April 2017

Tai Timu Tai Pari

Sea Change

Hauraki Gulf Marine Spatial Plan

Hauraki Gulf Marine Park
Ko te Pataka kai o Tikapa Moana
Te Moananui a Toi

In partnership with mana whenua and the following agencies:

Hauraki Gulf Forum
Tikapa Moana
Te Moananui a Toi

Ministry for Primary Industries
Manatū Ahu Matua

Department of Conservation
Te Papa Atawhai

Waikato Regional Council
Te Kaunihera ā Rohe o Waikato

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Cover photo: Raewyn Peart

Disclaimer

FOREWORD

For over a millennia, the Hauraki Gulf / Tīkapa Moana has been a taonga to the people who belong to this nationally significant place.

The Hauraki Gulf / Tīkapa Moana (also known as Te Moananui-ā-Toi) is of the utmost cultural and spiritual significance to mana whenua through its rich history of settlement and use since waka first navigated its waters. It is an incredible natural environment and special place highly valued by all.

The Hauraki Gulf / Tīkapa Moana is under significant pressure and its communities have seen a marked decline in the mauri, environmental quality and abundance of resources.

Sea Change – Tai Timu Tai Pari is the project established in 2013 to act to reverse this decline.

Sea Change – Tai Timu Tai Pari is led by a governance group representing a partnership between mana whenua and local and central government agencies, having equal membership. The writing of the marine spatial plan was undertaken by a Stakeholder Working Group comprising 14 members reflecting a diverse range of interests including mana whenua, environmental and conservation, commercial and recreational fishing, aquaculture, land use, farming and infrastructure.

The development of the marine spatial plan was guided by the following vision:

"He taonga tuku iho – treasures handed down from the ancestors Tīkapa Moana / Te Moananui-ā-Toi – the Hauraki Gulf Marine Park is vibrant with life, its mauri strong, productive, and supporting healthy and prosperous communities."

The plan includes a number of significant principles and proposals to deliver on this vision. The plan challenges the status quo via bold and innovative measures creating a real 'sea change' for the Hauraki Gulf / Tīkapa Moana.

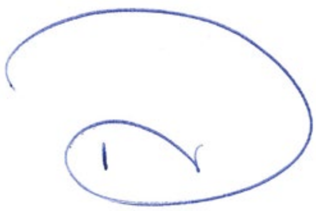
The plan is the culmination of an intensive open process resulting in New Zealand's first marine spatial plan. The input of mana whenua, the gulf communities, agencies and scientific expertise has been critical to the process.

The members of the Stakeholder Working Group worked in a highly collaborative manner, demonstrating significant levels of personal commitment, sacrifice, perseverance and vision to deliver this plan. The marine spatial plan could not have reached this point without the leadership of the Project Steering Group, and the strong support of mana whenua, agencies and the writing, project support and technical teams.

The next step for the marine spatial plan is the implementation process. There are high community expectations that the plan will be the catalyst for mana whenua, communities and agencies work together to return the Gulf to a place that is vibrant with life, has a strong mauri, is productive and supports healthy and prosperous communities.

We are delighted to recommend New Zealand's first marine spatial plan to be acted on by local and central government agencies to care for our prized taonga, the Hauraki Gulf / Tīkapa Moana.

Paul F Majurey
Chair
Project Steering Group
Sea Change – Tai Timu Tai Pari



Paul Beverley
Independent Chair
Stakeholder Working Group
Sea Change – Tai Timu Tai Pari

EXECUTIVE SUMMARY RĀPOPOTOTANGA MATUA

The Hauraki Gulf Marine Park is in serious trouble from many often inter-related causes. This process has been happening for some time and must be addressed. It is in the hands of us all to turn things around, rebuild healthy, functioning ecosystems that support the people and the economy, while restoring the values we hold for the Hauraki Gulf Marine Park.

Ka nui te raru o te mauri o Tīkapa Moana / Te Moananui-ā-Toi mai i ngā tūmomo pūtake. Kua roa kē tēnei āhua e pā ana ā, mātua me tahuri ki te rapu oranga. Kei roto i o tātou ringa katoa te tikanga hei takahuri i aua tūmomo pūtake e puta ake ano ai te oranga pūmau o ngā pūnaha hauropi hei toko ake i ngā tāngata me tō rātou ohaohanga me te hanga ngātahi anō i ngā uara o Tīkapa Moana / Te Moananui-ā-Toi.

Sea Change – Tai Timu Tai Pari has produced a marine spatial plan through a collaborative, stakeholder-led, co-governance process, with the involvement of many people who live, work, and play, in and around the Hauraki Gulf Marine Park and its catchments. We have worked closely with partner agencies to identify how to turn things around, and to focus on the long-term health and wellbeing of the Hauraki Gulf Marine Park.

Kua puta he Mahere Pūwāhi Moana mai i a Tai Timu Tai Pari me ngā whiringa ngātahi o ngā hunga whai pānga me ngā tāngata maha e noho kāinga ana, mahi ana mō te oranga, whai tākaro ke ana rānei i te rohe o Tīkapa Moana / Te Moananui-ā-Toi me ōna kōawaawa. Kua mahi ngātahi mātou me ngā pokapū matua ki te whai huarahi e oti ai te takahuri me te whai mārika i te oranga pūmau o Tīkapa Moana / Te Moananui-ā-Toi.

The Plan has grown out of information that has been gathered over three years. The aim is to provide the future directions and actions that we all need to take in order to restore a healthy and abundant Hauraki Gulf Marine Park – Tīkapa Moana / Te Moananui-ā-Toi. It is not a prescriptive document, is non-statutory, and non-binding on agencies. It does, however, provide clear directives for all of us, agencies and communities alike, who have interests in, and responsibilities for, the Hauraki Gulf Marine Park.

Kua puta ake te mahere nei mai i ngā pārongo kua emiemihia i roto ngā tau e toru. Ko te whainga matua ko te tohu i ngā tūmomo huarahi hei hāpai i te oranga pūmau o Tīkapa Moana / Te Moananui-ā-Toi kia puta ake i ōna hua. E hara te mahere nei i te kaupapa herehere erangi he mahere arataki kei waho mai i ngā kati ā-ture ā, kahore hoki e herehere ana i ngā pokapū. He tohu taki ara mō te katoa ā-tangata, ā-pokapū rānei e whai pānga atu ana ki a Tīkapa Moana / Te Moananui-ā-Toi.

When fully implemented, the Marine Spatial Plan will improve the health, mauri (life force and vitality), and abundance of the Hauraki Gulf Marine Park by:

- Restoring depleted fish stocks and restoring benthic (sea floor) habitats that support healthy fisheries.
- Reducing the impacts of sedimentation and other land-based activities on water quality.
- Recognising and protecting cultural values.
- Enhancing the mauri of the Hauraki Gulf Marine Park.
- Protecting representative marine habitats.
- Promoting economic development opportunities for the Hauraki Gulf Marine Park while ensuring marine environments are restored.

A te wā e oti ai te whakatinana i te Mahere Pūwāhi Moana ka piki ake te oranga pūmau, te mauri me ngā hua tini o Tīkapa Moana / Te Moananui-ā-Toi mā te:

- Haumanu i ngā tūmomo ira ika me te mātai hauropi o te papa moana e hāpai ana i te oranga ake o aua tauranga;
- Ārai i te patere pokanoa pū oneone me ērā atu mahi ā-whenua ki te oranga pūmau o te wai;
- Whai aronga me te haumaru i ngā uara tikanga-ā-iwi;
- Haumaru i te mauri o Tīkapa Moana / Te Moananui-ā-Toi;
- Tiaki i te hauropi ā-moana; me te,
- Hāpai i ngā angitū ohaohanga mō Tīkapa Moana / Te Moananui-ā-Toi I ngā wā e hora ana kia haumanu ngā hauropi moana.

WHILE THERE ARE MANY OPPORTUNITIES FOR ACTION, WE HAVE IDENTIFIED THE FOLLOWING INITIATIVES AS BEING KEY TO ACHIEVE THESE OUTCOMES:

1 Mahinga Kai – Fish Stocks and Aquaculture

- Transitioning commercial fishing methods that impact benthic habitat (including trawling, Danish seining and dredging) out of the Hauraki Gulf.
- Reviewing the management settings for priority fish stocks.
- 13 new areas prioritised for future aquaculture development, including mussels, oysters and fin fish.

2 Biodiversity and Habitat Restoration Initiative

- Fifteen new marine protected areas, including no take (excluding cultural harvest on a case by case basis by special permit) areas nested within larger, special management areas with fisheries management objectives.
- Restoring historic habitats such as green lipped and horse mussel beds.

3 A Gulf Sediment Initiative

- Setting and achieving catchment sediment and nutrient load limits for all major catchments to minimise adverse impacts on water quality.
- Restoration and creation of major wetland systems to trap sediment before it reaches coastal waters.
- Land-based measures to ensure sediment stays on the land where possible to significantly reduce sediment reaching the coast.
- Stabilising sediment already in the marine environment.

4 Ahu Moana initiative

- Novel co-management areas covering the coastline of Tīkapa Moana / Te Moananui-ā-Toi to provide for joint mana whenua and community co-management of local marine areas.

5 Kaitiakitanga/Guardianship

- Connecting everyone including the next generation and different ethnicities to the marine environment to strengthen kaitiakitanga and guardianship.

Each chapter provides a different element of the overall Plan, but does not stand alone. These chapters form an integrated package, with each contributing to the others. Place studies throughout the Plan provide practical, localised examples of each subject.

AHAKOA TE MAHA O NGĀ MOMO HUARAHI ANGITŪ KUA TOHUA KO ĒNEI E RĀRANGI IHO NEI HEI WHĀINGA AKE:

1

Mahinga Kai – Fish Stocks and Aquaculture

- He hūnuku i ngā tūmomo hao ika tauhokohoko e aweawe ana i te hauropi [pērā i ngā hao kupenga kukume me ngā hao ketu papa moana] ki waho kē atu o Tīkapa Moana / Te Moananui-ā-Toi;
- He arotake i ngā kaupapa whakahaere mō ngā tūmomo ira ika whai hua; me ngā,
- Wāhanga tekau mā toru kua tohua mō āmuri ake nei hei rohe ahumoana kūtai, tio, ika taramutu.

2

Kaupapa Rerenga Rauropi Haumanu Nōhanga

- Ngā wāhanga rāhui moana tekau mā rima, pērā i te rāhui kohinga kai [Ehara ko ngā kohinga āhei ā-iwi ia wā ia wā mā roto i ngā tikanga tohu mana] kei waenga I ngā rohe motuhake whānui kua tohua me ngā whāinga whakahaere hī ika; me te,
- Haumanu I ngā tauranga kūtai kukuroroa hoki.

3

Kaupapa Pū Oneone mō Tīkapa Moana / Te Moananui-ā-Toi

- Te whakatau me te whai kia tutuki te pāteretere o te pū oneone me te taiora mō ngā kūawaawa matua kia iti iho ai te pānga ki te oranga pūmau o te wai;
- Haumanu me te waihanga ake o ngā pūnaha papa repo ki te hopu pū oneone i mua atu i te putanga ki ngā wai takutai;
- Ngā whāinga ā-whenua hei āta pupuri I te pū oneone ki te tuawhenua ahakoa hoki te aha kia kore ai e puta kē atu ki te takutai; me te,
- Ko te pupuri ake i ngā pū oneone kua puta noa atu ki te papa moana

4

Kaupapa Ahu Moana

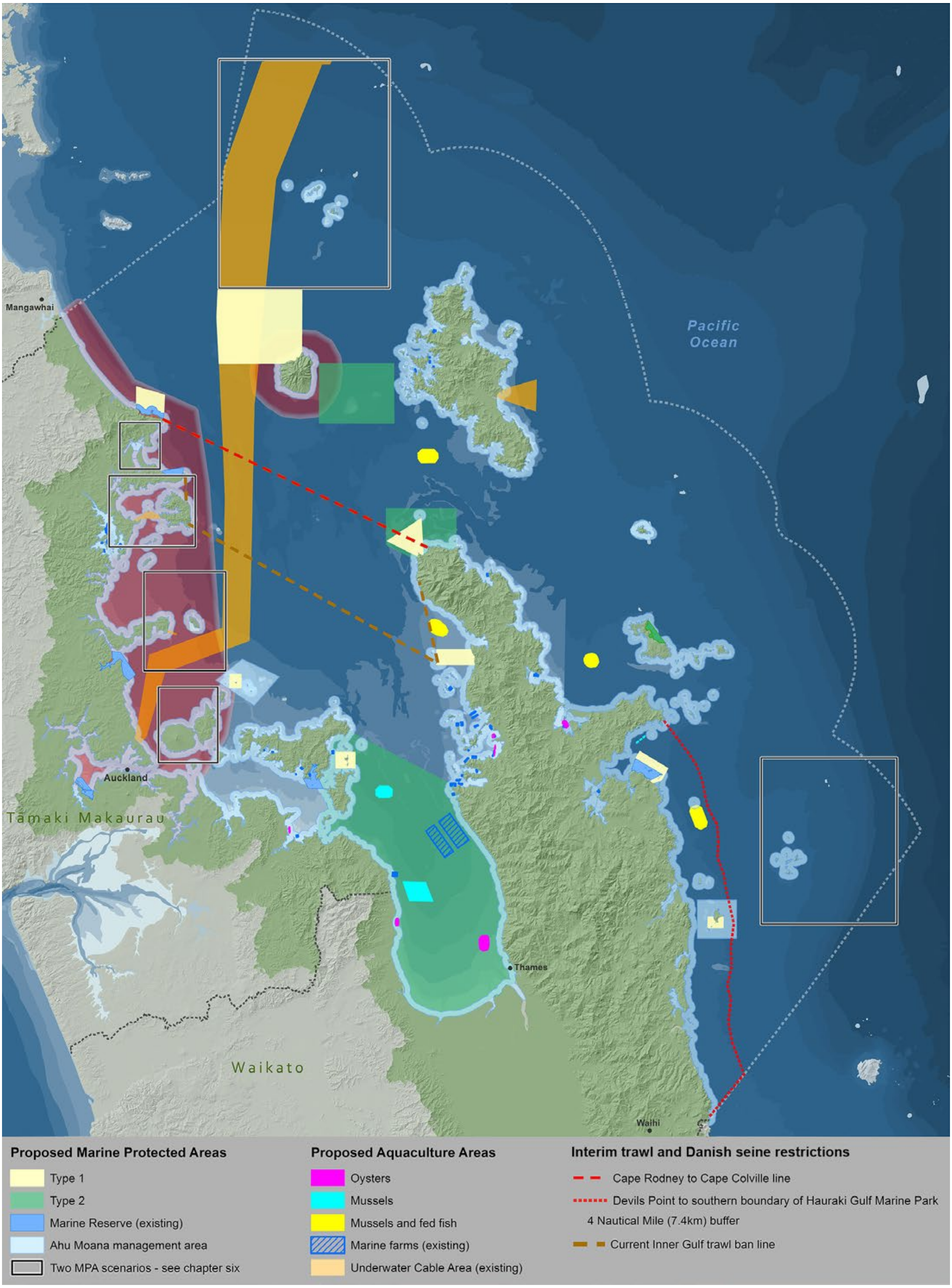
- He rohe waihanga noa whakahaere ngātahi mō te takutai o Tīkapa Moana / Te Moananui-ā-Toi hei uru ngātahi mō ngā mana whenua me ngā hāpori ake o aua rohe moana.

5

Kaitiakitanga

- He hononga ngātahi, mō te katoa ahakoa ko wai puta atu ki ngā reanga o āmuri ake nei, te ki rohe moana e piki ake ai te kaitiakitanga.

Kei ia wāhanga ngā tīpako o te Mahere Pūwāhi Moana whānui erangi kahore aua wāhanga e tū motuhake ana. He hononga ake o ia wāhanga ki te katoa. Ko ngā mātai o te katoa o te mahere e tohu ana i ngā tauira mō ia take mai i ngā hāpori.



Map overlaying proposed Marine Protected Areas (see map 6.1), proposed Aquaculture Areas (see map A2.1) and Interim trawl and Danish seine restrictions (see map 4.1).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF MAPS

LIST OF TABLES

1. SETTING THE SCENE

HORA I TE KAUPAPA

The development of the Marine Spatial Plan was guided by the following vision:

He taonga tuku iho
– treasures handed down from the ancestors

Tīkapa Moana / Te Moananui-ā-Toi – the Hauraki Gulf Marine Park vibrant with life, its mauri strong, productive, and supporting healthy and prosperous communities.

WHAT IS SEA CHANGE – TAI TIMU TAI PARI?

Sea Change – Tai Timu Tai Pari is a collaborative and co-governance process tasked with preparing a marine spatial plan for Tīkapa Moana / Te Moananui-ā-Toi (the Hauraki Gulf Marine Park). It is a bold and innovative initiative to improve the entire Hauraki Gulf Marine Park and its catchments by taking a fresh look at management, and to develop a roadmap for the future. This Plan identifies issues and offers solutions, it invites you to grasp the challenges now as it will be a long time before another such opportunity comes our way.

WHY DO WE NEED A MARINE SPATIAL PLAN?

Pressures on the Hauraki Gulf Marine Park are high, and increasing. Forecasts indicate that by 2030 more than 2.8 million people will be living within 80km of the Park. The associated development and intensification of land-use will add pressure to Auckland's aging infrastructure and its receiving environment. Boat and ship numbers on the water, already crowded on some occasions, will increase with this growing population, and a corresponding growth in imports and exports. Thousands of tonnes of fish and shellfish are extracted by commercial and recreational fishers each year and new non-indigenous marine species continue to appear. Alongside are land-use practices which introduce significant sediment loads, nutrients, pathogens, marine debris, and other contaminants, to the Hauraki Gulf Marine Park.

Key components of the natural ecosystem have been lost, such as subtidal mussel beds that used to filter the water of the entire Firth of Thames in one day. Vast areas of horse mussels have been destroyed by sediment and benthic disturbance. Declining biodiversity is reducing the ocean's capacity to provide food, maintain water quality, and recover from stressors. Limited progress has been made towards allowing fish stocks to rebuild, creating new marine protected areas (MPAs), or improving the capacity of mana whenua to implement their kaitiakitanga and rangatiratanga rights.

Even with these many pressures the Hauraki Gulf Marine Park is incredibly resilient, and we see limited signs of recovery. The Plan intends to build on these, and provide the way forward for a coordinated programme of active restoration.

THE HAURAKI GULF MARINE PARK

The Hauraki Gulf Marine Park Act 2000 recognised the Hauraki Gulf Marine Park as being nationally significant. The Park spans 1.2 million hectares of ocean and approximately 2550 kilometres of coastline, extends 12 nautical miles (22km) seaward, and covers the entire east coast of the Auckland and

Waikato regions, including the Coromandel Peninsula. The Hauraki Gulf Marine Park is a taonga of the utmost cultural and spiritual significance to mana whenua through its rich history of settlement and use since the first waka (ancestral canoes) navigated its waters many centuries ago. Māori and Western world views of the Park are displayed in Maps 1.1 and 1.2 on the right

THE ECONOMY OF THE HAURAKI GULF MARINE PARK

The catchments of the Hauraki Gulf Marine Park encompass a substantial portion of the economy of New Zealand and support the lives and livelihoods of more than 1.5 million people (around one in three New Zealanders). From the industry and services powerhouse of Auckland to the fertile farms of the Hauraki plains, the rich marine waters to the forests and parks of the Coromandel and Hunua Ranges, and from the recreation on beaches and islands throughout the Hauraki Gulf Marine Park, the catchments support and underpin a wide range of industries and activities.

The Hauraki Gulf Marine Park is much more than an 'asset', or a piece of natural capital that produces things that are bought and sold. The Hauraki Gulf Marine Park is the environment upon which the economy sits. Key components of the economy include:

- **Fishing – commercial harvesting.**
  The Hauraki Gulf Marine Park forms an important part of New Zealand's commercial fisheries especially for snapper.
- **Non-commercial Fishing – recreational and customary fishing.**
  Recreational fishing is a major activity on the Hauraki Gulf Marine Park with more than 220,000 fishers estimated to be active in the Park.
- **Aquaculture.**
  The Hauraki Gulf Marine Park is one of New Zealand's foremost centres for the aquaculture sector.
- **Transport.**
  As well as transport in and around the catchment itself, the Hauraki Gulf Marine Park provides crucial shipping corridors, particularly into and out of the Ports of Auckland.
- **On the land**
  When we think of the Hauraki Gulf, we tend to think of the wet (and salty) part. But the landward part of the Park's catchment, of which about 60% is farmed, is integral to its economy.
- **Tourism.**
  The Hauraki Gulf Marine Park is a hotspot for tourism, drawing not only on the 'locals' that make up one third of New Zealand's entire population, but also leveraging off Auckland as a key transit point and destination for international visitors.

A great deal of additional analysis of the economy of the Hauraki Gulf Marine Park has been identified as a necessary part of the implementation of the Plan.

This Plan is the work of many people from all walks of life. The common theme threading throughout everything that we have been told has been the urgent need to restore our Gulf. The recommendations we have made will draw different reactions within our communities and there will be many discussions. But one thing is certain – we must all make compromises if the right result is to be achieved. No one person, organisation, or agency can restore our Gulf. This task is in the hands of every single one of us.

A TURN-AROUND PLAN FOR THE HAURAKI GULF MARINE PARK

In October 2013, key leaders with an interest in the Hauraki Gulf Marine Park were invited to participate in a democratic selection process to form the Stakeholder Working Group (SWG) representing those sectors that have an impact on or an interest in the Hauraki Gulf Marine Park. The group includes Mana whenua, recreational and commercial fishing, farming, aquaculture, industry, community, and environmentalists, and has worked in partnership with central and local government agencies. All Stakeholder Working Group members have long-term personal and cultural connections with local community groups, alongside a deep knowledge of, and a set of priority concerns for, the Hauraki Gulf Marine Park.

Map 1.2 Hauraki Gulf Marine Park presented according to the western world view

Map 1.1 Hauraki Gulf Marine Park presented according to a mana whenua world view (explained in Chapter 2)

Hauraki Gulf Marine Park boundaries from two world views

Who are the Stakeholder Working Group?

- Jake Bartrom: Coromandel, youth and recreation.
- Matt Ball: Auckland, Ports of Auckland.
- Laurie Beamish: Ngāi Tai ki Tāmaki, mana whenua member.
- Joe Davis: Ngāti Hei, mana whenua member.
- Katrina Goddard: Waipu, environmental.
- Alison Henry: Whitianga, community.
- David Kellian: Warkworth, commercial fishing.
- Callum McCallum: Clevedon, aquaculture.
- Scott Macindoe: recreational fishing.
- Dirk Sieling: Whitianga, farming and recreational fishing.
- Tame Te Rangi: Ngāti Whātua, mana whenua member.
- Lucy Tukua: Ngāti Paoa, mana whenua member.
- Conall Buchanan: Paeroa, farming.
- Raewyn Peart: Point Chevalier, environmental.

The SWG has an appointed independent chair, Paul Beverley.

In addition to the above, Alan Proctor (recreational fishing) was a member of the SWG from 2013 until 2015, and Nick Main the independent chair and Kaaren Goodall the independent facilitator from 2013 until mid 2015.

The Stakeholder Working Group has developed the Plan through extensive engagement with mana whenua, local communities, and stakeholder groups, gathering science and mātauranga from many sources including technical experts, and considerable contributions from local and central government agencies.

Partner agencies

Through the process of preparing the Plan we have had four partner agencies assisting by providing information, technical advice, and guidance. These are:

- Waikato Regional Council (WRC)
- Auckland Council (AC)
- Department of Conservation (DOC)
- Ministry for Primary Industries (MPI)

Each of the partner agencies has provided technical advice as requested, and attended Stakeholder Working Group meetings. The agencies are also represented on the Project Steering Group.

Community engagement

From January to June 2014 SWG members attended many of the twenty-five group discussions, or 'listening posts', which were held up and down the coast, on islands, and in catchments of the Hauraki Gulf Marine Park. These included more than 250 participants and provided members with valuable opportunities to ask questions and learn from those who know the Hauraki Gulf Marine Park best - its people. Many were also asked to contribute thoughts and ideas more formally through on-line surveys.

Roundtables

To inform the work required, the SWG established seven issues-based 'Roundtables' to explore different pressures on the Hauraki Gulf Marine Park. In addition to the SWG members, these Roundtables included stakeholders with expertise and interest in the following topics:

1. Mātauranga Māori
2. Water quality and catchments
3. Fish stocks
4. Biodiversity and biosecurity
5. Infrastructure
6. Aquaculture
7. Accessible Gulf

Mana whenua engagement

Throughout the Sea Change – Tai Timu Tai Pari process there has been significant involvement by mana whenua (representatives of local iwi). In addition to having four mana whenua members on the Stakeholder Working Group, the Mātauranga Māori Round Table provided a Māori perspective to Sea Change – Tai Timu Tai Pari. This group also ran the programme of engagement with Māori, holding a series of hui (meetings) on Marae and at public venues across the Hauraki Gulf Marine Park. Additionally an online survey of mana whenua was conducted.

The plan creation process and agreed principles

Following this wide range of information gathering approaches the task of the SWG was to develop the responses and interventions needed to address the issues facing the Hauraki Gulf Marine Park.

Several important principles developed and agreed by the Stakeholder Working Group are:

1. The Plan is developed as an integrated package to be implemented as a "whole". Those implementing the Plan should not pick and choose between the proposed actions.
2. A key principle guiding the implementation of the plan will be the preservation of the integrity and value flowing from the current and future Treaty settlements. Accordingly, none of the Sea Change proposals, restrictions, actions or other measures will diminish or detract from any commercial or non-commercial Treaty settlements or related interests of any kind, whether capable of being held or exercised individually or collectively.
3. The community, stakeholders and mana whenua must be substantially involved in subsequent planning and decision-making and implementation of the Plan.
4. Throughout the document we provide dates for agencies to implement actions. These dates should be interpreted as the end of that particular year; e.g. something that should be completed by 2018 refers to 31 December 2018.
5. With regards to MPAs (Marine Protected Areas) there were some very limited areas where the Stakeholder Working Group did not reach a consensus. Where this occurred we have identified options, or scenarios that reflect the different outcomes sought by members. In order to gain consensus or sufficient support to select and progress one of the options discussions with mana whenua, local communities and stakeholders will be required for all these areas.
6. The Stakeholder Working Group members have worked closely together through a collaborative process which has resulted in the mechanisms set out in this plan. All Stakeholder Working Group members agree to and support the plan and no member or group has a veto over the implementation of the plan moving forward. The collaborative spirit that has been reflected in the Stakeholder Working Group should continue as mana whenua, communities and agencies work together to implement the plan to uplift and enhance the mauri of Tīkapa Moana/Te Moananui-ā-Toi.

NAVIGATING THE PLAN

The plan is broadly divided into four sections grouping related chapters and issues. Each chapter contains a description of the current situation, identifies objectives for the subject and a series of actions for implementing these objectives.

Wherever possible we have provided target dates for agencies to implement actions, although we realise that these will ultimately be implemented on a priority basis. Prioritisation and implementation is addressed in the final chapter of the Plan.

The four overarching concepts that underpin the Plan are described in the diagram over the page.

INITIATIVES

The initiatives described after the Executive Summary are presented at the end of Chapter 3.

A series of case-studies is also spread across the Plan to provide practical illustrations throughout. These tell mana whenua and local community place-based stories of kaitiakitanga, guardianship, and management within the Hauraki Gulf Marine Park.

PRIORITISATION AND IMPLEMENTATION

The final chapter discusses the need for much greater knowledge about the Hauraki Gulf Marine Park through research, monitoring, and the development of indicators, including cultural health indicators. It provides an explanation of the need to prioritise implementation, and discusses future governance needs for the Park.

PART ONE: KAITIAKITANGA AND GUARDIANSHIP

WĀHANGA TUATAHI: KAITIAKITANGA

Photo: Chris Williams

2

MANA WHENUA MANA MOANA.

"Te mana Atua kei roto i te tangata ki te tiaki i a ia, he tapu"

Sustain the divine power that sustains wellbeing, sacred essence.

3

WEAVING THE STRANDS: KAITIAKITANGA AND GUARDIANSHIP.

HE WHIRINGA O NGĀ AHO: KAITIAKTANGA.

'If you want to go fast, go alone.
If you want to go far, go together'
– Listening Posts.

The kaitiakitanga and guardianship of Tīkapa Moana / Te Moananui-ā-Toi – The Hauraki Gulf Marine Park is both the focus of Part One, and the overarching theme of Sea Change – Tai Timu Tai Pari. Kaitiakitanga is commonly translated as guardianship or stewardship. Mana whenua are the kaitiaki of their ancestral lands, a responsibility of the highest order handed down to the current generation by their Tupuna (ancestors) over many centuries. Many other New Zealanders rely on and are passionate about the Hauraki Gulf, and the theme Kaitiaki and Guardianship acknowledges that mana whenua, the wider community, and their agencies, each has a role if the vision of Sea Change is to be realised.

Part One, Kaitiakitanga and Guardianship, is made up of two chapters. Chapter 2, mana whenua Mana Moana introduces the iwi (tribes) and hapū (sub-tribes) of Tīkapa Moana / Te Moananui-ā-Toi, describes tikanga (values and practices) and their view of their world, then explains their legal and Treaty of Waitangi rights and interests. Chapter 3, Te Raranga - Weaving the Strands describes a synergistic, interwoven approach to restoring and safeguarding the Hauraki Gulf Marine Park. Mātauranga Māori and western knowledge are seen as complimentary rather than conflicting, and mana whenua and other New Zealanders passion and energy is harnessed, and their ways of doing things brought together.

Five initiatives are presented at the end of Part One. These condense the most significant intended planning responses and actions from the various subject-specific chapters of the Plan. They sift multi-stranded and sometimes complex issues objectives and courses of action into short clear statements of what needs to be done, and how we propose to do it.

2. MANA WHENUA

MANA MOANA

"Te mana Atua kei roto i te tangata ki te tiaki i a ia, he tapu"

Sustain the divine power that sustains wellbeing, sacred essence.

The Plan attempts to interweave Western perspectives, values, interests, and management approaches, with those of mana whenua. Mana whenua describes the relationship of Māori with their ancestral lands, and is the term used to refer to local iwi (Māori tribes) and hapū (sub-tribes) in the Plan. Mana translates as authority or prestige, and local Māori both derive mana from their lands and waters, and have customary authority over them.

Because Māori perspectives, values, interests, and management approaches are foreign to many New Zealanders, and as they are an integral part of the Plan we introduce the mana whenua iwi Māori (tribes) of Tīkapa Moana / Te Moananui-ā-Toi – the Hauraki Gulf Marine Park. We then explain mana whenua values and practices, briefly describe the current Treaty settlements environment in which Sea Change was developed, and consider Māori rights, interests, and practices arising from settlements, in common law or legislation, as these relate to the Hauraki Gulf Marine Park. Corresponding mana whenua issues, objectives, and actions are included throughout the sections of the Plan.

A MĀORI PERSPECTIVE OF TĪKAPA MOANA / TE MOANANUI-Ā-TOI

The Māori view of the world considers Aotearoa (the North Island) to be the fish, pulled up by the ancestral demigod Maui, from his waka Te Waipounamu – the South Island. Te Ika a Maui (the great fish of Maui) is conceptualised with its head to the south and tail to the north, so local Māori talk of travelling up to Wellington, while other New Zealanders talk of travelling down (see Maps 1.1 and 1.2 p. 4). The Coromandel Peninsula is known as Te Tara o Te Ika ā Maui, the barb on the tail of Maui's stingray, or as Te Paeroa ō Toitehuatahi (the long mountain range of Toitehuatahi). Maps in this chapter and for the place studies show this world view.

The name Tīkapa Moana refers to ceremonies held to protect the crews of the Tainui and Te Arawa waka (voyaging canoes) on the small island called Tīkapa or Takapū (which means gannet) off Cape Colville. Moana is the name attributed to the waters of the Hauraki Gulf and the Bay of Plenty, after the early Polynesian explorer Toitehuatahi. The two names are used together in the Plan to reflect different traditions of mana whenua across the Hauraki Gulf Marine Park. The tribes of Hauraki and Tāmaki descend from the crews of these and many other waka.

The Hauraki Gulf includes the earliest places occupied by Māori, some more than a thousand years ago according to tribal history. There are many accounts of journeys from Hawaiki to Rarotonga, the Tahitian Islands, then Rangiahua (the Kermadec Islands), ending in Hauraki and Tāmaki Makaurau. Tribal dynasties evolved from these ancient travellers, expanding through Aotearoa, often intermarrying with earlier peoples, adapting their traditions and practices to their new home. Tīkapa Moana / Te Moananui-ā-Toi has been intensively occupied since these earliest arrivals. The extent of historic occupation can be seen in Map 2.1 (over page), which shows recorded archaeological sites, defensive pā sites, and early Native Title Māori land blocks from the Native Land Court. While the recorded sites are thought to be only 30 percent of actual sites, they are strongly concentrated along the coast. This reflects Māori dependence on the moana, and that they were a seafaring people.

IWI OF HAURAKI AND TĀMAKI MAKAURAU

Mana whenua of Hauraki, Tāmaki Makaurau, and Mahurangi include Ngāti Whātua, its hapu Ngāti Whātua o Orakei, and Te Uri o Hau, whose combined rohe (ancestral areas of interest) extends from the Kaipara Harbour to Mahurangi and into central Auckland. The combined rohe of Te Kawerau-a-Maki, Ngāti Te Ata Waiohua, Ngāti Tamaoho, Ngāi Tai ki Tāmaki, Te Ahiwaru, and Te Akitai Waiohua extends from the Waikato River mouth to the western beaches north of Auckland, and across the Auckland Isthmus and inner Gulf Islands and back to the northern Kaiaua coastline. The rohe of Ngāti Wai, and its two hapū Ngāti Manuhiri and Ngāti Rehua extends from around Whangarei in the north, Aotea (Great Barrier Island), Hauturu (Little Barrier Island), and back to Warkworth. The Marutuahu confederation consists of Ngāti Maru, Ngāti Tamaterā, Ngāti Paoa, Ngāti Whanaunga, and the aligned Te Patukirikiri. The Marutuahu rohe is almost the same area as the Hauraki Gulf Marine Park, although it extends south toward Tauranga. Waikato-Tainui has interests in Tāmaki Makaurau. Ngāi Tai also has lands in Hauraki, along with Ngāti Hako, Ngāti Hei, Ngāti Porou ki Hauraki, Ngāti Pūkenga, Ngāti Rāhiri Tumutumu, and Ngāti Tara Tokanui. This list may not be complete, and many of these iwi have multiple hapū (sub tribes) with ancestral areas and interests inside and outside of the Hauraki Gulf Marine Park.

The lands of Tīkapa Moana / Te Moananui-ā-Toi are unique in Aotearoa for the nature of tribal rohe. Elsewhere iwi occupy largely contiguous areas. While this occurs here too, these are interspersed with what Hauraki elder Taimoana Turoa called 'kāinga pockets', places where multiple iwi and hapū have interests. This is a product of a turbulent history and long competition for this most sought after place, and it's many resources, and the relationships between iwi that have resulted. This tribal complexity has been a significant driver in the final shape of the Marine Spatial Plan, particularly for its Māori provisions such as the proposed Ahu Moana - mana whenua community co-management areas.

Descriptions of local mana whenua are provided in the place studies across the Plan. Today Māori have lost most of their traditional lands, as shown in Figure Two, but they continue to strive to fulfil ancestral kaitiaki obligations across their rohe. Today there is a resurgence of elements in the landscape that reflect mana whenua, pou (carved boundary markers), and Marae being two of the most visual elements, both often feature ancestors and events from over a thousand years of Māori occupation.

Today Māori hold little of their traditional land. Remaining land and marae within the Hauraki Gulf Marine Park are shown in Map 2.2.

Notably, many of the Marae shown in Auckland City are urban, community or pan-tribal Marae, some belonging to iwi not traditionally from this area.

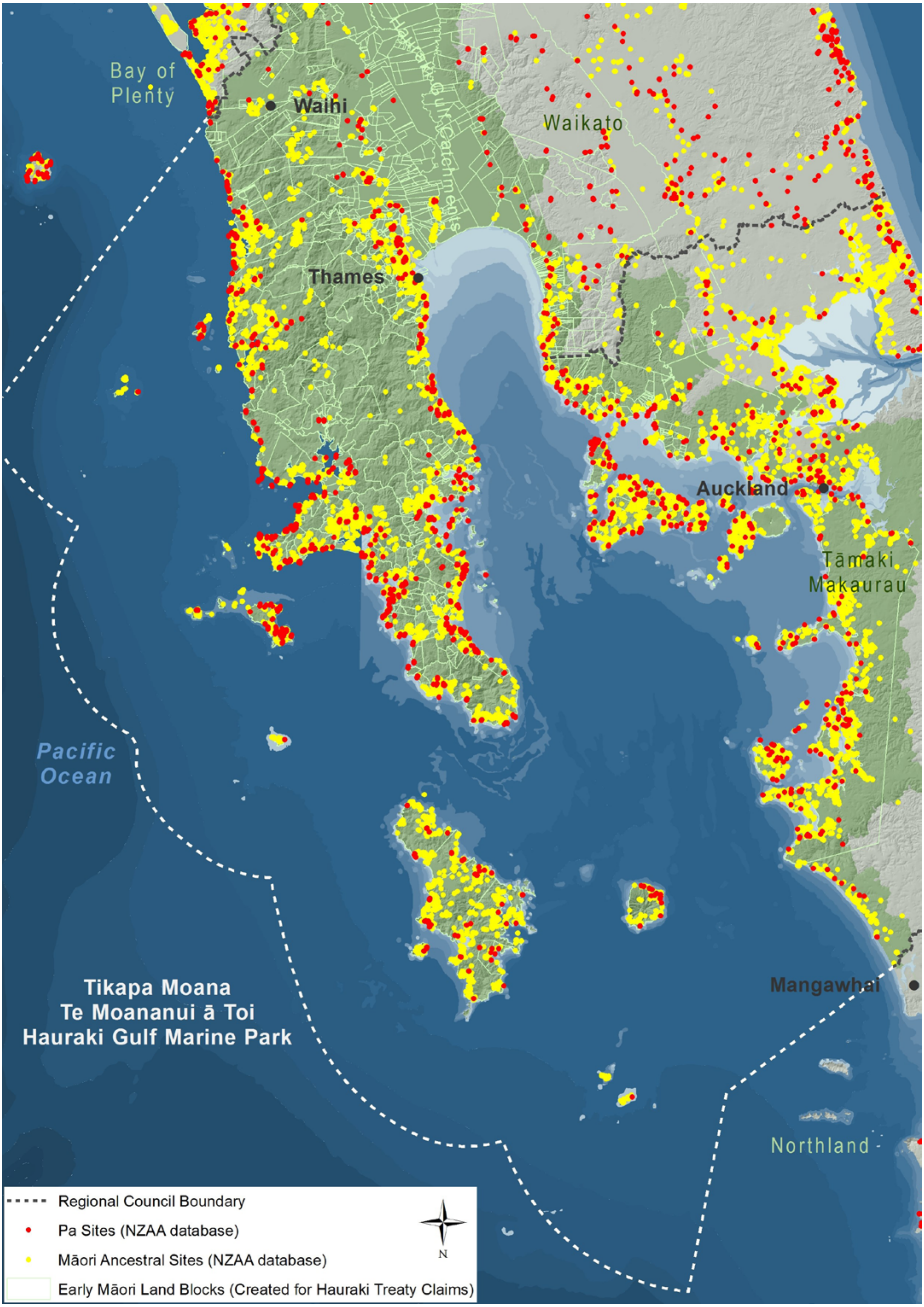
TIKANGA MĀORI AND KAITIAKITANGA: VALUES, PRACTICES, AND STEWARDSHIP

Tikanga Māori includes traditional practices and customs, and determines the way Māori interact with the world around them. Some tikanga central to environmental management are briefly introduced.

Kaitiakitanga

Kaitiakitanga is the ethic and practice of protection and conservation of the natural environment and the resources within it on which people depend. It is considered an obligation of mana whenua to maintain the lands and waters to which they whakapapa (have a genealogical relationship).

Māori do not see themselves as separate from the natural world, but related through whakapapa, whereby all elements (living or otherwise) descend from Papatūānuku (Mother Earth), Ranginui (the Sky Father) and their children. Accordingly, a Māori world view is distinct from a Western one, in which mankind has dominion over the rest of the world. For Māori the use of natural resources is subject to kinship obligations. For this reason kaitiakitanga is concerned with maintaining a natural and appropriate balance, particularly between the needs of people and those of Papatūānuku, their mother earth, Tangaroa, her son and Atua of the sea, and all the species that descend from them.



Map 2.1 Recorded archaeological sites, defensive pā sites, and early Māori title block boundaries, drawn south-north according to a mana whenua world view.

A number of other tikanga are important to management of the Hauraki Gulf Marine Park and to the Plan. Mana, the authority derived from and in relation to ancestral lands, waters and resources was described above.

Tapu and noa (loosely, sacred and profane) are important tikanga that order human relationships and direct our behavior toward the natural environment. For example the mixing of any bodily waste in waters from which kai is taken is extremely offensive to Māori because of its tapu nature. Manaakitanga, obligations to nurture and look after manuhiri (outsiders) mean that local whānau (extended families), hapū (sub-tribes) and iwi (tribes) loose mana (prestige and authority) if unable to provide manuhiri with the kaimoana (seafood) for which the area and its marae are traditionally famous.

Mauri – The spirit and life supporting capacity of Water

For Māori, mauri is the vital essence or spirit found in all elements of the natural world. In relation to water mauri is often equated to life-supporting capacity, as the Waitangi Tribunal's (1995) Te Whanganui-a-Orotu Report.

> *"The purity of water is precious and jealously guarded because the mauri, the vital essence, is the same spiritual stuff as vivifies and enlivens human beings and all other living things. To violate the purity of water is therefore to violate your own essential purity."*

Freshwater is revered for its associated tapu and healing qualities. In fact water remains a central feature of many spiritual practices today. Together with mauri, water has its own mana, or power, and is thus deserving of respect and protection as a taonga, or resource of immense material and spiritual value (Waitangi Tribunal, 1998).

The mauri of Tīkapa Moana / Te Moananui-ā-Toi has been substantially weakened by land use effects, and over-harvesting of kaimoana (sea food) for nearly two hundred years. This has left the waters with reduced resilience, or ability to absorb or cope with new and existing pressures. Fortunately, mauri can be restored. Conservation measures include rāhui (closures), which are instituted through handed down rituals and ceremonies. Restoring and sustaining a taonga like the Hauraki Gulf Marine Park to a state of mauri ora (a strong mauri), is central to the duty of kaitiakitanga (obligations as guardians or stewards of ancestral lands and waters) of mana whenua hapū, iwi and whānau.

An objective of the Plan is to restore protect and enhance the mauri of marine, estuarine and fresh water in the Hauraki Gulf Marine Park.

> *"An objective of the Plan is to restore, protect and enhance the mauri of marine, estuarine and fresh water in the Hauraki Gulf Marine Park."*

CUSTOMARY KNOWLEDGE, RIGHTS AND PRACTICES IN LAW

Mātauranga (Māori world views and knowledge) relating to water, fisheries, and to the Hauraki Gulf Marine Park is a vast body of knowledge spanning a thousand years. This includes centuries of familiarisation with the environment, detailed understanding of natural systems and cycles, and learning which management approaches work, and which don't. This cannot be replicated or replaced by western science. The inclusion of indigenous people's knowledge and practices in environmental management is required in international conventions to which New Zealand is signatory. The mana whenua peoples described above continue to exercise ancestral rights to harvest local kaimoana and to participate in the management of their ancestral places.

