations include loss of habitat, decline in habitat quality and food supply, predation and human disturbance.

6.2.11 Threatened animals and plants on islands, dunes and estuaries

Animals

Several islands of the Gulf provide important habitat free of pest mammals for indigenous species that are threatened locally, regionally or nationally (see Appendix 5).

Intense effort has gone into pest eradication on these islands so that they can be used to provide this pest-free habitat.

[58] Note that not all streams in the Gulf's catchment have been surveyed, and records may be several decades old and no longer accurately reflect presence of fish

Table 6.1 Diadromous fish found in the catchments of the Gulf.
Source: Niwa 2004, McDowell (2000) Hitchmough (2002)

Common Name	**Species Name**	**Status/Threat ranking**	**Known distribution (does not exclude presence in unsurveyed waters)**
Longfin eel	*Anguilla dieffenbachii*	Gradual decline	Widespread, most abundant around Coromandel
Shortfin eel	*Anguilla australis*		Widespread and abundant
Spotted eel (Australian longfin)	*Anguilla reinhardtii*	Coloniser	Little information on distribution - records from Auckland - Kaiaua only
Lamprey	*Geotria australis*	Sparse	East coast Coromandel only
Koaro	*Galaxias brevipinnis*		Few records around Auckland; common on West Coast of Coromandel and occasional on East Coast
Inanga	*Galaxias maculatus*		Widespread, though less common around central Auckland. Abundant in Firth of Thames
Banded kokopu	*Galaxias fasciatus*		Widespread, particularly abundant on Coromandel, Great Barrier Island
Shortjaw kokopu	*Galaxias postvectis*	Gradual decline	Two records from west coast of Coromandel Peninsula
Giant kokopu	*Galaxias argenteus*	Gradual decline	Seven sites north of and around central Auckland; four records from Coromandel
Common Smelt	*Retropinna retropinna*		Widespread around the Coromandel Peninsula, abundant in Firth of Thames, occasional records further north
Torrentfish	*Cheimarrichthys fosteri*		Common around Coromandel; less common around and north of Auckland
Redfin Bully	*Gobiomorphus huttoni*		Abundant throughout area; less common South Auckland coast of Firth of Thames
Common Bully	*Gobiomorphus cotidianus*		Abundant throughout
Gaint Bully	*Gobiomorphus gobioides*		Occassional throughout
Bluegill Bully	*Gobiomorphus hubbsi*		Found occasionally around northern Coromandel and on Great Barrier Island

Table 6.2 National status of waders, seabirds or wetland birds that have been observed in the Firth of Thames or elsewhere in the Gulf
Sources: Brownell and Brejaart (2001); Walls (2004), Status Hitchmough (2002)

Status	**Species**
Nationally critical	Masked booby *(Sula dactylatra)*; white heron *(Egretta alba)*; black stilt *(Himantopus novaezelandiae)*; New Zealand fairy tern *(Sterna nereis)*
Nationally endangered	Reef heron *(Egretta sacra)*; Australasian bittern *(Botauris stellaris poiciloptilus)*
Nationally vulnerable	Wrybill *(Anarhynchus frontalis)*; Caspian tern *(Sterna caspia)*
Serious decline	Black billed gull *(Larus bulleri)*; Black fronted tern *(Sterna albostriata)*
Gradual decline	Sooty shearwater *(Puffinus griseus)*; flesh footed shearwater *(Puffinus carneipes)*; black petrel *(Procellaria parkinsoni)*; little blue penguin *(Eudyptula minor)*; banded dotterel *(Charadrius bicinctus)*; white fronted tern *(Sterna striata)*
Range restricted	Royal albatross *(Diomedea epomophora)*; Buller's shearwater *(Puffinus bulleri)*; grey ternlet *(Procelsterna cerulea)*
Sparse	Black shag *(Phalacrocorax carbo)*; pied shag *(Phalacrocorax varius)*; little black shag *(Phalacrocorax sulcirostris)*; New Zealand dotterel *(Charadrius obscures)*; fernbird *(Bowdleria punctata)*; banded rail *(Rhallus philippensis)*

Box 6–5

Case Study – Firth of Thames and the Ramsar Site

The area of the Firth from the Waihou River to just north of Kiaua is listed as a Ramsar site (internationally recognised wetland area) due to its importance as roosting and feeding habitat for endemic and international migratory wading birds. Some 132 species of birds have been recorded in the Firth of Thames, with about half of these species being abundant or common and half classified as uncommon, rare or vagrant (Brownell and Brejaart 2001). Forty nine migratory species have been observed in the Firth, 37 of which are international migrants on the Australasian Flyway, and 12 of which are indigenous migratory birds (Brownell and Brejaart 2001, Lundquist *et al.* 2004). The birds use four key habitats: mudflats and sandflats, mangroves and saltmarsh, shellbank (chenier), and adjacent pasture areas.

The coastal plain between Kaiaua and Miranda, where the highest wading bird concentrations are observed, is made up of a series of stranded ridge systems called cheniers which run parallel to the shore. They are composed principally of the fossilised shells of the cockle *Austrovenus stutchburyi*. This globally rare land formation is unique in New Zealand (Woodroffe *et al.* 1983) and provides a key roosting site for the migratory birds.

The Firth is a productive habitat for fish and a range of species is found, including (from Lundquist *et al.* 2004): benthic soft-sediment feeders such as yellowbelly flounder *(Rhombosolea leporina)*, dab flounder *(R. plebeia)*, and short finned eel *(Anguilla australis)*, snapper *(Pagrus auratus)*, schooling fish such as yellow-eyed mullet *(Auchenocerus punctatus)*, pilchard *(Sardinops pilchardus)*, ahuru *(Auchenocerous punctatus)*, and grey mullet *(Mugil cephalus)*, and shark species which feed in the area (for example rig *(Mustelus lenticulatus)*) or use the Firth for birthing (rig, hammerhead *(Sphyrna zygaena)*, bronze whalers *(Carcharhinus brachyurus)* and school sharks *(Galeorhinus galeus)*.

There is relatively poor information on the benthic species which live in the habitats within the Firth despite its recognised values for birds and fish. Studies available tend to be limited to small areas and periods of time, but indicate that species which are likely to provide food for migratory wading birds include bivalves, polychaetes, suspension feeders, mud crabs and marine snails (Lundquist *et al.* 2004). Lundquist *et al.* (2004) noted that there was no site-specific information on organisms living in the habitats provided by mangroves, saltmarsh and the chenier ridges.

Biodiversity in the Firth is enhanced by the presence of hot water springs at the mouth of the Miranda Hot Springs Stream, which appears to support large numbers of the endemic acorn worm *(Balanoglossus australiensis)* (P. Maddison (Ecoquest), pers. comm. cited by Lundquist *et al.* 2004).

Table 6.3 Threatened fauna species present on islands within the Gulf

Fauna type	Threatened species present (t= population translocated to the islands or between islands)
Birds	kiwi (t), kokako (t), saddleback (tieke) (t) stitchbird (hihi) (t), black petrel, Cook's petrel (titi), kereru, kaka, long tailed cuckoo, yellow crowned kakariki, Caspian tern, white fronted tern, pied shag, brown teal (pateke)(t), banded rail, kaka, New Zealand dotterel, spotless crake, Australasian bittern, wrybill (ngutu-parore), godwit, golden plover, sand dotterel, banded dotterel, weka (t), red crowned kakariki, grey ternlet, little blue penguin, little spotted kiwi (t), takahe (t), black shags, Pycroft's Petrel (t)
Reptiles	chevron skink, tuatara (t), moko skink, striped skink, Duvaucel's gecko, green gecko, pacific gecko, marbled skink (t), Mokohinau skink, Robust skink (t), Shore skink, Suter's skink (t), Whitaker's skink (t)
Mammals	short tailed bat, long tailed bat
Amphibians	Hochstetter's frog
Invertebrates	wetapunga (weta), flax snails, Mokohinau stag beetle, Middle Island tusked weta (t), Mahoenui giant weta (t)

These islands are now special places that provide critical refuge for the survival of some native species whose mainland habitats have been lost or are predator-ridden. Tuatara and Whitaker's skink, for example, were once widespread in New Zealand but are now found only on islands because pests on the mainland have wiped them out.

On several islands cleared of mammalian pests species have been brought back ("translocated") to restore the original biodiversity. In addition to restocking islands with endemic species, some islands are used as refuges for non endemic species translocated as part of national species recovery programmes. Kiwi on Motuora Island is an example. Threatened species found on islands are listed in Table 6.3.

In addition to threatened species, the islands provide critical breeding habitat for a large number of other species. For example, petrel species are restricted to breeding only at sites free of mammalian predators. The eradication of kiore from Little Barrier Island (Hauturu) is expected to improve the survival of thousands of petrel chicks each year. To date, up to 95% of chicks have been predated by rats.

Plants

The islands of the Gulf provide, or provided in the past, habitat to a range of plants including one species that is now extinct and 57 species that are nationally threatened. Of these, seven species are no longer on islands in the Gulf although are not extinct nationally, and a further eight species are gone from some of the islands on which they were formerly located. The species concerned, and the factors contributing to the decline in these species are described in Appendix 3.

6.3 Pressures on the Gulf's Biodiversity

6.3.1 Fish and Shellfish

Fish populations exist in a state of balance that may be upset by human activities and natural events. Human activities can apply both direct and indirect pressures on these populations. Healthy and plentiful fisheries in the Gulf need populations of adults that are large enough to produce sufficient recruits each year to replace fish that are caught or die from natural causes.

The adult population of all species must have a healthy environment with unpolluted waters and sufficient food supplies for this to happen. These populations must also be protected from over fishing.

Many fish species release their eggs and developing juveniles into the sea where they drift in the plankton. Changes in weather patterns, water temperatures, algal blooms and other natural influences can affect these life stages. Other fish and birds eat many as they grow. They must also compete for food with their own and other species.

Some species are more vulnerable than others, for example because they have slow reproductive rates (like rig); a limited habitat where they can live (like reef fish); or a habitat that is under stress because of the effects of development (like shellfish habitat in sandy intertidal areas in estuarine systems).

6.3.2 Direct Impacts of Fishing

Commercial fishing

Commercial fishing methods used in the Gulf and some kinds of fishing equipment apply direct pressure on fish and shellfish through capture or incidental damage and death of both target[59] and associated species. See Box 6–6 for a description of commercial finfish fishing methods used in the Gulf.

Figure 6.4 shows the average commercial catch quantities per fishing year[60] of finfish species and kina. Catches are shown for two parts of the Gulf – one, the main part inside Great Barrier, including the Waitemata Harbour and the Firth of Thames – the other the area off the eastern coast of the Coromandel Peninsula. This split in two is because there are quite different kinds of commercial fishing in each part of the Gulf.

[59] The species which fishers are intending to catch

[60] Fishing year is from 1 October – 30 September the following year

Notes: The New Zealand coastline is divided into statistical reporting areas for commercial catch reporting purposes. Commercial fishers record catches for the statistical area that they are fishing in. Areas 005, 006, 008 and 009 fall within the Marine Park. Main species in "other" category in areas 005, 006 and 007 are grey mullet, leatherjacket, blue cod and tarakihi. In area 008 they are kahawai, bluenose, ling and gemfish. Quantities shown are averages for each of the fishing years 2000-2003.

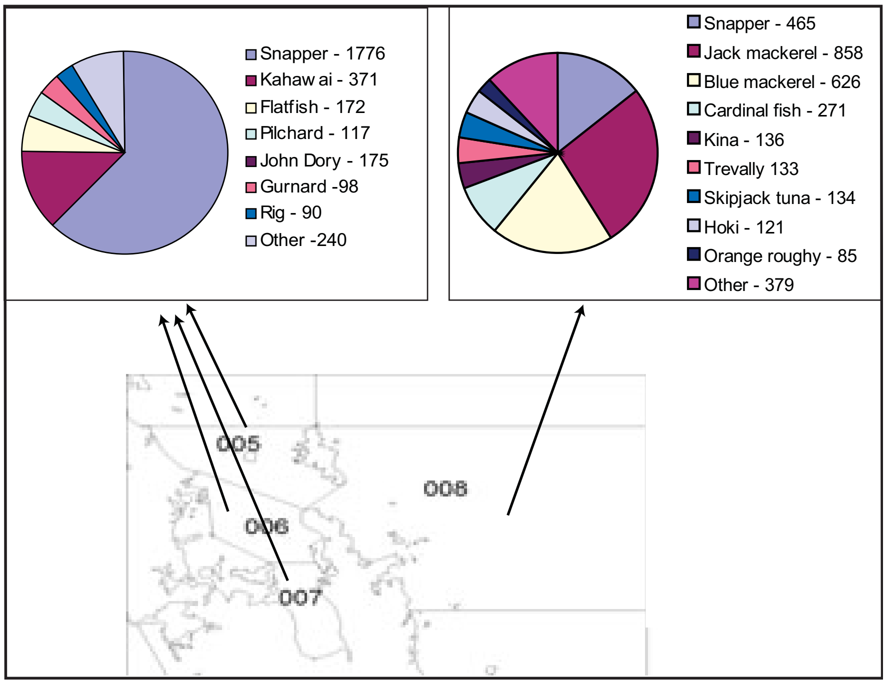


Figure 6.4 Average Landings (Tonnes) of Main Commercial Finfish Species and Kina

The commercial snapper fishery in the Gulf is one of the most important in the domestic inshore fishing industry in terms of both tonnages landed and value of catch. The main commercial snapper fishing methods are trawling and Danish seining in the outer Gulf and long lining in the inner and mid Gulf. An illustrative history of the snapper fishery in the Gulf is provided in Box 6–7.

Set netting in the mid Gulf and Firth of Thames is the main method used to catch mullet, flatfish and some of the other species shown in Figure 6.4, especially snapper, rig, and kahawai.

Commercial fishers use long line and trawl methods to catch most of these species in the part of the Gulf that extends out into deep water off the eastern coast of the Coromandel Peninsula. Trawling, Danish seining and purse seining for deep-water species such as jack and blue mackerel, cardinal fish, skipjack tuna, hoki and orange roughy also occurs. Commercial fishers obtain a sizable quantity of kina by diving in this region.

Recreational fishing

The Gulf is the most intensively fished recreational fishing region in New Zealand. An estimated several hundred thousand people fish in the Gulf each year. The Ministry of Fisheries has conducted nationwide surveys to obtain estimates of the tonnage of fish that recreational fishers' catch. Catches are estimated for the entire range of most species caught, but catches are not specific to the Gulf. There are two exceptions to this – snapper and kahawai.

Snapper is the most popular species for recreational fishers. Most of the catch is obtained in the summer by fishers using rods and lines from small boats or fishing from shore. A 2000 – 2001 recreational fishing survey gave an estimate of 830 tonnes of snapper caught in the Gulf[61].

There is also an estimate of the kahawai catch in the Gulf – another species popular with recreational fishers. The estimate was that recreational fishers caught 861 tonnes in the Gulf in 2000-2001[62].

Recreational fishers also use nets, longlines and other methods to catch snapper and most of the species that commercial fishers take – especially, kingfish, flounder, mullet, John Dory, gurnard and pilchard.

Quantities of fish and shellfish that recreational fishers catch are steadily growing. This appears to be because of the

[61] This estimate does not cover the area of the Gulf off the east coast of the Coromandel Peninsula.

[62] Due to data collection issues both the snapper and Kahawai estimates are though to be higher than the actual catch.

combined effects of increasing numbers of fishers and technological improvements in fishing and fish-finding equipment.

Customary Fishing

Maori are entitled to fish for customary purposes in all coastal regions. Chapter 6.4.9 summarises several different ways that they can do this. Customary fishing occurs in some parts of the Gulf, notably Waiheke Island, Kaiaua and along the west coast shoreline of the Coromandel Peninsula. So far, quantities caught are small and fishing for customary purposes is likely to place minimal pressure on populations of the species taken.

Shellfish

Both commercial and non-commercial fishers harvest scallops in the Gulf. Commercial fishers use dredges to obtain scallops from beds near Waiheke, Little Barrier, Colville, Whitianga and Waihi. Catches from all five beds rose and fell during the 1990s (refer Figure 6.5). These fluctuations have mostly been caused by natural causes, rather than harvesting pressure.

Non-commercial fishers dive and dredge for scallops from beds in Kawau Bay, around Great Barrier and other places where commercial dredging is prohibited.

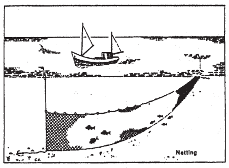
Non-commercial fishers take various subtidal and intertidal shellfish species in the Gulf. The most popular, taken in greatest quantities, are cockle, pipi, green-lipped mussels, Pacific and rock oyster, and paua. Fishers also harvest other species including tuatua, periwinkles, kina, crab, snails, cats' eyes, and horse mussels.

The Ministry of Fisheries Honorary Fishery Officers have identified large numbers of people harvesting, especially at the most popular places – Whangateau, Kawau Bay, Koherurahi Point–Kaiaua and the western side of the Coromandel Peninsula – as the main pressure on intertidal shellfish populations. They consider that people taking quantities well in excess of the permissible daily limits are adding to the pressure on these populations.

Box 6–6

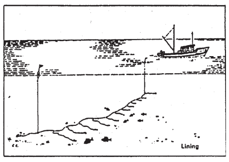
Gulf Commercial Finfish Fishing Methods

Set Netting



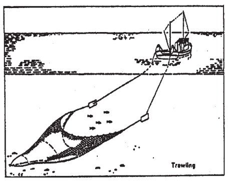
While there are many kinds of set net, all rely on the fish getting snared or caught in the net's mesh. Nets are typically long, narrow and flat, weighted at the bottom edge and supported along the top edge by floats. Set netting from small boats was one of the first methods to be used in the Gulf to catch species like flatfish and mullet, especially in the Firth of Thames.

Long lining



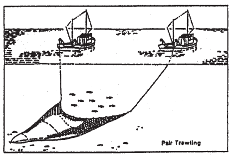
Longlines consist of a main line running parallel to the bottom, with baited short lines attached at intervals. The line is anchored at each end and held at the surface by floats. While single line fishing was one of the first fishing methods used, long lining appeared recently. It is used to catch high-quality, high-value fish such as snapper.

Trawling



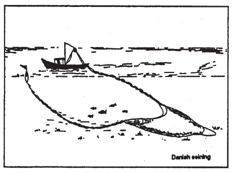
Trawling involves one or two (pair trawling) fishing vessels towing a large net. Nets may be towed along close to the seabed (bottom trawling), or at middle depths. Steam trawlers first appeared in 1915 and steadily increased in number until they began to be replaced by motor trawlers in the 1950s. Trawling is used in the outer Gulf to catch snapper, gurnard and John Dory.

Pair trawling



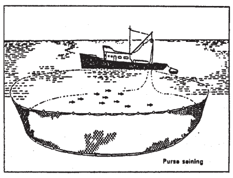
Pair trawling was introduced in the 1970s. Its success in taking species such as snapper and trevally led to the rapid expansion in use of this method. However, controls have been placed on its use, and most now occurs in the area off the eastern coast of the Coromandel Peninsula where it is used to catch hoki, tarakihi, orange roughy and cardinal fish.

Danish seining



Danish seining is another method with a long history of use after its first introduction in 1923. It is used to encircle, herd and finally trap the fish. A long, weighted rope fixed to each end operates a net bag, similar in shape to a trawl bag. The two ropes are used to encircle the fish and to haul the net in. They are usually operated on the bottom and are used to catch snapper and John Dory.

Purse seining



Purse seining became more commonly used from the 1980s onwards in the Gulf mainly in area 008, to catch surface dwelling species such as mackerel, kahawai, trevally and pilchard. The purse seine net is laid in a circle around a school of fish. The net is then "pursed", drawing the bottom closed and trapping the fish.

Box 6–7

Case Study: The Snapper Story

Ask anyone to name the most important fish species in the Hauraki Gulf and the answer is usually snapper. These fish, living up to 40 years and weighing 15 kilos or more have become an icon of the Gulf. Snapper are attractive and fascinating to watch but, unfortunately for them, also fun to catch and delicious to eat.

The Hauraki Gulf is the largest and most important spawning ground for snapper on the northeast coast. There are spawning concentrations between Tiritiri Matangi and Flat Rock north of Waiheke Island, and in the outer Gulf.

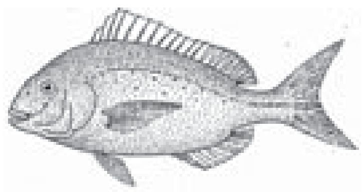
Commercial snapper fishing has a long history in the Gulf. Hand lining, set netting and beach seining were the methods used to catch snapper until the introduction of steam trawlers in 1915. From then until 1971 catches of snapper in the Gulf rose and fell as different fishing methods evolved, had restrictions placed on them and markets changed.

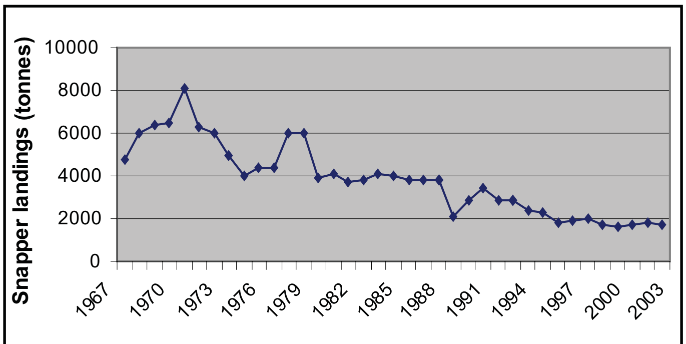
Snapper landings reached a peak in 1971 with 8600 tonnes landed. This expansion occurred when new export markets were opened in the United States and Japan. However, following this peak, the total catch fell to 4400 tonnes in 1975. Catch per unit effort also began to decline – both signs that fishing pressure was causing population numbers to fall.

Despite these warning signs, landings increased between 1975 and 1979 due to the larger quantities that pair trawlers were catching. This was also when long lining began to be used, especially in foul ground where trawlers could not go. However, catches then fell between 1979 and1986 by approximately 12% (from 6400 tonnes to 3839 tonnes). This fall happened even though fishing effort increased.

When the Quota Management System was introduced in 1986, an overall annual commercial catch limit of 4710 tonnes was set for the entire northeast coast region from Cape Runaway to North Cape. Appeals by some commercial fishers about the quantities of fish (quota) that each individual fisher was permitted to catch caused the catch limit to increase to 6010 tonnes in 1991. This was assessed as not sustainable and the catch limit was eventually reduced to 4500 tonnes. This level has applied from 1997 until now.

Recreational snapper catch has been estimated at 830 tonnes in the Gulf in 2000-2001. Recreational daily catch limits were reduced to 9 in 1995 to ease pressure on the snapper population.





Landings of snapper in the Hauraki Gulf since 1967

6.3.3 Rock Lobster

There is a small commercial fishery for rock lobster in the Gulf, mostly around Great Barrier, Waiheke, and the Coromandel Peninsula. Both commercial and non-commercial fishers use pots to catch rock lobster. Non-commercial fishers also use scuba (commercial fishers are not permitted to use this method). Figure 6.3, which shows commercial catch per unit effort for rock lobster, and Figure 6.6, which shows commercial catch in tonnes, both indicate that fishing pressure and/or environmental conditions may be causing a decline in numbers of this species.

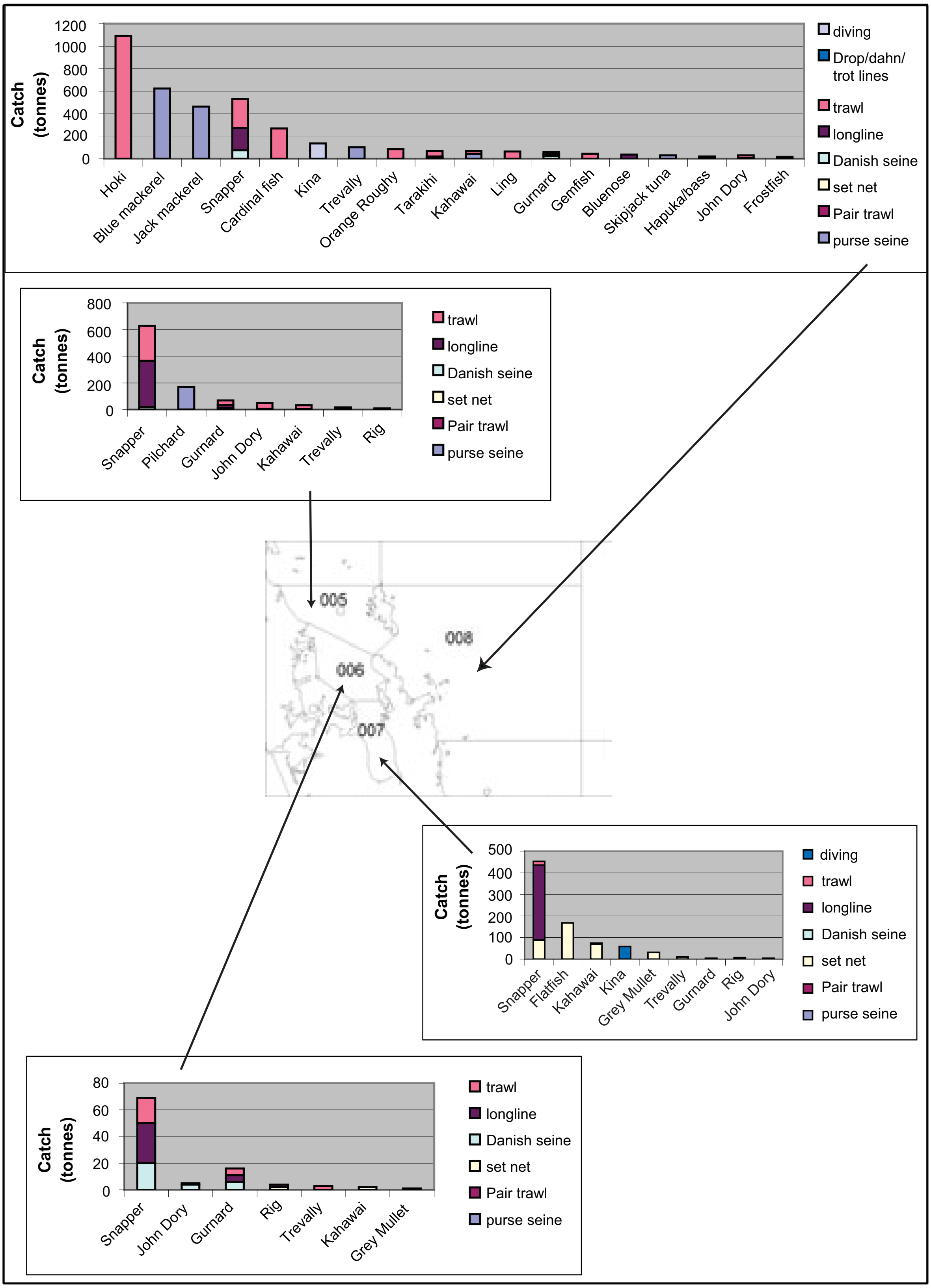
6.3.4 Indirect Impacts of Fishing

Some fishing methods have unintended direct impacts that kill fish and shellfish, so further reducing population numbers and biodiversity. For example, most of the methods used to catch finfish catch more than just their target species. The extra fish are referred to as by-catch. Until recently, a problem with by-catch was that there were no limits on the quantity of many fish species accidentally caught in this way. This could have led to depletion of populations of by-catch species, if new management measures had not been applied to prevent this happening.

The Ministry of Fisheries has commissioned research on the effects of scallop dredging on growth and mortality of scallops. The results indicate that dredging causes mortality that in turn affects population numbers (see Box 6–8).

Furthermore, fishing activities such as bottom trawling and dredging can have direct effects on the marine environment.

Table 6.4 Average[63] reported catches of main target species for each fishing method in Hauraki Gulf statistical areas (Note that for illustrative purposes there are different scales used to show tonnages in each area)



[63] Average catch for fishing years 2000-2003

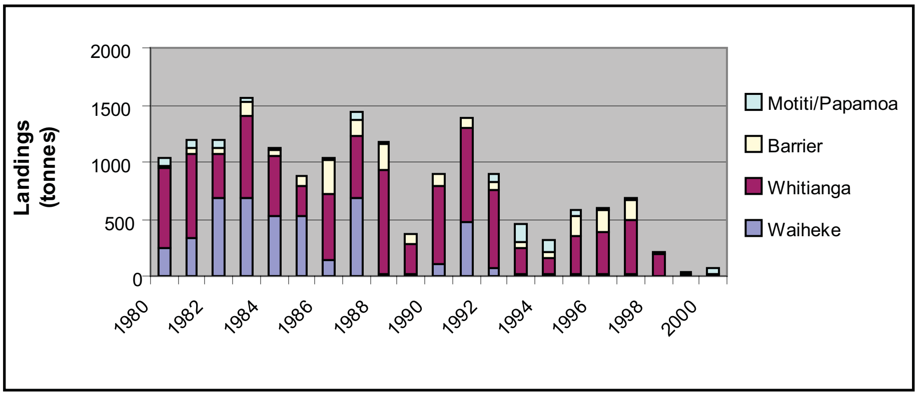


Figure 6.5 Reported annual landings of scallops from Hauraki Gulf beds

For example, available information provides evidence of broad-scale changes in benthic communities that can be directly related to fishing (Thrush and Dayton 1998). In the scallop fishery, dredging appears to have caused short-term changes in marine communities off the Coromandel Peninsula.

6.3.5 Habitat loss, modification and disturbance

Environmental changes associated with human activities apply indirect pressure by changing water quality (see Chapter 5) and marine habitats. Such changes can produce conditions that ecosystems and the fish and shellfish either cannot tolerate, or can tolerate only in reduced numbers. These include habitat loss from dredging and reclamation, and habitat modification by sedimentation and discharges.

Effects of sedimentation on benthic species

Estuaries receive sediment from both landward inputs (muds and clays delivered by rivers) and seaward inputs (sands moved by waves and tidal currents). Accelerated sediment loading from landward components is a problem in estuaries throughout the Gulf and monitoring indicates that sedimentation is probably the cause of changes in abundance and composition of benthic communities. Changes in sediment regimes have also been associated with changes in spatial extent and distribution of vegetated habitats. Inputs of terrestrial sediments can modify substrate properties, particularly by increasing the percentage of finer particles such as silt and clay. This results in increased muddiness, especially in the upper reaches of many estuaries.

Estuary monitoring studies within the Gulf have shown trends in sediment characteristics and benthic fauna as a result of deposition of sediment. Refer to Text Box 6–9 for a case study on the effects of sedimentation on the Mahurangi Estuary. It is likely that the effects of sediment loading on estuarine communities observed in monitoring of the Mahurangi are occurring in other estuaries in the Gulf. Observations by scientists suggest that such affects may also be occurring in Whitford, Okura and the Upper Waitemata (ARC 2003).

As estuaries infill, the complexity of habitats reduces and muddy habitat prevails. Species composition consequently changes to favour those better adapted to muddy sediments. The net effect is that the biodiversity reduces (Lundquist *et al.* 2003).

Experiments involving the deposition of terrestrial sediments onto marine sediments in Okura, Whangapoua, Whitianga, Whitford, Mahurangi and Motuketekete all show a consistent response of a rapid decline in macrofaunal abundance and diversity, and a slow recovery, and observations indicate that sediment loading has probably influenced estuarine habitats and communities in Whitford, Okura, and the Upper Waitemata within the Auckland region (Cummings et al. 2003).

Factors affecting shellfish

Environmental influences that are potential stressors for bivalve species include:

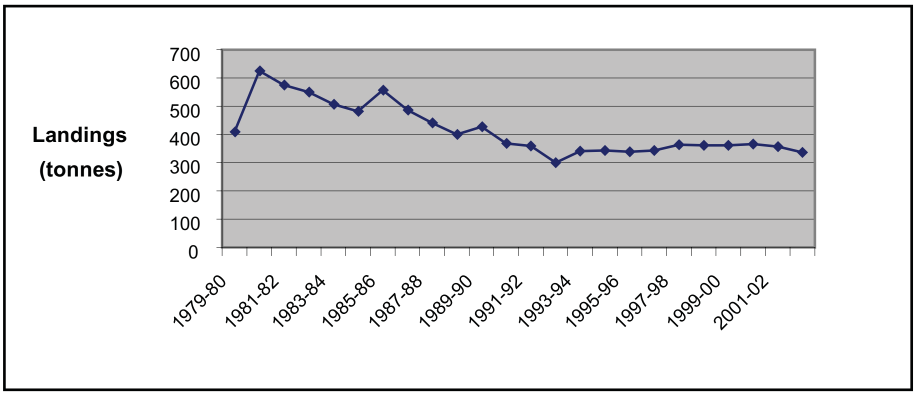


Figure 6.6 Reported annual landings of rock lobster in the Area Kaipara Harbour – East Cape[64].

Note: This is combined catch information for two sub areas – one from Kaipara Harbour –Te Arai Point, the other Te Arai point – East Cape, including the Gulf

- Contaminants introduced by humans, such as organotin compounds and organic booster biocides (such as those associated with marine antifoulants), heavy metals, organochlorines and polyaromatic hydrocarbons;
- Changes in the marine environment associated with human activity, such as increased sediment loading, nutrient enrichment and climate change;
- Natural phenomena of an extraordinary nature such as harmful algal blooms, and diseases and parasite events (Grant and Hay 2003).

Potential risks to bivalves in the Gulf are characterised by:

- A general trend of increasing risk with increasing proximity to metropolitan areas, particularly the large metropolitan area of Auckland;
- A general trend of increasing risk with increasing urbanisation of the coastline;
- Within these trends, there is a general trend of increased risk of contaminants in inter-tidal zones in enclosed estuarine areas (i.e. depositional areas) as opposed to open coastal environments;
- Variations in risk between species due to physiological and behavioural differences;
- A general trend (with some exceptions) of higher sensitivity to potential stressors in larval and juvenile stages than in adults;
- In general it appears that the occurrence of potential causes of stress at high levels is rare and localised. (An exception to this could be harmful algal blooms, which can have widespread impacts). The occurrence of sub-lethal stressors is likely to be more common;
- Most potential stressors associated with human activity are predicted to have a trend of increasing risk over time;
- Immediacy of the risk varies between potential stressors. For example, increased sediment loading arising from urbanisation of the coastline is likely to present a current risk to shellfish in areas across the Gulf, whereas the potential risks associated with climate

Box 6–8

Estimated impact of scallop dredging

In the scallop fishery, an allowance is made for the incidental mortality that dredges cause, when Total Allowable Catches are set by the Ministry of Fisheries.

At present, this mortality is calculated as being 34.4% of the annual yield. Therefore in the 2004 fishing year, the Total Allowable Catch (TAC) is 117 tonnes, and 26 tonnes is calculated for incidental mortality. Stakeholders are allocated the remaining 91 tonnes as their catch allowances.

In other words the Ministry of Fisheries estimates that for every 2 scallops landed by dredging at least one scallop is left dead on the seafloor as a result of the dredging process.

As noted above, allowance is made for this loss when setting the TAC. Neverthless, it provides an indication of the incidental damage that is done.

In addition to allowing for incidental mortality when setting TAC, there is a restriction on dredge size that is intended to reduce impacts on the seabed and commercial dredging is allowed only in a very small part of the Gulf.

[64] This is combined catch information for two sub-areas – one from Kaipara Harbour –Te Arai Point, the other Te Arai point – East Cape, including the Hauraki Gulf

change have implications in the longer term (Grant and Hay 2003).

Effects of sedimentation on intertidal vegetation

In addition to changes in populations of benthic animals, sedimentation is associated with changes in intertidal vegetation. The most significant changes in estuaries over recent decades have been the increase in mangroves and loss of seagrass and saltmarsh habitats (Turner and Riddle 2001). Aerial photos indicate that the increase in mangroves in Coromandel estuaries, for example, has been substantial, ranging from 10 to 465% over recent decades (Table 6.5). The largest continuous stand of mangroves in New Zealand is located in the Firth of Thames, an area that lacked mangroves in the 1950s.

Some scientists think that the expansion of mangroves occurs because the plants trap sediment amongst their aerial roots (pneumatophores) reducing current velocities which in turn leads to increased sediment deposition. Progressive in-filling of areas to the seaward side of the mangroves creates new, shallower areas which are suitable for colonisation by young mangroves. The mangroves thus extend their range. Others consider that the response is more passive; mangroves are simply colonising new areas which are now available because of increased rates of sedimentation. In both cases, there is agreement that increased sediment loads play a key role in mangrove colonisation.

Other factors may also be important, including nutrients and responses to climatic conditions. A study in Whangamata and Whangapoua estuaries found no conclusive evidence that nutrients were the main factor causing spread of mangroves, but concluded that nutrients may have localised effects in different parts of an estuary (Schwarz 2002).There are also suggestions that the increase in extent of mangroves may be a response to previous local disturbances which lead to a historical decrease in their extent, or that the spread may be part of a natural cycle of variation.

Seagrass is dependent on water clarity or low turbidity to allow adequate light for photosynthesis. Increased turbidity of water is associated with a decrease in seagrass productivity and survival. Comparison of aerial photographs between 1945 and 1995 suggests that the percentage of Whangapoua Harbour in seagrass has both increased and decreased over time, but currently stands at 14% of the Harbour, about half of the maximum amount recorded in 1960. Similarly, Whangamata harbour currently has 60 ha of seagrass compared to 70 ha in 1944 and 101 ha in 1965, however, the photographs suggest that seagrass has increased in Wharekawa Harbour between 1944 and 1993 (Turner and Riddle 2001).

Sedimentation also affects subtidal habitats, decreasing light available for growth of algae and kelp. This is most noticeable after large storm events outside of rivers and harbours, where locations closest to the river receive high settling rates of terrestrial clay particles, covering kelp plants and associated organisms and reducing growth and survival rates (C. Lundquist pers. comm.).

There are few data on changes in distribution and extent of saltmarsh habitat in the Waikato region. Saltmarsh is currently present at around 10% or less of total estuary area of the Waikato region (see Chapter 7). Saltmarsh has a restricted distribution in the Auckland region, possibly because the area that it occupies is relatively vulnerable to human disturbance

Table 6.5 Summary of mangrove coverage in a selection of Coromandel Peninsula estuaries
Source: Turner and Riddle 2001

Estuary	Dates of aerial photos	Area (ha) at most recent aerial	% increase between aerial photos
Manaia	1971, 1995	173	195
Te Kouma	1971, 1995	15	67
Coromandel	1971, 1996	62	124
Whitianga	1970, 1995	489	10
Tairua	1983, 1996	38	215
Wharekawa	1983, 1996	49	145
Whangamata	1978, 1995	105	43
Otahu	1978, 1978	11	465

Box 6–9

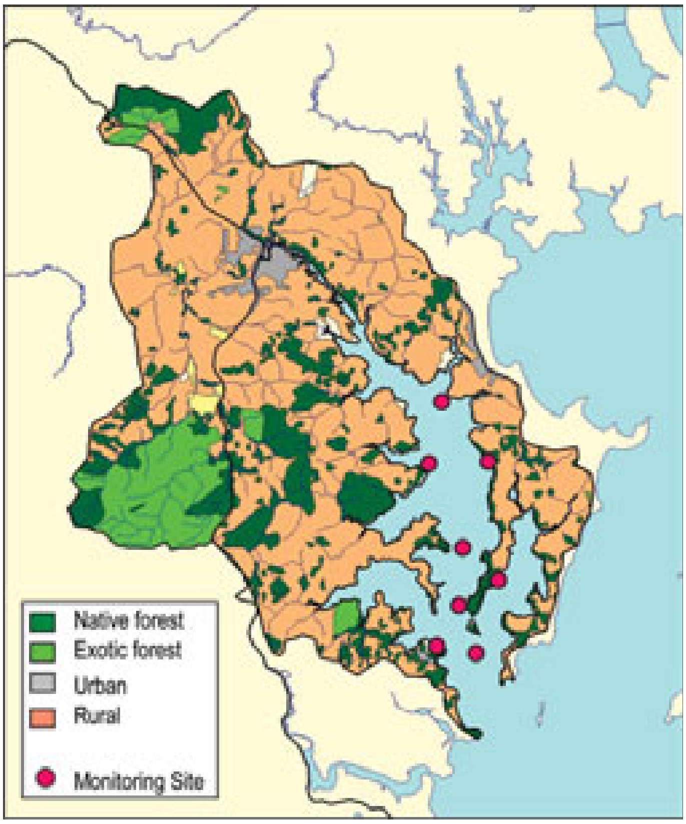
Case study: Mahurangi Harbour

Mahurangi Harbour is the second largest harbour in the Auckland region of the Gulf, after the Waitemata. It has a largely rural catchment, with areas of exotic forestry. Warkworth is the largest town in the catchment. The harbour is valued for recreation, including boating and fishing, and for its natural character. It also has areas of marine farming.

The Mahurangi has been the subject of considerable study by the ARC for the past 10 years. Monitoring was seen as providing a chance to detect early warning signs, and thus avoid the adverse effects of development that have been seen in other parts of the Auckland region, such as the Waitemata Harbour. Water quality and marine ecology have been monitored with the aim of detecting such changes. Sediment investigations have also been performed as part of large scale research on sedimentation in the Auckland region.

Over this time, significant changes have been observed in the ecology of the harbour. Decreases in abundance and loss in the diversity of intertidal macrofauna populations (particularly sediment-intolerant species) have been detected since monitoring started in 1994 (Cummings *et al.* 2003). In particular, the wedge shell and cockle have declined in abundance and numbers of small wedge shells have decreased, indicating that future recruitment may be affected. At the same time, numbers of species that prefer muddy, organically enriched habitats have increased in abundance. Effects are most pronounced at the uppermost intertidal site but changes are also occurring at the most coastal monitoring site. An increase in the amount of fine sand in sediment has been observed at all sites during monitoring by ARC.

Research shows that, like many harbours and estuaries in the Gulf, sedimentation in the Mahurangi has increased dramatically in the past 150 years. Major deforestation following European settlement led to an approximate twenty-fold increase in sedimentation rate (Swales *et al.* 1997). In upper parts of the harbour, sedimentation rose to forty times the original rate (Swales *et al.* 1997). Since that time, sedimentation rates have remained elevated. A recent study found post-1980 sedimentation rates on intertidal flats of ~ 7mm/yr and 1950-1980 rates of ~ 4 mm/yr (ARC 2002) compared with native forest (pre-1840) rates of 0.3-0.8 mm/yr and deforestation (1840-1900) rates of 2-21 mm/yr (Swales *et al* 1997).



The Mahurangi is naturally more susceptible to infilling than some other harbours because:

- the catchment experiences more high rainfall and storm events than some other parts of the region
- slopes are steep in some parts of the catchment and their soils do not readily absorb rain, making these areas more susceptible to erosion during rain
- upper parts of the harbour are already infilled and so do not have the capacity to store more sediment. This means that sediment is shifted further out into the harbour, extending the area of infilling (Swales *et al.* 1997).

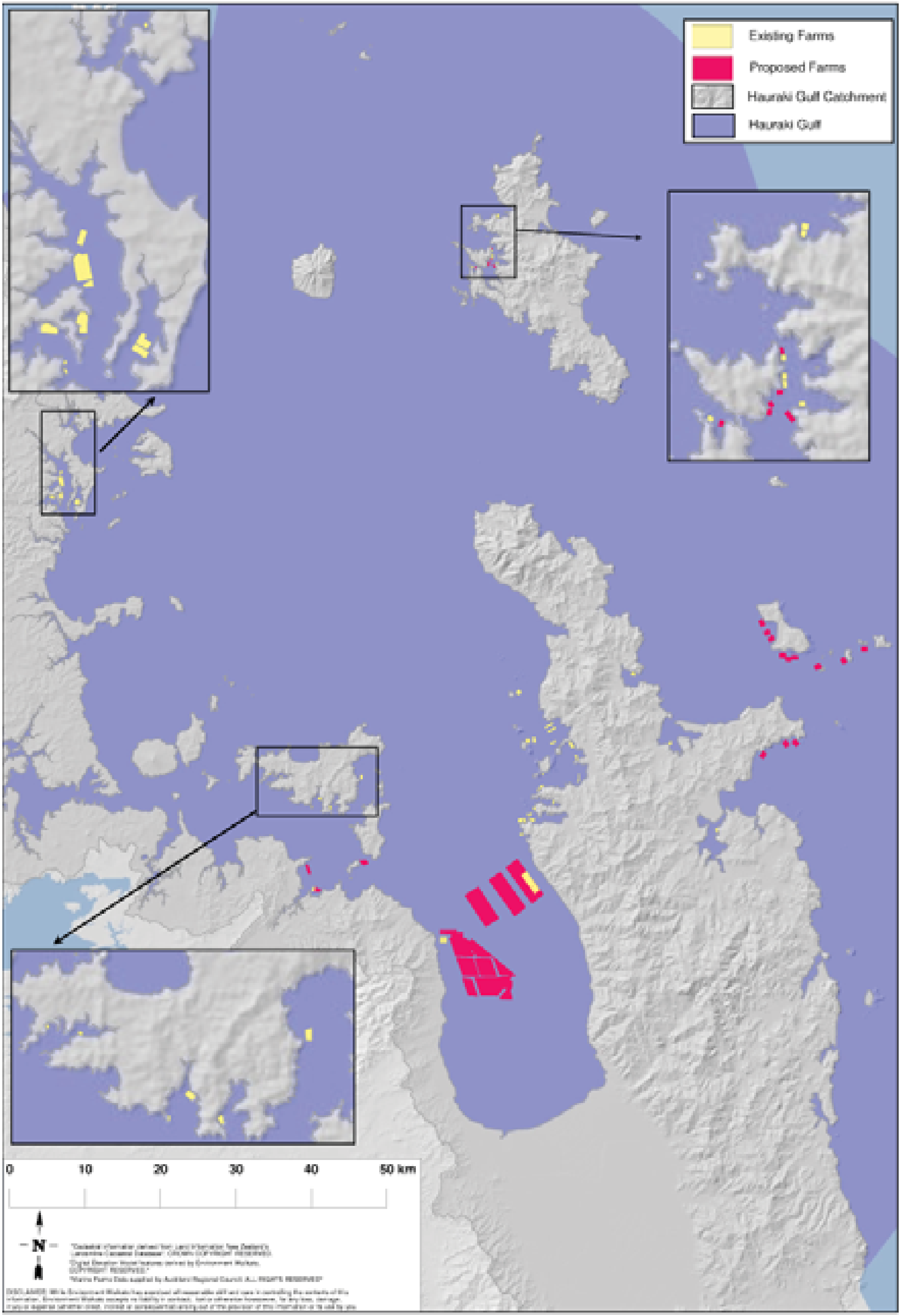


Figure 6.7 Location of existing marine farms and applications for proposed farms

ranging from dumping of waste to land reclamation (Morrisey *et al.* 1999). Analysis of aerial photographs of estuaries indicated that the area of saltmarsh has declined in Lucas Creek and increased in Mangamangaroa Estuary, and Okura Estuary. However, areas of saltmarsh in each harbour were less than 1 ha.

Impacts Associated with Aquaculture

Aquaculture activities currently carried out in the Gulf are primarily mussel and oyster faming. There are 1606 ha of marine farms within the Gulf, plus a further 1085 ha in the Wilson's Bay Area B aquaculture management area (see Figure 6.7). The ARC also has applications for approximatley 6000 ha for mussel spat catching within the Firth of Thames.

The direct effects of mussel farms on the water and sea bed in the immediate vicinity of each farm are relatively well documented. These effects include local phytoplankton and zooplankton depletion, changed sediment characteristics through deposition of shell material, faeces and pseudofaeces onto the sea bed, and changed nutrient dynamics through release of nutrients from shellfish excretion. If sufficiently extensive, it is thought that shellfish aquaculture may reduce nitrogen concentrations within the Firth of Thames because the Gulf is relatively nitrogen deficient. Given that nitrogen probably limits growth in this region, this would probably result in reduced rates of primary production, lower phytoplankton production and possibly changes in the species composition of the phytoplankton community (Broekhuizen *et al.* 2002).

Aquaculture structures may also provide habitat for a variety of opportunistic species including undesirable exotic species.

The farming of mussels and oysters may have indirect positive effects on biodiversity. Availability of farmed species reduces pressures on wild stocks, and in the Gulf this enabled a ban on harvesting wild oysters to be lifted. Mussel farms in particular are known as good places to fish.

There is interest in New Zealand in farming other species, for example caged fish, and this interest extends to considering the suitability of the Gulf for other such farming operations.

Pressures on Indigenous Freshwater Fish

The migratory lifecycle of our native freshwater fish highlights the importance of the linkages between the sea and headwater catchments. This migratory lifecycle can allow some protection from small-scale disturbances in that recolonisation of habitats can take place after an event such as a large flood depopulating an area. It can also make some species particularly vulnerable to loss of access to either spawning or adult habitat as a result of physical barriers or reductions in water quality that act as barriers to movement (Speirs 2001).

A key threat to these fish is the ongoing loss of suitable freshwater habitat, through loss of access, modification and destruction (Speirs 2001). Urban areas often contain physical barriers to migration, such as poorly constructed culverts, stormwater pipes, drainage structures and channelisation of streams. Poor water quality and elevated water temperature may also prevent movement of species up a catchment and affect upstream recruitment (McCarter 1990; Boubee *et al.* 1997).

Banded kokopu are highly sensitive to land-use impacts and are one of the most sensitive species to suspended sediment and turbidity, particularly in the juvenile migratory stage.

6.3.6 Impacts of introduced plant and animal pests

Aquatic pests

A number of exotic aquatic species have established in the Gulf. Invasive introduced marine species threaten ecosystems, natural character, fisheries, recreational and spiritual values, and human health.

Hayward (1997) recorded 39 foreign species known to live in the Waitemata Harbour, with 14 of these species thought to have not spread beyond the inner Gulf. They include foraminifera, sea anemone, bryozoa, sea slater, barnacle, crab, sea squirt, algae, gastropod and bivalve species. The largest diversity of organisms exists within fouling species on hard substrates.

Since Hayward's summary in 1997, new invaders have included a fierce swimming crab *(Charybolis japonica)* which has recently spread through Waitemata harbour as far east as Kawakawa Bay, and a spiny stalked sea squirt *(Pyura spinosissima)* which appeared in 2002 around the shores of the Waitemata Harbour and is now a significant element of the rocky low tidal community (B. Hayward, pers. comm.). More recently Undaria has been recorded from a number of locations within the Waitemata Harbour.

Increasing contact with foreign places due to increased trade and travel means that there is a constant risk of more exotic species arriving. Ballast water and hull fouling organisms are the main potential carriers of exotic species. Other sources include transfer with aquaculture equipment and organisms, live bait for fishing, fish food for aquaculture, and release of aquarium species. Foreign marine organisms may also arrive naturally via currents, debris, on other marine species and on the feet of migrating seabirds.

Some of these foreign species become pests because of their invasive growth habits, predation of other organisms, competition for habitats and alteration of the environment. They can also introduce diseases which affect our marine biota, have economic impacts on harvested species or affect humans. Exotic species may also have other effects. For example, it is possible that the tubeworms that appeared in scallop beds in the Gulf in 1998 were originally foreign species. These worms blocked dredges used by commercial fishers, causing a sharp fall in catches from 1998 to 2000.

It can be difficult to detect foreign species until they are well established, and to determine their impacts on coastal ecosystems. Hayward (1997) considered the greatest environmental change had arisen from four bivalves introduced in the past 30 years. The carpet mussel or Asian date mussel *(Musculista senhousia)* forms carpets which accumulate mud and smother low tidal and shallow subtidal flats in the Waitemata Harbour and Firth of Thames. The pacific oyster *(Crassostrea gigas)* is having a major impact on intertidal hard shore communities by forming intertidal banks of oysters and leaving sharp shell substrates. It has displaced the native rock oyster through the Firth of Thames region (Brownell and Brejaart 2001). The bivalve *Theora lubrica* thrives in disturbed and polluted environments under wharves and marinas. The file shell *Limaria orientalis* is a dominant mollusc in muddy shell gravels of the main harbour channels and has become a component of the diet of bottom-foraging fish such as snapper.

Brownell and Brejaart (2001) also note that the introduced parchment worm *(Chaetopterus sp.)* has taken over vast areas of benthic habitat by colonising mussel culture lines at Waimangu Point and firmer patches of sediment in the Firth. This worm is now spread throughout the Gulf with dense beds even at 40-80 m depth around Coromandel Peninsula and into Rangitoto Channel. The dead tubes are washed up in there billions on the beaches (B. Hayward pers. comm.).

Estuarine plant pests

Spartina *(Spartina anglica, S. alterniflora)* is present in the Firth of Thames, Tairua, Coromandel, Whangapoua, Waikawau, and Manaia Harbours within the Waikato region. In Auckland spartina has been eradicated from the Whangateau Harbour, the Puhoi Estuary, the Waitemata Harbour (Te Atatu and Orakei Basin) and the Umupuia Stream. Remnants remain in Mahurangi Harbour and the Wairoa River Estuary.

Spartina forms dense swards in intertidal areas of estuaries and harbours, replacing native vegetation and vegetating sites which would naturally be sparsely vegetated. It alters sediment dynamics and benthic ecology by accumulating sediment and altering estuarine morphology.

The introduced grass saltwater paspalum *(Paspalum vaginatum)* also tolerates high levels of salinity and occurs in many estuaries including Manaia, Coromandel, Whangapoua, Whitianga, Tairua, Whangamata and Otahu within the Waikato region. It also forms dense swards displacing native vegetation.

Plant pests on islands and dunes

Invasive introduced terrestrial plant species alter habitats and displace indigenous species on islands, dunes and other coastal areas of the Gulf. Weed pests are also present within the wider catchment of the Gulf. Catchment-wide pests are not addressed in this report except to note that Auckland Regional Council and Environment Waikato prepare and implement Regional Pest Management Strategies to deal with pests on a regional basis, and the Department of Conservation manages plant pests on conservation land.

Plants introduced to islands (such as pampas, box thorn, Mexican devil) typically become weeds if they are aggressive colonisers of slips, cliffs and open sites smother by forming a thick mat of vegetation or by causing canopy collapse (such as buffalo grass, kikuyu, mothplant), or out-compete indigenous species (such as nasturtium). Establishment of weed species results in exclusion of indigenous vegetation and the altering of natural processes of succession.

Most dune systems within the Gulf are highly modified. Invasion of weed species alters biodiversity through effects on other indigenous plant species, but also through effects such as availability of bird nesting habitat or availability of web building habitat for Katipo spiders.

On coastal dunes, species such as pampas, century plant and Spanish heath out-compete or overtop indigenous species and prevent their regeneration, and consequently alter the vegetation structure. Marram grass traps greater amounts of wind-blown sand than native sand-binding species (such as pingao and spinifex), changing dune profiles and sand movement dynamics. This modifies dune habitats making them unsuitable for native dune plants and reducing nesting habitat for shore birds (such as New Zealand dotterel). Other species alter the ecological processes, for example lupins increase the fertility status of the dunes.

Specific key weeds and/or an indication of the number of weed species managed by the Department of Conservation are shown in Appendix 4. Appendix 4 illustrates the widespread distribution of some weed species.

Weeds are managed on some of the least modified dune systems to preserve their ecological integrity (refer Appendix 4). Weeds are also managed at various other coastal sites around the Gulf, for example around the northern Coromandel, where the impact is on regenerating forest, forest understory, or other indigenous habitats.

There is a constant threat of new weed species arriving, carried by wind or water, on boats or on peoples' clothing and shoes. For example, sea spurge *(Euphorbia paralias)*, a coloniser of dune habitats, has invaded the coast of southern Australia and is expected to reach New Zealand shores either by floating seed or by ship. Once established, this weed is extremely difficult to eradicate.

Animal pests on islands

Animal pests modify or destroy indigenous plants and habitats, and prey on species such as birds and invertebrates. As for plant pests, the regional councils deal with catchment-wide pests through their Regional Pest Management Strategies and the Department of Conservation manages animals pests on conservation land. However, several islands in the Gulf are specifically maintained in a mammal-pest free state in order to further the survival of indigenous species that exist on or have been specifically transferred to the islands (refer Appendix 5). Appendix 5 also indicates islands where pest management has not been implemented but have fewer pest species than the mainland, or a key predator, such as stoats, is not present.

There is a constant risk that visitors to islands will re-introduce mammalian pests such as mustelids (ferrets, stoats, and weasels), rats or cats to an island, or that mammalian pests may swim to an island and re-establish a population. Rats can swim for up to 1,400 metres. One pregnant female rat escaping from a boat could devastate entire reptile, bird and insect populations. Cats or dogs let loose on an island could have equally disastrous results.

6.3.7 Pressures on Marine Mammals

Ship strikes to large whale species are recognised as a serious problem within the Gulf. In recent years, six whales found dead in the area have showed signs of trauma consistent with those caused by ship strike. It is likely that ship strike in the Gulf has been an ongoing threat to whales in the area, but agencies were not aware of the problem until relatively recently.

Whale carcases are now examined for signs of ship strike trauma and most of the recent dead large whales found in the Gulf have exhibited evidence of ship strike.

Ship strikes may cause death through the direct impact with the ship or through damage inflicted, such as cuts by the propeller. Ship strikes remain an ongoing threat. Increases in boating traffic during events or sustained over time as a consequence of increased utilisation of port facilities may exacerbate the problem.

Entanglement and litter ingestion

Around New Zealand marine mammals die from entanglement in discarded fishing gear likely to come from recreational sources and from entanglement in or ingestion of other plastic litter. Instances do occur within the Gulf, for example a juvenile bottlenose dolphin wrapped in nylon line was found at Coromandel in September 2003. Entanglement in mussel spat lines was suspected in two Bryde's whale deaths since 1996, though only one of these was confirmed as attributable to entanglement.

It is possible that Bryde's whales could be particularly susceptible to ingesting floating plastic due to their feeding behaviour, and that plastic litter poses a risk for the Bryde's whales which frequent the Gulf. A Bryde's whale which stranded in Queensland, Australia in 2000 was found to contain 6 square metres of plastic tightly packed in its gut.

Conflict with recreational and tourist activity

Development and subdivision along the coast inevitably increases the number of people, vehicles and animals on the beaches. Coastal and beach recreational activities may impact on habitats and species through effects of vehicles and human disturbance and pets on dunes, intertidal areas and bird nesting areas. Some dune and beach dwelling species, such as dotterels, are particularly vulnerable to disturbance, predation by dogs and cats, and trampling and vehicle damage to nests.

The occasional fur seals that visit the Gulf may haul out into urban or industrial areas, where they are at risk from traffic, people and dogs.

Fire also presents a threat, particularly on islands where the ability to fight the fire may be limited. Fire has the potential to wipe out entire plant and animal populations.

At present there is one marine mammal tourism operator in the Gulf. The operator is permitted to view whales and dolphins and swim with common dolphins. The operation area is limited to south of a line from Cape Rodney to Great Barrier Island and to the south west of Cape Colville on the Coromandel Peninsula. The area of operation includes part of the Firth of Thames. There are another two applications currently under consideration by the Department of Conservation.

6.4 Responses to Pressures on Biodiversity

A large number of actions are being undertaken by agencies and individuals in the Gulf Catchment which will have direct or indirect benefits for biological diversity and natural values in the Gulf. Many of these responses relate to fisheries and aquaculture management, but also sustainable land management, pest and weed control, and numerous other initiatives.

This section reports progress on strategic actions identified by the Forum as well as major activities by individual Forum members. The actions that the Forum encourages its members to take are set out below with examples of actions taken. It is not possible to report on all response actions. The description of those actions is purely illustrative, and should not be considered to be exhaustive.

Progress on Forum actions

- **Raise awareness and understanding of natural heritage and biological diversity values, as well as the relationship between peoples' activities and effects on natural heritage, biological diversity and ecosystems processes.**

The Forum is developing a communication strategy, to assist in achieving this goal. In addition, most of the Forum members have public awareness and or educational programmes, as well as regular publications, which are directed to this purpose. The Auckland Conservancy of the Department of Conservation has a Gulf specific programme aimed at involving the Chinese community in marine conservation.

- **Assess biosecurity risks to values in and of the Gulf.**

No action to date.

- **Prepare a report on the linkages between management of fisheries and the management of their habitats, the functions and roles of the Forum members, and advocating options for improved management.**

No action to date.

Other progress

In addition to the projects and programmes that the Forum undertakes, individual Forum members have undertaken a range of initiatives.

6.4.1 Manage activities that can adversely affect biodiversity

By participating in the Forum, members have all acknowledged a commitment to ensuring the values of the Gulf are not denigrated by inappropriate activities. Those members with statutory decision making powers have a specific responsibility to consider the management objectives set out in Sections 7 and 8 of the Hauraki Gulf Marine Park Act and make decisions cognisance of that duty. Regional and district councils implement this through their plans prepared under the RMA and through the annual planning process.

Forum members administer a wide variety of initiatives aimed at reducing the impact of land-based activities on biodiversity values in the Gulf. Some of these projects (such as the Peninsula Project) are described in section 5.5.6.

The Department of Conservation has begun investigating the option of placing a moratorium on issuing any further permits for marine mammal watching concessions. Concurrently the Department is in the process of preparing a marine mammal research strategy for the Gulf.

To adequately manage the impacts of activities on biodiversity value in the Gulf, good information on those impacts needs to be collated. Auckland Regional Council and Environment Waikato have programmes aimed at monitoring sediment characteristics and trends in marine macrobenthic species that have the potential to be affected by sedimentation, pollution and other impacts associated with urban development.

Monitoring by Auckland Regional Council is conducted in the following areas:

- Mahurangi Harbour: monitoring of five intertidal sites and two subtidal sites, established in 1994, is ongoing.
- Waitemata Harbour - a long-term programme was established in 2000 to monitor five sites for 20 taxa. Some taxa monitored in the Waitemata Harbour are also monitored at Mahurangi. The taxa are selected based on abundance (taxa present at more than one site so that site specific disturbances can be assessed), key species, variety of niches, prey species, responses to disturbance, practical aspects and consistency with other sites.
- Okura Estuary: monitoring was established in 2000. In 2002/03 four additional estuaries (Puhoi, Waiwera, Orewa, and Maungamaungaroa) were sampled together with Okura to provide comparative data. Okura Estuary is a marine reserve but is under increasing pressure from urbanisation.
- Long Bay: during 2002 and 2003 intertidal soft sediments and subtidal rocky reefs at Long Bay and in the surrounding area were surveyed as part of ongoing monitoring of the Long Bay-Okura Marine Reserve.

Environment Waikato's state of the environment monitoring includes the Regional Estuary Monitoring Programme. Monitoring started in 2000 and is ongoing in the Firth of Thames at permanent sites at Kaiaua, Miranda, Thames, Kuranui Bay and Te Puru. Included in the monitoring is particle size, organic matter and nutrient content, microalgal biomass (chlorophyll a and phaeophytin), and rates of sediment deposition and erosion. Macrobenthic communities are monitored through a suite of 26 indicator species or taxa which are characteristic of intertidal sand/mud-flat benthic macrofauna communities, and selected to represent a variety of taxonomic groups, and a range of life-histories, ecological niches and feeding methods.

To date one report has been produced (2001 – 2002 summary) and trends will not be apparent until subsequent years' data are analysed.

These monitoring programmes do not monitor biodiversity. They use indicator species representative of community types, habitats and ecological niches present in the regions so that a picture is obtained of the effects that urban development and catchment use are having on the Gulf. In general the monitoring is in the near-shore environment and does not extend out to deeper waters in the outer Gulf, and the monitoring focuses on benthic species and does not include other species potentially impacted at higher levels of the food chain. However, in the absence of monitoring of biodiversity, these studies provide the best available assessment of potential ecological change.

While Environment Waikato's Regional Estuarine Monitoring Programme provides information about benthic community composition at the sampled sites, the use of indicator species means that only selected organisms are identified to species level. Non-indicator species are classified into broad groups (polychaetes, oligochaetes, amphipods, bivalves etc.) and the diversity within these categories is not recorded. For any monitoring programme, the benefits of the ability to use species diversity as an indicator of community health must be weighed up against the costs associated with the additional identification that this involves, compared to the use of a selected, limited number of indicator species.

In addition, as the Regional Estuary Monitoring Programme only monitors macrobenthic communities, it provides no information about the diversity of other size categories of benthic biota, mobile larger animals (e.g. birds, crabs and starfish), meiofauna (organisms such as nematodes and copepods, which are smaller than macrofauna) or microbial communities. In the absense of specific monitoring of biodiversity, these programmes provide the best available assessment of potential ecological change.

6.4.2 Marine reserves

Marine reserves are established to set aside no-take regions of the marine environment within New Zealand's exclusive economic zone, for the purpose of studying of marine habitats in their natural state, rather than for maintaining biodiversity. Nevertheless, their establishment is a reflection of the value accorded the marine environment and, as a focus of scientific study, the information that has been compiled about them provides a useful insight into biodiversity. Five marine reserves are located within the Gulf, as indicated in Table 6.6. As a percentage of the total area of 1,388,786 ha for the Gulf, less than 0.3% is under marine reserves protection.

6.4.3 Expanding the network of reserves

In August 2004, the statutory process for the Aotea (Great Barrier) Marine Reserve proposal was initiated by the Auckland Conservancy of the Department of Conservation on behalf of the Director-General of Conservation. This public submission process, which may result in the establishment of the sixth marine reserve in the Gulf, was preceded by a two year consultation process. A national strategy for establishing a network of marine protected areas, including areas within the Gulf, is being developed by the Department.

Te Matuku Bay, Waiheke Island is the most recent Marine Reserve to be established within the Gulf since the Forum was established, having been approved in March 2003 (see Table 6.6).

In early 2004 a snorkel trail was installed at Gemstone Bay in the Te Whanganui-a-Hei Marine Reserve to improve the recreational opportunities available at the reserve and its appreciation. Four marker buoys with information panels depicting

Table 6.6 Marine Reserves in the Gulf

Name and location	Area (ha)	Description
Cape Rodney-Okakari Point, Leigh, north of Auckland	518	Gazetted in 1975 and NZ's first marine reserve. Typical rocky northern semi-exposed coast with inter-tidal platform reefs, kelp forest, urchin barrens, sponge garden, sub-tidal sand flats and warm temperate reef fish. Ngatiwai is the traditional guardian of this area and exercise Kaitiakitanga (guardianship) in the protection of Wahitapu (sacred place) and food gathering places traditionally handed down from ancestors as taonga tuku iho (treasures).
Long Bay-Okura, North Shore	980	The reserve protects a stretch of coastline on the east coast just north of Auckland metropolitan area. The coast here is semi-sheltered coast typical of that found throughout much of the Waitemata Harbour and inner Gulf. It is moderately sheltered, and largely formed of Waitemata sandstones and mudstones. Formally established in 1995, the marine reserve includes a variety of coastal habitats: sandy beaches, rocky reefs, estuarine mudflats and mangroves.
Motu Manawa (Pollen Island), Inner Waitemata Harbour	500	Includes the intertidal mudflats, tidal channels, mangrove swamp, saltmarsh, and shellbanks surrounding Pollen and Traherne Islands. The intertidal flats to the west of Pollen Island are probably the best examples of mangrove saltmarsh habitat in the Waitemata Harbour. The intertidal mudflats of the reserve are one of the most important feeding grounds for wading birds in the Waitemata Harbour. Some, such as godwits, knots and sandpipers, are international migrants that breed in the north Asian wetlands during the northern spring and summer. The extensive mangrove and saltmarsh areas are rich feeding grounds for white faced herons, pukeko, spotless crake and the endangered banded rail. These wetlands are equally important for several non-waders, including kingfisher and fernbird.
Te Matuku Bay, Waiheke Island from Te Matuku Bay out to Passage Rock islet	700	Approved in March 2003 but yet to be formally established by Order in Council. Contains a large estuary rare in the Auckland area and under-represented among New Zealand's protected marine areas. The reserve also protects a unique sequence of habitats from indigenous forest on the fringes of Te Matuku Bay, through fresh- and salt-water wetlands and mangroves, inter-tidal waters and out to the deeper waters surrounding Passage Rock.
Te Whanganui-A-Hei (Cathedral Cove), South eastern end of Mercury Bay	840	Gazetted in 1992. Semi-exposed coast typical of the Coromandel Peninsula. Kelp forest, urchin barrens, sand flats and warm temperate reef fish. Major habitat types include shallow mixed algal zones, rock flats (dominated by kina *Evechinus chloroticus*), *Ecklonia* forests, shallow and deep sand flats, and intertidal reef platforms with provisional species lists including more than 50 fish species, 80 algal species, and 140 mobile and sedentary invertebrates.

which species inhabit each area are anchored from 50 to 165 metres offshore. The position of each buoy coincides with different habitats within the bay.

The Marine Reserves Bill is proposing changes to the legislation regarding the protection of marine habitats. The newly proposed legislation is based on the New Zealand Biodiversity Strategy, which commits toward protection of marine biodiversity in both representative or common habitats, and rare and unique habitats, with a goal of 10% of the New Zealand marine environment to be protected by 2010. In particular, the new focus is on a reserve network design that includes existing marine reserves that preferentially protect rocky reef habitats, but also soft-sediment subtidal and intertidal habitats that comprise a large portion of the New Zealand marine environment.

In addition to the marine reserves located with the Gulf, the 588 ha Tawharanui Marine Park is located on the northern shores of the Tokatu peninsula, adjacent to the Tawharanui Regional Park. This park was established in 1981 using a combination of fishing controls imposed under the Fisheries Act through the Fisheries Regulations (no fishing is allowed) and controls on other activities using the provisions of the Harbours Act 1950.

6.4.4 Species Management

Species on islands in the Gulf are the focus of special recovery programmes. For example, species managed by the Auckland

Conservancy include takahe on Tiritiri Matangi which is the only population north of Wellington Conservancy, two of the three populations of stitchbird (hihi) on Little Barrier (Hauturu) and Tiritiri Matangi, weka on Rakitu and Kawau, and tuatara on Hauturu. Motuora Island provides a safe Operation Nest Egg crèche for Northland kiwi chicks hatched at Auckland Zoo. These islands also provide safe release site options for the transfer of additional threatened species, thereby providing increased national security of these species. Tiritiri Matangi, for example, has recently had tuatara released on it and islands such as Motuihe are undergoing habitat restoration with community effort with a view to supporting species such as brown teal (pateke) in the future.

Species on Coromandel islands managed by the Waikato Conservancy include tuatara, tieke, and Whitaker's and Suter's skinks. The Middle Island tusked weta which have been re-introduced onto a number of islands in the Mercury Group were successfully reared from a remnant population found on only one small predator-free island. These weta are now found only on Gulf islands and their survival is dependent on maintaining these island populations. Species not from the area that have been translocated to islands include Little Spotted Kiwi and Mahoenui giant weta.

6.4.5 Advocacy

The Department of Conservation has a specific mandate to advocate for the conservation of natural and historic resources generally and promote the benefits of this to present and future generations. The Department undertakes this responsibility in a variety of ways, including participating in RMA processes.

6.4.6 The New Zealand Biosecurity Strategy

The New Zealand Biosecurity Strategy was released in 2003. An "Outcomes" document has been produced that identifies goals and values for biosecurity actions. Regulations are being developed to control fouled hull cleaning. Work on controlling the entry of fouled hulls into our waters is still in the developmental stages. An Import Health Standard was developed under the Biosecurity Act 1993 to control ballast water discharge. The standard details the conditions that must be met before ballast water loaded in the territorial waters of any other country may be discharged into New Zealand waters.

A Strategic Biodiversity Unit has been formed. One of its functions is to set goals and objectives for all biosecurity issues. The process of implementing the Biosecurity Strategy has included work to define roles of the agencies involved. Moving responsibility for marine biosecurity from the Ministry of Fisheries into the Ministry of Agriculture and Forestry is part of the process of clarifying roles.

The strategy process has recognised the need to improve coordination of incursion responses, and to set priorities between them. The Strategic Biosecurity Unit will have a role in ensuring consistency in decision-making. Agriquality has been given responsibility to develop and maintain incursion response capability in the marine environment. This will include maintaining decision-making frameworks, contacts and procedures.

6.4.7 Pest Plant and Animal Management

The Department of Conservation uses sniffer dogs on a regular basis to detect for presence of animal pests on pest-free or relatively pest-free islands. The Department is continually working at improving these programmes' efficiency and ability to detect traditional pests such as rodents, as well as others such as argentine ants and rainbow skins.

The Department of Conservation's control or management of weeds seeks to maintain a low density of a species (for example pampas on Cuvier Island) or its eradication (for example, mothplant and buffalo grass on Cuvier Island). The latter may apply if the species is detected early and is at an early stage of invasion. A major programme is underway on Great Barrier Island to prevent the expansion of multiple weeds that are currently at low densities, but are known to be highly invasive. Regular surveillance is carried out for new plant pests on islands already managed for weeds as well as on islands which are not currently being managed (for example, surveillance is carried out on Mokohinau Stacks, Groper Island). The Department's weed control programme undergoes reviews and management decisions, including both control and surveillance, are made on the basis of those reviews.

The Department of Conservation actively controls plant pests on islands on a 'site led control' basis. The focus of weed control differs between sites. For instance, weeds dispersed by birds often need to be controlled on islands close to the mainland, whereas weeds dispersed by wind (such as pampas grass) are typically the focus at more remote islands. Several site-led weed control programmes are also being undertaken by private landowners and community groups, for example on Noises Island and Rakino Island.

A programme for eradication of spartina is underway in the Waikato region. In Auckland, eradication work is underway in the two areas remaining with spartina, Mahurangi Harbour and the Wairoa River estuary. When work in these harbours is completed, spartina will have been eradicated from the Gulf coastline of the Auckland region.

6.4.8 Research into marine protected areas

The Department of Conservation has contracted NIWA to prepare a report to identify areas of conservation value in the Waikato Coastal marine environment. The investigation identifies a range of representative habitats including typical, rare and unique biological and physical features. In addition the Department and Environment Waikato are establishing a comprehensive Waikato marine meta-database designed to include technical information on both physical and biological parameters. The database notes areas that lack physical research and biological information.

6.4.9 Co-ordinating marine research and monitoring

Any summary of research into the effects of fishing on (directly) fisheries and (indirectly) the marine environment needs to start with an explanation of fisheries management.

Fisheries Management

As outlined previously, all of the fish and shellfish species that live in the Gulf are part of populations with a wider distribution. Consequently, fisheries management responses to the pressures on these species consist of management measures that also apply over this wider area.

The main technique used to ensure sustainable catches and to rebuild small population, is catch limits applied on species covered by the Quota Management System. Figure 6.10 shows how this system works.

The essential features are firstly that research information is used to estimate total population size. Then further estimates are made of all possible ways that fish may be removed from the population – commercial and non-commercial catches, incidental mortality and illegal catch. Allowances are made for each of these factors and the overall quantity that can be sustainably caught each year determined – the Total Allowable Catch.

In any one year commercial fishers may only catch the quantity of fish that they hold quota for. Appendix 2 shows the commercial catch limits and catches for the main Gulf species.

Individual recreational fishers must comply with daily limit to keep overall catches within the non-commercial allowance. Since 1986 there have been cuts in daily limits for recreational fishers to prevent increasing numbers of fishers taking more than the non-commercial allowance.

The Ministry is progressively adding more species to the Quota Management System, including those taken as by-catch. This means that there is now a limit on the quantity of by-catch species that can be caught, to prevent overfishing of these species.

The Ministry has progressively devised controls on where the various commercial fishing methods may be used in the Gulf (see Box 6–10). Controls are mainly used to prevent competition between commercial

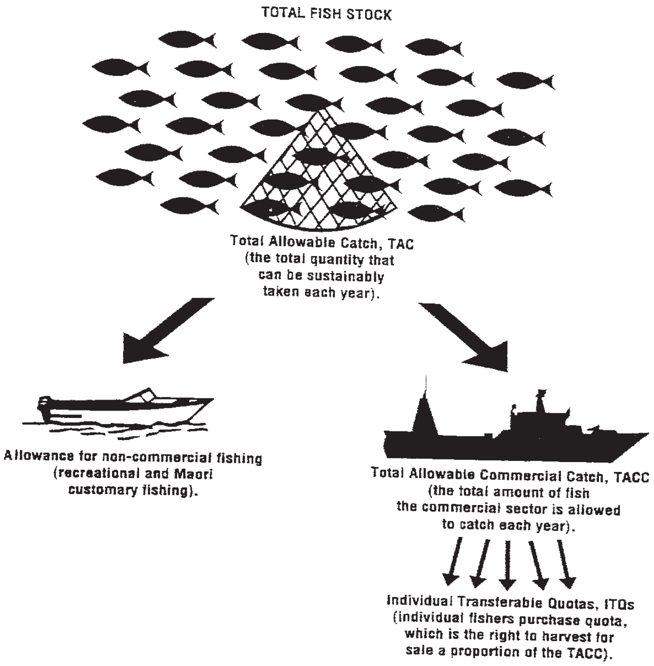


Figure 6.8 Operation of the Quota Management System

and non-commercial fishers, rather than for sustainability reasons. However, they are also intended to prevent the more powerful commercial fishing methods causing depletion of the main finfish species in the inner Gulf region.

The Ministry is beginning work to develop stock strategies for fishery complexes including the main bottom trawl fisheries. These strategies will provide an opportunity to satisfy Fisheries Act requirements to prevent adverse effects of fishing on the aquatic environment. They will identify environmental standards and performance indicators, and include specific measures to mitigate bottom-trawling impacts.

The Ministry has responded in several ways to the pressures that non-commercial harvesting is applying on shellfish in the Gulf. First, a limit of 50 has been placed on all shellfish species not subject to individual limits. This was in response to increased harvesting of species that had not previously been taken, and for which there was no limit. Such harvesting was noticeable in the Auckland and Coromandel region.

Daily limits in the Auckland and Coromandel region for cockle, green-lipped mussel, oyster (Pacific or rock), pipi and tuatua are lower than apply elsewhere. This is because of the greater harvesting pressure occurring in the Gulf than other coastal regions. Shellfish gathering has been banned at Cheltenham and Eastern Beaches because of the low numbers of cockles and pipi (although harvesting may not be the cause).

Fisheries monitoring

The Ministry of Fisheries requires commercial fishers to report all of their catches to provide information on both quantities taken and trends in catches. The Ministry also lets contracts for research programmes on species populations and catch rates. This monitoring can then be used as the basis for setting the catch limits that apply in the Quota Management System.

Research on recreational fishing includes surveys to provide information on quantities of all species caught by recreational fishers. This information is used to calculate the overall quantity of fish allocated for non-commercial fishing, when the commercial allowance is calculated. The Ministry of Fisheries, ARC and volunteer groups regularly survey shellfish populations at areas in the Auckland and Coromandel region where harvesting pressures are high.

The Forum report on shellfish (Grant and Hay 2003) is the first of a two-part process. The second stage involves devising a strategy for further research and investigation into possible causes and solutions for the depletion issues. The strategy is likely to include suggestions for such things as:

- Increased support for local community shellfish monitoring efforts
- Establishment of regular information sharing forum or annual workshop for researchers and practitioners
- Increased /improved regulatory authority monitoring of shellfish resources
- Maximising use of opportunities to gain leverage within existing research and investigation initiatives (e.g., FRST

programmes) so that shellfish related matters are specifically included
- Issues where agency research/ investigation would be most effective
- High priority knowledge gaps where more information is needed.

6.4.10 Co-ordinated management of aquaculture

The interest, nationally, in development of aquaculture has resulted in a moratorium on development while new legislation on aquaculture management is drafted. The moratorium was uplifted in December 2004. The moratorium was designed to provide an opportunity for central and local government to commission research necessary to determine the scientific basis for decision making regarding location and scale of marine farms, and to determine the appropriate locations of and policies relating to aquaculture management areas (AMAs). It is anticipated that new marine farm development will occur within AMAs and be prohibited elsewhere in the Gulf. In order to develop AMAs the two regional councils responsible for the Gulf have commissioned or carried out a number of studies (for example Broekhuizen *et al.* 2002) to determine potential location of AMAs and the ecological carrying capacity of waters of the Gulf and in particular, the Firth of Thames.

6.4.11 Members' support for community and tangata whenua action

Maori can get kaimoana (seafood) for customary purposes by using a fishery regulation that allows a quantity to be taken that is higher than the amateur limit. Maori may also apply to have Kaitiaki (guardians) appointed for areas of coast with which they have a traditional connection. The main role of the Kaitiaki is to issue permits for kaimoana to be taken for customary purposes, provided that the quantity applied for is sustainable.

There is a process enabling Maori to have traditional fishing areas to be declared as either a Taiapure, or Mataitai reserve. In a Taiapure, a management committee can recommend controls on fishing to the Minister of Fisheries. In a Mataitai, Kaitiaki can decide the kinds of controls needed. So far, Maori in the Gulf region have expressed interest in applying for these powers, but would prefer a simplified application process.

Box 6–10

Case Study: Evolution of Controls on Commercial Fishing Methods in the Gulf

Management of the Gulf commercial finfish fishery has always faced an issue of potential conflicts between the various fishing methods used there. The first such conflict surfaced in 1899 when the appearance of a steam trawler caused a disagreement between the trawl operators and commercial line and net fishers. The trawler was alleged to be depleting snapper stocks and the first regulations prohibiting trawling in most of the Gulf were introduced in 1902.

In 1907, the trawl line was moved inshore in an effort to encourage growth in the trawl industry, but steam trawlers did not re-appear until 1915.

Danish seiners first appeared in the Gulf in 1923. These vessels proved to be very successful in obtaining good catches on previously unfished grounds. They were alleged to have depleted snapper in inshore zones. In 1924 Danish seiners were prohibited to operate in the Firth of Thames. During the 1920s, much of the inner and middle Gulf was closed to their activities.

Since that time there have been numerous changes in the position of the trawl and Danish seine prohibited areas.

Numbers of commercial fishers were restricted until 1964, when a decision was made to allow anyone to fish. As a result, there was a rapid expansion of fishing effort for snapper in the Gulf. By 1980, there was clear evidence of stressed fish stocks and declining catches. Despite this, fishing effort continued to increase.

A moratorium on issuing of permits was declared. This prevented an increase in the number of fishers, but did not deal with the excessive fishing effort already present in the fishery. In 1983, the Gulf was declared to be a controlled fishery, and the number of vessels allowed to fish there was restricted to 374. In addition:

- No trawl or Danish seine vessels longer than 19 metres were allowed to fish in the controlled fishery area. This was intended to maintain fishing effort at a level consistent with the inshore nature of the snapper fishery, by keeping out the larger vessels that could fish in more exposed waters;
- Minimum trawl net mesh size was set at 125mm (100mm elsewhere). This was to reduce fishing mortality of smaller snapper that were being caught in area 005 between Horn Rock and Tryphena;
- An annual quota was set for all methods at 3,800 tonnes of snapper (1,200 tonnes in summer, 2,600 tonnes in winter). This was the quantity considered to be sustainable in the Gulf.

The Quota Management System was introduced in 1986. The controlled fishery was removed and there were major reductions in catch for most of the important commercial species.

However, problems continued to be caused by commercial set net and long line fishing in the Inner Gulf. In 1995 use of these methods was prohibited in the region inside a line from Whangaparoa – Waiheke – Ponui Island – Musick Point from 1 October to 31 March each year.

Box 6–11

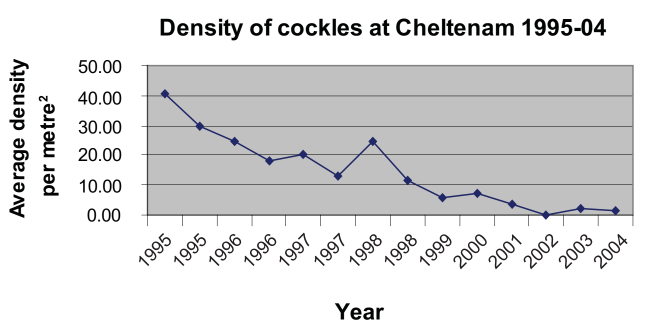
Case Study-Cheltenham Beach Caretakers

In the early 1990s residents living in the Cheltenham beach area on the North Shore, became concerned about depletion of cockle (and pipi) at the beach. While there were signs that cockle and pipi populations were getting smaller, until that time Cheltenham had been a popular place to gather these shellfish.

Most people thought human harvesting was causing this depletion. They asked MFish to prohibit harvesting to give the cockles and pipi a chance to recover. A temporary two-year closure was adopted in 1993. The closure has since been extended, and remains in force.

From 1995 onwards, a group that became known as the Cheltenham Beach Caretakers began regular surveys of the cockle and pipi populations at the beach. The volunteers have used a systematic grid sampling-monitoring programme to survey cockle and pipi populations at the beach every year since 1995.

The use of a standardised sampling method over this extended period of time means that there is now useful information about the size of the Cheltenham Beach cockle population, as shown below.



Unfortunately, as the figure illustrates, there has been a steady decline in the cockle population at Cheltenham, even though there has been no harvesting for 11 years. An inference from this is that environmental/habitat changes (possibly siltation), rather than human harvesting may have caused the decline in this population.

Table 6.7 Ministry of Fisheries Compliance Actions in the Gulf – 2001-2003

Season	Offender Decision for Incident	Commercial	Non-Commercial
2001-02	Infringement Notice		177
	Prosecute	3	109
	Warning	14	59
	Total 2001-02	17	345
2002-03	Infringement Notice	3	278
	Prosecute	9	214
	Warning	28	168
	Total 2002-03	40	660
2003-04	Infringement Notice	9	256
	Prosecute	3	150
	Warning	21	107
	Total 2003-04	33	513

The Cheltenham Beach Caretakers is one example of a community group taking a direct interest in the problems facing a particular shellfish habitat (refer Box 6–10).

6.4.12 Raising Public awareness of Fisheries

The Ministry of Fisheries, with backing from some Forum agencies, widely circulates brochures that summarise recreational fishing rules and good fishing practices. The Ministry has worked with councils in the Gulf to ensure there are signs at popular boat launching ramps, and at beaches where people gather shellfish telling fishers about size and catch limits.

6.4.13 Enhancing compliance

The Ministry of Fisheries has employed more staff to oversee and co-ordinate teams of Honorary Fishery Officers whose work involves a combination of public education and prevention of illegal harvesting. There is also a team of 'Fish Care Volunteers' who help the Ministry with stakeholder education and compliance.

The Ministry of Fisheries has also increased compliance efforts in the Gulf region in several ways. One involves increasing numbers of both permanent and honorary fishery officers and there are now 35 officers working in the Gulf. Police and ranger staff from other agencies also assist with compliance in this region.

Table 6.7 shows the results of compliance efforts in efforcing fisheries regulations in the region over the past three years in enforcing fisheries regulations.

All compliance work involves a combination of these enforcement actions and an educational role. The main purpose of education is to make people more aware of the limits that apply and the risks of being fined or prosecuted for taking more fish and shellfish than they are allowed.

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7 Natural Character and Landscape Values of the Gulf

Key points

- The coastline adjoining urban areas is often highly modified by the presence of seawalls, stormwater outfalls and other structures. Within more sheltered locations such as harbours and estuaries there are a considerable number of structures such as jetties, boatramps, boatsheds, seawalls and moorings.
- There are over 2750 recorded structures within the Gulf and there is ongoing demand for further structures.
- Demand for subdivision and development along the Gulf's coastline places considerable pressure on natural character and landscape values. Most beaches along Auckland's east coast, and a large proportion (over 70 %) of beaches along Coromandel's east coast, have been modified significantly.
- Areas of coastal forest in the Gulf's catchment have dramatically reduced over the past 120 years and are now generally limited to small remnant areas along with large areas of regenerating vegetation.
- The cliffed and rocky coastlines of the Gulf are generally the least modified by human built structures.
- There are over one hundred sites and areas along the Gulf's coastline that have been identified as being of particular significance due to ecological, landform or geological values. These areas are afforded special protection in coastal planning documents.
- A number of landscape assessments have been undertaken by regional and district councils in order to identify significant and outstanding landscapes. Four natural character assessments have been undertaken. However there is no consistent approach to landscape or natural character assessment and protection within the Gulf.

7.1 Introduction

The importance attributed to natural character and landscape values reflects the attachment or affinity New Zealanders as a whole have for the coast. Natural character and landscape are critical to the well-being and quality of life of communities living in the Gulf's catchment[65]. The coastal environments of the Gulf provide a physical and spiritual respite for people. The landscapes and natural character values associated with these areas provide a sense of place and belonging.

Within the Gulf, preservation of natural character and protection of outstanding natural features and landscapes is a major resource management issue. Located within a ninety minute commute from major population centres, coastal areas in the Gulf, particularly north of Auckland and in the Coromandel Peninsula, draw large numbers of visitors and are highly sought after locations for coastal development. However increasing development pressure seriously threatens the outstanding natural values that draw us to such areas.

Natural character is important to both coastal ecosystems and to human use and enjoyment of the coast. The value of the experience people enjoy in the Gulf is often dependent on the natural character of that environment, including its landscape, geology, landform, amenity value, and the ability of the ecosystem to function in terms of biological and physical processes. A diversity of experience, from modified urban beaches to wild and undeveloped coastal areas, is also important to people's use and enjoyment of the Gulf. However, much of the Gulf's coastal environment has been modified with extensive areas of urban development and farmland adjoining the coastline. The remote, scenic and unspoilt coastal areas are becoming a scarce resource and the retention of such areas is a challenge to the public and resource managers alike.

The importance of preserving and protecting natural character and landscape

[65] Several surveys have found that the values associated with our coasts and beaches are key reasons for living in the Auckland Region and/or protection of these values a key environmental issue.g. ARC 2004, FDC 2003.

Box 7–1

Strategic Issues and Objectives

The Forum has identified natural character and landscape as a key issue for the Gulf. In particular:

- Natural character and landscape values are important in retaining the national significance of the Gulf.
- These values are susceptible to degradation from exotic plants and animals, modification of natural processes, use of natural resources, and human activities such as development along coastal margins.
- Perceptions about appropriate and acceptable levels of modification and protection of 'naturalness' vary.

The Forum identified the following objectives for natural character and landscape values:

- Significant areas or attributes of natural character and landscape are described, there is consistent policy to define appropriate development, and these values are managed consistently across MHWS.
- The public appreciates and values the Gulf's natural character and landscape and is empowered and encouraged to participate in its management.

Box 7–2

Kaitiakitanga

Kaitiakitanga determines the relationship to the landscape. Kaitiakitanga is an all encompassing term, determining the relationship between people, the physical universe, and the atua. The Maori sequence of creation accords tuakana, or senior status to the plants and animals. More senior are the forces of nature, and more so the Earth and Sky, personified as Papatuanuku and Ranginui. A respect is due to these senior whanaunga, and kaitiakitanga is the response in terms of exercising control over the resources, and sharing the benefits of the use of those resources. Use of the products of a landscape is an integral part of the perception of landscape, and is sustainably managed as an aspect of kaitiakitanga. The spiritual, physical, biological, social and cultural aspects of landscape are woven together and maintained through kaitiakitanga.

Box 7–3

What is natural character?

Natural character is a term used to describe the naturalness of the coastal environment. The degree of natural character will depend on:

- The extent to which natural elements, patterns and processes occur,
- The nature and extent of modifications to the ecosystems and landscape/seascape.

The highest degree of natural character (greatest naturalness) occurs where there is the least modification.

The effect of different types ofmodification upon the natural character of an area varies with the context, and may be perceived differently by different parts of the community.

values is recognised in the Resource Management Act, New Zealand Coastal Policy Statement, in regional policy statements and regional coastal plans, as well as in district planning documents. In addition, the Forum has identified natural character and landscape as strategic issues for the Gulf (see Box 7–1).

7.2 What is Natural Character?

Natural character refers to qualities and features that are products of nature. The introduction of structures such as buildings and roads, along with loss of vegetation and modification of coastal landforms, invariably detracts from natural character values.

Natural character is linked to human perceptions and values. However while perceptions of natural character may be unique to each individual, there are many elements and features which are commonly agreed to be important components of natural character. These include:

- landscapes and landforms, geological features, wild and scenic areas
- indigenous flora and fauna
- natural and physical processes including ecological and biotic processes, and wind, wave and tidal processes that shape the Gulf's coastline
- ecosystems that are unique to the coastal environment including estuaries, coastal wetlands, dunes, rocky shorelines and subtidal habitats
- clean water that provides a healthy habitat for shellfish, fish, and other marine organisms.

A definition of natural character determined through a Ministry for the Environment consultation process is provided in Box 7–3.

All parts of the coastal environment have natural character. However there is a spectrum reflecting the degree of modification as a result of human activities (Boffa Miskell, 1997). This ranges from largely developed, built environments such as the Port of Auckland to largely unmodified coastal environments, e.g., Little Barrier Island.

7.3 What is Landscape?

The meaning of 'landscape' encompasses the particular character of an area defined by the way people live and the scenery. While this includes both scenic and natural components it is more than just what we can see – landscapes reflect the interaction between humans and nature (Peart, 2004). For Tangata Whenua, cultural landscapes features such as maunga, awa and moana form the basis of most pepeha which locate people within a landscape. Change to, or loss of, such features compromises fundamental statements of identity (refer Chapter 9: Cultural Heritage of the Gulf).

A public perception survey of what outstanding natural landscapes look like identified the following key elements (Fairweather, 2003):

The Gulf's natural landscapes provide important habitat for New Zealand's unique biodiversity. Our cultural and heritage landscapes reflect the inter-relationships between people and the environment over time, and historical landscapes provide New Zealanders with an understanding of earlier relationships to the land (Peart, 2004). The dynamic landscapes and seascapes of the Gulf are some of the most important components of natural character and many areas identified as having outstanding landscape values are also areas of high natural character.

7.4 State of Natural Character and Landscape Values

Although natural character has been a component of environmental planning since at least the Town and Country Planning Act 1977, it is a poorly understood facet of resource management. Whilst the concept of natural character is well understood by practitioners, there is no comprehensive methodology for assessment at the regional scale (a recognised methodology does exist for landscape). Accordingly, the information that follows does not purport to be comprehensive but provides an overview of the state of natural character.

7.4.1 Coastal Environments in the Gulf

Sheltered harbours and tidal estuaries

Sheltered harbours and tidal estuaries are a dominant feature of the Gulf's coastline and have a range of values associated with them including recreational, amenity, landscape and ecological values. A variety of habitat types are found in and around these harbours and estuaries including coastal forests, saltmarshes, mangroves,

Table 7.1 Examples of elements and features of outstanding natural landscapes

	Outstanding natural landscape	Not outstanding natural landscapes
Elements	Natural beauty. Native vegetation. Natural processes, forms. Steep and rugged/ sandy shores. Variety, complexity, diversity. Not interfered with.	Residential development, roads, housing. Exotic vegetation. Power lines. Unnatural structures, hard surfaces. Development too close to shore. Human intervention. Removal of vegetation.
Character	Untouched, uncorrupted by man, no man made development. Clean, unpolluted, clean water. Remoteness, openness. Grandeur, spectacular. Good vegetation growth, regenerating bush. Quiet, serene, peaceful.	Intense recreation. Commerce Modified bycoastal defences. Artificial Not peaceful
Feelings	Excitement, drama. Refreshing. Pleasant place. Remote, isolation.	

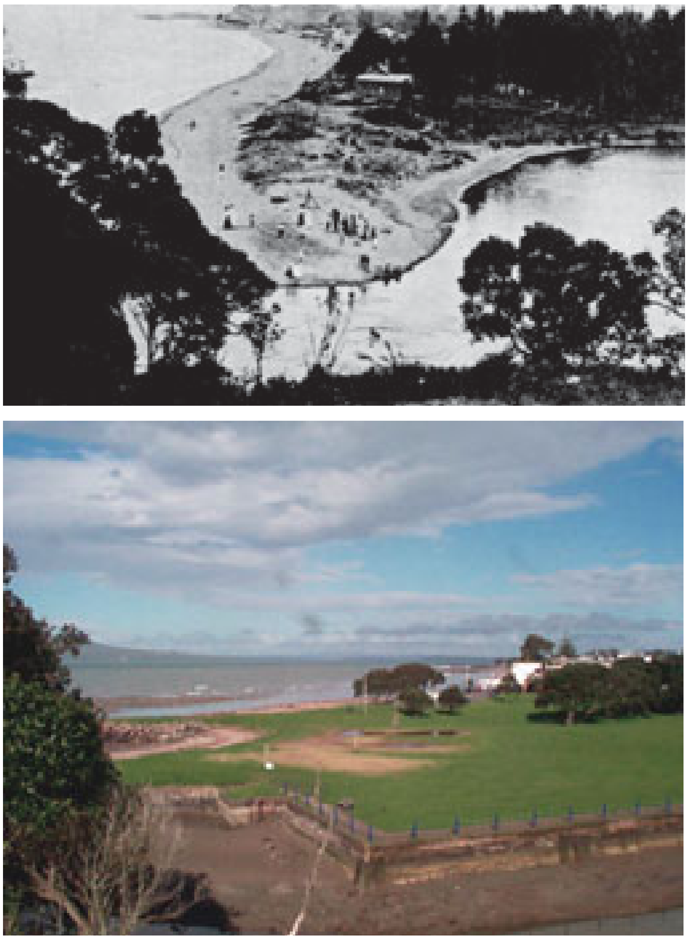


Figure 7.1 Milford Beach in 1910 and today showing changes, in this case reclamation, that have occurred to estuarine systems

seagrass beds, and sand and mud flats (refer Chapter 6: Biodiversity). The habitat and ecological values associated with these areas are an important component of the natural character of the Gulf.