Māori rights and practices are provided for in New Zealand legislation. Examples include customary recognitions and rights orders under the Marine and Coastal Area (Takutai Moana) Act 2011 (MACA), deeds of recognition in the Hauraki Gulf Marine Park Act, RMA instruments including heritage orders and recognition as heritage authorities (section 187), section 33 transfers of powers and functions, and joint management agreements in section 36B, rohe moana and customary management tools within fisheries legislation, including mahinga mātaitai (traditional food gathering areas), taiāpure (local fisheries), and rāhui (temporary closures), and the ability for kaitiaki to allocate permits for harvesting kaimoana for

Map 2.2 Hauraki Gulf Marine Park Marae and remaining land in Māori title. (Marae icons source. Afterglow)

cultural purposes. In some places Māori still own title of coastal lands extending into the coastal marine area. Examples are given in the Sea Change case-studies of ways hapū and iwi of Tīkapa Moana / Te Moananui-ā-Toi utilise statutory instruments, and participate in the management of their ancestral lands, waters, and fisheries.

THE TREATY OF WAITANGI AND TREATY SETTLEMENTS

The Treaty of Waitangi was the founding document of New Zealand, signed between Māori and the Crown in 1840. It guaranteed Māori undisturbed possession of their ancestral lands, waters, fisheries and other taonga. In modern times a range of Treaty principles have been established by the courts and Waitangi Tribunal. These include a Crown duty of active protection of Māori rights and interests, and recognition that the relationship between the two parties is one of partnership.

Despite this raft of statutory recognitions and rights some of the most important examples of Māori involvement in the management of their ancestral lands and waters have derived from Treaty settlements. These include statutory acknowledgements and property vesting, but also co-management arrangements, including settlements such as the Waikato River settlement, which established a massive restoration initiative for the Waikato River, with local iwi being partners and participants at all levels.

The Plan was written when regional Treaty claims negotiations were taking place for settlements for at least 19 iwi and hapū. These settlements will significantly change the cultural, economic and political landscape in Hauraki and Tāmaki Makaurau. Greater iwi involvement in environmental management will include iwi-council/ Crown management of Hauraki and Coromandel Peninsula waterways, and discussions are planned for the co-governance and management of Hauraki and Auckland harbours. The results of those settlements will be important for the make-up of the governing body of the Hauraki Gulf Marine Park, and for implementing the plan.

In earlier settlements iwi secured Treaty-protected rights to fisheries when the Crown sought to establish the quota management system. The Waitangi Tribunal acknowledged that Māori have commercial, recreational and customary fisheries interests, and these were identified in the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992 and subsequent Acts. As a result iwi are now major players in aquaculture and commercial fisheries. They are also keen recreational fishers, maintain customary harvesting practices, and many still rely on kaimoana to feed their whānau.

Mana whenua and the Stakeholder Working Group have agreed that this Plan must not dilute or otherwise affect Treaty settlements. Those settlements clearly record that the redress provided to mana whenua was only a very small percentage of their losses suffered as a result of breaches of the Treaty. That fact reinforces the importance of protecting the redress that has been provided through Treaty settlements.

“They are intended to reflect the tikanga of mana whenua alongside the values and views of local communities in all the different circumstances that exist across the Hauraki Gulf.”

Ahu Moana, the mana whenua and community co-management areas initiative, is intended to bring in many of these statutory rights and practices, and to integrate local near shore management across these many statutes in a way that local communities are involved. They are intended as a means of cutting through exhausting and uncertain existing statutory processes and provisions for existing legal customary rights and practices. They are intended to reflect the tikanga of mana whenua alongside the values and views of local communities in all the different circumstances that exist across the Hauraki Gulf.

3. WEAVING THE STRANDS: KAITIAKITANGA AND GUARDIANSHIP

HE WHIRINGA O NGĀ AHO: KAITIAKITANGA

'If you want to go fast, go alone.
If you want to go far, go together'
– Listening Posts.

To achieve the vision of the Sea Change process and the Plan, mana whenua, the wider community and agencies (Central Government and Local Government) will have to work collectively utilising a bi-cultural management framework shaped by the ethics of Guardianship and Kaitiakitanga. Application of Guardianship and Kaitiakitanga principles will promote all communities sustaining and enhancing the mauri (life essence or well-being) of the Hauraki Gulf Marine Park for future generations.

For Māori, all things, both tangible and intangible are interconnected and possess mauri – a life force or vitality derived from the Atua (Gods). This guides our interactions with the environment, and sustaining and protecting mauri is therefore central to the exercise of Kaitiakitanga / Guardianship.

A wealth of local knowledge is held about the Hauraki Gulf Marine Park, its ecosystems and its catchments. Place-based narratives of Māori and local communities describe a long experience of living in a particular area. Place-specific experiences, our cultural and spiritual beliefs, institutions and ways of doing things, and the way we look at the world as a result, weave us together as communities of the Hauraki Gulf Marine Park.

Our combined knowledge (mātauranga and scientific) and knowledge within local communities, equips us – if we learn from what has taken place in the past - for the task of restoring the mauri of the Hauraki Gulf Marine Park and of its inhabitants. The task ahead is turning that knowledge into actions.

Making substantive changes cannot be achieved through rules and regulations alone. The people who love or depend on the Gulf need to embrace change and ensure their knowledge, understanding, commitment and passion furthers this collaborative drive to restore the mauri of the Hauraki Gulf Marine Park.

Recently in New Zealand, Te Urewera and the Whanganui River (Te Awa Tupua) became the first landscape features in the world to be given status as a legal being. This is very much in line with a Māori view of the world, in which rivers and mountains are considered relatives. It resonates well with many other New Zealanders too, and when people come to see the natural environment as a living being they are less likely to abuse it.

Gulf communities need to adjust their relationships with the lands and waters around them. Rather than thinking of the environment and its bounty as an entitlement, considering it as a being in its own right will help us to rethink our reciprocal responsibilities, and work toward a better balance. Currently environmental management thinking is preoccupied with mitigating effects rather than striving for mutual benefit. Sea Change – Tai Timu Tai Pari aims to turn this around.

Sea Change promotes building and maintaining strong relationships between agencies and local communities, mana whenua and industry in order to share mātauranga, knowledge and good practices. We need to celebrate our individual and collective sense of this place, and build on the long relationships in order to realise the potential of effective co-management. This will not be all plain sailing, but the process we have mapped will provide the opportunity to strengthen relationships, to learn from each other, and to empower communities and mana whenua to achieve local aspirations.


mission
mission
mission

A selection of quotes from members of the public at Listening Posts

The visions people have for the Gulf are expressed below in a selection of quotes from members of the public at listening posts. We provide further listening post quotes in each of the main chapters of Sea Change.

Whangamata

I would love for my grandchildren to be able to surf the bar like I do now but in better quality waters.

Maraetai

The revival of Taniwha stories that give a sense of tradition, history and ecology.

We want a pristine beautiful harbour, enhance this or at least preserve it. It is something special and we don't know how lucky we are. In the end it's adding value to us all.

Thames

Need places to connect with nature, the "breathing space".

Character of the island and the reason we are all here. Needs to be a balance between future growth and our community, those things we find special – peace and quiet, not many people, walking the dog on the beach. Our freedom to enjoy what we have here.

Mahurangi

I'd like to see it preserved as much as possible in its most natural state. Also want to see it used with a conscious and caring approach.

The goal is to leave things better than we've found them.

Mercury Bay

The noises in the summers – a lot of noise from seabirds, ocean teeming with kahawai, crack open a kina and all the fish would come –so much life, so much vibrancy.

It's most important that the next generations can enjoy what we enjoyed – walking the beaches, being safe, the freedom, fishing or boating or whatever – a similar experience.

Maraetai

The underlying theme for me is sustainability and not only for kaimoana but for a growing population.

Great Barrier

Reduce plastic and pollutants from the mainland to our island. I'd like an environment where we could be rubbish free.

That mana whenua have at least equal governance and management arrangements in final decision making.

Get back to the ancient understandings - Ngā Whetu o te Rangi, mai ki uta ki tai, tai noa tu te ki te kōpua o te whenua

Thames.

Conserve for the future. We need to identify the values we want to preserve. That might mean we have to lock up areas; and we have to identify areas that enable investment opportunities, as a gateway to these protected areas.

Ngatea

Three top issues for Tīkapa Moana / Te Moananui-ā-Toi are Cultural Heritage protection, Kaitiakitanga and Natural resource management and decision making.

It's the atmosphere, the fresh air, whales, dolphins, birds – the expectation and anticipation of what you might see out there (while fishing).

Waiheke

We are blessed and have to do our best to keep it!

Love the freedom of the Gulf.

Orewa

The coast is part of a lifestyle for everybody – lifestyle is an enlarged word – discovery, adventure is part of the way of life.

Sounds of the sea.

If we all hurt together for the benefit of the Gulf, though, I'm sure we can come up with ideas where we don't all have to hurt so much.

St Marys Bay

Coast is a magnet. Everybody loves the coast and being by the sea. Part of it's in you.

We need to sacrifice now so that we can have more.

PLACE STUDY:
KAITIAKITANGA AND GUARDIANSHIP OF ŌKAHU BAY - NGĀTI WHĀTUA ŌRĀKEI

Iti ka rearea, teitei kahikatea ka taea –
The small bird can scale the great height of the kahikatea
(Ngāti Whātua Ōrakei proverb).

The spiritual significance of Whenua Rangatira ('chiefly or noble land') at Ōrākei and Ōkahu Bay is recognised by Ngāti Whātua Ōrākei through its vigorous campaigns to safeguard the place, which links Tāngaroa, Papatūānuku, Tāne-mahuta and Ranginui (water, land, forest and sky). Under the Orakei Act (1991) the land is set aside as a Māori Reservation for the common use of the hapū and the citizens of Tāmaki Makaurau (Auckland), it is the oldest co-governance arrangement between mana whenua and Local Government.

Ngāti Whātua Ōrākei plays a major role in the strategic planning of the use and development of hapū owned and co-managed whenua, guided by Ngāti Whātua Ōrākei values. The whenua and moana (land and sea) are highly impacted by urbanisation, former coastal terrestrial ecosystems are decimated, infrastructure construction has desecrated the mana and mauri of the hapū and the marine environment, which receives large quantities of heavy metal and pathogen laden sediment into an over-engineered receiving environment that can no longer flush and regulate itself naturally. Examples are the construction of Tāmaki Drive (which covered the sewer pipes that previously caused death and disease to Ngāti Whātua Ōrākei), piping of streams, and the construction of rock walls, marinas, and stormwater infrastructure.

In order to address these impacts, the hapū developed "Ko te Pūkākī", the only hapū based terrestrial ecological restoration programme in the region. Over the 48 hectares of reserve land the hapū refuses to use poisons or sprays that are considered to destroy the mauri of the whenua. The hapū has planted 200,000 native plants grown in their purpose built nursery, to ensure these whakapapa to the whenua. The replanting provides a korowai (cloak) to protect Papatūānuku, and also provided training, employment and vocational pathways for hapū members for over 15 years.

Figure 3.1 Kaitiaki at work at Ōkahu (Source. Richelle Kahui-McConnell)

The award winning marine environment restoration programme, Ōkahu Catchment Ecological Restoration Plan (Kahui-McConnell, 2012) includes a suite of methods to 'bring the fish back' and achieve the cultural health indicator "A healthy bay has our whānau in it". The programme includes tidal creek re-instatement, naturalisation of all waterways, a mussel reef restoration programme, and removal and mitigation of engineering and infrastructure. The restoration programme is underpinned by an adaptive management strategy that amalgamates mātauranga Māori and science to inform and develop restoration initiatives, and importantly, creates vocational and educational pathways for hapū members to implement kaitiakitanga practices.

Management of the traditional coastline and foreshore include initiatives such as the revival of traditional customary practices, the development of a whare waka on the foreshore, development of a waka ama/ paddle centre adjacent to their land within the bay, opposing marina developments, and advocating for and achieving the removal of moorings from the Bay, to be implemented through the Auckland Unitary Plan by 2018.

MUSSEL REEF RESTORATION PROJECT

The mātauranga (traditional knowledge) of Ngāti Whātua Ōrākei has informed the restoration of mussel beds in Ōkahu Bay, Waitematā Harbour, since 2013. In order to restore the pātaka kai (food cupboard) that was formerly present this mātauranga identified existing mussel reefs, in order to extend their reach, and biologically appropriate areas for placement according to knowledge of tides and fresh water flows. Ōrākei Water Sports laid the first mussels using conventional means of laying them on the seabed. The next phase is to use existing three dimensional structures (constructed rock walls) to grow the mussels on, to avoid them being smothered on the sediment-loaded sea floor. This will include utilising existing mussel beds that whakapapa (have lineage) to the bay, and working with Kairaranga (weavers) to create kupenga (nets) to collect and stabilise the mussel onto rocks until they attach themselves. Research partnerships with the University of Auckland are investigating heavy metal uptake in mussel shells from such an impacted receiving environment. Adaptive management is setting the direction for methodology changes to ensure restoration of the mauri of the hapū and their ancestral bay. The goal of the mussel reef restoration is to return the fish to the bay, return the pātaka to its former state, and have whānau interact with their traditional bay as their ancestors have done for over 600 years.

Figure 3.2 Kaumatua Tamaiti Tamaariki laying the first phase of mussel reef restoration in Ōkahu Bay (Source. Charlotte Graham)

Figure 3.3 Tumutumuwhenua Marae of Ngāti Whātua Ōrākei, overlooking Okahu Bay. (Source. Ngāti Whātua Ōrākei)

INITIATIVE ONE.
BIODIVERSITY AND HABITAT RESTORATION

THE PROBLEM

Biodiversity is a critical component of human wellbeing and sustainable development. When species disappear the “ecosystems services” they provide do too. With marine biodiversity loss comes a reduction in the ocean’s capacity to provide food, maintain water and air quality, and recover from stressors such as pollution, disease, extreme weather events, rising temperatures, and ocean acidification.

With an expanding population, forecast to exceed 2.8 million living within 80 km of the Hauraki Gulf by 2030 (Statistics NZ, 2014), intense pressure is placed on our natural resources within the marine and coastal environment from inappropriate land use, nutrient and sedimentation run-off, pollution, over extraction, and harmful fishing techniques.

BIODIVERSITY THEMES WITHIN THE PLAN - TAI TIMU TAI PARI

There are three main, inter-related themes incorporated within the biodiversity section of this Plan: 1). Ecosystems - Restoring healthy functioning ecosystems throughout the Hauraki Gulf Marine Park including those in freshwater, estuarine, inshore and deep water areas; 2). Habitats - Protecting, enhancing and restoring the full range of habitats throughout the Hauraki Gulf Marine Park; and, 3). Species - Protecting and restoring the diversity and abundance of all species within the Hauraki Gulf Marine Park.

THE GOAL

The overall biodiversity goal is to restore the lost natural ecosystem function in the Hauraki Gulf Marine Park, for replenished abundance and diversity of life.

The rehabilitation and restoration in the Gulf is an overarching aspiration of Sea Change, including more abundant fisheries, strengthen mauri of Tīkapa Moana / Te Moananui-ā-Toi and its inhabitants, and improved health and functioning of the Gulf.

A great deal of significant work has and is being done by a network of community-based charitable trusts and mana whenua to eradicate animal and plant pests from many Hauraki Gulf islands. Restoration of these islands safeguards the breeding sites for many of the seabird species that live in and visit the Gulf and provides safe habitat for a large number of native insects and reptiles including our iconic tuatara. As well, there are projects underway to restore margins of streams and rivers to protect freshwater and diadromous (which use both salt and fresh water in their lifecycles) species and to provide both living and breeding habitat. What happens under the water is not so easily seen, but the degradation of marine habitat from sedimentation, disruptive harvesting practices, and nutrification is now better understood.

But we have identified the need for more information, and a consistent and integrated inter-agency approach to monitoring and reporting, in order to better understand the Hauraki Gulf Marine Park and work toward its restoration. Sea Change identifies the need for communities, mana whenua, relevant sector groups, alongside the agencies, to implement this Plan together.

Marine Protected Areas

MPAs range from “no take” marine reserves that prohibit any extraction, but often allow scientific research, non-extractive commercial activities and recreation, to ‘multiple use zones’ where there are fewer restrictions.

PASSIVE RESTORATION

Passive restoration involves the retirement or mitigation of key stressors (e.g. high seafloor fishing gear impacts and/or sedimentation in areas of high importance) to allow natural regeneration.

MPAs are a form of passive restoration. By closing off areas to external pressures, or removing a particular activity the area may be able to naturally regenerate. The six marine reserves in the Hauraki Gulf provides a window into the recovery of marine ecosystems.

ACTIVE RESTORATION

Active restoration involves the transplanting/establishment of new habitat patches/areas through direct human intervention. While the scale issues are significant, initial restoration attempts for cockles and seagrass in Whangarei Harbour and elsewhere have shown promise; and green-lipped mussel restoration efforts in the Gulf are uncovering key hurdles to overcome in re-establishing beds, both biophysical, and social.

REEF RESTORATION

Restoration of biogenic habitat such as seagrass meadows, shellfish beds and mussel reefs that provide important ecosystem services and functions (filtering water, provide habitat for fishes and other invertebrates to shelter and grow) as well as opportunities for mahinga kai may succeed where the pressures that caused the original loss no longer exist and the seabed substrate is suitable for recolonisation.

> *...We need to see past the blue – that the marine environment is worthy of protection.*
> **- Listening Posts**

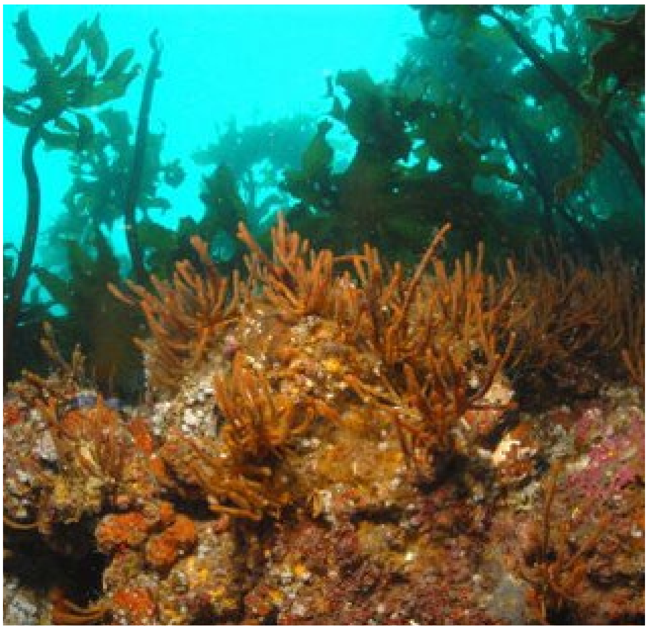


Figure 3.4 Hauraki Gulf restoration successes

Figure 3.5 Mussel reef restoration, depositing shell

Figure 3.6 Before and after photos of mussel reef restoration

WHAT YOU TOLD US

- Healthy marine habitats are critical.
- MPAs are seen as the most important means to protect the marine ecosystems and habitats, and biodiversity in the Gulf.
- Whole of catchment management planning is also an important means of marine protection and can prevent impacts from land-based activities.
- Use areas like nature island reserves and extend existing marine reserve areas as protected areas to help with biodiversity regeneration.

OBJECTIVES FOR RESTORING BIODIVERSITY AND MARINE HABITATS

For the three themes described above we arrived at 17 objectives, five for restoring healthy functioning ecosystems, four for protecting, enhancing, and restoring habitats, and eight for restoring species diversity and abundance.

Two of these described in Initiative One, active and passive restoration, are: 1) Restore historic ecosystem functionality of bivalve beds by 2040 to recover self-sustaining, expanding, filtering capacity and secondary production; and, 2) Systematically identify by 2018 and protect by 2020 representative and ecologically important marine habitats throughout the Hauraki Gulf Marine Park using a variety of tools including marine reserves, benthic protection areas, customary management tools and other spatial management tools.

A comprehensive suite of actions is detailed in the Plan for achieving these objectives.

RELATIVE IMPORTANCE OF BIODIVERSITY AND BIOSECURITY ISSUES

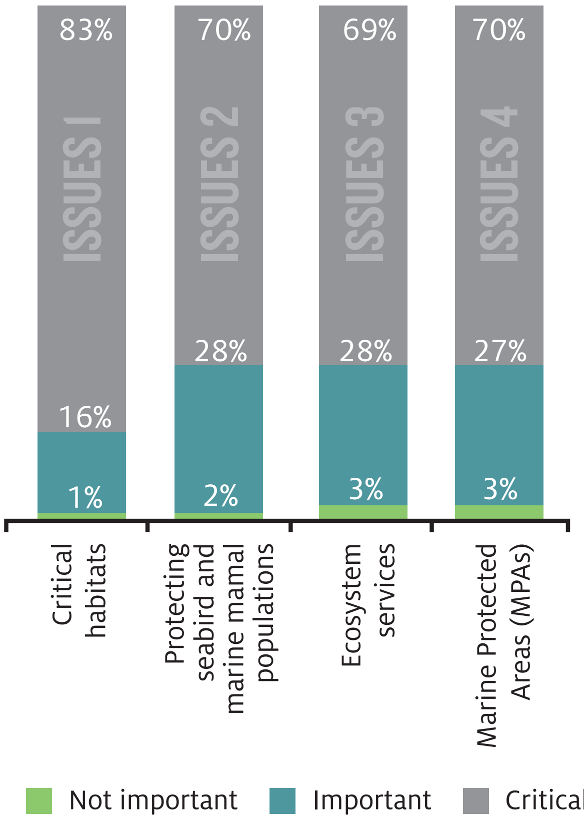


Figure 3.7 Relative importance of biodiversity and biosecurity issues.

INITIATIVE TWO.
MAHINGA KAI / PĀTAKA KAI – REPLENISHING THE FOOD BASKET

The Sea Change theme Mahinga Kai/ Pātaka Kai recognises Tīkapa Moana / Te Moananui-ā-Toi as a food basket. Protecting and replenishing a bountiful food basket will help to maintain increases biodiversity and the health capacity of the coastal area, and meets the spiritual and physical needs of mana whenua and all communities.

FISH STOCKS

The Hauraki Gulf Marine Park has supported commercial and non-commercial fishing for more than 170 years, and that of Māori for closer to a millennia. The Park forms an important part of New Zealand's commercial fisheries, including local artisanal fishermen, and supports a large recreational fishing community of around 220,000 active fishers. Mana whenua have significant commercial fishing interests secured in Treaty Settlements, are traditionally keen fishers, and have protected customary rights.

Today there continue to be many issues of concern around the state of fish stocks, localised depletion and the ability of ecosystems to support healthy fisheries in the Hauraki Gulf Marine Park. Our overall vision for fish stocks is to manage fisheries and marine habitats together, to increase abundance and biodiversity, in order to provide multiple benefits. The outcomes we are seeking are:

- Increased abundance of all species, recognising the interconnectedness of ecosystems and the impact that loss of one species or habitat has on others.
- An end to any further loss of biogenic habitats, and cessation of activities which hinder their ability to recover through ongoing disturbance, due to the large extent of historic loss and their importance in the life cycle of many species.
- A flourishing Hauraki Gulf Marine Park fishery that focuses on harvesting high quality, high value fish.
- A return to localised abundance that provides for recreational and cultural wellbeing.

Sustainable harvesting indigenous flora and fauna species, particularly taonga (culturally important) species, is important to enhancing the mana of mana whenua, and also for the well-being of the wider community. In order to achieve our goal of restoring the mauri of Tīkapa Moana / Te Moananui-ā-Toi, changes are required to the way in which fishing occurs in the Park. Bottom trawling, Danish seining, and dredging are fishing methods that should be transitioned out of the Gulf over time.

> "In the fished areas the management needs a huge shake up; bottom methods like trawling should be kicked out of the Gulf. We need to leave more fish in the sea. (Getting to) 20% of the original biomass has had a huge impact on the rest of the ecology; the kina barrens are there because there's not enough snapper and crayfish there.
> **- Listening Posts**"

FISH STOCKS OBJECTIVES

There are two broad themes and overarching objectives to the Fish Stocks chapter: 1, Using an ecosystem-based approach to manage the harvest of wild fisheries in the Hauraki Gulf Marine Park in order to rebuild depleted fish stocks within a generation; and 2, Putting in place mechanisms to protect and enhance marine habitats in the Hauraki Gulf Marine Park so that the current decline is reversed and healthy habitats are restored. We have set 7 objectives for the first theme, and three for the second, which together will achieve the outcomes stated above.

Figure 3.8 Gathering kaimoana and mussel farms in the Firth of Thames

AQUACULTURE

There are 210 hectares of consented oyster farm space in the Hauraki Gulf Marine Park, accounting for nearly half of national production, and approximately 1500 hectares of mussel farms. The Gulf's aquaculture industry provides a number of economic and social benefits, including creating wealth and employment, supporting Māori development, providing for research and development, and supporting other sectors such as charter fishing and tourism.

Our overall goal for aquaculture is that prosperous aquaculture positively contributes to the health and wellbeing of the people and environment of the Hauraki Gulf. There are several objectives that will help realise this vision for Aquaculture:

- By 2018, have a 'three tiered' regulatory regime in place for aquaculture that enables aquaculture in identified areas where the overall benefits of aquaculture to the Park are maximised, allows case-by-case consideration of aquaculture in areas which may be suitable but which have not been identified as an area where benefits will be maximised, and restricts aquaculture in areas which are not suitable for aquaculture.
- By 2020 a robust and supportive regulatory framework (based on the above) provides clear and consistent policy, rules, monitoring and engagement requirements for the community, industry and mana whenua.
- By 2020 mana whenua aspirations regarding aquaculture need to be provided for.
- By 2020 iwi, the industry, government, universities and research institutes support research and innovation through the creation of a Hub for Aquaculture Excellence.

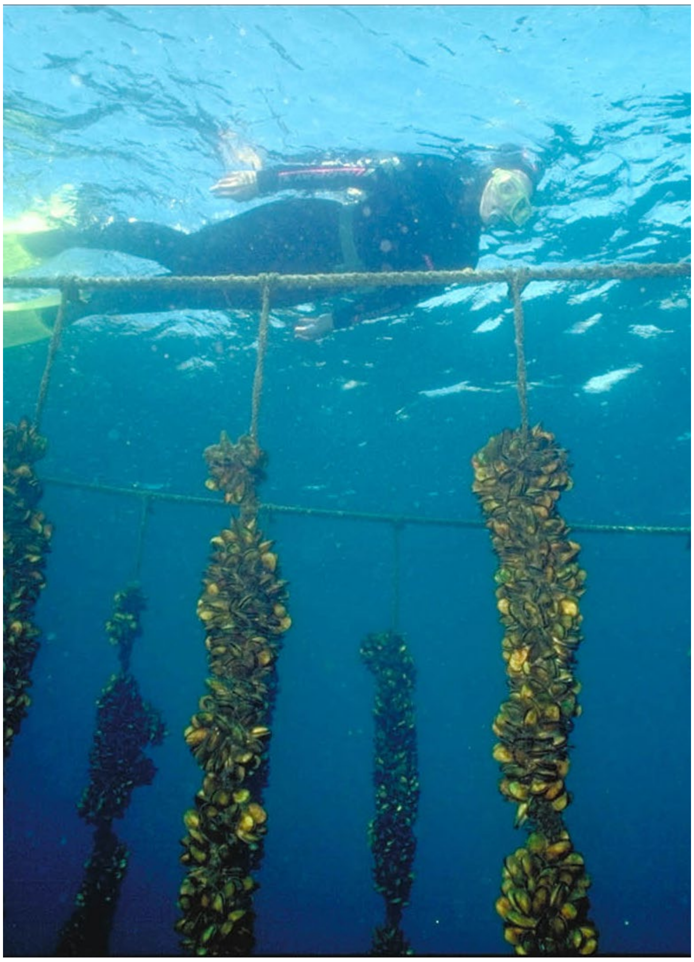


Figure 3.9 Suspended mussel lines

Future aquaculture development

In order to achieve our desired objectives, Sea Change has identified 13 areas within the Hauraki Gulf Marine Park that should be prioritised for future aquaculture development. It also identifies areas that are not suitable for aquaculture, and recommends means to ensure potential adverse ecological effects associated with aquaculture are appropriately managed. What you told us:

There is a willingness to compromise and accept recreational fishing impacts – via rāhui, MPAs or catch/size limits – but only if commercial fishing operations are made sustainable, restricted or removed from the Gulf.

Fishing technologies and sectors that damage the seafloor and its habitats are not acceptable.

Provide fishing quotas for all species and place limits on size (under/over) ensuring that there is equity between recreation and commercial fishers.

Quotas are not targets', a campaign would be valuable, people need to be educated to take what they need and leave the rest for another day - 'tiakina te pātaka kai (take care of our food cupboard).'

Introduce or strengthen penalties for people or organisations breaking the rules and give regulatory agencies the funding and resources they need to enforce compliance.

RELATIVE IMPORTANCE OF FISH STOCK ISSUES

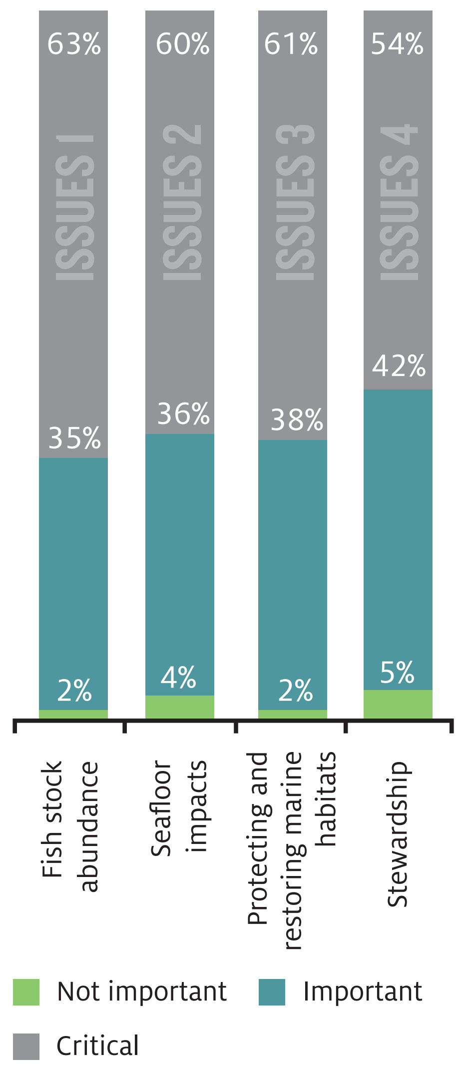


Figure 3.10 Sea Change Summer Survey 2014-2015 Results and Analysis report - Fish Stocks

INITIATIVE THREE.
SEDIMENT AND WATER QUALITY – WAIPARA

THE PROBLEM

In the Plan we identify and deal individually with five aspects of water quality and marine pollution in chapter 6. These are sediment, nutrients, heavy metals, microbial pathogens, and other risks and threats. This initiative focuses on sediment. We found excessive sediment runoff from the land to be the main cause of degraded marine habitats in estuaries, harbours and the Inner Hauraki Gulf.

THE GOAL

Our overall goal is to reduce sediment entering the coastal marine area, to levels which support healthy marine habitats. This will, in turn, support more abundant marine life and fish stocks and provide greater opportunities for people and communities to enjoy the Gulf.

Our objectives for sediment are to:

- Minimise sediment erosion off the land
- Capture sediment runoff before it reaches the marine environment
- Stabilise sediment already deposited in the marine environment including the Firth of Thames.

Figure 3.11 Exposed stream banks versus intact riparian margins

WHAT WE ARE SAYING

The Gulf Sediment Initiative will be a high-powered, proactive collaborative initiative to drive the implementation of the actions set out below. Drawing inspiration from the Waihou Valley Scheme which, during the 1970s, engaged in a concerted effort to reduce erosion within the Waihou catchment, the Gulf Sediment Initiative will provide the impetus to reverse the current sediment degradation in the greater Hauraki Gulf.

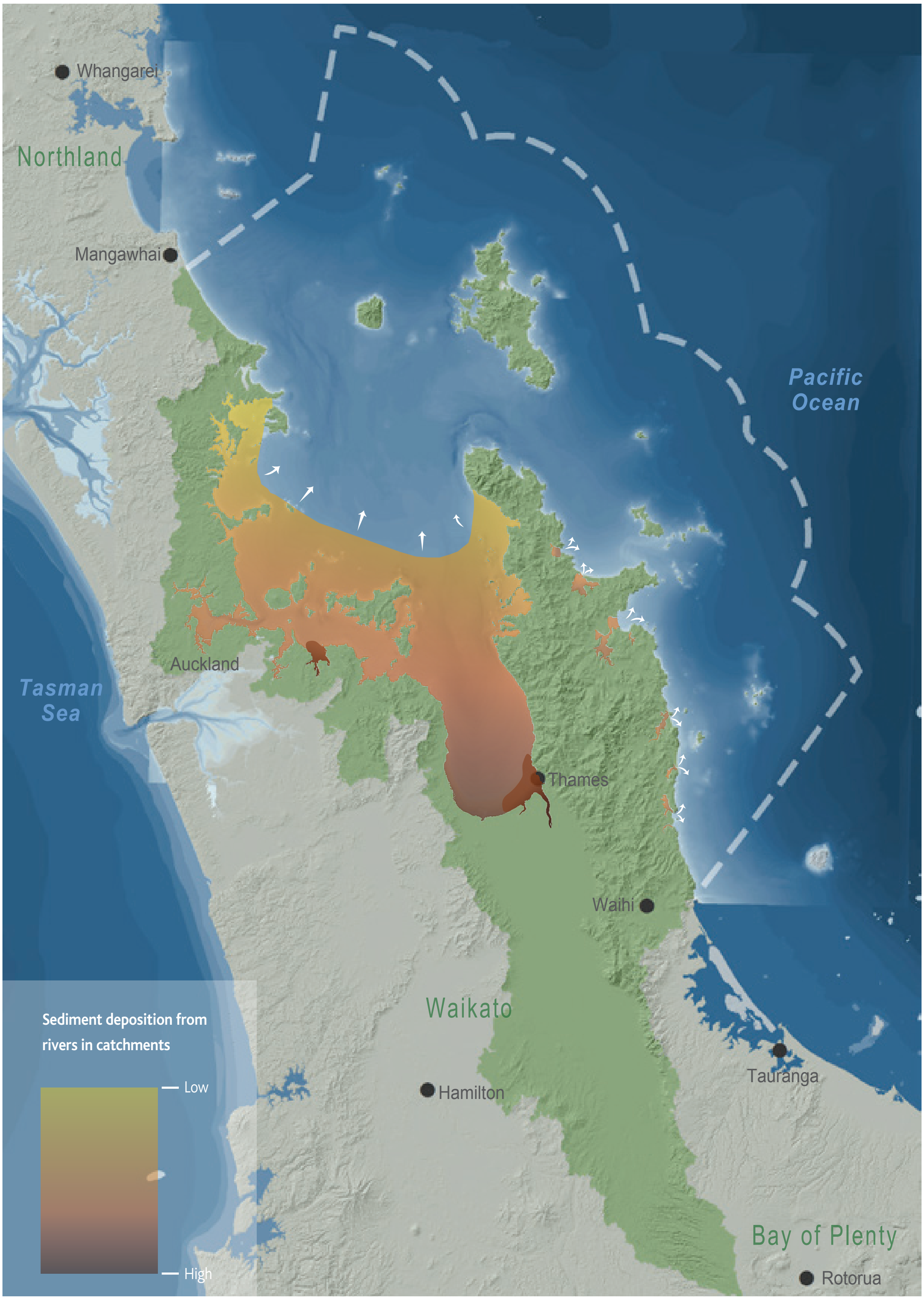
The initiative will be inclusive of agencies, mana whenua and communities. It will draw on kaupapa Māori approaches, the best available knowledge and will be innovative in securing resources and targeting interventions.

Within the gulf sediment initiative there are eight major actions that will collectively help achieve the desired outcomes:

- Catchment management plans
- Establishment of catchment sediment load limits
- Increase Sediment Traps in contributing freshwater waterways
- Better waterway management
- Ensuring good sediment management practice
- Review of forestry impacts on sedimentation
- Protection of highly erodible soils
- Addressing Sediment in the Coastal Marine Area

Three sediment-related objectives are set out in the Plan. These combined with three for nutrients, and four each for heavy metals and microbial pathogens form a comprehensive package of objectives, and a plan of action, to address the pollution of the waterways and waters of the Park.

> *...I love sediment treatment wetlands. They're the best thing ever –beautiful birds, the water being cleaned. I just love them! A few years ago the neighbours were worried about mosquitos, but the opposite has happened. It's a lovely thing to look at it functioning so well.*
> **- Listening Posts**



Map 3.1 Sediment travel within the Park

Figure 3.12 An example of built water treatment solutions

> *..The one thing I've noticed is sedimentation from all the developments. Now they put sediment ponds in. I can remember doing a dive course, and the person in front of you would kick up all the mud off the bottom. Stanmore Bay is always muddy. A few years ago it would have been clear. I notice the sand that came off the coast. The shell beds were corrugated. There was so much shellfish there.*
>
> **- Listening Posts**

Figure 3.13 Scuba diving in the Gulf

INITIATIVE FOUR.
AHU MOANA – MANA WHENUA AND COMMUNITY COASTAL CO-MANAGEMENT AREAS

The Ahu Moana - mana whenua and community co-management areas ('Ahu Moana') are a mechanism designed to allow mana whenua and local communities to work together in the future to manage their coastal areas. Ahu Moana will be initiated and jointly managed by coastal hapū/ iwi and local communities, but will not affect their ability to use other statutory management tools, including MPAs in the future.

Ahu Moana are localised near-shore co-management areas along the length of the Hauraki Gulf and its islands, that will extend from mean high water springs (the high tide mark) generally out 1km. The word ahu means to nurture or build up, and to move with purpose in a certain direction. Moana is the ocean. The name 'Ahu Moana' therefore represents our intention of restoring our coastal fisheries and environments, and the shared determination of mana whenua and local communities to improve them for our children and grandchildren.

Ahu Moana will focus the energy and knowledge of local hapū/iwi and communities, including local kaitiaki and recreational and artisanal fishermen. This knowledge is critical for the effective management of local fisheries and coastal waters. Local people have 'skin in the game' and suffer the most immediate effects from overfishing or pollution.

It will take some time for mana whenua and communities to find the best ways to implement Ahu Moana. It is important to note that, on commencement, Ahu Moana will not prevent or restrict commercial or recreational fishing, aquaculture, marine protection or other activities in these areas. However, it may be that mana whenua and communities may decide that there is a need for such restrictions in the future, to provide protection or to restore an area for example.

Figure 3.14 Teaching mokopuna to gather kaimoana

NGĀ TIKANGA - PRINCIPLES

These are the principles that apply to Ahu Moana:

- A 50:50 co-management approach between mana whenua and local communities.
- Ahu Moana and MPAs will not dilute Treaty settlements.
- Where Ahu Moana intersect with MPAs, the more stringent rules will prevail.
- Commercial and recreational fishing are allowed in Ahu Moana.
- Fishing and other activities may be restricted by mana whenua and local communities in Ahu Moana to protect fisheries or the environment.
- Customary harvest may take place in all areas – except during rāhui or where more stringent rules prevail[1].
- Ahu Moana areas do not restrict the establishment of future no take marine reserves or other MPAs.
- Ahu Moana areas do not restrict the establishment of future aquaculture areas.
- Ahu Moana areas do not restrict access to the marine environment.

While providing the opportunity for local community involvement in coastal management, Ahu Moana are also intended to assist mana whenua to fulfil ancestral kaitiaki obligations, and to recognise the historic, traditional, cultural, and spiritual relationship of the tangata whenua with the Hauraki Gulf and its islands, which is specifically provided for in the purpose of the Hauraki Gulf Marine Park Act 2000.

Ahu Moana will be designed for the unique circumstances that exist within the Hauraki Gulf, Tīkapa Moana / Te Moananui-ā-Toi. They are able to be integrated with existing (and future) fisheries and conservation instruments, such as marine reserves and MPAs, mahinga mātaitai, taiāpure and rāhui within fisheries legislation, Māori customary rights provided for in the Marine and Coastal Area (Takutai Moana) Act 2011, heritage orders under the RMA, or deeds of recognition in the Hauraki Gulf Marine Park Act 2000.

Ahu Moana will act as a korowai (traditional cloak) to enclose some of the MPAs proposed through this Marine Spatial Plan, and existing marine reserves. In some places MPAs and Ahu Moana will coexist, hence the principle that where this happens the more stringent rules prevail.

Importantly Ahu Moana will allow for the bringing together of mātauranga Māori and local knowledge, including that of recreational and artisanal fishers, alongside scientific data, to provide responsive and adaptive management. They will strengthen iwi and hapū relationships with local communities in their shared spaces.

1 Customary take or harvest to be on a case by case basis by special permit – refer to the discussion on the two approaches to this on page 118

Map 3.2 Ahu Moana across the Hauraki Gulf Marine Park

The intention is that the chain of Ahu Moana will operate 'organically', as it does under the care of kaitiaki who have been issuing customary permits for decades. While no formal network exists, kaitiaki go to lengths to cooperate to regulate pressure across kaimoana beds. If local pipi beds or pāua populations are depleted permit holders are sent to the nearest strong beds, with agreement by that hapū. Kaitiaki are aware of the impact on neighbours if they restrict their beds, so if all of the beds are depleted they are all closed.

KEI TE WHAKATINANATIA TIA – PUTTING FLESH ON THE BONES / GIVING EFFECT TO THE VISION

It is possible that the legal vehicle for Ahu Moana will be realised through Treaty settlements, or dedicated legislation. Discussions about harbours co-management and Marine and Coastal Area (Takutai Moana) Act customary rights are taking place in Treaty negotiations at this time for many local iwi, and this provides a unique opportunity to design and implement this innovative co-management approach with communities.

IMPLEMENTATION MEASURES

The establishment of Ahu Moana will involve the following elements:

- There could be a Treaty settlement-negotiated bespoke (designed for the specific circumstances) arrangement for Ahu Moana through future Treaty settlement processes.
- There is a need to determine collective and iwi/hapū-specific areas.
- Mana whenua – local community committees would be established (with the appointment process to be developed).
- There would be integration with adjacent or intersecting MPAs; as the same people are likely to be on both committees.
- There would be co-ordination with the Hauraki Gulf Forum, MPI, DOC, local authorities and other agencies, and with instruments such as for mahinga mātaitai and taiāpure and under the Marine and Coastal Area (Takutai Moana) Act.
- Some existing functions could move to Ahu Moana committee, e.g. from harbour committees.
- There will also need to be coordination with DOC and regional council administration of esplanade reserves, coastal riparian strips, and other landward protected areas.
- There could be a single implementation phase or a number of phases, depending on hapū and community preparedness.