There are over 100 estuarine systems and coastal wetlands along the Gulf's coastline. These are highly productive and sensitive ecosystems, however they are some of the most at-risk coastal ecosystems in the Gulf and tend to have suffered degradation both by direct impacts such as reclamation, stock grazing, discharges and dumping, and indirect impacts such as diffuse source runoff and sedimentation. Mangrove forests in particular were once considered to be boggy 'waste lands' and often regarded as somewhere to dispose of rubbish, or places to drain for farmland or urban development. Reclamation has destroyed thousands of hectares of mangroves, saltmarshes and saltmeadows, and road causeways continue to adversely affect a number of estuarine areas by cutting them off from the natural flushing action of the tides, particularly where inadequate culverts are provided.

Rocky and cliffed coastlines

Rocky and cliffed coastlines are common in the Gulf, particularly along the western side of the Coromandel Peninsula and on offshore islands. The coastline on the eastern side of the peninsula, and in the Auckland Region from North Head to Cape Rodney, consists of embayed beaches contained between rocky headlands and steep hills and cliffs. The rocky coasts of the Gulf include landforms and geological sites of regional and national significance and contain areas of outstanding landscape and natural character. Landforms and coastal processes along most rocky coastlines remain relatively unmodified, although the vegetation cover has significantly changed.

Beaches

Beaches are a natural feature of the Gulf's coastline, ranging from sheltered, embayed beaches to exposed open coast beaches. Sand dunes, which are present behind a number of the more exposed beaches, play a significant role in the natural character of these beaches. They provide habitat for a variety of specially adapted plants, animals, birds and other organisms, provide a range of unique landforms and processes which have intrinsic value, and form a natural backdrop to an open beach system, screening development and enhancing natural character, aesthetic and amenity values (Hesp, 2000).

As coastal zones are favoured for development, large areas of dune formations along the Gulf's coastline have been significantly changed from their natural state, and remaining dunes areas are under significant pressure from recreation and development (see Figure 7.1). Coastal sand dunes are now one of New Zealand's most endangered habitats and less than 10% of New Zealand's dunes exist in a natural unmodified state.

The rate of coastal development has meant that, in some parts of the Gulf, little coast remains undeveloped (see Table 7.2).

Offshore Islands

Offshore Islands are an important feature and make a significant contribution to the natural character of the Gulf. Great Barrier Island (28,500 ha) occupies a prominent position at the entrance to the Gulf sheltering much of the inner reaches from the north east. Whangapöua Estuary, on its east coast, has extensive mangrove forests (107 hectares) and is one of the least disturbed estuaries for its size in New Zealand. Little Barrier Island contains the largest remaining area of relatively unmodified northern North Island forest, and Rangitoto Island has unique characteristics with its association of pöhutukawa and rata forest growing on lava and scoria, and wide diversity of native plant species (DOC, 1995). Many of the small islands and rocky stacks close to the Coromandel Peninsula also provide important wildlife habitats, helping to protect rare, threatened and endangered native species.

Box 7–4

Cultural Heritage

As Maori settlement was frequently in coastal areas, dunes in the Hauraki Gulf contain many important urupa and other waahi tapu. These archaeological sites are of significant spiritual value to Tangata Whenua, however many have been destroyed by natural erosion as well as by coastal development and wind erosion caused by loss of dune vegetation. An inspection of 90 known archaeological sites in coastal dunes along the eastern Coromandel in 1982 indicated that over 20 percent appeared to have been destroyed and a further 50 percent were being damaged by wind or wave erosion (Environment Waikato, 2001).

In addition to these sites, there are a number of other Tangata Whenua values associated with dune systems. Pingao is a native sand-binding plant with rich green-bronze coloured leaves that dry to a bright golden yellow colour. For this reason it is much sought after by Maori weavers. Pingao was once prominent but has now disappeared from many beach and dune areas of the Hauraki Gulf.

7.4.2 Elements of Natural Character

Physical Coastal Processes

Waves, tides and currents that shape the coast are key components of the natural character of the Gulf (see Chapter 1: Introduction). The Gulf is characterised by warm water flowing south, low to moderate wave conditions with occasional storm events, and displays a spectrum of coastal environments from sheltered harbours and estuaries to exposed rocky islands and beaches. Variations in physical coastal processes occur due to changes in exposure, from the moderate energy beaches such as Pakiri, Tawharanui, Whangamata and Whiritoa to the sheltered estuaries in inner harbours such as Tamaki Estuary, Upper Waitematä Harbour, Whitianga, Whangapöua and Tairua Harbours.

Ecological and Biotic Systems

Ecosystems found along the coastline of the Gulf are influenced by a number of factors including the difference in wave

Table 7.2 Extent of development along the Gulf's coast.

Landform	Level of Development
Open coast beaches – Waikato	65 percent of all sandy beaches subdivided or partially subdivided.Subdivision close to the shoreline at many beaches over the past 30 to 40 years.
Waikato Estuaries	All major eastern Coromandel Peninsula estuaries have adjacent settlements. Scattered houses and lifestyle blocks around estuary margins. West Coast Coromandel Peninsula is less developed, though only Te Kouma Harbour is largely undeveloped.
Rocky and cliffed coasts - Waikato	Largely undeveloped, particularly in northern Coromandel Peninsula.
North Shore (Devonport to Okura)	88 % of the North-shore coastline is developed, and the remaining 12 percent is developed to some extent.
South East Coast Beaches	From Beachlands to just north of Kaiaua approximately 50 percent of the coastline has some form of development along it. Sixty-eight percent of beaches along this same stretch of coastline are developed either fully or partially.
Waitematä Harbour	Only 10 percent of the Waitematä Harbour coastline remains undeveloped.
Long Bay	Long Bay is the only remaining beach within the Auckland Metropolitan Urban Limits with dune formations, however even these have been significantly modified (although restoration work is now underway).

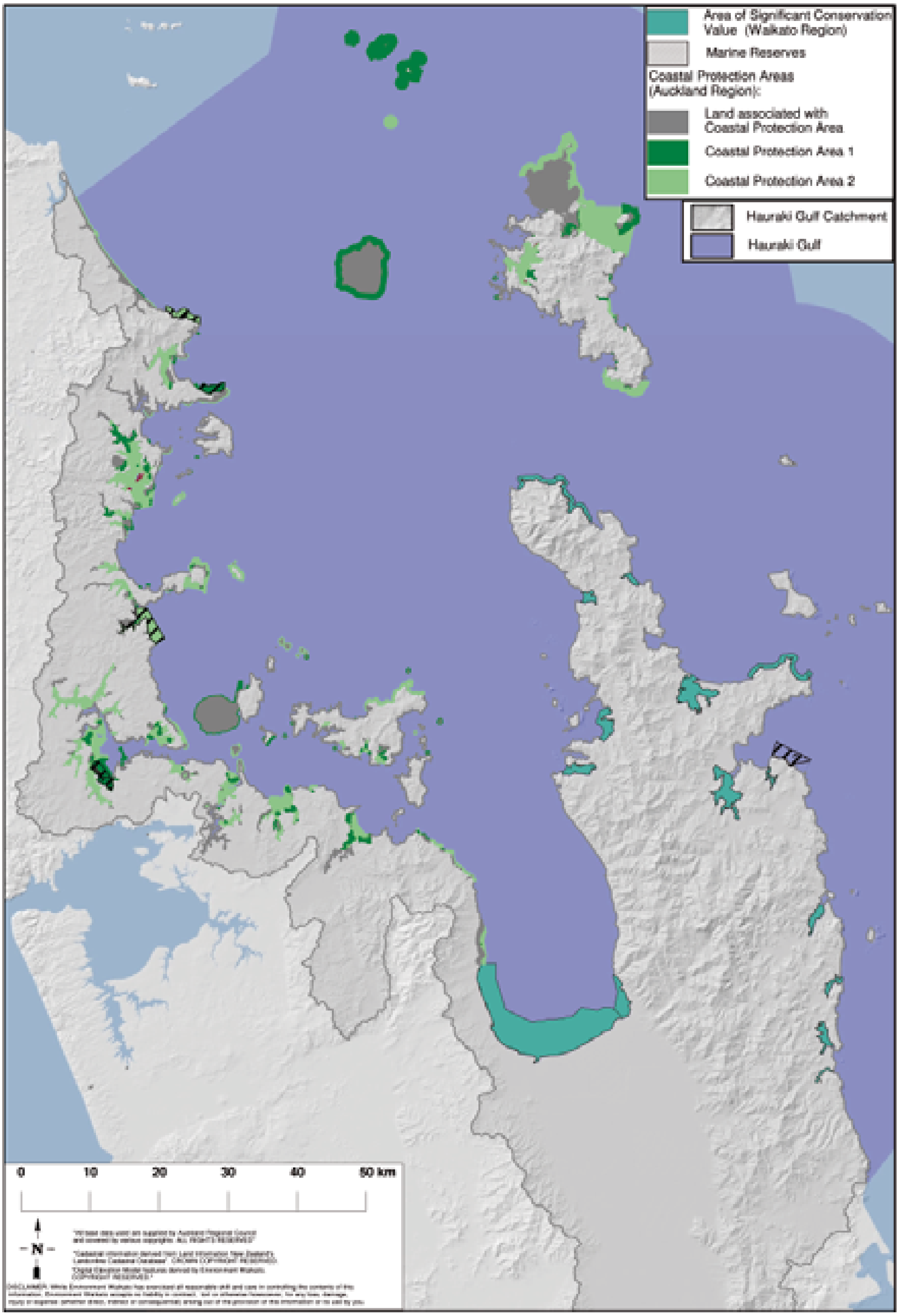


Figure 7.2 Coastal Protection Areas and Areas of Significant Conservation Value

action in exposed versus sheltered waters, the differences created by geology and substrate, and variable tidal and freshwater influences. These variations create a range of habitats which in turn support a rich array of marine species. This species diversity and variety of habitats is a key component of the natural character of the Gulf's coastal environment (see Chapter 6: Biodiversity).

The natural environment of the Gulf has been extensively modified. While detailed figures on the loss of coastal and marine communities are not available, modification is thought to have been extensive. The consequences of that modification now appear in the extensive loss of particular biological features and habitats and a reduction in ecological viability (ARC, 1999). Notwithstanding this, a number of areas in the Gulf have retained significant natural values.

Areas that are significant due to their ecological, landform or geological values are identified as Coastal Protection Areas or Areas of Significant Conservation Value (ASCV) (see Figure 7.2). These areas are afforded special protection in coastal planning documents. In all, there are over 110 Coastal Protection Areas or ASCV identified along the Gulf coastline. These include areas of regionally or nationally rare habitat types, significant ecotones (sequences) of coastal vegetation, key areas of unconsolidated shell and sand within harbours and estuaries used for bird roosting purposes, as well as regionally, nationally and internationally significant landforms and geological sites.

Indigenous Vegetation

Originally the Gulf's catchments would have been almost entirely covered in native forest (including kauri, rimu, taraire, tawa and pöhutukawa in the canopy), with wetlands and swamp forest (kahikatea) in the low-lying areas. At the coast the forest would have given way to saltmarsh and mangrove forest in tidal inlets and estuaries, with Pingao *(Desmoschoenus spiralis)* and Spinifex *(Spinifex sericeus)* on the sand dunes (Esler, 1991). However the indigenous vegetation of the Gulf has been extensively modified and reduced from its original state.

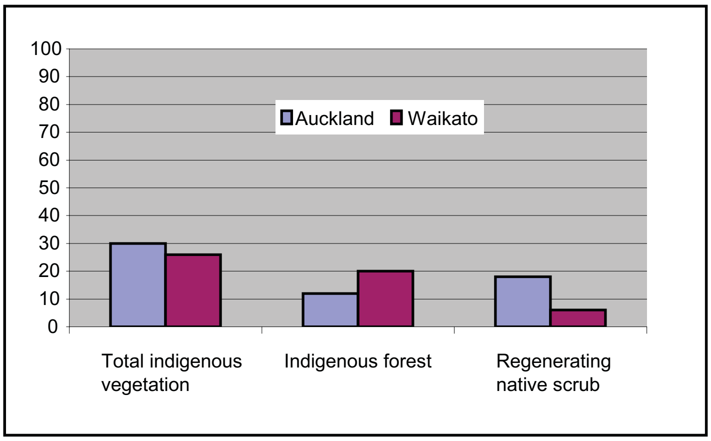


Figure 7.3 Percent of indigenous vegetation – forest and regenerative scrub[66]

Figure 7.3 shows the percentage of remaining indigenous vegetation within the Auckland and Waikato regions. Within the Auckland Region these areas are predominantly regional parks such as Tawharanui and Mahurangi, the Hunua Ranges, and off shore islands in the gulf including Great Barrier, Little Barrier and Rangitoto. Within the Waikato Region most indigenous vegetation occurs in the hill country, while in lowland areas only 18 percent of indigenous vegetation remains. It is notable that almost 60 percent of the Thames-Coromandel District is covered in terrestrial indigenous vegetation, much of it recovering from past clearances and logging.

An estimated 14% of the Auckland Region is in protected natural areas, including Department of Conservation reserves, local authority reserves and regional parks. However part of this lies outside the Hauraki Gulf catchment along the west coast of the region from Whatipu to Kaipara / South Head and the Waitakere Ranges. Remaining areas are predominantly regional parks such as Tawharanui and Mahurangi, the Hunua Ranges, and off shore islands in the gulf including Great Barrier, Little Barrier and Rangitoto. An estimated 45 % (270,000 ha) of the indigenous vegetation in the Waikato Region is protected as public conservation land. This equates to approximately 12 % of the region, a significant portion of which is in the Coromandel Peninsula.

[66] Statistics are on a region-wide basis and therefore include areas outside of the Gulf's catchment. For the Waikato Region, native scrub includes wetland, dune, geothermal and tussock vegetation.

Coastal Forest

Coastal forests, which include a rich mix of species such as pöhutukawa, puriri, karaka, kohekohe, kawakawa, taraire, kowhai, karo and other plants, were once common on lowland, cliffed and rocky coasts along the Gulf. However urban and rural development has been extensive and most of the Gulf's coastal lowland vegetation has been cleared for farming and coastal subdivision. Human induced changes mean that only fragments of coastal lowland vegetation remain.

Within the Waikato Region:

- In 1840, over 70 percent of the coastal bioclimatic zone (roughly the area within one kilometre of the coast and less than 300 metres above sea level) was covered in original forest. Today, less than five percent remains, most of this on islands off the Coromandel Peninsula.
- Excluding the islands, original forest now makes up only half a percent of the coastal bioclimatic zone.
- Areas of regenerating forest and scrub make up about 20 percent of the coastal bioclimatic zone. The regenerating forests are mostly in hilly areas and are threatened by land clearance, stock access and pests.

The Coromandel Peninsula retains significant areas of high quality forest, although little of this remains in coastal areas. The Moehau ecological area supports an almost complete altitudinal sequence of plant and animal communities from near sea level to sub-alpine conditions. Within the Auckland Region, examples of coastal forest remnants can be seen at Okura/Long Bay, Wenderholm, Tawharanui and Mahurangi Regional Parks and on the Gulf Islands.

Estuarine and wetland vegetation and habitats

The Gulf's estuaries contain a range of vegetation and habitat types. The margins of most estuaries originally included species such as manuka, kanuka, salt marsh ribbonwood, flax and cabbage trees. This riparian vegetation, which has an important role in buffering estuarine habitat from surrounding land uses, has now been eliminated from most harbour margins.

Intertidal vegetated habitats make up important proportions of the total area of many of the estuaries in the Gulf:

- Whangapöua Harbour on Great Barrier Island – over 60 percent
- Lucas Creek in the Waitematä Harbour, and Manaia, Whitianga, Whangamata and Wharekawa Harbours on the Coromandel Peninsula – 40-60 percent.
- Mangamangaroa Estuary, Otahu and Tairua Harbours – 20-40 percent.
- Okura Estuary, Te Kouma and Coromandel Harbours – less than 20 percent.

These habitats are an important component of the natural character of the Gulf's sheltered harbours and estuaries. Information from the past 40-50 years shows a number of important changes in different vegetated habitats have occurred in estuaries in the Gulf, including an increase in the area of mangroves, decreases in the area of seagrass and decreases in the amount of wetland areas around some estuaries (see Chapter 6: Biodiversity).

Sand dune vegetation

Duneland ecosystems cover about 50,000 hectares in New Zealand, most of which have been heavily modified by grazing, fires, drainage, coastal development and introduced trees and grasses (MfE, 1999). Sand dunes along the Gulf's coastline are no exception and have been highly modified since the earliest human settlement, with original dune vegetation significantly disrupted by human activity. Except for remnants and some regenerating areas, there are no remaining mainland examples of the full original plant sequence that once characterised dunes, nor are there any significant areas of coastal dune forest.

- Within the Waikato Region, 5790 hectares of coastal dune vegetation has been lost since 1840, a reduction of 98 percent. Approximately 129 ha of coastal dune vegetation remains. This equates to less than 1 percent of the region.
- Of the remaining dunelands, most are now relatively barren and degraded - over 70 percent in the Waikato are significantly modified. The percentage in the Auckland Region is not known,

however it is likely to be higher than 70 percent.

A national survey of New Zealand's sand dune and beach vegetation was carried out between 1984 and 1988 by the Botany Division of the Department of Scientific and Industrial Research (refer Figure 7.4). Dunelands were ranked according to four criteria:

- The diversity of their landforms
- The extent to which native sand plants were present including characteristic or rare dune species
- Degree of modification
- Degree of invasion by weed species.

Of the 33 beaches assessed along the Gulf's coastline from Te Arai Point to Waihi Beach, only five were identified as being priority one beaches indicating that they retain significant botanical value (i.e. total rating of 13 or greater)[67]. A further 24 beaches, which are not included on Figure 7.4, were identified as having no botanical value due to clearance of dune vegetation and modification to dune landforms. This highlights the degree of modification to dune systems that has occurred along the Gulf's coastline.

Pakiri Beach is particularly notable for its dune vegetation, dune lakes and wetland communities which are among our most threatened ecosystems. Otherwise, on the east coast of the Auckland Region, areas of high botanical value are limited to parts of Omaha Beach. On the Coromandel Peninsula, those dunes that have retained their botanical values tend to be in the remaining isolated areas where development has been restricted, particularly Waikawau Beach, Otama Beach and Hot Water Beach. Together they constitute an extremely valuable core of representative communities (Partridge, 1992). In other areas, such as Cooks Beach, dunes have disappeared entirely and their botanic value has been lost (see Figure 7.5)

7.4.3 Natural Character Assessments

While natural character is recognised as an important issue, it is clearly a difficult concept to come to terms with. Consequently only four specific natural character assessments have been undertaken within the boundaries of the Gulf, and landscape assessments tend to be used as a proxy for natural character. However while landscape is an important component of natural character, this overlooks the ecological and physical aspects of natural character.

The natural character of the coastal environment of the Gulf is complex and variable. However in the assessments undertaken to date, the less modified or undeveloped nature of the coastline has been a key component in the high natural character rating attributed to the sites. As such, the presence of rural land and parkland or open space adjacent to the coast of the Gulf indicates land that may be less modified or developed. Approximately 24 percent (215 km) of the coastline adjoining the Gulf in the Auckland Region is zoned rural[68]. Within Thames Coromandel, approximately 53 km or 9 % of the coastline is identified as being urban coastline[69].

7.4.4 Landscape Values and Visual Amenity

Amenity values are the natural and physical characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes. As such, the visual and scenic qualities of coastal landscapes and seascapes are important indicators of visual amenity.

The Gulf's coastal environment has many diverse landscapes. The important landscapes within the Auckland and Waikato Regions encompass much of the coast and the islands of the Gulf. The presence of features such as indigenous vegetation, prominent landforms such as dune systems, peninsulas, points, and combinations of land and seascapes contribute to the value of important landscapes. Significant landscapes also include geological features that are noted for their scientific, educational and aesthetic importance. Volcanic cones such as Rangitoto and Mt Victoria at Devonport are prominent icons within the inner Gulf.

[67] Total rankings give an indication of those areas with the greatest botanical value. However, shortcomings with the ranking system are identified by MfE (1999) who conclude that the survey probably understates the ecological importance of many dunelands. It should be noted also that this study was undertaken over 15 years ago. In the past 15-20 years there has been significant changes, particularly development, along the Gulf's coastline.

[68] This figure excludes off-shore islands.

[69] From Statistics New Zealand Census 2001

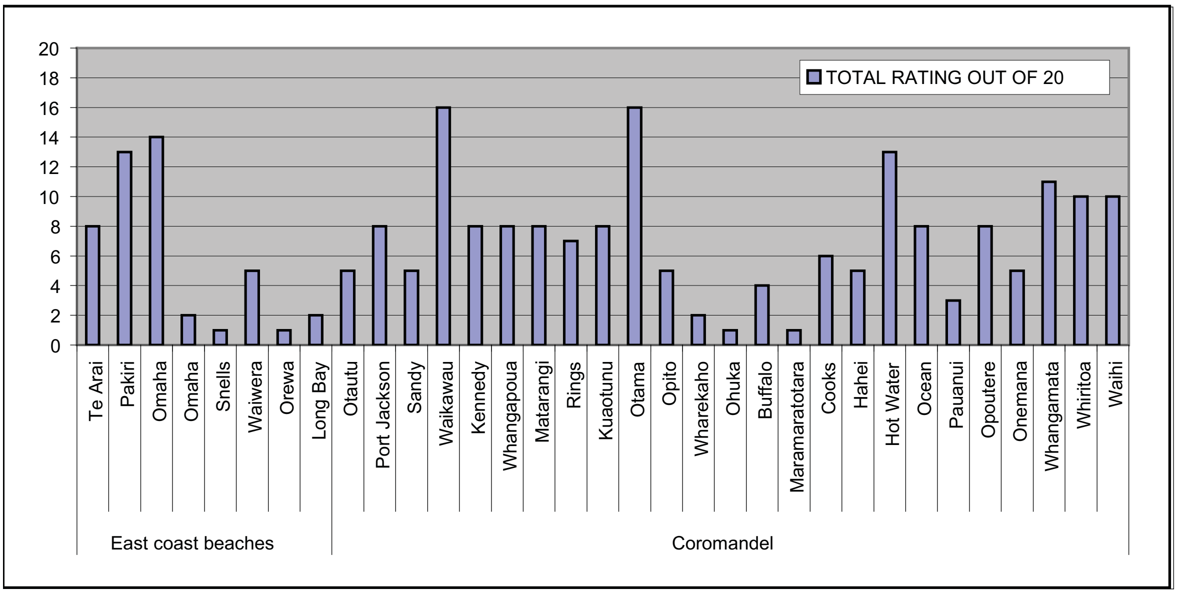


Figure 7.4 Sand dune and beach vegetation inventory

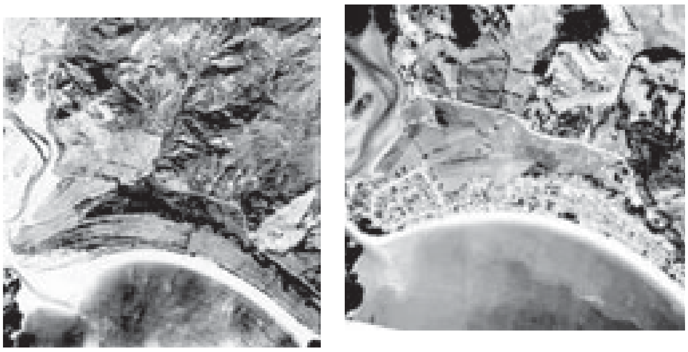


Figure 7.5 Comparison of dunes at Cooks Beach 1940 and mid 1980s

Box 7–5

Coromandel Peninsula Landscape Assessment

In the context of the landscape assessment undertaken for the Coromandel, a number of characteristics were found to constitute the outstanding natural features and landscapes of the District, including: headlands and peninsulas, scarps and cliffs, stony shoreline with tapering foothills, rocky Coastline, bays, dunelands and spits, estuaries, inlets, harbours and tidal Bays with small headlands. This comprises the entire coastal environment, excluding settlement areas.

While this study identified and categorised landscapes, no value was attributed to them. The Environmental Defence Society concluded that: "The coastal areas of the Coromandel Peninsula are under high pressure for the development of holiday homes. . .[However] important landscapes have yet to be identified and are not well protected" (Peart, 2004).

Ongoing development means that some types of landscape are becoming increasingly rare, e.g., relatively intact dune systems at Pakiri and Tawharanui, unmodified estuaries such as Whangapöua. They are important for scenic qualities as well as being representative examples of landform and landscape heritage. In addition, there is a strong correlation between 'naturalness' and landscape quality and sensitivity. Those parts of the coastline that are least touched by development have higher scenic value and are also increasingly rare.

The coastline of the Gulf within both the Auckland and Waikato Regions has been assessed in terms of landscape values. Within the Auckland Region, lengths of coastline of highest quality or landscape sensitivity have been assessed as being either Outstanding or Regionally Significant Landscapes (see Figure 7.6a). These include some of the recognisable icons of the region such as North Head, Tamaki Drive and the Auckland Harbour Bridge, while in the non-urban parts of the coastline the elements, features, and patterns which contribute to the area's landscape value are normally characterised by high levels of naturalness. In all, 908 km, or 55 % of the Auckland Region's Gulf coastline is specifically identified as having significant or outstanding landscape values.

Table 7.3 Natural Character Assessments

Report	Outcome / key natural character features
Draft report on north-eastern Rodney District from Maungawhai Beach to south of Waiwera (Stephen Brown Environment Ltd, 2004).	Identifies significant stretches of coastline as having outstanding or high natural character values including: Regional Parks – Tawharanui, Mahurangi, Wenderholm; Points such as Takatu Point, Ti Point, Cudlip and Karangatuoro Points; Goat Island Marine Reserve;Pakiri and Maungawhai Beach. High values are also attributed to a number of inner harbours and estuaries.
Covers northwest corner of Firth of Thames (Boffa Miskell, 2002) To assist in defining Aquaculture Management Areas. Ecological component specifically excluded.	The natural character of the Firth varies between high in two landscape units, to moderate/ high in seven landscape units, and moderate in one landscape unit. The two higher ranks at Tawhitokino and Matingarahi Point reflect the lack of road access to Tawhitokino and the relatively high natural character associated with the indigenous vegetation near Matingarahi Point. The overall natural character was found to be moderate to high which reflected the "relatively small scale nature of development in this area, including roading and settlements, the pastoral setting with some areas of indigenous vegetation, and the relatively unmodified foreshore and waters".
Firth of Thames in the Waikato Region (Brown, 1996)	Factors positively influencing natural character were views connecting a repeating series of headlands, peninsulas, sandspits and islands. Factors that were found to negatively influence natural character ratings concern the lack of bush cover in open sections of the coast. Settlements, structures and roads were found generally to be collectively visually integrated and subdued by the dominant coastal landform backdrop with some exceptions (e.g., settlement of Thames). Identified four areas of high natural character: The Firth Estuary – No visible shoreline modification. Extensive natural patterns formed by mangroves and mudflats. Ruamahunga – Distinctive character is owed to continuous bush clad mountains extending to the shoreline, only isolated settlement, numerous rocky headlands. Manaia Te Kouma Coastline – Diverse indented shorelines, irregular shaped peninsulas and headlands, extensive mudflats and large portions of land covered in regenerating bush. The Motukawao Islands – Contributes to high interest views from the mainland north of Coromandel township. This seascape rates highly for natural character when seen from the mainland and at close quarters.
Natural Character Assessment – Eastern Tamaki Strait/Waiheke Channel (Boffa Miskell 2004) To assist in defining Aquaculture Management Areas. Ecological component specifically excluded	The natural character along the southern and eastern coast of Waiheke was found to be moderate/high overall. The high score attributred to Man'o War Bay reflects the relative lack of development and the extent of indigenous vegetation. These attributes also contribute to the localised increase in natural character at Whakanawha Regional Park. The moderate natural character of north Putiki Bay is due to the extent of development. Recent construction of rural residential development and associated tracking fencing, boat ramps and jetties is evident around the Waiheke coastline, especially towards the western part of the island. The natural character of the string of islands from Pakatoa to Pakihi was found to be moderate/high overall. Only one unit, Karamuramu and Pakihi was ranked as low due to the highly modified quarried landscape of Karamurmu island and the pine covered working landscape of Pakihi. The overall natural character of the mainland coastline from Ruakura Point to Whakakaiwhara Point was moderate/high. Clustered settlements, roading and cultivation within the bays are contrasted with a lack of development on the headlands and peninsulas.

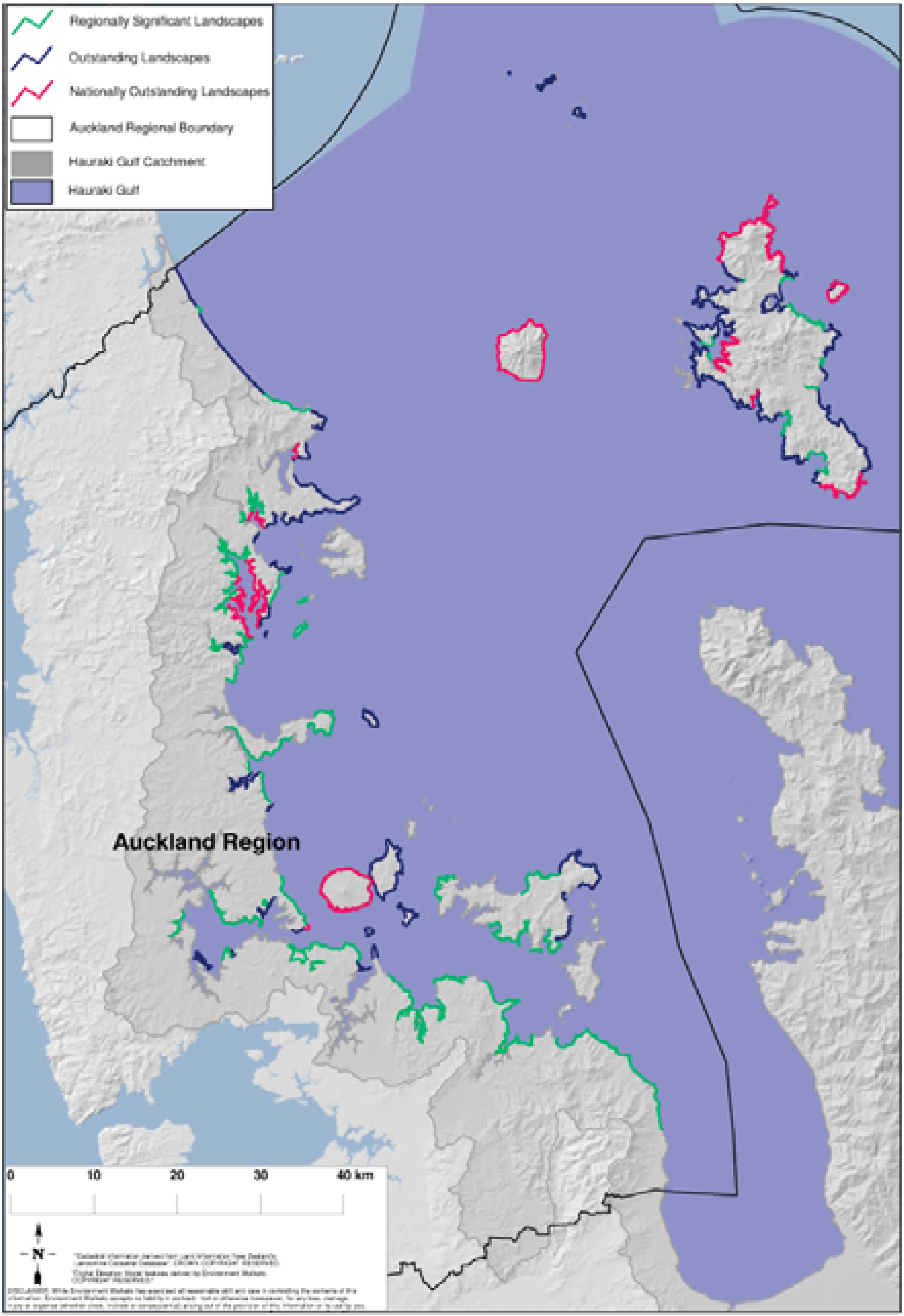


Figure 7.6a Significant and outstanding landscapes of the Auckland Region

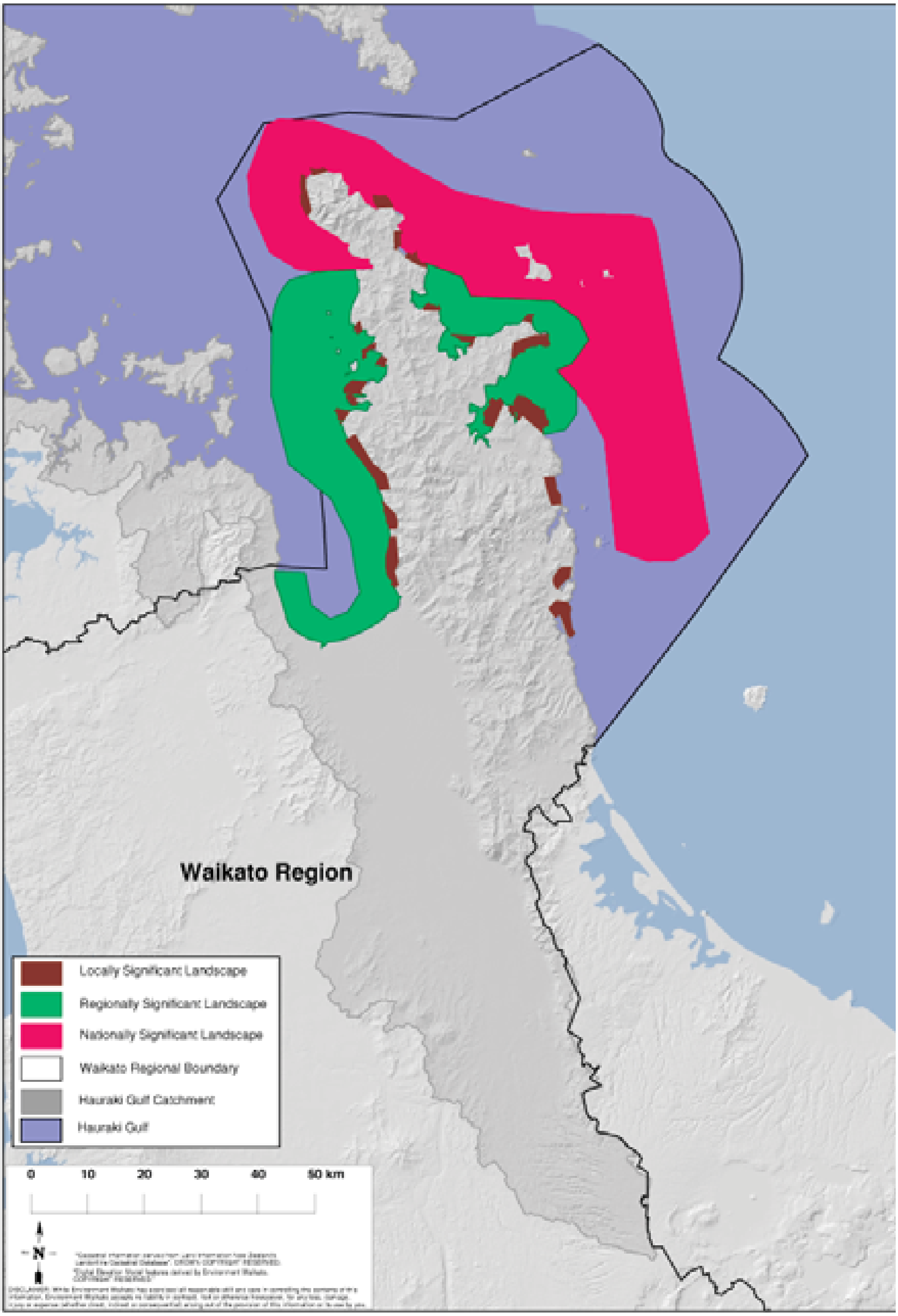


Figure 7.6b Significant landscapes of the Waikato Region

Within the Waikato Region, the coastline of the Gulf has been identified as being either Nationally, Regionally or Locally Significant. The Firth of Thames and eastern Coromandel beaches are identified as Regionally Significant, while the northern most part of the Coromandel Peninsula and surrounding off shore islands are classified as Nationally Significant Coastal Environments (see Figure 7.6b).

7.5 Pressures on Natural Character

Coastal environments in the Gulf have been and continue to be impacted by subdivision, use and development. In many beach locations coastal dunes have been modified to provide for roads, building platforms and development, and back dune vegetation has been largely eliminated or replaced with introduced or ornamental species. Housing has been built close to the coastline to take advantage of views and maximise commercial return. Little account has been taken of dynamic coastal processes such as erosion and accretion, and the natural protection mechanisms of coastal dunes and native sand binding plants have been lost.

Small harbours and estuaries are in demand for marinas and mooring areas. These coastal areas have been and continue to be impacted by both diffuse and point source discharges, loss of riparian vegetation and the introduction of plant and animal pest species, and development in surrounding catchments which has resulted in increased sedimentation and run-off. Further subdivision, use and development will continue to erode natural character and its elements (ARC, 1999).

Currently the biggest pressures facing the natural character of the Gulf's coastal environment include:

- Coastal subdivision and development
- Coastal structures
- Catchment land use (see Chapter 5: Water Quality)
- Introduced plant and animal pests (see Chapter 6: Biodiversity)
- Demands for recreational space (see Chapter 9: Access).

7.5.1 Coastal subdivision and development

Coastal subdivision and development is the main pressure affecting the natural character of the Gulf's coast. Nowhere is the pressure greater than in the Hauraki Gulf. With two of New Zealand's major urban areas and some of the country's most productive farmland within an easy drive of the coast, demand for coastal property and second or holiday homes is high. This is reflected in the amount of building activity within 1km of the coast (see Figure 7.7). Of some note is the trend for the proportion of all building that occurs near the coast to have remained relatively static over time. This suggests that coastal land has continued to be made available for

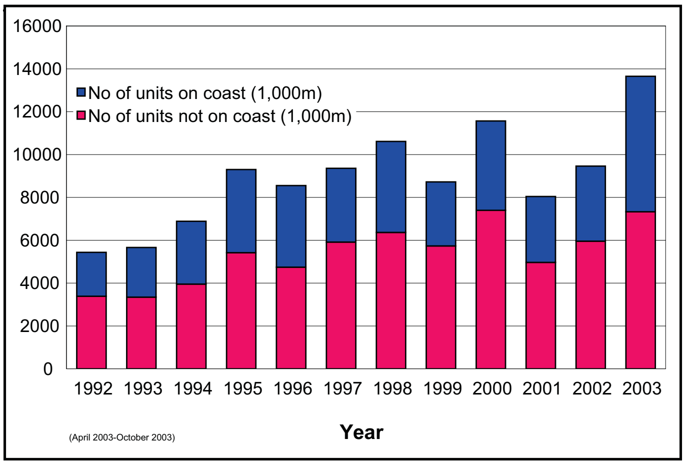


Figure 7.7 Number of units built within 1 km Gulf coast of the Auckland Region

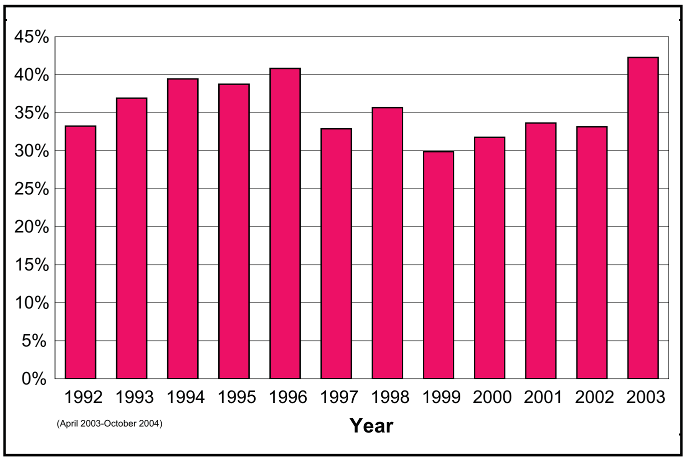


Figure 7.8 Proportion of buildings built within 1km of the Auckland Region's Gulf coast

development in response to demand (see Figure 7.8).

Demographic projections indicate population and household trends which influence the demand for and provision of housing and supporting infrastructure such as stormwater and roading. As Auckland's population grows, increased pressure is placed on natural and physical resources. In addition to new development, the increasing density of Auckland's urban area will inevitably place further pressure on the coastal environment. This includes further loss of natural character and landscape values.

7.5.2 Development setbacks

Table 7.4 sets out housing setbacks along parts of the Gulf's coastline (see Figures 7.9 and 7.10). While factors such as screening and landscaping, typography, and colour schemes all play a part, as a general rule of thumb the closer development is to the coast the more it will impact on natural character values.

7.5.3 Coromandel Peninsula: A Case Study

Coastal subdivision has been particularly significant along the eastern Coromandel Peninsula where over 70 percent of the beaches and dunes now have houses on them, many of which are holiday homes[71]. Pressure for subdivisions, marinas and other developments is also significant around the main estuary systems on the east coast of the Coromandel.

As one of the areas most in demand, the Coromandel Peninsula has experienced significant increases in prices. Between 1982

Table 7.4 Development Setbacks

Area of Coast	Average Minimum Setback	Average Common Setback[70]
North Shore Beaches	12m	28m
Waitematā Harbour Coastline	20m	50m
Beachlands – Maraetai to just north of Kaiaua	12m	32m
Northern East Coast Beaches	12m	26m

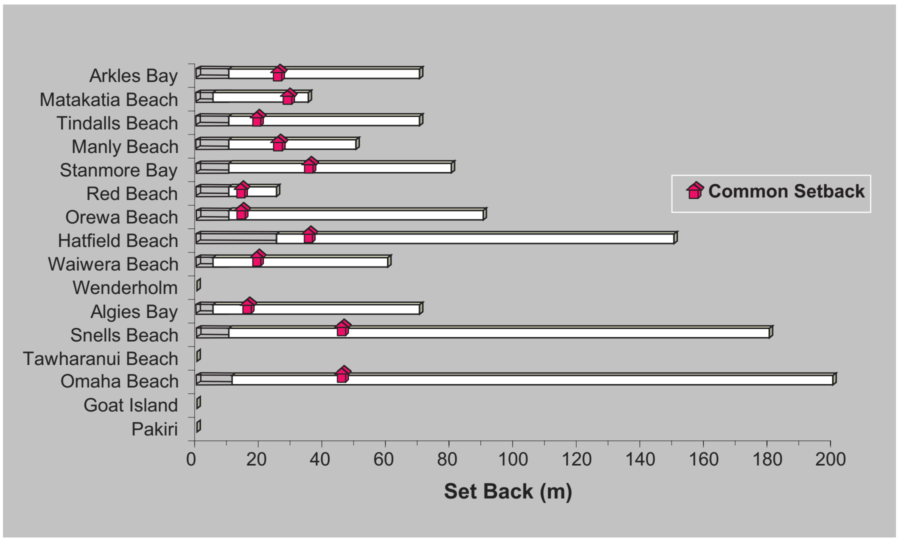


Figure 7.9 Set back along northern beaches

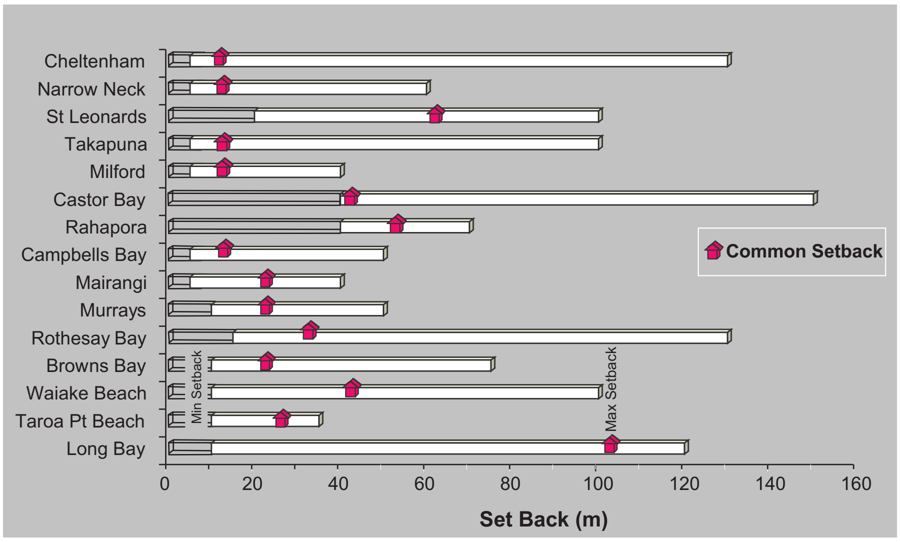


Figure 7.10 Set back along North Shore beaches

[70] Setbacks from edge of building to line of dune vegetation or seawall as measured off 1999 aerial photography. Average common setback based on measurements and a visual assessment of aerial photography.

[71] On the 2001 census night, 44.5 per cent of dwellings were unoccupied indicating the large proportion of holiday homes within the Thames-Coromandel District

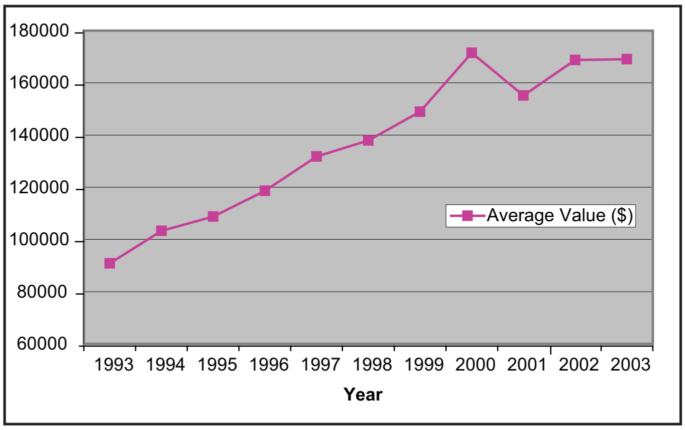


Figure 7.11 Average value of new buildings in the Thames Coromandel District

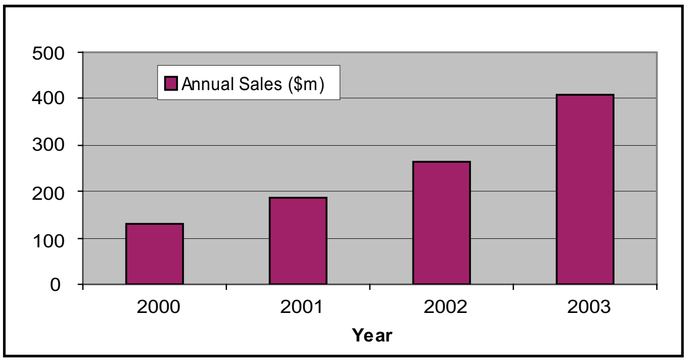


Figure 7.12 Annual sales in the Coromandel

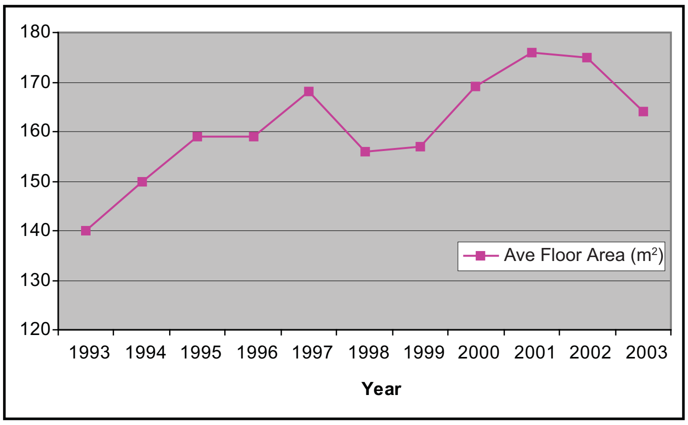


Figure 7.13 Average floor area of new buildings in Thames Coromandel District

and 2001, properties in the Coromandel increased in value by an average 2,000 to 2,500 per cent (Milne, 2003) (see Figure 7.11). Property sales on the peninsula have more than trebled in the past four years (see Figure 7.12). Tairua is expected to increase in size by more than 25 per cent when a subdivision restriction is removed in the next few years. Developers already have plans for up to 400 new sections in the holiday town, increasing the number of homes by 30 per cent. In Whitianga the permanent population is set to almost double by 2020. Within three years another 600 apartments will be added to the town's 2400 or so dwellings. This pace of change means development is difficult to control (NZ Herald, 6-8 July 2004, A7).