INITIATIVE FIVE.
KAITIAKITANGA AND GUARDIANSHIP

Tīkapa Moana / Te Moananui-ā-Toi is an icon worth preserving and restoring, it holds 'the best coastline in the world'. It is a learning ground that provides active transmission of cultural knowledge and intergenerational stories by continued interaction with the ecosystems.

Sustaining the mauri of the park, its resources, inhabitants, and many places, is central to the exercise of Kaitiakitanga / Guardianship. This is an overarching theme of Sea Change – Tai Timu Tai Pari. In our vision each one of us has rights and responsibilities here, and strives to protect the Park and its treasures. This includes mana whenua, our children, everyday citizens, newcomers to the area, businesses, government agencies, and councils.

There is a very clear link in people's minds between the health of Tīkapa Moana / Te Moananui-ā-Toi and the wellbeing of those who make use of it and are connected to it. People are more likely to take care of the environment when they have access to wilderness places and experiences.

"Kaitiakitanga, whakapapa, and papakāinga are highly valued and as such, the deep connection between whānau and Tīkapa Moana / Te Moananui-ā-Toi are inseparable" - Mātauranga Māori Survey.

Figure 3.15 Te Kotuiti – wakataua (war canoe) of Ngāti Paoa, at the opening of Te Ara Moana (the seagoing pathway) waka trail, 5th April 2014 (Source. Ngāti Paoa Iwi Trust)

The kaitiakitanga and guardianship outcomes we are seeking are:

Recognising the ancestral history and traditional use of Tīkapa Moana / Te Moananui-ā-Toi by mana whenua and the 'sense of place' the wider community have towards the Gulf

Protecting the mauri and natural values of the moana, freshwater, coastal and terrestrial ecosystems, wāhi tapu sites and other identified taonga against adverse impacts caused by use, infrastructure and accessibility

Providing coastal facility and walkways plans which allow for a spectrum of experiences where we can channel demand, and have other locations remain a wilderness experience which is less frequently visited

An extension of coastal parks and reserves and natural areas to interact with to increase access and create opportunity to build relationships with the coastline for new migrants and the wider community

A centralised social media and marketing campaign to inspire kaitiakitanga/ guardianship by collecting stories, sharing them and celebrating that sense of place and connection

A transport strategy providing well publicised and regular public transport to a range of locations with transport hubs that offer multiple types of affordable transport options to connect to the coast Alongside a 'Walking on Water' campaign

A Tīkapa Moana / Te Moananui-ā-Toi 'One Gulf One Message' communication and marketing strategy which centralises information to highlight campaigns and kaitiakitanga/ guardianship initiatives

Engaging the next generation so that they value Tīkapa Moana / Te Moananui-ā-Toi more than the previous generations by providing a centralised support and advocacy strategy for organisations that are educating about the marine environment and protecting and restoring the mauri of the environment

KAITIAKI AND GUARDIANSHIP IN ACTION

There is a huge number of ways that individuals and groups already tiaki / care for and protect their valued places. There are friends of the island associations that have worked tirelessly over decades to eradicate pests and replant Gulf islands, sometimes in partnership with DOC or regional councils. Dune and harbour care groups operate in many areas, and hapū and whānau are also active in protecting ancestral lands and waters. We highlight two examples of kaitiakitanga in action.

WATERCARE HARBOUR CLEAN-UP TRUST

Man-made rubbish is a widespread issue for Tīkapa Moana / Te Moananui-ā-Toi, rubbish ending up on the Gulf's beaches is dominated by plastics, which are environmentally persistent, disperse widely and cause a wide range of impacts. The bulk of rubbish near Auckland mainly comes from land-based sources, while fishing related material dominates further afield.

The Watercare Harbour Clean-Up Trust continues to remove large amounts of rubbish from coastal areas, working in conjunction with volunteers to clean the shoreline, estuaries and mangrove areas of the Waitematā Harbour, Tāmaki Estuary and islands in the Gulf.

Figure 3.16 The Watercare Harbour Cleanup Trust at work

ROCK FISHING SAFETY CAMPAIGN

We also need to look after each other, and promote safety in our ever increasing interactions with the Park and its waters. Rock fishing continues to be one of Aotearoa's most dangerous pastimes. Fishers continue to place themselves at risk on Auckland's rugged and unpredictable west coast by failing to heed simple safety advice that could save their lives.

In 2013 drowning statistics show that the most common recreational activity contributing to drowning is swimming, followed by rock fishing/land based fishing. Fishing populations continue to be transient, predominantly male and, culturally and linguistically diverse. Multi-agency education programmes have made significant impact on reducing the number of land-based fishing fatalities by influencing behaviour change and promoting a safety culture among this high risk group of aquatic recreationalists. While lifejacket wearing among fishers continues to increase they appear to be resistant to change when it comes to other risky behaviours.

Figure 3.17 Promoting safe rock fishing. Rock fishing safety campaign

PART TWO: REPLENISHING THE FOOD BASKET

WĀHANGA TUARUA: MAHINGA KAI – HE KOHINGA KI TE KETE KAI

4

FISH STOCKS. IRA MOMO IKA.

Ātea moana, tauranga ika, toka mātaitai

Managing fisheries and marine habitats together, to increase abundance and biodiversity, in order to provide multiple benefits.

5

AQUACULTURE. AHUMOANA.

The Stakeholder Working Group vision is that prosperous aquaculture positively contributes to the health and wellbeing of the people and environment of the Hauraki Gulf Marine Park.

Mahinga kai are food gathering places. Part two recognises that the Hauraki Gulf Marine Park is an important pātaka (food basket), and that many people enjoy and rely on its bounty for their livelihood, for recreation and to feed their families, and for cultural purposes such as sustaining marae and nurturing visitors. Operating within the Park we have large scale fishing companies and marine farms, and also artisanal local and family owned businesses, whose owners spend a large portion of their lives on the water. Māori are both large scale and local fishers and marine farmers.

Sea Change sought to balance the needs and aspirations of people to fish and grow seafood, with other demands on the Park, and the needs of fish and marine life, seabirds, marine habitats, and the moana (oceans). The results are contained in two chapters. Chapter 4, entitled Fish Stocks, presents a comprehensive description of fishing within the Park, and economic, social, cultural and environmental matters relating to fishing. It outlines objectives for fish stocks, ways that the various sectors involved can contribute to improving the health of fisheries and the many habitats of the Park, and the management actions intended to achieve this. Chapter 5, Aquaculture, similarly lays out the current extent of aquaculture within the Park, including economic, social, cultural and environmental matters. Part two describes our objectives for fish stocks and marine farming within the Park, and plots a path to achieving these.

4. FISH STOCKS

IRA MOMO IKA

Ātea moana, tauranga ika, toka mātaitai

Managing fisheries and marine habitats together, to increase abundance and biodiversity[1], in order to provide multiple benefits

BACKGROUND

The Hauraki Gulf Marine Park has supported commercial and non-commercial fishing for more than 170 years, and that of Māori for a millennia. With the undertaking of large scale commercial fishing over a long period of time (trawling was first introduced to the Hauraki Gulf Marine Park in 1899 and Danish seining in 1923), and the popularity of recreational fishing, the fish stocks of the Hauraki Gulf Marine Park are under significant pressure. While the setting of Total Allowable Catches in 1986 arguably saved many fisheries around New Zealand from further decline, this success was not universal, and today there continues to be many issues of concern around the state of fish stocks, localised depletion and the ability of ecosystems to support healthy fisheries in the Hauraki Gulf Marine Park.

The availability of kai moana in local areas is a fundamentally important element of cultural wellbeing. It enables mana whenua to participate in the communal experience of collecting, preparing and eating local foods and fulfilling their manaaki manuhiri obligations (providing hospitality) at their marae. It also enables the transfer of Mātauranga Māori across the generations, including understanding of life cycles, species management and food harvesting methods. Ultimately, localised resource depletion affects iwi and hapū identity. Today Māori fisheries are artificially designated as customary, commercial, and recreational, and Māori strive to balance their roles and interests across the three, in an effort to feed their families and fulfill their kaitiaki role.

The Hauraki Gulf Marine Park forms an important part of New Zealand's commercial fisheries – especially for snapper. While the area of the Park forms only a small part of the 'Snapper 1' stock area (i.e. the management area for the snapper population in this part of the country), it accounts for around one third of the catch from the area. The average quota value of snapper caught in the Park over the period 2012 – 2014 (i.e. 3 years) was more than 80% of the value of the entire commercial catch (excluding crayfish) in the area, as shown in the table below[2].

Table 4.1 Values of Quota and catches within the Hauraki Gulf Marine Park 2012-2014

	QUOTA VALUE	CATCH VALUE*	CATCH VOLUME
ALL SPECIES	$73.897 million	$8.87 million	10,574 tonnes / year
SNAPPER	$63.16 million	$7.58 million	2,049 tonnes / year

The commercial fishing sector makes a significant contribution to the nation as well as to the communities around the Hauraki Gulf Marine Park through providing jobs, incomes and a local fish supply, as well as generating export earnings. Community events associated with the sector include the Auckland Seafood Festival and the Whitianga Scallop Festival. Due to the large mana whenua interest in Total Allowable Commercial Catch shareholdings, the commercial fishing sector also makes a contribution to the economic welfare of the mana whenua of the Hauraki Gulf Marine Park. Commercial fishers seek to maximise the overall yield from the fishery. Different fishing methods yield different qualities of fish, with methods such as long-lining yielding higher value fish than bulk methods such as trawling and seining.

1 Biodiversity refers to diversity within species, between species and of ecosystems.
2 The figures above are based off FishServe published ACE prices and MPI reported catch data 2012 – 2014. Quota price was capitalised at 12% based off Annual Catch Entitlement (ACE) market data. This was based off historical Annual Catch Entitlement and quota market data as well as that used in previous Statistics NZ Fisheries Monetary Reports (we have used the Annual Catch Entitlement (ACE) figures as a proxy for Catch Value).

Recognising the cultural, social, economic and environmental importance of the Hauraki Gulf, government passed the Hauraki Gulf Marine Park Act 2000 (HGMP Act). This sets out a set of management objectives for the Hauraki Gulf that overlay management under the Fisheries Act. They include the following matters of particular relevance to fisheries management:

- Protection and where appropriate enhancement of the life-supporting capacity of the environment of the Hauraki Gulf Marine Park.
- Protection, and where appropriate enhancement of kaimoana with which tangata whenua have a relationship.
- Maintenance and, where appropriate, enhancement of the contribution of the resources of the Hauraki Gulf Marine Park to the social and economic well-being of people and communities and those which contribute to the recreation and enjoyment of the Hauraki Gulf Marine Park.

In order to achieve our goal of restoring the mauri of the Hauraki Gulf and the objectives of the HGMP Act, and for it to be increasingly productive and supportive of thriving communities, changes are required to the way in which fishing occurs in the Hauraki Gulf Marine Park. Positive changes are already occurring. Commercial fishers have made efforts to reduce juvenile catch, to place observer cameras on trawlers and to introduce electronic reporting systems.

Over the years, the recreational sector has volunteered a series of catch reduction measures for snapper and has recently embraced a significant bag limit reduction and size limit increase. The equipment and skill used by recreational fishers continues to develop. Generally fish are caught one at a time, after a few minutes on the line, and fish can be released in good condition. Modern lures work best when fishers actively fish, using rod and reel to impart movement. Most fish are lip hooked and lures tend to catch fewer small fish. Kingfish and kahawai are often caught and released. The increased size limit for snapper (to 30 cm for recreational fishers) has also increased the number released. Better fishing and handling practices to ensure fish are released in good condition have been widely promoted as has the recent phenomena of catch, photograph and release length-based fishing contests. A growing number of anglers practise a conservation catch policy with utilisation of catch also becoming a more conscious behaviour – www.freefishheads.co.nz being a good case in point.

The management actions set out below build on these positive initiatives by both sectors.

The outcomes we are seeking are:

- Increased abundance of all species, recognising the interconnectedness of ecosystems and the impact that the loss of one species or habitat has on others.
- An end to any further loss of biogenic habitats, and cessation of activities which hinder their ability to recover through ongoing disturbance, due to the large extent of historic loss and their importance in the life cycle of many species.
- A flourishing Hauraki Gulf Marine Park fishery that focuses on harvesting high quality, high value fish.
- A return to localised abundance that provides for recreational and cultural wellbeing.

In improving the management of fisheries within the Hauraki Gulf Marine Park, and restoring habitats of importance to fisheries, the plan is intended to support a flourishing and financially successful commercial fishing sector. We have identified some of the benefits to the industry of the implementation of this plan as being:

- Obtaining greater value for fish caught within the Hauraki Gulf Marine Park.
- Greater confidence in the ongoing sustainability of fish stocks within the Park to underpin new investment in the industry.
- Improved ecological health of the Park, leading to improved productivity of fish stocks and therefore potentially enabling improved harvest levels on an ongoing basis (through improved fisheries habitat, reduction in juvenile mortality, and removal of overfishing)
- Improved community relations.

We recognise that although the Hauraki Gulf Marine Park is the most heavily researched marine space in New Zealand, the scientific basis on which we have undertaken our work is far from complete and there are still many significant knowledge gaps. We have supplemented the available science with other information sources including Mātauranga Māori and local community knowledge. We have recommended in Chapter 11, Implementation of the Plan, that a more rigorous and integrated research and monitoring programme be undertaken in the Hauraki Gulf Marine Park, including the use of cultural indicators, to provide a stronger platform to inform future management decision-making. However we cannot wait for perfect knowledge. It was very clear to us that action was required now. So although, from a purely scientific perspective, the information base to support some of the recommendations below may be uneven, this is balanced by an overwhelmingly strong sentiment from local communities and mana whenua of the Hauraki Gulf Marine Park that a sea change is needed to increase abundance and biodiversity.

A COMMUNITY PERSPECTIVE

Fishing is a popular recreational activity in the Hauraki Gulf Marine Park, with around 220,000 active fishers in the Park. Numbers are likely to continue increasing with projected population growth. Recreational fishers gain a range of values from fishing, in addition to the provision of food. They value being able to catch a wide range of fish and sizes in accessible localities and therefore benefit from high stock levels and suffer disproportionately from localised depletion. The ability to pass on fishing knowledge to the next generation is also critical in this age of digital escape. As well as providing many social benefits, recreational fishing supports a large industry consisting of firms who support fishers including boat builders, service providers, tackle and bait suppliers, charter operators and attendant hospitality and accommodation providers. Recreational fishing in the Hauraki Gulf Marine Park supports a growing high value international and domestic tourism economy.

Artisanal fishermen and women live in many of the Park's communities. Smale-scale local businesses, often leasing catch entitlement off the large fishing companies, they provide much needed jobs, and rely on abundant fish stocks for a living. They too want the opportunity to pass on their knowledge (and their boats) to their children, as their fathers did.

A MANA WHENUA PERSPECTIVE

For Māori all ocean species descend from Tangaroa, the god of the sea, and live within his domain. Kaimoana was a primary protein source for many hapū. Its availability was therefore crucial to tribal survival and prized kaimoana grounds were jealously guarded. Over millennium mana whenua accumulated a vast knowledge of their fisheries, and developed methods for ensuring that local kaimoana grounds were not depleted. The nature of Māori fisheries was investigated by the courts when Māori took legal action in an effort to ensure that Māori rights were preserved when the quota management system was being introduced. Justice Greig of the High Court wrote: [3]

> *"I am satisfied that there is a strong case that before 1840 Māori had a highly developed and controlled fishery over the whole of the coast of New Zealand, at least where they were living. That was divided into zones under the control and authority of hapū and tribes of the district. Each of these hapū and tribes had the dominion, perhaps the rangatiratanga, over those fisheries. Those fisheries had a commercial element and were not purely recreational or ceremonial or merely for the sustenance of the local dwellers".*

Mana whenua have widespread fishing interests – in customary, commercial and recreational fishing. This reflects the centuries old connection mana whenua have with Tīkapa Moana / Te Moananui-ā-Toi. The many tribes of the seas of the HGMP have received full and final Treaty of Waitangi settlements for their commercial fishing interests and are therefore are a major participant in commercial fishing through the fisheries Treaty settlement under the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992.

3 NZ Māori Council and Anor vs. Attorney-General (Ministry of Agriculture and Fisheries) and Anor. High Court, Wellington, CP 553/87

The Stakeholder Working Group have agreed that this plan must not dilute or otherwise affect Treaty settlements. Those settlements clearly record that the redress provided to mana whenua was only a very small percentage of losses suffered as a result of breaches of the Treaty. That fact reinforces the importance of protecting the redress that has been provided through Treaty settlements. A key principle guiding the implementation of the plan will be the preservation of the integrity and value flowing from the current and future Treaty settlements. Accordingly, none of the Sea Change proposals, restrictions, actions or other measures will diminish or detract from any commercial or non-commercial Treaty settlements or related interests of any kind, whether capable of being held or exercised individually or collectively[4].

Māori are also traditional fishers, and many rely on kaimoana to feed their whānau. Additionally, mana whenua have a legally protected customary entitlement, much of which is used to sustain locals (Māori and Pakeha), manuhiri (visitors), and local marae. The customary take is a small portion of the overall fisheries harvest. The Ahu Moana (mana whenua and community coastal co-management areas) initiative will not, in the first instance, affect commercial, recreational and cultural fishing activity. However, there will be provision for bylaws to be promulgated to restrict fishing as deemed necessary for the wellbeing of the area, the local community, or the kaimoana.

A SCIENTIFIC PERSPECTIVE

Declining stock levels

Scientific estimates of the total biomass in the Hauraki Gulf Marine Park, based on modelling commercially fished “mobile” species, indicate that the Hauraki Gulf Marine Park currently supports less than half of the biomass present in 1925 (with species biomass declines varying between species). However, estimates of historical and today’s relative abundance are imprecise. While ‘fishing down’ of the virgin biomass of populations is inherent in commercial fisheries, a number in the Hauraki Gulf Marine Park have been fished to well below an optimum level, in terms of the species itself, and/or its wider role in ecosystem functioning.

Overharvesting of fish has had a significant impact on the mauri and ecological health of the Hauraki Gulf Marine Park.

Snapper and rock lobster in particular, as the most dominant and iconic fisheries species in the Hauraki Gulf, are currently well below target stock levels. Other species for which stock status concerns exist include John Dory, porae, gurnard and trevally, while there is a lack of information for flatfish (several species), jack mackerel, leatherjacket, parore, rig and tarakihi. For many stocks, the Total Allowable Commercial Catch (TACC) for the fisheries management area incorporating the Hauraki Gulf Marine Park is currently unable to be caught including for flatfish, gurnard, John Dory, Hāpuku, rock lobster both red and Packhorse and others. This means that the current commercial catch is, in practice, unconstrained by the TACC.

There have been no allowances made for non-commercial fishing interests or mortality caused by fishing for the following fish stocks in Fisheries Management Area 1 (FMA1) – gurnard, trevally, hāpuku, blue cod, John Dory, Jack Mackerel among others.

With regards to rock lobster there are widespread anecdotal accounts and concern, including from commercial fishers on the water, that there has been a large-scale decline in abundance across the Hauraki Gulf Marine Park including inside some marine reserves. As a keystone functional species on ‘mid-Gulf’ rocky reefs, rock lobster regulate kina to densities low enough to prevent the establishment of ‘urchin barrens’, allowing more productive kelp forests to exist. Packhorse lobsters probably also once provided similar functions, but have been reduced to very low abundances. Similarly, other species such as hāpuku, once wide-spread across shallow water systems, have had their range reduced to deeper shelf and slope waters, with an unknown loss of ecological function. They continue to decline in abundance and size/age even in these remaining deeper water stocks.

Non-commercial intertidal shellfish fisheries, especially cockles (tuangi) and pipi, are also under pressure from both over-harvesting and environmental factors, with increased sedimentation and muddiness being the most likely drivers. The closure of beaches to harvest has not always resulted in these populations recovering, suggesting the above factors are at play and/or a lack of larval sources.

4 Refer to the agreed principles for the plan, specifically principle 6

Spatial scales of fisheries management

Fish stocks are generally managed at large spatial scales, and as such deal with fish abundance across entire regions. Ideally, a stock would be managed spatially across its full life cycle (spawning, larval settlement, juveniles, and adults) but this is often not practically possible. Stock/population boundaries are however, poorly known for many New Zealand species, and many stock boundaries are pragmatically set on distinctive geographic features, which may or may not be biologically relevant. For example, the SNA1 (snapper) stock is comprised of three sub-stocks: East Northland, Hauraki Gulf, and the Bay of Plenty, with the latter areas having a significant but poorly estimated level of fish mixing by movement. East Northland is largely separate from the others.

Managing these stocks at these large spatial scales largely ignores issues around 'spatial depletion'. This is where smaller local areas may hold less fish than other areas within the range of the overall stock, making access and catching of fish by some sectors, such as recreational and customary, more difficult. These depletions can be caused by both natural variation (e.g. yearly climate effects) and/or (over) fishing of some areas.

As customary and recreational fishers often have less mobility than commercial fishers and/or are relatively fixed as communities, localised depletion makes catching fish more difficult and expensive for them. Examples of localised depletion issues in other parts of New Zealand include blue cod in the Marlborough Sounds and Fiordland, which in both cases resulted in directed management actions to address conflicts between sectors and over-exploitation. Localised depletion issues are not well documented formally in the Hauraki Gulf Marine Park, but have anecdotally included issues around kahawai, snapper, trevally, parore, crabs, flounder, mullet, rock lobster and scallops.

A further issue of having large stock areas is that harvesting is able to be undertaken anywhere within the stock area. This can mean that catch per unit effort data, that may appear stable across the entire quota management area, can mask stock declines as commercial fishers tend to target areas of abundance and will spatially shift their effort when the stock becomes depleted in localised areas.

An example of this occurring has been for flatfish and grey mullet in the Kaipara Harbour, with these two species falling within FLA1 and GMU1 respectively (both of which include the upper west and east North Island coasts). Small dory fishers using gillnets and/or ring-nets are able to fish anywhere within these stocks, and a perceived focus of small dories from outside the Kaipara region on the putatively high abundances of these species in the Kaipara Harbour led to conflict between 'locals' and 'outsiders' (Hartill 2004). Further improvements in the fish stocks of the Hauraki Gulf Marine Park could be subject to similar issues and conflicts under the present management regime.

Kahawai – an example of localised depletion

Recreational fishers became concerned about the state of the kahawai stock in the Hauraki Gulf Marine Park due to a lack of large surface schools and low catch rates. This was attributed to overfishing by some and the fish remaining offshore by others. A large scale influx of large kahawai into the Hauraki Gulf Marine Park over the last several years further complicated the story.

Large scale fish movements are common across many species, which means that (in addition to local over-fishing) localised depletion may occur because the stock is being targeted elsewhere (e.g. this may occur for snapper which move between deep and shallow/ onshore and offshore seasonally); and/or because of changes in environmental conditions, which may stop fish migrating into an area (e.g. the large seasonal snapper migrations into the Hauraki Gulf Marine Park are thought to not come as far in during cooler water temperature years).

Food supply for seabirds

The Hauraki Gulf Marine Park is the seabird capital of the world. However the breeding success of many species is dropping and adult birds are now foraging further afield. There are concerns that food supplies within the Hauraki Gulf Marine Park may not be sufficient for seabirds breeding here. One possible hypothesis is that reductions in kahawai, trevally and jack mackerel numbers as a result of industrial-scale purse seining has led to fewer surface feeding aggregations of these species (also known as 'boil-ups'), where they drive up and concentrate small baitfish. In turn, this might reduce the availability of small baitfish to foraging seabirds. However, there is currently insufficient scientific information available to assess whether such a mechanism is operating, or whether kahawai, trevally and jack mackerel have been or remain depleted through targeted purse seining.

Impacts on habitat and fish stocks

Commercial fishing impacts extend beyond the direct effect of removals of adult fish. Most methods return some level of catch of other commercially marketed species, juvenile fish and non-commercial species including habitat formers (biogenic habitats). Fishing practices that result in high juvenile catch impact the health of the fishery through removing a proportion of the future harvestable adult population. Unwanted catch risk differs between fishing methods with the trawl fishery having a juvenile bycatch rate many times higher than the long line fishery.

Unwanted catch does not represent all of the species affected, as many are impacted by fishing gear but are not physically caught and bought to the surface. In particular, bottom trawling, Danish seining, and scallop dredging all involve gear contact with the seafloor, with the effects generally increasing with heavier larger fishing gear, greater hydrodynamics drag, faster towing speeds, and on softer/finer sediments. The greatest effects are on low energy environments (including the resuspension of fine sediments), and biogenic habitats, with a key issue being the removal of larger, long lived, slow growing, fragile, erect, sedentary species, and associated habitat complexity. Impacted species groups include sponges, bryozoans, seaweeds, hydroids, polychaete worms, soft and hard corals, and horse mussels. Re-suspension of fine sediments by trawling, Danish seining and dredging is also a serious concern.

Green-lipped mussels are a particularly significant case for the Hauraki Gulf Marine Park, where commercial dredging for this species in the Firth of Thames and inner Gulf during the 1920s to 1960s completely eliminated an estimated 500 km^2 of mussel beds, which have failed to recover in the 60 years since. These beds almost certainly provided fundamental 'ecosystem services' including water quality through their filter-feeding, significant increases in primary and secondary production (as shelter and growing surfaces for invertebrates and plants), nursery habitat for juvenile fish, and foraging areas for adult fish.

More broadly, bottom fishing methods have also removed valuable biogenic habitat areas of sponges, bryozoans, horse mussels and other biogenic habitat forming species. Recent advances in technology (such as electronic net monitoring and 3-D bottom scanning technology) have put more foul territory at risk of disturbance, as they enable trawl gear to be towed into foul ground. Over the same time period, land-based effects, especially sedimentation, have negatively impacted on these habitats closer to the land (e.g. the loss of most subtidal seagrass from the Hauraki Gulf Marine Park, making it functionally extinct [5]).

Collectively, the loss of these biogenic habitats has fundamentally reduced their ecological roles in the Hauraki Gulf Marine Park, including as critical fish nurseries (as well as performing many other roles). Where they still exist, many of these habitats hold high densities of juvenile fish, and increase the survival and growth of juveniles, leading to a disproportionate per unit area contribution to adult populations (and associated fisheries).

With the reduction of these habitats, a number of species may now face 'habitat bottlenecks', where the overall production of juveniles is constrained by a lack of sufficient habitat to support them. In such situations, the rebuilding of fish stocks back towards most historical abundances without associated habitat management could be problematic if the carrying capacity of the environment has been significantly reduced. Such issues are increasingly being recognised both nationally and globally, and are being integrated into ecosystem based fisheries management initiatives.

5 Functional extinction is defined here as where a population of a species is reduced to such low densities that it no longer plays a significant role in ecosystem function.

Effects of loss of habitat

Traditionally the role of habitat has been largely ignored in fisheries management. However, in recent decades the impacts of fishing activities on seafloor habitats and associated assemblages (beyond just the targeted species) has become the focus of a great deal of research (e.g., Auster et al. 1996, Auster & Langton 1999, Kaiser 1998, Watling & Norse 1998, Hall 1999, Ball et al. 2000, Collie et al. 1997, Collie et al. 2000a, b, Kaiser & de Groot 2000). While impacts vary across different systems, and fisheries types, it is clear that impacts are generally significant in magnitude and extent, and are one of the greatest human impacts on both coastal and deep-water ecosystems (Thrush & Dayton 2002, Kaiser et al. 2006, Tillin et al. 2006).

The link between habitat presence, extent and quality and the abundance and production of fisheries species is not yet a well-developed concept in the realm of fisheries research and management. Habitat considerations are not yet included in the stock assessment of major species, either in New Zealand or internationally (e.g., Armstrong & Falk-Petersen 2008). Incorporating habitat knowledge into population dynamics, especially at the scales at which fisheries management operates, remains a major challenge. This omission results in such issues being afforded less weight, as stock assessments are the central tools in fisheries management (Armstrong & Falk-Petersen 2008).

Stock assessments are generally focussed on pure harvest effects on stocks. More recently, quantitative and qualitative damage assessments of gear impacts have received attention, but the consequent cascade effect of habitat loss onto stocks, and then into associated fisheries yields have been largely neglected.

Land-based impacts are another important stressor, in particular increased sedimentation; as well as marine industries. These can include both impacts on habitats (e.g., smothering, clogging of filter-feeding habitat formers, reductions in light penetration and competitive regimes for plants), and direct impacts on the fisheries species themselves (see Morrison et al. 2009 for a New Zealand focussed review).

Finally, in some situations there are also feedback loops from the reduction of some stocks (in abundance and size structure) into reductions in habitat type and associated productivity. A well-documented example in New Zealand is where high level predators such as snapper and rock lobsters are fished down to low levels on shallow rocky reef systems, removing their control of sea urchins by predation pressure, which then graze down kelp forests, converting them into 'urchin barren' habitats (Babcock et al. 1999), which have lower primary productivity (see Shears et al. (2008a) for Hauraki Gulf Marine Park examples).

The Park has experienced large declines in the abundance of many habitats, in particular through the loss of biogenic (living) habitats, which provide numerous ecosystem goods and services, including supporting fisheries. These include 'foundation species' which create habitat for other species, including wide spread horse mussel, green-lipped mussel and scallop beds, kelp forests, soft and hard corals, sponge gardens, bryozoan fields, polychaete worm meadows and red algal beds.

Some habitats, such as subtidal seagrass meadows and benthic green-lipped mussels, are now effectively functionally extinct in the Hauraki Gulf Marine Park, although intertidal seagrass is making a comeback in some areas. Research in other regions where such habitats still exist, such as some of East Northland's harbours (e.g., Parengarenga and Rangaunu), and the coastal sea of Te Rawhiti Strait, Bay of Islands, show that these habitats support high abundances of juvenile fish (especially of snapper), and are likely to be critical habitats, providing a disproportionately high contribution per unit area to fisheries adult stocks.

Natural capital and ecosystem services

All of the activities that occur in and around the Hauraki Gulf Marine Park and its catchments depend on the area's natural resources and the 'services' they provide. In this sense, the natural resources of the Hauraki Gulf Marine Park can be considered as a type of 'natural capital', which, along with other types of capital is needed to create the things we value. Natural capital, on its own, or combined with other types of capital, provides a means of creating the things enjoyed by people. This process is often referred to as the provision of 'ecosystem services' which provide us with food, water and other raw materials. But they also help regulate and support the environment itself, upon which we all depend. A healthy environment can be equated to richness in natural capital. Te mauri ora o te taiao is an important goal in itself, it provides collective benefits, and we need to preserve it and its ability to nurture us. Appendix 3 describes in more detail the assessment of ecosystem services that we believe should be undertaken to support the implementation of this plan.

Habitat restoration

While numerous research has now shown how trawling and dredging impacts on soft sediment seafloor habitats, there is (rather surprisingly) little published research on how habitats and environments recover once such impacts are removed (as opposed to fished target species). Time scales of recovery and re-establishment of associated key ecological functions are likely to be slow.

The Hauraki Gulf Marine Park has been intensively and extensively fished for many decades, and much of the seafloor structure was removed in the early days of industrial fishing. Combined with land-derived issues, especially sedimentation, ongoing bottom contact fishing has probably worked to remove additional seafloor structures and prevent regeneration of habitats.

The rehabilitation and restoration of the Hauraki Gulf Marine Park is an important objective, which offers the potential to increase fisheries production as well as the overall mauri, health and functioning. This can take both passive and active forms. Passive restoration involves the retirement/mitigation of key stressors (e.g. high seafloor fishing gear impacts and/or sedimentation in areas of high importance) to allow natural regeneration; while active restoration involves the transplanting/establishment of new habitat patches/areas through direct human intervention. While the scale issues are significant, initial restoration attempts for cockles and seagrass in the Whangarei Harbour and elsewhere have shown promise including green-lipped mussel restoration efforts in the Hauraki Gulf Marine Park.

A nested approach, with larger areas being used for passive restoration, within which active restoration efforts are undertaken, can be a positive way forward. Moving towards an ecosystem based approach to fishing, where habitat management is seen as central to fisheries production, is likely to allow for higher longer term fisheries yields, within a fundamentally more productive and healthy ecosystem.

A community perspective

Alongside the scientific perspective discussed above (and in Appendix 3), the Stakeholder Working Group has been provided very clear feedback that the 'social licence to operate' of the commercial fishing sector is predicated on changing the way in which fishing occurs. There was overwhelming support for the removal of bottom trawling, seining and dredging in the Listening Posts and community surveys we conducted in the initial stages of the Sea Change process. Ongoing discussions with all elements of the communities in which we reside has continued through the Plan development.

Red snapper in the Gulf of Mexico – a model for the Hauraki Gulf Marine Park?

A notable example of where juvenile survival has been increased through habitat restoration is in the Red Snapper fishery in the Gulf of Mexico. In Alabama, almost 20,000 habitat structures were deployed in an area that was previously almost entirely without natural structures on the seabed. Along with the cessation of shrimp trawling in the area, this new habitat enabled large numbers of 1+ juveniles to survive. Now the fishery is expanding and providing increased yield and age structure to the population. Such an approach could be considered for the new inner Gulf bottom trawling and Danish seining closure area.

A selection of quotes from members of the public at listening posts

Whangamata

Trawlers (15 years ago) destroyed fish habitat by trawling the seabed. I want legal sized fish so abundant that I catch my limit every time. Commercial fishing should all be done by long line, do away with dredging.

Hamilton

I wish that habitat was improving, not in decline, it would include banning of bottom trawling.

Trawling, gill netting and seining should be banned in the entire Hauraki Gulf Marine Park. Not banning commercial fishing entirely, just these methods.

Mahurangi/Snells Beach

In the fished areas the management needs a huge shake up; bottom methods like trawling should be kicked out of the Hauraki Gulf Marine Park. We need to leave more fish in the sea. (Getting to) 20% of the original biomass has had a huge impact on the rest of the ecology; the kina barrens are there because there's not enough snapper and crayfish there. I wish to push it up to 40% or 50% of the biomass.

Great Barrier

I think everybody, or 90% of locals, practice conservation, they don't clear the whole lot out. Protect the fish by getting people on board locally and close off an area for a time, like during spawning time. Obvious ways like no trawling in the Hauraki Gulf Marine Park, we manage it so there's fish in the future, we know what's going on here locally.

Orewa

Some activities would be barred – maybe a fishing bar but you can long line; controls introduced over the spawning season 6-8 weeks - that kind of thing.

When the quota system came in, the fishermen sold out and it all changed.

There was less connection with the industry to the community around here. You can't even buy fish from a fisherman any more!

Those big trawler boats [purse seiners] should be forced to fish further out. They should not be allowed in the marine park area. They are large offshore fishing fleets, using sophisticated location systems, helicopter spotters and they wipe out entire schools, taking all our fish so there is nothing for the small time commercial fisher.

There is a conflict between these large scale commercial fishers and game fishermen – I've been in the water where the large fleet has tried to bully us out of the area. They impose themselves on people who have far more right, in my eyes, to those fish.

The Summary and Outcomes of Sea Change – Tai Timu Tai Pari Community Engagement (January 2014 – February 2015) noted the following:

- There is a willingness to compromise and accept recreational fishing impacts – via rāhui, MPAs or catch/size limits – but only if commercial fishing operations are made sustainable, restricted or removed from the Hauraki Gulf Marine Park.
- Fishing technologies and sectors that damage the sea floor and its habitats are not acceptable.
- Provide fishing quotas for all species and place limits on size (under/over) ensuring that there is equity between recreation and commercial fishers.
- The 'Quotas are not targets' campaign was valuable: people need to be educated to take what they need and leave the rest for another day. 'Tiakina te pātaka kai.'
- Introduce or strengthen penalties for people or organisations breaking the rules and give regulatory agencies the funding and resources they need to enforce compliance.

A survey completed in the summer of 2015 found that the following are very important:

- Fish stock abundance;
- Sea floor impacts; and
- Protecting and restoring marine habitats.

In addition, a survey of mana whenua conducted last year provided similar support for the removal of these methods.

The collective perspectives of the Hauraki Gulf Marine Park community overwhelmingly advocate for change. The Fish Stocks section of the Plan thus responds to the community's desire for a change to the status quo and a move toward a more abundant, environmentally healthy Hauraki Gulf Marine Park.

WHAT DO WE WANT TO ACHIEVE?

In developing the objectives and management actions for fish stocks we have focused on the following key issues:

- The need to **increase the ability of the Hauraki Gulf Marine Park to produce more fish:** by restoration and protection of habitats of importance to juvenile fish (green-lipped and horse mussel beds, seagrass beds, sponge and coral gardens etc.). This necessitates transitioning fishing methods out of the Hauraki Gulf Marine Park that can cause further damage and/or prevent habitat recovery through impacting the seabed. It also requires reducing sediment inputs from land (addressed in the Water Quality chapter).
- The need to **adjust harvest levels to rebuild fish stocks within a generation** so that there is greater abundance for the benefit of customary, recreational and commercial fishers as well as for the environment more generally.
- The desirability of **generating the greatest value from the fishery,** through encouraging commercial methods that produce the highest quality and therefore highest value fish (e.g. artisanal methods such as long-lining) and recognising not only the considerable economy supported by recreational fishing today but its potential to fundamentally expand the economy with restored abundance.
- The need to **ensure local abundance of fisheries** (through reducing localised impacts of fishing activities as well as achieving broader habitat and stock recovery) to support marae-based customary harvest, recreational fishers and local communities.
- The need for **nested spatial management** to address pressures on vulnerable habitats and species (using a combination of marine reserves, customary management tools and other marine protected area designations) (addressed in the Biodiversity Chapter).

It is also essential that significant government investment is put into increasing our knowledge of the Hauraki Gulf. We need to have a better understanding of key habitats and ecosystems, species abundance and the impacts of human activities. The Water Quality and Biodiversity sections of this Plan should be read alongside the Fish Stocks section; in particular with regard to sediment (Water Quality) and MPAs (Biodiversity). The objectives and actions for these themes will support those set out below, and in particular help protect and restore habitats of importance to fisheries, to jointly move towards healthy and abundant fish stocks.

It should also be recognised that the approach to be taken to fish stocks in the Hauraki Gulf Marine Park is not intended to have broad application elsewhere. It is based on the specific circumstances within the Hauraki Gulf Marine Park, which are unique, and reflect:

- The Hauraki Gulf Marine Park Act 2000 which requires the Minister to have regard to the matters of national significance and management objectives set out in the Act when setting or varying any sustainability measure (including the total allowable catch and total allowable commercial catch) under the Fisheries Act which applies to the Hauraki Gulf Marine Park. There is also a requirement to 'have particular regard[6]' to these matters when undertaking other functions under the Fisheries Act.
- The important role of the Hauraki Gulf as a fisheries spawning and nursery area for the wider north-east coast.
- The role of the Hauraki Gulf in supporting the largest pre-European Māori population in the country and very strong interest of mana whenua, encompassing numerous iwi and hapū groupings, in the ongoing health of local fisheries. This has resulted in a nationally-unique landscape of tribal lands and waters.
- The location of the largest population centre (the wider Auckland region, estimated to reach two million by 2030).
- The largest number of people practising recreational fishing in the country.
- The long history of commercial fishing in the Hauraki Gulf Marine Park.

6 The Court of Appeal has considered this in 'the Kahawai case', which the obligation puts MPI and the Minister to be on *inquiry*. It is insufficient to simply claim the matter has been considered. The Minister must mount an inquiry and give greater weight to achieving the purpose of ss 7, 8 than other relevant factors.

OVERALL THEMES FOR FISH STOCKS

There are two broad themes to the Fish Stocks section:

1. Using an ecosystem-based approach[7] to manage the harvest of wild fisheries in the Hauraki Gulf Marine Park in order to rebuild depleted fish stocks within a generation.
2. Putting in place mechanisms to protect and enhance marine habitats in the Hauraki Gulf Marine Park so that the current decline is reversed and healthy habitats are restored.

Inherent in these themes is the need for the commercial and recreational fishing sectors to take responsibility for their impacts on the Hauraki Gulf Marine Park and to play their part in achieving the rebuild of stocks and restoration of the habitats on which those stocks depend. Significant investment by all parties, including government, will be needed to achieve the level of change required.

Objectives for Theme One – rebuilding fish stocks

1. Ensure all harvested stocks[8] of wild marine species are at or above the management target prescribed by the Harvest Strategy Standard or equivalent, taking into account the desirability of restoring natural age and size structure to populations and addressing localised depletion:
   Where there is currently sufficient information to set a management target to be reached by 2030.
   a) For all other species by 2040.
2. Put in place measures by 2018 to significantly decrease mortality of undersized fish caused by all harvesting sectors and methods.
3. Put in place an effective management regime to address recreational harvest pressure on the inter-tidal zone by 2021.
4. Ensure that local tikanga and mātauranga inform fisheries management, as well as the considerable historical knowledge and wisdom of more recent settlers.
5. Have in place robust methods to monitor and predict fish populations and to understand the underlying driving mechanisms of population change by 2020.
6. Lift the value per unit of fish harvested.
7. Establish the Hauraki Gulf Marine Park as a separate fisheries management area by 2018.

Objectives for Theme Two - restoring habitats

1. Remove fishing methods, which harm benthic habitats and/or prevent their recovery, from the Hauraki Gulf Marine Park by 2025.
2. Have in place spatial mechanisms to protect ecologically important habitats by 2018 including a variety of MPAs and customary fisheries management tools (see Biodiversity section).
3. Initiate a programme of action by 2018 to achieve long term habitat restoration including developing and testing innovative ways of restoring degraded habitats.

MANAGEMENT ACTIONS FOR THEME ONE – REBUILDING FISH STOCKS

Fish stock reviews

1. As part of the implementation of the plan, establish a detailed schedule for the review of related groups of key harvested species within 6 months. The schedule will identify:
   a) Priority groups of related species for initial reviews and rationale for identifying these.
   b) Set timing and information requirements for reviews.
2. Priority species[9] will be identified through the application of the following criteria:
   a) There is evidence (based on science, mātauranga and local knowledge) that the stock is well below target levels or there is uncertainty as to the current status of the stock; and/or

7 The term 'ecosystem-based management' means different things to different people, and there is no one universal definition. Here we use it in the context of managing fisheries species and their harvest with explicit regard to their interactions with other species, habitats, and the ecological functions they provide within the ecosystem.
8 This includes both QMS and non QMS stocks.
9 Potential priority species include pāua, rock lobster, hāpuku, paddle crabs, gurnard, pilchards, John dory, flatfish, grey mullet, scallops, snapper, porae, trevally, kahawai, Jack mackerel and tarakihi.

b) There is evidence of localised depletion; and/or

c) They are reef species; and/or

d) The species has economic, recreational and/or cultural significance; and/or

e) The species plays a significant role in the ecosystem.

3. Initiate reviews in accordance with the schedule to:

a) Determine evidence-based target stock levels for each stock (incorporating science, mātauranga and local knowledge).

b) Ensure that the targets are consistent with, or higher than, those provided for in the Harvest Strategy Standard.

c) Apply the Harvest Strategy Standard Operational Guidelines default proxies for stock target levels where scientifically-based targets are not set.

d) Address localised depletion, considering the need for finer scaled management.

e) Set catch limits for each stock to ensure the target stock level is achieved by 2040 at the latest, with targets to be achieved by 2030 for stocks which currently have sufficient information to set a management target.

f) Set other controls as required to meet the target stock level such as gear restrictions, seasonal closures, bag limits and size limits.

g) Have regard to fisheries interactions with the larger Quota Management Areas.