Development is extending along the coastline resulting in the intrusion of large buildings into natural areas. As Figure 7.13 below depicts, the average size of houses shows an increasing trend as demand moves from bach-type buildings to larger houses and 'holiday villas'.

Ongoing subdivision pressures threaten most of the remaining undeveloped Coromandel beaches and will intensify at existing settlements. For example, New Chums Beach and Kereta, two outstanding undeveloped beach areas have been sold for development. Waikawau and Otama Beaches on the Coromandel Peninsula are two of the few sites that are protected from coastal development.

7.5.4 Coastal structures[72]

Structures are generally placed in the coastal marine area in order to enable people and communities to use the coast for a variety of commercial and recreational activities. These include structures such as wharves, jetties, breakwaters, moorings, groynes, ramps, slipways, seawalls, cables and pipelines, marine farms, marinas, bridges, reclamations and causeways. Within the Gulf there is also high demand for coastal space to be used for aquaculture. Coastal structures have the potential to individually or cumulatively alter physical coastal processes, disrupt ecosystems and impact on amenity and landscape values. As such, structures detract from the natural character values of an area.

Many of the beaches have been affected by coastal structures such as shoreline protection works, groynes and storm water outlets and there continues to be significant pressure for the development of more structures (see Figure 7.14). Within the Waikato Region there more than 1,953 known coastal structures located along the Gulf's shoreline: 833 along the eastern Coromandel Peninsula and 1120 along the western peninsula and Firth of Thames.

[72] ARC coastal structures information is based on number of consents (coastal permits) issued. This data is therefore under-representative as unauthorised structures are not included. Environment Waikato information is based on a field survey undertaken in 1994/95.

Figure 7.14 Comparison of Buffalo Beach before and after coastal protection works

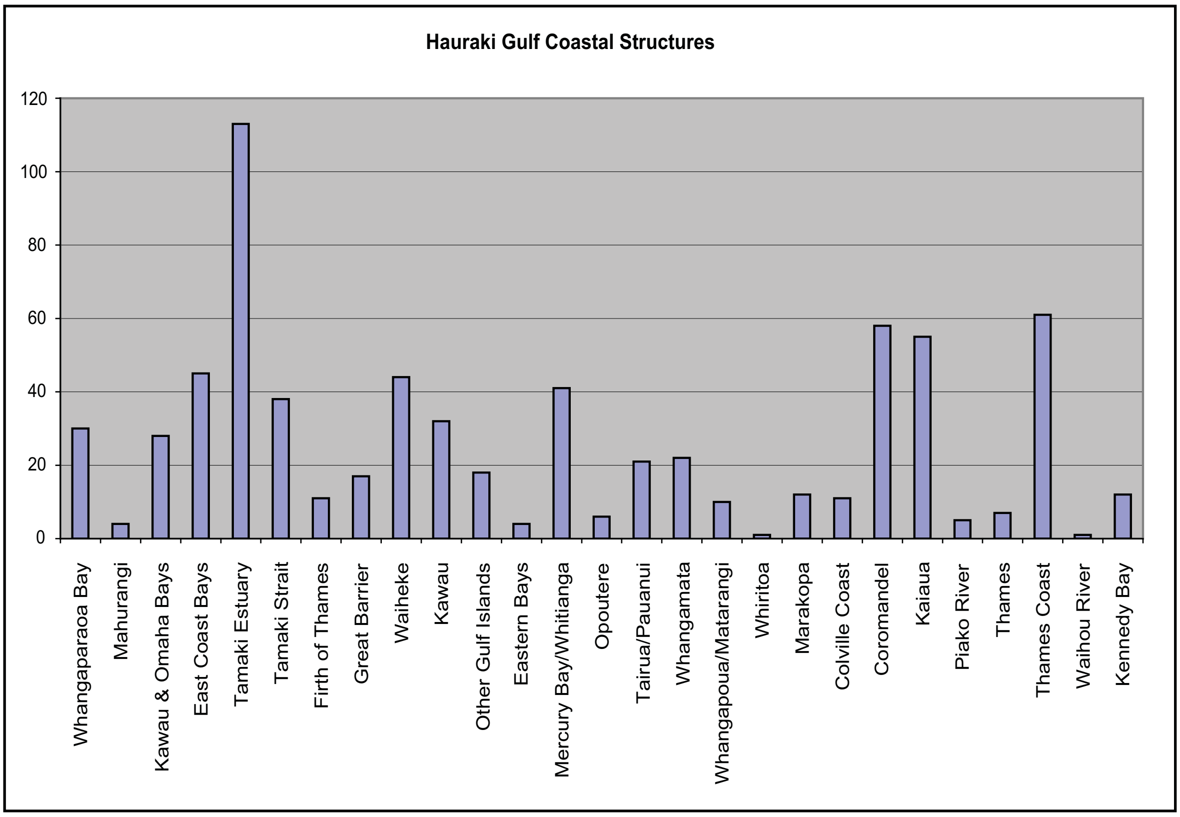
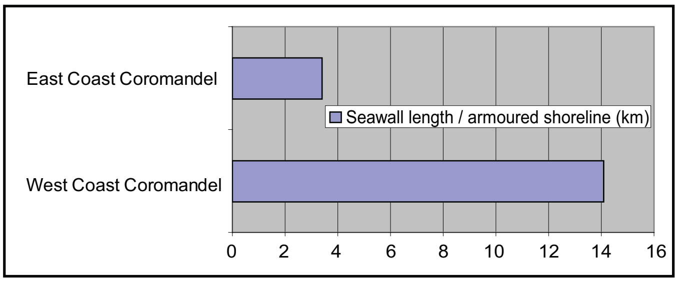


Figure 7.15 Coastal Structures in the Gulf[73]

The ARC has records for 796 coastal structures along the Gulf's coastline occupying a total area of approximately 180 hectares (see Figures 7.15 and 7.16). However the actual figure is significantly greater than this taking into account the large number of unauthorised structures in the region.

In the future, sea level rise and other likely changes caused by climate could alter the stability of many beaches and cause a long-term recession trend (see Chapter 10: Coastal Hazards). Responses involving coastal structures such as seawalls and revetments would further impact on natural character values associated with the coast.

[73] ARC information includes consents for all coastal structures. Environment Waikato information covers coastal protection structures only.



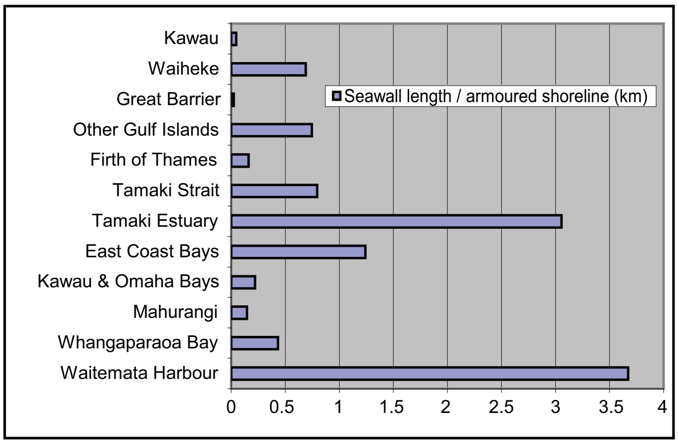


Figure 7.16 Armoured shoreline of the Gulf

7.6 Responses to Pressure on Natural Character

Responses to Forum Actions

- **The Forum will promote public awareness and appreciation of natural character and landscape values of the Gulf, islands and catchments.**

Individual constituent parties have promoted public awareness and appreciation of natural character through various planning processes. Collective action by the Forum has been limited and awaits implementation of its communication strategy.

Other Responses

In addition to the projects and programmes that the Forum undertakes, individual Forum members have undertaken a range of initiatives.

7.6.1 Managing growth

The Auckland Regional Policy Statement (ARPS) recognises that the region will need to accommodate continued growth and development, but also that urban development in the region threatens environmental values. Policies direct that provision be made for countryside living in the region in a coordinated manner. The ARPS also directs that 'urban development' shall be contained within the Metropolitan Urban Limits (MUL) and its form shall be planned and undertaken through an integrated process on a regional basis and in ways that are consistent with the strategic direction in the ARPS (i.e. provided for through structure planning or similar processes).

The ARC and territorial authorities have collaborated on a range of initiatives to ensure the potential effects of land use intensification are adequately considered and understood prior to management decisions being made. The major focus of these initiatives has been on catchments with sensitive receiving environments where land use intensification has been identified as likely to occur in the near future (e.g. Okura and Mahurangi).

The Auckland City Council has identified areas of change and recently mapped these as *Growth Management Areas* in order to more effectively manage the effects of growth.

In order to better manage growth at the regional level, the regional and district councils have formulated the Auckland Regional Growth Strategy: 2050 ("RGS"). This strategy identifies the key growth related issues and defines outcomes to provide a consistent and uniform direction for how Auckland's growth would be managed for the next 50 years. The RGS describes a growth concept for the region for the next five decades and provides for the preparation of plans for sectors of the region as an intermediate level between the RGS and locally focused structure planning.

7.6.2 Managing coastal activities

Coastal activities within the Gulf are primarily managed through the resource consent process. This process is established by district and regional planning documents, environmental monitoring results, and a number of non-statutory documents for example best management practices and coastal management plans.

The Coastal Hazard Strategy and Coastal Erosion Management Manual *(refer Chapter 10: Coastal Hazards)* provides guidance on coastal hazards including soft and hard options to mitigate coastal hazards where they exist.

In response to significant pressure on coastal space for aquaculture at various locations within the Gulf, particularly the Firth of Thames, the regional councils have commissioned marine farming investigations within the Firth of Thames, Tamaki Strait and western coast of the Coromandel Peninsula. Aquaculture variations have been proposed to regional coastal plans with a view to providing for aquaculture within Aquaculture Management Areas that have been defined by way of appropriate size, location and management to avoid, remedy or mitigate adverse effects.

7.6.3 Coastal development and land use intensification

District plans are the main mechanism for controlling subdivision and development and the impacts this may have on landscape and natural character values. For example:

- Waitakere City Council manages natural character and landscape through the District Plan, and in particular through objectives, policies and rules associated with the plan's Natural Environment overlay.
- North Shore City Council has undertaken a general landscape study along with more detailed assessments for particular areas (e.g. Okura and Long Bay). The application of a building set back or foreshore yard as a buffer between the coastline and development is a key component of the council's approach. In addition to this, natural environment rules control earthworks, buildings and structures in the Coastal Conservation Area to protect natural coastal character.

Some local authorities have imposed development setbacks which restrict the proximity of buildings to the coastal edge. Thames-Coromandel District Council has revised development setbacks for Coromandel Beaches. These setbacks include an allowance for natural character and amenity values in undeveloped areas.

Manukau City Council has recently undertaken the Whitford Study and draft plan change. The purpose of this study was to assess and define rural character and consider the capacity to have further development. An ecological and natural heritage assessment was completed as part of this study. The draft plan change is to address the pressure to allow greater rural-residential development by delineating rural character areas and defining appropriate development in these areas.

The Franklin District Council has adopted *The Franklin District Growth Management Approach*" ("DGMA") which recognises the need to focus growth on existing settlements. The Rural Plan Change supports this approach and proposes a comprehensive replacement of the existing sections relating to rural areas in the Operative District Plan, providing for development in a structured manner that supports nodal growth. A Coastal Zone has been created to recognise the particular characteristics and sensitivity of the coastal areas to potential adverse effects emanating from certain activities and the need to protect and enhance the environmental quality and coastal character.

Coastal Compartment Management Plans also provide specific provision for management of natural character. For example, Rodney District Council has proposed a series of Coastal Compartment Management Plans (38). Currently two have been completed (Omaha and Leigh-Ti Point) and two are in draft form (Whangaparaoa North and Algies Bay).

7.6.4 Landscape assessments

The state of landscape and visual amenity values of the coastline of the Gulf has been addressed in a number of landscape assessments as set out in Table 7.5:

Table 7.5 Landscape assessments for the Gulf coastline

Title	Date	Council	Coverage
TCDC Landscape Resource Evaluation	1997	Thames-Coromandel District Council	Coromandel Peninsula and Range and includes a small portion of the Hauraki Plains.
Greenhithe Albany & Okura Structure Plans Landscape Assessment	1995	North Shore City Council	Greenhithe, Albany, Okura
Landscape Assessment	1994	ARC	Great Barrier Island and Waiheke Island
Coastal Landscape Assessment	1994	Environment Waikato (assessment criteria based on the revised Draft Conservation Management Strategy for the Waikato Conservancy)	Broadbrush assessment for the Waikato region coastline.
The North Shore Visual Landscape Study	1992	North Shore City Council	Whole of the North Shore City.
Landscape Assessment	1984	ARC	Entire Auckland Region
Landscape Assessment		Waikato District Council	Broadbrush report on landscape values for the district.

A landscape assessment was also undertaken by Rodney District Council as background to the revised provisions for rural areas (Plan Change 55). Landscape and Geologically Significant Sites are provided for in the Proposed District Plan. In rural areas, zones have been identified to protect highly valued landscapes. There is also a Landscape Protection Rural Zone applicable to the coastline, dunelands and inland backdrop from Maungawhai to Pakiri. In urban areas, highly valued landscapes are protected through the low intensity landscape protection zone.

7.6.5 Open space and natural values

Parks and reserves

ARC manages an extensive regional parks network which contains regionally and nationally significant heritage resource including coastal forests at Tawharanui, Wenderholm and Shakespear Regional Parks on the Gulf.

City and district councils also hold and manage many coastal reserves. Further detail is provided in Table 8.8.

Marine Reserves, established under the Marine Reserves Act 1971 provide for the preservation of marine habitat in its natural state and are another mechanism for preserving and protecting the natural character of the Gulf's coastal marine area. Within the Gulf, there are six reserves which cover 4526 hectares or 0.33% of the area of the Gulf. In addition to these reserves, there is a no-take Marine Park at Tawharanui (350 ha) and plans for several more reserves including Tiritiri Matangi Island, the Firth of Thames, and Whangaparaoa on the east coast of Great Barrier Island.

Partnership Programmes

Environment Waikato's Natural Heritage Partnership Programme was launched in September 2004. The programme is funded by a rating levy of approximately $6 per property. This will raise around $800,000 annually which will be used to support and assist district councils, community groups and non-profit organisations in protecting natural values and areas. Currently Environment Waikato is investigating various options for preserving part of Te Kouma Peninsula through the programme in partnership with the landowner.

Support for Community Initiatives

Both regional councils and a number of the city and district councils within the Gulf's catchment support the Coastal Dune Vegetation Network which promotes research and information transfer about the restoration of indigenous vegetation species.

Community based approaches including BeachCare and CoastCare initiatives are supported by the regional councils and a number of district and city councils. Initiatives including planting of coastal plants, removal of invasive exotic species, installation access ways and signage. In all, there are 15 BeachCare groups along the Gulf's coastline.

Landcare Groups also contribute to maintaining and restoring the natural character of the coast through catchment management. There are also a number of other community and school-based groups that undertaken restoration and enhancement works along the Gulf's coastline.

Table 7.6 Beach Care groups in the Gulf

Location	BeachCare and CoastCare Groups
East Coast Coromandel	Whiritoa, Whangamata, Pauanui, Tairua, Whitianga and Kuaotuana.
Gulf Islands	Onetangi, Medlands, Awana, Palm Beach
Auckland	Whangateau HarbourCare, Pakiri Taumata B, Omaha, CoastCare Rodney, Long Bay

Box 7–6

Long Bay Dune Restoration Project

Long Bay is an east coast beach situated on the North Shore approximately 20km from Auckland City centre. As well as being an ARC regional park, it adjoins the Long Bay Okura Marine Reserve administered by the Department of Conservation. The landscape of Long Bay has been modified by clay capping of much of the original dune system and the introduction of exotic species. The remnant dunes at Long Bay comprise the only dune system remaining on the North Shore.

The Long Bay dune restoration project commenced in 2000 with the planting of 200 Spinifex plants by CoastCare volunteers. Since this time the clay cap has been progressively removed and over 3000 native sand-binding plants (Spinifex and Pingao) have been planted. These plants are an important component of the natural functioning of dune systems and provide habitat for native fauna. In addition to this, they make a significant contribution to amenity and landscape values. The Long Bay dune restoration project is an example of the restoration and enhancement of the natural character of the coastal environment in an urbanised and high-use area.

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8 Access to the Gulf

Key Points

- 58% of the 2500 km long Gulf coastline is adjacent to publicly owned land or road. It is not clear how much of the coast is actually accessible for the public.
- Beaches and coastal areas are important recreation spaces for a large proportion of the population. There are at least 104 playgrounds and 267 public conveniences / changing sheds around the Gulf. There are around 70 – 100,000 boats accessing the Gulf, utilising over 11,000 moorings or marina berths and at least 169 public boat ramps. Around 16% of households own a boat.
- The numbers of people accessing coastal reserves, walking tracks and islands have generally increased in recent years. Satisfaction with coastal areas appears to remain high.
- The key pressures on access are increasing population, rising property prices and changes in coastal communities. These trends are making it harder to improve access opportunities, causing loss of access facilities such as camping grounds, and adding to disputes over access.
- Environmental pressures such as erosion and the spread of mangroves and oysters are decreasing public access values.
- Public access is placing pressure on environmental, cultural and amenity values and creating conflict with other access users.
- Responses involve a range of actions by Forum members including: regulations and numerous policy documents and spending millions of dollars buying land for new reserves and the provision of access facilities.

8.1 Introduction

Access to the coast is one of the key reasons why people live around the Gulf and why tourists visit the area (ARC 2004). Recreation, commercial activities and community well being all depend on access to the Gulf. However, the extent of available access and the pressures created by an increasing population are not well understood. The Forum has identified access and recreation as values of the Gulf and has developed a series of strategic issues and objectives for the Gulf (see Box 8–1).

Evaluating the state of public access to the Gulf involves considering the different types of access involved. Access includes the ability to get to, and move about, the waters of the Gulf in boating activities such as sailing and fishing. It includes access to the beaches for swimming and relaxing, and access to land adjoining the Gulf for recreation such as walking and camping. Providing for public access to the Gulf requires not only physical access to the coastline, but also provision for a range of experiences in different types of coastal environment (e.g. wild isolated coasts and urban beaches), providing for different interests (e.g. commercial and customary use, fishing and sailing, visitors and residents), and providing facilities and information that allow or encourage access (e.g. walkways, boat ramps, carparks and signs). In some areas it is important not to allow public access in order to protect cultural and environmental values or for public safety.

Access is particularly significant for recreational purposes because it is one of the largest areas of open space in the Auckland and Waikato regions and is within a day-trip distance of over half of New Zealand's population. Many people live close to the Gulf and also holiday within the Gulf catchment at such places as the Coromandel, Pakiri or the Gulf islands.

Commercial activities dependent on access to the Gulf include those related to tourism, transport and fishing. The Auckland Region currently receives about 22 percent (24.2 million) of New Zealand's

Box 8–1

Strategic Issues and Objectives

The major issues identified by the Forum relating to recreation, tourism and access in the Gulf are:

- The Gulf is the largest area of public open space in the region. Use and development of the coastal environment has the potential to alienate this space and restrict public access to coastal areas including the land and waters of the Gulf.
- Increasing demand for access to the Gulf places greater necessity for facilities to minimise adverse effects on the environment and people's enjoyment of that environment.
- Management of access to the coast is a joint responsibility of regional and local authorities, which if not effectively integrated, may result in gaps or overlaps in management resulting in inconsistency and confusion.
- Tangata whenua perspectives and values in specific areas are inadequately presented and promoted. Recognition of tangata whenua relationships to specific areas, for instance in the form of pouwhenua or place names, are not planned for or sufficiently resourced.
- Visitor and public access to the Gulf can compromise customary rights and taonga, including waahi tapu and mahinga mataitai used and valued by tangata whenua.
- There is a lack of awareness of navigation and safety controls and foreshore controls.
- Different rules for navigation safety in different parts of the Gulf, enforced by numerous agencies can result in confusion and in low levels of compliance.
- There is a lack of integrated management of marine mammal tourism initiatives.

The Forum identified the following objectives for recreation, tourism and access in the Gulf:

- A network of public access facilities provides appropriate access to the full range of Gulf sites from typical to unique.
- Public facilities are provided in such a manner as to support and enhance the values and understanding of the Gulf, its resources and its people.
- Presentation and promotion of tangata whenua perspectives and values and the recognition of tangata whenua relationships to specific locations is resourced and provided to the satisfaction of tangata whenua.
- Customary rights and taonga used and valued by tangata whenua are protected from impacts of visitor and public access to the Gulf.
- The Gulf is internationally recognised as a coastal recreation and tourism destination.
- The water and foreshore areas of the Gulf are managed in a safe and orderly manner and compliance with navigational rules, regulations and bylaws is high.

total tourism visitor nights (106 million). These are predicted to increase by 45 percent by 2009 – significantly more than their increase nationally (29 percent). Commercial transport within the Gulf includes several commuter ferry routes, tourist excursions and access to the Port of Auckland. The extensive use of the Gulf for marine mammal tourism, commercial fishing and marine farming is described further in the Biodiversity chapter.

Access to the Gulf contributes to a sense of belonging and well being for many parts of the community. The nationwide debate over the proposed foreshore and seabed legislation has demonstrated the strength of feeling both Maori and Pakeha hold over public access to the coast. For tangata whenua, access, use and management of a range of sites, places and resources is an important element of retaining customary practices, resource use and transmitting knowledge from generation to generation. Tangata whenua require access to mahinga kai (traditional food or resource areas) and native plants for the continuation of customary practices (MaF 2003). Maori and Pakeha seek coastal access to gain connectedness with a physical setting for spiritual understanding, family history, customary traditions or simply the enjoyment arising from coastal activities. This connectedness may be reinforced by visiting the coast on a regular basis or merely being satisfied with the knowledge that it exists and it is possible to gain access (MaF 2003). Such attachments to the coast are demonstrated by the way that people return to the same beaches or coastal settlements every summer over several decades (Thomson 2003a, Dahm 2003).

Information on access to the Gulf is available from a range of surveys and studies. Different aspects of access are assessed through indicators such as the amount of coastal land in public ownership, numbers of people visiting offshore islands and the number of boats in marinas and moorings. Each indicator has some limitations and some elements of access can only be described in general or through case studies.

8.2 State of Access to and Along the Coast

8.2.1 Ownership of Coastal Land

The proportion of coastal land in public ownership is a common indicator of the amount of public access to and along the coast[74] (MfE 2001). It is not an exact measure of public access but where there is public ownership, access is likely to be available. In some cases, access will be restricted because of topography, risks to public safety, or the need to protect the conservation or cultural values of an area. The need for such restrictions is recognised in New Zealand Coastal Policy Statement Policy 3.5.1 (DOC 1994). Public access to the coast may also be possible outside of publicly owned land where it is allowed by the owners. Land Information New Zealand (LINZ) analysis of land parcel ownership around the coast shows that 1.5% (40km) of the Gulf coastline adjoins private land with statutory access recorded on the title (e.g. esplanade strip or access covenant)[75]. The data also indicates that 6% of the Gulf coastline is adjacent to Maori land. However, such land is similar to other private land in that it does not necessarily allow public access.

Box 8–2

Reserve Types

The different levels of government typically have different types of reserve:

- Territorial Local Authorities – esplanade reserves, recreation reserves, road reserves (NB esplanade strips are established through TLA activities but remain in private ownership).
- Regional Councils – regional parks.
- Department of Conservation – marginal strips (Crown land reserved from sale), scientific reserves, historic reserves, scenic reserves, wildlife refuges, state forests, national parks.

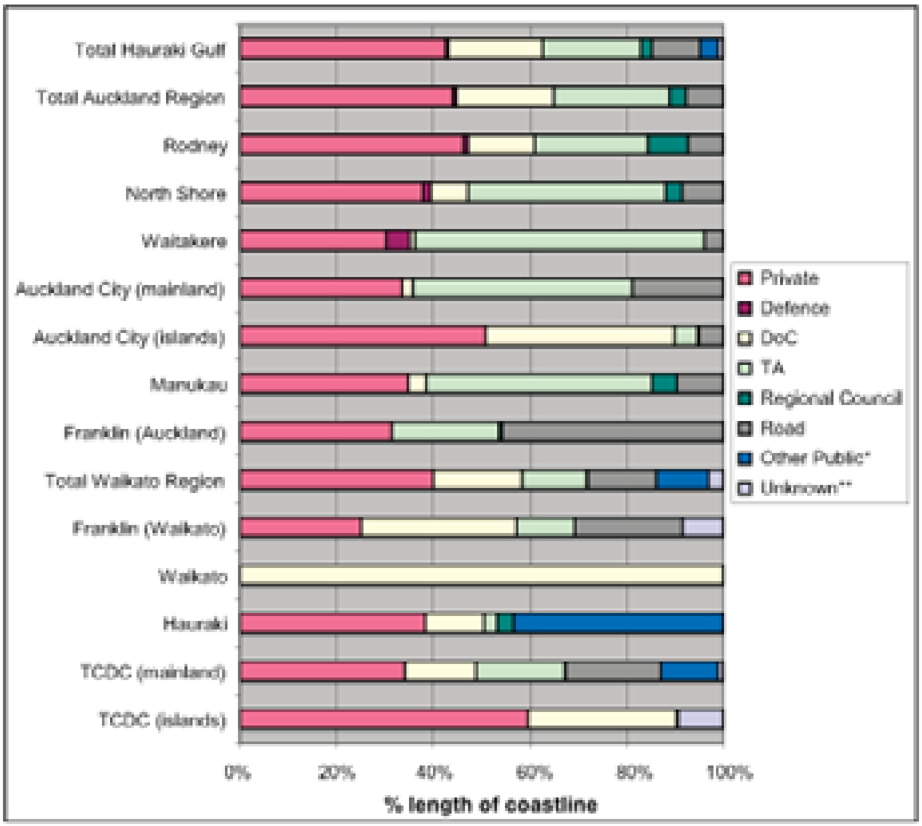


Figure 8.1 Percentages of Gulf coastline adjacent to public and privately owned land

Special note should be made of the lengths of coastline in each city or district. Waikato Region data collected in June 2004. Auckland Region data collected in April 2002.

* "Other Public" includes Waikato Region land described as: Crown Land Reserved from Sale (Marginal Strip), Foreshore, Recreation Reserve, State Forest, Vested in Crown for Flora & Fauna Preservation, Local Purpose Reserve (Esplanade), Land Information New Zealand.

** "Unknown" is Waikato Region land that is described as coastal edge with unknown ownership, most likely Crown Land, for example, small islands of the Coromandel.

Publicly owned land that allows public access along the coast mainly consists of reserves and roads. Reserves are held for a range of purposes by territorial local authorities, regional councils and the Department of Conservation (see Box 8–2). Roads ending at the coast may not have a formed road all the way to the coast but typically provide access via road or walking track. Some of these roads are 'paper roads' where access may be legal but not formed.

Over half (58%) of the 2500 km Gulf coastline is adjacent to publicly owned land or road (see Figure 8.1). The proportion of coastline adjoining public land or road varies around the Gulf depending on the topography, land uses and development in

[74] "Coastal land" refers to land adjacent to the coast, above Mean High Water Springs, rather than land within the coastal marine area.

[75] Data received from Tim Robertson, LINZ, 17 August 2004. Analysis of 'Land on Line' data undertaken in 2003.

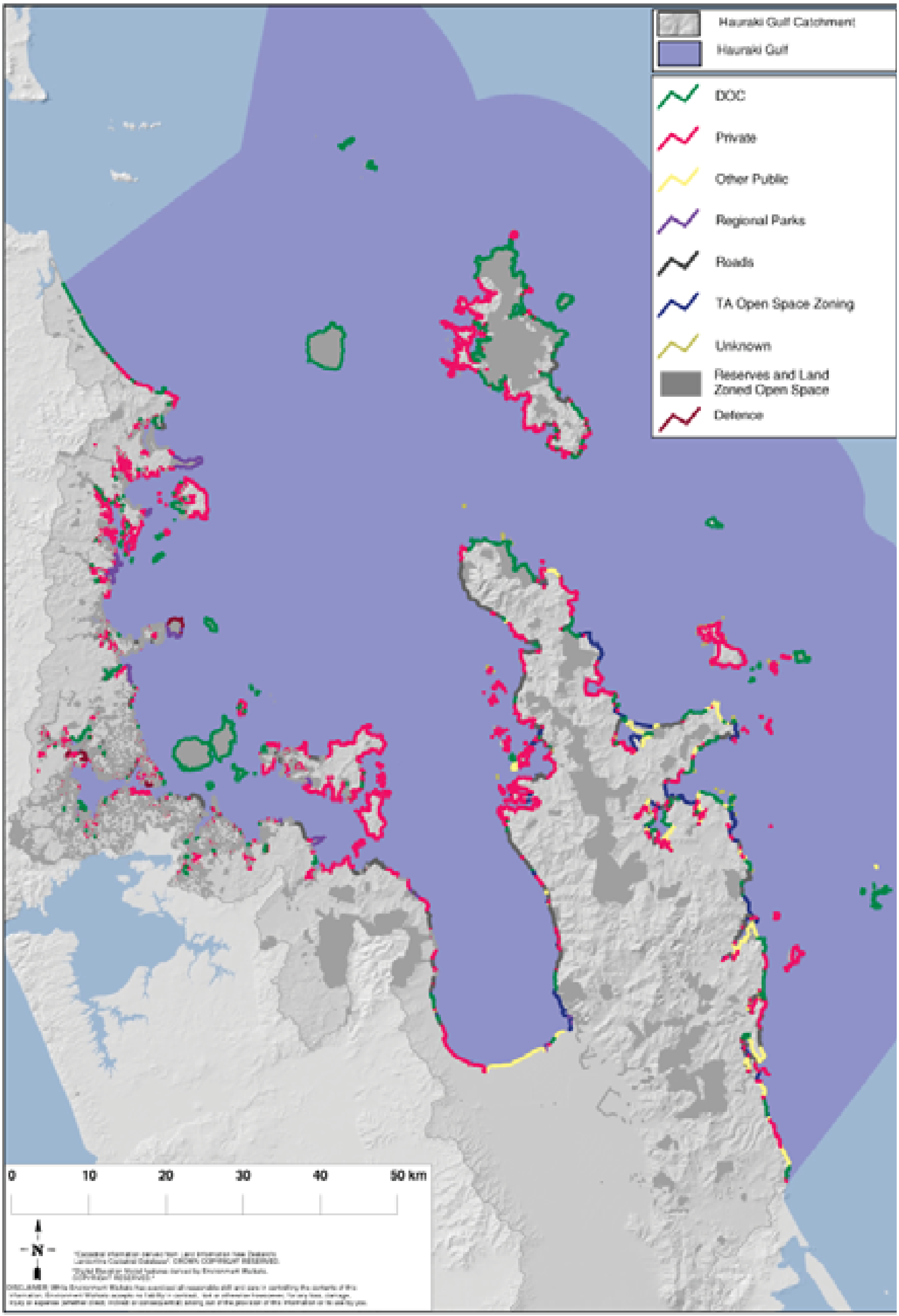


Figure 8.2 The Gulf coastline coloured to show whether it is adjacent to public or privately owned land

the area. The area with the highest level of public land adjacent to the coast is Franklin District but a significant part of this land is road rather than reserve. The areas with most coastline next to private land are the islands (51% of Auckland City islands and 60% of Thames Coromandel islands). The Gulf coastline of Waikato District is distinctive in having its full length adjacent to Crown land managed by the Department of Conservation. However, it is only 219 m long. This demonstrates the importance of noting the length of coastline in each city or district (Table 8.1) and the spatial distribution of public land around the coast (Figure 8.2).

Box 8–3

Survey of Beach Preferences (Environment Waikato)

Thomson (2003a and 2003b) reported on the result of a mail back survey distributed with Environment Waikato's community newsletter (Envirocare) in February 2002. 1173 surveys were returned from across the region and outside the Waikato. In the survey people were asked to rank four colour photographs of different types of beaches ('rip-rap', 'natural', 'grass verge' and 'city') in terms of which they would most like to visit and why. 80.2% of people chose the 'natural' beach as the type they would most like to visit. 17.5% wanted to visit the 'grass verge' beach, 3.3% the city beach and 2.5% the riprap beach. (These values total more than 100% as some people stated that more than one and sometimes all beaches ranked as their first choice.) Reasons given for preferring the different beaches showed that the same things some people regard as negative aspects in a beach (e.g. isolation / lack of development or shops / playgrounds), were regarded as a positive aspect by others.

8.2.2 Use of Beaches

The level of use of coastal beaches and reserves can be demonstrated through surveys asking people how often they visit an area or by counting people visiting a particular site. Such data show the continuing popularity of the Gulf as a place to visit and that use of some sites has increased over time as the population around the Gulf has grown and remote areas have become more accessible. Repeated counts of visitors are only available for regional parks and Department of Conservation tracks and offshore islands. The use of beaches is indicated by responses to surveys and one-off visitor counts.

Beaches are the most heavily used parts of the coastline and where there are disputes over public access, they are often at beaches. The beaches of the Gulf range from the developed beaches of Mission Bay and Takapuna to the more natural settings of the Coromandel and Gulf Islands, but they are all in high demand and the aspects that some people dislike in a beach will often be seen as a positive by others (see Box 8–3).

In the urban parts of the Gulf, the beaches are a key recreational space. A telephone survey of North Shore City residents in 2003 found that the majority (86% of 1,250 respondents) had visited a beach in the city in the last 12 months (Gravitas Research and Strategy Ltd 2003). About two thirds of people (64%) used North Shore City beaches at least once a month on average. The frequency of people using North Shore beaches has remained consistently high over several years (between 74 and 90% of people have reported using a beach in the past 12 months in each annual survey for 1996-2003).

In more remote parts of the Gulf, beaches are used predominantly by visitors rather than local residents. One study found that less than half of the people on two Coromandel beaches were from the Waikato Region (Figure 8.3, Thomson 2003a and 2003b). Local residents made up 11% of the people found on the beaches. There were more visitors on the beaches from Auckland (40%) than from elsewhere in the Waikato Region (30%). Only 1% of the respondents were from overseas indicating that the Coromandel is a predominantly domestic tourist destination. Sources of visitors also varied between the beaches. Aucklanders made up only 39% of visitors on Whangamata Beach but 69% of Pauanui Beach visitors (Thomson 2003a and 2003b).

Even where beaches are predominantly used by residents, they are important places to take guests. The North Shore City Council Tourism Survey in 2001 asked residents where they had taken visitors to the city during their stay. It was found that nearly half of the respondents who had visitors (46.6%) had taken their visitors to a North Shore beach (cited in NSCC 2004).

The activities beaches are used for differ between different beaches. A survey of Waikato residents showed that the most popular activities at beaches are walking/ running, swimming and sunbathing/ relaxing (Table 8.1). However, nearly half of the respondents visit beaches to fish or gather shellfish. The analysis also indicated that local residents typically use beaches for active recreation (surfing, playing sports and playing with children) whereas visitors have high rates of passive pastimes (reading, sunbathing and relaxing) (Thomson 2003b).

North Shore City surveys have also shown the high use of beaches for recreation that is not necessarily water-based. Fifty six percent of beach users in the North Shore City 2003 telephone survey had used a beach for swimming at least once in the past 12 months (Figure 8.4) (Gravitas Research and Strategy Ltd 2003). Just over a quarter (27%) of beach users had used a North Shore beach for boating once or more in the past 12 months. Ninety percent of beach goers had used a beach for recreational purposes other than swimming and boating, including 29% who used a beach at least once a week for such purposes. Helicopter surveys of 10 high use beaches in North Shore City on 18 occasions over the 2002/03 summer found an average of 1225 people undertaking passive recreation, 247 in water-contact recreation (swimming, windsurfing) and 15 participating in boating and other limited water-contact recreation (NSCC 2004).

8.2.3 Visits to Regional Parks

The regional parks adjoining the Gulf are some of the most commonly visited sites around the Gulf[76]. There are almost one million visits to Long Bay Regional Park each year and 500,000 visits to Shakespear Regional Park (Figure 8.5). Visitor numbers increased in all of the regional parks adjoining the Gulf between 1995 and 2002. The increases have been moderate in long established parks closer to the central city such as Long Bay, Shakespear and Wenderholm, whereas there have been

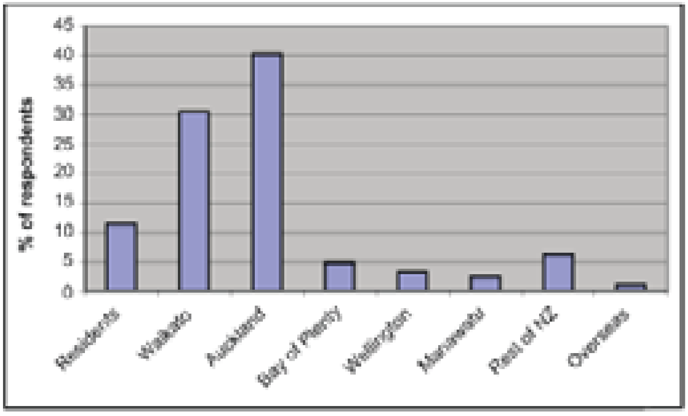


Figure 8.3 Origins of people on Whangamata and Pauanui beaches, Coromandel, January 2002

Note: Figures are a percentage of the 331 people who responded to a mail back survey handed to people on Whangamata and Pauanui beaches in January 2002 (Thomson 2003b)

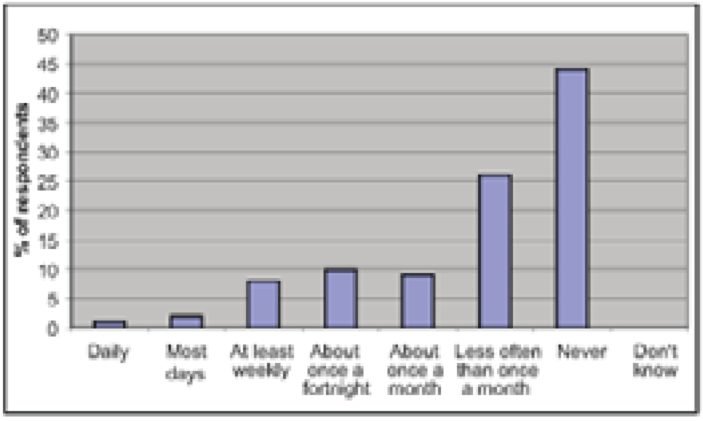


Figure 8.4 Frequency of use of North Shore beaches for swimming

N = 879, a random selection from those who responded in a telephone survey that they had used a North Shore City beach in the last 12 months (Gravitas Research and Strategy Ltd 2003)

Table 8.1 Beach activities reported by respondents to an Environment Waikato "Envirocare" survey

Source: Thomson 2003a and 2003b

Activity	% Participating
Walking / running	93
Swimming	85
Sunbathing / relaxing	77
Playing with children	56
Fishing	47
Gathering shellfish	45
Playing sports	23
Surfing	22

[76] They are also some of the few parks with visitor number records.

dramatic increases in the more isolated parks such as Tawharanui, Duder and Waharau.

8.2.4 Use of Walking Tracks

The Department of Conservation has a number of track counters on Coromandel walkways adjacent to the Gulf. Unfortunately, trend analysis over several years is not possible because few tracks have complete datasets (Table 8.2). The data that is available does indicate that more than 200,000 people use the walkways each year. The most popular site is the track adjacent to the Te Whanganui-A-Hei (Cathedral Cove) Marine Reserve. Use of the tracks is consistently higher in summer but a low level of use continues throughout the year.

DOC track counters on Great Barrier Island have similar problems with incomplete datasets. Data from counters on seven tracks indicate that at least 32,828 people used the tracks in 2002. The most popular tracks were Kaitoke Hot Springs with at least 13,467 visitors and Windy Canyon with 6,760 visitors (Duncan 2003).

It is estimated that both North Head and Goat Island Bay in Cape Rodney – Okakari Point Marine Reserve receive over 300,000 visitors each year (Duncan 2003).

Note: visitor numbers have been calibrated from vehicle counts (ARC internal data)

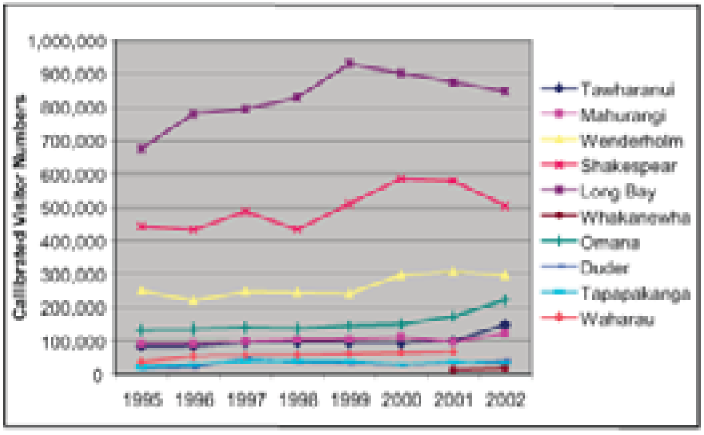


Figure 8.5 Annual number of visitors to some of the regional parks bordering the Gulf

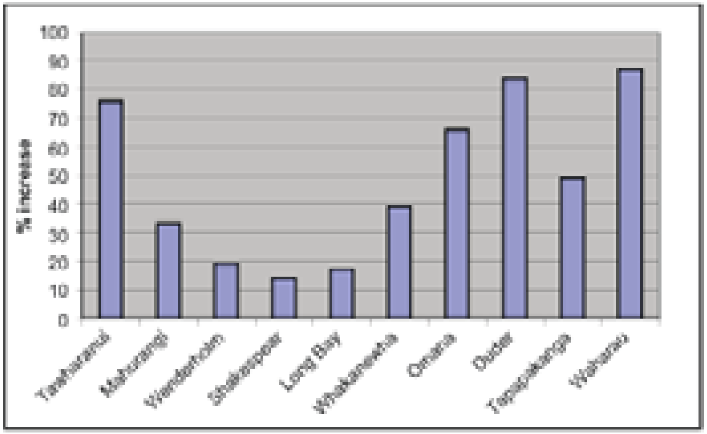


Figure 8.6 Percentage increase in annual visitor numbers for regional parks along the Gulf from 1995 to 2002

***Table 8.2** Track count data from Department of Conservation walkways adjacent to the Gulf in the Waikato Conservancy*
Note: * = at least one month in the year is missing data due to a broken recorder or the recorder not being read.

	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004
Lynch Stream Track	3,731	5,541	3,801	3,906	2,863*
Whitianga Rock Walk	8,150*	17,345	12,232	10,058	9,063*
Te Pare Pa Walk	13,892*	16,080	19,378	8,984*	13,570*
Cathedral Cove (near start of track)	113,849*	149,688*	9,878*	99,020*	104,203*
Cathedral Cove (further down track)	22,087*	*	68,638*	1,817*	51,759*
Gemstone Bay Walk	32,579	32,037	36,262	23,242	38,339*
Stingray Bay Walk	16,883	21,056	29,795	32,064*	6,670*
Opera Point Walk	*	13,225*	11,878*	*	13,970*
Opito Pa Walk	*	*	*	*	11,328*
Coromandel Walkway (Stony)	*	4,186*	2,201*	*	1,742*
Coromandel Walkway (Fletcher)	*	4,856*	2,265*	*	881*
TOTAL	211,171*	264,014*	196,328*	179,091*	254,388*

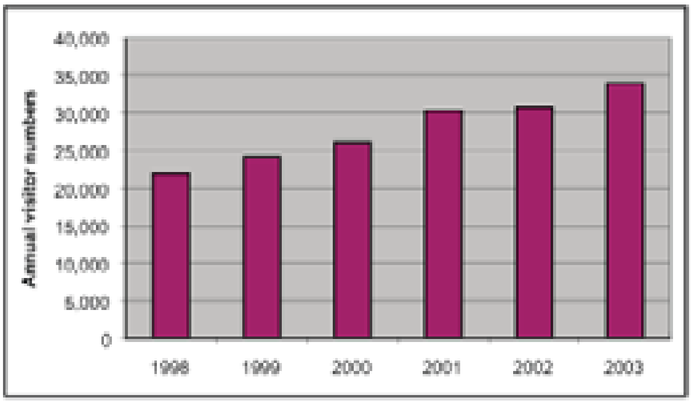


Figure 8.7 Annual visitor numbers for Tiritiri Matangi 1998-2003
Source: Duncan 2003 with additional DoC data

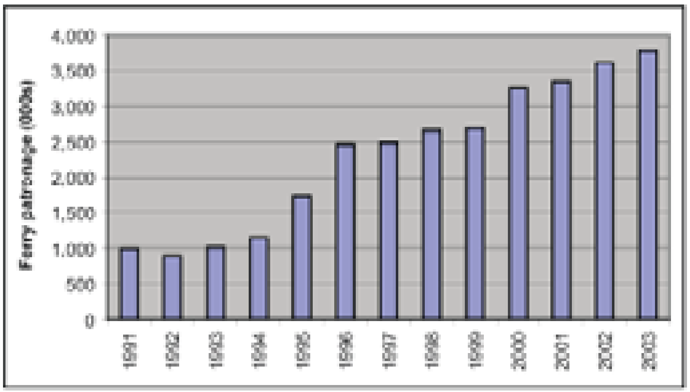


Figure 8.8 Annual ferry patronage in Auckland Region 1991-2003
Source: ARC data

8.2.5 Visits to Off-Shore Islands

Visitors to Tiritiri Matangi Island Scientific Reserve have been steadily increasing over recent years with 20,000 to 30,000 people visiting each year (Figure 8.7). Overall there has been a 54% increase in visitors between 1998 and 2003. There was a 10.4% increase in visitor numbers in 2003 (compared to 2002). It is thought that a 67% increase in visitors arriving by private boat was the main contributor to this. The percentage of overseas visitors is around 20% (Duncan 2003).

There were 52,755 visitors to Kawau Island in 2003, down slightly from the 2002 total of 53,715 visitors. Just over half of these visitors arrive by private boats (Duncan 2003 with additional data from DOC Auckland Conservancy June 2003).

In 2002 58 permits were issued for visitors travelling to Little Barrier Island (Hauturu), representing 375 people. This was a 36% increase in the number of people from the previous year. Over 30% of the visitors to Little Barrier Island are there to do voluntary work such as track work, flora or fauna surveys and weeding (Duncan 2003).

More than 35,000 passengers visited Rangitoto Island via a Fullers Ferry in 2002. This was a 13% increase on 2001 visitors (Duncan 2003). Total visitor numbers would be higher than this as many people visit Rangitoto Island via private boats.

8.2.6 Use of Ferries

Access to the Gulf is important for commuting to work as well as for recreation and tourism activities. There are ferries connecting Auckland's CBD with Devonport, Northcote Point, Gulf Harbour, Birkenhead, Bayswater, Half Moon Bay and Waiheke Island. The use of ferries within the Gulf has been steadily increasing in recent years and they are a vital part of Auckland's transport infrastructure (Figure 8.8).

8.2.7 Restrictions on Access to and along the Coast

Little quantitative information is available regarding restrictions on access in coastal areas around the Gulf. For example, there is no measure of where access along the coast is actually possible across private and public land (as opposed to legally possible).

In some areas, access is restricted by physical constraints such as cliffs, headlands or erosion. Restrictions on access are present in some areas to protect wildlife or cultural values. Such restrictions include the physical barriers (for example, where dotterel breeding sites are roped off from the public) and legal barriers (for example, the requirements for permits to visit Little Barrier (Hauturu) which is a nature reserve).

Restrictions can include cases where land has legal access but is not managed to provide access. Examples of this include legal roads that have never been formed so the access is not apparent, and esplanade reserves that are used by neighbouring property owners as an extension of their land so that it appears to be private land. This is particularly a problem where esplanade reserves are separated from other reserves and have no access from a road (land-locked) as it can be hard to get access to the new esplanade reserve for public recreation or council maintenance.

Development along the coast can create physical restrictions on access along beaches. Where sites have been surveyed to Mean High Water Mark or Mean High Water Springs, the owners can own parts of the dunes or the dry part of a beach. They can legally fence off an area that people view as part of the beach (see Figure 8.9) and may restrict access along the beach at high tide (such fences may require resource consent under the relevant district plan).

Seawalls built to protect coastal sites can also restrict access along a beach and limit the amount of dry high tide beach.

Some parts of the coast are valued specifically because few people can access them. Communities or owners can try to restrict access where there is existing access or where a council wants to develop a new walkway. With the development of rural land, new landowners can restrict access where it was once allowed across private land. The extreme case of this is gated communities where the public cannot gain access to the subdivision let alone the coast. Long running disputes regarding access such as at Jamieson Bay, Mahurangi, and Stony Batter, Waiheke Island, illustrate the importance to communities of maintaining access and the issues that can arise where the legality of access is not clear (see Box 8–4).

The effectiveness of walkways and reserves as an access route can be restricted by a lack of signage, carparks or other facilities. A lack of clear information or signage showing where access is possible can lead to conflict, particularly in rural areas where the demarcation of private space is not as clear as in urban areas. Information is also needed to explain significant sites so that their values are recognised and protected. Markers such as pouwhenua and place names that recognise tangata whenua perspectives and values can be an important part of this.

Education about restrictions on access is important as issues can also be created by public misconceptions of access

***Figure 8.9** Takapuna Beach, North Shore City – An example of a legal restriction of access to a beach where the property extends to mean high water mark*

Box 8–4

Disputes Over Access

Jamieson Bay, Mahurangi Harbour, has been the subject of a 20 year long dispute over whether there is legal public access to the beach. The 19 year dispute regarding legal road access to Stony Batter, Waiheke Island, was resolved in June 2002 but has been said to be the longest running legal battle in New Zealand local body history and was settled through an appeal to the Privy Council.

Box 8–5

The Queen's Chain

The term "Queen's Chain" reflects Queen Victoria's 1840 instructions to Governor Hobson to reserve appropriate lands for recreation or as the sites of future quays and landing places or other purpose of public enjoyment (MaF 2003, Hayes 2003). In various statutes this has been interpreted as a strip of land one chain or 20m wide.

The ways coastal land has been reserved have changed over time and there are now eight basic types of reservation that make up the Queen's Chain:

- Roads (1840-1892)
- Fixed marginal strips (1892 to the present time)
- Ambulatory marginal strips (1990 to the present time)
- Public reserves along water (1840 to the present time)
- Esplanade reserves, of various types (1912 to the present time)
- Recreation reserves (1977-1979)
- Esplanade strips (1991 to the present time)
- Maori reservations (2002 to the present time) (MaF 2003).

The whole coastline is not part of the "Queen's Chain" and this has never been a legislative intent (MaF 2003).

arrangements. For example, people can walk along the coast in the belief that they are on the "Queen's Chain", believing that there is a strip of public land along all waterways even though this does not exist. This term is used to describe various types of reserve that have been created along waterways (see Box 8–4).

8.3 State of Access within Coastal Space

8.3.1 Recreational Boating Areas and Routes

A lot of recreational boating in the Gulf is clustered close to the coastline of mainland Auckland and Coromandel because of the sheltered bays and wide range of popular destinations. The Gulf is also well suited to longer cruising trips between Auckland and Coromandel, Waiheke or Coromandel (Figure 8.10). The extent of the high use areas, cruise destinations and cruise routes shows that the boating fleet of the Gulf commonly moves between Auckland and Waikato regions and often travels between different city or district council areas.

8.3.2 Boat Ownership and Participation in Boating

The number of people within the Gulf Catchment owning a boat would be a useful indicator of how accessible the Gulf is for boating. The most recent estimates of boat ownership in New Zealand are based on data from 13,357 interviews CM Research conducted in 1997 and 1998 (cited in MSA 1999). Their work found that the greatest number of boats is in the Auckland Region (58,000 boats) where 16% of households own a pleasure boat ("boats" includes all types of pleasure boats from kayaks to keel yachts). In the Waikato Region 13.4% of households have a boat, giving a total of 14,000 boats. A 1969/70 survey conducted by the Auckland Regional Authority estimated that 16.2% of households in the Auckland Region owned a pleasure boat (ARA 1970 cited in Tonkin and Taylor Ltd 2004), indicating the proportion of households with a boat has remained quite constant although there has been significant population increase in the past 30 years.

The types of boats owned in New Zealand are given in Table 8.3. Approximately half of the boat owning households owns a powerboat that is stored or transported on a trailer (52%) and a third have a dinghy (31.2%). Fourteen percent of boat owning households have a boat that is permanently moored in the water (motor launches and keel yachts) and these equate to 11% of the boat population. There are about 5600 moorings and 5800 marina berths in the Gulf. If these represent 11% of the boat population, there would be about 104,000 boats in the Gulf area. This is close to the 80-100,000 boats the ARC has estimated would be in the Auckland Region based on projections from the boat ownership reported in the 1981 census[77].

Table 8.3 Types of pleasure boats owned in New Zealand based on households owning a pleasure boat
Source: CM Research cited in MSA 1999

Type of Boat	Percentage of boat owning households owning this type of boat	Equivalent number of boats	Percentage of boat population
Trailer Power Boat	52.0	97,200	40
Dinghy	31.2	58,300	24
Trailer Yacht	15.3	28,600	12
Motor Launch	8.8	16,500	7
Personal Water Craft	5.3	9,900	4
Keel Yacht	5.2	9,700	4
Other (e.g. canoes, kayaks, rowing skiffs).	11.2	20,900	9
Total Number of Boats		241,100	100

[77] There have not been census questions relating to boat ownership since 1981.

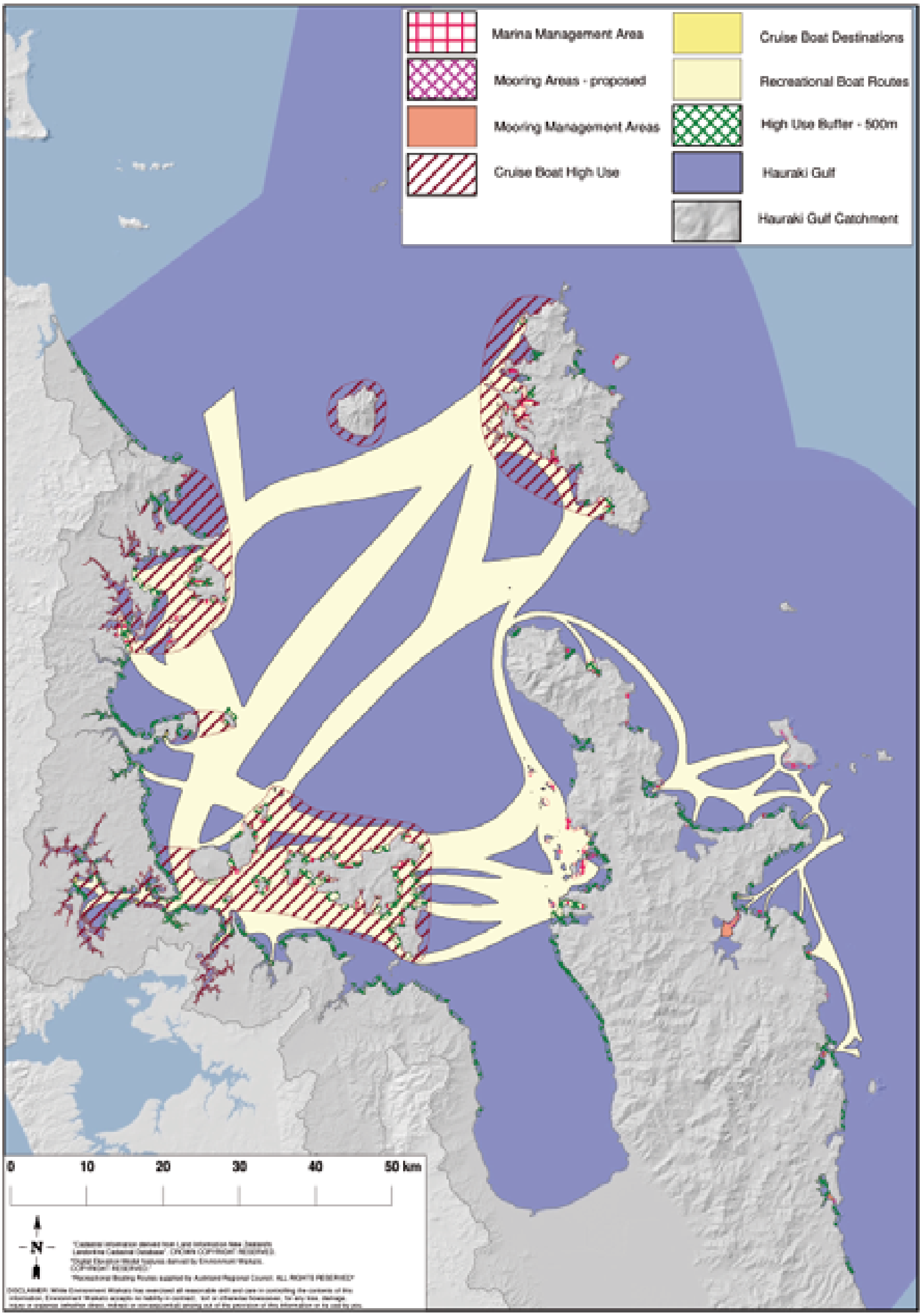


Figure 8.10 Recreational boating areas and routes

Table 8.4 National participation rates in boating activities each year
Source: AGB McNair, Sport Participation #2, cited in MSA 1999

Boating activity	Percentage of NZ population	Number of participants
Rowing	1	37,000
Boardsailing	2	74,000
Water Skiing	5	185,000
Sailing/Yachting	6	222,000
Motor Boating	6	222,000
Fishing	23	851,000
Total	43	1,591,000

Table 8.5 Numbers of recreational vessels in the Thames/Coromandel area at peak periods (mid summer, long weekends)
Source: Estimates provided by Environment Waikato Harbour Masters for the areas listed

	Number of trailer vessels (Peak Period)	Vessels, PWC, sailing, water ski active within harbour control area (Peak Period)
Tairua/Pauanui	360	90
Thames	220	30
Whangamata	768	
Coromandel	750	
Whitianga	3000	
Total	5098	120

Boat ownership has some flaws as an indicator of boating access to the Gulf as many people regularly sail or fish from other people's boats. Participation in boating was surveyed throughout New Zealand in 1996 (Table 8.4) but there do not appear to have been corresponding surveys specifically for the Gulf area. It is likely that the population of the Gulf has similar participation rates to the rest of New Zealand. The 1996 survey found that 23% of people participated in fishing (by boat) each year and that 6% go sailing or motor boating.

8.3.3 Small Boat Access to the Gulf – Boat Ramps and Boat Counts

The accessibility of the Gulf for many small boat users is primarily determined by the availability of public boat ramps. There are also many boat ramps associated with boating clubs that may be available to the public at certain times. Private boat ramps are another important resource for many people as they allow easy access to the Gulf from residential properties or business sites. There are at least 169 public boat ramps around the Gulf. Figure 8.11 shows their widespread distribution.

Tonkin and Taylor Ltd (2004) surveyed boat ramp users in Manukau City and found that travel time to a ramp appeared to be the major factor in determining which ramp people use, suggesting ramps should be situated so they are widely distributed around the coastline. Other factors important to the usability of ramps are the condition of the ramp surface, gradient, tidal restrictions, exposure and parking availability. Variations in these factors mean that not all boat ramps are useable for all types of boats or all stages of the tide. Of the 26 Gulf Manukau City boat ramps that Tonkin and Taylor Ltd (2004) reviewed, only two ramps could be classified as being suitable at most states of the tide and weather. Small ramps with only high tide or beach access do not cater for large boats, however, they are a valuable resource for smaller craft such as kayaks, runabouts, jet skis and hand-launched vessels.

Another way of assessing the accessibility of the Gulf for recreation in small boats is to count or estimate the number of boats active at key places at peak times. The Waikato Harbour Masters have estimated (May 2004) that in peak periods there may be over 5000 trailer vessels operating in the Thames/Coromandel area (Table 8.5).

8.3.4 Larger Boat Access to the Gulf – Marina Berths, Moorings and Boat Counts

Access to the Gulf on larger yachts and launches is largely dependent on the availability of marina berths and moorings. There are over 5000 marina berths in the Gulf area (Table 8.6). The largest is Westhaven Marina with 1432 berths. Westhaven Marina is reputed to be the largest managed marina in the southern hemisphere. It has been expanding in stages since the first breakwater was constructed in 1928.

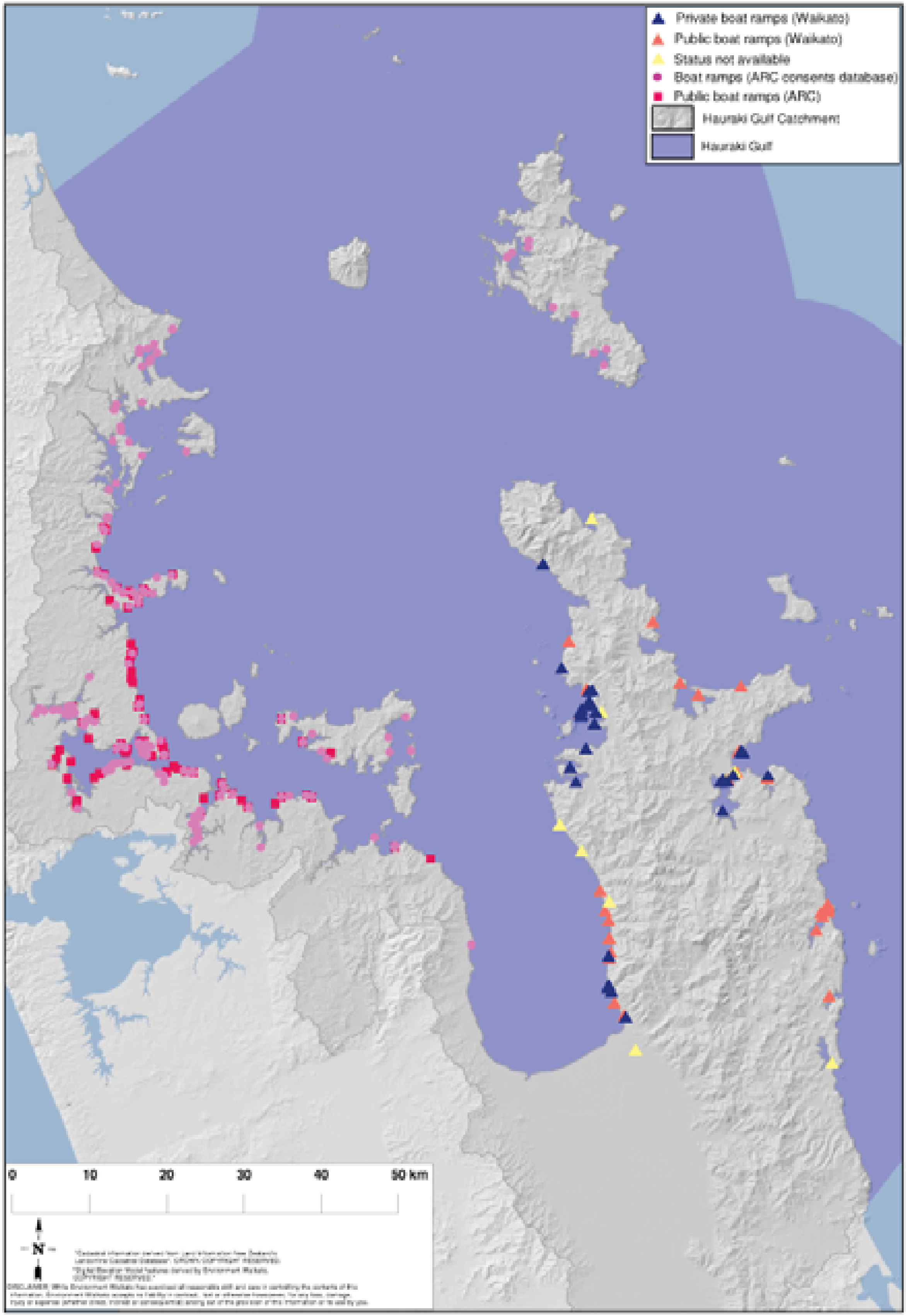


Figure 8.11 Distribution of boat ramps around the Gulf

Note: The ARC resource consents database includes public and private ramps. The Auckland public boat ramps are from Wises Maps (1999/2000). The Waikato Region boat ramps are from a 1994/95 survey of existing structures plus resource consent authorisations.

Table 8.6 Marina Berths in the Gulf

Marina	Number of berths
Gulf Harbour	966
Milford	185 berths on finger wharves, 35 on piles
Westpark	592
Westhaven	1432 (plus 331 pile moorings and 53 swing moorings)
Hobson West	23
Whakatakataka Bay	221
Half Moon Bay	500
Bucklands Beach	102
Pine Harbour	557
Pine Harbour Extension	230
Bayswater	413
Orakei (consent granted)	172
Tairua Harbour (Paku)	12
Pauanui Waterways	140
Thames	67
Whitianga	190
Total	5802

Table 8.7 Numbers of boats at anchor at cruising destination sites within the Gulf on 4 January 2002

Source: Aerial photos of numerous bays were taken and boats at anchor were then counted from the photos. Vessels that appeared to be moving were identified by a wake behind the boat and not counted.

Location	Boats within mooring area	Boats outside mooring area	TOTAL
Kawau	142	33	175
Rodney District	173	73	246
Tiritiri Matangi	0	0	0
Rangitoto/ Motutapu	0	69	69
Rakino	7	9	16
Waiheke	269	203	472
Motuihe	0	2	2
Ponui	0	78	78
Great Barrier	127	374	501
TOTAL	718	841	1559

At present there are approximately 5600 boats on moorings in the Gulf. The ARC's Marine Operations Team records 3550 moorings in the 78 mooring management areas defined in the Auckland Regional Plan: Coastal, and 360 moorings outside these areas. The majority of these moorings (2860) are in or close to the Waitemata Harbour, the remainder being located at Waiheke, Great Barrier and other islands. There are also 929 moorings in the coastal area off Rodney District[78]. The Environment Waikato part of the Gulf has about 770 moorings (Environment Waikato moorings database).

In a number of locations, particularly around the Gulf islands, the use of moorings is seasonal, with holidaymakers utilising a mooring for the summer months. Some areas also accommodate foreshore moorings, where vessels rest on the foreshore for part of the tide. In some instances these foreshore moorings are permanently occupied.

A survey of the number of boats at anchor at various recreational destination sites in the Gulf at the peak of summer in 2002 identified 1559 boats (Table 8.7). The most popular anchorages were Waiheke Island and Great Barrier Island. These figures are a snapshot of one date and quite different results may be found in other weather conditions. They do indicate the considerable number of boats that are active in the Gulf in the peak summer period.

8.3.5 Restrictions on Access within the Gulf

The main restrictions on access within the Gulf are shown by the space allocated to non-public uses – marine farms, cable routes, defence areas and ports (Figure 8.12). Marine farming is discussed further in Chapters 6 and 7.

Additionally within the waters of the Gulf, there are issues over access to private structures such as jetties and wharves. These structures occupy space within Crown land (the coastal marine area) and there is a general expectation that such structures will allow public access.

[78] Rodney District moorings number is at June 2004, pers. Com. Ann Hatwell, Rodney District Council 22 July 2004.

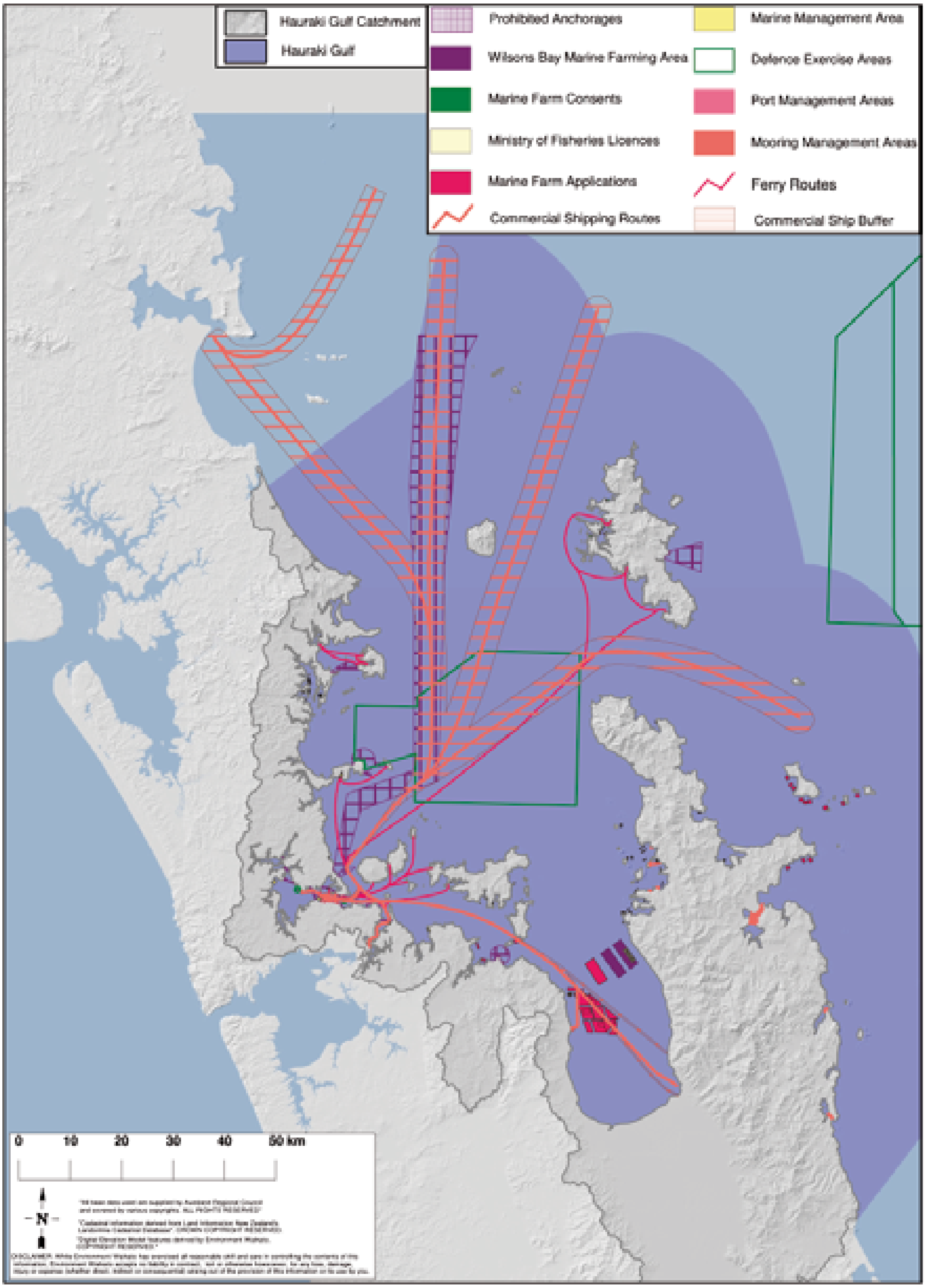


Figure 8.12 Main restrictions on public access within the Gulf

Box 8–6

Coromandel Camping Grounds

Eight Coromandel camping grounds have closed since 1999, principally owing to the pressure to develop coastal sites as property values rise. This raises concerns that holidays by the beach will only be available to people able to purchase beach homes. There are currently about 27 camping grounds on the Coromandel Peninsula.

Camping grounds which have closed include:

- Whangapoua's Back to Basics Motor Camp – closed in 2000.
- Tairua Motor Camp – closed in 2001.
- Kuaotunu Holiday Park – closed in 2001.
- Blue Dolphin, the Brophy's Beach Camp, Whitianga – closed in 2001.
- Homestead Park Resort, Flaxmill Bay – closed 2002.
- Pauanui Airtel camp – closed November 2003.
- Hotwater Beach Motor Camp – closed in May 2003.
- Water's Edge, Whitianga – closed 2003.

8.4 Pressures on Access to the Gulf

8.4.1 Pressures on Access Due to Population Increase and Changing Land Use

The general trends of increasing population and changes in coastal development with intensification of use and higher level of investment around the Gulf (see Chapter 1) are resulting in a range of pressures on access to the Gulf. The pressures include an increased demand for access to the coast and increased issues in obtaining new reserves but have also made the Gulf more accessible in some places.

The increase in population in Auckland, Waikato and Bay of Plenty is likely to result in greater numbers of people accessing the Gulf and its coastal areas. Reserve agencies will be required to spend more to maintain and manage existing reserves as well as having increased demand for new services and facilities. As well as a total increase, the population is likely to be older, more Polynesian and more Asian, with an increased preference for the coastal environment, easily accessed sites and short-duration activities (MaF 2003). This is likely to change the type of sites and facilities in demand.

Increases in coastal land values, development and subdivision place pressure on access in several ways. The higher cost of land makes it more expensive for local authorities and the Government to purchase land for reserves. New developments increase the likelihood of physical restrictions on access along beaches in the form of seawalls or fences. The high value of coastal land also contributes to some landowners being very unwilling to provide an esplanade reserve upon subdivision, and the subdivision consent process can become quite adversarial with the council having to justify why a reserve is required (e.g. Power v Rodney District Council[79]). The value of coastal land has created a pressure on coastal farmers to subdivide their sites. This is an issue for access where access has been allowed across the farms and this is likely to be removed with a change to lifestyle blocks or settlements.

Similar pressures are placed on coastal camping grounds where the value of the site when subdivided can be far greater than the economic value of the camping ground (see Box 8–6). New owners may stop allowing access across private land where it has been a long standing tradition. Such owners may not understand or be aware of informal arrangements that may exist between tangata whenua and previous owners for access to kai moana or wahi tapu sites (MaF 2003).

These development trends are, however, improving access opportunities in some areas. Road improvements are making the remote parts of the Gulf more accessible. Subdivision of coastal sites allows local authorities to acquire esplanade reserves or establish esplanade strips. The trend in downtown Auckland to focus development on the waterfront is improving access to the coast in areas such as the Viaduct Basin and providing new types of access experiences with cafes and boulevards as opposed to a bush or beach experience.

8.4.2 Pressures on Access from Environmental Processes

The quality of access experiences within the Gulf can be affected by changes in the surrounding environment. For example, the increased sedimentation and spread of mangroves in many estuaries around the

[79] Environment Court, Decision No A30/2000.

Gulf has decreased the water depth and space available for recreation. These changes are outlined more fully in Chapters 5 and 6. The spread of Pacific oysters in several bays and harbours has decreased the quality of public access as the oysters can cut swimmers' feet and scrape boats and windsurf boards. Changes in ecological factors such as ease of catching fish and abundance of birdlife can also reduce the enjoyment of access experiences.

Erosion of the coastline threatens various walkways and reserves. Even where an esplanade reserve has been established, it may not provide effective access if its width is eroded. More boardwalks or walkway structures extending from cliffs may be needed to bridge gaps in eroding areas. Seawalls or other coastal protection measures can be used to maintain access but this can impact on the natural character and sediment processes of an area.

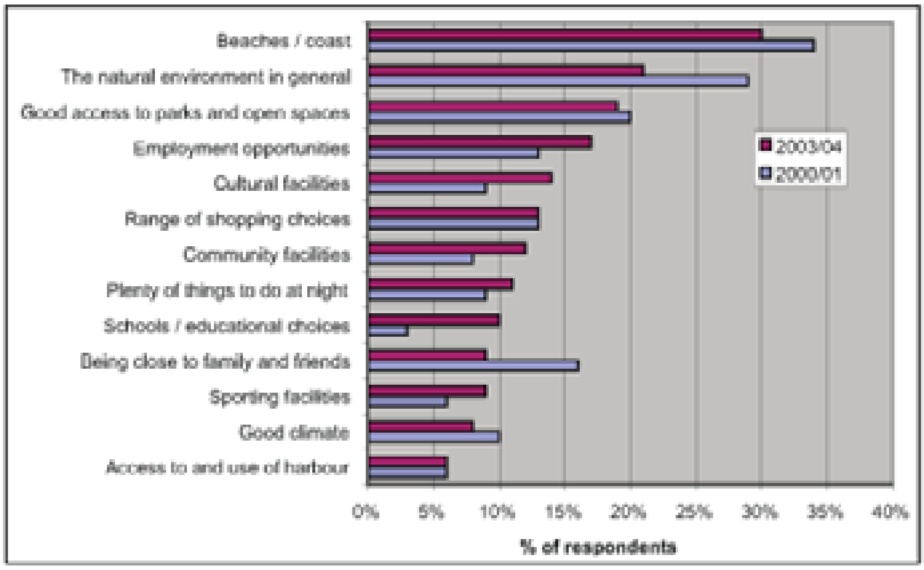


Figure 8.13 Key contributors to the quality of life in Auckland

Note: The Environmental Awareness phone survey asked residents about the key things that they liked about living in the Auckland Region – things that add to their quality of life. Answers were unprompted. There were 956 respondents in the 2001/01 survey and 1980 respondents in the 2003/04 survey (ARC 2004).

8.4.3 Pressures on the Satisfaction of Access Users

Increasing population size can result in more people accessing the coast and cause dissatisfaction with access opportunities or experiences. This can be because the reserves and facilities are no longer sufficient to cope adequately with the number of people, or reflect a change in perception where people feel other people are crowding or disrupting their visit to the coast.

Responses to a telephone survey of 1980 households in the Auckland Region between October 2003 and June 2004 found that the top three contributors to the quality of life in the Auckland Region were considered to be: the beaches and the coast, the natural environment in general, and good access to parks and open spaces (Figure 8.13) (ARC 2004). These results demonstrate that access to the Gulf is an important aspect of satisfaction with quality of life in the area. However, nearly half (45%) of the respondents in the survey agreed with the statement that '*access to the coast for leisure and recreation is becoming more difficult*'. Over a quarter of respondents (27%) disagreed with this statement. Few conclusions can be drawn from these results as it is not clear why people considered access was becoming more difficult or what type of access they were thinking of. As a result it is necessary to consider more localised satisfaction surveys.

ARC regional park customer research over the past five years has shown a very high level of satisfaction with regional parks (90-95%). People value regional parks for their "peaceful scenic settings", as places to "escape" to and as places to "discover" new places and things of interest. The ability to "escape" to a peaceful natural setting is the dominant driver of why people use regional parks and their satisfaction with them. People value regional parks because they offer free access to undeveloped coastline. This is increasingly seen as a major contribution regional parks make in protecting the region's natural and cultural heritage[80].

[80] Pers com Neil Olsen, ARC, June 2004.

There have been few other studies of the satisfaction of coastal access users. In a 2003 telephone survey, nearly three quarters (71%) of North Shore City beach users rated the beach areas in the city positively overall, almost one in five (19%) being "very satisfied" (Gravitas Research and Strategy Ltd 2003). Reasons given for dissatisfaction with the beaches included: beaches not cleaned well enough, pollution or poor water quality, poor dog control and not enough rubbish bins.

Issues with facilities being at capacity are usually localised and not reported in large-scale surveys. They may only be an issue at peak times, for example a lack of carparks at some beaches, delays at boat ramps, insufficient boat trailer parking. The high occupancy of moorings and marina berths shows these facilities are near capacity in some areas. New recreational activities can lead to demands for space and new facilities. Such activities as kite surfing, sea kayaking and waka racing are all now more common than in the past and have created new demands for boat storage or boat set-up areas at some beaches. Well established sports can also have trouble finding space within the Gulf for their activities or facilities. For example, there are few rowing courses around the Auckland coast and it has been difficult for some clubs to develop new facilities.

One of the main causes of dissatisfaction with access to the Gulf can be conflict from competing uses for the same space. Examples of such issues include recreational fishers trying to fish around the same area, disputes between kite surfers and board sailors using the same bay, and concern from recreational fishers over expansion of marine farming.

Disputes are also caused through a lack of understanding of the navigation and safety controls. An increase in the boating population could lead to an increase in accidents.

Box 8–7

Access through the Maori land at Kaiaua

The Maori land at the mouth of the Whakatiwai Stream, Kaiaua, has urupa, middens and a stand of native vegetation. For many years, the public have been able to cross this land to access an esplanade reserve and to launch boats into the river. There have been issues with this access such as rubbish left, people camping, and vehicle access. It is difficult to monitor such activities as there is no one living on the site.

Part of the area surrounding this land has recently been re-zoned for future development. The tangata whenua are concerned that this development will increase the number of people using the access route across their land and that greater damage could occur. There have already been occurrences of nearby sites being advertised as having access to the coast when such access is dependant on access across the Maori land. The closest public boat ramp is several kilometres to the south.

8.4.4 Pressures on the Environment Caused by Access

Public access can cause a range of pressures on the environment, including effects on ecological, cultural and amenity values. Such effects depend on the sensitivity of the area. They may be significant only where there are large numbers of people accessing a site, but in some areas, even a low level of public use can cause adverse effects.

Areas of high ecological value such as bird breeding sites can be affected by people disturbing the birds or by destroying nesting areas. Foot access over dunes can damage vegetation and lead to erosion or dune blow-outs. Vehicle access on beaches is an issue because of the damage it can cause to vegetation and bird life if not restricted to appropriate places. People bringing dogs to the coast can disturb birds. On the water, boating activities can impact on marine mammals. Such issues are considered further in Chapter 6.

Public access to the Gulf can compromise tangata whenua customary rights and taonga, including wahi tapu and mahinga mataitai. Facilities such as walkways and buildings can disturb urupa and middens.

Amenity values are affected by people leaving rubbish and damaging facilities. The facilities required for access such as toilet blocks and look-out structures can also create visual effects and impact on natural character and landscape values. Noise from human activities can disturb the isolated or peaceful nature of a coastal setting. Access can bring illegal activities such as graffiti, dumped cars and fires. See Box 8–7 for an outline of problems experienced by tangata whenua at Kaiaua.

Access over private land or through reserves managed as farms can lead to disruptions of farming activities for example by taking up a farmer's time asking for access, bringing dogs onto a farm, leaving gates open or disturbing stock (MaF 2003).

On the water, boat traffic can increase erosion from boat wakes. Boating activity may result in waste disposal issues such as litter in the water and wastewater discharges from boats (see Chapter 5).

8.5 Responses to Pressures on Access

A number of actions are being undertaken by agencies and individuals in the Gulf catchment which will have direct or indirect benefits for public access to the Gulf. This section reports progress on the strategic actions identified by the Forum, as well as major activities by individual Forum members. It is not possible to report on all response actions. The description of those actions is purely illustrative, and should not be considered comprehensive.

Progress on Forum action

- **Promote the Gulf as a highly diverse and dynamic destination**

All of the city and district councils with significant lengths of coastline along the Gulf promote the Gulf through their tourism promotions and information centres. For example, Thames-Coromandel District Council provides funding to Tourism Coromandel for promoting the Thames Coast.

The Forum has begun scoping a communications strategy. The promotion of the Gulf is one of the matters given consideration in that work.

Other Responses

In addition to the projects and programmes that the Forum undertakes, individual Forum members have undertaken a range of initatives.

8.5.1 Acquisition of Land through Legislation and Regulation

The two principal legislative means currently available for extending public access around the coast are esplanade reserves under the Resource Management Act and marginal strips under the Conservation Act (MaF 2003, Hayes 2003).

Box 8–8

Esplanade Reserves and Marginal Strips

An esplanade reserve is a narrow piece of public land next to the coast, a lake or river, and is generally vested in the local council. Section 230 of the RMA requires that a 20m wide strip of land is retained as esplanade reserve when any land adjacent to the coast is subdivided to create an allotment of less than four hectares. This requirement can be altered through rules in a district plan or through a resource consent. It can also be changed to a requirement for an esplanade strip where the land remains in private ownership but conditions are placed on the use of the land. The purposes of esplanade reserves and strips are to contribute to the protection of conservation values, to enable public access or to enable public recreation where this is compatible with conservation values (section 229 RMA). These purposes do not all need to be provided for at each site; consequently public access will not be provided along all esplanade reserves. Esplanade reserves have fixed boundaries whereas esplanade strips move with any shoreline movement from erosion or accretion.

Marginal strips are land retained by the Crown on the sale or lease of Crown lands. The width of marginal strips is usually 20m but this can be reduced to 3m through an application to the Minister of Conservation. The purposes of marginal strips are similar to those of esplanade reserves and strips.

See Box 8–8 for a description of these tools. Both of these are only triggered when there is a change in the circumstances of the land adjoining the coast.

All the district and city councils around the Gulf have district plans with policies about the taking of esplanade reserves. The councils generally require a resource consent to reduce or waive the width of an esplanade reserve and so requires a resource consent application.

8.5.2 Acquisition of Land through Purchase

Local and central government can directly purchase land for reserves and there have been several recent examples of this occurring around the Gulf. Such purchases can be a very expensive undertaking because of the value of coastal land but are justified because of the high use of such sites. Public ownership generally also protects the landscape and heritage values of these sites.

Some examples of recent land purchases around the Gulf are listed in Table 8.8.

Table 8.8 Examples of reserve land recently purchased by Forum parties around the Gulf

Date	Site	Description
May 2004	Kaikoura Island, Great Barrier Island.	The Government purchased Kaikoura Island for $10.5 million. Local authorities of the Auckland region have contributed $500,000 toward the cost of the 564 hectare island. ASB Community Trusts also contributed $2 million.
April 2004	Westhaven Marina, Auckland City.	Auckland City Council purchased the Westhaven and Hobson West marinas for $46 million from the Government. The Government had paid $54 million to ensure the marinas remained in public ownership.
February 2004, 1999	Kennedy Park, East Coast Bays, North Shore City.	A vacant 812 square metre residential site next to Kennedy Park was purchased for $950,000 in 2004. In 1999 a 1038 sq m section adjoining the park was purchased for $400,000.
February 2003	Waikawau Bay, Coromandel	The Government purchased 149 hectares of land adjacent to the Waikawau Farm Park (already managed by DOC) to ensure access to whole of the Bay. The cost of the land was $3.54 million.
2002, 2003	Long Bay, East Coast Bays, North Shore City.	Extensions to the Long Bay Regional Park were purchased by North Shore City Council (38.5 hectares for $22.5 million) and ARC (5.8 hectares for $7.9 million).
2002	Sanders Road, Paremoremo, North Shore City.	North Shore City Council purchased a 40 hectare farm for $3.1 million. The land has a long coastline and has high potential for active and passive recreation.

8.5.3 Policies for Acquisition and Management

An important part of responding to the demand for public access is to develop policies and plans to guide the management or acquisition of reserves and coastal areas. Some examples of such documents are listed in Table 8.9. Reserve management plans have also been prepared under the Reserves Act for many of the reserves around the Gulf.

8.5.4 Developing Access and Facilities

Enhancing public access to the coast requires the provision of a wide range of public facilities and information resources. Table 8.10 summarises some of the facilities provided on land bordering the Gulf. Some agencies also provide camping grounds and wharves. For example, the Department of Conservation's Auckland Conservancy has nine campsites and nine wharves on Gulf islands. The Department's Waikato Conservancy has five coastal campsites and two coastal amenity areas. In 2003 the Department conducted a review of all its visitor facilities throughout New Zealand. The review made recommendations for facility upgrades, new facilities and in some cases, removal of facilities. Decisions on the submissions received were released in October 2004. Key proposals in the Gulf include new huts on Great Barrier Island (Hauturu), new campsites on Great Barrier and Rangitoto, and improvements to Coromandel campsites and tracks (DOC 2004a and b).

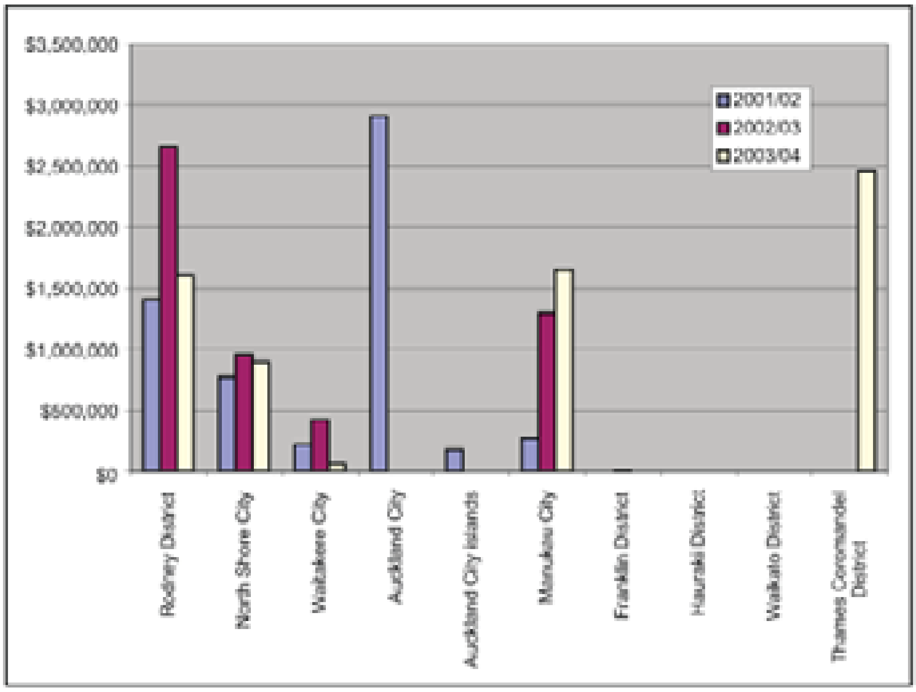
The Forum members also provide many signs, information leaflets and maps that encourage and facilitate access.

Table 8.9 Examples of policy documents that manage or enhance public access to the Gulf coastline

Agency	**Policy Document**
Rodney District Council	• District Walkways Strategy 1999 • Recreation Strategy 1999 • Coastal Management Strategy 1999 • Draft Open Space Strategy 2003 Technical Report • Coastal Compartment Plans for Omaha (April 2003) and Leigh-Ti Point (November 2002) • Esplanade Reserves Management Policy (currently under preparation)
North Shore City Council	• Coastal Esplanade Reserves Guideline 2002 • Open Space Strategy 1999 • Parks Acquisition Plan 2001 • City Blueprint 2002
Auckland City Council	• Reserve Management Plans for Coastal Reserves: Panmure Basin (2001) • Tamaki Drive Master Plan (in development) • Pt Chevalier Walkway Plan (completion end 2004) • Coastal Strategies: Eastern Bays (1999), Point Chevalier Peninsula (1999), Tamaki Estuary (in development) • Greening the City Strategy (in development) • Hauraki Gulf Islands Strategic Plan (2001)
Manukau City Council	• Making Connections – A Strategy for Manukau's Parks 2002 – 2010 • Hauraki Gulf Coastline Management Plan 1989 (under review) • Boat Ramp Study (in progress) • Walkway Development Strategy (in progress) • Coastal Structures Management Strategy (in progress)
Franklin District Council	• Franklin Recreation Plan 1998 (currently being reviewed)
Thames Coromandel District Council	• Reserve management plan for Whangamata and Thames Coast (currently being prepared) • Recreation Strategy • Asset Management plans for Parks, Harbours and Cemetery
ARC	• Draft Regional Open Space Strategy 2003 • Regional Parks Management Plan 2003 • Regional Parkland Acquisition Plan 1999

Table 8.10 Summary of some of the public access facilities provided along the Gulf coastline
Note: N/a – not available

Territorial Local Authority Area	No of public boat ramps	No of public conveniences / changing sheds	No of playgrounds	No of carpark areas
Rodney District	30	37	25	60
North Shore City	47	15	17	20
Waitakere City	23	7	6	13
Auckland City	19	4	3	15
Auckland City islands	0	1	0	0
Manukau City	26	24	11	27
Franklin District	0	1	1	2
Hauraki District	0	2	1	1
Waikato District	0	0	0	0
Thames Coromandel District	20	81	38	n/a
Regional Parks[81]	4	45	2	18
DOC Auckland	0	20	0	2
DOC Waikato	0	30	0	9
TOTAL	169	267	104	167



Notes: Facility types are shown in Figure 8.15. The amounts spent by different councils reflect their respective lengths of coastline. The North Shore City data is incomplete as several citywide projects in the budgets would have had coastal components that could not be distinguished. Data was not available from Auckland City for 2002/03 and 2003/04 or from Thames/ Coromandel District for 2001/02 and 2002/03.

Figure 8.14 Annual expenditure on certain public access facilities by city and district councils along the Gulf coastline in the last three financial years, shown by council

[81] The regional parks along the Gulf include Tawharanui, Scandrett, Mahurangi, Wenderholm, Shakespear, Long Bay, Whakanewha, Omana, Duder, Tawhitokino, Tapapakanga, Waharau and Whakatiwai parks.

Examples of council responses to the demand for access are indicated by the city and district council expenditure on various types of facilities along the Gulf coastline in last three years (Figure 8.14 and Figure 8.15).

Some examples of joint projects to develop and improve public access and facilities in the Gulf include:

- The ARC and North Shore City Council have worked together to purchase additional parkland adjacent to Long Bay Regional Park and to integrate the development of the City Council's Long Bay Structure Plan with changes to the Regional Council's Regional Park Management Plan.
- Franklin District Council and the Auckland Regional Council have worked together to provide a campervan waste disposal station at Waharau Regional Park.
- Auckland City Council and the Department of Conservation have a memorandum of understanding regarding access facilities.
- Thames-Coromandel District Council, Environment Waikato and the ARC are working together to investigate the Te Kouma Farm Park proposal with the James family of Te Kouma. The James family have a 450 ha farm with sandy beaches and bays that are popular boating destinations. There are also pa sites and other evidence of Maori and early European occupation. The James family have proposed that the property be run as a farm-park which the public can experience and enjoy. In return for an annual "rental" to maintain the property, the family would forego the right to sell in perpetuity.
- The ARC has worked with Auckland City Council, Manukau City Council, North Shore City Council and the Auckland Regional Transport Network Limited to improve ferry passenger facilities at several locations.

The Ngati Whatua o Orakei Reserves Board's management of Whenua Rangatira (see Box 8–9) is a good example of how public access to coastal land can be enhanced through the partnership of tangata whenua and a local authority (in this case Auckland City Council).

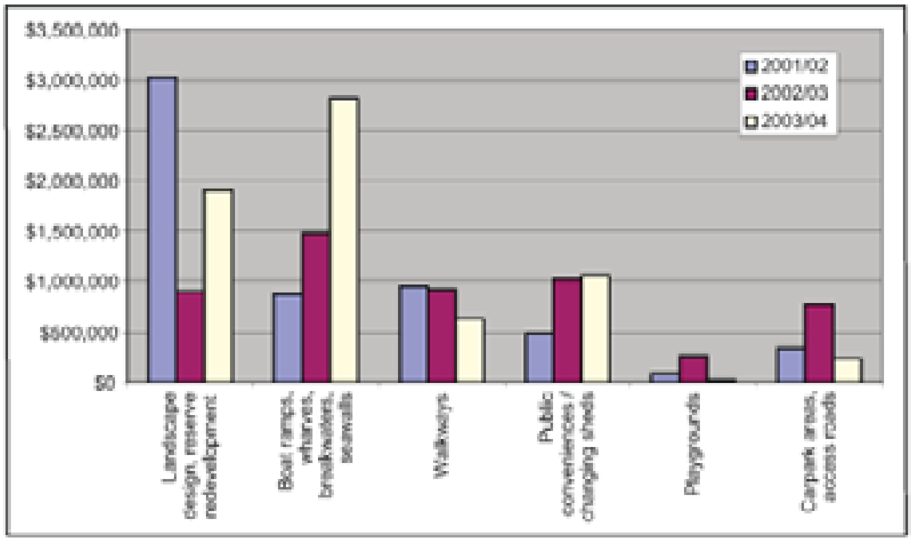


Figure 8.15 Annual expenditure on certain public access facilities by city and district councils along the Gulf coastline in the last three financial years, shown by facility type

Note: The North Shore City data is incomplete as several citywide projects in the budgets would have had coastal components. Data was not available from Auckland City for 2002/03 and 2003/04 or from Thames-Coromandel District for 2001/02 and 2002/03.

Box 8–9

Whenua Rangatira, Okahu Bay, Auckland City

Whenua Rangatira, also known as Takaparawhau, covers 49 ha of harbour-edge land between Paritai Drive and Mission Bay, as well as the Okahu Bay Reserve and the land known as Bastion Point. The land was returned to Ngati Whatua following a 1987 Waitangi Tribunal ruling, on condition that it be kept as open space for the mutual enjoyment of the public. Auckland City jointly looks after the land with Ngati Whatua o Orakei through the reserves board. The Board was established as a result of the Orakei Act 1991, which requires the two parties to work in partnership for the benefit of the land and the community. The Board is made up of three Ngati Whatua and three city council members.

The reserve management plan for the area (signed on 29 May 2003) recognises the historical and cultural significance of the land and details how it will be managed and conserved in the future. This includes considering what activities are appropriate in the area. The Board receives about 35 applications every summer for activities including triathlons, concerts and filming. They have also begun an extensive planting programme which will restore much of Bastion Pt to native bush and help stabilise eroding cliffs. Last year, 25,000 trees were planted and 130,000 will go in over the next three years.

8.5.5 Co-ordination of Bylaws and Other Regulatory Controls

Several councils in the Auckland Region have been working together on a review of their bylaws with regard to dog control in response to the 2003 changes to the Dog Control Act 1996.