Fisheries review process

The intention is to establish a fisheries review process for the Hauraki Gulf Marine Park that is transparent, well-informed and appropriately scaled; that is responsive to fisheries management issues as they arise; and that avoids unnecessary costs and bureaucracy.

Immediate action for rock lobster stocks[10]

4. Initiate an urgent review of:

a) The current management rule and other recreational and commercial harvest controls which apply to rock lobster stocks within the Hauraki Gulf Marine Park, to be completed by 2018, with particular regard to the catch per unit effort fisheries index and total allowable catch for rock lobster, to ensure a rebuild of stocks to levels which maintain sustainable harvest and healthy ecosystems.

b) Whether closures of the fishery are warranted.

c) The makeup and resourcing of the National Rock Lobster Management Group to ensure all interests are adequately represented.

Focused management for kina

5. Implement a package of management measures aimed at reducing the density of kina, improving the condition of harvestable kina and restoring healthy kelp forests, which could include:

a) Placing areas of kina under cultural management.

b) Subdividing the SUR1B management area to create a new 1C area for the Hauraki Gulf and increasing the total allowable catch for that area.

c) Restoring the abundance of kina predators, including rock lobster and snapper, to levels that keep kina populations under effective control

d) Providing for kina aquaculture.

e) Educating the public on the benefits of consuming kina.

f) Regularly monitoring the health of kelp forests, and spatial extent of kina barrens, and using this information to inform the setting of the total allowable catches for kina, snapper and rock lobster.

10 Red and packhorse lobster

Addressing sequential depletion of hāpuku

6. Implement measures aimed at restoring abundant hāpuku stocks throughout the Hauraki Gulf including:
   a) Protecting areas of hāpuku habitat through the establishment of MPAs [see Biodiversity chapter].
   b) Completing a review by 2018 of the current total allowable catch and regulatory framework for hāpuku harvest.

Urgent review of purse seining

7. Undertake an urgent review of purse seining within the Hauraki Gulf Marine Park, to be completed in 2018, including:
   a) Potential impacts on seabird foraging behaviour and breeding success.
   b) Potential impacts on ecosystem health of the Hauraki Gulf Marine Park, including impacts on the food chain and other fish stocks.
   c) The value of the harvested fish in the market place and within the ecosystem.
   d) The appropriateness of the total allowable commercial catch and quota management area.
   e) The potential impacts of withdrawal of bottom trawling and Danish seining from the Hauraki Gulf Marine Park on catch levels.
   f) The location of voluntary closure areas and possible expansion to the southern east coast part of the Hauraki Gulf Marine Park
8. In the interim, prior to the completion of the review, no new purse seining vessels are to operate within the Hauraki Gulf Marine Park.

Protection of vulnerable species[11]

9. Rebuild intertidal species[12] by:
   a) Listing species that can be recreationally harvested (e.g. pipi, cockles etc.) by 2017 and considering seasonal closures for those species.
   b) Placing an immediate moratorium on recreational (non-cultural) harvest for indigenous species not on the list until a new management regime is put in place.
10. Develop a new management regime (in conjunction with mana whenua) by 2021 to effectively manage non-commercial harvest pressure on intertidal areas, including:
    a) Deploying effective tools to regularly monitor the health and abundance of kaimoana beds across the Hauraki Gulf Marine Park (including mana whenua and community shellfish monitoring).
    b) Putting in place responsive management mechanisms which are properly resourced and which can readily adjust to changing pressures and environmental health (including support for local kaitiaki).
    c) Integrating the management regime with those for Ahu Moana – mana whenua and community co-management areas as they are established [see Biodiversity chapter].
11. Review controls on other harvested non-quota species by 2020 to ensure that appropriate recreational bag limits and localised spatial/seasonal closures are in place.
12. Prohibit all recreational and commercial set netting (excluding ring netting) on reefs[13] by 2017 to protect vulnerable reef species. Introduce a standard for ring netting.
13. Identify brood stock source populations for scallop and green-lipped mussel beds by 2020 and consider closure to ensure healthy breeding populations to help replenish other areas throughout the Hauraki Gulf Marine Park.
14. Develop a programme to better resource local kaitiaki to participate in marine and fisheries management by 2018.Implement a targeted education programme for new New Zealanders by 2018 to ensure they understand the fisheries regulations and the reasons for them.

11 Potential vulnerable species include intertidal species, tuangi, pink maomao, reef fish, hāpuku, porae and red moki.

12 Intertidal is defined as above the lowest astronomical tide (chart datum); intertidal species are defined as those that occur either wholly above chart datum (e.g. cockles, various barnacle species), or whose populations have an intertidal life stage, but may also occur as subtidal populations, e.g. pipi, green-lipped mussels.

13 Reef is defined as a single natural rock feature that has a base footprint of 25 m^2 or more, or a mosaic of smaller rocks in close proximity to each other which in aggregate encompass an area of 25 m^2 or more.

Reduction of mortality of sub-legal and small fish

15. Require commercial fishers deploying long-lines, and recreational fishers targeting snapper, within the Hauraki Gulf Marine Park, to use suitable hooks to minimise capture of undersize fish, such as appropriately sized Japanese recurve and/or appendage hooks by 2017.
16. Investigate the potential benefits of increasing the minimum size of snapper caught by commercial fishers to be the same as that for recreational fishers, and methods to avoid catching smaller fish, by 2017.
17. Improve the dissemination and uptake of the voluntary protocol for recreational fishers on good handling and release practices utilising a range of opportunities (eg charter fishing, videos, TV shows and education in schools).

Reporting and observer coverage

18. Improve fisheries information and compliance through:
    a) By 2017, requiring recreational fishing charter vessels to report all their catch.
    b) By 2018, implementing sufficient observer coverage for charter boats to obtain reliable figures on seabird interactions.
    c) By 2018, establishing a system to enable the voluntary reporting of catch and observations of seabirds and marine mammals by recreational fishers.
    d) By 2020, achieving 100% camera or in-person observer coverage on long-line, trawling, Danish seining and purse seining vessels operating within the Hauraki Gulf Marine Park.
    e) For other commercial fishing vessels operating within the Hauraki Gulf Marine Park, working towards achieving 100% camera or in-person observer coverage with milestones of 20% by 2018 and 40% by 2020.

MANAGEMENT ACTIONS FOR THEME TWO – RESTORING HABITATS

Transitioning to seabed-friendly fishing methods

The following actions are designed to achieve the transition of bottom trawling and Danish seining out of the Hauraki Gulf Marine Park. Acknowledging that during the transition, there is likely to be a need to retain some bulk fishing capacity, we have made interim provision for Danish seining to continue in the Inner Gulf (above the current trawl line) after bottom trawling has been withdrawn from the area. This is on the basis that Danish seining has less impact on benthic habitat and sediment re-suspension than trawling and is a more targeted method with less juvenile mortality and unwanted catch. It is therefore to be preferred as an interim bulk method within the Hauraki Gulf Marine Park.

19. Establish and resource a multi-stakeholder advisory group (including recreational and commercial fishing interests, mana whenua, the environment sector, government and scientists) to address the impacts of fishing methods on benthic habitats within the Hauraki Gulf Marine Park and to achieve the objective of the removal of all bottom trawling, Danish seining and scallop dredging from the Hauraki Gulf Marine Park. The advisory group will be tasked with developing detailed implementation steps designed to achieve the following in a practical and fair manner:
    a) From 2016, the avoidance of any additional bottom trawling or Danish seining vessels commencing operations within the Hauraki Gulf Marine Park.
    b) From 2017, in collaboration with the fishing industry, universities and crown research institutes, expediting of research and development into innovative new harvest methods that avoid the negative impacts of current bottom contact methods.
    c) By 2018, the withdrawal of bottom trawling from the Inner Gulf within the line shown on Map 4.1 (Cape Colville to Cape Rodney); from the east

coast of the Coromandel Peninsula within the line shown from Devils Point in the north to the southern boundary of the Hauraki Gulf Marine Park extending 4 nautical miles out from land, and from areas within the Hauraki Gulf Marine Park identified as Type 1 and 2 MPAs in Map 4.2.

d) By 2018, the withdrawal of Danish seining from the east coast of the Coromandel Peninsula within the line shown on Map 4.1 (a line from Devils Point in the north to the southern boundary of the Hauraki Gulf Marine Park extending 4 nautical miles out from land); the area within the Inner Gulf below the current inner trawl line; and from the areas identified as Type 1 and 2 MPAs in Map 4.2.

e) By 2019, the completion of habitat mapping an assessment of the Hauraki Gulf Marine Park to identify the impacts of bottom contact methods on benthic habitats and redistribution of sediments and the likely impacts and benefits of the withdrawal of bottom contact methods. The purpose of this assessment is to identify the spatial areas referred to in the phased withdrawal under f), g) and h) below.

f) By 2020, the withdrawal of bottom trawling and Danish seining from areas identified as being of 'High' priority based on ecological importance.

g) By 2023, the withdrawal of bottom trawling and Danvish seining from areas identified as being of 'Medium' priority based on ecological importance.

h) By 2025, the withdrawal of bottom trawling and Danish seining from the entire Hauraki Gulf Marine Park.

i) By 2030, a review of progress in achieving the restoration of the Park's benthic habitats, and implementation of any further actions required to restore benthic habitats to the extent possible.

j) Put in place mechanisms to prevent any displacement of these methods to other areas, including the east coast of the Coromandel Peninsula and the nearby Islands, during the transition.

Removing scallop dredging

20. Use a phased approach to transition commercial and recreational scallop dredging out of the Hauraki Gulf Marine Park:

a) Immediately restrict the use of scallop dredges to existing scallop beds as shown on Map 4.3.

b) Immediately allow the use of Underwater Breathing Apparatus (UBA) for commercial scallop harvesting. (UBA is already permitted for recreational and cultural harvesting).

c) By 2018 ban the use of scallop dredges in areas less than 20m deep within the Hauraki Gulf Marine Park.

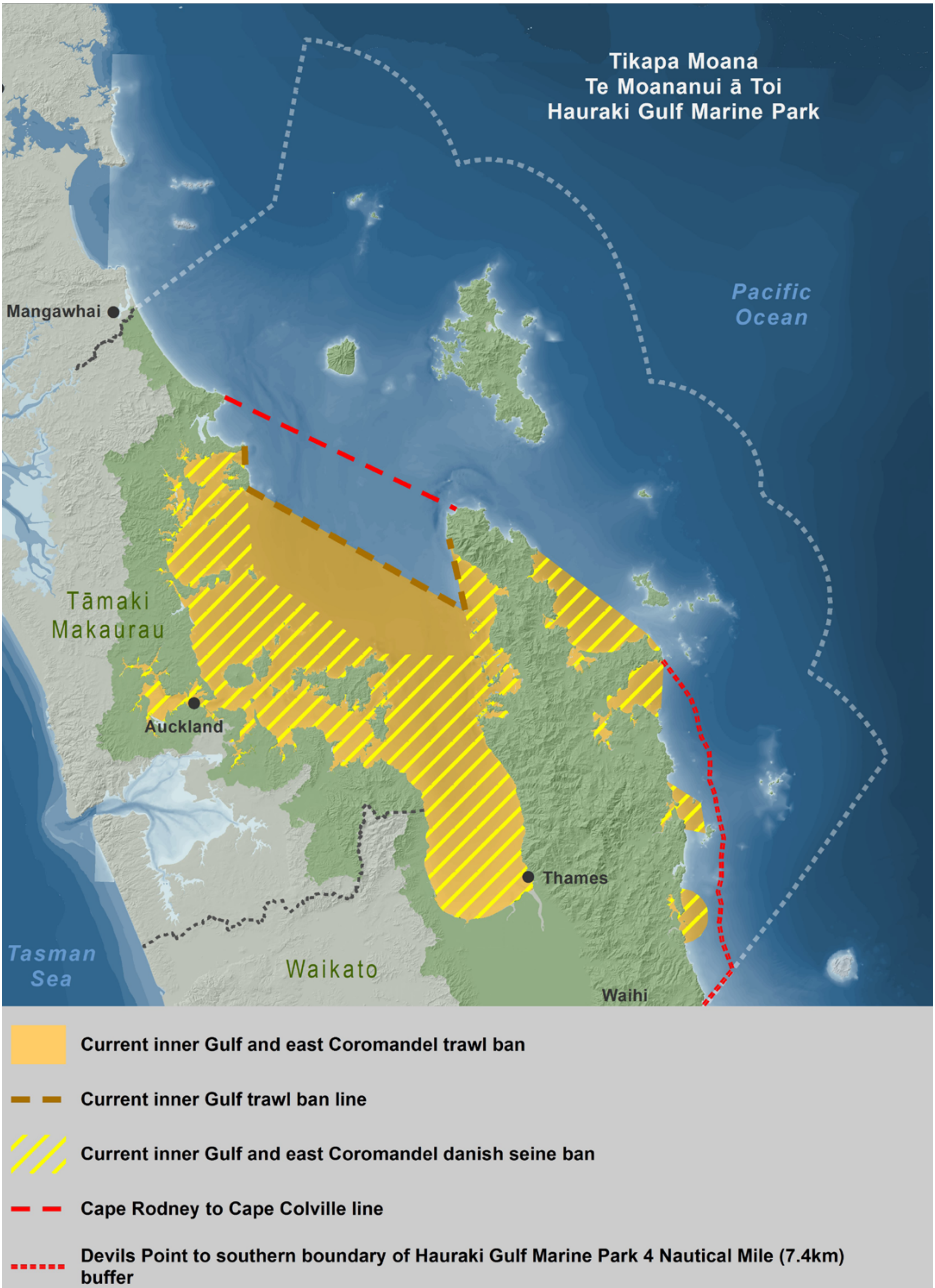
d) By 2025, prohibit the use of scallop dredges within the entire Hauraki Gulf Marine Park.

e) Provide research, development and funding support, including looking at overseas developments, to enable scallop fishers to transition to other methods (e.g. robots) that do not impact the seabed.

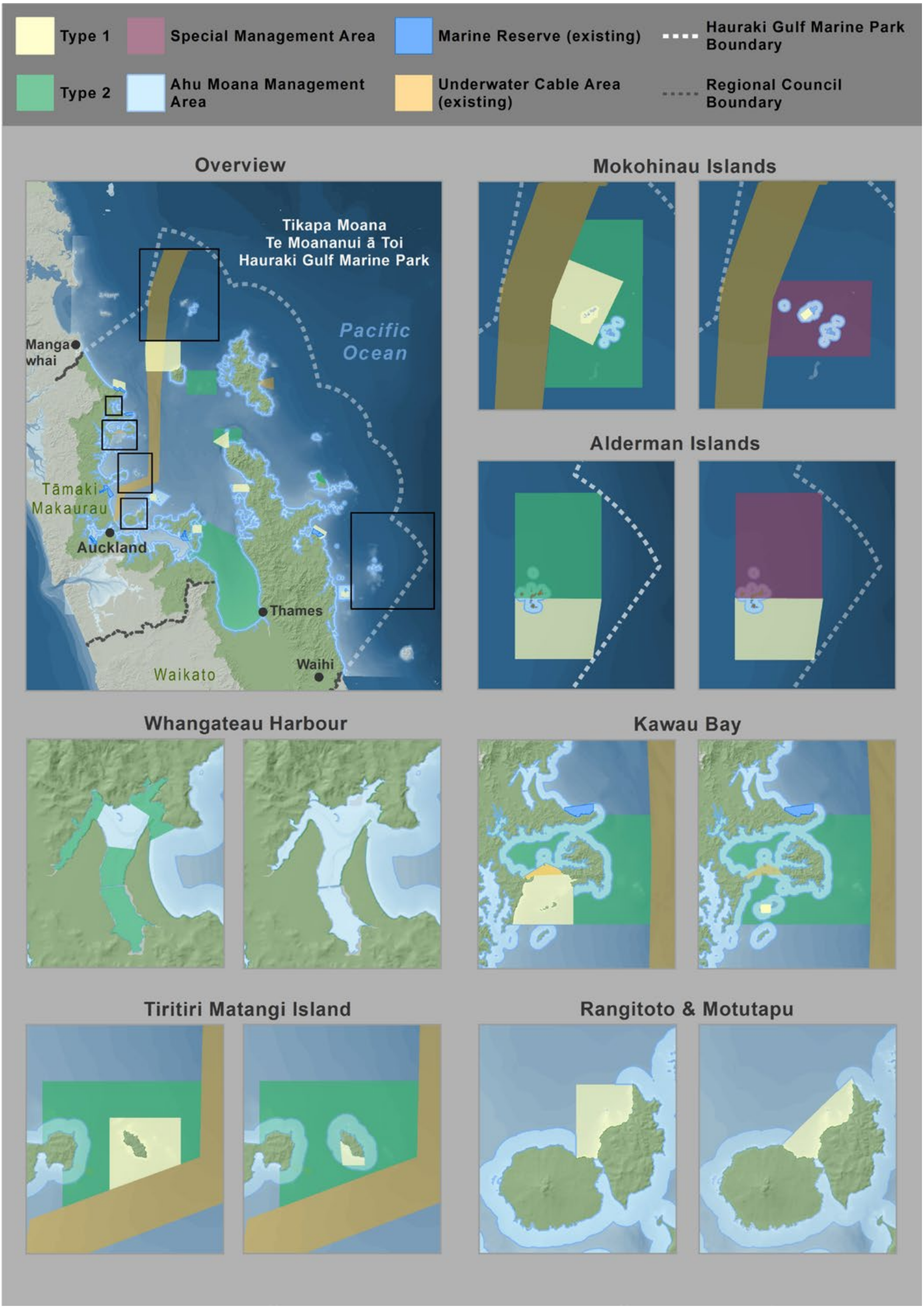
f) Investigate opportunities for scallop aquaculture.

Scallop dredging

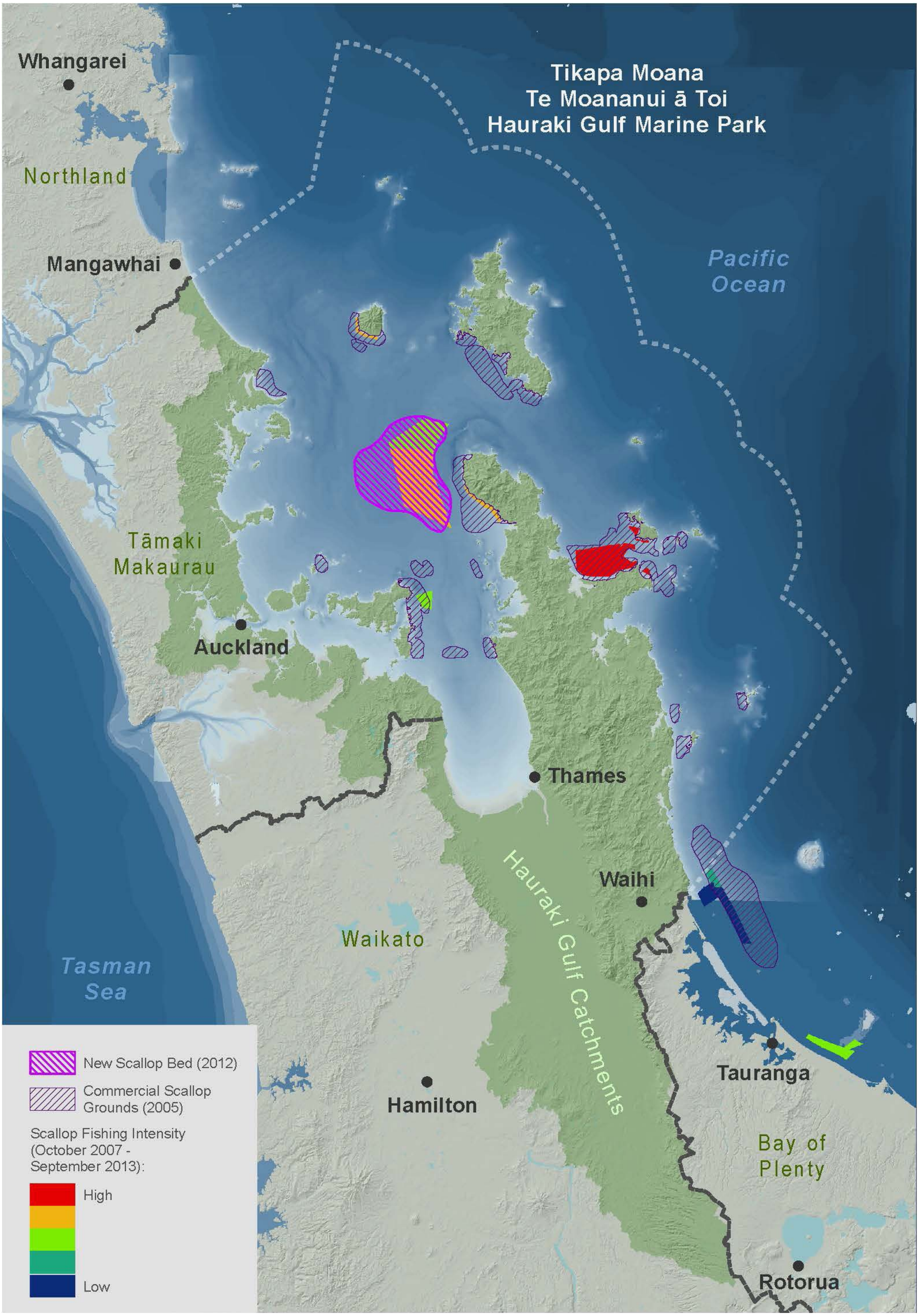
The eventual removal of methods such as bottom trawling, Danish seining and dredging that have negative effects on habitats out of the Hauraki Gulf is the most effective means of achieving the outcomes we are seeking. We do recognise however that, in the future, new technologies (e.g. Precision Seafood Harvesting - http://www.precisionseafoodharvesting.co.nz) may be developed that allow new methods provided those negative effects are avoided. We do not believe that these technologies are sufficiently advanced yet to be promoted as part of the solution through this Plan.



Map 4.1 The inner Hauraki Gulf, four nautical mile (7.4km) eastern Coromandel coastal buffer, and existing trawling and danish seine ban areas within the Hauraki Gulf Marine Park



Map 4.2 Locations of MPA Type 1 and Type 2



Map 4.3 Scallop beds in the Hauraki Gulf Marine Park

Habitat restoration

21. Drawing on scientific, customary and local knowledge:
    a) Map the historical and current extent of culturally and ecologically important habitats within the Hauraki Gulf/Tīkapa Moana by 2018.
    b) Protect existing culturally and ecologically important habitats through MPAs (see Biodiversity Chapter).
    c) Undertake an ecosystem services valuation of the habitats within the Hauraki Gulf Marine Park to support the business case for investment in habitat restoration by 2018.
    d) Identify priority areas where passive[14] and active restoration will be initially focused, taking into account current conditions by 2018.
22. Initiate a high-profile *Hauraki Gulf Restoration Initiative* with the following elements:
    a) Mobilisation of mana whenua and community members to engage in active restoration activities. Inclusion of culturally significant marine places and areas outside coastal marae in restoration efforts.
    b) Removal of unnecessary regulatory barriers to restoration.
    c) Support, resourcing and scaling up of current green-lipped mussel reef restoration initiatives in the Hauraki Gulf Marine Park.
    d) Initiation of a horse mussel restoration programme, with an initial focus on the Mahurangi and Whangapoua harbours.
    e) Establishment of a research programme, in partnership with mana whenua, universities and research organisations, focused on a rapid identification of potentially successful approaches to active restoration.
    f) Identification of additional sources of stock and spat collection mechanisms.
    g) Investigation of closer links with the aquaculture industry including linking supply of restoration stock to aquaculture consents and allocating aquaculture space for the cultivation of shellfish for restoration efforts.
    h) Nesting active restoration efforts within larger passive restoration areas.
    i) Learning from restoration efforts elsewhere.

MANAGEMENT ACTIONS WHICH SUPPORT BOTH THEMES ONE AND TWO

Establish a separate fisheries management area and quota management area for the Hauraki Gulf Marine Park

23. Establish a multi-stakeholder advisory group (including recreational and commercial fishing interests, mana whenua, the environment sector, government and scientists) by 2017 (potentially a sub-group within a revamped Hauraki Gulf Forum and a continuation of the fisheries implementation group described in item 28 below) to provide recommendations to the Minister for Primary Industries, and other Ministers as appropriate, on fisheries measures and regulations under the Fisheries Act applying to the Hauraki Gulf Marine Park, and other relevant matters, including:
    a) Regulations to set specific catch limits for QMS species caught within the Hauraki Gulf Marine Park as determined by the review process.
    b) Recreational fisheries regulations that apply specifically to the Hauraki Gulf Marine Park.
    c) The results of an investigation into splitting quota for QMS species within the Hauraki Gulf Marine Park by 2018.
    d) Creating a separate fisheries management area and quota management area for QMS species within the Hauraki Gulf Marine Park by 2020.
    e) The deployment of any new commercial or recreational fishing methods within the Hauraki Gulf Marine Park.
    f) Funding required to adequately resource fisheries management within the Hauraki Gulf Marine Park including scientific research, stock assessments, monitoring and enforcement.

14 Passive restoration involves removing or mitigating against present day human-generated stressors which are acting to prevent natural system regeneration/recovery.

24. Apply the following principles to fisheries management decision-making within the Hauraki Gulf Marine Park:
    a) The Environmental Principles set out in section 9 of the Fisheries Act 1996.
    b) The Purpose and Objectives set out in the Hauraki Gulf Marine Park Act 2000.
    c) Tikanga Māori - kaitiakitanga.
    d) Ecosystem-based management (as referenced in the Hauraki Gulf Marine Park Act).
    e) The precautionary approach (as referenced in section 10 of the Fisheries Act).

Support for fisheries management decision-making

25. Develop and begin implementing a mana whenua fisheries management strategy that accommodates current and future Treaty settlements (both individual iwi and collectives) by 2018 to ensure that future fisheries management in the Hauraki Gulf Marine Park:
    a) Supports customary fishing rights and traditional fisheries resources and habitats.
    b) Supports active mana whenua involvement in fisheries management including provision for mātaitai, taiāpure and rāhui.
    c) Provides for mana whenua economic and social well-being aspirations.

26. Develop and begin implementing a Gulf-wide fisheries research and monitoring system which:
    a) Measures population age and size structure, spatial abundance and depletion, and cyclical and seasonal changes.
    b) Monitors the health of habitats of importance of fisheries.
    c) Develops and applies cultural health indicators for fisheries that incorporate kaupapa environmental monitoring tools.
    d) Improves our understanding of, and ability to, manage the ecological functions of the Hauraki Gulf which generate fisheries resources; e.g. spawning aggregations, larval transport/ connectivity, nursery habitats, migrations and predator/prey dynamics.
27. Develop and coordinate a fisheries community/mana whenua science and care network across the Hauraki Gulf.
28. Encourage the development of a Hauraki Gulf Marine Park brand for fish sustainably caught, with benthic friendly methods, within the Hauraki Gulf Marine Park.

Hauraki Gulf Fisheries Advisory Group

The Hauraki Gulf Fisheries Advisory Group would report directly to the Minister of Primary Industries who would make the final decision on regulations and other measures under the Fisheries Act. A similar arrangement of direct Ministerial advice currently operates for some fisheries. The Group would liaise with other fisheries management groups.

Research and monitoring

We recognise that putting in place a comprehensive Park-wide fisheries research and monitoring system will not be cheap, simple or occur quickly and agencies need to prioritise the potential research and monitoring. If central government research spending is reorientated to support this effort, then there are a range of other potential funding sources which are also likely to align. Some of it may already exist in part, for example sampling of catch in commercial fish sheds, State of the Environment reporting, and various public good science and other projects. Other past initiatives provide precedents for the type of effort required here including the Ocean Survey 2020 funding and recent large direct allocations of government funding to freshwater and pest management issues.

IMPLEMENTATION PROCESS

We recognise that there are many actions being recommended, with significant practical and cost implications. There is clearly a need to develop a strong fisheries implementation plan to progress our recommendations. A multi-stakeholder group (including recreational and commercial fishing interests, mana whenua, the environment sector, government and scientists) will be formed, under the auspices of the Hauraki Gulf Forum and supported by MPI, to recommend an implementation plan by the end of 2017, including to:

1. Identify funding sources and research priorities, recognising implementing the plan is in the public interest. In principle there is no intention to impose additional new costs on quota owners for managing fish stocks over a smaller spatial area based on the Hauraki Gulf Marine Park. New costs should be borne by government in its role of managing fisheries and the broader marine environment in the public interest.
2. Further develop the transition process to move bottom trawling, Danish seining and dredging out of the Hauraki Gulf Marine Park.
3. Consider whether there should be a requirement to use a 6 inch mesh cod end for Danish seining nets deployed in the Inner Hauraki Gulf.
4. Undertake an economic impact analysis and develop an assistance package associated with the transition of bottom contact methods out of the Hauraki Gulf Marine Park, and during the interim, within the proposed MPAs. The assistance package will be multi-dimensional, and may include financial support, investment in new vessels and/or refitting existing vessels, investment in new technology development and training for people involved in the commercial fishing sector. Principles for an assistance package need to be developed as part of implementation but should learn from global best practice as nothing at this scale or significance has been undertaken in New Zealand previously. It must:
    - Be innovative;
    - Be fair, honest, and transparent;
    - Be based on agreed principles;
    - Recognise actual costs and the desirability of avoiding displacement of effort; and
    - Draw on learnings from other negotiated outcomes (such as Treaty of Waitangi settlements, establishment of MPAs in Australia etc.).
5. Develop the ongoing devolved governance arrangement incorporating a range of stakeholder interests to provide recommendations to the Minister for Primary Industries on fisheries management issues within the Hauraki Gulf Marine Park.
6. Prioritise research and monitoring, linked into the broader Hauraki Gulf Marine Park research and monitoring needs identified in this document.

Branding and marketing

We believe that significant additional value can be achieved for fish commercially harvested within the Hauraki Gulf Marine Park by environmentally-friendly methods through effective branding and marketing to a quality and environmentally-conscious market. A compelling story of how the industry is innovating to actively support the recovery of the Hauraki Gulf Marine Park and protection of its unique species would ensure that many consumers would be willing to pay more for fish caught in the Hauraki Gulf Marine Park.

Achieving the changes

Achieving the changes required in the commercial fishing sector to achieve the fish stock objectives set out in this plan will require government assistance to facilitate the restructure of the industry. Such assistance needs to be provided as an integral part of the implementation of the management actions set out above.

PLACE STUDY: TE RUAMAAHUA – THE ALDERMAN ISLANDS

The Aldermen Islands are known among Hauraki Māori as Te Ruamaahua. Located 15 kilometres east of Tairua, the nine islands of varying size bear numerous remnants of Māori occupation over many centuries. The islands are home to rare and threatened indigenous plants, birds, reptiles, and insects, and the surrounding waters are important recreational and commercial fisheries.

Figure 4.1 Te Ruamaahua.

The Alderman Islands from the north-east. Ruamaahua-nui Island (to viewers left) is the Kei or stern, and the bow or Tūrere is Ruamaahua-iti Island, Middle chain as they are known today personifies the hull or Tākerenui and its ill-fated crew. (Source. Landcare NZ)

Ruamaahua traditions

Hauraki Gulf publications have translated the name Ruamaahua "thrust up from the depths", referring to the volcanic origin of this group of rocky outcrops and islands, and this explanation was given by the late Hauraki elder Taimoana Turoa. According to the Ngāti Hei tradition, the name Ruamaahua recalls an epic ill-fated southern voyage of the ancient Waitaha O Hei ancestor, Tama-Rere-Tii and his crew. The double hulled waka built for the voyage was named Te-Rua-o-Māhu, or Te Rua O Māhuhu-ki-Te-Rangi, a Ngāti Hei celestial reference to the pointer stars of the Southern Cross, and sometimes to the Milky Way. The Waitaha explorers set out to find the source of the southern lights, Te-Whare-tiaho a-Maui (Aurora Australis).

In their consultation with the Atua (gods) prior to the voyage they were instructed to stay "kei raro te ria a Marere-O-Tonga" beneath the protection of the guiding southern star known as Marere-O-Tonga; coming home they would be guided by schools of parāoa (sperm whales) and upokohue (blackfish) on their annual return to the warmer waters known today as Whangaparāoa. This they did, but while returning their rangatira (chief) died by choking on a small fish.

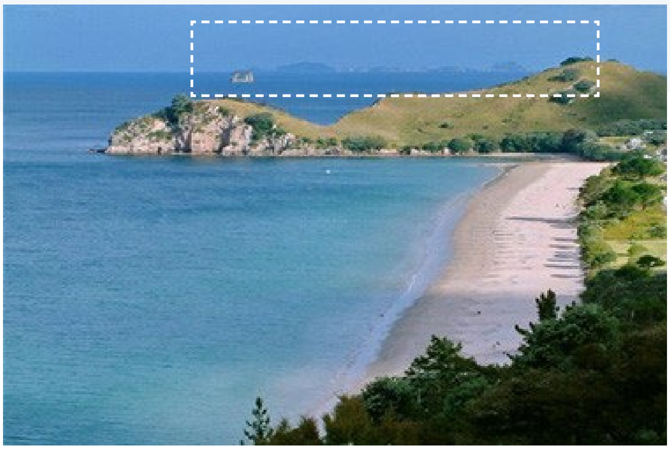


Figure 4.2 Te Ruamaahua from Hahei.

The white frame locates Figure 4.2 above, its left side bisecting the pā Hereheretaura and right side the pā Te Pare. (Source. Joe Davis)

Crossing from Tuhua (Mayor Island) on the final leg of the home journey to Whakahau (Slipper Island), the waka and its exhausted crew succumbed to huge seas, it was destroyed and many died, but one or two survivors described the voyage and the wonders they had seen at the Antarctic. The two massive hulls were said to have separated and damaged beyond repair. One was found at Whakahau, and the other at Māhuhu-ki-Te-Rangi (Māhurangi Island near Whitianga). Hence, Paku, the Ruamaahua Islands, and Mahurangi Is are all intricately linked with this Antarctic journey.

The Ruamaahua Islands are the personification of the waka Te Rua-o-Māhu and the memory of its ill-fated commander and crew. The Middle Chain Islands being the waka and crew, Ruamaahua Nui the stern, and Ruamaahua Iti its bow. In tangi at Wharekaho the wairua of the tūpāpaku (the deceased) is sometimes said to have returned to the heavens on the celestial waka of Te Rua-O-Māhu Ki-Te-Rangi ki te Whare-Tiaho-A-Maui, e tu anā tera taha, "Go-alight the waka of Te Rua-A-Māhu, to Maui' house of light, it is on that side that you will now stand".

The islands are of particular cultural, spiritual, and environmental importance to Ngāti Hei, Ngāti Hako, and Marutuahu. For generations, they have been culturally harvesting oi (grey-faced petrel) from the islands on an annual basis, up until the 1990s, when concern was raised by birders that the oi numbers were declining. Since then rāhui (closures) have been imposed, and a pest eradication program maintained, and population numbers have steadily rebuilt. However, even during recent decades a token small-scale collection has continued as a means of maintaining the practice and the relationship with the islands.

Map 4.4 Te Ruamaahua and surrounding Ahu Moana.

Oriented south-north, the white arrow shows the viewpoint from Hahei in Figures 4.1 and 4.2 (Aerial Photography source. ESRI Ltd).

Gifting of the Ruamaahua Islands

In 1959, a Section 438 Trust was established for the benefit of the descendants of Ngāti Hako, Ngāti Hei and the four Marutuahu iwi, with twelve trustees appointed from them. Since 1959, several replacement trustees have been appointed, including Joe Davis from the Sea Change SWG, who sits on the Trust for Ngāti Hei, and gave the above kōrero.

In 1963, the Crown accorded the islands the status of wildlife sanctuary with the primary objective at the time of purchasing the islands. In 1968, the Crown made an offer to the Trust to purchase the islands. Although this offer was rejected, the trustees agreed to gift the islands to the Crown under certain conditions, namely:

- That the Islands be set aside as a specifically named reserve and any change of designation or use be referred back to owners for their consent;
- That should the Islands be no longer required as a reserve, they would automatically revert back to previous ownership;
- That the owners be permitted to land on the islands to take mutton birds and sea-foods under permit by the Trustees.
- Subsequently, the gifting was formalised in 1969. The islands are classed as "nature reserves" and managed by the Department of Conservation. They are home to many indigenous plants and animals of important cultural, environmental and economic importance to Hauraki Māori, including oi (grey-faced petrel), and today there are approximately 30,000 - 40,000 pairs of oi breeding on the islands annually. Manaaki whenua, Landcare New Zealand, has partnered with iwi over this time to use mātauranga Māori to understand the long-term trends in oi numbers on the Islands and identify what type of factors might be causing changes in the population.

The area around the islands is rich in kaimoana so is frequently visited by the public for recreational diving and fishing. However, it remains an important fishery for mana whenua.

What will co-management look like at Te Ruamaahua?

As is the case at nearby Hahei Marine Reserve, members will represent the local community and mana whenua. But the community here is quite different to that on the adjacent mainland, and the shape of their representation may be too. Recreational and artisanal fishermen within the community have a vast knowledge of this area, are affected by its management, and their cooperation here is essential given that the islands are remote and any management difficult to enforce, perhaps they might occupy some community seats.

The legal status of the islands means that DOC will likely retain a greater role than elsewhere, and the gifting conditions will always have to be met. The proposed adjacent and overlapping MPAs (or SMA) will also need to align, and it is possible that the same committee night administer both.

Figure 4.3 Ko Te Rā Matiti marae at Wharekaho, north of Whitianga (Source. http://www.maorimaps.com)

Figure 4.4 Baby Oi. (Source, Landcare NZ)

5. AQUACULTURE

AHUMOANA

The Stakeholder Working Group vision is that *prosperous aquaculture positively contributes to the health and wellbeing of the people and environment of the Hauraki Gulf Marine Park.*

Within the Hauraki Gulf Marine Park there are nearly 1500 hectares of consented mussel farm space, mainly within the Wilson Bay zone in the Firth of Thames, producing around 30,000 tonnes per year, accounting for over a quarter of national production. Production from the existing farms is predicted to double to 60,000 tonnes per year by 2025 based on improved productivity, development of consented farms within the Wilson Bay zone, and small extensions to existing farms outside the zone.

There are 210 hectares of consented oyster farm space in the Hauraki Gulf Marine Park, accounting for nearly half of national production. Two thirds of the Hauraki Gulf Marine Park's oyster production occurs in the Auckland region, with Mahurangi Harbour (108 ha of farms) being the centre of the industry. There are currently no finfish farms in the Hauraki Gulf Marine Park. However, there is 90 hectares of space in the Wilson Bay zone (of which 18 hectares is Treaty settlement space) and 300 hectares of space in the Coromandel Marine Farming Zone (of which 60 hectares is Treaty settlement space). The Waikato Regional Council will begin a tender process for the Coromandel Marine Farming Zone in late 2016.

Oysters are typically grown on wooden racks, trays and baskets fixed to structures on intertidal flats. In some areas, oysters that are ready for harvesting are transferred from the racks to long-line farms where they are suspended in baskets. This allows the oysters to flush themselves of any sediment or bacteria they may have ingested while in the intertidal zone. Mussels are grown on long lines in water depths of 10–45 m. Fish are held in pens or nets, which reach from the surface to depth, suspended under a surface structure, typically in water depths of 20–30 m.

Oyster farming and mussel farming (collectively known as shellfish farming) are examples of non-fed aquaculture, since oysters and mussels extract phytoplankton from the water by filter feeding and no additional feeding is required. Fish farming is an example of fed aquaculture where fish are fed manufactured feed pellets. This introduces additional product into the marine area with potentially greater environmental impacts.

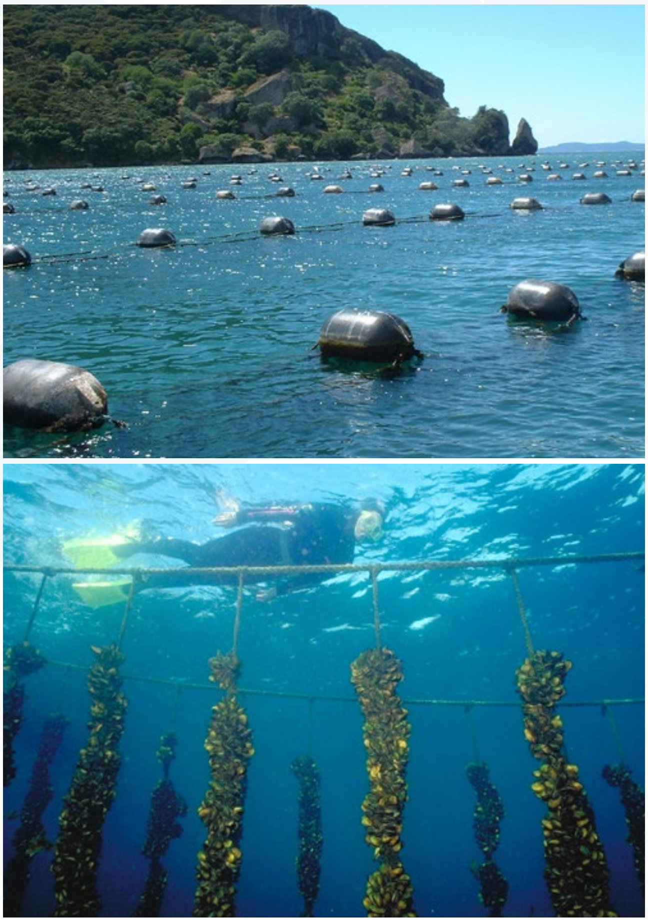


Figure 5.1 A mussel farm on the surface, and snorkelling underneath

A MANA WHENUA PERSPECTIVE

The Māori Commercial Aquaculture Claims Settlement Act 2004 addressed Māori rights relating to aquaculture. It consisted of three phases in which iwi received assets to settle commercial aquaculture obligations for a representative 20% of total approved aquaculture space. First iwi were compensated with cash for "pre-commencement space" (coastal space approved under the regime operating between 1992 and 2004), equivalent in value to 20% of allocated space. Second, where these were implemented, iwi received 20% of new aquaculture management areas

(AMAs) created between 2004 and 2011. Finally, iwi are entitled to 20% of new forecasted aquaculture space since 2011, but this may be paid in space, cash, or a combination of these.

To date some aquaculture settlements have been finalised for the Hauraki Gulf Marine Park; for the eastern Firth of Thames and Aotea/Great Barrier. These resulted in Hauraki iwi jointly establishing fisheries and aquaculture businesses, and becoming one of the major aquaculture participants within the Hauraki Gulf Marine Park. Their role in the sector is likely to increase as further settlement space is allocated.

Mana whenua tikanga and concerns relating to aquaculture

As well as being important aquaculture industry players as a result of Treaty settlements, Māori hold mana moana with associated inherited kaitiaki responsibilities. They therefore have dual roles in relation to aquaculture which require careful negotiation. As kaitiaki, local hapū and iwi are mindful of potential negative effects associated with aquaculture. Marine farms compete for traditional coastal marine space, and occupy areas in which mana whenua have traditional interests. This is further complicated by the fact that, in the Hauraki Gulf Marine Park, the extent of customary rights has not yet been tested or addressed.