8.5.6 Partnership Education Programmes to Promote Safety Matters

The ARC has contracts with several agencies to provide recreational boating education including Coastguard Education, Watersafe Auckland Inc and Surf Lifesaving Northern Region. The Regional Council supports the Ministry for the Environment and Marine Safety Authority in promoting the Marine Pollution Regulations at Auckland boat shows. Both the ARC and Environment Waikato have developed leaflets illustrating the extent of the Marine Pollution Regulations on the east coast of both regions. Hauraki District Council sponsors professional lifeguards during high summer at Whiritoa.

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9 Cultural Heritage of the Gulf

Key Points

- There are a broad range of types of cultural heritage sites and landscapes in the coastal margin, and in the Coastal Marine Area of the Gulf.
- Information on, and responses to, cultural heritage protection varies greatly in the statutory authorities.
- The greatest pressure on cultural heritage comes from coastal subdivision.
- Middens in sand dunes are under the greatest pressure, and frequently are not accorded appropriate status and response.
- The Forum has made little progress towards the actions for cultural heritage set in the Strategic Issues document.

9.1 Introduction

The cultural heritage of the Gulf includes many different sites that together record the history of human use and modification in an area. Cultural heritage includes archaeological sites, buildings and landscapes with cultural associations. The Gulf is particularly rich in cultural heritage resources, with diverse sites such as ancestral landscapes occupied by numerous iwi, the early transport, military and maritime industrial sites around Auckland, and the mining history of the Coromandel.

This record of human interaction is written into the land, but often in a form not easily read. Coastal sand dunes usually contain shell middens, rich with information about pre-European life. Pa sites and their terraces are often obscured by afforestation, housing development or agricultural usage. Within the marine area of the Gulf almost two hundred shipwrecks lie unseen by most people.

Preservation and recognition of cultural heritage has to struggle against the pressures of development, and lack of awareness of its vulnerability and the constantly diminishing record. The Forum has recognised the importance of the cultural heritage in its strategic issues document (see Box 9–1).

9.1.1 The Importance of Cultural Heritage

Cultural heritage is important because it is central to individual and community identity, it links people and place, enables better understanding of cultural differences and promotes appreciation of the past and present, as well as having significant amenity and recreation values (Tatton 2001). The status of cultural heritage has been recognised by international agreement and by domestic law. The *United Nations Convention – Protecting World Cultural and Natural Heritage*[82] was ratified by New Zealand on 12 November 1984. In its preamble it says "In view of the magnitude and gravity of the new dangers threatening them, it is incumbent on the international community as a whole to participate in the protection of the cultural and natural heritage".

The principal New Zealand statutes that aim to protect cultural heritage are the Resource Management Act 1991 (RMA), the Historic Places Act 1993 (HPA) and the Conservation Act 1987. The Local Government Act 2002 with its requirement for cultural wellbeing and quadruple bottom line reporting extends the mandate for councils to address heritage issues. The key agencies exercising functions relating to cultural heritage under these acts are

[82] Convention Concerning the Protection of the World Cultural and Natural Heritage (1972) www.gdrc.org/heritage/whc

Box 9–1

Strategic Issues and Objectives

- The Hauraki Gulf and its surroundings contain a wealth of cultural heritage values. Many sites, features or artefacts are not formally protected and heritage values are being degraded and lost.
- Tangata whenua are not effectively involved in cultural heritage decision-making processes associated with the Gulf.
- Much cultural heritage is retained in oral tradition, (including songs, poems, nursery rhymes, prayers, and story telling) or in literature and photographic archives distributed throughout the region. Records about the extent and nature of this heritage are incomplete, dispersed, and often inaccessible to people. Inaccurate and incomplete information and the complexity of management systems to record and store archaeological information limits effective protection. Holders of cultural heritage knowledge can be reluctant to share information with agencies and the community in the absence of protocols for protection of information. Co-ordination between tangata whenua, Forum members and the wider community in the collection, recording, interpretation and protection of heritage information is limited.
- There is an imbalance in the types of cultural heritage that is protected. For example there is a strong emphasis on heritage found in urban areas (specifically describing buildings of particular periods) while heritage of rural, industrial and commercial, coastal and marine areas is not well represented and continues to be lost. Also there is a management focus on protecting isolated heritage sites rather than protection of heritage landscapes.
- Pre-European archaeological sites and landscapes are numerous which reflects the lifestyle and resources used by Maori in the past. While these sites are often protected, significant losses of the cultural heritage of tangata whenua continue. Community awareness and respect for the relationships that tangata whenua share with waahi tapu and cultural heritage sites and landscapes is necessary for effective heritage protection. The culture of the people who once lived and used these areas is not well described or connected to these places. Opportunities for educating communities about the cultural heritage of tangata whenua are often missed.
- The values of archaeological landscapes, such as duneland midden areas, are not always valued. Because protection is focused on identified and investigated sites there can be inadequate provision for the protection of undiscovered sites under the RMA and Historic Places Act.
- Cultural heritage sites are often located on land in private ownership which can add complexity to management by public agencies. However it may also have beneficial spin-offs as landowners may voluntarily protect heritage values on behalf of the community.

Objectives

- There is widespread recognition and respect of the diverse cultural heritage values found in the Gulf and its surroundings, including archaeological landscapes and sites.
- Co-ordinated conservation action ensures protection of cultural heritage in the Gulf.
- Waahi tapu and cultural heritage sites of tangata whenua are being actively protected.
- Tangata whenua are actively participating in cultural heritage decision making processes associated with the Gulf.
- Tangata whenua protect and manage waahi tapu and heritage sites and features in accordance with tikanga Maori.
- Comprehensive records are established and maintained that add description of the status of significant cultural heritage sites, features and artefacts.
- Cultural heritage in private ownership is acknowledged and respected by owners. Similarly the Forum and community acknowledges the important role that private landowners play in protecting cultural heritage on their land.

the Historic Places Trust, regional and territorial authorities and the Department of Conservation. Various reviews of cultural heritage management have raised concerns with this system as a whole.

"The Parliamentary Commissioner for the Environment has identified the lack of commitment on the part of government as representing a major difficulty. The higher priority given to the natural heritage in terms of finance, staffing and strategic planning was also noted" (Allen 1998). "The system for the management of historic and cultural heritage as a whole lacks integrated strategic planning, is poorly resourced and appears to fall short of the principles of the Treaty of Waitangi." (PCE 1996).

More recently the PCE has commented: "So far there is little evidence of Agenda 21 principles having influenced the integration of environmental, social and economic policy making" (PCE 2002). Agenda 21 is a comprehensive plan of action that implements the Rio Declaration[83].

9.1.2 Tangata whenua perspective

The difficulties tangata whenua have in protecting sites of significance to them are reflected in the following statements:

"For us the sacred sites are our history books and education processes, necessary for our spiritual existence and survival, for without them we are nothing. They speak to us from another time, another world, the space and its environs within the universe. Sacred sites are defined as everything or all those happenings that pertain to the ancestors. These are our taonga – our treasures"[84]

"Maori heritage management has come as something of an afterthought. It is not yet conceived that as a field it may require its own approaches. As a result Maori have been forced to use the existing measures to safeguard their heritage. Inevitably these have failed to measure up, and serious conflicts have been the result". (Allen 1998).

To adequately understand the past both the ordinary and the spectacular need to be preserved. Much of the important pre-European record is preserved in sites such as shell middens, which do not capture the attention they often deserve. "Tangata whenua reported cases where middens and other sites had been destroyed before an assessment could be undertaken of the evidence or its significance. Middens can contain important evidence of occupation, and items can be carbon dated to establish more precise historical understanding."(PCE 1998). Sand dunes are locations frequently rich in sites such as middens. The pressure of coastal subdivision has impacted severely on these landscapes to the extent that only Pakiri retains unimpacted middens on the east coast of mainland Auckland Region. Maori have frequently fought to retain sites where there is subdivision or development, but have seldom had major successes.

9.1.3 The role of the Historic Places Act and the Historic Places Trust

The New Zealand Historic Places Trust (HPT) is the primary advocacy body for the preservation and the protection of historic places and archaeological sites. It is also the regulatory body that approves authorities for destruction of sites and this dual role has been criticised as conflictual.

The legislation of the HPA is lagging behind the academic and practical archaeological practices. Up to the 1950s archaeology concentrated on the collection of artefacts. In the 1960s the focus shifted to archaeological sites, which may or may not contain artefacts. Current archaeology studies archaeological landscapes containing sites. The HPA focuses on discrete sites, rather than including archaeological landscapes, and the failure of the legislation to move past this stage is one of the most limiting effects of the implementation of the HPA in preservation of cultural heritage (see Allen 1998).

One of the roles of the HPT is the registration of sites. "However, while registration identifies historic places and hence plays an advocacy role, it does not provide any direct protection. A registration system that appears to schedule historic places but in reality provides no protection beyond identification achieves two ends. Firstly, it is a method of advocating the protection of privately owned historic places without taking away any of the property owner's rights

[83] United Nations Conference on Environment and Development (1992)

[84] Submission to the Second World Archaeological Congress, Barquisimento, Venezuela, September 1990

and hence avoids hearings, adjudications and appeals. Secondly, formal scheduling of sites by councils involves a system of hearings and adjudication and a consent procedure which are beyond the resources of the HPT. However, the public believes that registration conveys some form of statutory protection and owners frequently complain that registration affects their ability to develop their properties" (Allen 1998).

9.1.4 The NZ Archaeological Association

The New Zealand Archaeological Association (NZAA) maintains a paper file of recorded sites. The data collected by archaeologists and recorded in the NZAA Site Record File has no statutory weight, and the number of sites are much more numerous than those in the HPT register.

There are problems with this NZAA data. The process for transfer from the NZAA data base to the HPT registration is time consuming, and it must be done site by site, not by landscapes or groups of sites. Data recorded earlier for old imperial inch to the mile maps accrued significant errors when transferred to metric maps; for instance coastal sand dune midden sites are now often recorded on the maps in the sea beside the actual sites. Efforts are being made to correct the accuracy of the data, but this will take some time to complete.

9.1.5 The Role of Councils

While the role of HPT is to record and advocate, the responsibility for the management of cultural heritage resources lies with local government. Planning instruments can, by inclusion of schedules, afford some protection. Effects based responses, rather than reliance on prescriptive schedules, are able to provide more comprehensive opportunities for protection.

9.1.6 Short History of Maori and Pakeha in the Gulf

The Gulf area is a natural intercept for voyagers from Eastern Polynesia. The early expedition of Toi (Toitehuatahi) made landfall first in the Tamaki area, and from there went on to Aotea (Great Barrier Island). Oral traditions record earlier tangata whenua occupying the sane area prior to Toi's arrival. Many of the well known waka from the migration period passed through the Gulf: Takitimu, Tainui, Te Arawa, Matatua, Aotea. There were other less well known, but equally important landings such as the Moekakara at Te Waka Tuwhenua near today's Leigh Marine Reserve.

The temperate climate, the numerous islands and harbours, the richness of coastal wetlands, and the inland forest areas all provided ideal environments for the traditional Maori way of life. The density of occupation is evidenced over time by the numerous coastal pa sites. Natural resources of stone and obsidian from Aotea, Motutapu and the Coromandel Peninsula provided trade throughout Aotearoa, found as far away as Otago.

The occupation of the Gulf area during following centuries up to the colonial period was complex and dynamic. Warfare and migration continually changed the presence and dominance of different iwi. European contact led to an increase in the effects of conflict with use of the musket. The subsequent land sales and the impact of colonisation had the effect of freezing iwi occupation and identity in mid nineteenth century patterns.

In November 1769 Captain James Cook and his ship's crew were the first recorded European visitors, when the transit of the planet Mercury was observed off Whitianga. It was also where Cook "took formal possession in the name of His Britannic Majesty King George the Third".

In 1800, despite the impact of occupation of the land for several centuries by Maori, much of the forest areas in the Gulf remained the same as when first seen by Toi. The past 200 years of colonial impact and resource extraction have totally transformed that environment. Felling kauri and other timber, mining gold, swamp drainage in the nineteenth and early twentieth century transformed the land and its ecology. In the second half of the twentieth century urbanisation and coastal subdivision maintained the pace of change.

While many examples of environmental change as a result of the colonial period exist – forest felling and burning, sand dune modification, estuarine siltation and so on – one of the best documented and evocative of the changes is the impact on the wetlands. The wetlands were traditionally a major resource for Maori. "They watered and gave access to vast areas of country, birds were attracted to them for food and native fish that came to spawn. Dominating the swamps were rushes, reeds, flax and kahikatea ... Mature, fruiting kahikatea were a seasonal important for birds and people. Waikaka (mudfish), a traditional delicacy for presentation at feasts, hibernated during summer drought beneath kahikatea roots. They and myriad fish species migrated through the estuaries and lagoons into pools enclosed by flax and raupo in the gaps in the kahikatea forests". (Park 2001).

This was the environment witnessed by Cook at the Waihou River in 1769. Joseph Banks recorded: "The Noble timber, of which there is such an abundance, would furnish plenty of materials ... Swamps which might doubtless Easily be drained, and sufficiently evinced the richness of their soils". (quoted in Park 1995). That intention was achieved to the extent that almost none of the original wetlands remain. Swamps were drained, cattle grazed, kahikatea felled and used for butter boxes. Acts of Parliament supported and encouraged the transformation of the "useless swampland". Maori, who had learnt that lakes and rivers were not included in land titles of alienated land, and presumed the ownership of wetlands had not been lost, could only bear powerless witness to the destruction.

In the early twentieth century the strategic military position of the Gulf led to defence installations in many areas (see Box 9–3). Prisoner of war camps were established during the First World War at Takapuna and Motuihe Island. Many of the military sites now have heritage status. However, both of these military sites were built on pa and other Maori sites, which do not enjoy the same public recognition.

Box 9–2

The History of Little Barrier Island (Hauturu)

To Ngatiwai, Hauturu is one of the floats (poito) of the net of Toi. When the ocean was the most used highway, Hauturu – midway between Aotea and the Mahurangi area - was one of a chain of islands that provided linkage for Ngatiwai.

In 1881 the Government issued a Gazette notice declaring the Crown's intention to purchase the island for military purposes. In 1886 Ngatiwai offered to sell Hauturu to the Crown, conditional on maintaining a Ngatiwai reserve and presence on the island. The same year the Auckland Institute & Museum requested the Government to buy Hauturu and proclaim it a forest reserve, while Buller strongly urged purchase as a bird sanctuary

The Governemnt remained convinced that the continued existence of Maori on Hauturu posed a threat to the establishment of any natural reserve. Having dismissed the suggestion of Ngatiwai being custodians, the Government created a position for a European ranger. The Ranger Robinson, rather than protecting the rarest birds, collected them for Museums and private collectors.

Following unresolved conflict with remaining owners, led by Tenetahi and Rahiri Te Kiri, the Government reacted by preparing to forcibly remove the families from Hauturu.

On 8 October 1894 the Little Barrier Island Purchase Bill was introduced to Parliament.

The intention to purchase the island was challenged by Maori and some Pakeha MPs. The Bill passed into law on 24 October 1894, but many issues remained unresolved. While it was acknowledged in the Act that Tenetahi and others had not signed a deed of sale, they were bound by it "according to Native custom and usages". This was a Crown version of "Native custom", and clearly not that of the remaining owners.

On 17 June 1895 the Government issued written notice to Ngatiwai to quit Hauturu under threat of trespass. On 26 June 1895 the Commissioner of Crown Lands and police visited Hauturu.

Tenetahi replied to the Commissioner's statement that the island now belonged to the Crown: "First, I refuse to leave the island because I do not consider that the purchase is a proper purchase. Second, neither myself or my wife have sold our shares - I do not recognise the sale that has been effected. Third, my reply regarding the preservation of the birds on the island is that they are all mine and I have always preserved them to the present time."

On 23 October 1895 the Crown initiated trespass proceedings. Ngatiwai was directed to vacate Hauturu by 10 December. Tenetahi published a long letter of protest in NZ Herald invoking Article II 'in return for cession of sovereignty over the lands of the colony, Her Majesty confirms and guarantees to all Maoris the exclusive and undisturbed possession of their lands so long as they desire to retain the same". He stated he would not resist when the bailiffs came to remove him.

As a consequence, the Crown Solicitor advised it would be necessary to arrange for a force of police to accompany the bailiff. The cost of eviction was to be deducted from the payment for Hauturu. Tenetahi and Rahui Te Kiri were subsequently removed from Hauturu in chains,

In 1910 Tenetahi was still petitioning Parliament. Today Hauturu is subject to a Waitangi Tribunal claim.

During the first half of the 20th century the classic kiwi baches were built on beaches accessible to main centres. Few of these remain, such as those on Rangitoto. The second half of the 20th century has seen the development of coastal subdivisions distant from main centres as road quality improved and ownership of private cars increased.

The historic record remains in sites throughout the Gulf. These include sand dune middens, coastal pa, shipwrecks, early industrial sites and military installations. Many of these sites and landscapes have been lost or impacted over recent years. This chapter will consider the state of the remaining record, and its continued security of existence.

Table 9.1 List of maritime historic places with more than one example in the Auckland Region

Type	Number	Type	Number
Shipwrecks	186	Tramlines	4
Wharves	179	Aeroplanes	2
Shipyards	139	Fish traps	4
Hulks	122	Lighthouses	5
Landings	40	Navigation beacons	4
Brickworks	36	Signal stations	4
Sawmills	27	Copper mines	4
Jetties	26	Fish factories	4
Quarries	21	Navigation lights	4
Bridges	11	Stores	4
Ballast	10	Water supplies	3
Seawalls	13	Careening areas	
Stone working areas	11	Magazines	3
Middens	10	Stockyards	3
Booms	9	Walking stones	3
Find spots	6	Whaling stations	3
House sites	9	Boilers	3
Limeworks	9	Tanneries	3
Buildings	7	Fences	2
Portages	5	Fords	2
Flour mills	6	Groynes	2
Oyster farms	2	Iron works	2
Break waters	6	Navigation markers	2
Coastal defences	6	Plaques	2
Swimming pools	6	Slipways	2

9.2 State of Cultural Heritage

9.2.1 Information on cultural heritage

Cultural heritage sites and landscapes can be discovered through deliberate archaeological survey and investigations, through informal or accidental processes, or through the monitoring of development impacts.

As noted above, information from investigation of sites is recorded in the NZAA Site Record File, and few of these sites are registered with the HPT. No formal process for identifying and recording cultural landscapes exists. Hence, an area rich with sites which defines a cultural landscape has no general recognition. Development proposals within such landscapes, when there are no sites specific to the developer's property, can fail to trigger any protective mechanism.

The ARC Cultural Heritage Inventory (CHI) has created a comprehensive data base from the available information, and hence the basis for improved cultural heritage resource preservation. Work of this scale is yet to be undertaken in other regions.

9.2.2 Types of sites in the Gulf

For the purposes of this report, the Hauraki Gulf cultural heritage area is:

- The Coastal Marine Area
- The coastal margin, within at most one kilometre above MHWS
- The full area of all gulf islands

A wide range of sites are identified in the ARC CHI. These include pa, Maori settlements and middens in the coastal margin, shipwrecks, waka moorings, 19th century industrial sites, waka portages, wharves and jetties, and many others.

9.2.3 Indicators

A national set of indicators has yet to be determined for cultural heritage. The ARC has developed proposed indicators in *A Cultural Heritage Monitoring Network for the Auckland Region* (Mackintosh 2001). These are being applied to selected identified sites, and an ongoing monitoring programme developed. The extent of loss or degradation over time is being recorded. Work is continuing to collect and analyse data from this project.

At a more global level, the number of sites for which an Historic Places Trust Authority for modification or destruction is issued can be monitored. This is not a fully reliable indicator, as some authorities may not be implemented, and others may lead to the destruction of multiple sites. The ARC CHI can record this information, and can be used to provide this wider range of indicators. The ARC reports that 17% of the region has been the subject of archaeological survey; and that 80% of the sites have been damaged in some way (Ross and Foster 1996).

9.2.4 How can the "State" of cultural heritage be defined?

One concept of state is that used by the ARC in its monitoring project: i.e., the state of a selection of specific sites subject to regular monitoring.

Alternatively, the state can be represented by the total number of sites recorded and extant. This is a dynamic state, as knowledge of previously undiscovered sites increases the quantity, and destruction of known sites decreases the quantity.

Unlike many other factors in this or any other state of environment report, that loss of cultural heritage sites is permanent, and full sustainability is in practice not possible. Cultural heritage is a finite, non-renewable resource.

9.3 Pressures on Cultural Heritage

Cultural heritage resources are subject to a range of pressures, both from natural processes such as erosion, and from human activities such as farming and urban development. Ross and Foster (1996) assessed the state of archaeological sites in the Auckland Region and found that the major causes of destruction of historic sites had been from commercial development, especially in the central Auckland area. Over half the surveyed sites in the central city had been destroyed since being recorded and less than half had a NZHPT authority to modify the site. A large number of sites had been damaged by natural processes such as coastal erosion and many sites had been impacted by farming activities. Their work has been followed up by the assessment of Tatton 2001.

Table 9.2 Numbers of significant maritime historic places in the Auckland Region coastal environment

	High	Medium	Low	Total
National	10	5	0	15
Regional	71	82	67	220
District	42	87	180	309
Total	123	174	247	544

Ross and Foster (1996) and Tatton (2001) concluded that the single most contributing factor to the loss of archaeological evidence had been the modification of sites by human activities. Natural processes can play a significant part in the destruction of coastal sites but this is generally a relatively slow and continuing process compared with human-induced destruction. Overall natural effects are outweighed by the collective damaging forces of urban, industrial and commercial activities and the impact of farming activities in the rural sector.

There have not been any comprehensive assessments of the threats on cultural heritage around the Gulf. The following indicators have been suggested as a means of measuring the pressures on cultural heritage sites (Mackintosh 2001):

- Extent of pest and weed impact
- Extent of erosion impact
- Extent of natural hazards impact
- Extent of visitor impact
- Extent of fencing protection
- Extent of development impact
- Land use pressure
- Adjacent land use pressure

Tatton (2001) developed a framework for assessing the threats to cultural heritage resources using four categories:

- Urban growth and development
- Natural processes, such as coastal erosion
- Land use, such as farming and forestry
- Visitor impacts.

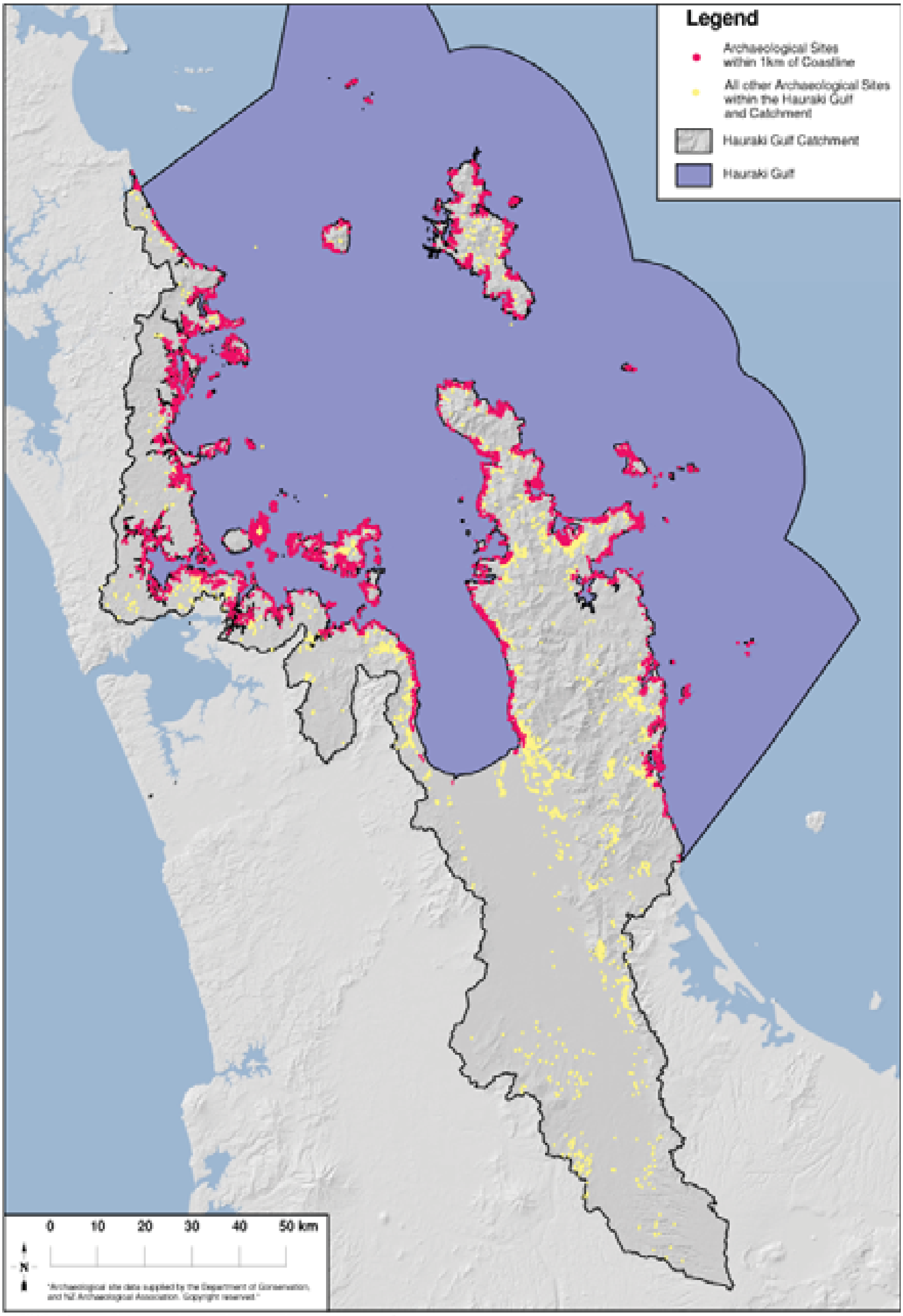

Figure 9.1 Archaeological sites of the Gulf

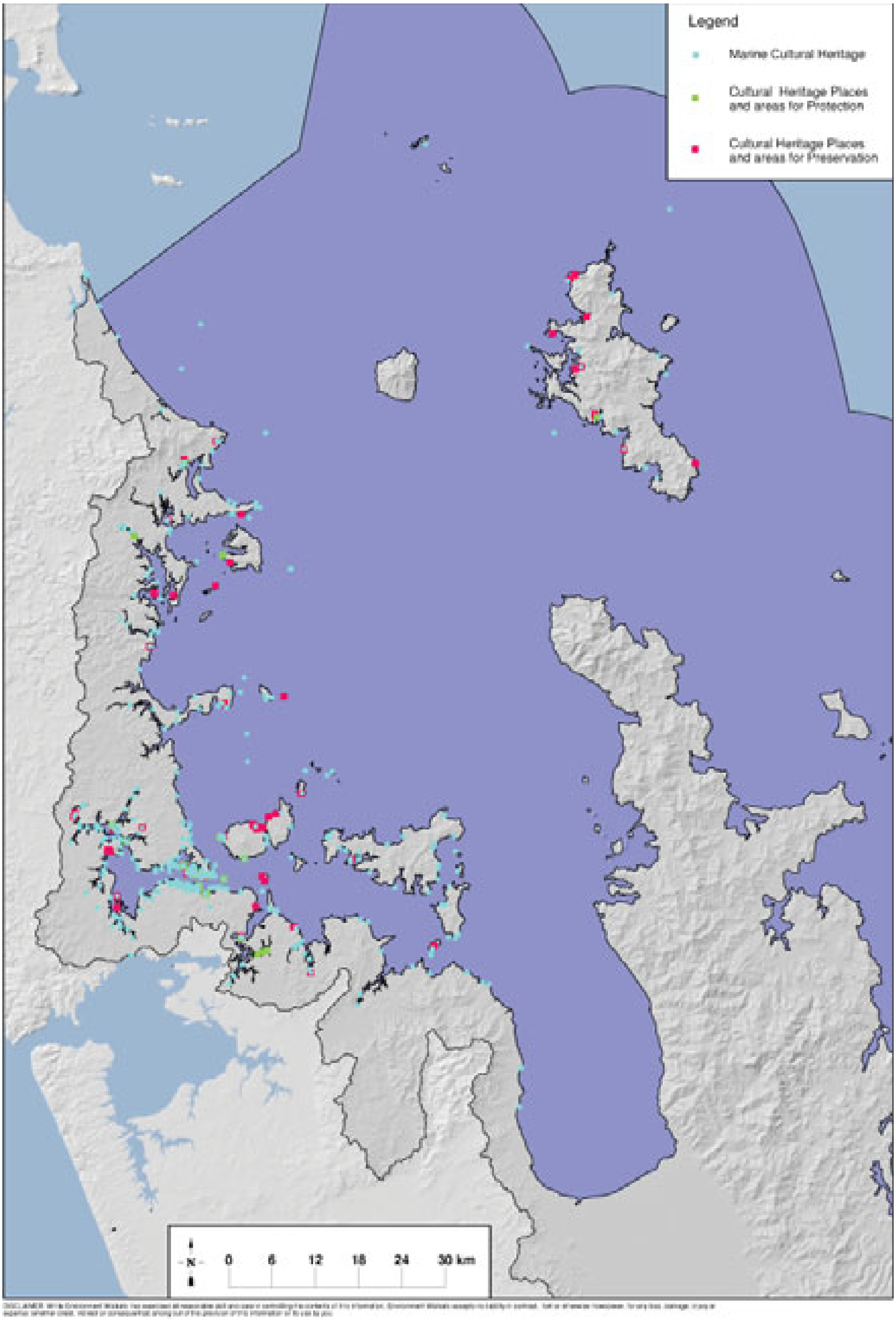

Figure 9.2 Cultural heritage sites of the Gulf

9.3.1 Urban growth and development

Urban growth around the Hauraki Gulf has resulted in the modification or loss of many archaeological sites and historical features. Major engineering works such as roads and pipelines have also affected significant sites.

9.3.2 Natural processes, such as coastal erosion

Natural processes affecting cultural heritage resources around the Gulf include gradual erosion by sea, stream or wind, and more catastrophic events such as slips, floods and fires. Coastal erosion is a key threat for shell middens and coastal occupation sites (Ross and Foster 1996, Tatton 2001). Examples of this issue include Tapapakanga Regional Park where slips and erosion along the coastline have affected two beachfront midden occupation areas (Tatton 2001).

9.3.3 Land use, such as farming and forestry

Farming activities are a major threat to the cultural heritage resources in rural areas around the Gulf. Stock trampling and pugging can cause a significant amount of damage to sites such as storage pits and terraces. Other farming activities such as ploughing or discing can disturb middens and modify landforms. Land changes such as reversion to scrub can hide archaeological sites and cause damage from tree roots.

Forestry can damage cultural heritage sites through roading and tracking activities. Tree roots can also disturb sites.

9.3.4 Visitor impacts

Many of the cultural heritage sites that remain are in parks and reserves and are impacted on by the activities of visitors. This can be directly through fossicking or erosion from people walking over a site. Damage can also be caused through the provision of facilities such as buildings, carparks, playgrounds and tracks.

9.4 Responses to Pressures on Cultural Heritage

Progress on Forum Actions

The Forum's strategic issues document listed the following priority action regarding cultural heritage:

- **The Forum will raise awareness and understanding of cultural heritage values and preservation, in particular with regard to archaeological landscapes and heritage values of tangata whenua.**

The Forum has begun scoping a communications strategy. Cultural heritage values are one of the matters that have been considered in this work.

Other Progress

The Forum's strategic issues document listed the following priority action that it would encourage members to undertake regarding cultural heritage:

- Develop an efficient, effective and integrated information management system to record and store archaeological information.

ARC continue to update and expand the Cultural Heritage Inventory, a GIS based database of cultural heritage sites.

North Shore City is currently reviewing its archaeological sites record and will include the results on GIS.

Auckland City Council is also piloting a major study of the Gulf.

9.4.1 Local government: planning responsibilities

"The purposes of the [HPT] Register as set out in Section 22 (2) [of the HPA] are to inform members of the public about historic places, areas and wahi tapu, to notify owners of historic places, areas and wahi tapu, and to assist the protection of such places through the Resource Management Act. Consequently, while the Trust's register identifies places it is left to territorial authorities to manage their long-term survival" (Allen 1998).

"A review of local authority heritage protection measures ... found that councils were relying too heavily on scheduling as a protective measure when their District Plans and associated rules provided little protection for any listed places…." (Allen 1998). This means that a prescriptive approach is being used, i.e., a schedule of sites. The more appropriate RMA approach of planning instruments providing an effects based methodology, is less evident in general.

As noted above, the HPT has the role of identifying and recording sites, but local government has the responsibility for their management and long term protection. Further, the limitations of a prescriptive approach through schedules of sites must be recognised. An RMA relevant approach must reflect that effects-based nature of the Act. Further, since the amendment to the RMA in 2003 it is now a new matter of national importance to recognise and provide for ... the protection of historic heritage from inappropriate subdivision, use, and development. All local bodies need to consider plan changes to ensure that this purpose of the Act is implemented, and that objectives, policies and rules give appropriate guidelines and constraints.

Box 9–3

Stony Batter Historic Reserve

The impressive remains of a Second World War 9.2 inch Counter Bombardment (CB) Heavy Coast Defence Battery survive at the eastern end of Waiheke Island. The 9.2 inch CB battery at Stony Batter is one of only three built in New Zealand; others are at Whangaparaoa and Wright's Hill in Wellington.

A combination of good design and isolation has resulted in a remarkably good state of preservation. The extensive use of underground tunnels and connecting passages, and the adoption of existing civil rather than military designs, are unique in coast defence battery design. Stony Batter is considered to be an engineering heritage site of international significance.

Stony Batter is a Historic Reserve managed by DOC. The Stony Batter Protection and Restoration Society was formed to restore the Stony Batter defence complex.

Source: Department of Conservation

9.4.2 Local government: data responsibilities

Without reliable and accurate data, management responses can only be minimal. To an extent, the problem of insufficient information can be always somebody else's responsibility. The largest data base, the NZAA archaeological sites, is not automatically integrated with other sets of information. Local government can, as the ARC has demonstrated, construct comprehensive data bases including the NZAA information, maintain their currency, and use the data in proactive ways. The ARC has, for instance, identified areas under pressure from subdivision from information in planning instruments, overlaid those areas with archaeological information, and provided advice to territorial authorities on potential management challenges. Alert layers can be constructed to trigger precautionary measures.

However, this work only happens where there is a political will to initiate it, and where there is a willingness to allocate resources to it. Arguably, the ARC has a scale that makes that more achievable.

9.4.3 Responsibilities of other agencies

The Historic Places Trust is not a constituent party on the Forum, and while its role is critical to aspects of cultural heritage, its responses fall outside the scope of this report.

The Conservation Act 1987 includes as functions of the Department of Conservation (DOC): "to manage for conservation purposes, all land, and all other natural and historic resources, for the time being held under this Act" and "to advocate the conservation of natural and historic resources generally". There are many sites within the Gulf in the DOC estate managed by the Department. These include examples of both pre-European Maori and post contact sites.

9.4.4 Department of Conservation Guiding Policy: Historic Resources

As manager of almost one third of the country, DOC has responsibility for a substantial part of New Zealand's historic heritage. The Reserves Act 1977 administered by the Department also has an important role in providing for the management of historic heritage by other parties.

DOC's first national historic heritage strategy was published in 1995. The strategy was revised in 2001 to take account of significant changes which have occurred since then. These include the restructuring of the Department's organisation in 1997, the establishment of the Ministry for Culture and Heritage in 1999, and the publication of the Department's Statement of Intent in 2001.

DOC's primary strategic focus for its historic heritage work is conserving and interpreting historic heritage in areas for which it is responsible.

There are six parts to this strategy. The priorities of each are:

1. Repairing and maintaining key historic heritage in areas managed by the Department. Only selected historic places can be repaired and maintained. An asset management approach has been implemented as a basis for prioritising work nationally.
2. Placing a stronger emphasis on the historic and cultural values of protected areas. Interpretation and active management of high priority historic heritage in areas managed by the Department will be enhanced.
3. Contributing, with other agencies, to the protection of a more comprehensive range of historic heritage. Where purchase is involved, protection can only be extended to a small number of high priority historic places. Other agencies which contribute to this outcome include the HPT, local authorities and community organisations.
4. Increasing community participation and improving co-operation with other agencies in historic heritage management.
5. Strengthening partnerships between the Department and tangata whenua to achieve historic heritage conservation.
6. Strengthening the Department's historic heritage management capability. This will ensure that the priorities summarised above are achieved.

The guidelines in the National Heritage Strategy influence the direction of historic resource management specified in each Conservancy Conservation Management Strategy (CMS). Further detail is outlined in each Conservancy's Historic Heritage Strategy and is implemented on a day to day basis through the Department's computerised Historic Assets Management System (HAMS). This in effect schedules the annual cycle of maintenance and remedial work.

Concept of Active Management

The DOC has a guardianship role over all heritage sites on the lands it administers but it recognises that some sites are better suited than others for long term preservation, public interpretation and education purposes. These are the ones (about 10% of the total) that it 'actively manages' and invests large sums annually to maintain them to a standard. Reasons that influence their selection include their historic, technological and social significance as well as ease of accessibility, stability and resolution of public safety issues.

In the Hauraki coastal area there are literally hundreds of Maori archaeological sites, especially concentrated on the offshore islands, around harbours and along waterways up to five kilometres from the coast. The sites include pa, kainga, wahi tapu, fish traps, pits, terraces, middens, rock shelters, rock art and quarries and rock sources for stone tool production. All these sites are significant to tangata whenua groups. In addition there are much smaller numbers of European era sites including jetties and gold workings and industrial sites and military sites near the sea.

DOC, along with other stakeholders such as the HPT, has a mandate to raise awareness and understanding of cultural heritage values and the preservation of key heritage sites and landscapes. This includes those of tangata whenua.

The national archaeological site record data base (containing records of more than 55,000 sites) was established by the NZAA in 1959. The Department actively assists the Archaeological Association to maintain and expand the database. For example the Hauraki and Waikato area files (8000 site records) are housed in the Waikato Conservancy office in Hamilton and are administered by the Conservancy Archaeologist. The Department's Head Office maintains the computerised index of archaeological sites in the NZAA database (CINZAS). Eventually it is anticipated that other stakeholders such as Environment Waikato, the Auckland Regional Council, District Councils and iwi will have full on-line access to the database.

The Department's mandate requires it to support and encourage community and tangata whenua actions to promote and protect significant cultural heritage in the Gulf and elsewhere.

The Department's policy is to work with tangata whenua to devolve the management of waahi tapu to tangata whenua if they wish as a way to protect the heritage and cultural values of the places in question.

9.4.5 Evaluation of local government responses

The Historic Places Trust has recently published *Heritage Management Guidelines for Resource Management Practitioners* (HPT 2004). Based on the roles and responsibilities of councils identified in these guidelines, the following criteria for evaluation of statutory planning instruments and council procedures have been derived:

For all councils:
- Review heritage within jurisdiction;
- Determine criteria for identifying and assessing heritage of importance;
- Require assessment of effects of activities on heritage;
- Promote integrated management of heritage;
- Keep a copy of the NZAA site records;
- Create heritage alert layer using a predictive model.

Regional Policy Statements:
- Require integration of heritage conservation in planning instruments;
- Establish objectives, policies and criteria for identifying and assessing historic heritage of regional significance;
- Give guidance on appropriate themes and criteria for identification of heritage places of regional significance;
- Provide a context for research strategies for investigation and recording of heritage sites.

District Plans:
- Identify significant resource management issues associated with heritage protection;
- List and map identified sites of significance;
- Incorporate an alert layer for areas where assessment required;
- Have rules for assessment, and where appropriate to decline, activities impacting on heritage sites;
- Include a policy to recognise and apply the ICOMOS[85] Charter, or integrate the Charter into policy framework.

9.4.6 Application of criteria

Evaluation using these criteria determines the extent to which planning instruments recognise and provide for cultural heritage protection, establish effective management, determine criteria for significance, set out issues informatively, and contain rules which may decline resource consent applications when the application may have adverse or irreversible impacts on significant cultural heritage items; and whether plan changes are being considered or implemented to reflect s6(f) of the RMA[86]. While prescriptive schedules can provide specific protection, the extent to which known and unknown sites and landscapes not on a schedule are protected from the effects of an activity is critical.

[85] International Council on Monuments and Sites

[86] "The protection of historic heritage from inappropriate subdivision, use and development"

When the constituent councils and their planning instruments are considered in terms of the evaluation criteria the following conclusions can be drawn:

- Both the Auckland and Waikato Regional Policy Statements meet the criteria of the HPT, except for the predictive alert layer requirement;
- All councils have schedules of cultural heritage sites;
- Most councils meet, or partially meet the remaining criteria.

An alert layer as considered by the HPT is a GIS based predictive method of determining areas of high probability of the presence of yet to be discovered sites. This can then be overlaid on LIM or planning maps so that an alert is triggered within specific areas so that appropriate responses can be made. Therefore known individual sites are not the only indicator of a precautionary response. At present no councils have this capacity, although the ARC is developing the capacity.

The availability of physical, rather than electronic, map overlays is more common. These then require a value judgment to determine whether the proximity of known sites is sufficient reason for a precautionary approach.

9.4.7 Other responses

These responses can include incentive funds with appropriate policy frameworks to ensure property owners are encouraged and resourced to maintain cultural heritage sites; information and promotion of cultural heritage values; rates relief options for protected or covenanted areas within properties; non-regulatory internal operational policies for increased protection of cultural heritage resources.

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10 Coastal Hazards of the Gulf

Key Points

- Significant parts of the Gulf's coastline are susceptible to coastal hazards.
- Coastal erosion, coastal flooding, and climate change impacts are the main coastal hazards.
- Fluctuations in the position of the coastline are a normal and expected process along the Gulf's 'sandy' coastline.
- The most notable sites of coastal erosion and flooding are near the entrance of tidal estuaries, rivers or streams.
- Coastal cliffs, particularly of Waitemata Group sediments, are slowly eroding, average rate of 4-8m/100 years.
- Storm surges are a frequently occurring phenomenon, most of which are insignificant unless they coincide with high tide, in which case low lying areas are typically flooded.
- The longest record of sea level is that recorded in the Waitemata Harbour. The record shows a trend of rising sea level since 1899 of 1.4mm per annum.
- Climate change is expected to influence a number of 'drivers' of coastal change, e.g. winds, waves.
- The predicted sea-level rise of 0.14 –0.18m by 2050 and 0.31-0.49 by 2100 could lead to a landwards retreat of the coastline – possibly by 15-20m along beach environments.
- Limited knowledge of tsunami. Locally generated tsunami are a significant potential coastal hazard.
- Site specific strategies need to be determined and implemented to address coastal hazard issues, and to ensure that other values, such as the natural character of the coastal environment and pubic access are appropriately provided for.

10.1 Introduction

Coastal hazards arise from the interaction of natural processes with human use, property, and/or infrastructure. Natural processes, such as storms, that drive physical changes in the ocean, along the coastal margin or in the hinterland can lead to a hazard where use and development has concentrated near the coast.

Not only can coastal hazards affect the economy, health, well-being and safety of people and communities, they can also adversely affect vegetation and habitat; public access to and along the coastal environment; visual character; amenity values; recreation; aspects of coastal heritage, such as historic buildings or structure; and sites of significance to tangata whenua, such as waahi tapu, urupa, middens and other taonga.

There are significant parts of the Gulf which are exposed to coastal hazards: coastal erosion, coastal flooding, extreme weather events, changes in sea-level, and tsunami. Of these the predominant coastal hazards are coastal erosion and coastal flooding.

The Forum has identified a series of strategic issues and objectives relating to coastal hazards in the Gulf (see Box 10–1). In order to avoid future hazard risks and to manage existing hazards, councils, affected property owners and the community must work together.

Box 10–1

Strategic Issues and Objectives

The major issues identified by the Forum relating to coastal hazards in the Gulf are:

- Foreshore erosion threatens private property and community assets such as parks and beaches. Degradation and destruction of wetland ecosystems is a major factor exacerbating coastal erosion.
- There is a lack of understanding of natural coastal processes that create and maintain sandy beaches and the long term and cyclical nature of these processes.
- Lack of public awareness and recognition of existing coastal hazards leads to demand for development in high-risk areas, uncertainty of legal requirements and responsibilities, and demand for physical protection works.
- Continuing inappropriate subdivision and development along the coast places more property at risk from coastal erosion and sea level rise.
- Control of coastal erosion or flooding using physical protection works (e.g., sea walls) can have adverse effects on the natural character of the coastal environment, public access and amenity values, biological diversity, waahi tapu and cultural heritage sites.
- Management of coastal hazards is a joint responsibility of regional and local authorities, which if not effectively integrated, may result in gaps or overlaps in management resulting in inconsistency, confusion and ineffective overall management.
- The potential for oil spills is a major risk to the values of the Gulf.

The Forum identified the following objectives for coastal hazards in the Gulf:

- Consistent and co-operative management of natural hazards between regional councils and territorial authorities.
- Communities and agencies have a greater understanding and respect for natural coastal processes and the need to take the long-term view to allow for natural processes and manage development on the coast accordingly.
- Where protection of coastal development is appropriate it is undertaken in a way that minimises effects on the environment, waahi tapu and cultural heritage sites of tangata whenua, while allowing reasonable use of coastal properties.
- Existing wetlands are maintained, enhanced and protected and where possible areas of wetland are restored.
- The potential for oil spills is minimised through preventative management and recognition of MARPOL regulations.

10.2 State of Coastal Hazards in the Gulf

10.2.1 Coastal Erosion

Fluctuations in the position of the coastline (advance, retreat or dynamic equilibrium) are a normal and expected process on virtually every part of the Gulf's coastline. The change in position of the coastline invariably is the result of natural processes, however, it may result from or be exacerbated by human activities.

In general terms, *short term* coastal erosion is associated with the dynamic coastline fluctuations which occur on all beaches. Averaged over time such fluctuations do not result in permanent coastline retreat, and are regarded as part of the 'dynamic envelope' of the active beach. Evidence suggests that most of the coastal erosion of the Gulf's beaches is in this category.

The most notable sites of coastal erosion and fluctuations in the position of the coastline are near the entrance of tidal estuaries, rivers or streams. These areas can be very dynamic and experience large coastline movements, greater than 100m in places. However the general range of coastline movement for beaches not near estuary, stream or river entrances, are typically in the order of 10 – 40m.

The landward translation of the coastline (generally 20+ years) is termed long term coastal erosion. A few beaches in the Gulf are subject to *long-term* coastal erosion. Generally, average rates of long term erosion are slow, usually less than 0.1 to 0.2m/yr, but some sites have experienced higher rates, e.g. Koputauaki Bay on the western Coromandel coast has experienced an average rate of erosion of 0.3 – 0.4m/yr over the past 90 years.

Erosion along the Gulf's cliffed coastline is common. Rates of erosion are variable, due to the range of controlling factors, e.g. rock properties, aspect, angle of wave approach, groundwater. All cliffs, however, have at least one thing in common, the loss of material is a oneway process. Once the cliff has eroded it does not reform. The effect is a regression of the coastline.

Coastal cliffs in the Waitemata Group sediments (sandstones/siltstones) in general are retreating at an average rate of 4-8m/100 years.

Where rivers and streams have delivered sediment (predominantly gravel) to the coast, low-lying flat areas of land have been developed, such as at Te Puru, in the Firth of Thames. These deltaic fans have been heavily developed, and as they are low lying they are prone to coastal erosion and flooding. There is evidence that such landforms might be substantially reworked over periods of 50 – 100 years.

Over 75 percent of all beaches along the Gulf's coastline have, to some extent, been subject to human developments. Such development is in general very close to the sea, for example along the Coromandel Peninsula over 70 percent of all beachfront development is setback less than 100m from the sea. Hence much of this development is susceptible to coastal hazards.

10.2.2 Coastal Flooding

Coastal flooding (the inundation of land by seawater) occurs relatively frequently in low lying areas of the Gulf. The Miranda Plains and the alluvial deltaic fans along the Thames-Coromandel coast are particularly vulnerable to coastal flooding, however, flooding is not restricted to those areas. For example, Whitianga, Tairua, and Maraetai have all been subject to flood events in recent years.

Coastal flooding generally occurs as a result of significant storm events coinciding with periods of high tides, storm surge and high wave energy. Rainfall across catchments that raises river levels, add to the flood risk, particularly in the vicinity of river mouths.