Physical structures present potential impediments to iwi use of significant resources, such as kaimoana grounds, and create barriers to culturally important practices such as traditional waka routes and modern waka-ama. Of particular concern are the visual effects of marine farms on the experience and enjoyment of whānau that still reside on ancestral coastal lands, and for those reconnecting with lands returned via Treaty settlements. In the absence of iwi involvement over recent decades, Hauraki Gulf marine farms have been located inappropriately close to coastal wāhi tapu (sacred sites).

Marine farms are also a potential barrier to mana whenua environmental and kaimoana restoration goals, and bring a risk of entanglement and loss of territory for marine mammals. Coastal hapū are regular witnesses to paru, rubbish resulting from farms, including lost floats and lines. But they are also concerned with pollution that is unseen, the accumulation of detritus and waste on the seabed.

Tikanga Māori includes codes of conduct, based on centuries of living in a particular area, which may be offended by some activities associated with marine farming. For this reason, iwi seek involvement in any plans for new marine farms.

Despite significant shareholdings in commercial fishing and aquaculture companies, some individual iwi and hapū have experienced barriers to participation in aquaculture-related statutory processes. As a result, marine farms have been approved without consideration of effects on mana whenua values and interests. Barriers to participation limit the opportunity for farms to proactively address tikanga issues and mana whenua concerns, and places hapū and iwi in a reactive mode.

A community perspective

We found through our community engagement process that people have both positive and negative perspectives on aquaculture. In general, shellfish aquaculture is viewed positively. The overall sentiment clearly recognises the importance of the industry to local communities in the Hauraki Gulf Marine Park.

AQUACULTURE OBJECTIVES

We have identified a set of objectives that will collectively realise this vision and ensure that:

- There is a thriving aquaculture industry in the Hauraki Gulf Marine Park that supports local communities, including mana whenua.
- Marine farms are sentinels for a healthy environment and contribute to the restoration of the Hauraki Gulf Marine Park's mauri.
- Negative effects of aquaculture are avoided or managed so that a healthy environment is maintained.
- Environmental degradation which affects aquaculture is addressed so that the industry is not negatively impacted.
- Cultural, environmental and economic aspirations of mana whenua are supported and Treaty Settlement rights protected.
- The community has adequate certainty regarding the effects of aquaculture, while the industry has certainty for investment and sufficient flexibility to innovate,

diversify and adapt to changes in the business and natural environment.

- Well-targeted and sensible monitoring of aquaculture is carried out and is integrated with Gulf-wide state of the environment monitoring.
- Marine farms in the Hauraki Gulf Marine Park are part of the Aquaculture New Zealand's A+ Sustainable Aquaculture programme.
- Conflicts over the use of space are minimised.
- The regulatory framework is clear and consistent across the entire Hauraki Gulf.
- There are a variety of scales and types of aquaculture in the Hauraki Gulf Marine Park and innovation and research is actively promoted.
- Areas suitable for the various types of aquaculture currently undertaken are identified, and allowance is made for other types that are not currently found in the Hauraki Gulf Marine Park.

The Summary and Outcomes of Sea Change – Tai Timu Tai Pari Community Engagement (January 2014 – February 2015) noted the following:

- Aquaculture is valued for its economic and environmental benefits, but its impacts on natural character, water quality and other uses of the marine environment need to be closely managed.
- Many people think aquaculture enhances recreational fishing.
- Agencies need to provide more research opportunities to identify both the benefits and effects of aquaculture.
- Agencies need to support the aquaculture industry to be in the right place and doing the right thing by the environment.

A selection of quotes from members of the public at listening posts

Thames

Mussel farms are not a problem – you can go fishing in them, they're not a hazard to my interests.

Mussel farms have increased tourism in the Hauraki Gulf Marine Park because of the good fishing around the farms. Increased charter boat fishing.

Orewa

Mussel farms...affects sailing anchorages. In past, filtered the water but farms affect public ownership.

St Marys Bay

What about fish farms? They are just horrendous. I've dived under salmon farms in the Sounds.

Concern about the idea of salmon and fish farming with all the intensive feed that goes into the water but oysters and mussels are filtering.

Great Barrier Island

Mussel farms were a family thing – they were a community thing from here, and the people were from here. Two to three mussel farms are still locally owned but are leased out. Some of them are Sanford owned, and there are locals harvesting

Waiheke

Mussel farms attract giant snapper. They are like a supermarket – you go out and catch what you need for dinner

Kaiaua

I see people in this room who looked a lot younger and happier a few years ago, who have put years of energy into battling and worrying about the impact of extended aquaculture, their worry is returning.

Economic and social impacts of Aquaculture

Beneficial impacts

The Hauraki Gulf Marine Park's aquaculture industry provides a number of beneficial economic and social impacts including creating wealth and employment, supporting Māori development, providing for research and development and supporting other sectors such as charter fishing and tourism.

Value in the product that is produced

Aquaculture is a significant primary industry in the Hauraki Gulf Marine Park. Currently 27% of NZ's total Greenshell Mussel and 45% of Pacific Oyster production is grown in the Auckland and Waikato regions. This production is worth about $52m per year for mussels and $7.3 m for oysters in export revenue. It contributes about $31m to Waikato's GDP and $28m to Auckland's GDP[1].

Provides employment

The Hauraki Gulf Marine Park's aquaculture industry provides direct full-time employment for over 340 people in Auckland and 370 in Waikato. Indirect employment brings the total across both regions to over 900 people[2] . Employment on inter-tidal farms is usually located close to the farms, while employment on sub-tidal farms, such as mussel farms is centred around the landing facilities that service those farms. In the Firth of Thames, the main landing facility is the Sugarloaf Wharf at Te Kouma in the southern part of Coromandel Harbour. This brings employment to areas with fewer other opportunities.

Employment in processing is about 3-4 times higher than in the farm based operations and is located in towns and cities with sufficient population to provide a reliable source of employees and the necessary infrastructure (water supply, wastewater facilities and transport links). Mussels and oysters grown in the Hauraki Gulf Marine Park are processed in Whitianga, Tauranga, Warkworth and South Auckland. Oysters are also processed in Coromandel town.

Supports Māori development

Māori-owned farms in the Hauraki Gulf Marine Park have directly supported Māori development in Hauraki and allow Māori to express kaitiakitanga in practical ways. Returns from farms owned by Hauraki Māori have funded health, education and social services. For example, they contributed to funding the evolution of the Manaia Primary School (26 students and 2.5 staff) to a Kura ā Iwi with a roll of 130 students and 13 teachers. Māori businesses are a major part of the aquaculture sector and are expected to grow as a result of the delivery of the Crown's Aquaculture Treaty Settlement obligations in the coming twelve months.

Aquaculture supports research and innovation

Aquaculture in the Hauraki Gulf Marine Park already supports some educational and research activities and this opportunity can be leveraged further because of the proximity of the Hauraki Gulf Marine Park to a large highly skilled workforce, the proximity to a number of existing tertiary educational facilities, and the proximity and accessibility of the aquaculture activities within the Hauraki Gulf Marine Park. There is the potential for the Hauraki Gulf Marine Park to become a hub of aquaculture excellence, supported by research and innovation relating to all aspects of aquaculture activity including environmental enhancement projects.

Future growth of aquaculture can support increased benefits

There is growing demand for seafood, both domestically and internationally, so that the value derived from aquaculture production in the Hauraki Gulf Marine Park has the potential to significantly increase. To date, there are 1480 ha of consented space for mussel farms and 210 ha for intertidal oyster farms. National forecasts suggest that by 2035, mussel farming may seek to grow by an additional 920 ha and intertidal oyster farming by 145 ha. Growth in aquaculture will create additional employment opportunities and will lead to subsequent growth in associated sectors.

As a first step, support for increased productivity in the existing farms, and incremental increases in areas around existing farms, should occur where a net benefit is achieved. This will likely result in cost efficiencies and the minimisation of additional impacts on the Hauraki Gulf Marine Park's environment. However, in some existing locations, expansion may not be appropriate due

1&2 Figures combined from Murray and McDonald, 2010, and Wyatt, 2011.

to environmental constraints. Although these measures will provide some increased capacity, there will almost certainly be demand for new areas of marine space to be made available for aquaculture as markets expand and new marine farming technology develops. Aquaculture of new species, not currently farmed in the Hauraki Gulf Marine Park, could also play a role in increasing the value derived from aquaculture.

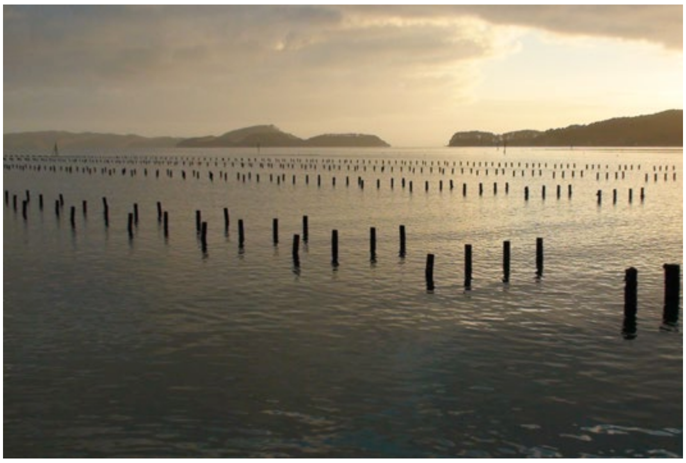


Figure 5.2 Oyster farm located at Clevedon

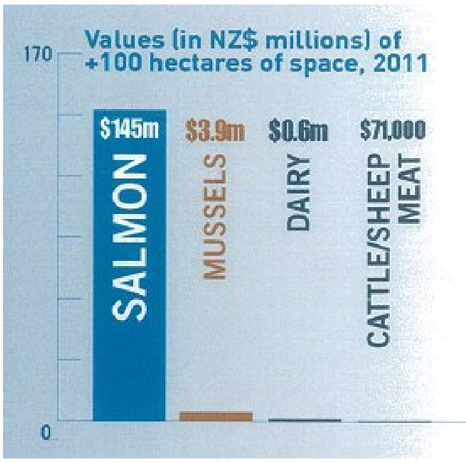


Figure 5.3 Value of salmon farming vs. other agriculture and aquaculture

Whilst growing finfish is an extremely efficient way of producing protein, there are ecological impacts including the amount of fish food needed which should be considered. Finfish farming returns more dollars per hectare than many other forms of agriculture and aquaculture. For example, the New Zealand salmon industry returns 2000 times as much money per hectare as beef and sheep meat[3] .

Aquaculture supports other sectors

The presence of marine farms can also support other sectors, in particular charter fishing boats and recreational fishing (as mussel farms attract snapper and other fish), and tourism and seafood restaurants. Aquaculture also makes seafood more available to everyday consumers.

Negative social impacts

Marine farms may exclude some human uses of the coastal marine area, including water sports, recreational boating and commercial fishing (although legally vessels are permitted to transit through marine farms and small powered vessels often do for recreational fishing purposes). The Hauraki Gulf Marine Park is the most highly utilised area for commercial and recreational boating in the country, with the number of yachts and launches predicted to increase significantly over the next 20-30 years.

Marine farms can be a navigational issue for vessels if located in popular cruising routes. They have the potential to be a navigational hazard during the day and night time if not well marked. Marine farms should not be located in areas suitable as safe anchorages for vessels as these are essential for safe boating and are becoming increasingly over-crowded with the growing number of vessels. There can be noise and disruption impacts on adjacent landowners, and the opportunity cost from using public space for aquaculture instead of for other purposes.

3 Industry investment opportunities in the New Zealand Salmon industry (2012), Coriolis Research, p15

Environmental impacts

As with the social effects descried above, aquaculture brings with it both positive and negative environmental effects. Both types are considered here.

Figure 5.4 Fishing over mussel farms

(Source. Top and bottom pictures supplied by Coromandel Marine Farmers Association, middle two supplied by Raewyn Peart)

Beneficial impacts

Restorative potential

There are ecological benefits that can be derived from aquaculture. Mussels and oysters feed on phytoplankton by filtering them out of the water as it flows past. In doing so they indirectly remove nutrients from the water and filter out other particulate matter such as sediment. They excrete the inedible material as 'pseudo faeces', which settle to the seafloor, removing them from the water column. A single mussel can filter up to 75 litres of seawater each day.

In this way, mussel farms can replicate some of the ecological functions of the natural sub-tidal mussel beds that were once widespread throughout the Hauraki Gulf Marine Park region, although currently on a much smaller scale. Historically mussel beds covered hundreds of square kilometres of the Hauraki Gulf Marine Park and made a major contribution to maintaining water quality. These beds have largely disappeared due to dredging in the 1950s and 60s, and subsequent high sediment loads, but were capable of filtering all of the water of the Firth of Thames every day. The development of additional shellfish farms will increase the filtering of water in the Hauraki Gulf Marine Park with resultant water quality benefits.

Shellfish restoration projects, which seek to restore rich benthic habitats in the Hauraki Gulf Marine Park for both ecological and water quality reasons, can benefit from the support of shellfish aquaculture (and other types of aquaculture which are valuable in this respect, e.g. seaweed, may develop in the future). For example the Revive our Gulf project, which aims to restore the mussel beds in the Hauraki Gulf Marine Park, has been supported by the aquaculture industry through the provision of live mussels that were unsuitable for the commercial market. These have been dropped to the sea floor in an attempt to recreate self-sustaining wild mussel beds.

It is important that restoration projects continue to benefit from support like this into the future. Other potential positive synergies may develop, such as through the provision of waste shell for deposition in the marine area or seaweeds for the collection of spat.

Creates habitat for other species

Marine farms create an 'artificial reef' effect through the physical structures of the farm and the crop on them providing shelter and food for other species. Small fish shelter among the crop lines, and this attracts bigger fish to prey on them. Snapper in particular are attracted to farms as they prey on mussels. Live mussels and shells accumulate on the seafloor under a farm. As farms are usually placed over soft sediments (rather than rocky reefs), this adds biogenic structure to the seafloor and may attract scavenging and predatory organisms such as starfish.

Accumulation of organic matter on the seafloor can provide hard substrate for other organisms to grow on, potentially increasing species abundance and diversity, including more predators (e.g., starfish), scavengers (e.g., sea cucumbers) and decomposing organisms (e.g., worms and bacteria).

Monitoring the environment

As marine farms require very high water quality they act as a sentinel in the environment. For example, seawater at shellfish farms is intensively monitored for bacterial contamination and harvesting is sometimes halted following any rainfall event due to the presence of E. coli in runoff from land.

Monitoring of the environment surrounding aquaculture farms, when targeted towards strategic issues, could assist in developing a better overall picture of the health of the Hauraki Gulf Marine Park, the impacts of aquaculture, including both positive and negative impacts as well as cumulative effects, and the influence of water quality (in particular sediments and nutrients).

Adverse ecological impacts

There are potential adverse ecological effects associated with aquaculture that need to be well managed. In general, fed aquaculture is intensive, has external inputs into the water column and has the potential for greater adverse effects than non-fed aquaculture, but it typically has a smaller physical footprint. Non-fed aquaculture is more extensive (requiring a larger area to be economically viable) and so typically affects a greater area, but the ecological effects are less intense.

Biosecurity

Aquaculture is unlikely to be the cause of a new pest incursion into New Zealand, but marine farm structures provide potential habitat for pest organisms to colonise, which become a reservoir for further spread. Movement of equipment, vessels and stock is a potential mechanism for the movement of pests (as are recreational and commercial vessels).

Biosecurity risks are not just non-native species arriving but include diseases, pathogens, parasites and other biological threats. The effect of diseases on farmed populations has raised concerns in New Zealand. For example, the effect of a herpes virus, especially between 2009 and 2011, on the introduced Pacific oysters.

Water-column effects – shellfish farming

The main effect on the water column from farming shellfish is the extraction of phytoplankton, zooplankton and organic particulates by the farmed shellfish. Phytoplankton forms the base of the marine food web; depletion therefore has the potential to impact on other species. Zooplankton includes fish eggs and larvae and its depletion therefore could potentially affect localised fish stock recruitment. The short-term composition of plankton communities can also be altered. The depletion zone usually only extends a short distance from the farm and is influenced by flushing rates, currents, depth, wind, etc. Depletion can be minimised by locating farms in areas with good flushing and/or high natural levels of phytoplankton. On the other hand, shellfish farms benefit from some land-sourced nutrients and can assist in mitigating negative effects of land sourced nutrients through extracting nitrogen.

Water-column effects – fin fish farming

Decomposition of fish faeces and uneaten food releases dissolved nutrients into the water column and can result in nutrient enrichment, impacting water quality. It may also change the species composition of phytoplankton with flow on effects in the food web. Potential problems can be minimised by good management, locating farms in areas that are deep and well-flushed, not overstocking them and avoiding areas which are nitrogen enriched.

Seabed effects

Both shellfish and finfish farming result in deposition of organic matter on the seabed. Negative impacts of accumulated organic matter include organic enrichment, reduced diversity and elevated levels of organic carbon. These impacts are much greater with fed-aquaculture, due to the deposition of high-nutrient faeces and uneaten feed on the seabed, which can transform well-aerated sediments into low-oxygen zones. In extreme cases the seafloor can become anoxic (lacking oxygen) as all the available oxygen is consumed in the decomposition of the organic matter. This eliminates all life except mats of bacteria. These conditions have been seen under salmon farms in New Zealand, but never under shellfish farms. Such effects can be reduced through good management, avoidance of overstocking and locating farms in deep, well-flushed areas and away from ecologically significant seabed areas.

Effects on wild stocks

When selective breeding is used for farmed species which are also present in the wild, the mixing of farmed and wild populations can potentially impact on the genetic structure of wild fish populations. There is also the risk of the transfer of diseases and parasites between farmed and wild stocks. This is mainly an issue for finfish farming where escapes can roam widely and mix with the wild population. This means that there needs to be tight control over finfish farm infrastructure to avoid the risk of escapees. On the other hand, released farm fish could be used to supplement wild stocks (for example, in Japan it is a part of the conditions of having a fish farm that stock is released to build up the wild stocks). These issues require ongoing research.

Effects on wildlife

Marine farms may exclude wildlife; either directly through displacing desired habitat, or indirectly through human presence or excessive noise. On the other hand, marine farms can attract fish, birds and marine mammals due to the increased availability of prey species that are attracted by the habitat provided by farm structures, as well as for artificial reefs.

Marine farms have the potential to exclude or modify how marine mammals use habitat when they impact on foraging, resting and nursery areas and migration routes. In addition, marine mammals can become entangled in structures, ropes and other non-biological waste material. Underwater noise associated with farm activities may also interfere with natural behaviours. The Hauraki Gulf Marine Park has several endangered marine mammal species, including Bryde's whales, bottlenose dolphins and orca, which need to be safeguarded from any adverse impacts from aquaculture. This can be achieved through careful siting of farms and good management of equipment to minimise any waste material entering the marine environment.

Areas with significant or outstanding conservation value for other wildlife may also demand additional safeguarding from impacts. The Firth of Thames intertidal-flat Ramsar site is an example. On the one hand, some overseas studies suggest that shorebirds may benefit from the establishment of marine farms through the provision of extra feed, so long as detritus from the farm does not smother the seabed. On the other hand, the disturbance of waders could increase with marine farms in the immediate vicinity (boat traffic, presence of farm workers, noise), and the cost to birds of disturbance may be high when they are putting on weight prior to their annual migration.

Effects on landscape and natural character

Marine farming on the sea surface, by its very nature, introduces human-made structures and activities into a natural environment. This can include buoys, racks, sea cages, supporting structures and vessel movements. Such structures and activities can adversely impact on natural landscape and natural character values of the Hauraki Gulf Marine Park.

The concepts of landscape and natural character encompass both the 'naturalness' of an area, which is the extent to which it is free from human-made structures and influences, and people's experience of that naturalness. Retaining the naturalness of high value coastal landscapes and seascapes is important to protect cultural values and the quality of life and economic prosperity of the Hauraki Gulf Marine Park. Because much of the Hauraki Gulf Marine Park has been heavily developed, particularly around Auckland and the Coromandel Peninsula, it is important that we protect remaining areas with high landscape and natural character values. This can be achieved through locating marine farms in appropriate areas that avoid adverse effects on these values.

Effect of additives and chemicals

Chemicals associated with marine farming may include feed additives, antifoulants, and treatments for bacterial diseases or parasites like sea lice. Currently no chemicals are used in shellfish farming, apart from treated timber for inter-tidal oyster farm racks, or in salmon farming apart from copper in antifoulants and zinc in feed. Antibiotics are not currently used in New Zealand. Good management practice minimises the use of additives and chemicals, and consent conditions can restrict their use.

Hydrodynamics

Structures in the water have an impact on currents and waves. This has the potential to reduce currents and wave energy. This may be positive by reducing the wave energy reaching the coasts, and hence reduce shoreline erosion, or could negatively affect surf breaks. Effects can be reduced by locating farms in areas that are not a significant part of the swell corridor for popular surf breaks, by orienting infrastructure so it does cut across main current flows and by modelling the hydrodynamic effects, including cumulative effects of any proposed large scale aquaculture development.

Cumulative effects

Individual marine farms may be judged to have an acceptable ecological effect but they need to be considered in the context of both other marine farms and other human activities that are stressing the same ecosystem. This becomes particularly important as additional farms are proposed, existing activities increase in intensity and new activities appear.

WHAT DO WE WANT TO ACHIEVE?

By 2018, have a 'three tiered' regulatory regime in place for aquaculture that:

- Specifically enables aquaculture in identified areas where the overall social, economic and environmental benefits of aquaculture to the Hauraki Gulf Marine Park are maximised.
- Allows case-by-case consideration of aquaculture in areas which may be suitable but which have not been identified as an area where benefits will be maximised.
- Restricts aquaculture in areas which are not suitable for aquaculture.

There is potential for significant growth in the aquaculture sector. To determine where aquaculture should best be located and how it should be managed, there needs to first be consideration of the benefits of aquaculture and how these can be maximised, and then consideration of the matters that are important to ensure appropriate siting, scale and management of aquaculture as described above. Consideration also needs to be given to where aquaculture should not be located to provide some certainty for the community, industry and the environment.

By 2020 a robust and supportive regulatory framework (based on the above) provides clear and consistent policy, rules, monitoring and engagement requirements for the community, industry and mana whenua

A clear, robust and supportive regulatory framework, which clearly sets out where aquaculture is best located and where it should not go, will help to ensure a prosperous aquaculture industry which is strongly supported by the community. Central government and local authority policy and regulatory documents that provide certainty and consistency of regulation and monitoring requirements across jurisdictional boundaries will provide industry with the confidence for long term investment. The application of good practice industry guidelines, practises and standards is also very important as is the widespread adoption throughout the Hauraki Gulf Marine Park of Aquaculture New Zealand's A+ Sustainable Aquaculture programme.

In addition to the ecological and landscape/natural character issues set out above, Council decisions regarding aquaculture should avoid adversely impacting on culturally significant areas, in particular wāhi tapu (both terrestrial and marine). Allocations of new coastal marine space need to avoid pātaka kai, mahinga mātaitai and mana whenua food gathering areas. Councils also need to be mindful of community aspirations to participate in decision-making over the location of marine farms.

The regulatory approach should encourage increased production from existing space, where located in appropriate areas, as well as the reorientation or relocation of existing farms to other suitable areas where this has the potential to significantly increase productivity and reduce environmental impacts.

The regulatory framework should encourage a diversity of scale of aquaculture farms, scale of operator and type of operator. The allocation of marine farming space should prioritise operators with stronger links to the Hauraki Gulf Marine Park communities and whose operations will have greater positive socio-economic and environmental outcomes. Small-scale, marae-based marine farms should also be supported. This can be achieved through appropriately weighting the tendering process for space.

Restrictions should be placed on the circumstances in which consents can be transferred to others and should require that development is completed within 5 years of the consent being granted.

By 2020 mana whenua aspirations regarding aquaculture need to be provided for

Mana whenua are involved in aquaculture, are pragmatic, and many hapū and iwi[4] recognise potential benefits – economic, social and environmental – from marine farming done well. Where mana whenua have been applicants for marine farms, or have been meaningfully engaged by applicants, there have been positive results, as described in the Wharekawa kūtai place study. But there is clearly scope to better realise mana whenua aspirations for aquaculture. Local hapū and marae aspire to establish nearby small-scale marine farms, as pātaka kai, for their wellbeing and sustenance.

By 2020 iwi, the industry, government, universities and research institutes support research and innovation through the creation of a Hub for Aquaculture Excellence

There is potential for the Hauraki Gulf Marine Park to become a hub of aquaculture excellence, supported by research and innovation relating to all aspects of aquaculture activity including environmental enhancement projects, new species, new technologies, and climate change mitigation.

HOW WILL WE DO IT?

Identify preferred locations for aquaculture within the Hauraki Gulf Marine Park

We have undertaken a detailed assessment of possible locations for future aquaculture development. These have been identified with the expectation that further investigation will be undertaken on a place-by-place basis to identify potential benefits and effects and to further define the boundaries.

Many of the negative impacts discussed above can be avoided or managed by locating farms appropriately. Attention has been paid to biophysical factors, environmental factors, minimising adverse effects on sites of significance to mana whenua, natural character and landscape, and minimising exclusion of other users of coastal space. Different species and farming methods have different biophysical requirements. The spatial element of managing aquaculture is not simply about avoiding areas with environmental constraints, but also about identifying the water space that is well-suited to farming and areas where the benefits of aquaculture will be maximised.

Table 5.1 and Map 5.1 identify areas that are considered likely to be appropriate for future aquaculture development, and Appendix 2 provides a detailed map of the proposed locations and analysis that underpins the recommendations. The areas identified are a preliminary guide, based on our initial assessment which indicated that aquaculture is likely to be suitable in the vicinity of these locations. The analysis also identified the boundaries of areas within which we considered that some marine farming would be appropriate and these are shown in Appendix 2. The boundaries have been carefully drawn to exclude areas where farms would likely have negative locational effects. It is not envisaged that marine farming would occupy all or even the bulk of these areas.

These indicative sites do not override the regional coastal planning and resource consent application processes, and it is these which will ultimately decide the zoning for and authorisation of a marine farm. It is through these processes that the candidate areas will be subject to more detailed site investigation and assessment of environmental effects and more precise boundaries will be determined. These processes will also enable greater iwi, public and industry involvement in the decision-making process through the Resource Management Act 2001 consultation, submission and appeal rights. Early engagement with iwi by councils and applicants is essential.

Because commercial scale aquaculture of any finfish species likely to be grown in the Hauraki Gulf Marine Park has not taken place anywhere in New Zealand as yet, we recommend sufficient trialling of the species proposed and comprehensive monitoring to show that there are no significant environmental effects. This would provide more certainly for the industry and the community, before full scale farms are released.

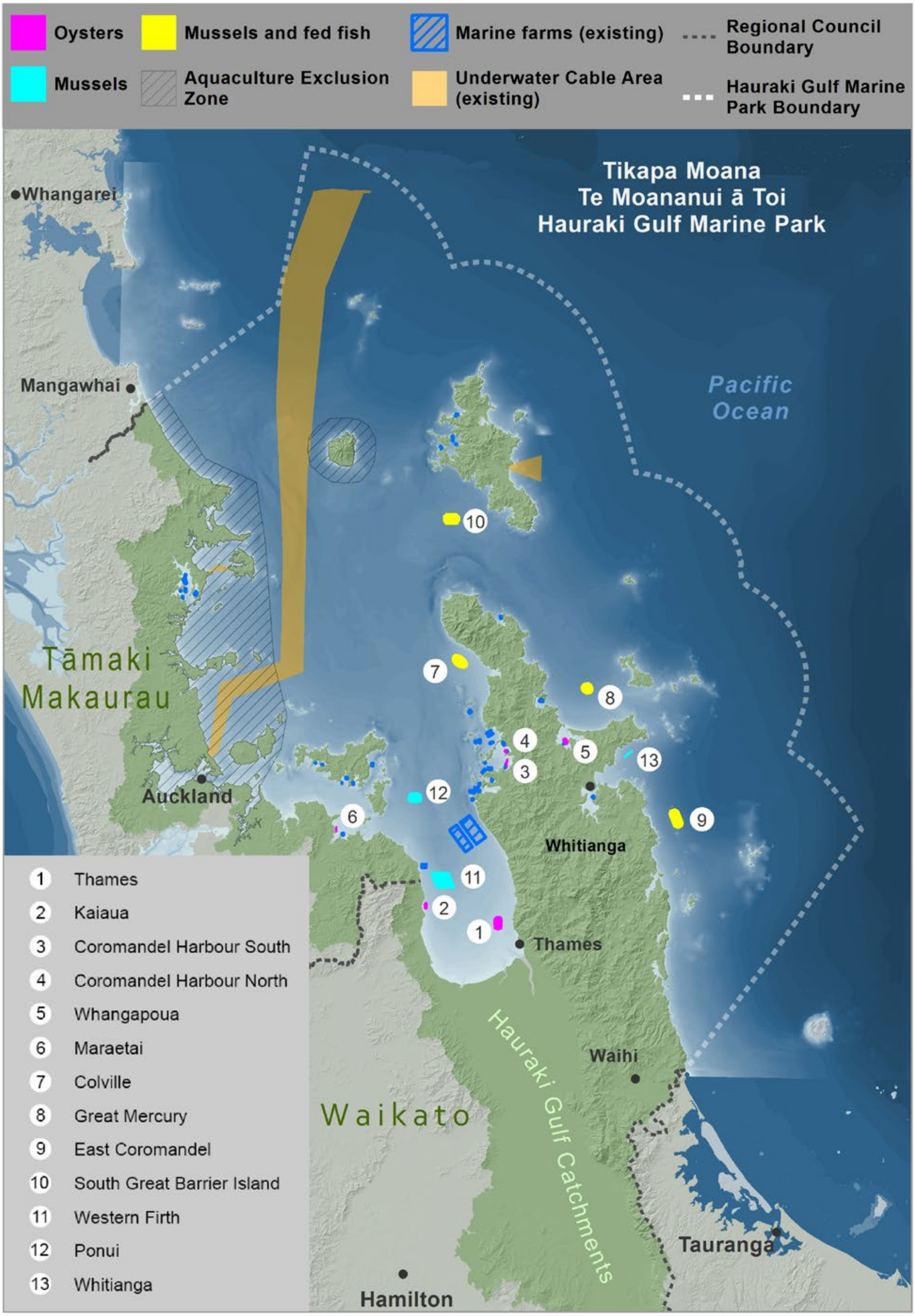
The sites identified in the Table are based on current knowledge of the industry and its growth aspirations, biophysical and natural character attributes of the areas, other uses of marine space, and mana whenua aspirations. We expect that new entrants to the sector, new types of aquaculture, or new technologies will almost certainly emerge in the future and further opportunities for these may need to be considered at that time.

4 Any reference to mana whenua is not the position of all iwi of the Hauraki Gulf Marine Park but reflects the opinion of those we discussed aquaculture with. Work is required with each iwi to determine their individual priorities and perspectives.

In addition, iwi and hapū should be supported to prepare plans identifying the potential location of future iwi/hapū operated commercial or customary marine farms to inform forward planning for aquaculture across the Hauraki Gulf Marine Park.

Table 5.1 Description of preferred indicative aquaculture areas

SITE	LOCATION	SPECIES
1	Thames	Inter-tidal shellfish (oysters)
2	Kaiaua	Inter-tidal shellfish (oysters)
3	Coromandel Harbour South	Inter-tidal shellfish (oysters)
4	Coromandel Harbour North	Inter-tidal shellfish (oysters)
5	Whangapoua	Inter-tidal shellfish (oysters)
6	Maraetai	Inter-tidal shellfish (oysters)
7	Colville	Subtidal shellfish (mussels and fish)
8	Great Mercury	Subtidal shellfish (mussels and fish)
9	East Coromandel	Subtidal shellfish (mussels and fish)
10	South Great Barrier Island	Subtidal shellfish (mussels and fish)
11	Western Firth	Subtidal shellfish (mussels)
12	Ponui	Subtidal shellfish (mussels)
13	Whitianga	Subtidal shellfish (mussels)



Map 5.1 Existing aquaculture sites, indicative areas preferred for future aquaculture development, and areas unsuitable for aquaculture.

See Appendix 2 for detailed locations and explanations of the numbered aquaculture sites.

Identify areas where aquaculture should be restricted

Areas which are unsuitable for aquaculture need to be identified in order to provide certainty for industry, the community and the environment. An initial identification of unsuitable areas is shown on map 5.1. There are other areas which are unsuitable and the full spatial range of these will need to be identified by councils.

A robust regulatory framework and monitoring regime that supports mana whenua, industry and local communities

The identification of preferred locations and inappropriate locations need to be supported by consistent policies, rules and other methods in order to provide industry with the clarity and certainty it needs to make large scale investment decisions and to deliver on mana whenua and local community expectations regarding protection of the environment and engagement with councils and industry. At present, inconsistent decision-making and monitoring requirements across council boundaries are an impediment to further growth of the sector. In many cases, mana whenua have been given insufficient input to aquaculture decision making and monitoring.

Planning framework

Regional Coastal Plan reviews should occur by 2018. The focus needs to be on the community providing input at the planning stage in terms of identifying suitable sites to zone as suitable for aquaculture and to zone as unsuitable. The reviews should address the following matters:

1. Provision of more permissive resource consenting for those areas identified as suitable in Table One (as further defined through the plan review process), than for aquaculture applications outside those areas (we suggest a restricted discretionary status for new farms). This will provide the industry with an incentive to grow in a planned manner, through reducing the significant costs, timeframes and uncertainty associated with a full discretionary resource consenting process. For those sites identified as unsuitable for aquaculture, non-complying activity status and associated policies and objectives should apply.
2. Provision for the re-consenting of existing farms as a controlled activity, where they are located in areas identified as suitable for aquaculture in the regional coastal plan, although retaining the requirement to undertake a site-based assessment of environmental effects.
3. Full-scale finfish farms are not to be released until there has been sufficient trialling of the species proposed and comprehensive monitoring has shown that there are no significant environmental effects.
4. Provision for small scale aquaculture (less than 5 hectares), in areas identified as suitable for aquaculture in the Regional Coastal Plan, as a limited notified restricted discretionary activity, to reduce the consenting barriers to establishment but still providing for a robust consenting process taking in to account cumulative effects.
5. Provision for experimental aquaculture sites of less than 3 hectares and of no more than five years duration, as a controlled activity, in areas identified as suitable for aquaculture in the regional coastal plan, to provide for the small scale piloting of new species and methods. Experimental aquaculture involving finfish species, which is located in areas outside those identified as suitable for finfish farming but within areas identified as suitable for other forms of aquaculture should be a restricted discretionary activity.
6. Provision for the expansion, readjustment and/or relocation of existing marine farms based on a robust set of criteria.
7. Recognition of mana whenua values and interests in any planning and resource consenting decision-making and providing for joint planning, learning and employment opportunities through such mechanisms as combined marine farmer and iwi forums.
8. Inclusion of criteria for tendering new aquaculture space which recognises the importance of providing for a range of operators and maximising the cultural, social economic and environmental benefits of marine farms to the Hauraki Gulf Marine Park.
9. Provision for imposing conditions of consent that require applicants to be certified by Aquaculture New Zealand's A+ Sustainable Aquaculture programme, and to incorporate technological and industry improvements.

Monitoring framework

Monitoring of marine farms should be designed, so that the information collected contributes to a wider understanding of the dynamics and state of the Hauraki Gulf Marine Park, as well as identifying any adverse environmental impacts of individual farms. This can be achieved through:

1. Providing consistent farm-by-farm monitoring and reporting requirements across the Hauraki Gulf Marine Park.
2. Carefully designing monitoring requirements so that the information generated can be utilised within the broader Park-wide monitoring programme.
3. Developing and using cultural indicators as part of the monitoring and restoration regime and involving mana whenua in the monitoring programme, particularly for measuring any cultural effects (discussed in more detail in the Implementation Chapter).
4. Ensuring that any data generated through farm monitoring programmes is freely available to councils, iwi, research institutions and the public.
5. Considering delegations of council monitoring functions to iwi.

Implementing an integrated marine monitoring system for the Park will require additional resources. The aquaculture industry can provide a valuable contribution to this. We recommend that any council and central government funds raised through tendering new aquaculture space within the Park be utilised to help fund an improved Park monitoring system including, in the first instance, the deployment of additional monitoring buoys.

Supporting research and innovation through the creation of a hub for aquaculture excellence

The benefits of the development of a hub jointly run by universities, industry, iwi and government for research and innovation for aquaculture in the Hauraki Gulf Marine Park could be valuable for both the industry, at a local, national and international scale, and for those that seek to better understand the state of the Hauraki Gulf Marine Park and the changes that are occurring. It would also provide opportunities for stewardship of the Hauraki Gulf Marine Park for larger parts of the community and provide greater opportunity for jobs in a highly productive and skilled research sector.

Aquaculture in the Hauraki Gulf Marine Park already supports some educational and research activities and this opportunity can be leveraged further because of the proximity of the Hauraki Gulf Marine Park to a large highly skilled workforce and a number of tertiary educational facilities, and the accessibility of the aquaculture activities within the Hauraki Gulf Marine Park.

The hub should be dually focused on environmental and commercial matters (as opposed to pure research) and could consider subjects such as:

- **Restoration benefits -** The development of additional shellfish farms has the potential to increase the filtering of water in the Hauraki Gulf Marine Park, as well as restoration of benthic mussel beds using unwanted mussel shells. While the extent of the potential positive impact of this is unknown, and will vary from species to species, it is important that this potential is maximised. The hub could lead research into the potential of aquaculture to contribute to the restoration effort for the Hauraki Gulf Marine Park and how such contributions could be enhanced.

- **New species -** The hub could coordinate and lead the investigation into species not currently farmed in the Hauraki Gulf Marine Park such as finfish, seaweeds, kina and sea cucumbers. These are experimental at this time and not commercially farmed in the Hauraki Gulf Marine Park, so more work is required before these become a commercial reality. For example, farming of sea cucumbers under farms may reduce the depositional and organic enrichment impacts. Other positive effects may be achieved such as farming seaweeds, which directly remove nutrients from the water, may increase localised oxygen content, and provide additional habitats for some fish and shellfish species
- **New technologies and modelling -** New technologies will continue to evolve, both in NZ and overseas, that could assist with aquaculture development, and monitoring. The hub could have a technology development and / or testing focus to ensure that as new technologies become available, they are tested and proven to be appropriate for deployment in the Hauraki Gulf Marine Park. Determining the aquaculture carrying capacity of potential farm sites requires sophisticated science, including modelling. For example, biophysical models have been used to understand the potential adverse effects due to phytoplankton depletion associated with mussel farms in the Wilson Bay zone.
- **Climate change -** As the global average temperature increases and CO2 within the ocean begins to reach saturation, the ability of the ocean to absorb carbon may alter significantly. At some point in the future removing carbon from the ocean may need to be considered. One method for achieving this could be through shellfish farming. Shellfish absorb carbon as they grow and convert it into calcium carbonate (CaCO3) to form their shell. The effectiveness of this method is still unknown and will vary significantly depending on species, stocking densities and a range of other variables – a research and innovation hub could lead this type of investigation.
- **Ocean acidification -** Increasing carbon dioxide in the atmosphere is causing the ocean to acidify. This changes the chemistry of the water, which in turn affects marine ecosystems and organisms including kai moana. Currently Ngāti Whātua and Ngāti Paoa are working alongside NIWA, the Universities of Auckland and Otago and the Cawthron Institute (including the aquaculture industry, MPI, regional councils, DOC and the Hauraki Gulf Forum) on the Coastal Acidification Rate, Impacts & Management Project. This 4-year project funded by the Ministry of Business, Innovation and Employment will monitor the rate that New Zealand coastal waters are acidifying. The project will also determine the effect of ocean acidification on important species like green shell mussel, pāua and snapper. The project will focus on three sites around New Zealand, one of which is the Firth of Thames Tīkapa Moana / Te Moananui-ā-Toi. We have data on water chemistry in the Firth that show it may be experiencing acidification – a research hub could also continue input into this research.

PLACE STUDY:
WHAREKAWA– MANA WHENUA AND AQUACULTURE IN THE FIRTH OF THAMES

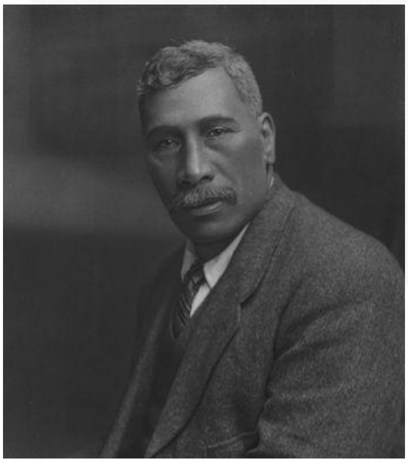


Figure 5.5 Tukumana Taiwiwi Te Taniwha – Ngāti Whanaunga /Ngāti Maru (1862 –1941)

The Kaiaua coastline, known as Wharekawa to mana whenua, is the rohe of Ngāti Paoa and Ngāti Whanaunga. Having once relied on the great mussel reefs within Tīkapa Moana, today most of the reefs have not recovered from the dredging of the mid-1900s. However, now as then, the coastline has ideal conditions for mussels. The coastline is subject to a tidal wave of mussel farming applications, almost all off-shore of the early land block Wharekawa number 4. This concentration of aquaculture activity is one of the pressures we are seeking to address in the Plan.

Mātauranga Māori – traditional fisheries knowledge

Wharekawa 4 was confirmed by the Native Land Court as the estate of four Ngāti Whanaunga hapū, Te Mateawa, Ngāti Puku, Ngāti Rangiaohia and Ngāti Kotinga. They had been the kaitiaki of this area since the coming of Marutuahu to Hauraki, probably in the 16th century.

Over this timespan iwi have built up a vast mātauranga, a body of traditional knowledge, about the coasts and harbours, and the kaimoana that lives there. This knowledge is key to understanding and managing local resources. Tukumana wrote down some of his knowledge of kūtai:

> *"If arose a wind from the North and if the wind blew towards that hill [Hauroa], or if the wind it blew down from it or lowered so that it drove (banked up) the sea land ward, then is seen the mussels (kuku and kūtai) – and they come ashore, not in the least were broken a single one of these mussels cast ashore – all were quite fresh though quite ashore. Nor was a single mussel to be seen outside the sea mark (below high tide mark).*
> *But if the wind is rising at the time it is flood tide – at dead low tide there will be no mussels cast up. If it should happen that the wind veers about to that mountain [Kohukohunui] when it is only half tide, those mussels will all be broken – and will be found also spread about all over the place".*

Figure 5.6 Existing mussel farms are within 800m of the shoreline at Wharekaw

Ngāti Whanaunga and Ngāti Paoa still live at Wharekawa, at their papakāinga at Kaiaua, Waihihi, and on the last remaining substantial piece of Māori land on the coastline at Waimango. While they have shares in aquaculture through the pan-tribal Hauraki fishing companies, they are not directly involved in mussel farming.