10.2.3 Extreme weather events

Extreme weather events, primarily ex-Tropical Cyclones (1/yr) and subtropical storms, at times generate storm surges. Storm surges can raise the sea level by 0.5 to 0.7m. Typically coastal erosion and coastal flooding of low lying land, are associated with storm-surges. Storm surges, in New Zealand, are mainly driven by atmospheric pressure changes, with winds usually having a relatively minor effect as our weather systems move rapidly across the region, giving the ocean little time to respond before the wind changes direction. This means that storm surges are limited by the change in atmospheric pressure, which typically drops by up to 40hPa in a storm, resulting in water level rises of up to 400mm[87].

Storm surges around New Zealand have had an upper limit of approximately 1m above the predicted tide. The highest recorded storm surge was 0.9m at the Port of Tauranga during the 'Wahine' storm in 1968. Historical storm-surges in NZ have not produced extensive flooding, except on the Hauraki Plains. A storm-surge in 1938 flooded about 35 000 ha, extending inland as far as Ngatea, 7.5km from the coast. The total elevation for this event, including tide, storm-surge and wave set-up was 3.0m above mean sea level. A smaller storm-surge (2.5m) on 14 July 1995 caused more than $3 million of damage in Thames.

Storm surges are a frequently occurring phenomenon. New Zealand experiences approximately 20 significant storm surge events a year. These can be significant when they coincide with large tides.

10.2.4 Changes in Sea Level

In terms of coastal hazards, it is the trend in *relative* sea-level rise that is important (i.e. the change in sea-level relative to the local landmass).

The last major change in sea-level (about 6000 years BP) established the position of our present coastline. There is substantial evidence of historical sea-level rise on a world wide scale, and an often cited consequence of climate warming is sea-level rise. The longest sea-level record in New Zealand is that for the Port of Auckland (Waitemata Harbour). That record shows a trend of rising sea-level since 1899 of 1.4mm per year (or 0.14m per century). In comparison the NZ average has been slightly higher at 1.7mm/yr, and the global average over the 20th Century was a rise of between 0.1m – 0.2m.

Global warming is projected to cause an acceleration of sea level rise, mainly through thermal expansion of a warming ocean, and to a lesser extent meltwater from glaciers and non-polar ice caps. To-date there is no discernible evidence of an increase or acceleration in the rate of sea-level rise. However, a sea-level record contains a spectrum of responses of the ocean to the various physical driving forces, e.g. storm surges, tides, changing atmospheric pressure, effects of the Southern Oscillation, and a recently discovered phenomenon called the Interdecadel Pacific Oscillation (IPO) which operates across the Pacific Ocean at 20-30 years cycles, meaning identifying a

[87] Using the inverted barometer relationship which says that when pressure drops by 1 hPa, sea level will rise by 10mm

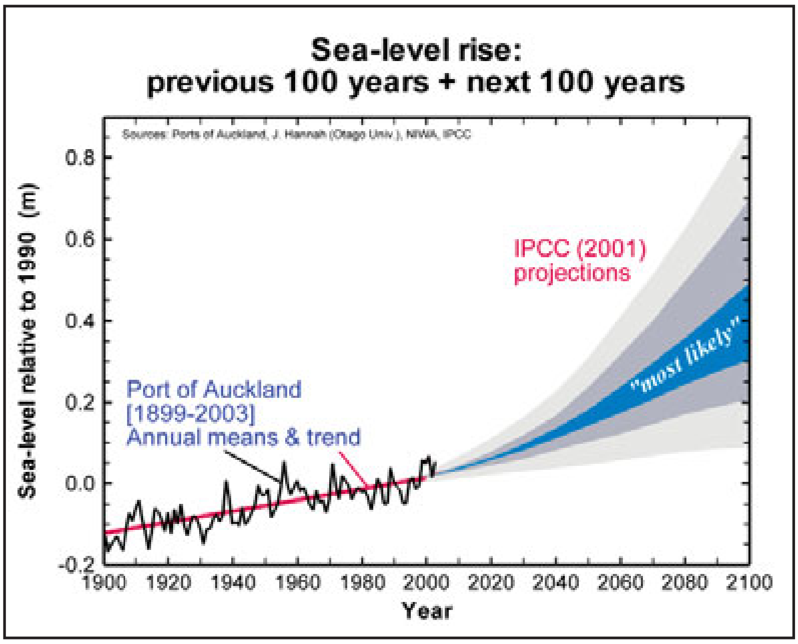


Figure 10.1 Sea level rise in the Waitamata Harbour since 1899.

change that is measured in millimetres will be difficult to discern.

The sea-level record shown in Figure 10.1 has distinct fluctuations at timescales of a few decades that appear to match with the 20-30 year cycle of the IPO. It is notable that when the IPO is in its negative phase, sea-level rises faster than when IPO is positive. The graph shows that the IPO appears to have shifted to a negative phase around 1998. Therefore over the next 20-30 years sea-levels round NZ will probably rise faster than the average trend.

10.2.5 Tsunami

Tsunami can be loosely grouped into those that are generated beyond the continental margins (distant or teletsunami), and those generated on or within the continental margins (local tsunami). There is limited knowledge of the Gulf's vulnerability to tsunami, particularly for locally sourced tsunami that represent the greatest potential hazard.

Distant tsunami are estimated to have a maximum height of 3.6m above mean sea level. Since the 1800s distant tsunami have generally reached 1-3m in height along the NZ coast. There is evidence that there has been at least four 'moderate', distant tsunami recorded along the eastern Coromandel coast over the past 120 years. The most recent, in May 1960, was generated off the South America coast and caused minor flooding in low lying areas, including Whitianga. It has been calculated that potentially damaging teletsunami have a moderately high return period (~75 years).

Local tsunami are generated by seismic activity (earthquakes) and volcanic activity. Seismically generated tsunami are likely to be in the order of 2.5-3m above mean high sea level. It is unlikely that tsunami generated by volcanic activity will be larger than teletsunami or local, seismically generated tsunami.

10.3 Pressures on, and from Coastal Hazards

Fluctuations in the position of the coastline (advance, retreat or dynamic equilibrium) and coastal flooding is a normal and expected process on the Gulf's coastline. The fluctuation of the coastline and/or flooding is not generally a problem, except where valued assets and infrastructure are located along a retreating or low-lying coastline. The close proximity of development along the Gulf coastline and the damage caused to natural dune systems, e.g. the lowering of dunes to improve sea views, has resulted in widespread coastal hazard problems in the Gulf, with many houses and properties threatened by coastal erosion and flooding.

The potential for coastal hazards to become of greater concern over the next 50-100 years, and beyond, is considerable. The likelihood is that ongoing subdivision and development of coastal areas, particularly intensification of existing beachfront development, and sea level rise and other changes, e.g. increased frequency and intensity of storms, that may accompany global warming will increase the incidence and risk of coastal hazards. Similarly, development in close proximity to the sea has a high likelihood of detracting from the natural character of the coastal environment, and having adverse effects on amenity, cultural, recreational, and public access values.

10.3.1 Climate Change

Global warming is likely to affect most of the physical processes that drive changes along coastal margins. The drivers of coastal change are:

- Winds – extreme storms and prevailing windiness
- Waves – extreme storms and prevailing wave climate
- Sea-level variability – seasonal, interannual ENSO and interdecadel IPO cycles
- River flow – extreme storms and baseflows
- Storms and cyclones – incidence, intensity, tracks, storm surge
- Ocean and coastal currents
- Sediment supply to the coast.

It is anticipated that the coastal response to climate change will be a mix of change to these drivers, rather than a simple response dictated mainly by the rise in sea level.

10.3.2 Sea Level

The effects of sea-level rise will vary by location and depend on a range of physical, and biological characteristics, as well as socio-economic factors. The primary effects will be physical changes to the environment. Probable changes will include the following hazards.

Coastal erosion:

The predicted sea level rise (0.14 – 0.18m by 2050 and 0.31 – 0.49m by 2100) could lead to a landwards retreat of the coastline of 15 – 20m at beaches along the Gulf's coastline over the next century. However, predicting coastline response to changes in sea-level is a complex matter. Simple conceptual models of coastline response based mainly on sea-level rise (such as the often cited Bruun Rule) are at best indicative. The potential effects of sea-level rise on beaches that have historically exhibited a trend of erosion will be continued erosion, but at a faster rate. Dynamically stable beaches (fluctuate round a stable position) are likely to show a bias towards erosion, unless the supply of sand balances the rise in sea-level. Accreting beaches are likely to continue to accrete, but more slowly – again the supply of sediment being a major factor. Erosion of cliffs comprising of sedimentary rocks and clays/silts will continue, at similar rates. Estuarine coastlines are likely to erode.

Coastal flooding

Sea level rise will result in more frequent coastal flooding. This will include inundation of low-lying coastal areas by extreme tides and storm surge, and permanent tidal inundation of low-lying coastal margins. The implications of this include a landward shift of the coastline along undeveloped low-lying areas and consequent damage to assets located in those areas. On developed coastal margins, especially within estuaries and harbours, where the coast is fixed in position by seawalls, a rising sea level is likely to reduce the extent of intertidal area, and a potential loss of habitat. The loss of intertidal habitats may affect the gathering of kaimoana/seafood, and have consequences for estuarine ecosystems in general. Potential effects include salinisation of coastal wetlands, lower reaches of rivers, aquifers and soils from incursion up rivers or seepage of seawater. Increasing salinisation of coastal margins will have an effect on their flora and fauna.

10.4 Responses to Pressure on and from Coastal Hazards

Current development trends, natural variability and climate change impacts are likely to exacerbate existing coastal hazards, and present new ones. The potential is for property to be damaged and human safety to be put at risk, and/or the environment to be degraded as a result of people's response to the issue, e.g. eventual loss of some beaches, coastal wetlands, or estuary intertidal areas.

Success in avoiding, remedying and/ or mitigating coastal hazards requires a comprehensive understanding of the areas susceptible to those hazards, an understanding of the frequency and magnitude of those hazards, and an understanding of the effects of undertaking activities within areas susceptible to coastal hazards.

In order to successfully manage coastal hazards the HGF determined the need for the following actions:

Progress on Forum Action

- **Co-ordinate and promote opportunities for learning such as visiting speaker, conferences and reports that are relevant to the issues faced by several parties.**

To date the Forum has ensured that actions undertaken by its constituent parties have been made available to all Forum parties.

Other Progress

10.4.1 Co-ordinated development of educational materials.

Coastal hazards are generally manifested at a specific locality, e.g. coastal erosion at Cooks Beach, though the physical process that in part creates the hazard, e.g. Cyclone Drena, may affect more than one locality. Generic information about coastal hazards is therefore useful, however implementing proactive and/or reactive responses requires site specific understanding as a basis for determining the appropriate response and to enable community buy-in. Further, within a particular community it is usually necessary to particularly raise the awareness and understanding of coastal hazards for sea-front property owners.

Therefore educational materials of a site specific nature, for example the Browns Bay Coastal Hazard Management Strategy developed by the North Shore City Council and ARC is usually required to determine appropriate outcomes.

Site specific educational material generally adds to and builds upon the more generic educational material, such as the ARC's Coastal Erosion Management Manual (CEMM) and EW's Coromandel Beaches: Coastal Hazards and Development Setback Recommendations, and the NZ Climate Change Programme's publication, Planning for Climate Change Effects on Coastal Margins.

The challenge for resource managers is to achieve community buy-in to long-term planning for coastal margins.

10.4.2 Planning to avoid the damage or destruction of waahi tapu and cultural heritage sites by physical protection works.

There are many areas of special interest to Maori, such as sites of urupa, middens, waahi tapu and marae, along the Gulf's coastline that are or may be subject to coastal hazards. Some, but not all, are provided a level of recognition and protection as they have been identified as sites worthy of protection within statutory plans, for example the Stone working area/midden known as the Sunde Site on Motutapu Island which is included in Schedule 1: Cultural Heritage Sites for Preservation, of the Proposed Auckland Regional Plan: Coastal. However, the majority of cultural heritage sites are not identified in statutory plans and how they are protected in terms of coastal hazards is generally determined on a case-by-case basis, and subject to the level of priority accorded to that matter via the annual planning process.

10.4.3 Joint coastal hazards assessments.

A number of joint coastal hazard assessments have been undertaken round the Gulf, including for Browns Bay (NSCC/ARC), Onetangi Beach and Huruhi Bay, which are both on Waiheke Island (ACC/ARC), Maraetai Beach (MCC/ARC), Buffalo Beach/Whitianga, Cooks Beach and Tararu (TCDC/EW). These projects have improved our knowledge of coastal hazards in the Gulf, and provide good working examples of coastal hazard assessments, including the identification of appropriate management options.

At the regional scale, Environment Waikato has identified the coastal hazard at Coromandel beaches and the ARC has identified the areas susceptible to coastal hazards for its entire region (Technical Reports in print).

The safe management of coastal hazards will require the dissemination of this information (areas susceptible to coastal hazards) and collective determination of how it can be used to appropriately manage coastal hazards. This component of work is planned for 2004/05.

In addition to the aforementioned, various projects are undertaken that contribute to our understanding and management of coastal hazards, including:

- Investigations and monitoring programmes of physical coastal changes. For example Councils undertake beach profile monitoring programmes. Generally these are co-ordinated to extend the usefulness of the datasets, and/or are collaborative programmes, and information is shared.
- Determination of the wave climate. The ARC has run a 5-6 year programme focused primarily on the Auckland Region, but including the Firth of Thames.
- Public perception surveys – contribution to GNS survey.
- Contribution to Coastal Dune Vegetation Network.
- Support and collaboration in associated projects, e.g. NIWA's national sea level monitoring programme.

10.4.4 Promotion of consistent policy direction and management of coastal hazards.

Coastal hazards affect peoples' lives, lifestyles and properties. By their very nature, coastal hazards can have devastating effects on people and communities. Resource managers and communities will need to make some very tough decisions on the future of some areas.

As stated by the Intergovernmental Panel on Climate Change in 1996, '*The challenge is not to find the best policy today for the next 100 years, but to select a prudent strategy and to adjust it overtime in light of new information*'.

Local authorities have developed a good understanding of the spatial and temporal extent of coastal hazards throughout the Gulf. Current statutory direction needs to be reviewed in light of this information and in light of overall coastal management objectives. A key issue here is a need for a truly integrated approach.

10.4.5 A consistent approach on approaches to the management of coastal erosion

Historically coastal hazards, such as coastal erosion, have typically been managed by adopting an engineering approach, e.g construction of a seawall, as evident by the large number of coastline armouring devices that line the Gulf's coastline. However, as almost universally accepted now, it has been recognised that there are usually severe consequences of adopting a 'simple' engineering approach. Rather it is recognised that the appropriate approach to coastal hazard management requires a consideration of the three main types of response to manage coastal hazards:

- Planned retreat: moving away from the coastline.
- Adaptation/accommodation: includes altering the use of land, and adaptive responses such as the elevation of buildings and roads etc, and enhancing natural 'protection systems', e.g. dunes.
- Protection/defence: involves maintaining the coastline in a 'fixed' position, either by 'hard' solutions, e.g. seawalls, or 'soft' solutions, e.g. beach nourishment.

Invariably the most appropriate response at any particular site is a combination of 2 or more of the aforementioned categories.

It is arguable whether a consistent approach has been adopted across the various management agencies. Any management approach should demonstrate that each of the following steps have been properly considered:

- Confirmation that there is a problem. For example, is coastal erosion occurring, at what rate, and what will the consequences of that erosion be?
- Determine the cause (or causes) of the problem – a prerequisite for determining the appropriate management response.
- Understand the environmental context, i.e., the key values and uses of that particular part of the coast.
- Identify the range of management options.
- Select appropriate management approach(es).

- Assess the potential environmental effects of the management options.
- Select preferred approach.

This approach is consistent with various statutory policies, but perhaps none-more-so than Policy 3.4.6 of the NZCPS. This approach is set out in the ARC's CEMM, and has been the basis for the previously mentioned coastal hazard management plans (developed by the ARC in partnership with TLAs of the Auckland region).

There is a new imperative for integrated coastal management, and a recognition that greater direction is required than what the various statutory plans currently provide. Over the next 5 years greater consistency and direction will be provided. That direction and consistency is likely to be achieved through the development of Coastal Compartment Plans, and/or changes to the various city/district/regional plans.

References

EW Technical Report 02/06 - Coromandel Beaches: Coastal Hazards and Development Setback Recommendations, April 2002.

11 Conclusion

This report presents a wealth of information. Indeed, there is so much information on specific issues that some readers may well be left wondering:

- Overall, how good or bad is the environment of the Gulf?
- Is it getting better or worse?
- Are management agencies doing enough?
- When can we expect to see an improvement?
- Are there pressures on the Gulf that are unmanaged or unmanageable?
- Are the issues that the Hauraki Gulf Forum identified in its strategic issues document really the key issues for the Gulf or are there other matters that have arisen as a result of the preparation of this report?
- How much do we really know about the Gulf's environment and what's affecting it anyway?

These are not unreasonable questions but they are much harder to answer than might be first thought.

The first point to note is that this report is the *start* of a process, not an end in itself. The Forum will be using the information provided in this report to answer the questions outlined above in the most rigorous way it can. This will inform the future work of the Forum and its constituent parties.

To some extent, the state of the Gulf and whether it is better or worse depends on your reference point. There can be little argument that the environment of the Gulf is degraded when compared to its pre-human or even pre-European state. There has been a massive acceleration of sedimentation of estuaries, contaminants within those sediments have increased, the number of species present has reduced as has the size of specific habitats and populations, access to many coastal areas is more limited, landscape values and natural character have changed markedly, in some cases irreparably, much cultural heritage has been lost forever and the risk associated with natural hazards has increased.

On the other hand, compared to more recent times many aspects of the Gulf's environment are well protected and are exposed to reduced threats. The state of some places and resources has almost certainly improved (or at least further degradation averted) and some natural systems have been given time to adjust to a new balance. The removal (or control) of many point source discharges, the reduction in lead in sediments, the restoration of islands and their use for species recovery, the recovery in the snapper fishery, and the purchase of coastal land by public agencies, are all signs that management efforts are making a difference. Whether these efforts are enough will be a question for on-going attention by the Forum.

In the future, environmental performance in the Gulf will be able to be assessed against the information contained in this report and a more rigorous assessment of progress may be made.

It is important to record, however, that this report does identify matters that certainly should concern all those with an interest in the Gulf. In particular:

- Although beach monitoring indicates bathing beach water quality is suitable for swimming on the vast majority of time it is monitored, it is also well accepted that water at many beaches adjacent to urbanised catchments is unsuitable for swimming after heavy rain. The Forum will need to support continuing work on catchment planning and stormwater (and wastewater) upgrading programmes.
- Notwithstanding improvement in stormwater and land management,

the rates of sedimentation (and the contamination associated with sediment in urban areas) will continue to have impacts on ecology and water quality. This serves to reinforce the importance of the Forum and the benefit of having a layer of management co-ordination across the entire catchment.

- Biodiversity continues to be subject to a variety of threats. Shell fish depletion is perhaps the most visible issue and seems related to environmental change – most notably sedimentation. One of the greatest challenges for the Forum and its constituent parties is in gathering sufficient information to monitor biodiversity and be certain of cause and effect relationships.
- Coastal development pressure, particularly in areas north of the Auckland metropolitan area and on the Coromandel, will have long term effects on the environment. Traditional planning approaches may not be adequate to protect the values over the long term. Management agencies will need to develop, and are developing, new management tools to protect coastal values. The Forum will need to work to ensure these are implemented expeditiously.

In preparing this report the Forum has learnt a great deal about what, and how information is currently collected and collated by constituent parties and other agencies. It has become apparent that the Forum will need to focus more attention on securing consistency in information collection and on promoting Gulf and Catchment-wide frameworks for environmental monitoring and reporting.

In particular, the Forum will need to give greater consideration to the following information issues:

Water

- Differences in monitoring programmes and guideline interpretation make it difficult to compare bathing beach water quality across the Gulf. This is an on-going issue that will need to be resolved at the national level. In the interim, however, there is potential both to look at alternative state of the environment indicators of bathing beach water quality (such as the number of waste water overflows) and to increase consistency of approach to measuring and reporting enterococci levels.
- While our understanding of nutrient dynamics in the outer Gulf has improved, there is currently no nutrient monitoring in near shore areas of the Firth of Thames or around the Coromandel Peninsula. Baseline monitoring of estuaries on the Coromandel Peninsula and Firth of Thames could be useful to determine whether there are any nutrient management issues for these water bodies. In addition, new methods such as remote sensing may assist in developing a broader picture of nutrient dynamics for the wider Gulf.
- Local authorities' resource consent databases are not currently designed in a way that allows critical information on waste water discharges (and other issues) to be extracted efficiently. Consequently state of the environment reports cannot include information on cumulative contaminant loads that might provide a useful indicator for the state of the Gulf. Furthermore many databases do not geo-reference the locations of consented activities meaning that the information cannot be interrogated using Geographic Informations Systems.
- Although there is good information on historic sedimentation rates for many Auckland and eastern Coromandel harbours estuaries, there is little information on sedimentation rates and dynamics within the Firth of Thames.
- There is little quantitative information of the effects of waste water, particularly septic tanks, throughout the Hauraki Gulf. Information on sewer overflows and pump station failures is also difficult to obtain.

Biodiversity

- Information on the Gulf's biodiversity is piecemeal. The information that does exist has various limitations, it may: only cover parts of the Gulf; focus on particular species or habitats (to the exclusion of others); be limited in time (and therefore not allow trends to

be determined or a sense of historical perspective); or be collected under varying conditions or methodologies (making comparison over time or between places difficult).
- Regular monitoring information focuses on indicator species which reflect estuarine health rather than species diversity. There is little or no monitoring of species or habitats outside estuaries and little or no monitoring for biodiversity *per se*.
- Spatial framework(s) are under development but either (like the MEC) do not provide direct species data or, like the INMARC provide species/habitat information only within near shore environments.

Natural Character and Landscape
- While there is some qualitative information available about natural character, there is no information on the state of different coastal environments along the Gulf's coastline, e.g., the state of beaches, rocky and cliffed coastlines, sheltered harbours and estuaries, etc.
- Natural character assessments undertaken to date have generally focused on marine farming areas (e.g. the Firth of Thames and Tamaki Strait - Waiheke Channel). The demand for marine farming in some ways has created a default priority for natural character assessments. While this is understandable there are other priority areas that are being neglected (e.g. beach and dune systems). Outside of the marine farming areas and north-eastern Rodney District, natural character has not been assessed in any comprehensive manner. Within these areas the assessments have not covered the ecological-biotic component of natural character.
- Landscape assessments have been undertaken by a number of city and district councils, often to address a particular issue or in relation to the development of district plans. Past approaches to such assessments has been varied, although more standardised methodologies for landscape assessment are emerging. Generally landscape assessment appears to be carried out in greater detail within the Auckland Region (at both the local regional levels). In the Waikato, regional landscape assessment is more broad brush.

Access
- Local authorities do not tend to keep, in any easily assessible form, information on how many esplanade reserves and strips had been established each year and the length of coastline they cover. Similarly, it is difficult to obtain information on how many times esplanade reserves are reduced in width or waived during the subdivision consent granting process.
- There are no recent counts of boat ownership or boating participation within the Gulf.
- Very few of the Gulf's parks or tracks have reliable visitor counts meaning that the use of parks cannot be reliably reported.
- Only North Shore City regularly surveys its residents by asking how often they use beaches and what activities they undertake there.

Cultural Heritage
- There is a broad range of cultural heritage sites within the Gulf, but a lack of co-ordination of recording and processing data relating to them.
- Auckland Region has developed a comprehensive cultural heritage data base which is being used as a vital management tool but no similar development has been achieved in the Waikato Region. Hence there is an inconsistency of data and management capacity for cultural resources across the Gulf.
- Although coastal subdivision appears to have the greatest impact on cultural heritage sites within the Gulf, information of the cumulative impacts of other activities is incomplete.

Coastal Hazards
- The Hauraki Gulf is subject to a variety of coastal hazards. All are significant and are a factor of the dynamic (changeable) nature of the coastline.

- Coastal hazards are not managed by managing nature but by managing human activities – where we place infrastructure and the type of works involved.
- Coastal hazards are site specific, management needs to reflect this.
- Management of coastal hazards is one of the biggest challenges for regulatory agencies and the community.

Future Action

The Forum's second State of the Environment Report will be compiled in 3 years time. The Forum will work to resolve these information issues prior to that so that its second report can benefit from even greater information availability and reliability. Although the second report will look to update much of the information provided in this report to illustrates change over time, it is anticipated that it will be more focused and less descriptive than the information provided in the preceding pages.

Glossary

Bathymetry	describes water depth.
Benthic	describes the flora and fauna found on the bottom of the sea.
Biogenic	means produced by living organisms.
Biomass	is the total quantity or weight of organisms in a given area or volume.
Biota	refers the animal and plant life of a region.
Conductivity	estimates the total dissolved solids content in a water sample. Conductivity is used t indicate the presence of contaminants in water.
Endemic	refers to plants and animals, for example, which are found only in a certain region.
Eutrophication	means elevation of nutrient levels leading to excessive plant growth (including algae) in a marine or freshwater body. Subsequent decay of these plants can decrease dissolved oxygen levels, leading to death or stress of other aquatic organisms.
Fauna	is the animal life of a region.
Flora	is the plant life of a region.
Kaimoana	means seafood (includes fish and shellfish).
Macrofauna	refers to the larger organisms found, for example benthic macrofauna are the organisms found on the seabed normally classified as what is retained on a 0.5 to 1 mm sieve size.
Mahinga mataitai	means an area for gathering seafood.
Mana	means authority, prestige, dignity[88].
Mauri	means life energy principle; the vital energy force that gives being and form to all things in the universe; also provides the interconnection between humankind and the natural environment[89].
Meiofauna	refers to organisms smaller than macrofauna and which would typically be retained on a sieve size of 0.05 to 0.5 mm. Sieve size may differ slightly among reports, but meiofauna typically include organisms such as nematodes, copepods and larvae of macrofauna.
Pseudo faeces	material filtered from the water by mussels which is inedible and is expelled onto the seafloor. Expelled inedible material is referred to as pseudo faeces to distinguish it from true faeces of the animals, derived from edible ingested material.
Taonga	means item(s) that are greatly treasured and respected (includes natural resources)[90].
Taxa	refers to taxonomic groups for the purposes of classifying organisms.
Water quality	indicators refers to the following:

[88] Hauraki Maori Trust Board, June 1999, Hauraki Customary Indicators Report (Technical Paper No. 57: Maori), Ministry for the Environment

[89] ibid

[90] Margaret Mutu, 1994

Indicator[91]	What does it tell us?
Dissolved oxygen saturation (DO %sat)	The higher the percentage of oxygen saturation, the greater the ability of the water body to support life. DO (%sat) levels of 40-60% are stressful to sensitive aquatic biota. If DO (%sat) remains low for an extended period of time, some organisms may die
Biochemical oxygen demand (BOD)	The amount of oxygen needed to break down organic matter in a particular volume of water. High BOD means that more organic matter is present, requiring greater volumes of oxygen for decomposition. This can result in a reduction in dissolved oxygen (see above).
Water clarity: measured using:	
Turbidity	Turbidity measures the extent to which particles (e.g. sediment, algae) suspended in water scatter light. When turbidity is high, water appears murky. High turbidity reduces the ability of plants to photosynthesise, makes it more difficult for fish to see their prey, and can adversely affect the gill structures of filter feeding animals.
Secchi disk depth	The depth at which a black and white disk (200mm) can be seen vertically through the water column. The greater the clarity of the water, the greater the Secchi disk depth.
Black disk transparency	A horizontal measure of water clarity. Measures the distance at which it becomes visible to an observer using an underwater viewer. It is an estimate of the distance that sighted animals can see horizontally under water.
Suspended solids (SS)	Measurement of the amount of suspended material in water (including plankton, clay, silt, organic material). Also called non-filterable residue (NFR). Suspended solids settle out as sediment, leading to problems such as estuarine infilling and smothering of biota.
Coliforms (or presumptive coliforms)	A group of bacteria which may be present in faecal material; however, only one *(E. coli)* is specific to faecal material. Many coliforms are found naturally in soil and decaying vegetation.
Faecal coliforms	These bacteria are more likely to indicate faecal contamination of water. However, again, some are naturally present in soil and decaying vegetation. The indicator therefore does not distinguish between human and non-human sources of faecal contamination.
Enterococci	Bacterial indicators which provide a better indicator of health risk than faecal coliforms. However, they are still not completely specific for human faecal contamination.
Nutrients	The nutrients nitrogen and phosphorus are essential for plant growth. However, elevated levels of these nutrients can lead to increased growth of algae, oxygen depletion and changes in marine community composition.
Ammonia	Ammonia is present in animal wastes and waste waters. In high concentrations, ammonia is toxic to many aquatic animals.
Nitrite	Nitrite is an intermediate compound produced during the breakdown of ammonia to the less toxic nitrate. It usually indicates the presence of a waste containing nitrogen. Nitrite is toxic, but less so than ammonia.
Nitrate	The end product of breakdown (oxidation) of ammonia by microbial decomposition. It is generally non-toxic to aquatic life. However, in higher concentrations (together with other nutrients) it can lead to the proliferation of aquatic plants and algae.
Dissolved inorganic nitrogen (DIN)	The sum of the concentrations of nitrate and ammonia.
Total Kjeldahl nitrogen	A measure of organic nitrogen and ammonia in a water sample. Organic nitrogen includes natural materials such as peptides, proteins and nucleic acids.
Total nitrogen	A combination of total Kjeldahl nitrogen, nitrate and nitrite. This represents all nitrogen that is biologically available in a water body.
Total phosphorus	A measure of all phosphorus present in a water sample.
Dissolved reactive phosphorus (DRP)	This is the portion of phosphorus dissolved in water, rather than adsorbed to sediment particles or present in organic matter. It represents biologically available phosphorus. Elevated levels of phosphorus (and other nutrients) can result in excessive growth of algae and other aquatic plants.
Chlorophyll *a*	A photosynthetic pigment present in all plants, including algae. Chlorophyll *a* can be used as an indicator of the amount of suspended plant matter, including algae, in a waterbody. High concentrations of algae can reduce water clarity, form surface scums, deplete oxygen in water and alter the colour of water. Some algal species can have toxic effects on aquatic life and human users of water bodies High chlorophyll *a*, together with elevated nitrogen and phosphorus, can indicate an overload of nutrients in a waterbody, and may represent algal blooms.

[91] Water quality indicator definitions adapted from Wilcock and Stroud 2000 and ANZECC 2000

Appendix I

Description of geographical and biota features of coastal units within the Hauraki Gulf, derived from INMARC (Walls 2004)

Unit	Location and geographic description	Oceanography	Marine biota
12	**Bream Head to Pakiri** This unit includes Pakiri and areas extending north of the Hauraki Gulf Park. Pakiri is an exposed, fine-grained sandy beach about 20 km long. This vast beach is only broken in one place by the exposed volcanic rock cliffs of Te Arai Point. Off-shore sediments are generally sand with calcareous gravel, through to muddy sands and calcareous gravel, and muddy sand with depth.	Influenced by the subtropical East Auckland Current. Maximum tidal range of 2.2 m	Crustacea of the sandy beaches include the sea-slater, sandlouse and common sandhopper, isopods of the families Sphaeromidae and Eurydicidae, paddle crab, ghost shrimp and mantis shrimp. The tuatua *(Paphies subtriangulatum)* is the most common bivalve on this and other east coast beaches. The fish fauna of the mainland coastal section of this unit is predominantly composed of widespread species, such as red moki *(Cheilodactylus spectabilis)*, john dory *(Zeus faber)*, butterfly perch *(Caesioperca lepidoptera)*, snapper *(Pagrus auratus)* and marblefish *(Aplodactylus arctidens)*, and warm-temperate species, such as goatfish *(Upeneichthys lineatus)*, blue maomao *(Scorpis lineolatus)*, parore *(Girella tricuspidata)* and silver drummer *(Kyphosus sydneyanus)*. Estuarine mangrove habitat exists at Pakari and provides excellent habitat for birds including fernbird, banded rail, banded dotterel, wrybill plover, variable oystercatcher and New Zealand dotterel. Just to the north of the Hauraki Gulf Park, at Mangawhai Spit, is one of a few regular nesting sites for fairy tern in New Zealand.
13	**Little Barrier Island** Little Barrier Island is roughly circular about 7 km by 7 km. It is the emergent part of a large, isolated, dacite-rhyodacite volcano in the active Hauraki Rift, 80 km northeast of Auckland and formed around one and a half million years ago. The island is a dissected andesitic volcanic cone of mid-Pleistocene age. The Island has high cliffs fringed by almost continuous boulder beaches except where rocky headlands jut into the sea. There is one flat area, Pohutukawa Flat, formed behind the banks of an extensive rock fall. The boulders on the beaches have become smoothly rounded by constant rotation against each other as a result of strong wave action and steep beaches on these exposed shores. Sediments surrounding Little Barrier are generally muddy sands with calcareous gravel.	Influenced by warm, subtropical waters of east Auckland Current. Maximum tidal range of 2 m Annual water temperature range 12-24°C.	The shallow immediate subtidal is dominated by fucoid algae, with *Carpophyllum plumosum* the most abundant species. Below 10 m *Ecklonia radiata* dominates, falling off rapidly with depth. *Evechinys chloroticys* overall is relatively uncommon but is most abundant at the 10 m depth contour. Adjacent to this are small stands of *Carpophyllum flexuosum*. The gradual slope of the shore allows for an extensive echinoid-red alga dominated zone from 250-300 m depth. On the most exposed outcrops small stands of bull kelp occur. The barnacle *Chamaesipho brunnea* is the dominant species of the upper littoral zone, with *Elminius plicatus* occurring directly below. Echinoids are abundant and concentrated in the 5-10 m depth stratum. Gastropods are most abundant at the centre of the bare zone and occur in deeper water, usually associated with laminarian stands. The mobile boulder beaches contain a special fauna adapted to these circumstances.

Unit	Location and geographic description	Oceanography	Marine biota
14	**Mokohinau Islands** The Mokohinau Islands comprises two main islands, Burgess and Fanal, 12 associated stacks and 16 rocks. They form part of a long discontinuous chain of rhyolitic volcanoes which erupted periodically for 2 million years. They rise steeply from the sea floor some 75 m below sea level. The islands are formed from Pliocene acid to intermediate volcanic rocks except Burgess which is a small plug of glassy andesite. Fossilised blow holes and mud pools are found on North-east Burgess Island reef. The islands are approximately 14 km south-west of the continental shelf edge and are the most remote of the outer Hauraki Gulf Islands. They are small and rugged with coastal cliffs. Fanal Island, the largest, has cliff faces up to 150 m high. The Islands contain a large variety of marine habitats including broken rock, boulder beaches, sandy bottoms, vertical drop-offs, guts and caves, and kelp forests. They possess many features also found at the Poor Knights Islands. The assemblages of encrusting invertebrates and fish-fauna are particularly diverse. The sediments around the Mokohinau Group are generally muddy sands.	Influenced by three currents: • subtropical waters of the southward flowing oceanic (deep water) East Auckland Current; • Trade Wind drift; • north-south tidal direction Maximum tidal range of 2 m	The islands are known for their diversity of marine fauna not found on the mainland coasts. A number of subtropical fish species are found around the Mokohinau Islands, although they are all rare. The rare intertidal chiton *Chiton aorangi* and subtropical fish species are similar to those found at the Poor Knights Islands. Most shores on the islands are either extremely or very exposed as indicated by the presence of the barnacle *Chamaesipho brunnea* which is abundant throughout. The isolated situation of the Mokohinaus may be the reason that the snake-skin chiton *(Sypahrochiton pelliserpentis)* is absent from the shores. The general sequence of zonation found on northeast coasts exists at the Mokohinaus. Intertidal rocks are followed by a shallow weed zone dominated by *Carpophyllum angustifolium, C. maschalocarpum* and *Pterocladia*. Below this is sea urchin grazed rock then a kelp forest deep reef zone and finally sand. However, the depths of each zone are not consistent with mainland zonation reflecting the clear, oceanic nature of the water, so that the kelp forests are found to a much greater depth. The main species here are *Ecklonia radiata* and *Carpophyllum flexuosum*. The fish fauna is comprised of widespread (47%), warm-temperate (27%) and subtropical (26%) species. These islands support a number of species of breeding seabirds including the grey ternlet *(Procelsterna cerulea)*, grey-faced petrel *(Pterodroma macroptera gouldi)*, fluttering *(Puffinus gavia)* and little shearwater *(Puffinis assimilis)*, diving petrel *(Pelecanoides urinatrix)* and white-faced storm petrel *(Pelagodroma marina maoriana)*. Removal of rats from the northern Mokohinau group has allowed petrels to expand their range.

Unit	Location and geographic description	Oceanography	Marine biota
15	**Western Great Barrier Island (west coast from Miners Head to Cape Barrier and adjacent islands)** Great Barrier Island is the largest offshore island in the coastal waters of the North Island, with an area of 28,500 hectares. The island occupies a prominent position at the entrance to the Hauraki Gulf, 80 km northeast of Auckland City and sheltering much of its inner reaches from the northeast. For much of its length, the coastline is steeply cliffed and exposed. On the sheltered, western side, the coast is intricately indented by numerous bays and inlets, formed by subsidence and subsequent draining of river valleys. The island is primarily of volcanic origin, apart from the portion north of Motairehe Point which consists of greywacke. This island appears to be a fragment of a range that extended northwards from Coromandel Peninsula. The major islands that lie off the west coast of Great Barrier Island are Kaikoura Island and the Broken Islands. The Broken Islands consist of three larger islands (Motutaiko, Rangiahua, Mahuki), separated by shallow narrow channels, and many smaller islands, including the Junction Islands.	Influenced by the southeast flowing subtropical East Auckland Current. Maximum tidal range of 2 m.	Common inhabitants of this sheltered shore are the barnacle *Elminius modestus,* rock oyster, *Hormosira-Corallina* turf, and subtidally the common kelp *Ecklonia radiata*. Six benthic associations and three sub-associations are recognised for the soft bottom around the Broken Islands. An infaunal bivalve *Scalpomactra scalpellum - Dosinia subrosea* association is found in shallow moderately sheltered bays. More exposed bays have another infaunal bivalve association *Felaniella zelandica - Talabrica bellula.* In greater wave exposure or strong current areas at 10-15m depth there is a rhodolith – *"Cucumaria"* (holothurian) – *Glycymeris laticostata* association. In deeper quieter water a *Pupa kirki* (gastropod) - *Echinocardium cordatum* (heart urchin) – *Myadora boltoni* (bivalve) association occurs. The most prevalent association in the area is that with common *Corbula zelandica (*bivalve). An association characterised by the ophiuroid *Amphiura* and the bivalves *Saccella bellula, Notocallista multistriata* and *Cuspidaria willetti* occurs in muddy sand in quiet conditions at 31-59 m depth. Port Fitzroy is noted as a nursery area and feeding ground for marine fish, due to its protected character and intertidal flats, which have rich benthic communities A large gannetry *(Morus serrator)* is found on Mahuki Island in the Broken Islands group off the western coast and Port Fitzroy is notable brown teal habitat.

Unit	Location and geographic description	Oceanography	Marine biota
16	**Eastern Great Barrier Island (north and east from Miners Head to Cape Barrier including Rakitu Island)** Great Barrier Island is the largest offshore island in the coastal waters of the North Island, with an area of 28,500 hectares. The island occupies a prominent position at the entrance to the Hauraki Gulf, 80 km northeast of Auckland City, sheltering much of its inner reaches from the northeast. The coast is dominated by steep cliffs dropping away to sand. The island is primarily of volcanic origin, apart from the north of Waikaro Point, which consists of greywacke. Rakitu Island, east off Whangapoua, is composed of relatively recent soft volcanic rocks. This creates a varied coastline with many sea caves, rock stacks, guts, rocky reefs, narrow shingle beaches and soft shores exposed to north-eastern storms. The northward coast from Miners Head to Needles Point is noted for its spectacular topography of cliffs, rocks and stacks. Long ocean beaches consisting of medium to coarse grained sand break the otherwise precipitous eastern coastline, notably Whangapoua, Kaitoke and Medlands Beaches. Whangapoua is the largest single estuarine wetland on the island and is one of the least disturbed estuaries for its size in New Zealand. It has predominantly sandy sediments throughout, with the more sheltered western part dominated by muddy fine sand and mangrove forest, while the eastern half is mainly intertidal flats of medium to fine sand, with some shell areas. A sand spit forms the eastern boundary of the estuary. Sediments off the east coast of the island are generally muddy sand through to sandy mud/silt with increasing depth.	Deep water close to shore allows clear oceanic water to come close to the coast. The area is intermittently influenced by the southeast flowing subtropical East Auckland Current resulting in slightly warmer and more saline than nearby coastal waters. Tidal range about 3.0m. Around the coast the seafloor is covered in a variety of cobbles, pebbles, gravel, and sand as well as muds. Offshore are fine quartzite sands sourced originally from the Waikato River, when it flowed out through the Hauraki Gulf.	These exposed, eastern rocky shores are characterised by the barnacle *Chamaesipho brunnea* and algal species *Gigartina alveata, Xiphophora chondrophylla, Carpophyllum angustifolium* and *Lessonia variegata*. The presence of bull kelp *(Durvillea antarctica)* is unusual for the gulf. Four main subtidal habitats are represented around the island, which are typical of those found on mainland coasts of the northeastern North Island, except that some sponge species are more typical of warmer waters. More than 70 algal species have been identified for this area and 73 species of fish. This fish fauna is clearly representative of the north-east coast of New Zealand, with species such as red moki *(Cheilodactylus spectabilis)* and leatherjacket *(Parika scaber)* abundant. A number of subtropical fish species are found around the coast of north-eastern Great Barrier Island although they are all rare, suggesting that the East Auckland current may not have a major influence on the region's fish fauna. These include the notchheaded marblefish *(Aplodactylus etheridgii),* the black-spot goatfish *(Parupeneus spilurus)* and black angelfish *(Parma alboscapularis)*. Deep rocky reefs occur to the south-east and north of Rakitu, supporting many sponges and other invertebrates. Benthic assemblages are distinct from the Poor Knights and the Far North with those offshore around Rakitu Island not previously recognised elsewhere in New Zealand. Mangrove forests are predominantly found in the Whangapoua estuary and occupy an area of 107 hectares. The estuary is a breeding area for common marine species, such as cockles *(Austovenus stutchburyi)*, wedge shells *(Macoma liliana)*, pipis *(Paphies australis)*, snapper *(Pagrus auratus)* and flounder *(Rhombosolea spp.)*, which feed and use the harbour as a nursery site. The highest diversity of macrofauna occurs in the main channel where sands are mixed with quantities of shell stabilised by clumps of small greenshelled mussels *(Perna canaliculus)* and coralline turfing algae. Mudsnails *(Amphibola crenata)* are common in the lower edges of the mangrove forest *(Avicennia resinifera)*, where patches of seagrass *(Zostera* sp.*)* are also common. Subtidal rocks in the harbour entrance channel support clumps of plumose brown algae *(Carpophyllum plumosum)*, with common catseye *(Turbo smaragdus)* and coralline turf *(Corallina officinalis)* and lots of parore *(Girella tricuspidata)*. The surf beach is typified by crashing waves and mobile sands and restricted faunal inhabitants, such as worms and small crustaceans and occasionally tuatua *(Paphies subtriangulatum)* and sand dollar *(Fellaster zelandiae)*. Whangapoua estuary attracts a wide range of wading birds including the New Zealand dotterel *(Charadruis obscurus)* and wrybill plover *(Anarhynchus frontalis)*, which overwinter here. Spotless crake *(Porzana tabuensis)* and brown teal *(Anas aucklandica)* occur here.

Unit	Location and geographic description	Oceanography	Marine biota
17	**Mid Hauraki Gulf (Pakiri/Okakari Point to Kaiiti Point (west of Cape Colville), includes exposed headlands and shores of Kawau, Waiheke, Motutapu, Tiritiri Matangi, Rakino and Noises Islands)** This unit spans a complex section of coast made up of islands, rocky headlands with a complex array of caves, tunnels and overhangs, enclosed harbours and estuaries (drowned river valley estuarine systems) and open coastal beaches. Whangateau Harbour and Mangatawhiri Barrier-Spit (Omaha) encloses about 640 hectares and is representative of a northeastern coast enclosed harbour containing extensive areas of mangroves, saltmarsh, and sand-shell mudflats. The spit is comprised of unconsolidated Holocene coastal sediments. The seaward side of Kawau Island is characterised by exposed coast lined with steep high cliffs and rocky foreshores. The northern coastline of Waiheke Island has an intricately serrated nature of rocky shoreline and numerous diminutive coves contained within steep cliffs. Tiritiri Matangi Island lies 4 km offshore of the Whangaparoa Peninsula and has a cliffed coast with the exception of one sandy beach.	Coastal waters are of variable salinity and temperature and high turbidity, although the water here is generally clearer than other Hauraki Gulf areas. Salinities in the gulf tend to decrease slightly from Cape Rodney, which is influenced by indraughts of saline oceanic water, south to the Waitemata Harbour end, where surface salinities are lower because of the precipitation and run-off in the shallow Firth of Thames. Maximum tidal range of 3 m	This area is representative of northeastern New Zealand rocky and sandy habitats. Characteristic organisms of the rocky shore include periwinkles *(Littorina unifasciata)*, barnacles *(Chaemisipho brunnea* and *Elminius plicatus)*, *Corallina-Hormosira* turfing algae, *Carpophyllum maschalocarpum*, and rock oysters *(Saccostrea commercialis)*. Shallow inshore sandy areas are often characterised by sand dollars *(Arachnoides zelandiae)* at high densities, accompanied by patches of the sea slug *(Dendrodoris gemmacea)*. Deeper sand habitat is dominated by hermit crabs and whelks, and cushion stars *(Petiriella regularis)* are found throughout. Urchin barrens, one of the typical northeastern, subtidal reef communities become compressed from outer to inner Hauraki Gulf until they are completely eliminated and replaced by *Carpophyllum flexuosum* forest in the inner gulf. Waters around Tiritiri Matangi contain habitats of sand, reef associated materials (sponges, shells, seaweed), muds armoured by shells, and soft muds. Beds of large green-lipped mussels still exist on the northern side of Waiheke Island. Significant features include a rare population of resident mado *(Atpyichthys latus)* at Tawharanui and Maharangi Harbour is used for collection of oyster spat. The harbours and estuaries provide important habitat for banded rail *(Rallus philippensis assimilis)*, variable oystercatcher *(Haematopus haematopus)* and many other coastal birds. The sand spits are also important as roosting grounds for waders.

Unit	Location and geographic description	Oceanography	Marine biota
18	**Inner Hauraki Gulf (South Takatu Peninsula – Matingarahi. Includes lee shores of mid Gulf Islands – Kawau, Waiheke, Motutapu and all other islands including Motuora Rangitoto, Motuihe, Browns (Motukorea) and Ponui. Includes the Mahurangi Estuary, Tamaki Strait and Rangitoto Channel and excludes the Waitemata Harbour)** This unit is made up of shallow protected northeastern coastlines, broad intertidal shore platforms, rocky reefs and headlands, tidal inlets, sandy beaches and coastal cliffs. The alternating layers of hard and soft papa rock from Long Bay to North Head are very prone to erosion creating distinctive wave cut platforms. The lee side of Kawau Island shelters the northernmost section of this unit and is characterised by tidal inlets and sandy beaches. The smaller islands of Motuketekete, Moturekareka and Motutara are characterised by steep rocky eastern shores and sheltered sandy bays on their west coasts. Offshore sediments are generally sandy silts. There are two major peninsulas in this area, Mahurangi and Whangaparoa. Mahurangi Peninsula, between Snells Beach and Mahurangi Harbour, is characterised on its eastern shores by exposed rocky headlands. In contrast, the western side of the peninsula forms one side of Mahurangi Harbour, an estuarine system that covers 1120 hectares. This is considered to be representative of east coast drowned river valley estuarine systems. 45% of the estuary is covered in mangrove forest; saltmarsh is also present and there are large areas of intertidal mud flats. Numerous other rivers and estuaries are included in this unit. Whangaparoa Peninsula is an elevated headland with conspicuous cliffs and shore platforms of the Waitemata Group rock type.	Generally high turbidity in the inner gulf, with a gradient on the western littoral of the Hauraki Gulf, decreasing southwards. Salinities tend to decrease slightly from Cape Rodney which is influenced by in draughts of saline oceanic water, to the Waitemata Harbour end, where surface salinities are lower because of the precipitation and run-off in the shallow Firth of Thames. Off Cape Rodney surface salinities are about 35.2‰ increasing to maximum values in April 35.6-7‰. Temperature ranges from 12 to 21°C. Maximum tidal range 3 m, though there is great difference between high and low tide in the tideways, such as Orewa resulting in large areas exposed at low tide. Current speeds are low, commonly 10-20 $cm.s^{-1}$, and tidal excursions are of the order of 2-4 km. Residence time of water in the Mahurangi and Lucas Creek are in the order of 4-10 days.	Rocky shore biota includes the periwinkle *Littorina unifasciata*, nerita snails *Nerita melanotragus*, barnacles *Chamaesipho columna*, limpets (*Cellana* spp), *Corallina-Hormosira* turfing algae and *Carpophyllum maschalocarpum*. At approximately 3-6 m Cystophora species replace *Carphophyllum* species as the dominant alga. This zone is followed by *Ecklonia radiata* forest then sponge and tunicate assemblages. Common soft shore fauna species include cockle *(Austrovenus stutchburyi)*, pipi *(Paphies australis)*, wedge shell *(Macoma liliana)* and nut shell *(Nucula hartvigiana)*. Shallow inshore areas at Long Bay are characterised by sand dollars *(Arachnoides zelandiae)* and the sea slug *(Dendrodoris gemmacea)*. Slightly deeper dominant species are hermit crabs and whelks. Horse mussel *(Atrina zelandica)* patches are present and are also a feature of the Mahurangi Estuary. Within the gulf tidal habitats are saltmarshes; consisting of: rushes and sedges with the mud crab *Helice crassa*, mud snail *Amphibola crenata* and horn snail *Zeacumantus lutulentus*; and mangroves *(Avicenna marina var resinifera)* comprising notably the mud crab, snapping shrimp *(Alpheus* sp*)*, mud snail, mud whelk *(Cominella glandiformis)*, *Nicon aestuarienis*, tube-dwelling amphipod *(Corophium acutum)*, tube-dwelling worm *(Boccardia polybranchia)* and species of capitellids (worms). Macroinvertebrates include barnacles *(Elminius modestus)*, mussels *(Crassostrea glomerata)* and oysters, and the algae Neptune's necklace *(Hormisira banksii)* is common. Fish include abundant yellow-eyed mullet *(Aldrichetta forsteri)* and eels *(Anguilla* spp*)*. Eelgrass beds (Zostera novazelandica) are found on exposed banks and have a rich fauna including limpets *(Notoacmea helmsi scapha)*, sea slugs and the bubble shells *(Haminoea zelaniae)*. Within the harbour, channels have typical shell-gravel fauna. Dominant subtidal kelp are *Ecklonia radiata* and *Carpophyllum flexuosum*. Urchin barrens, one of the typical northeastern, subtidal reef communities become compressed from outer to inner Hauraki Gulf until they are completely eliminated and replaced by *Carpophyllum flexuosum* forest in the inner gulf. The waters around the inner Hauraki Gulf are New Zealand's most important nursery areas for snapper and Mahurangi harbour is significant for the collection of spat of the introduced Pacific oyster *(Crassostera gigas)*.

Unit	Location and geographic description	Oceanography	Marine biota
18 cont.	Rangitoto Island is the youngest of a series of volcanic islands in the inner Hauraki Gulf, and is believed to have last erupted approximately 600 years ago. Waiheke Island is the largest of these islands and has a deeply indented and varied coastline, with tidal inlets, sandy bays, steep cliffs and rocky headlands.		Fish species that characterise the area are predominantly widespread species, such as snapper *(Pagrus auratus)*, red moki *(Cheilodactylus spectabilis)*, john dory *(Zeus faber)*, blue cod *(Parapercis colias)* and leatherjacket *(Parika scaber)* and warm temperate species, such as blue maomao (Scorpis violaceus), parore *(Girella tricuspidata)*, goatfish *(Upeneichthys lineatus)* and two spot demoiselles *(Chromis dispulis)*. Numerous wading, wetland and seabirds use both the mainland shores and islands of the inner Hauraki Gulf. In particular, many duck species use the estuarine areas and the oxidation ponds at Whangaparoa Peninsula. A variety of shags also use the area for breeding, feeding and roosting.
19	**Waitemata (Waitemata Harbour, Tamaki Strait, Beachlands and Clevedon estuaries, and includes shores and headlands of inner Hauraki Gulf)** The Waitemata Harbour is a drowned river system consisting of deep bays and broad sinuous estuaries. Volcanic eruption craters flooded by the sea and infilled with muddy sediments are located at Panmure Basin, Orakei Basin and Northcote. Large intertidal mudflats, sand/shell flats and mangrove habitats are located behind shellbanks at Pollen and Traherne Islands, and around several rivers, such as the Tamaki River estuary which has a sand-shell spit near the entrance. The upper reaches join with freshwater habitats. There is an extensive area of sheltered rocky reef near Point Chevalier (Te Tokoroa Reef), formed from the distal end of a larval flow. Extensive coastal development has occurred in this area.	Waitemata harbour is protected from high seas and swells by a series of islands. The average salinity range of Waitemata Harbour is 25-35‰ with wide fluctuations occurring in the upper reaches. Sea surface temperatures range from 9°C to 25°C. Maximum tidal range 3.5 m, with tidal currents up to 3 knots near the harbour entrance.	Major habitat types in the harbour are based on a combination of substrate (basalt, tuff, sandstone, Pleistocene clay, shell, sand and mud), vegetation (mangroves *(Avicennia marina var resinifera)*, salt meadow and saltmarsh, seagrass *(Zostera)* and large seaweeds) and dominant visible animals (mud snails, hornshells *(Zeacumantus lutulentus*), oysters, Asian date mussels *(Musculista senhousia)*, cockles *(Austrovenus stutchburyi)*, pipi *(Paphies australis)* and spionid worm tubes). The softshores of Waitemata Harbour are dominated by the mud crab *(Helice crassa)*, cockle *(Austrovenus stutchburyi)*, wedge shell *(Macoma liliana)*, nut shell *(Nucula hartvigiana)*, *Mactra ovata,* mud snail, *Zeacumantus lutulentus,* horse mussel *(Atrina zelandica)*, mud whelk *(Cominella glandiformis)* and mantis shrimp *(Squilla sp.)*. Rock surfaces are inhabited by the rock oyster *(Saccostrea glomerata)* and the black top shell *(Melagraphia aethiops)*. Te Tokoroa Reef supports a diverse marine biota, particularly sponges and bryozoans and saltmarsh vegetation. Mangroves cover about 951 hectares in the harbour and are particularly common around Pollen and Traherne Islands. There are two main benthic associations around Pollen Island, one which is dominated by an introduced bivalve *(Theora lubrica)*, and the other with large numbers of the small bivalve *Nucula hartvigiana*. Many fish species use the harbour for feeding and as a nursery ground including flounder *(Rhombosolea* spp.*)*, snapper *(Pagrus auratus)*, yellow-eyed mullet *(Aldrichetta forsteri)* and parore *(Girella tricuspidata)*. The intertidal mud and sand flats of the Harbour provide an important feeding ground for many bird species, such as arctic migrants, the bar-tailed godwit *(Limosa lapponica baueri)* and New Zealand waders, New Zealand dotterel *(Charadrius obscurus)* and banded dotterel *(C. bicinctus bicinctus)*. Banded rail *(Rallus philippensis assimilis)* are also present in the mangrove areas and the North Island fernbird *(Bowdleria punctata vealeae)* live on Pollen Island, an important roosting ground.

Unit	Location and geographic description	Oceanography	Marine biota
20	**Inner Firth of Thames (Kaiaua to Tararu)** The Firth of Thames is a 72,900 hectare shallow marine embayment, approximately 11-14 nautical miles wide, which lies in the northern part of the Hauraki Rift, bounded by fault lines along the Hunua and Coromandel Ranges. This inner firth is characterised by a low wave energy sheltered shoreline and extensive areas of tidal mudflats, sediments of sand and silt, and high shell banks between Miranda and Kaiaua. The Firth is the primary receiving environment for a large catchment of approximately 360,000 hectares. This area is shallow with a maximum depth of around 4 m at mean low water spring tide. Important features on the western shore between Kaiaua and Miranda include Whakatiwai gravel ridges running parallel to the coast, the Miranda chenier plain of sand and shell, and chenier shell banks. The area from Miranda to Thames is a fault line escarpment coast with gravel delta fans which grade to muddy sand and then through to mud with increasing depth. The area has gradual depth contours, following an "open bowl" configuration.	Circulation systems present in the Firth are the East Auckland Current, the M_2 tide and prevailing winds. Wind-induced currents show clockwise and anticlockwise circular gyres throughout the water column of the Firth. The East Auckland Current and the northwesterly winds act as partial barriers to the movement of sediments out of the Firth, resulting in deposition and accretion in the Firth itself and particularly along the southern and western margins. The considerable freshwater inflow from the Hauraki Plains results in variable sea surface temperatures (ranging from 11°C to 24°C) and salinities, and high turbidity. Wind and tidal currents cause a net retention of the extensive amount of sediments brought into this part of the Firth of Thames, mainly by the Waihou and Piako Rivers. Mean tidal range 2.45 m.	Mangroves *(Avicennia marina var resinifera)* with intermingling saltmarsh (mainly *Sarcocornia quinqueflora*) occupy about 660 hectares. The mudflat area is dominated by polychaetes such as *Aonides oxycephala*, burrowing crustaceans, heart urchins *(Echinocardium australe)*, bivalves such as cockles *(Austrovenus stutchburyi)*, pipis *(Paphies australis)*, whelks *(Cominella maculosa, C. glandiformis* and *C. adspersa)*, wedge shells *(Macomona liliana)* and *Arthritica bifurca*, cnidarians (e.g. *Anthopleura aureoradiata*). This area is a productive habitat for fish, particularly yellowbelly flounder *(Rhombosolea leporina)*, dab flounder *(R. plebeia)*, short finned eel *(Anguilla australis)*, snapper *(Pagrus auratus)*, yellow-eyed mullet *(Aldrichetta forsteri)*, pilchard *(Sardinops pilchardus)*, ahuru *(Auchenocerous punctatus)* and grey mullet *(Mugil cephalus)*. Several species of shark feed in the area, notably rig *(Mustelus lenticulatus)*, and use it for birthing in the spring. Orca *(Orcinus orca)* and common dolphins *(Delphinus delphis)* are occasional visitors. The estuarine habitat of the Firth of Thames is one of New Zealand's three most important coastal stretches for wading birds, supporting as many as 40,000 migratory birds during summer. The shore birds use this area for feeding and high tide roosting. Notable species include the bar-tailed godwit *(Limosa lapponica baueri)*, fairy tern *(Sterna nereis)*, white heron *(Egretta alba modesta)*, and the New Zealand dotterel *(Charadrius obscurus)*. The shell banks are particularly important roosting sites.

Unit	Location and geographic description	Oceanography	Marine biota
21	**Outer Firth of Thames (Matingarahi on the west coast of the Firth of Thames to Deadmans Point on the west coast of the Coromandel Peninsula and includes the east coast of the Firth of Thames north of Kaiaua to Waimangu Point)** The Firth of Thames is a shallow marine embayment which lies in the northern part of the Hauraki Rift, bounded by fault lines along the Hunua and Coromandel Ranges. The Firth is approximately 11-14 nautical miles wide and reaches a maximum depth of 35m, although 95% of it is less than 30m. The Firth is the primary receiving environment for a catchment of approximately 3600km^2. Both coastlines are characterised by a repetition of bays of boulders, mixed sand and gravel separated by rocky headlands, rocky outcrops and platforms. The area is semi-exposed with low wave energy. Large delta fans dominate the eastern coastline of the firth, interspersed with mixed sand and gravel beaches exposed to low wave energy. Sand and silt content of the shore increases towards the south as a result of decreasing exposure.	Circulation influenced by the East Auckland Current, the M_2 tide and prevailing winds. Wind-induced currents show clockwise and anticlockwise circular gyres throughout the water column of the Firth. The East Auckland Current and the northwesterly winds act as partial barriers to the movement of sediments out of the Firth, resulting in deposition and accretion in the Firth itself and particularly along the southern and western margins. The area has variable salinity and sea surface temperature regimes (ranging from 11°C to 24°C), and high turbidity. Maximum tidal range 2.45 m.	Common organisms of this shore include littorinid snails *(Littorina unifasciata)*, half-crab *(Petrolisthes* sp.*)*, black topshell *(Melagraphia aethiops)*, estuarine barnacle *(Elminius modestus)*, cats-eye *(Turbo smaragdus)*, small black mussel *(Xenostrobus pulex)*, greenshell mussel *(Perna canaliculus)* rock oyster, barnacle *(Cominella virgata)*, *Corallina-Hormosira* algal assemblage and towards extreme low water tide, the brown algae *Carpophyllum maschalocarpum*. Boulder beaches are characterised by rock oysters *(Crassostera glomerata)* and greenshell mussels *(Perna canaliculus)*. Fish species that inhabit the area include flounder *(Rhombosolea leporina* and *R. plebia)*, short finned eel *(Anguilla australis)*, snapper *(Pagrus auratus)*, yellow-eyed mullet *(Aldrichetta forsteri)*, pilchard *(Sardinops pilchardus)*, ahuru *(Auchenocerous punctatus)* and grey mullet *(Mugil cephalus)*. Several species of shark feed in the area, notably rig *(Mustelus lenticulatus)*. Orca *(Orcinus orca)* and common dolphins *(Delphinus delphis)* are occasional visitors.

Unit	Location and geographic description	Oceanography	Marine biota
22	**Coromandel (Deadmans Pt on west coast of Coromandel Peninsula to Kaiiti Pt)** This unit extends along the west coast of the Coromandel Peninsula from Deadmans Point west of Manaia to Kaiiti Point west of Cape Colville and includes numerous offshore islands (including Wanganui, Waimate, Moturuhi, and the Motukawae Group). The area is characterised by sheltered rocky platforms and pinnacles, sandy beaches, gravel pebbles and boulders backed by cliffs, sandy and cobble beaches, several harbours including Manaia, the large Coromandel Harbour, and Colville Bay. Off shore the sediments are generally muddy sands with calcareous sandy gravel. Coromandel Harbour tidal flats are mud and sandflats with some stony areas and extensive eelgrass beds. Mangroves and saltmarsh fringe the edges of the Harbour. Colville Bay is made up of shingle and shell banks and mudflats, fringed by mangroves and rushes.	The high turbidity seen here is characteristic of shallow, often muddy shore. Temperatures range from 12 to 21°C. Salinities are variable. The mean tidal range is between 2.2 m (Colville Bay) and 2.4 m (Manaia Harbour).	Mangrove forests *(Avicennia marina var resinifera)* occupy 486 hectares in this unit. Manaia Harbour is representatives of estuarine environments in the area and has extensive mangrove forests, seagrass *(Zostera)* and searush *(Juncus maritimus)* communities, adjacent to freshwater wetlands. Soft shore fauna is similar to that described for Waitemata Harbour, common species being the cockle *(Austrovenus stutchburyi)*, pipi *(Paphies australis)*, wedge shell *(Macomona liliana)* and nutshells *(Nucula hartvigiana)*. Oyster *(Crassostera gigas)* farming occurs in the sheltered bays of inner Waiheke and Coromandel harbours. Rocky shore biota includes littorinid snails *(Littorina unifasciata)*, neritid snails *(Nerita rnelanotragus)*, barnacles *(Chamaesipho columna)*, *Corallina-Hormosira* algal assemblages and the brown algae *Carpophyllum maschalocarpum*. The reef fringe and boulder beaches north of Otautau Point support kina *(Evechinus chloroticus)*, paua *(Haliotis iris)* and rock lobster *(Jasus edwardsii)*. In contrast, the nearby Motukawao Islands have a notable absence of normally common species, such as rock lobster and the sublittoral gastropods purple topshell *(Cantharidus purpureus)* and *Micrelenchus sanguineus*, and paua are rare. The Fantail Bay reef has highly irregular topography and high variation in species diversity of rocky reef invertebrate and cryptic fish communities. Around the reef there are healthy bryozoan and sponge gardens in the soft-sediment habitats, and the strong tidal currents are thought to support diverse filter-feeding communities. These shores provide important feeding and roosting grounds for local and migratory shore birds. Bird species that use the area include the variable oystercatcher *(Haemotopus ostralogus finschi)*, caspian tern *(Hydroprogne caspia)*, banded rail *(Rallus phillippensis assimilis)* and the New Zealand dotterel *(Charadrius obscurus)*. Additionally, several island sites including Motukaramarama are significant sites for roosting and breeding Australasian gannets *(Sula bassana serrator)*.

Unit	Location and geographic description	Oceanography	Marine biota
23	**Colville (Kaiiti Point, west of Cape Colville, to Te Anaputa Point)** This unit is characterised by exposed rocky shores and cliffs, strong currents & offshore stacks and pinnacles. The northern tip of Coromandel Peninsula has a shoreline that is generally rocky and backed by steep rugged terrain. There are numerous bays and headlands and several stone or shingle beaches. Port Jackson is a large beach formed of grey-white sand with extensive dunes in the northern half. Habitats are primarily rocky reefs, with variation in topography between larger rocky formation with gullies and crevices, and boulder reefs. Offshore sediments are generally characterised by sand and gravel shell beds on the inner shelf grading to muds on the outer shelf.	The East Auckland Current moves down the Hauraki Gulf and out through the Colville Channel. Tidal range 1.8 m.	Marine organisms found here are typical of rocky shores of north-east North Island. An exceptional variety of fish life occurs in this area and rocky reefs are dominated by *Ecklonia*.
24	**East Coromandel Island Groups (Includes Cuvier, Mercury, Aldermen Islands)** Cuvier Island has a rugged coastline with boulder beaches and sheer cliffs giving way to rounded slopes and open valleys further inland. The Mercury Islands consist of seven volcanic islands (Great Mercury, Middle, Double, Koropuki, Red Mercury, Stanley and Green) of steep, rocky cliffs and boulder beaches with lying 20 km off the east Coromandel Coast. There are also sandy beaches on the lee shore of Great Mercury Island. The Aldermen Island group is a barren cluster of three main islands, the remnants of an ancient volcano, off the coast of Pauanui. Extensive reef systems extend from the islands.	Influenced by the warm subtropical East Auckland Current. Tidal range 1.6 m.	Characteristic zone-forming organisms include barnacles *Chamaesipho brunnea* and *C. columna*, the cartilaginous red alga *Apophloea sinclairii* and/or the worm-like gastropod *Novastoa lamellosa*, coralline paint *(Lithathamnion* spp.*)*, *Xiphophora chondrophylla* and *Carpophyllum angustifolium*. The coastal waters surrounding the Aldermen Islands are considered unique, providing outstanding underwater scenery and an abundance and diversity of flora and fauna. Spanish lobster *(Scyllarides* spp.*)* occurs in large numbers and many species associated with warmer water, for example mado *(Atypichthys latus)* and Lord Howe Island coralfish *(Amphichaetodon howensis)*. The Aldermen Islands have a greater subtropical fauna than the Mercury group with, for example, *Novastoa lamellosa* is present on the former but absent on the latter. This difference appears to be current related. Surveys at Flat Island and Great Mercury Island show high diversity of fish and invertebrate communities compared to coastal sites. Blue penguin *(Eudyptula minor iredalei)*, red-billed gull and greyfaced petrel *(Pterodroma macroptera gouldi)* all breed on Cuvier Island. Coastal birds on the Mercury Islands include the rare Pycrofts Petrel *(Pterodroma pycrofti)*, four species of shearwater including the sooty *(Puffinus griseus)* and flesh-footed *(Puffinus carneipes)* shearwaters, pied shags *(Phalacrocorax varius varius)*, blue penguins and threatened New Zealand dotterel *(Charadrius obscurus)*. Flat Island of the Aldermen group supports the largest New Zealand colony of whitefaced storm petrel.

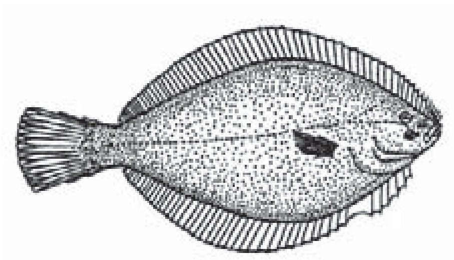
Unit	Location and geographic description	Oceanography	Marine biota
25	**East Coromandel Coast (Te Anaputa Pt to Waihi Beach)** This coastline is predominantly an exposed rocky shore interspersed with embayments, both white (Opito) and black (Wharekaho) sandy beaches, sand spits and extensive dune systems including about 60 parallel dune ridges at Tairua. In some places sea cliffs are vertical and rise up to 100 m above sea level. Steep marine eroded ignimbrite cliffs form significant features, particularly around Cathedral Cove, which is dominated by small coves with beaches of sand and rhyolitic boulders and steep marine eroded ignimbrite cliffs rising to 80 m above sea level. The numerous rock stacks, pinnacles, offshore reef systems and near shore islands include Ohinau, Shoe and Slipper Islands. The many small offshore islands and associated reef systems around the Hahei area enhance the diversity of coastal habitats and environs within this area. These islands are eroded remnants of rhyolite domes, with flows of rhyolite lava forming complex folds making up the underwater reef systems. This unit includes significant estuarine areas such as Whangapoua and Whitianga estuaries as well as many smaller estuaries. Whangapoua Harbour is one of the few remaining unmodified harbours on the Coromandel Peninsula. It is a shallow 1,300 hectare harbour with almost complete water turnover at low tide. Whitianga is a fairly large estuarine harbour partially enclosed by a low lying beach. There are large areas of intertidal flats with 74% of the 1,560 hectare estuarine area exposed at low tide, surrounded by extensive alluvial flats and ignimbrite cliffs. A notable feature of this unit is the geothermal activity at Hotwater Beach where water and gas bubble through the beach sand about 2 m above low tide.	Influenced by the subtropical East Auckland Current, especially around outlying points and islands. Maximum tidal range 1.6 m.	Because of the exposure of the coastal areas, there is a distinct elevation of subtidal algae into the littoral zone with *Carpophyllum plumosum* and *Xiphophora chondrophylla* occurring with *Corallina* turf and *Hormosira banksii*. Subtidal habitats include kelp forests, rock flats, sponge gardens, red algal assemblages, and sandflats with locally dense scallop populations. There is a relatively high abundance of the pencil urchin *(Goniochidaris umbraculum)* at Cathedral Cove and an unusual presence of the seaweed *(Pedobesia clacaeformis)*, which has only been found elsewhere at the Three Kings and Kermadec islands. There are numerous estuaries along this coast with extensive mangrove *(Avicennia marina var resinifera)* forests as well as seagrass *(Zostera)* and saltmarsh communities. Estuaries in the area are characterised by cockles (Austrovenus stutchburyi), pipis (Paphies australis) and native rock oysters *(Saccostrea glomerata)*. Other species include mussels, horse mussels *(Atrina zelandica)*, polychaetes, crustacean and numerous snail species. Estuaries also provide extensive fish breeding grounds. The Whitianga estuary supports the only estuarine inhabiting dolphin, the common dolphin *(Delphinus delphis)*, known in New Zealand. Numerous bird species breed along this coastline including the threatened New Zealand dotterel *(Charadrius obscurus)*, banded dotterel *(Charadrius bicinctus)*, little blue penguin *(Eudyptula minor iradelei)*, grey-faced petrel *(Pterodroma macroptera gouldi)*, pied *(Phalacrocorax varius varius)* and little *(Phalacrocorax melanoleucos brevirostris)* shags, and black-backed gull *(Larus bulleri)*. The beaches and estuaries also provide important habitat for the endangered brown teal *(Anas aucklandica chloritis)*, rare variable oyster catcher *(Haemotopus unicolor)*, Australasian bittern *(Botauris stellaris poiciloptilus)*, banded rail *(Rallus philippensis assimilis)* and caspian tern *(Hydroprogne caspia)*.

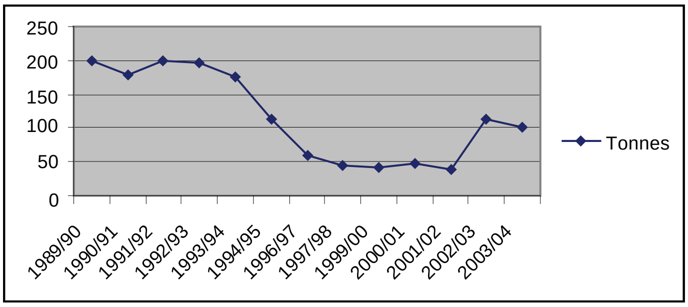
Appendix 2

Biology, Catches and Population Status of Main Hauraki Gulf Finfish Species

The information in this Appendix consists of brief summaries of the biology, fisheries, catches and population status of the finfish species that form the basis of commercial and non-commercial fisheries in the Gulf. Commercial catches have come from the four statistical areas that are within the Gulf. Recreational catch estimates are from a 1999-2000 national survey. They are for an area extending from a point south of the Kawhia Harbour on the west coast around to Cape Runaway in the eastern Bay of Plenty and are therefore not comparable with commercial catches.

Flatfish (Flounder)





The term flatfish refers to eight varieties of this species. In the Hauraki Gulf there are two species – yellow-belly flounder and sand flounder. All varieties are fast-growing and mainly short-lived, generally only to 3-4 years old.

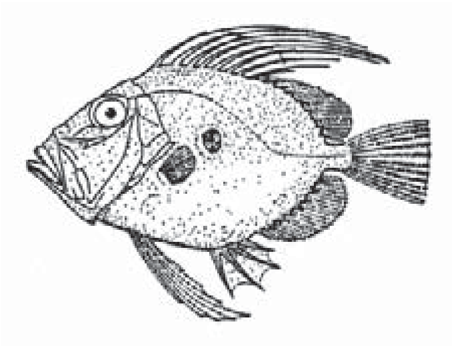
Flatfish are a shallow-water species, caught mostly by inshore trawlers and set nets in the Firth of Thames. Commercial catches of flatfish are shown in the figure below. They range from a high of 200 tonnes in 1989, to a low of 37 tonnes in 2001/02.

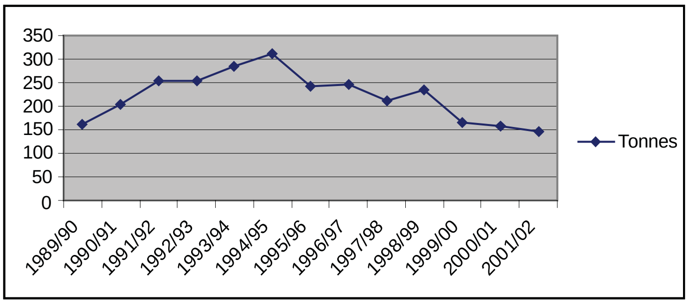
Flounder is also a popular non-commercial species, caught by set nets and spearing in bays and estuaries. The estimate of recreational flatfish catch in the north region in 1999-2000 is 203-336 tonnes.

The biology of flatfish, with their very short life–span means that population numbers can change significantly from one year to the next. However, the Total Allowable Catch for the flatfish population in the area that includes the Hauraki Gulf has been set at a constant level that has not changed since 1990. This means that in some years the limit may be too high in relation to the population size, and in others too low.

The only way that this could be changed would be to do research each year to determine the biomass, and for catch limits to then be adjusted accordingly. This could only be done at considerable expense.

John Dory





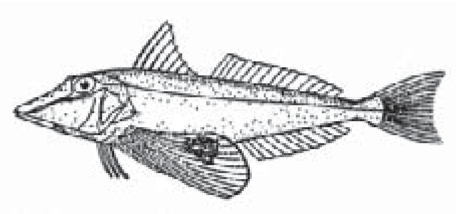
John Dory are common in northern New Zealand inshore waters, to depths of 50 metres. In the Hauraki Gulf adults move to deeper waters during summer, while feeding aggregations sometimes occur during winter.

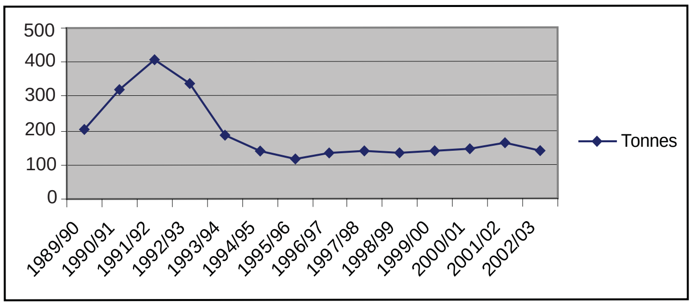
John Dory are mainly caught as a by-catch by trawl and Danish seine vessels. Catches have remained relatively constant since 1989/90 within a range of 150-300 tonnes.

John Dory is also a popular non-commercial species in northern New Zealand, including the Hauraki Gulf. The 1999-2000 estimate of recreational catch in the north east region is 174-280 tonnes.

Information is available on the biomass of John Dory in the inner Hauraki Gulf since 1989. The size of this population is estimated to have varied between a low of 227 tonnes and a high of 374 tonnes over this period.

Gurnard





Red gurnard is one of the most widespread species in New Zealand, occurring in most places except southern Fiordland. They are mostly found over muddy and sandy bottoms in shallow areas down to depths of 180 metres.

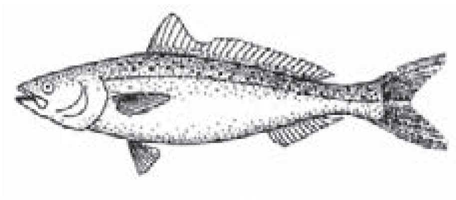
Gurnard are a major by-catch in inshore trawl fisheries and in the Gulf by Danish seine and longlines. After a peak catch of 410 tonnes in 1991/92, quantities taken have fallen to a relatively constant 60 – 80 tonnes.

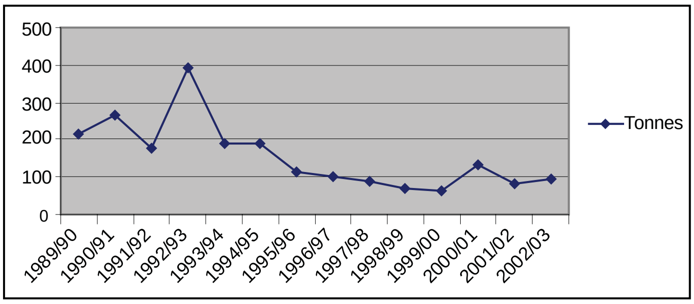
Because of their wide distribution in shallow coastal waters, and vulnerability to recreational fishing methods, gurnard represent another popular species for non-commercial fishers.

In the 1999-2000 survey of recreational catch, recreational fishers are estimated to have caught between 188 and 256 tonnes of gurnard in the northern region.

Red gurnard is often caught as a by-catch species and there are often wide variations in catch. This is partly due to changes in target species and partly due to natural variations in the gurnard population. It is thought that the gurnard population in the north-east coast region declined in the early 1980s and recovered slightly in the 90s. Indications are that current catch levels are probably sustainable.

Kahawai





Kahawai is an inshore species rarely seen more than 20km from the coast or at depths greater than 50 metres. They frequently enter shallow waters, harbours, estuaries and the tidal reaches of large rivers. Kahawai are fast swimming carnivores often seen in schools in the Gulf, feeding on smaller fish such as sprats, pilchards and yellow-eyed mullet.

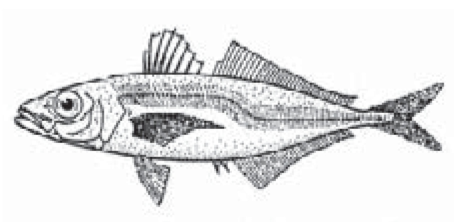
Purse seine vessels take most of the commercial catch, although substantial quantities are also taken seasonally in set nets and as a by-catch in trawl fisheries. After reaching a peak of 400 tonnes in 1992/93, catches since 1995/96 have been relatively stable around the 100 tonne level.

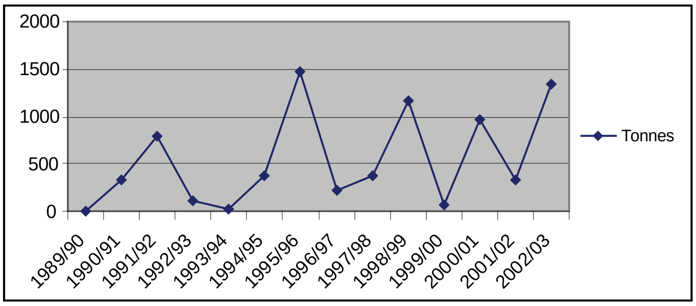
Kahawai were not included in the Quota Management System when it started in 1986. However there has been a limit on catches by purse seine vessels in an area that included the Hauraki Gulf since 1990-91.

Kahawai is one of the fish species most frequently caught by recreational fishers by target troll or lure fishery to catch surface or spatial aggregations of fish. The 1999-2000 estimate of recreational catch in the region that includes the Gulf is 2,195 tonnes.

Estimates of biomass are thought to be both unreliable and conservative and indicate that the population size is such that current levels of catch are sustainable. A decision has be made to add kahawai to the Quota Management System, so there will be a total allowable catch, catch limits for commercial fishers and an allowance made for recreational and customary fishing.

Mackerel





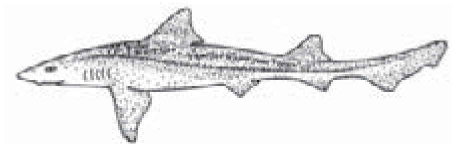
This term applies to three species of mackerel. The adults of all three spend some time in deep water, with large adults in depths beyond the continental shelf to 300 metres. Juveniles are found in shallower water and frequently enter harbours and estuaries.

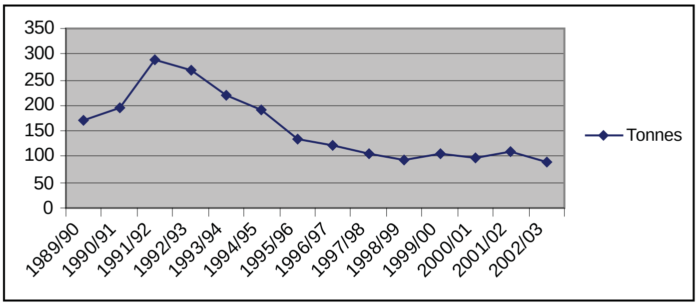
Virtually all the commercial catch of mackerels in the Gulf is taken by purse seine vessels in statistical area 008, off the east coast of Coromandel.

Mackerel is not an especially popular species for non-commercial fishers and while they are often caught for use as bait, the overall quantity is small.

As the figure shows catches of mackerel in the northern region have fluctuated widely since the early 1990s, and in the 1980s as well. There is a general trend of increasing catches, but this may partly be due to increased availability of the third species of mackerel. This variety had not been seen in New Zealand before 1987, but has gradually spread to most coastal regions.

Rig





Rig occur in all New Zealand coastal regions at depths up to 200 metres. Rig enter shallow coastal waters during spring and summer to mate and give birth. In autumn they are thought to move into deeper continental slope waters. While inshore waters they feed they feed mostly on seabed crustaceans, molluscs and worms.

Set nets in the Firth of Thames take most of the commercial rig catch in the Gulf.

While non-commercial fishers catch rig, it is not an especially popular species. There is no estimate of the non-commercial catch of rig in the northern region.

As the figure shows, catches in the northern region have generally declined since 1991-92. The reasons aren't known and there is no information available at present to determine whether current catch levels and the Total Allowable commercial catch is sustainable.

Appendix 3

Nationally threatened plants present on islands in the Gulf

Threat status categories: NEx Nationally Extinct; NC Nationally Critical; NE Nationally Endangered; NV Nationally Vulnerable; SD Serious Decline; GD Gradual Decline; S Sparse; RR Range Restricted; DD Data Deficient. Note that each species also has qualifiers as part of the threat ranking but these are not listed here (from de Lange et al (2004))

Species	Common name	Threat status	Threats	Habitat
Trilepidea adamsii	Adam's mistletoe	NEx	Forest clearance, browse	Shrubland – parasitic on mapou, mamangi, wharangi
Centipeda minima var. minima	Sneezewort	NC	Wetland draining, weeds	Open muddy margins of ponds and drains, wet tracks
Atriplex hollowayi	Crystalwort	NC	Weeds, vehicles, stock, people, browse	Strand line on beaches
Amphibromus fluitans	Water brome	NE	Wetland draining, weeds	Ponds and stream edges
Asplenium pauperequitum	Poor Knight's spleenwort	NE	Competition, climatic variation, brown scale	Caves, crevices on damp rocky surfaces, deep shade. Usually protected from direct effects of salt spray.
Carmichaelia williamsii	giant-flowered broom	NE	Rats, coastal erosion, lemon tree borer (Oeomona hirta), loss of pollinators	Open forest or scrub on steep coastal sites
*Epacris sinclairi*i		NE	Past logging	Montane kauri dominated cloud forest and associated rock tors
Lepidium oleraceum	nau, Cook's scurvy grass	NE	Lack of fertile seabird colonies and seal haul outs, introduced pests and diseases (e.g. snails, aphids, leaf miner, cabbage white butterfly, diamondback moth), browse, white rust, collection by people.	Fertile soils on coastal slopes, often associated with seabird roosts and nesting sites, rocky shorelines and gravel beaches.
Picris burbidgei		NE	Habitat loss through coastal development, succession, weeds, weed control	Coastal or lowland environments on open ground or amongst low scrub
Lepidium flexicaule	coastal cress	NE	Habitat loss through weeds, browse; introduced pests and diseases (e.g. cabbage white butterfly, aphids, snails, white rust, diamondback moth).	Coastal sites on bluffs, outcrops and amongst coastal turfs; often associated with nesting or roosting seabird sites.
Ophioglossum petiolatum	Stalked adders tongue fern	NE	Browse by snails, goats and pigs (possibly also rats), weeds	Stream banks in coastal forest
Phylloglossum drummondii	pygmy clubmoss	NE	Needs recently burned ground	Recently burned shrubland, usually growing with sedges under sparse low manuka
Rorippa divaricata	NZ watercress, matangoa	NE	Shading, predation, lack of fertile seabird colonies	Coastal forest in open sites
Senecio scaberulus	fireweed	NE	Hybridisation with Senecio hispidulus, weeds and weed control.	Rock outcrops, cliffs or banks on islands, or near the sea

Species	Common name	Threat status	Threats	Habitat
Prasophyllum aff. patens	Swamp leek orchid	NV	Wetland drainage	Standing water in swamps, bogs, found floating in swamps
Carex litorosa	sedge	SD		Salt marshes and sandy tidal river banks
Dactylanthus taylorii	woodrose	SD	Browse, lack of host tree regeneration, human collection	Shrubland
Daucus glochidiatus	Native carrot	SD	Weed spread	Lowland, open places in short turf and forest clearings
Euphorbia glauca	sand spurge	SD	Human and vehicle traffic on beaches; habitat degradation; browse; weeds.	Open sand dunes, coastal gravel banks, rocky bluffs
Marattia salicina	King Fern, Para	SD	Browse, weeds	Forest
Pimelea tomentosa	daphne	SD	Browse, weeds	Coastal shrublands, gumland scrub, rocky ground and stabilised sand dunes
Plumatochilos tasmanicum	Bearded Greenhood orchid	SD	Weeds, habitat loss	Clay banks, among mosses and lichens on near-bare clay among short scrub
Sicyos aff. australis	mawhai	SD	Browse, habitat loss through coastal development, reproductive problems (failure to attract pollinators, inbreeding, absence of male or female plants in the population). As this species is an early coloniser of open sites, natural succession can also be a threat.	Coastal scrub
Austrofestuca littoralis	hinarepe, sand tussock	GD	Cause not established, but could be stock, marram grass, trampling, vehicle disturbance	Sandy beaches although it occasionally occurs on damp sand on coastal stream margins
Colensoa physaloides	koru	GD	Cows	Streamsides in coastal forest
Desmoschoenus spiralis	pingao	GD	Marram grass, dune stabilisation and compaction, vehicle traffic, trampling, harvesting, browse, lack of wind blown pollen to isolated individuals	Coastal sand dunes, usually on the front face of active dunes on more or less unstable slopes and wherever there is wind -blown sand
Doodia squarrosa	Moki-moki, rasp fern	GD	Unknown	Coastal forest
Eleocharis neozelandica	Sand spike sedge	GD	Weeds e.g. Kikuyu grass, marram, rabbit browse	Damp coastal sand and tidal creek banks
Epilobium chionanthum	marsh willow herb	GD	Wetland destruction	Swamp margins and shady wet places
Gratiola nana		GD	Drainage, eutrophication and weeds	Muddy hollows in forest clearings, streamsides, swamps margins, in turf at lake margins
Paspalum orbiculare	Ditch millet	GD		Clay soils in open manuka scrub, dry banks and waste ground, also be on damp ground such as seepages
Peraxilla tetrapetala	Red-flowered mistletoe, pirita	GD		On *Quintinia* at high altitudes
Pimelea arenaria	sand daphne	GD	Weeds, trampling, vehicle traffic and browse.	Coastal sand dunes.

Species	**Common name**	**Threat status**	**Threats**	**Habitat**
Tupeia antarctica	White mistletoe	GD	Rats, lack of birds to disperse seed, fragmentation of populations preventing insect pollination	On coastal maire
Botrychium australe	Moonwort	S	Snails	
Calystegia marginata		S	Weeds.	Bush margins, in open scrub, and amongst low shrubs.
Fimbristylis velata		S	No serious threats in most sites, just sparsely distributed and somewhat local	Disturbed muddy ground, lake margins, and swamps
Fuchsia procumbens	Creeping fuchsia	S	Weed grasses, (e.g. Kikuyu), habitat loss.	Strictly coastal, often in grassland, scrub or open forest.
Grammitis rawlingsii s.s.	Strap fern	S		Kauri forest
Halocarpus kirkii	Monoao	S		Forest
Korthalsella salicornioides	Dwarf mistletoe	S	Loss of habitat (manuka shrubland)	Manuka shrubland
Leptinella tenella		S	Weed grasses	On freshwater streamsides, swamps margins, shady grassy places, sandy tidal flats
Lindsaea viridis		S	Flooding, disturbance	Found on dripping rocks or waterfalls on a bed of moss, shade usually in shade.
Peperomia aff. urvilleana		S	Browse	Shaded rock outcrops in coastal forest
Pittosporum virgatum		S	Browse	Kauri forest
Senecio marotiri	gulf groundsel	S	Habitat loss through weed spread, weed control	Coastal, found in herb fields with Senecio lautus. Also on disturbed ground in coastal forest, exposed beaches, amongst flax; confined to off-shore islands.
Senecio repangae subsp. repangae	Cuvier island groundsel	S	Weeds	Coastal, mainly off-shore islands, with coastal shrublands, also in canopy gaps caused by erosion or beneath pohutukawa. Grows on manure enriched soils e.g. around petrel burrows. Abundant on the rank pasture around the lighthouse and settlement at Cuvier.
Streblus banksii	large-leaved milk tree	S	Rat browse of seed, young plants	Coastal and lowland forest.
Tetragonia tetragonioides	NZ spinach	S		Shoreline
Thelymitra formosa	Sun orchid	S	Unknown	Open forest or scrub
Thelymitra tholiformis	Sun orchid	S	Unknown	Gumland scrub, second growth conifer/hardwood/kauri forest
Thismia rodwayi	pua-o-te-reinga, fairy lanterns	S	None	Forest
Hebe pubescens subsp. rehuarum		RR	Unknown	Coastal, open forest, usually growing on rock

Species	Common name	Threat status	Threats	Habitat
Hebe pubescens subsp. sejuncta		RR	None	Coastal scrub, cliff faces and inland on rocky outcrops, slips
Kunzea sinclairii	Prostrate kanuka	RR	None	Rhyolite outcrops in low shrubland communities, disturbed trackside habitats
Olearia allomii	Great Barrier tree daisy	RR	Possibly competition with weeds such as Hakea	Short scrub and shrubland, possibly also associated with rhyolitic outcrops.
Polygonum plebeium	Small knotweed	DD		Ephemeral wetlands, lake margins, muddy riparian sites.
Vittadinia australis	White fuzzweed	DD	Weed competition	Grassland and other open places

Appendix 4

Weeds managed on islands and coastal areas in the Gulf

Location	Key species/number of species controlled
Little Barrier (Hauturu) Island	Eradicated: Japanese honey suckle, smilax, kahili ginger, lantana
Controlled: climbing asparagus, pampas sp., mexican devil, mist flower; plus an additional 19 species	
Great Barrier (Aotea) Island	Multiple weed species controlled in Whangapoua basin, Kaitoke wetland/ dunes. Island wide program to eradicate or contain a further 12 species
Rakitu (Arid) Island	Key species pampas; a further five species controlled
Mokohinau Island group: Fanal (Motukino) (+stacks), Burgess (Pokohinu), Flax (Hokoromea) Islands	Pampas, mexican devil and 5 other species on Fanal; 26 species controlled on Burgess; inkweed controlled on Flax Island
Motuora Island	Management of 20 species
Tiritiri Matangi Island (+ stacks)	Six species intensively managed and a further 20 species managed as required
Motukorea (Browns) Island	Significant control of Rhamnus, boneseed, mothplant, & privet sponsored by Auckland City Council. An additional 5 species also controlled
Rangitoto Island (+stacks)	Key species Rhamnus, pine sp, ladder fern, mile-a-minute. A further 44 invasive species targeted. A further 21 weed species present but not targeted
Motutapu Island (+stacks)	18 species targeted across the island. Key species Rhanmus, woolly nightshade, mothplant, privet
Rakino Island (+stacks)	Key species Rhamnus, mothplant, pampas, boxthorn. Multiple others present
Motuihe island	Rhamnus, woolly nightshade controlled in the past.
Waiheke Island	Multiple weed species present; limited management undertaken in reserves managed by DoC. ARC undertaking extensive Rhamnus control
Atihau (Trig) Island	Inkweed
Cuvier Island	pampas *(Cortaderia jubata* and *C. selloana)*, mothplant *(Araujia sericea)*, buffalo grass *(Stenotaphrum secondatum)*, nasturtium *(Tropaeolum majus)*, other garden relics
Matariki Island	kikuyu *(Pennisetum clandestinum)*
Mercury Islands (excluding Great Mercury)	box thorn *(Lycium ferocissimum)*, pampas *(Cortaderia jubata, C. selloana)*, mexican devil *(Ageratina adenophera)*, hakea *(Hakea sericea)*
Dunes and coastal areas	
Otama, Opoutere, Waikawau, Hot Water Beach	pampas *(Cortaderia jubata and C. selloana)*, marram grass *(Ammophila arenaria)*, wilding pines *(Pinus radiata, P. nigra, P. pinaster)*, tree lupin *(Lupinus arboreus)*, Spanish heath *(Erica lusitanica)*, exotic iceplant *(Carpobrotus edulis)*, century plant *(Agave americana)*, coastal banksia *(Banksia integrifolia)*, various pasture grasses
Other coastal areas	wilding pines *(Pinus radiata, P. nigra, P. pinaster)*, pampas *(Cortaderia jubata, C. selloana)*, woolly nightshade *(Solanum mauritianum)*, wild ginger *(Hedychium gardnerianum, H.flavescens)*

Appendix 5

Pest management and current pest status of some islands in the Gulf

Location	Pests removed and year of removal	Current Pest status
Little Barrier (Hauturu) Island	Cat (1981); Kiore eradication in progress	Will be pest free
Great Barrier (Aotea) Island		Cat, pig, goat, ship rats, kiore, mice
Rakitu (Arid) Island		Cat, ship rats, possibly kiore and mice
Kaikoura (Selwyn) Island		Fallow deer, ship rats, possibly kiore and mice
Mokohinau Island group: Fanal (Motukino) (+stacks), Burgess (Pokohinu), Flax (Hokoromea)	Kiore (1996) from Fanal Island; Goat from Burgess Island	Pest free
Goat Island		Ship rats
Kawau Island		Cat, possum, stoat, wallabies, ship rats, mice, possibly Norway rats
Motuketekete Island, Moturekareka Island, Te Haupa (Saddle) Island		Mice
Tiritiri Matangi Island (+ stacks)	Kiore (1996)	Argentine ants
Motukorea (Browns) Island	Norway rat, mice (1996)	?
Rangitoto Island (+stacks), Motutapu island (+stacks)	Possum, wallabies (1999)	Cat, stoat, hedgehog, ship rat, mice, possibly Norway rat
Rakino Island (+stacks)	Norway rat (2003)	Cat
Motuihe island	Norway rat (1997)	Cat, rabbit
Waiheke Island		Cat, stoat, mice, Norway rat, kiore, goat, possibly ship rat, pigs
Motuora Island, Atihau (Trig) Island, Lizard Isle, Groper island, Arch Rock, Mokohinau stacks A-J, Navire Rock, Sphinx Isle (+stacks), Bird Rock		Pest free
Cuvier Island	Goat (1961), cat (1964), Kiore (1993)	Pest free
Red Mercury Island	Kiore	Pest free
Double Island	Kiore (1989)	Pest free
Stanley Island	Kiore, rabbit (1991)	Pest free
Korapuki Island	Kiore, rabbit (1986)	Pest free
Middle Island and Green Island (Mercury Group), Aldermen Islands		Pest free