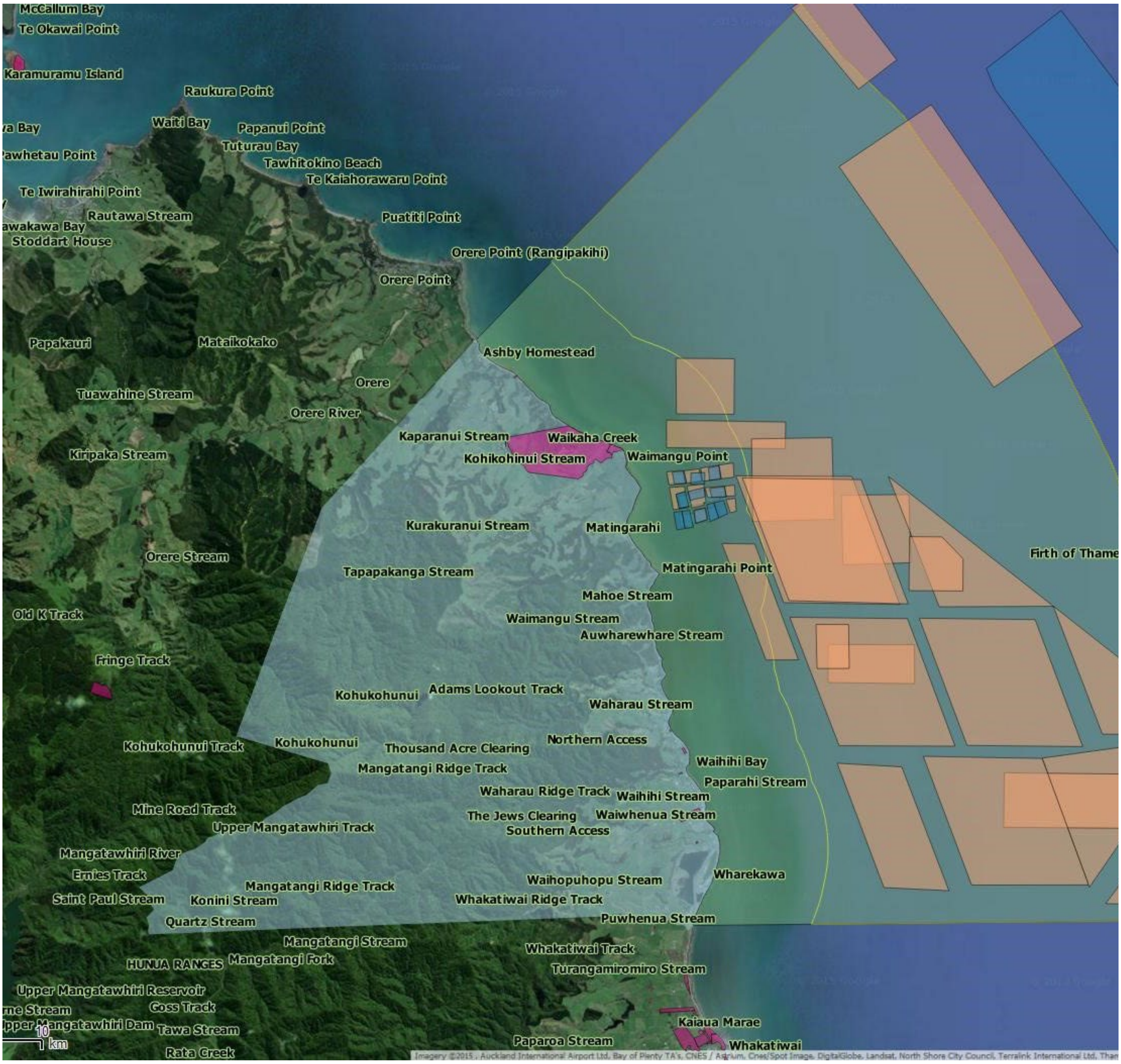


Figure 5.7 Wharekawa Māori owned land (purple), Iwi rohe boundary (white shading), regional boundary (yellow line), existing aquaculture (blue), and aquaculture applications (orange)

While there are currently only about 100 hectares of farms in the vicinity, applications are lodged for several thousand hectares. This Plan has recommended a range of alternative locations where aquaculture should be promoted.

The value of local relationships

Local hapū and whānau and the mussel farmers have established a group to oversee monitoring, develop a restoration plan, and undertake restoration initiatives in the vicinity. The Tūwhituaroa Aquaculture Steering Group was agreed between to the parties as a condition of consent. Called the Tūwhituaroa Aquaculture Steering Group provides a meaningful platform for the local hapū and whānau to exercise kaitiakitanga.

A critical aspect in the successful establishment of a kaitiaki steering group at Wharekawa is the long relationship between mana whenua and the local mussel farming families. Several of the owners have lived in the area for many generations, and the resulting relationship is cherished by local Māori and the farmers alike. It is hoped that this will provide a model for future marine farms.

Figure 5.8 The Wharenui.

Ancestral meeting house of Ngāti Paoa anad Ngāti Whanaunga at Wharekawa Marae, south of the mussel farms on the Wharekawa coastline (Source. Ngāti Paoa Iwi Trust)

PART THREE: RIDGE TO REEF OR MOUNTAINS TO SEA

WĀHANGA TUATORU: KI UTA KI TAI

6

BIODIVERSITY. RERENGA RAUROPI.

He moana mauri ora

Healthy functioning ecosystems with replenished abundance and diversity of life.

7

WATER QUALITY. ORANGA PŪMAU O TE WAI.

Integrated Catchment Management "Ki Uta Ki Tai" (mountains to the sea) is a holistic way of managing ecosystems within the Hauraki Gulf Marine Park.

Ki Uta Ki Tai, meaning from mountains to the sea, is a traditional holistic way of understanding and managing the environment. Consistent with western models such as integrated catchment management, Ki Uta Ki Tai is the approach adopted in Sea Change to restore and protect the terrestrial freshwater ecosystems and marine habitats of the Park, by recognising the critical linkages between terrestrial and marine ecosystems. Again, Māori and western/scientific perspectives, knowledge, and approaches are incorporated in our effort to understand what is happening within the Park, and within our proposed management response. Part Three is central to achieving the overarching vision guiding Sea Change: He taonga tuku iho (treasures handed to us from our ancestors), Tīkapa Moana / Te Moananui-ā-Toi– the Hauraki Gulf Marine Park is vibrant with life and healthy mauri, increasingly productive, and supporting healthy and prosperous communities.

Ki Uta Ki Tai consists of two chapters, Chapter 6 on Biodiversity and Chapter 7 on Water Quality. Chapter 6 is broken into four main themes, biodiversity, MPAs, marine debris, and biosecurity. As per previous chapters, objectives are stated relating to each theme, and management actions proposed. Chapter 7 presents a description of the main contaminants of the waters of the Park, sediment, nutrients, heavy metals, and microbial pathogens. Problems associated with each are identified, followed by an assessment of what is needed to address the issue, how we will achieve this, and the means by which we will determine success. Finally, particular risks and threats facing the Park are investigated, and responses to these proposed.

6. BIODIVERSITY

RERENGA RAUROPI

He moana mauri ora

Healthy functioning ecosystems with replenished abundance and diversity of life.

This Chapter encompasses four main sections:

1. Biodiversity;
2. MPAs;
3. Marine debris; and
4. Biosecurity.

Although they are presented as separate sections in the Chapter, there are close linkages between each section, so they should be considered as an integrated package. Biodiversity has significant links with many other sections of this Plan, especially Fish Stocks and Water Quality.

Photo: Raewyn Peart

Figure 6.1 Flesh-footed shearwater (*Puffinus carneipes*);

One of the largest colonies of this species in New Zealand occurs at Mercury and Ohinau Islands

BIODIVERSITY OF THE HAURAKI GULF MARINE PARK

The waters and islands of the Hauraki Gulf Marine Park are rich in life, including many species of seabirds, mammals, fish, and diverse invertebrates including sponges, corals, bryozoans, crustaceans, gastropods, worms, and bivalves. Large areas of kelp forests occur on many of its reefs, including large brown seaweeds which form habitats for many reef fish species, as well as smaller red and green seaweeds. On the soft sediments where light levels are sufficient for plants to grow, additional species occur such as rhodoliths, and calcareous algae which grow as stone-like forms, providing habitat for many other species. Dense beds of horse mussels, dog cockles and other shellfish species grow in some areas, while other seafloor areas support assemblages of burrowing sea urchins, sea cucumbers, scallops, and brittle-star beds.

Species include tiny copepods with long antennae, ribbon like mm-long *Oikopleura*, jellyfish and salp chains, while larger crustaceans such as euphasids at times occur in large swarms. Small pelagic fish such as pilchard and anchovies feed on the zooplankton, and at time are pushed to the surface and concentrated by larger fish predators such as kahawai, forming ‘boil-ups’ that also attract seabirds and dolphins.

Out in the deeper water, hard corals (including black corals and gorgonian trees) occur, along with populations of hāpuku. In the water column, phytoplankton provide food for a range of zooplankton species, while some zooplankton prey on others.

Figure 6.2 Shortbeaked common dolphins (*Delphinus delphis*), found throughout the Hauraki Gulf Marine Park

Similarly, trevally sometimes feed on concentrated euphasids and other invertebrate prey at the surface, creating noisy surface schools as they suck up prey.

The Hauraki Gulf Marine Park also changes through the seasons, as many fish migrate in large schools for spawning, while seabird species roam even further afield, or congregate at nesting sites to raise the next generation.

Seabirds and marine mammals occur throughout the Hauraki Gulf Marine Park, the species and numbers present at any time varying according to seasonal migration patterns and breeding cycles. Twenty-seven species of seabirds breed within the Marine Park. While raising chicks these species tend to spend a greater proportion of their time feeding within the waters of the Marine Park, whereas at other times of the year many leave for rich feeding grounds in the North and Southeast Pacific Ocean. While bottlenose and short-beaked common dolphins and Bryde's whales live and feed in the outer Hauraki Gulf, many other species of whale and dolphin pass through it as part of regular seasonal migrations to and from distant destinations, or in the pursuit of prey. Closer to shore the Hauraki Gulf Marine Park's numerous harbours and estuaries, and the vast tidal flats of the Firth of Thames, are used by tens of thousands of migratory and resident shore birds from at least 77 different species.

BIODIVERSITY - A COMMUNITY PERSPECTIVE

We have heard overwhelmingly from the public that marine biodiversity, MPAs, and biosecurity, are some of the most important issues for the Hauraki Gulf Marine Park. Many people want to see more marine reserves. Concerns about declining health and impacts of human activities on marine ecosystems and the species that live in them are commonplace, as the quotes from Listening Posts below demonstrate.

A selection of quotes from members of the public at listening posts

Mahurangi

Someone told me that all the crabs are going. You don't see them now. I can remember the crabs during my holidays. Without the crabs there's nothing for the flounder to crunch up. What's happened to them? You don't see children looking (for little creatures) in rock pools either. Where have the crabs gone to? Are the pools all silted up?

Mercury Bay

Aquariums in the rock pools – we would make a fish zoo. I remember my feet in the rock pool with all the little shrimps nibbling your feet.

I can remember as a youngster, when the tide was out we would find huge holes in the sand made by snapper, and lots of pipi.

Tiri I just love! We both help out on Motutapu, where the birds are. Restored ecology is attracting people.

Thames

Its (reduced fish catch) reflected in the sea birds. We see petrels, and there's still plenty of gannets but you don't see the terns sitting on the beach like there used to be, the black back or the red ones.

Very few kelp beds any more.

Tairua

Coastal Marine Reserves: easy to access (rather than going by boat) for families and kids.

St Marys Bay

I think marine reserves have made a difference. I'd like some more (marine) reserves. I think they breed the fish and you are going to get the range of mussels that bring the smaller fish and they bring the bigger fish – you create the whole eco system.

I support the proposals for more marine protected areas. Reserves help the fish to breed and live safely.

Point England

Parore for crayfish bait were everywhere, flitting and darting. Even so I set a net last week and got eight or nine parore and eight or nine trevally. We don't eat parore. There are still schools in the mouth of the estuary of mullet and trevally. And snapper in amongst the mangroves.

The seaweed used to be six-foot-deep and two chain wide after a storm, the flies would come and blow their eggs through it, then it would be crawling with maggots, then the piper would come, then the kahawai and kingies to feast.

Tairua

Kina barrens are massive! On the west coast the kelp is better. On the east coast there is less kelp and lots of barrens. You've got to swim right out over the barrens.

Mangroves need to be managed – not total removal. Look at where they are protecting land, have other roles such as marine ecosystem services, or impeding access.

Kaiaua

Securing habitat for shorebird, health of inter-tidal area, securing high-tide bird roosts, unobstructed.

I am concerned about the sea floor. With the reduction or removal of all the mussels we now have so many more invasive species. We have sea squirts. My family and I do the scallop fest thing but now have parasites in the scallops – where did they come from? Ballast from big container ships? And the fan worm… it's really concerning.

The sea floor is like a garden or a paddock – if it is healthy then the whole system will be healthy.

St Marys Bay

Reef restoration can take place through volunteer action and make a difference in three months.

Whitianga

Dune restoration has helped with erosion and the provision of walkways means the majority of people don't walk over the dunes to the ocean beach, but use the paths

Orewa

Marine reserves have got to be somewhere tourists can get to – need parking, accommodation, decent access, things like that.

St Marys Bay

There are no terns any more or very few – we used to look for terns diving. Now we look for gannets to indicate where kahawai are.

Used to get lots of sharks – hammerheads and others – in 1970s and prolific amount of flounder.

Used to be much more crayfish – at marine reserves there are loads more but reefs in between there are kina barrens.

There are a lot of eagle rays – they are very prevalent at oyster farms, they go in between the poles and our legs. They are lovely creatures.

Great Barrier

Without reserves the fish are bombarded with noise and other stressors like being caught on a hook. Reserves provide safe places, especially for crayfish to breed.

We need a really large network of marine reserves, partly educational, so the fish have an opportunity to establish themselves. Look at the contact at Goat Island. There's a push back – 'not in my backyard'. We need another 20 (MPAs) and of a reasonable size – 80% or 90% for fishing. Fishermen don't have to have all the Gulf. I'm talking about ones that are good for the Gulf…

Whangateau Harbour

Changing mentality: a marine reserve to show/tell people how rich the marine environment is. Change the mentality to enjoyment not just catching.

The Summary and Outcomes of Sea Change – Tai Timu Tai Pari Community Engagement (January 2014 – February 2015) noted:

- Families using the Hauraki Gulf Marine Park suggested that fishing and other types of recreation should be allowed in areas accessible to the coast, with marine reserves in less accessible areas. Others use marine reserves for different types of recreation.
- People want to protect what we have in the Hauraki Gulf Marine Park. Places and species that are unique to Aotearoa should be protected forever.
- Marine reserves allow people to experience biodiversity and discover something new in their own backyard.

Figure 6.3 The Hauraki Gulf Marine Park contains a resident population of bottlenose dolphins (*Tursiops truncatus*)

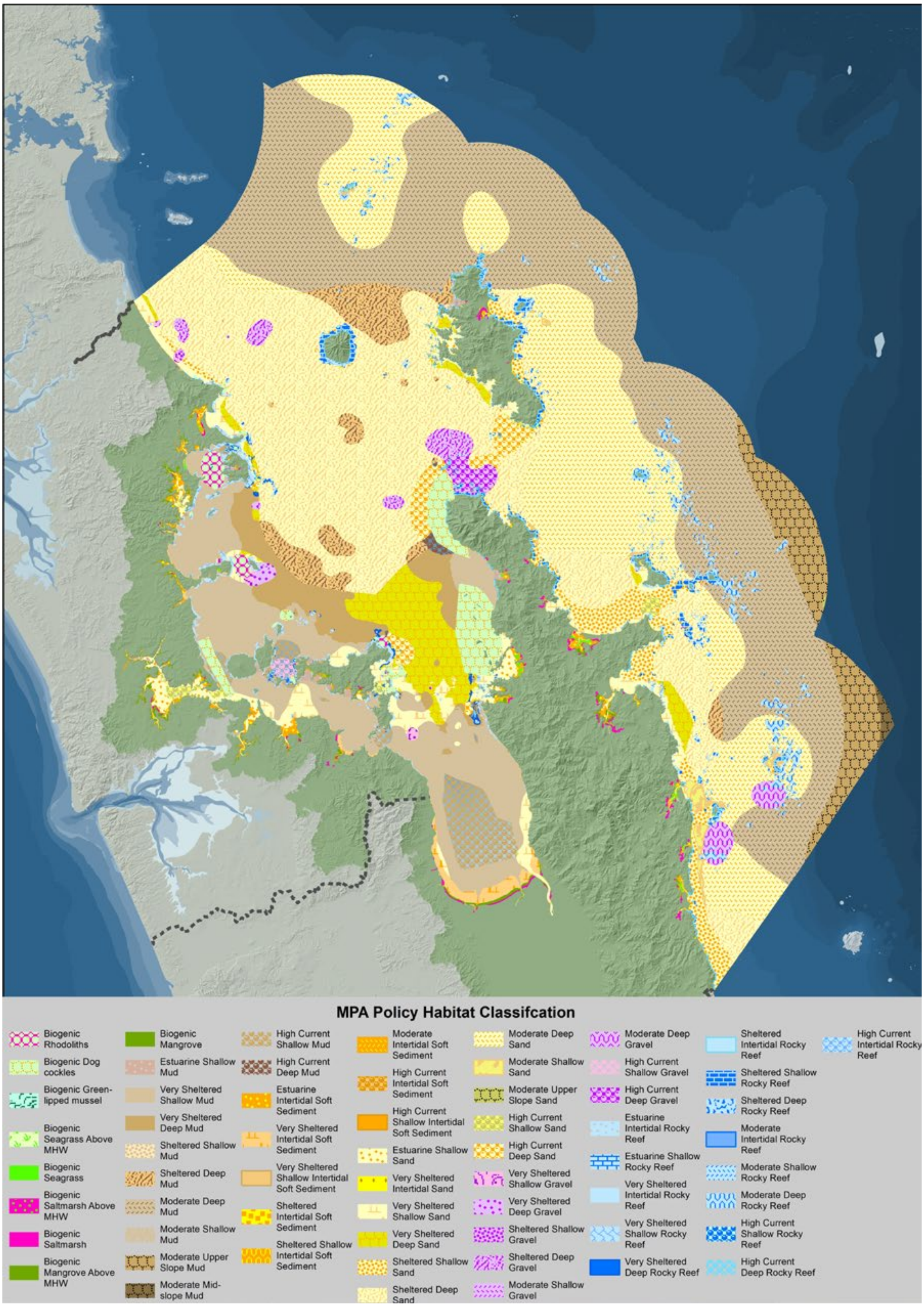
BIODIVERSITY - A SCIENTIFIC PERSPECTIVE

Hauraki Gulf Marine Park marine habitats range from shallow, extremely sheltered waters of estuaries and harbours, to exposed offshore islands and reefs and deep outer shelf and upper continental slope sediments (see Map 6.1). Extensive shallow rocky reefs occur around much of the coastline, except in the Firth of Thames which is dominated by soft sediments. Deep rocky reefs are located on the outer shelf northeast of Mokohinau Islands, east of Great Barrier Island and Coromandel Peninsula, and west of Little Barrier Island. High-current habitats occur in and around Colville Channel and Waitematā Harbour. This high level of habitat diversity is reflected in the diversity of marine life within the Hauraki Gulf Marine Park (e.g. Morley & Hayward 2009; Lee et al. 2015).

Phytoplankton growth throughout much of the Hauraki Gulf Marine Park is driven by nutrients upwelled over the outer continental shelf in spring and early summer. This supports a relatively high biomass of large zooplankton (e.g. krill, hyperiid amphipods, salps and jellyfish). This zooplankton, and a variety of squid and small bait fish that feed on it, are important in the diets of fish species such as Jack mackerel, kahawai, trevally and kingfish, as well as a highly migratory fish community that includes whale sharks, manta rays, tuna and marlins. Seabirds and marine mammals that live in and visit the Hauraki Gulf Marine Park also rely on this food source.

The whales and dolphin populations of the Hauraki Gulf Marine Park are relatively diverse. Resident species are Bryde's whale, common and bottlenose dolphins, and killer whale. Bryde's whale, bottlenose dolphin and killer whale are considered threatened species due to their naturally small population sizes.

The New Zealand Bryde's whale population is thought to be largely confined to the northeast North Island with a large proportion of individuals resident within the Hauraki Gulf Marine Park. As the populations of southern right whale, humpback whale, blue whale and New Zealand fur seal continue to recover from human hunting, encounters with these species are increasing, with southern right whales and fur seals increasingly seen in urbanised areas such as Waitematā Harbour.



Map 6.1 Mapping of marine habitat types within the Hauraki Gulf Marine Park.

The entire North Eastern Coastal Marine Bioregion, particularly the area between Cape Brett and Waihi, including the Hauraki Gulf Marine Park, is a globally significant seabird biodiversity hotspot (Gaskin & Rayner 2012). The greatest diversity and abundance of nesting seabirds occurs on predator-free offshore islands, with relatively few species still breeding at mainland locations. Of the 27 species of seabirds breeding in the region, four, the New Zealand fairy tern, Pycroft's petrel, black petrel, and New Zealand storm petrel, breed nowhere else. Nineteen of the species breeding in the Hauraki Gulf Marine Park are listed as threatened species. The New Zealand fairy tern and New Zealand storm petrel are two of the rarest seabirds in the world.

The numerous harbours, estuaries and the extensive intertidal flats located at the head of the Firth of Thames provide nationally and internationally significant coastal bird habitat. The Firth of Thames RAMSAR[1] site supports up to 25,000 mostly migratory wading birds belonging to at least 77 different species. These birds move and forage throughout the Hauraki Gulf Marine Park, as well as moving between east and west coast harbours, to take advantage of the opposing tide times to feed.

Figure 6.4 Bar-tailed godwit.

Large numbers of bar-tailed godwit (*Limosa lapponica*) and other shorebirds travel to the Hauraki Gulf Marine Park from Asia each year to feed

Many small estuaries and beaches also provide critical habitat for threatened banded dotterel and Northern New Zealand dotterel. Areas recognised as containing nationally and regionally important wading and shore bird habitats include Colville Bay, and the Waitematā, Coromandel, Whangapoua, Whitianga, Tairua, Wharekawa, and Whangamata harbours.

Human activities contribute to the ongoing loss of indigenous marine biodiversity

Human impacts on the indigenous biodiversity of the Hauraki Gulf began with hunting/foraging and increased freshwater inflow and sedimentation of harbours and estuaries following deforestation of the surrounding catchments by the first Polynesian settlers (Hayward et al. 2004). These impacts intensified in European times as deforestation, channelisation of waterways, and wetland reclamation increased, and then again as land use shifted from predominantly rural to increasingly urban in the 1950s (Hayward et al. 2004). Non-indigenous marine species and disease outbreaks are among the most recently recognised threats to indigenous marine species. Non-indigenous organisms began arriving in our waters on the hulls of the first European sailing vessels (e.g. wood-boring bivalves) and the number establishing here continues to increase, reflecting the changes in the level and nature of international shipping, and New Zealand's dependence on it.

Loss of indigenous marine biodiversity has been greatest in coastal habitats, particularly urban harbours and estuaries. In the Firth of Thames, where extensive coastal wetlands have been drained and converted to agricultural land, forest clearance and mining have resulted in large historic inputs of sediments to the marine environment, and poorly managed trawling and shellfish dredging resulted in the almost total loss of subtidal mussel reefs, scallop and oyster beds by the mid-1960s.

1 The Convention on Wetlands of International Importance, called the Ramsar Convention, is the intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources.

Figure 6.5 Dense bed of tuangi, New Zealand cockle (*Austrovenus stutchburyi*) on the edge of a tidal channel

Habitat homogenisation and loss, barriers to fish migration, pollution, and over fishing have, all reduced sea bed, reef and estuarine biodiversity. Estuaries provide important nursery habitat for a number of common coastal fishes (Morrison et al. 2014a-d) and represent critical migratory corridors for a high proportion of our native freshwater fishes. Within the Hauraki Gulf Marine Park, Great Barrier Island, the Coromandel Peninsula, and the catchments surrounding Waitematā Harbour, still retain considerable freshwater fish values. The Waitematā Harbour, although highly modified, has a relatively high diversity of small intertidal and shallow subtidal fish species compared to other New Zealand estuaries, and the larvae of all the freshwater species occurring in the surrounding catchments migrate through it (Larcombe 1973; Lowe & Morrison 2012). The inanga (*Galaxias maculatus*, the main 'whitebait' species) also spawns in riparian vegetation above Mean High Water Mark, and the giant bully (*Gobiomorphus gobioides*), a little known native species, has been recorded from the tidal reaches of several streams in the catchment (McDowall 1990). Significant remnants of indigenous coastal wetland and saltmarsh still occur in Manaia Harbour, Coromandel Harbour (south side of Preece Point), Colville Bay, Whangapoua Harbour, Tairua, Wharekawa and Whangamatā Harbours, as well as a number of sites around the coastline of Great Barrier Island. The small estuary on Whangapoua Creek, Great Barrier Island is notable for intact indigenous coastal vegetation sequences and a remnant subtidal green-lipped mussel reef (McLeod et al. 2014).

Beyond the coastal fringe, fishing has had, and continues to have, a pervasive influence on marine biodiversity, including: the direct removal of large amounts of shellfish and finfish biomass, the alteration of size structures of target species with consequent flow-on effects on ecological processes such as predator-prey relationships, the localised extinction of some species (e.g. hāpuku) and the reduction to low numbers of others (e.g. packhorse lobster), the bycatch of threatened species, and the disturbance and destruction of benthic habitats and associated fauna and flora (Morrison et al. 2014a,d; Maxwell & MacDiarmid 2016).

Alteration of predator-prey dynamics due to local depletion of snapper and rock lobster populations has been shown to be the main driver creating kina (the sea urchin *Evechinus chloroticus*) barrens[2] throughout the mid- Hauraki Gulf Marine Park and northeast North Island generally (Shears & Babcock 2002, 2003; Salomon et al. 2008; Leleu et al. 2012).

Figure 6.6 Kina/common sea urchin (*Evechinus chloroticus*).

Over-grazing by the kina/common sea urchin (*Evechinus chloroticus*) can transform large areas of reef from kelp forest to less productive 'urchin barrens'

2 Kina barrens are shallow areas of rocky reef where the only large organism present in any abundance are sea urchins. These urchins have become domimant as their natural predators have been fished down to low numbers. The grazing of the rock surfaces by the urchins prevents the establishment of new kelp forests.

But a more profound effect of fishing on the Hauraki Gulf Marine Park has been the almost complete removal of the extensive beds of green shell mussel and horse mussels that characterised much of the Firth of Thames, Tāmaki Strait, and inner Gulf, between Waiheke and Kawau Islands (McLeod et al. 2011, 2014; Morrison et al. 2014d).

The loss of these beds of large bivalves has greatly simplified the benthic ecosystem by removing a large amount of three dimensional structure provided by the mussel shells and the organisms growing on them (e.g. sponges, hydroids, ascidans). Over 500 km^2 of green shell mussel beds are estimated to have been lost from the Firth of Thames and Tāmaki Strait (McLeod et al. 2011, 2014; Morrison et al. 2014d). The area of horse mussels and other non-commercial species such as sponges that has been lost is unknown, but anecdotal evidence suggests that the area covered by horse mussels was comparable to that of green shell mussels (Paul 2014).

Other habitats probably greatly reduced in extent and abundance include bryozoans, sea pens, sponges, gorgonians, and hard corals (in deeper waters). At present horse mussel beds appear to be largely confined to some estuaries and inshore areas that have not been dredged or trawled. Threats to remaining populations include infrastructure development, sedimentation, pollution, non-indigenous marine species, anchor damage, and recreational scallop dredging.Other activities that have contributed to observed declines in biodiversity nationally and or globally include:

- **Sediment** – sedimentation of the seafloor smothers marine life, adversely affecting filter-feeding animals, covers plants surfaces preventing photosynthesis, and prevents new plant spores and animal larvae from establishing. Suspended in the water column, it has negative effects on visual feeding predators and pelagic filter-feeders, and reduces the amount of light that reaches the seafloor, adversely affecting plant growth and the depths to which they can grow. It is the single largest contributor to poor water quality in the Hauraki Gulf Marine Park.
- **Nutrient inputs from land** – these can cause algal blooms that lead to the development of anoxic conditions in sediments and the water column. Phytoplankton blooms and the growth of epiphytes[3] driven by elevated nutrient levels can also increase shading of sea grass and benthic macro algae (seaweeds), leading to declines in these species.
- **Increasing copper, lead and zinc levels in estuaries** – at high concentrations these can be lethal to marine life, but even at lower concentrations they can affect development, growth, and reproduction.
- **Plastic refuse** – this can kill marine species by entanglement and ingestion; large amounts of rubbish continues to enter the marine environment around Auckland.
- **Vessel strikes** – The first vessel-struck Bryde's whale was reported in the Gulf in 1996. From 1996 up until September 2014, a total of 44 whales have been found dead, with a further three reported dead but their carcasses not recovered. Of the 44 whales, only 20 had sufficient data collected to assign the definite or probable cause of death and in 17 whales (85%) vessel-strike was the most likely cause of death. Since September 2013, Ports of Auckland and the shipping industry have worked to reduce vessel speed in the Hauraki Gulf, with the result that only one whale has been killed by ship strike since then. No whales have been killed by ship strike since September 2014. Collisions with recreational vessels also contribute to deaths of smaller species, particularly penguins.

Finally, global climate change represents a chronic, long-term disturbance to marine ecosystems. Environmental changes associated with climate change include increased sea surface temperatures, changes in the frequency and intensity of storms, changes in ocean circulation, and ocean acidification. Sea-level rise will also create challenges for the conservation of coastal biodiversity through impacts on intertidal habitats and the composition of coastal vegetation types (in response to changes in immersion-emersion and salinity regimes). Negative effects of global sea-level rise on marine biodiversity will be greatest in estuarine and coastal ecosystems. The most obvious effect will be the loss of existing coastal lagoons and wetlands, shore bird nesting, roosting and foraging areas, and intertidal habitats, unless the ecological effects of coastal inundation are anticipated and planned for. Increased coastal erosion may also result in increased amounts of terrestrial sediment entering the coastal zone.

3 An epiphyte is a plant that normally grows harmlessly upon another plant e.g. filamentous algae growing on seagrass blades, which in turn are grazed by invertebrates such as gastropods and small limpits.

What does the loss of indigenous marine biodiversity mean?

High biodiversity is associated with high biological productivity, so that one of the most obvious consequences of a large scale loss of biodiversity is a reduction in food production. This has been dramatically demonstrated in the Hauraki Gulf Marine Park by the historic loss of over 500 km^2 of green shell mussel beds from the Firth of Thames. As well as representing an important food source, these beds provided habitat for a wide range of other invertebrates, and nursery and foraging habitat for fishes. They also provided other important ecological functions, such as filtering seawater, and linking water column production to the seafloor (called bentho-pelagic coupling) by feeding on plankton and excreting waste products, as well as increasing their own size. Observations of remnant Mussel beds in the Hauraki Gulf Marine Park indicate they support a distinct assemblage of macroinvertebrates, with 3.5 times the density, 3.4 times the biomass and 3.5 times the productivity of surrounding soft sediment areas. The density of small fishes on these beds is 13.7 times higher than in surrounding areas, and the estimated loss in predatory fish production across the former extent of the beds is 200-16,000 tonnes per year (McLeod et al. 2014; Morrison et al. 2014). The effect on estuarine fishes in the Firth of Thames of deforestation (sediment) and conversion of the Hauraki Plains wetlands to agriculture is revealed by the observation of a brief customary fishing trip about three miles up the Piako River in 1902 (see below).

Benthic primary producers found on soft sediments, the habitat type which dominates most of the Hauraki Gulf Marine Park, include sea grass, small red and green seaweeds and microphytobenthos (small primary producers including diatoms that live on the sediment surface, sometimes seen by divers as a 'brown fuzz' that may colour shallow sandy sediments). Similarly, the shallower rocky reef systems hold many kelp species, especially the larger brown kelps such as *E. radiata* and species of *Carpophyllum* and *Sargasum*, which substantially increase primary production and provide important habitats for many species. These range from tiny crustaceans, such as amphipods and shrimps which are responsible for most of the animal production on shallow rocky reefs (e.g., around 78% at Leigh, Taylor, 1998), through to larger fishes and invertebrates, some of which (e.g. lobsters and snapper) help to maintain the kelp forests and minimise kina barrens (Babcock et al. 1999).

As all plant species require light for photosynthesis, seaweeds are naturally limited in how deep they can grow. Unfortunately, declining water quality (including turbidity in the water column strongly reducing sunlight penetration), the direct smothering of plants photosynthetic surfaces by fine sediments, and sediments covering potential settlement surfaces for plant spores to create new plants, means that major reductions in benthic primary production across much of the Hauraki Gulf Marine Park (and wider New Zealand) have almost certainly occurred (Morrison et al. 2009). Added to these affects are the mechanical disturbance of the seafloor from fishing and other human activities, which have fundamentally effected the abundance and extent of these plant species.

Captain G. Mair, Notes on fish found in the Piako River, read before the Auckland Institute, 4 August 1902

Assisted by a native lad I twice lifted the net in about three-quarters of an hour, with the following result: 581 eels from 1 ft. to 4 ft. in length, the largest the size of one's arm; eight dozen flounders, of various sizes; large numbers of aua or kātaha (Agonostoma forsteri) [yellow-eyed mullet]; about 60 lb. or 70 lb. weight of pilchard or mohimohi (Clupea sagax), two varieties; a few Snapper, mullet, and kahawai; and hundreds of young red-cod, rarii (Lotella bacchus), and what I believe are the young rock-cod, or kōkopu or rāwaru (Percis colias) [blue cod]. The red-cod were from 8 in to 4 inches in length, and the rawaru, or as the natives here call them, "toitoi" or "panepane," from 2 inches to 6 inches long. Very large quantities of a kind of whitebait were also caught at the same time.

For some species this has resulted in their virtual ecological extinction in the Hauraki Gulf Marine Park (they no longer provide the important functions that they once did). For example, subtidal seagrass is now very rare in the Hauraki Gulf Marine Park, although historically it was common (Powell 1937). With its loss has gone all the important functions it provided, including acting as very high value fish nurseries per unit area, and the wide range of species which it supported (Morrison et al 2014a–d).

The disturbance of large areas of seafloor by trawling and dredging suggest that major reductions in benthic primary production across much of the Hauraki Gulf Marine Park are likely. Combined with the extensive loss of biogenic habitats from other stressors, the present day Hauraki Gulf Marine Park is less diverse and productive than it was historically (Thrush et al. 1998; Talman et al. 2004, Morrison et al. 2009, Maxwell & MacDiarmid 2016), or could be in the future. This conclusion extends to its ability to recover from disturbance, and to provide important regulating services such as nutrient recycling, as well as direct economic values such as higher fisheries production (Morrison et al. 2014d).

The role of Marine Protected Areas

The use of Marine Reserves, Parks and other spatial management tools to protect biodiversity from human impacts is now wide-spread across many countries. The level of protection varies. Full 'no-take' marine reserves are designed to release all fish and invertebrate species and assemblages within the reserve from the effects of fishing, while partial protection areas may serve other functions, such as protecting the benthic habitats from protection, and/or removing the specific impacts of some fishing methods or other activities on the area.

There is a large scientific literature on marine reserves, much of it focused on the recovery of larger harvested animal species (mainly lobsters and fish), but also others such as abalone (pāua) and sea urchins (including kina). While the level and speed of recovery varies with the size and age of the reserve, the level of enforcement, and other factors such as the presence of wider-scale environmental decline, in general populations of heavily exploited species do recover in abundance, size and age in no-take marine reserves ('old-growth structure') (Babcock et al. 2010, Willis 2013). These on-average bigger sized and older individuals also provide important regulatory functions on habitats.

Partial protection, where some forms of fishing are still permitted, does not allow such population recovery. For example, at the Mimiwhangata Marine Reserve, East Northland, commercial fishing is excluded but recreational fishing is permitted. Surveys showed that snapper numbers were no greater inside the Park than outside, and in fact were the lowest recorded for all of the areas surveyed (Denny & Babcock 2004). It was noted that the impression of such areas having greater fish abundance may actually increase recreational fishing pressure.

Perhaps the most widely known mechanism is that of trophic cascades between kina, kelp, lobsters and larger carnivorous fish such as snapper, which are widespread across temperate shallow reef ecosystems. In parts of north-eastern New Zealand, kina barrens (areas of shallow reef with large numbers of sea urchins and little else of any body size) are considered to be the result of a release from high predation pressure from large snapper, and in particular lobsters (Babcock et al. 1999). The kina remove the adult kelp plants, and/or prevent the establishment of new plants, by high grazing pressure. Such barren rock flats are less productive than those supporting kelp forests (Salomon et al. 2008).

There are significant time lags in such dynamics. When the Leigh Marine Reserve was established many kina had grown too large to be easily predated on, and so the return of the kelp forests was dependent not only on the re-establishment of a predator population, but also on the larger kina eventually dying off from old age and factors such as disease.

Marine reserves are receiving significant international research attention on their importance as larval production areas through much higher adult numbers, and the subsequent 'export' of larvae out into fished regions where production of larvae may be considerably lower. Modelling of snapper larvae exported from the Leigh Marine Reserve suggests that significant larval subsidies are likely up to 40 km around the reserve depending on larval behaviour and El Niño-Southern Oscillation patterns (via wind forcing effects) (LePort et al. 2014). However, no empirical evidence is yet available for any New Zealand species.

In New Zealand, marine reserves are not considered as part of formal fisheries management frameworks, but they are likely to be a critical part of the tool-box for moving towards more ecosystem based (fisheries) management.

The Type Two MPAs included in this Plan offer significant potential to protect and restore the ecological functioning of important seafloor habitats.

The use of marine reserves to protect important habitat, rather than fished species, has not yet been widely adopted in coastal New Zealand, although a string of marine reserves has been established in Fiordland to protect sensitive invertebrate communities ('china shops') on the fiord walls. There are, however, several examples of closures under fisheries legislation to protect significant fisheries habitat. These include the Separation Point closure in Tasman Bay and the Wairoa Hard closure in Hawke Bay. The setting aside in 1980 of 156 km^2 of seafloor off Separation Point (between Tasman and Golden Bays) to protect the extensive bryozoan fields found there from bottom-impacting fishing methods was a ground-breaking example of benthic habitat management (Mace 1981).

These bryozoan fields were considered to support large populations of juvenile tarakihi, snapper, red cod, John dory, and other species (Saxton 1980a, b). In 1981 the Wairoa Hard was also closed to all commercial fin fishing to protect juvenile fish habitat, in this case seaweeds and sessile invertebrates (sponges, hydroids and horse mussels) (Stevenson et al. 1987). Recent work on the Separation Pont bryozoan fields has shown that the benthic secondary (invertebrate) productivity of this closed area is significantly higher than that of the surrounding areas (Handley et al. 2014), though no equivalent fish surveys have yet been completed (Morrison et al. 2014c,d). Worryingly, evidence is accumulating that this area is now under threat of increasing degradation from land-derived sedimentation (Grange et al 2003, Morrison et al. 2009, Jones et al., in press). Such inter-relationships reinforce the need for this Plan to work on multiple fronts, including strong and fundamental interactions of the biodiversity and fisheries components with the water quality section of the plan.

MPAs can also be used to provide added protection for particular species by protecting areas of importance during vulnerable life-history stages (e.g. spawning and nursery habitats, critical feeding areas, migratory corridors), protecting self-sustaining populations, or providing a buffer from human disturbance or threats. Current examples of species specific MPAs in New Zealand include some places (primarily estuaries) protected under the Wildlife Act 1953, marine mammal sanctuaries established under the Marine Mammals Protection Act 1978, and the whale sanctuary and New Zealand fur seal sanctuary established under the Kaikoura (Te Tai o Marokura) Marine Management Act 2014.

Varying levels of protection may occur within species-specific sanctuaries (e.g. spatial controls on set netting generally do not extend across the full extent of most existing marine mammal sanctuaries) and between them, depending on the species in question. Although the Plan does not contain any specific proposals for species-protection MPAs it identifies objectives for the protection and restoration of populations of vulnerable and at risk species that could lead to the establishment of these in the future. Particular issues of concern identified by the Stakeholder Working Group were the impact of ship strike on Bryde's whales, chronic disturbance of whales and dolphins, seabird foraging and a lack of food for seabirds, the risk of oil spill arising from large commercial vessels navigating through Craddock Channel and between the Mercury and Ohinau Islands and the mainland, and the potential for surface structures to increase the risk of mammalian predators establishing on predator-free islands.

BIODIVERSITY THEMES

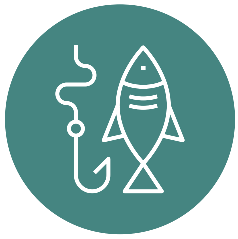
There are three main, inter-related themes incorporated within the biodiversity section of this Chapter:

Ecosystems

Restoring healthy functioning ecosystems throughout the Hauraki Gulf Marine Park including those in freshwater, estuarine, inshore and deepwater areas.

Habitat

Protecting, enhancing and restoring representative and ecologically important habitats throughout the Hauraki Gulf Marine Park.



Species

Protecting and restoring the diversity and abundance of all species within the Hauraki Gulf Marine Park.

Threading through these themes is the underlying need for education and understanding, kaitiakitanga and stewardship to ensure the well-being of the mauri and health of the Hauraki Gulf Marine Park. It is also essential that sustainable economic growth within the Park is based on a healthy functioning marine ecosystem.

We articulate objectives for each of the three biodiversity themes, then propose a series of management actions for reaching these.

WHAT DO WE WANT TO ACHIEVE

Objectives for Theme A

Restoring healthy functioning ecosystems

1. Maintain and restore the quality of ecosystem services provided by the Hauraki Gulf Marine Park, including its estuaries, coastal waters and sea floor habitats.
2. Ensure that all government agencies and sectors consider potential impacts of their activities on the Hauraki Gulf Marine Park's ecosystems as an integral part of their decision-making systems by 2018.
3. Establish a long-term research programme by 2018 focused on better understanding the dynamics of the Hauraki Gulf Marine Park's ecosystems and impacts on them, including comprehensive mapping and description of seafloor habitats within the Park.
4. Establish a monitoring system that measures the ecosystem health of the Hauraki Gulf Marine Park as a whole by 2018.
5. Establish a baseline and achieve measurable improvements in the overall ecosystem health of the Hauraki Gulf Marine Park by 2025.

Objectives for Theme B

Protected, enhanced, and restored habitats

1. Systematically identify by 2018 and protect by 2020 ecologically important marine habitats throughout the Hauraki Gulf Marine Park using a variety of tools including marine reserves, benthic protection areas, customary management tools and other spatial management tools.
2. Restore ecologically significant habitats throughout the Hauraki Gulf by 2040[4].
3. Restore historic ecosystem functionality of bivalve beds by 2040 to recover self-sustaining, expanding, filtering capacity and secondary production.
4. Understand the risk and impacts of marine disposal of spoil on marine biodiversity by 2018 with a view to eliminating any (more than minor) impacts of the activity within the Hauraki Gulf Marine Park by 2025.

Objectives for Theme C

Restored species diversity and abundance

1. Halt any further decline in biodiversity within the Hauraki Gulf Marine Park by 2025.
2. Restore species diversity and abundance so that there are healthy functioning populations within the Hauraki Gulf Marine Park by 2040.
3. Ensure threatened species are not put at risk from fisheries bycatch within the Hauraki Gulf Marine Park by 2025, with a view to eliminating all threatened species bycatch.
4. Understand seabird foraging habits (especially during their breeding seasons) and ensure that there is adequate food supply for Seabirds in the Hauraki Gulf Marine Park by 2025.
5. As far as practicable, eliminate Bryde's whale ship strike from the Hauraki Gulf Marine Park by 2025.
6. Avoid any increase in human disruption of the Bottlenose dolphin population in the Hauraki Gulf.
7. Significantly increase the amount of freshwater habitat that can support healthy populations of Eel and Whitebait species (Link to catchment management plans) by 2020. Actively manage all populations of threatened species in the Hauraki Gulf Marine Park so that they all exhibit a stable or increasing population trend within three generations (of each species).

4 Objectives to restrict and remove destructive fishing methods can be found in the Fish stocks Chapter.

HOW WILL WE DO IT?

Management actions for Theme A – Restored healthy functioning ecosystems

Ecosystems-based decision-making

1. Develop guidance material on how an ecosystem management/Mātauranga Māori management approach should be applied to fisheries, conservation and resource management decision-making in the Hauraki Gulf Marine Park and its catchments by 2018.
2. Require agencies to report progress to the Hauraki Gulf Forum, every two years, towards applying an ecosystem/Mātauranga Māori management approach. If significant progress in applying the approach has not been made after four years (i.e. two reporting periods) consider applying a stronger regulatory approach to achieve the change required.

Ecosystem research **(Link to Fish Stocks and Water Quality)**

3. Develop a 10-year Hauraki Gulf Biodiversity Research Plan by 2018 to enable better understanding of:
    - Current gaps in information by undertaking a Gulf wide desktop gap analysis;
    - All inshore and offshore habitats through comprehensive habitat mapping and description;
    - Interrelationships between habitats and species;
    - Links between Shorebirds and Seabird foraging behaviour, state of fish stocks and other environmental indicators;
    - Ecosystem services provided by different habitats and species;
    - Cumulative impacts of pressures on the wider Gulf system;
    - Impacts of anthropogenic light on marine species;
    - Impacts of anthropogenic sound on marine species.
4. Coordinate and source funding to enable the Hauraki Gulf Biodiversity Research Plan to get underway by 2018 through:
    - Integrating Gulf research projects into existing research programmes;
    - Focusing and coordinating local and central government research funding into Hauraki Gulf Marine Park priorities;
    - Partnering with Universities to focus academic and student research on ecosystem projects within the Hauraki Gulf Marine Park;
    - Working with the Ministry of Business, Innovation and Employment (which provides government research funding) to include Hauraki Gulf Marine Park ecosystem research into public good science funding programmes; and
    - Philanthropic funding.

Management actions for Theme B – Protected, enhanced, and restored habitats

5. By 2020, establish the MPAs identified in this plan following a process of consultation with mana whenua, local communities and stakeholder groups.
6. By 2018, identify any gaps in the MPA network with specific attention to Waiheke Island and Aotea – Great Barrier Island. Establish further MPAs if required[5].
7. Initiate a research programme to understand the impacts (including contaminants and invasive species) of the marine dumping of spoil on the Hauraki Gulf including dumping outside of the Hauraki Gulf Marine Park Boundary (e.g. over the edge of the continental shelf) and to investigate alternative disposal options including on land.
8. By 2018 Identify freshwater and estuarine areas suitable for restoration (i.e. riparian habitat) and initiate a programme of actions to achieve long-term restoration.
9. Develop and test innovative ways of restoring degraded habitats, and protecting these areas, involving mana whenua and community groups.

5 The Stakeholder Working Group was approached by community representatives from Waiheke and Aotea (Great Barrier) seeking that marine protected areas be included in the Plan for both islands. Because the SWG also heard conflicting views and concerns at not being consulted regarding proposals it was considered more appropriate for the location of MPAs for the two islands to be decided by those communities as part of the implementation of Sea Change.

Management actions for Theme C – Restored species diversity and abundance

Shorebirds and Seabirds

10. Maintain the mammalian predator-free status of all predator-free islands in the Hauraki Gulf.
11. Establish a collaborative working group to report and advise on the status of Seabird and Shorebird populations and important breeding sites within the Hauraki Gulf Marine Park, including any adverse impacts, management actions and research affecting these. The work of this group will include:
    - Reviewing National and Regional Marine Oil Spill Contingency Plans with respect to the protection of Seabird and Shorebird populations in the Hauraki Gulf Marine Park from the adverse effects of oil spill by 2019; and identification of industries that need to specifically consider potential effects on Shorebirds and Seabirds in their Site Marine Oil Spill Contingency Plans by 2020.
    - Assessment of the risk to Seabird and Shorebird populations posed by the wreck of the Niagara by 2020.
    - Review of the risk to Seabirds posed by ongoing public access to Pokohinu/Burgess Island, Mokohinau Islands by 2019, including agency contingency planning for predator incursion and fire.
    - Prioritisation of the research recommendations in Gaskin & Rayner 2013 (Seabirds of the Hauraki Gulf: Natural History, Research and Conservation)
    - Development of priority management actions and research for Shorebirds by 2019.
12. Work towards the elimination of all Seabird and Shorebird by-catch in fisheries by:
    - Increasing camera or in-person observer coverage to all commercial fishing vessels operating in the Hauraki Gulf Marine Park to improve bycatch information.
    - Implementing a programme to better estimate recreational fishing Seabird bycatch.
    - Supporting ongoing refinement, improvement and uptake of Seabird mitigation measures.
    - Significantly up-scaling existing programmes focused on education and outreach targeted towards recreational fishers to reduce Seabird bycatch.
    - Investigating the effectiveness and feasibility of spatial and/or temporal closures when most at-risk Seabirds are foraging and breeding within the Hauraki Gulf.
13. Improve the quality of seabird and Shorebird terrestrial habitat by:
    - Identifying terrestrial areas of importance to threatened Shorebirds and Seabirds by 2020.
    - Increasing legal protection for roosting and nesting sites for Seabirds on beaches and coastlines.
    - Maintaining existing predator control programmes at high priority mainland sites, and extending these by encouraging and supporting local communities to undertake effective predator control for lower priority (less threatened) species.
    - Coordinating and supporting community-led projects aimed at protecting and restoring important habitats that benefit Shorebirds and Seabirds by 2025.
    - Regularly monitoring reproductive success of Seabirds and Shorebirds.

Bryde's whales

14. As far as practical work towards eliminating Bryde's whale deaths by ship strike through the following actions:
    - Support the voluntary protocol to reduce the speed of ships travelling through the Hauraki Gulf, with a target to keep speeds to no greater than 10 knots on average, acknowledging that there needs to be some flexibility to allow for oceanographic variation such as tides and other exigencies.
    - Continue regular monitoring of the speed of ships transiting the Hauraki Gulf Marine Park (currently undertaken voluntarily by the International Fund for Animal Welfare - IFAW).
    - Undertake necropsies of all dead Bryde's whales, subject to mana whenua consent, to identify the cause of death.

- In the event of further Bryde's whale deaths due to ship strike, or the above target not being met by 2018, convene a meeting of the Bryde's Whale Collaborative Group to examine what further action, if any, is necessary.
- Support ongoing Bryde's whale research to provide a better understanding of the distribution and movements of the Whales and threats to them.

Bottlenose dolphins

15. No new permits should be issued to approach and interact with Bottlenose Dolphins within the Hauraki Gulf Marine Park, including swimming with the Dolphins.
    - All existing permits that authorise interaction with Bottlenose Dolphins within the Hauraki Gulf Marine Park should exclude interactions with Bottlenose Dolphins when next reviewed.
    - Establish and fund a monitoring programme to identify any adverse effects of the exercise of the current marine mammal tourism permits in the Hauraki Gulf Marine Park.

Diadromous fishes[6] (including Whitebait and Eels)

16. Initiate a programme by 2018 to identify and progressively remove barriers to the movement of diadromous species by:
    - Constructing fish passages where needed; or
    - Where required, modifying infrastructure to remove the obstacle (recognising that this may not be practical in tidal areas or for flood control structures) to fish movement.
17. Ensure all new structures affecting freshwater systems provide for fish passage where possible (recognising that this may not be practical in tidal areas or for flood control structures).
18. Increase spawning areas for diadromous species by:
    - Identifying (and where required assisting with) restoring īnanga spawning habitat in key areas (link to restoration in catchment plans).
    - Working with landowners to increase understanding of the issue and to develop migration route and riparian habitat restoration plans for private properties.

6 A general life history category describing fishes that spend different parts of their life cycles in fresh water and sea water.

Figure 6.7 Experiencing marine reserves (top-bottom): snorkelling around mangroves in an estuarine marine reserve at high tide; populations of fished species such as Snapper (*Pagrus auratus*) and Rock Lobster (*Jasus edwardsii*) recover and become more accessible within MPAs.

MARINE PROTECTED AREAS

MPAs are a form of passive restoration. By closing off areas to external pressures, or removing a particular activity, the area may be able to naturally regenerate. The six existing marine reserves in the Hauraki Gulf provide a window into the recovery potential of marine ecosystems.

A common theme highlighted in the Listening Posts was a concern for declining species and habitats, and a clear desire for more marine reserves. A parallel result came from an Auckland Council People's Panel survey published in 2014 which showed that 39% of respondents had visited a marine reserve in Auckland, whereas only 24% had fished in the ocean. These results, along with extensive ecological analysis, led the Stakeholder Working Group to conclude that we had a clear mandate to recommend creation of more MPAs.

Marine Protected Area objectives

- Establish a network of MPAs to assist the protection and passive restoration of at risk, high value and representative ecosystems in the Hauraki Gulf Marine Park and to boost the abundance of fish stocks.
- Create a nested approach with MPA establishment, which recognises that some areas should be heavily restricted in the uses allowed to best enable ecosystems to recover (no take other than for customary harvesting purposes – by special permit on a case by case basis[7]). These no take areas should generally be nested within larger areas that allow greater levels of recreational and commercial activity whilst protecting the benthic habitats from damaging human activities.
- Establish continuous in-shore co-management areas for the Hauraki Gulf Marine Park. These, for the most part, would extend from Mean High Water springs (the high tide mark) out to 1km. In some places they would extend further out to take in significant fisheries or places, or to edge-protect MPAs. This is discussed in more detail in the Ahu Moana Initiative, and later in this chapter.

Types of MPAs

There are four types of Marine Protected Area:

- Type 1: no take marine reserves (other than for customary purposes on a case by case basis by special permit[7]).
- Type 2: benthic protection (restrict all commercial and recreational fishing methods that impact on the benthic habitat).
- Special Management Areas (SMA, no commercial fishing allowed and restricted recreational fishing allowed).
- Ahu Moana (mana whenua and community co-management areas).

Type One MPAs (no take marine reserves other than for customary purposes[7])

Purpose: To protect, enhance and restore the full range of marine communities and ecosystems and outstanding, rare, distinctive or nationally important marine habitats in order to protect the mauri of the Hauraki Gulf.

Objectives of Type One MPAs

1. Set aside places where mana whenua and communities want to experience abundance and diversity of marine and coastal life.
2. Conserve and protect cultural and spiritual values and practices associated with nature according to tikanga such as solitude, protection of wāhi tapu, and connection to tupuna.
3. Identify and protect the full range of marine communities and ecosystems with high biodiversity value by 2020.
4. Identify and protect enough of each habitat type to ensure ecosystem integrity and resilience.
5. Through these areas develop a baseline to better understand the ecological integrity of ecosystems within the Hauraki Gulf Marine Park including progressing the knowledge on impacts of human activities.
6. Provide reference areas for marine research, monitoring and education.
7. Provide opportunities for the enjoyment of restored marine environments through education, and sustainable recreation and tourism.

Design and management principles for Type One MPAs

The following design and management principles apply to all new MPAs located within the Hauraki Gulf Marine Park:

- Mana whenua, local communities and stakeholders will take a leading role in the implementation phase through a co-design process. In addition, there needs to be early engagement with adjacent land owners.
- Adverse impacts on the commercial fishing sector of creating protected areas need to be addressed.
- Co-governance and co-management of protected areas will be put in place once they are established.
- There should be provision for customary take in protected areas (see explanation below).
- Any concessions granted within the protected areas will be non-exclusive.
- A 25-year generational review is to be undertaken for each new protected area.
- In some of these proposals two options have been given where the SWG was unable to reach consensus on one. Where there are two options we expect the local community to be fully engaged with a sufficient level of support.
- The establishment of all MPAs will be subject to engagement with and gain a sufficient level of support from local community.

Customary take in Type 1 MPAs will be on a case by case basis by special permit. There are two perspectives on how to approach the 'case by case basis by special permit' principle, which are set out below:

- Mana whenua's support for Type 1 MPAs is based on a presumption that customary take can occur in any protected areas, where permits are issued by kaitiaki, unless rāhui or other agreed closures are in place. Inherent in the concept of kaitiakitanga is respect for an area, its biota and the need for its preservation or protection. Kaitiaki have and will continue to exercise discretion and judgment over the issuing of permits or not for a particular area and/or species.

7 Customary take or harvest to be on a case by case basis by special permit – refer to the discussion above

- Other stakeholders support for Type 1 MPAs and other aspects of the Marine Spatial Plan is based on the presumption that while provision should be made for customary take in a Type 1 MPAs, this will be on a case-by-case basis by special permit as reflected in the current legislation. This issue should be addressed in the co-design process with mana whenua, communities and stakeholders prior to the establishment of each MPA. The mechanism for the authorisation of any customary take should also be developed though that process.

Type Two MPA – benthic protection

Purpose: Maintain, restore and protect ecologically important habitat while allowing for compatible uses.

Objectives of Type Two MPAs

1. Identify, restore and protect key habitats (e.g. biogenic habitats) in order to maintain the integrity of ecosystems and their functioning by 2020.
2. Significantly increase the productivity of the Hauraki Gulf Marine Park by 2035.
3. Exclude activities (e.g. dredging, bottom trawling, Danish seining, dumping and sea bed mining) that damage habitats by 2025.
4. Potentially serve as a buffer to areas with a higher level of protection (thereby implementing a nested approach).
5. Potentially support restoration projects.

Special Management Areas (SMAs)

Special Management Areas are designated as protected for almost all species and habitats, while allowing for carefully managed and targeted sport fishing of several high value sport fish species under a 'small volume, high value' harvest regime[8]. Their dual purpose is to protect the integrity and healthy functioning of the system, while also allowing for a high value economic activity (sports fishing) to create economic returns. Other high-value economic activities, such as diving and eco-tourism, are also encouraged.

Objectives of Special Management Areas

1. For destinations such as the Mokohinau and Alderman archipelagoes, use as a management tool to protect the biodiversity present, while also allowing for low impact, high value sport fishing for selected species and diving experiences to occur.
2. Promote nationally and internationally as a remarkable experience where the benefits of protection combined with far thinking management can be showcased to a wide audience.
3. Provide for employment and economic activity for communities and areas where these opportunities are limited and highly valued.

Ahu Moana – mana whenua and community co-management areas

Described previously in the Ahu Moana initiative, these co-management areas are intended to provide for adaptive management of the coastal and mainly near-shore environments.

In accordance with Māori practices, Ahu Moana do not permanently close off areas, but allow for dynamic management. While their starting point is that commercial and recreational fishing is allowed, Ahu Moana provide the ability for the prohibition of fishing or particular harvest methods, or the temporary closure of areas to allow species or habitat restoration. This is expected to result in more responsive management than currently provided by fisheries and marine protection legislation, where responses (for example closing local tuangi/cockle beds) require high level engagement with Crown departments, and can take years to put in place.

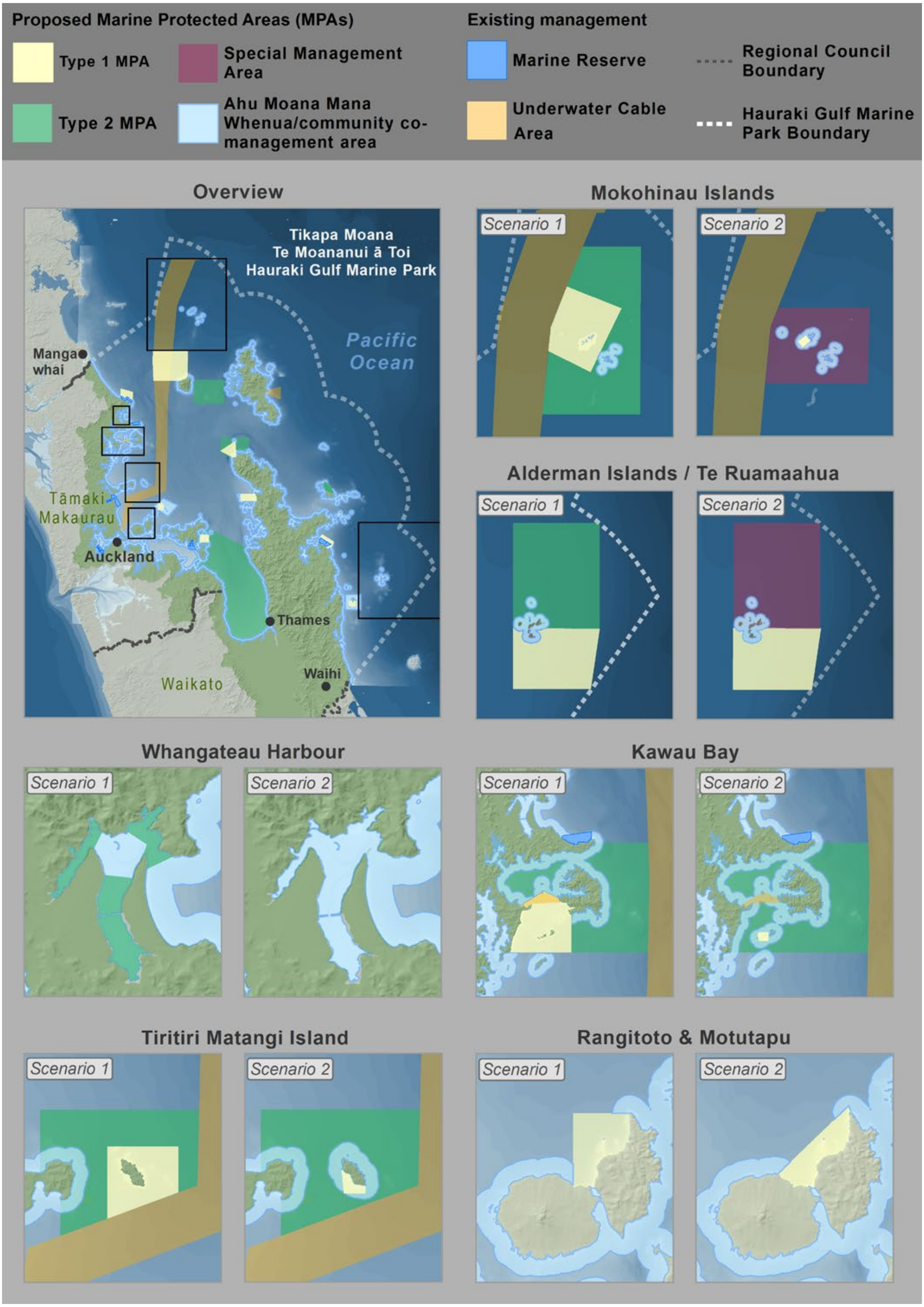
Importantly, Ahu Moana are intended to be used as korowai (cloaks) to wrap around other types of MPA, buffering them from the edge pressures previously described.

Proposed MPA network

Fifteen MPA sites have been identified across the Hauraki Gulf Marine Park. All of these were identified for their habitat and ecological values, and were based on the information provided by our science advisors. Nine Type 1 marine reserves and ten Type 2 benthic protection areas were agreed and recommended by the SWG.

Five areas - Mokohinau Islands, Tiritiri Matangi, Kawau, Motutapu / Rangitoto, and the Alderman Islands - were also agreed and recommended by the SWG as areas that would benefit from protection, but a decision was not reached on a single size, location, or shape for the Type 1 MPAs and which other type

8 While the SWG has agreed to put forward proposed SMAs, they were not fully supported by every SWG member.



Map 6.2 Overview map of proposed MPA network and two scenarios sets. See Appendix 3 for detailed MPA maps shown in the overview.

of protection would be applied. The SWG members arrived at two options for each of these areas, which include both Type 1 MPAs as well as Type 2 protection. A different option, at the Alderman Islands, is Scenario 2, which provides for an SMA (no commercial fishing with restricted recreational fishing) bordering a Type 1 MPA. As well, the Whangateau Harbour has two options for co-management between mana whenua and the local community. In order to gain consensus or sufficient support to select and progress one of the options, discussions with mana whenua and local communities will be required for all these areas.

MARINE DEBRIS

Marine debris includes litter as well as discarded or lost fishing gear, aquaculture equipment, abandoned vessels and structures, flotsam (floating wreckage of a ship or its cargo) and jetsam (part of a ship, its equipment or cargo that is purposely cast overboard). The adverse impacts of marine debris include death of marine life caused by ingestion and entanglement, changes to the integrity and functioning of habitats, release of toxins into the food chain, degradation of the amenity value of beaches and waterways, hazards to navigation, and as a vector for introduced species (both terrestrial and marine).

While lost or abandoned fishing gear may affect ecosystems for months or even years, the amount of litter entering the marine environment is a significant, and growing, global problem. The vast majority of debris entering the marine environment is from diffuse land-based sources. Although deliberate dumping does occur, litter is primarily transported to the sea in storm water and by the wind.

Plastic litter is of particular concern due to its environmental persistence, large volume, chemical composition, and widespread dispersal. Plastics photodegrade in UV light but do not bio-degrade, so they persist in the environment. Seabirds that feed on small prey near the surface can mistakenly ingest plastic pellets floating on the water. When ingested, plastics, particularly microplastics and fragmented items, weaken and kill Seabirds through starvation and false feelings of satiation, irritation of the stomach lining, and failure to put on fat stores necessary for migration and reproduction. Globally over 170 marine species are known to ingest plastic debris. Within the Hauraki Gulf Marine Park there has been very little research on the adverse effects of marine debris, however a recent study of six east coast North Island offshore islands found large amounts of plastics associated with flesh-footed shearwater burrows on Ohinau Island, Coromandel Peninsula.

As regurgitated plastics were not found around the burrows of Seabirds that forage closer to shore, it was suggested that the shearwaters may be picking plastic up as far away as the southeast Pacific Ocean. Within the Hauraki Gulf Marine Park, most of the debris found along the coastline of the inner islands is plastic from domestic sources, followed by glass and aluminium, whereas commercial fishing and other marine based activities contributed a much larger proportion of the debris found on the outer islands.

Of principal concern to the community is the potential contamination of the marine food chain by plastic litter. Plastics are consumed by fish and the chemical components are absorbed into the flesh of the animal, which can end up affecting human health through exposure to carcinogens (cancer causing chemicals) and endocrine disrupters (which negatively affect human development).

Marine debris objectives

1. Reduce the quantity of marine debris generated.
2. Improve the collection and removal of marine debris within stormwater and marine systems, including particular risk items such as fisheries debris and shipwrecks, where appropriate.
3. Improve the understanding of the sources and impacts of marine debris on wildlife and the food chain.
4. Support existing organisations which are raising awareness and working to clean up marine debris in the marine environment

Management actions

1. By 2018, source funds for a public-education campaign on litter in the marine environment. This could include signage at popular beaches and boat ramps and on bait bags, and the use of digital and social media to inform and educate the public.
2. By 2018, develop and implement a comprehensive framework for evaluating and monitoring progress with reducing litter and other marine debris.
3. By 2019, complete a formal desktop review using best local and international knowledge on the risks of contamination of the food chain from plastic marine debris, and develop further actions as necessary based on the findings of the research.
4. By 2020 develop research priorities for improving understanding of the sources and impacts of marine debris on marine life and the food chain within the Hauraki Gulf Marine Park.

BIOSECURITY

Introduced marine species (termed Non Indigenous Species) pose a serious threat to marine ecosystems throughout the Hauraki Gulf Marine Park. The Hauraki Gulf is a major point of entry and departure for international vessels, and a central hub for recreational vessels and the maritime transport industry. The Hauraki Gulf Marine Park therefore presents a major initial point of entry for marine pests and diseases into New Zealand's waters, followed by subsequent transport to other regions as the species gains a foothold and then expands its distribution. The persistent spread of the marine pest Mediterranean fan worm (*Sabella spallanzanii*) throughout New Zealand is an example.

Figure 6.8 Invasive, non-indigenous marine species.

Examples of invasive, non-indigenous marine species. Upper right to left: club tunicate (*Styela clava*), the green seaweed (*Caulerpa taxifolia*), Chinese mitten crab (*Eriocheir sinensis*); Centre right to left: Australian droplet tunicate (*Eudistoma elongatum*), Northern Pacific seastar (*Asterias amurensis*), European shore crab (*Carcinus maenas*); Lower right to left: Mediterranean fan worm (*Sabella spallanzanii*), overbite clam (*Corbula amurensis*), wakame (*Undaria pinnatifida*).

In addition to shipping, there are various other human activities within the Hauraki Gulf Marine Park that contribute to the spread of marine invasive species, including activities related to aquaculture, and numerous recreational and tourism activities (both land-based and at sea). At least six non-indigenous species with the potential to cause serious harm to the marine environment have already become established in the Hauraki Gulf Marine Park, with five of these arriving in the past 15 years. Another four new species have been reported since 2011, one of which (the Mediterranean fan worm *Sabella spallanzani*) is a high risk species capable of causing serious problems. Since arriving, it has become widespread, including on artificial structures such as wharf pilings and pontoons, in the limited subtidal seagrass areas between Meola Reef and the Harbour Bridge, around Tāmaki Strait, and on Firth of Thames aquaculture structures, as well as being established in east Northland and in the Lyttleton Port. Individuals have also been detected in the Tauranga, Gisborne, and Nelson harbours.

Currently there are more than 141 non-indigenous marine species known to occur in the Hauraki Gulf Marine Park. Many of these have been present for decades without any significant known (positive or negative) impacts to economic, ecological, recreational, social and cultural values and/or human health. However, some have spread significantly and do have impacts, both positive and negative, depending on their abundance and the existing values in the affected area. An example of a positive impact for aquaculture is the economic value of farmed Pacific Oysters (*Crassostrea gigas*). However, from an environmental perspective, this species has come to dominate many intertidal estuarine reefs, displacing native rock Oysters and other species, and causing silt to accumulate. In some extreme cases, reefs have been encased by a metre or more of thick dead shell. In soft sediment upper estuarine areas, they have overgrown most of the hard surfaces available, increasing the trapping rate of fine sediments, and causing issues to both recreational users (swimming, fishing, boating) and commercial users (net fishing, silting up of navigation channels). This species is now a dominant non indigenous species globally, and is continuing to expand its distribution.

Other economically valuable species include the Greentail Prawn (Metapenaeus bennettae) detected in the Waitematā Harbour and Tāmaki Strait, and the large Mantid Shrimp (Oratosquilla oratoria), currently confined to the Kaipara and Hokianga harbours on the west coast.

Examples of negative effects include ecological impacts through competition for food and space with native species, economic impacts for the aquaculture industry through fouling, spreading disease, and impacts on recreational and cultural values by changing habitats. Our current knowledge of the ecological impact of non indigenous species on native species and assemblages is very rudimentary. We know from terrestrial and international examples that impacts on natural ecosystems can be profound. In some cases, species may ‘sit quietly’ for a number of years without any major impact, but then change their interactions and rapidly emerge as a major issue. Asian date Mussels might be such a species; when first detected they were assessed and thought to be relatively benign and localised (Creese et al. 1997). However, since then it has been found as extensive ‘carpets’ in parts of Tāmaki Strait and surrounds (see figure below, from Morrison et al. 2014b), where few other species appear to be able to co-exist with it. It is now a dominant component of adult Snapper diets in the inner Hauraki Gulf and Waitematā Harbour (Lohrer et al. 2008). Of note, it also forms very extensive monospecific beds in the Kaipara Harbour, with few other species aside from large numbers of 11-armed Starfish preying on them. However, at some limited locations date Mussels support dense beds of an invasive *Gracillara* sp. (a red macro-algae), which in turn appear to facilitate high numbers of juvenile Snapper (i.e., acts as a nursery habitat, Morrison et al, in prep.). Such different impacts at different locations highlight the ecological complexity of the non indigenous species issue.

Figure 6.9 Mediterranean fan worms growing on native green shell mussels (*Perna canaliculus*)

Figure 6.10 Mediterranean fan worms

Mediterranean fan worms attached to the hull of a boat; invasive species can be rapidly transported over large distances on the hulls of vessels, as well as on contaminated materials and equipment

Other well-known marine invasive species in the Hauraki Gulf Marine Park include the clubbed tunicate (*Styela clava*), Asian paddle crab (*Charybdis japonica*), and the Asian seaweed *Undaria pinnatifida*.

Once established, the eradication of non-indigenous marine species is extremely difficult or impossible, and very expensive. There have been no successful complete eradications of marine pest species in New Zealand. Therefore, more stringent control measures are required to prevent non-indigenous marine species from entering the country (State of our Gulf 2014).

To be able to address negative impacts of marine invasive species there is a need to:

- Better understand the presence and distribution of non-native marine species within the Hauraki Gulf Marine Park.
- Understand the impacts (ecological, economic, recreational and cultural) of these species.
- Use existing tools and methods to detect, eradicate or control impacts of established species and develop new tools and methods in the future.
- Reduce the risk of the introduction of new species or further spread of established species through pathway/vector management.

Figure 6.11 Asian date Mussel (Arcuatula senhousia)

Above bottom: Asian date Mussel (*Arcuatula senhousia*); Top: extensive mat of Asian date Mussels in Tāmaki Strait, inner Hauraki Gulf, about 10 m water depth, June 2008. (Source: Ministry for Primary Industries and J. Williams, NIWA)

Biosecurity objectives

The overall goal is to identify, manage and mitigate threats to the Hauraki Gulf Marine Park from pests and diseases through prevention, early warning and detection, eradication, and control measures. Specific objectives to achieve this goal for marine biosecurity are:

1. By 2020, develop pathway management plans and pest management plans to prevent the arrival and further spread of new and existing species and diseases, especially to high value areas.
2. By 2020, increase regional monitoring and surveillance efforts to be able to detect and respond quickly to new introduced species.
3. Where feasible, eradicate or control present species using available and evolving tools and methods.
4. Increase stewardship through an informed and engaged industry and public.

The Biosecurity Act 1993 regulates biosecurity management within the Hauraki Gulf Marine Park. One of the provisions in the legislation (section 52) requires permission to be obtained from the chief technical officer before an activity can be undertaken which spreads a species identified as 'unwanted'. This requirement has unwittingly impeded the transport of Mussels within the Hauraki Gulf Marine Park, as part of Mussel restoration projects, as the Mussels sourced from marine farms host 'unwanted species'. Given the importance of Mussel reef restoration to the Park, a solution to this issue needs to be found as a matter of urgency.

Management actions

Strengthening co-ordinated regional action

1. Central government agencies and councils are to provide coordinated management and funding to support biosecurity efforts on existing pest free islands (e.g. Treasure Islands work) and enhance eradication programs for other islands and mainland areas within the Hauraki Gulf Marine Park by 2020.
2. Expand the *Top of the North* Partnership[9] to include industry and key stakeholders with a goal to produce and implement a Marine Biosecurity Strategy by 2018. This strategy should cover prevention, early warning, eradication and control measures.
3. Develop regional pathway management and pest management plans by 2020, and implement by 2025, through the Top of the North Partnership, acknowledging and building on existing initiatives and ensuring alignment with (the development of) national pathway management plans[10].
4. Establish a regional surveillance programme by 2018 to complement existing national surveillance.
5. Investigate the utility of using existing monitoring programmes to pick up new marine introductions, taking into account the different monitoring techniques required to sample different (artificial) substrates.
6. Coordinate monitoring efforts between regions, including sharing resources and combining funding.
7. Increase assistance provided to marine users to identify and report specific non-native marine species, and create a central portal for monitoring and publishing results.
8. Promote voluntary measures to reduce biosecurity risks in the absence of regulatory tools.

Eradicating or controlling species

9. Support the development of new tools and methods to eradicate or control unwanted species, taking into account (evolving) overseas initiatives.
10. Encourage the take of non-native marine species not listed under the Biosecurity Act and support feasibility studies into the viability of commercial extraction of marine pest species (e.g. Asian paddle crab).

Increasing stewardship

11. Support current education and awareness programmes and initiatives (e.g. by providing funding) and carry out regular coordinated education campaigns targeting sectors such as the recreational boating community, marine farmers, marina operators, and tourists participating in marine activities[11].
12. Establish a coordinated information network on marine pest species management.

Enabling mussel and other restoration projects

13. By 2017, identify and implement an effective solution to the current obstacles created by the Biosecurity Act which are impeding Mussel reef restoration projects within the Hauraki Gulf Marine Park.
14. Coordinate and source funding to support marine biosecurity initiatives in the Hauraki Gulf Marine Park through for example:
    - Integrating Hauraki Gulf research projects into existing research programmes.
    - Focusing and coordinating local and central government research funding into Hauraki Gulf priorities.
    - Partnering with universities to focus academic and student research on Hauraki Gulf ecosystem projects.
    - Including Hauraki Gulf ecosystem research into public good science funding programmes.
    - Philanthropic funding.
    - Applying a user fee for users of marinas and ports.
    - Craft Risk Management Strategy 2018.

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9 Department of Conservation, Ministry for Primary Industries, Northland Regional Council, Waikato Regional Council, Auckland Council, Bay of Plenty Regional Council and Gisborne District Council coordinate on marine biosecurity matters

10 Examples of topics that should be included are consistent management plans for marinas and ports, rules around managing mooring zones, measures to address risks related to hull fouling (e.g. mandatory cleaning of boat hulls and equipment and regular hull inspections), measures to address biosecurity threats related to aquaculture activities (e.g. movement of aquaculture gear, barge cleaning, discharges from processing facilities, transmission of diseases and pathogens to wild populations), and measures to control imports of products (e.g. freezing times/temperatures for bait to kill parasites/viruses/bacteria)

11 Examples of activities include signs at boat ramps, tackle shops, and boat maintenance shops, presentations at marina's and community facilities include aquaculture industry.

PLACE STUDY:
NGĀTI REHUA NGĀTIWAI KI AOTEA - TAIKO (BLACK PETREL) RESTORATION

Kia mau i ngā taonga tuku iho	*Together we can move mountains*
Kia kaitiaki o to tātou Ao Māori	*We are our own best champions*
Kia whai ki tōu tatou mana Motuhake	*Economic independence and profitability*
Kia eke ki te karamatamata o te rākau	*Social responsibility and participation*

Ngāti Rehua Ngātiwai ki Aotea is a hapū of Ngāti Wai. Aotea, Great Barrier Island, is their ancestral land. Ngāti Rehua are tangata whenua and mana whenua of Aotea, Hauturu, the Pokohinu Islands, Rakitu, Rangiahua and other outlying islands and rocky outcrops.

Within the Ngāti Rehua Ngātiwai ki Aotea Trust Hapū Management Plan, the hapū has identified environmental consultation requirements. One of these, in particular, is the provision for opportunities for Ngāti Rehua Ngātiwai ki Aotea to be involved in the integrated management of natural resources in ways that:

- Recognise the holistic nature of Ngāti Rehua Ngātiwai ki Aotea world views.
- Recognise any protected customary right in accordance with the Marine and Coastal Area (Takutai Moana) Act 2011.
- Restore or enhance the mauri of freshwater and coastal ecosystems.

In November 2015, as part of this inspirational objective, Ngāti Rehua Ngātiwai ki Aotea and Southern Seabirds Solutions organised the first formal blessing and welcoming ceremony for the Tāiko/Black Petrel which is Aotea/Great Barrier's most iconic species. Tāiko are Seabirds that migrate 10,000 kilometers each year from Peru to their home nesting burrows on Hirakimata (Mt. Hobson). Apart from a few on Hauturu/Little Barrier Island, Tāiko nest nowhere else – Aotea is its island. Unfortunately, Tāiko are in dangerous decline and in serious need of protection.

Tangata Whenua welcomed manuhiri (guests) including the World-Wide Fund for Nature, Southern Seabirds, Haruaki Gulf Forum, Forest and Bird, the Great Barrier Island Environmental Trust, the Local Board, Ōkiwi School, media representratives and others. About 50 people climbed beyond Windy Canyon through the mist-shrouded forest to the sound of Ngāti Rehua's ceremonious welcoming. Representatives from the Hauraki Gulf Marine Park's fishing industry attended and explained how they now educate fishing staff, and have measures in place to prevent Tāiko mortality while fishing. Students from Ōkiwi school gently sang waiata to the Tāiko, as a male bird found in his burrow was handled by skilled hands and shown to everyone.

Figure 6.12 Nicola McDonald, Chairperson of the Ngāti Rehua Ngātiwai ki Aotea Trust Board and Chris Howe, Conservation Director (NZ) for World Wildlife Fund cut the Tāiko welcome cake (Source. Ngāti Rehua Ngātiwai ki Aotea Trust)

Ka hoki te manu tāiko ki uta
Ka hoki te manu tāiko ki tai
Hoki mai ra ki Hauturu ki Aotea
He kōhanga ki te tihi o Hirakimata
He hua manu ki te ao
E tāiko e

Soar above the land o Tāiko
Soar out to sea o Tāiko
You shall return to Hauturu and Aotea
To nest again at Hirakimata (Mount Hobson)
And give birth to the world once again o Tāiko

The kōrero was concluded by Rodney Ngawaka stressing the significance of the maunga to tangata whenua and their desire to see increased Tāiko numbers and a functional food-chain supporting them. This ceremony for Tāiko was a significant, positive step along the way to halting the decline of this bird.

Sea Change endorses the goals of restoring biogenic reefs to the Firth of Thames, Tāmaki Strait and the Waitematā Harbour to improve water quality and provide habitat, and the restoration of Seabird populations; and supports projects such as the Revive our Gulf, the Ngāti Whātua Ōrākei, Ngāti Rehua Ngātiwai Ki Aotea restoration projects, to achieve these goals.

Figure 6.13 Bottom - Kawa Marae, Aotea. Above - Ngāti Rehua whānau handle a juvenile and adult tāiko. (Source. Ngāti Rehua Ngātiwai ki Aotea Trust)

7. WATER QUALITY

ORANGA PŪMAU O TE WAI

Integrated Catchment Management
"Ki Uta Ki Tai" (mountains to the sea) is a holistic way of managing ecosystems within the Hauraki Gulf Marine Park.

Water quality is one of the greatest areas of concern affecting the health and mauri of the Hauraki Gulf Marine Park. Water quality is degraded in some parts of the Hauraki Gulf, however, there are many other parts for which there is not enough information to draw conclusions on the current state. This lack of information is a risk.

The most common known causes of water quality degradation trace back to contaminants that are washed from the land into the coastal marine area through freshwater runoff. These contaminants include sediments, nutrients, heavy metals, and microbial pathogens. Poor water quality impacts virtually all uses and values associated with the Hauraki Gulf Marine Park. It is therefore vitally important that we identify the causes and effectively address them, in order that healthy water quality is restored where it is currently degraded.

Mana whenua consider the state of the moana as an imbalance caused by humans. Tikanga requires that appropriate action is taken to restore balance. This is expressed as take–utu–ea, meaning that when events result in an injury a response commensurate with the scale of the offending action is required, in order to return to a state of equilibrium. In this case, the issue is the state of the Hauraki Gulf Marine Park, a response is needed to restore the mauri.

Although there have been considerable efforts to address water quality issues in recent years, these have not been sufficient to cope with the scale of the problem. A step change in effort is required if the current situation is to be turned around. There remains a great deal to be done!

This Chapter describes four categories of contaminant that are together significant contributors to water quality problems in the Hauraki Gulf Marine Park. Accordingly objectives and actions are presented for the water quality themes of sediment, nutrients, heavy metals, and microbial pathogens.

While each of these main drivers of water quality is considered separately, we recognise that, in reality, there are many overlapping causes and solutions, so that an integrated approach to catchment management is ultimately required. This section identifies the desired future state for water quality and the actions that we need to take to get there. The objectives for each of the four themes are explained in detail, and supporting information provided, in Appendix 4.

Figure 7.1 Port Jackson

A selection of quotes from members of the public at listening posts

Hamilton

With the Hauraki Gulf Marine Park it's about what's coming down the catchment. Look at the land that drains into it. It's rare through land based exercises that someone says 'what about the impact on the Hauraki Gulf Marine Park or the marine environment?' The commissioners don't mention the impact. Get the land aspect right, what's draining into the Hauraki Gulf Marine Park, and you'll get the rest right.

Thames

Ensure the waterways into Tīkapa and indeed all moana are controlled and managed in a way that ensures the protection of all waterways, particularly activities that occur on farmlands and ngahere that might threaten our waterways.

Maraetai

I think the little things matter – the Whitebait, the Cockles. That means land use is important – say for īnanga to follow their life cycle. If we control sediment, we get water clarity for filter feeders especially where both sides of a channel have a bit of protection (planting). From the little things, the big things are sustained – a good paddock gives good seabeds.

Whitianga

Water and land for me are inseparable.

THEME A. SEDIMENT

What is the problem?

Excessive sediment runoff from the land is the main cause of degraded marine habitats in estuaries, harbours and the Inner Hauraki Gulf.

Our **overall goal** is to reduce sediment entering the coastal marine area to levels which support healthy marine habitats. This will, in turn, support more abundant marine life and fish stocks and provide greater opportunities for people and communities to enjoy the Hauraki Gulf Marine Park.

What do we need to achieve?

Our objectives for sediment are to:

- Minimise sediment erosion off the land;
- Capture sediment runoff before it reaches the marine environment; and
- Stabilise sediment already deposited in the marine environment including the Firth of Thames.

How will we do it?

1. **Catchment management plans**
    a) By 2025, prepare an integrated harbour and catchment management plan for every catchment that drains into the Hauraki Gulf Marine Park, in consultation with local communities, and using Mātauranga Māori, local knowledge and scientific information.

Catchment management planning enables an integrated approach to be applied to the reduction of sediment and other contaminants from individual catchments, taking into account the special characteristics of each area. The catchment management plans will help drive statutory planning processes and budget allocation by management agencies. They will also provide support for action by landowners and local communities. Appendix 1 discuss catchment management plans in more detail.

b) By 2019, develop and begin implementing catchment management plans for the following highest priority catchments to achieve significant sediment reductions:

i. Whangapoua (noting that a Harbour and Catchment Plan has been prepared by Waikato Regional Council but needs to be fully resourced and implemented).

ii. Waihou/Piako.

iii. Wairoa.

iv. Mahurangi (noting that a great deal of work has already been undertaken in the catchment, but greater resourcing and effort is still required).

These priority catchments have been selected as places to start on the basis of the following criteria:

- The largest impact on the marine environment (levels of sediment produced and sensitivity of receiving environment).
- The greatest threat from current and future activities (e.g. future forestry harvesting).

Additional plans will then need to be prioritised for development.

Prioritisation of catchments:

Considerable land owner, council, industry and community resources will be required to bring about the required changes to reduce sediment inputs, and obviously not everything can be done all at once. Prioritisation of spending requires careful consideration of the ability to make a difference, cost, and capability and capacity of landowners to work with council.

Models can assist with prioritisation. They can be used to identify 'critical source areas' in the catchment – areas where, for instance, sediment erosion or nutrient loss is greatest. Where these areas are connected by transport pathways to vulnerable aquatic receiving environments, they should receive priority attention. Models can also be used to estimate the cost of taking action to reduce the flow of sediment and of applying mitigation. In addition, they can estimate the benefits of likely improvements (reduction in sediment runoff or nutrient loss, for instance) following mitigation (Appendix 1 has more detail on this approach).

2. **Establish catchment sediment load limits**

c) By 2022 reach agreement with agencies, communities and mana whenua on overall sediment load limits for all catchments draining into the Hauraki Gulf Marine Park by:

i. Developing implementable sediment targets applicable to the estuaries and inner coastal waters of the Hauraki Gulf Marine Park that can be converted into objectives and then catchment sediment load limits.

ii. Implementing a comprehensive set of workable catchment sediment load limits for protecting ecosystem integrity, functioning and associated values throughout the Hauraki Gulf Marine Park.

iii. Implementing a framework for ensuring compliance and accountability.

iv. Implement land use practice changes required and reporting on monitoring with reference to achieving the 2050 target.

v. Achieving catchment sediment load limits by 2050, to achieve generational change. Appendix 1 contains a more detailed explanation of load limit settings.

Photo: Raewyn Peart

Figure 7.2 Mahurangi Harbour

3. **Increase sediment traps in contributing freshwater waterways**

a) Progressively increase the number and spread of natural, managed (wetlands, floodplains and ponding areas) and enginee red sediment traps:

i. By 2021 initiate at least five significant new wetland systems along river courses, at the nexus of tributary streams and/or at the heads of estuaries.

ii. By 2026 initiate the construction of at least 15 significant new wetland systems.

iii. Encourage and incentivise the establishment of wetlands and sediment traps on private land through the deployment of on-farm advisers and targeting of co-funding schemes.

iv. Incorporate green infrastructure such as swales, wetlands and permeable surfaces into all new urban developments.

v. Facilitate and incentivise wetland restoration and/or creation through inclusion as mitigating or offsetting conditions for sediment-generating activities requiring resource consent (such as forestry harvesting and earthworks).

vi. Where practicable, engineer sediment traps into future capital works for new and existing infrastructure (such as the Waihou Valley and Piako River Schemes and roading developments).

vii. By 2035, have in place a network of natural and/or artificial sediment traps at strategic points in all catchments draining into the Hauraki Gulf Marine Park.

Figure 7.3 Purangi River Cooks Beach

Managing sediment loads

Catchment sediment load limits enable the cumulative effects of sediments on the Hauraki Gulf Marine Park to be managed. Reaching agreement on the limits to sediment runoff, and keeping within those limits, will preserve what we value about the Hauraki Gulf Marine Park, enhance the mauri and provide a firm basis on which councils, mana whenua and communities can manage land use within catchments. It has taken generations to create today's sediment problems. These actions will start reversing that, the timeframes recognise the realities and scale of the task.

Figure 7.4 Long Bay wetland

4. **Waterway management**

a) Significantly improve the management of waterways, to reduce transportation and loss of sediment to the marine environment including:

   i. Continue and significantly increase the extent of stock exclusion, and riparian planting programmes along waterways to stabilise stream banks and to provide ecological co-benefits. Each catchment management plan is to include a specific target for the percentage of natural waterways which are to have riparian planting in place within 10 years of plans being agreed.

   ii. Apply active and pragmatic management of waterways and drains to reduce sediment loss, streambank erosion and bankside collapse.

Industry, mana whenua and regulatory agencies need to

Steep slopes and erodible soils

Given the steep slopes and erodible soils within Hauraki Gulf Marine Park catchments, and frequency of storm events, it is not possible to stop excess sediment washing off the land through good land management alone. This means that a network of natural and engineered sediment traps is required at strategic points in all catchments to intercept sediment before it reaches the coastal area.

Wetland systems are particularly effective in reducing sediment and other contaminant discharges from land from reaching the marine area. They also provide a range of other co-benefits by providing habitat for native plants, freshwater fish and birds, and increasing local amenity value through the provision of public walkways and viewing spots.

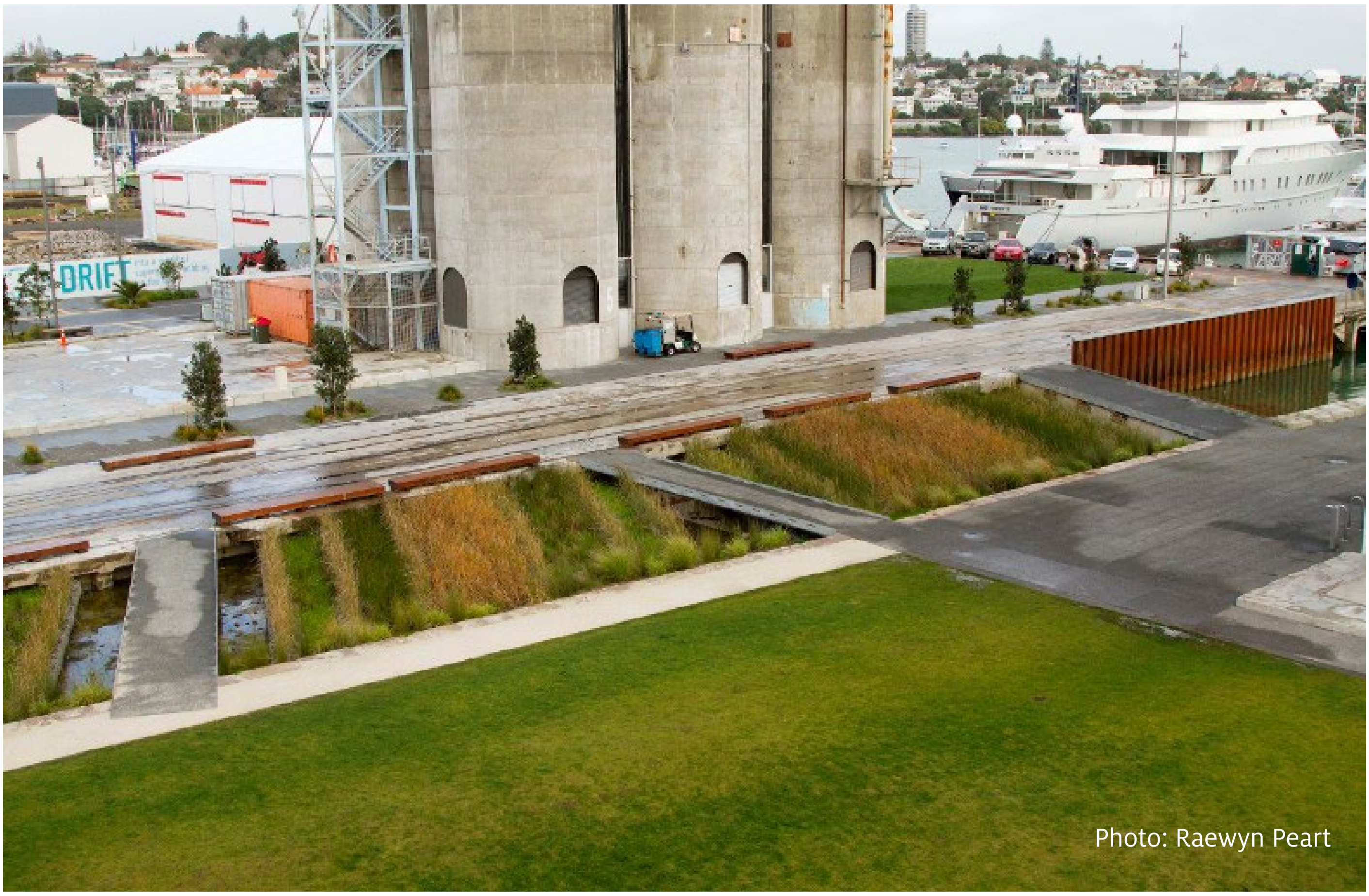


Photo: Raewyn Peart

Figure 7.5 Green infrastructure – Constructed wetlands at Wynyard Quarter banks and capture sediment

Guidelines for riparian planting

Dairy NZ has an online Riparian Planner tool[1] designed to assist with planning, budgeting and managing riparian planting. Waikato Regional Council provides extensive advice on planting for waterways and wetlands[2], including guidelines for the selection of trees in different parts of the Region, a guideline for native planting for soil conservation, biodiversity and water quality, and best practice guidelines for vegetation management and controlling weeds in riparian margins. Auckland Council has a streamside planting guide[3], with information on the key steps for planting and maintaining a riparian area, and species to plant. 'Managing Riparian Zones: A contribution to Protecting New Zealand's Rivers and Streams' is a detailed DOC publication[4] that includes information and advice on planning riparian management, managing channel and bank stability, and managing water temperature and light.

work together to achieve the above.

Photo: Raewyn Peart

Figure 7.6 Riparian planting to help stabilise stream

1 www.dairynz.co.nz/environment/waterways/riparian-planner/
2 www.waikatoregion.govt.nz/Community/Your-community/For-Farmers/Waterways-and-wetland-management/
3 www.aucklandcouncil.govt.nz/EN/environmentwaste/coastalmarine/Documents/streamsideplantingguide.pdf
4 www.doc.govt.nz/documents/science-and-technical/riparianzones2.pdf

5. **Ensure good sediment management practice**

a) By 2017, councils in partnership with mana whenua and sector groupings, should establish a standard set of good management practice guidelines for adoption by land users within the Hauraki Gulf Marine Park catchments. This includes pastoral farming, forestry, urban development, horticulture and cropping, roading (development and maintenance), and DOC owned and managed land.

b) By 2017 undertake a specific review of the standardised forestry good management practices, recognising the strong relationship between forestry practices and sediment runoff. Actively work with the sector to ensure those practices will be universally adopted.

c) Promote the universal adoption of good management practice by:

i. Requesting each land use sector to advise the Hauraki Gulf Forum and councils of their plan to ensure universal uptake of good management practices by 2018.

ii. Every two years thereafter, sectors formally reporting to the Hauraki Gulf Forum and councils on progress in achieving universal uptake. Council compliance teams should provide advice on the standard of this reporting and the achievements being reached for the period.

iii. Councils, Government and Industry bodies must actively support land holders to overcome knowledge, financial and practical barriers to implementing recommended good practices.

iv. If substantive progress in achieving universal adoption of good management practice has not occurred after four years (i.e. the second update) Councils should review the adequacy and application of the current regulatory framework and amend if required to ensure universal adoption.

v. Removing unnecessary legal barriers to good management practices such as the requirement in some forestry leases to replant down to stream and coastal edges.

d) Encourage land management that decreases the risk of sediment loss by:

i. Significantly scaling up the one-on-one approach with landowners, by doubling resources to employ additional land management officers and to provide co-funding for initiatives that improve water quality on private land within two years.

ii. Encouraging the establishment of coordinated catchment care groups.

e) Ensure rigorous and consistent enforcement of existing earthworks regulations by councils. Where guidelines have been agreed, include the use of chemical flocculants (Appendix 1 has a more detailed explanation).

Compliance monitoring

There is a need for uniform, quality monitoring of both consented and permitted activities, particularly higher risk activities such as earthworks. Councils need to increase the staff resource available to competently and consistently monitor these activities.


Photo: Raewyn Peart

Figure 7.7 Forestry Operation at Whangapoa


Photo: Raewyn Peart

Figure 7.8 Large scale earthworks for residential development

Working with landowners

Working one-on-one with landowners on a voluntary basis has proven to be successful in changing land-management practices and improving water quality (this applies to both sediment and nutrients). It therefore makes sense to scale this activity up.

6. **Review of forestry impacts on sedimentation**
   a) By 2017, identify the location of current and soon to be harvested (pre 31/12/18) forest sites. Initiate a comprehensive review of the impacts of those forestry harvesting-related activities on sedimentation affecting estuaries and embayments within the Hauraki Gulf Marine Park. Review and consider the adequacy of current practices and regulations to minimise sedimentation occurring. Work with the sector (small and large) to recommend and implement measures to minimise sedimentation until good practice is universally adopted in 2018 as above. This may include the review of current leasehold obligations regarding harvest and replanting close to waterways or on specific problematic slopes.
7. **Protect highly erodible soils**
   a) Implement effective pest control on all steep bush-clad slopes, particularly conservation, reserves and stewardship land on the Coromandel Peninsula and Kaimai Ranges, so that the understorey is thick, robust and able to protect underlying soils from erosion.

   b) Ensure appropriate use of highly erodible land:

   i. By 2017, identify land and land use which is generating disproportionally high amounts of sediment and work with land owners to investigate alternative land uses.

   ii. Retire steep slopes and riparian areas from production forestry and farming (including reviewing the replanting requirements of Crown forest leases).

   iii. Incentivise and encourage native timber (high value, long rotation) production. Planting of Manuka for honey production is a recent new alternative landuse.

   iv. Avoid urban subdivision of areas with highly-erodible soils.

Photo: Raewyn Peart

Figure 7.9 Eroding hills at Port Jackson

Figure 7.10 Moehau before storm

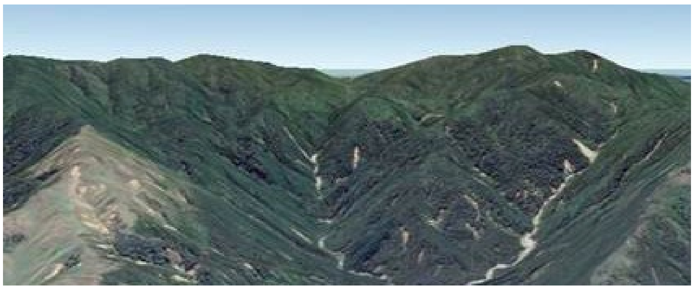


Figure 7.11 Moehau after storm illustrating sediment runoff from highly erodible steep land

8. **Addressing sediment in the coastal marine area**
   a) Actively investigate innovative solutions to addressing sediment already in the marine area including:
   - i. Restoring large bivalve (including green-lipped and horse mussel) beds in the Inner Gulf to enhance filtering and trapping of fine sediment already in the marine system.
   - ii. Options to cap sediment with waste shells or other hard substrates which allow re-establishment of natural marine seabed life.
   - iii. Extraction or harvesting of sediment, possibly for reuse on land.
   - iv. Retaining coastal mangroves where appropriate as effective natural means of trapping sediment.
   - v. Transitioning seafood harvesting methods that disturb seabed sediment out of the Hauraki Gulf Marine Park (link to fish stocks provisions).
   - vi. Other novel techniques to stabilise fine sediments already in the Hauraki Gulf and otherwise impairing recruitment of high value benthic bivalve populations

Excess sediment already in the coastal marine area is resuspended by wave action and currents resulting in cloudy water, reduced light levels and clogging of filter feeders. Effective solutions to such resuspension are not currently known but need further research.

Pest control

Poorly managed indigenous vegetation is unable to hold soil during storm events. Effective pest control needs to be a priority for DOC as the single largest manager of highly erodible land in the Hauraki Gulf Marine Park.

Irrespective of the application of good sediment management practice, some land uses are unsuitable for highly erodible soils. In such cases, there needs to be a change of use for the land by working with land owners.

Forestry

Sediment runoff from forestry blocks may be relatively low under the mature forest canopy, but is elevated during logging and re-foresting operations. Much of the sediment runoff arises from roads constructed to service the forest blocks. Forestry operators have a range of sediment mitigations available to them, including:

- avoiding winter earthworks;
- staging earthworks;
- stabilising disturbed areas as soon as possible by compacting, benching, mulching and planting;
- installing perimeter controls;
- Avoid trimming felled trees within waterways;
- diverting clean-water runoff;
- protecting steep slopes;
- avoiding direct discharges to streams;
- using small check dams to slow runoff;
- discharging runoff from roads at regular intervals;
- using soak holes where the soil allows;
- minimising side-casting when constructing roads;
- building roads to match natural contours of the land;
- keeping landings clear of streams;
- directing stormwater runoff from landings and roads to stable outlets;
- stabilising approaches to stream crossings and protecting abutments;
- protecting stream headwaters and stream banks;
- applying riparian setbacks.

How will we know when we've got there?

Naturally sandy seabeds will not be muddy, and seabeds already affected by sediment will be returned to their naturally sandy state. Healthy and abundant shellfish beds, inter-tidal seagrass beds and nearshore fisheries will return. Mangrove expansion will stop or naturally reverse.

Three sediment objectives

Objective WQ1 is intended to limit the sedimentation rate in estuaries and coastal embayments. Reducing the sedimentation rate will improve ecosystem health and functioning, improve human amenity, and extend the lifespan of estuarine and coastal systems.

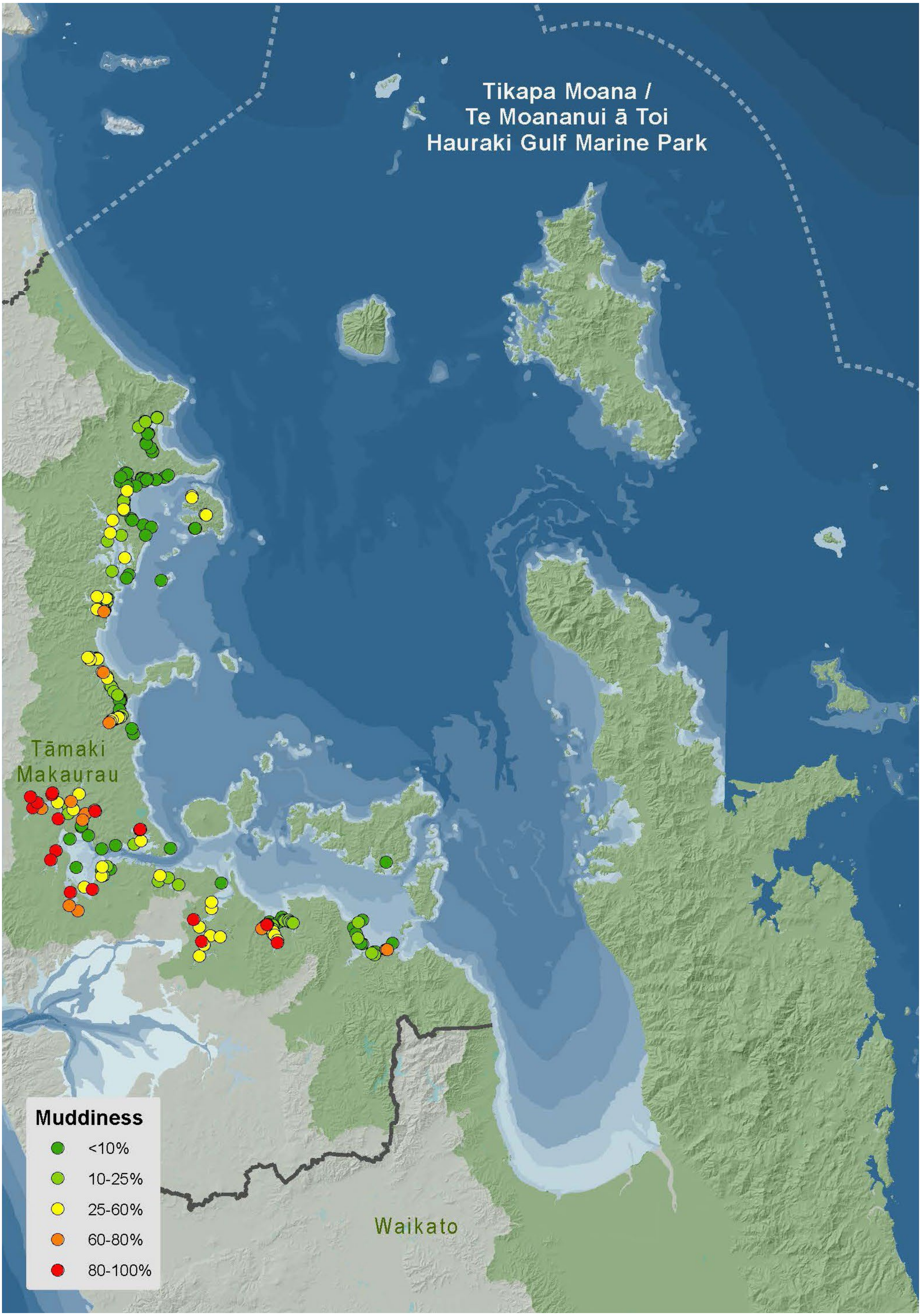
- Objective WQ1: Sedimentation rate across the appropriately selected monitoring sites in the Hauraki Gulf Marine Park to be no more than 2mm per year above the baseline rate by 2050. Baselines vary throughout the Hauraki Gulf Marine Park.[5]

By 2019 all monitoring to be in place and baselines established. Specific reporting to be made on sedimentation rate monitoring in 2025, 2030, 2035, 2040, 2045 and 2050. 2030 and 2040 reporting to include a review of progress to 2050 target, comment on likelihood of reaching the target and any additional actions likely to be required. It is expected that the majority of these measures will be put in place by 2030 to achieve this objective by 2050.

Refer to Appendix 4 for text on implementation and assessing achievement on this and the following objectives. Map 7.1 shows muddiness monitoring results for the Auckland Region and Map 7.2 locates possible sedimentation rate monitoring sites across the whole Park.

Figure 7.12 Northern Coromandel – silt meets sea after rainfall

5 The baseline rate is the rate when the catchment was fully forested. It varies from location to location within any given estuary or embayment, for example, 1 mm per year on exposed intertidal flats, 2 to 4 mm per year in tidal creeks. Recognition will be required, that in places, flood protecton has substantially reduced the deposition of sediment on historic flood plains.



Map 7.1 Muddiness monitoring in the Auckland region

Map 7.2 Possible sedimentation rate monitoring sites

Objectives WQ2 and WQ3 are intended to prevent sandy seabeds from becoming muddy, and help already-affected seabeds return to their natural state.

With less mud in the seabed, habitats will be more suitable for a wider range of plants and animals. The seabed will feel better underfoot and the water will tend to be clearer, which will provide for a better swimming experience.

- Objective WQ2: Proportion of intertidal area with seabed mud content greater than 25% not to expand in all estuaries of the Hauraki Gulf Marine Park.
- Objective WQ3: Seabed muddiness to be less than 10% at 95% of intertidal flats that are exposed to winds and waves by 2050.

Further details on Sediment objectives are given in Appendix 4.

THEME B. NUTRIENTS

What is the problem?

The marine environment is generally nitrogen limited. The introduction of nutrients, particularly nitrogen, promotes the growth of phytoplankton which is the basis of the marine food chain. Nutrients in the marine environment come from upwelling of nutrient-rich bottom waters from the sea and from land-sourced discharges.

Some enhanced levels of nutrient can be beneficial, as they increase the productivity of the marine system, but too much can cause excessive phytoplankton growth. When the phytoplankton die, they drop to the seafloor and decompose in a process that uses oxygen in the water and generates carbon dioxide that acidifies the seawater. Low oxygen levels can damage marine life. Acidification of seawater can affect species which use carbon to build structures, especially bivalves such as mussels. Nutrients from the land are not usually a problem where harbours and estuaries are often well flushed by the tide.

The Firth of Thames is sensitive to excessive nutrients because it is not well flushed and the water column is sometimes stratified. In summer and autumn, the Firth has higher levels of phytoplankton than the rest of the Hauraki Gulf Marine Park. In autumn, oxygen depletion and water acidification have been measured in the outer Firth. In addition, dissolved nitrogen levels at the outer Firth have risen over the past 15 years despite total nitrogen loads in rivers draining to the Firth of Thames being stable or increasing only slowly for at least the past 20 years but stable to slightly declining over the last 14 years (Vant 2011). Green and Zeldis (2015) estimated that, at least when there is no strong ocean upwelling (which is the case for about 90% of the time), inputs from the land are the dominant source to the total nutrient loading of the Firth. Furthermore, point and diffuse human sources contribute about 8% and 70% respectively, of the total nitrogen load to the Hauraki rivers, with natural sources making up the remainder (Vant, 2011). Before human settlement, the landside loads would have been much lower.

What do we need to achieve?

Our objective for nutrients is to ensure that human-derived nutrients entering the Hauraki Gulf Marine Park are not at a level which cause adverse effects such as oxygen depletion and acidification of seawater.

How will we do it?

1. **Establish a long term monitoring programme**
    b) Within a year, Waikato Regional Council should engage a multi-agency scientific team, including mana whenua experts, in a targeted research programme to:
    i. Understand the effects of changing nutrient levels in the Firth of Thames; and
    ii. Determine the assimilative capacity of the Firth of Thames within required thresholds for healthy ecosystems as a basis for the establishment of catchment nutrient load limits (see Appendix 1 for further detail). This will underpin the WRC Plan Change Two as a ‘receiving environment’ load limit on nitrogen and phosphorus carried by the Hauraki rivers.

The programme will:

- Assess the nature of the monitoring and research required;
- Identify the sources of nutrient inputs (external and internal);
- Develop a model able to integrate with catchment water quality models and simulate current nutrient loads accurately in the Firth;

- Utilise the model to generate a robust nutrient load limit by 2020; and
- Incorporate mātauranga Māori and kaitiaki methods.

Expected outcomes from this programme would be increased understanding of the processes governing nutrient availability in the Firth of Thames, impacts of nutrients (including from the catchment and from in situ sediment regeneration) on those processes and, with the development of an appropriate model, a recommendation on nutrient load limits to ensure no adverse effects on marine life.

c) By 2018 have a comprehensive monitoring programme in place to provide ongoing scientific data and mātauranga Māori necessary to monitor and understand nutrient levels. This includes the deployment of a significant number of additional monitoring buoys in the Firth of Thames

d) Within five years develop an integrated catchment economic model as part of the Waikato Regional Council Plan Change Two, for the Firth of Thames catchment as a management tool. Use this model to understand how values are likely to change as a result of policy decisions when establishing safe nutrient load limits.

e) Include provisions in Plan Change Two to achieve the nutrient load limits within an appropriate time frame.

Dissolved nitrogen levels

There are still uncertainties about the causes and impacts of higher dissolved nitrogen levels in the outer Firth of Thames including whether these indicate greater overall nitrogen levels (these are not yet monitored in the outer Firth). Further research is required to fully understand the issue and to establish safe limits, and this needs to be undertaken as a matter of urgency, both within the Firth and it's outer reaches.

2. **Ensure no increase in the interim**

f) Ensure nutrient loads, particularly nitrogen, are kept at or below current levels as an interim measure until sufficient information is available to set nutrient load limits by:

i. Encouraging land managers to adopt good nutrient management practices, such as the minimum standards for dairy farms developed by Dairy NZ and with milk companies for use elsewhere in the Waikato. These address issues such as effluent capture and storage, application to land, stock exclusion from waterways and wetlands and riparian management (see breakout box below for more detail).

ii. Ensuring that any new sources of nutrient but especially nitrogen input, such as through land use intensification or the introduction of fish farms, do not result in an overall increase of nutrients available in the Firth of Thames.

Although the impacts of the current nitrogen loadings entering the Firth of Thames are not fully understood it is prudent to ensure that there is no increase whilst further urgent research is undertaken.

3. **Establish catchment nutrient load limits**

g) Establish catchment nutrient load limits for the Firth of Thames that ensure there are no adverse effects such as oxygen depletion and acidification of seawater:

i. By 2020, reach scientific, mana whenua, and community agreement on appropriate catchment nutrient load limits for the Firth of Thames.

ii. By 2021, have in place agreed minimum standards for more intensive landuse such as horticulture, cropping and dairy farming, adapted to local conditions as necessary, in all catchments draining into the Firth of Thames.

iii. By 2022, have in place agreed minimum standards for less intensive landuse such as drystock, using relevant parts of the above minimum standards as appropriate.

Once safe nutrient levels for the Firth of Thames have been established, these can provide a firm basis for catchment management and any measures required to reduce nutrient inputs.

Integrated catchment economic and scientific modelling

The Hauraki Gulf Marine Park is a complex and dynamic combination of natural and artificial systems that interact with each other like a giant, ever-changing puzzle. Māori conceptualise the moana as integrally connected by whakapapa. They also recognise the indivisibility of the land and sea as a functioning system – as described by the phrase ki uta ki tai – mountains to the sea. When making policy and management decisions about such a system, we often think about particular pieces of the puzzle. But there is a danger that decisions aimed at outcomes for one part of the puzzle will have unintended consequences for another part.

One way of overcoming such issues is to develop an 'integrated model' (see Appendix 1 for a more detailed description) that incorporates all the key features of the catchment, and the ways in which these interact. The overall question that this type of modelling tries to answer is how do values change as a result of our policy decisions? This approach can help us to figure out what policies might be needed, what effect they will have, and who will be affected.

Mana whenua have accumulated a vast body of knowledge about the Firth of Thames. It is imperative that this knowledge, and Māori management and restorative methods, be included in the development of an integrated model, and that this be accorded equal weight to that of Western scientific information and methods.

Dairying minimum standards

The Sustainable Dairying: Water Accord (2013) commits all dairy farmers to, amongst other things, riparian action plans that will reduce nutrient (and sediment & E. Coli) loss from farms to waterways and, ultimately, the coast. The Water Accord requires that all dairy farms with waterways have a riparian planting plan by 31 May 2020, and that by this time half of riparian actions are completed with full implementation of plans by 2030. Well prior to this, all dairying stock must be excluded from waterways (by 31 May 2017) and all crossings used more than once monthly, bridged or culverted by 31 May 2018 to prevent crossing related discharges and disturbance of stream bed habitat. This covers not only milking but also supporting land. To support this initiative, a wealth of information has been produced with regional authorities nationwide and published on how best to design, plant and maintain riparian margins for water quality.

In the Waikato Region, the dairy sector is promoting a draft package of minimum standards for dairy farms for inclusion in the Healthy Rivers Plan on the Waikato and Waipa Rivers. Amongst other things, the minimum standards address nutrient loss to waterways, and include expectations concerning effluent capture, storage and application to land (including a maximum annual nitrogen application rate to land from effluent, and a requirement that there be no discharge of effluent to water); stock exclusion from waterways and wetlands; and riparian management (as above). There is also an expectation for creation and maintenance of farm-level spatial risk plans that identify where there is a high risk of contaminants (nitrogen, phosphorus, E. coli and sediment) being lost to water, and target these with actions to minimise those risks pragmatically. These actions are to be auditable and reported on annually by an independent third party.

Standards and associated rules and practices for dairy farms at least as high as those being promoted by the dairy sector elsewhere in the Waikato need to be adopted for catchments that drain to the Hauraki Gulf, adapted for local conditions (e.g., soils, climate, ecology and stream hydrology) as necessary (Note that land draining to deep, low turnover hydro dam lakes may need more stringent measures that are not appropriate in this catchment).

The progress made on dairy farms is urgently needed across the full suite of land uses contributing sediment, nutrients and/or faecal pathogens into the Hauraki Gulf in a "whole of catchment" approach to reaching water quality objectives. Minimum standards for drystock (sheep and beef) farms, horticultural and cropping farms, and forestry operations need to be agreed, using relevant parts of the dairy minimum standards as appropriate (e.g., rules around riparian management for drystock farms).

How will we know when we've got there?

The Firth of Thames will be a healthy marine system with no excess phytoplankton levels, significant oxygen depletion or seawater acidification.

Three nutrient objectives

The overall goal is to manage nutrient loss from the land to the coastal marine area to maintain primary production at optimum levels and prevent the potential adverse effects of eutrophication such macroalgae proliferation and depletion of dissolved oxygen.

Nutrient objectives designed to prevent excessive growth of phytoplankton in coastal embayments (including the Firth of Thames) aim to maintain nitrogen and phosphorus in the water column to provide optimum phytoplankton levels. Further detailed explanation of the objectives below is provided in Appendix 1.

Objective WQ4 intends to control nutrients in the water column, which are a driver of eutrophication:

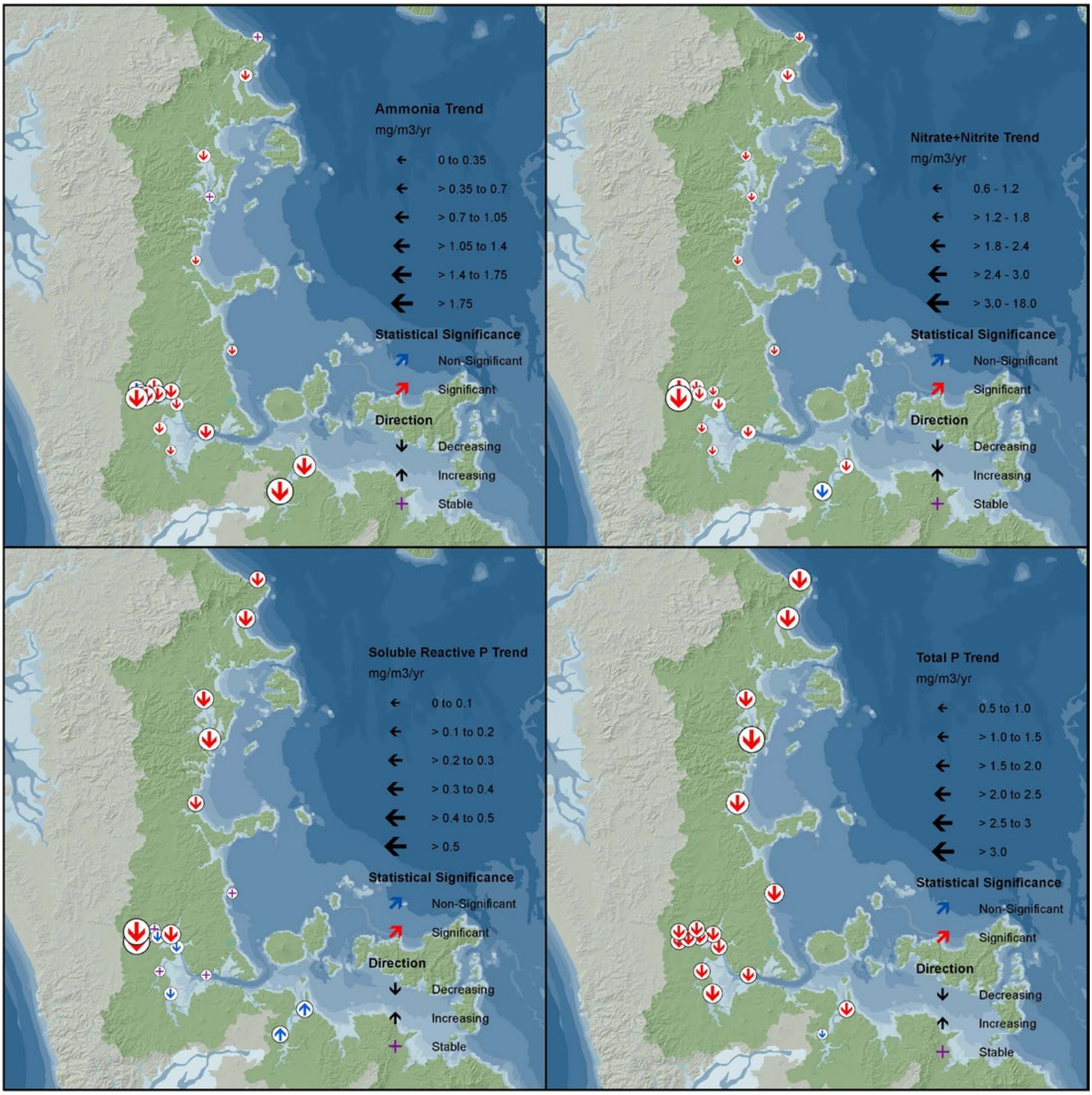
- **Objective WQ4:** 80% of subtidal areas and coastal embayments with increasing trends in water-column ammonia-N, nitrate+nitrite-N, soluble reactive phosphorus and total phosphorus have the trend reversed within 15 years.

Objectives WQ5 and WQ6 focus on the symptoms of eutrophication – the amount of phytoplankton (primary symptom) and dissolved oxygen (secondary symptom) in the water column:

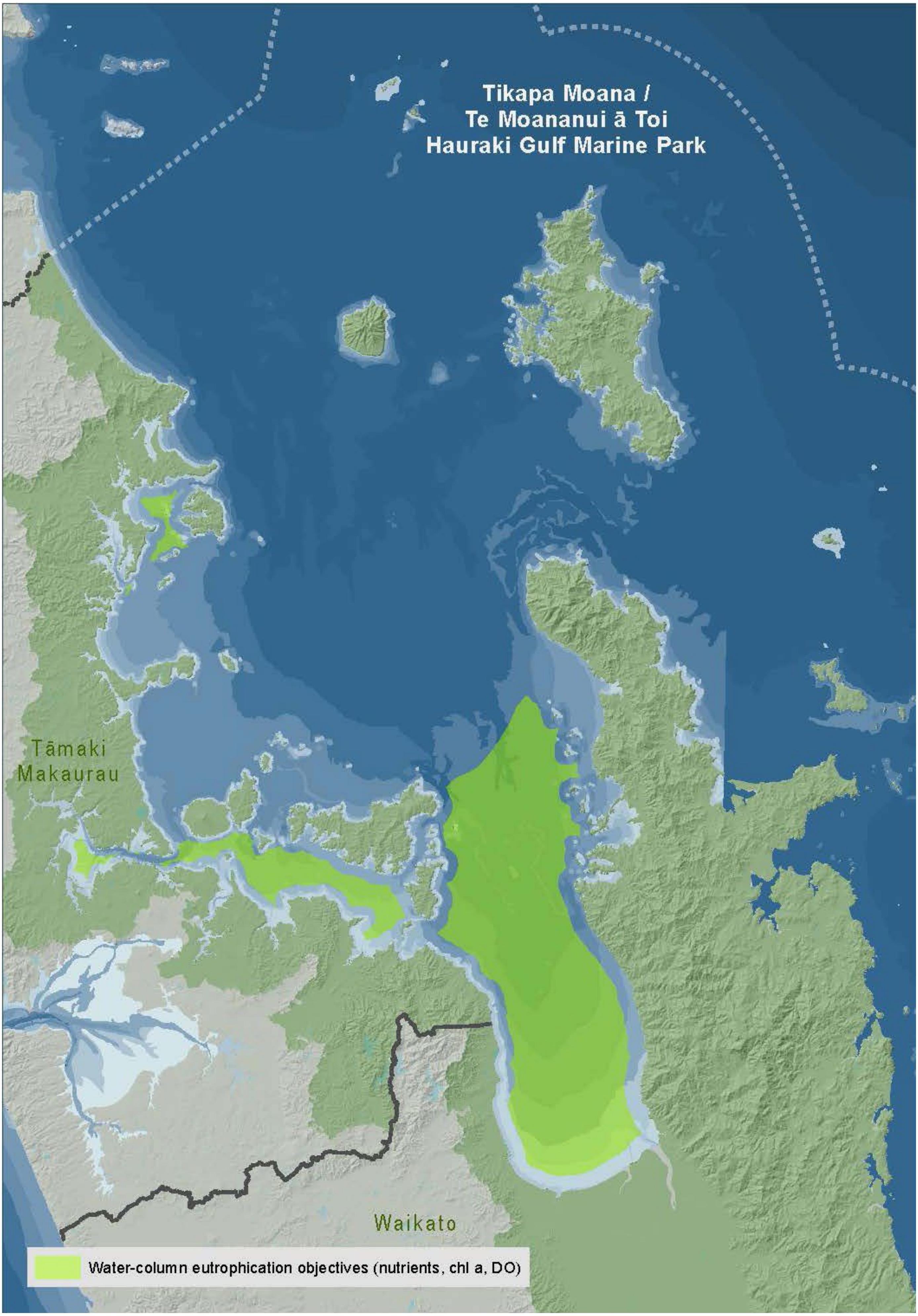
- **Objective WQ5:** Within 10 years, chlorophyll a in the surface water (i.e., above the thermocline) of subtidal areas and coastal embayments does not exceed 5 mg m-3 during the summer when primary production is greatest.
- **Objective WQ6:** Within 20 years, dissolved oxygen concentration in subtidal areas and coastal embayments is no lower than 5 mg L-1.

Map 7.3 shows trends in coastal nutrient concentrations in the Auckland region, and Map 7.4 where water-column eutrophication objectives apply within the Park.

Figure 7.13 Cows on a Hauraki Dairy Farm



Map 7.3 Auckland regional trends in coastal nutrient concentrations.



Map 7.4 Locations where water-column eutrophication objectives apply

THEME C. HEAVY METALS

What is the problem?

Stormwater draining from roads and other impermeable surfaces like roofs contains dissolved metal contaminants such as zinc and copper. These are carried to the coast and accumulate in muddy sediment. The main sources of these contaminants are from tyre and brake wear and uncoated surfaces of zinc and copper. Corroding or uncoated galvanised roofs are a typical source of zinc.

The health and productivity of some marine habitats near urban areas is being reduced by the toxic accumulation of heavy metal contaminants in the sediment, sourced from urban stormwater and runoff.

The overall goal is to reduce heavy metal loss from the urban landscape to the coastal marine area and thereby limit the buildup of heavy metals in seabed sediments to protect benthic ecological health (Appendix 1 describes this in more detail). Map 7.5 depicts heavy metal problem areas in the Auckland Region.

What do we need to achieve?

Our objectives for heavy metals are to:

- Reduce contaminants at source.
- Prevent contaminants entering waterways.

How will we do it?

1. **Reduce contaminants at source**
   - h) Transition to materials that are not sources of heavy metals:
   - i. By 2018 amend building codes to require exposed galvanised and copper surfaces to be coated in urban areas.
   - ii. Strongly encourage brake pad alternatives that don't contain copper.
   - i) Reduce vehicle use through investing in infrastructure to support alternatives including public transport, cycling and walking.
2. **Prevent contaminants entering waterways**
   - j) Embrace green urban design that minimises heavy metal generation at source and that slows and filters runoff in urban areas such as filter strips, constructed wetlands, sand filters, grass swales, infiltration trenches, porous pavements, catchpits and sumps, sediment traps, litter baskets, detention basins and oil and grit separators.
   - k) Put in place stormwater devices to trap heavy metals.
   - l) Use public education to increase awareness and change behaviours such as washing cars on grass to reduce contaminant runoff into stormwater.
   - m) Incentivise rainwater reuse, beneficial reuse and groundwater recharging.
   - n) Promote innovative technologies for boat anti-fouling.
   - o) Incentivise or require third pipe (grey water) networks for all new subdivisions.
   - p) Promote the use of permeable surfaces rather than sealed ground surfaces, where practical, particularly in residential and domestic situations.

Appendix 4 describes these in more detail. Map 7.5 locates heavy metal hotspots, showing concentrations of copper, lead and zinc in coastal sediments from the Firth of Thames to the Waitematā Harbour.[6]

6 Bubble colour relates to threshold effects level (TEL) and probable effects level (PEL) guideline values: bubble size is proportional to metal concentration (mg/kg). Reproduced from State of the Gulf 2104.

Map 7.5 Heavy metal hotspots as concentrations of copper, lead and zinc in coastal sediments. Appendix 4 describes these in more detail.

How will we know when we've got there?

Heavy contaminants in the seabeds of the Hauraki Gulf Marine Park will be at healthy levels which do not impact on marine life.

Four heavy metals objectives

Objective WQ7 intends to arrest the increasing trends in heavy-metal concentrations in seabed sediments. Arresting trends that are currently increasing indicates a reduction in heavy metals that can adversely affect animals that live in and on the seabed.

- **Objective WQ7:** 95% of intertidal and subtidal seabed with an increasing trend in heavy metals have trend arrested within 15 years.

Objectives WQ8 and WQ9 intend to reduce heavy-metal concentrations in seabed sediments to levels that do not pose a threat to the animals that live in and on the seabed. Seabed heavy-metal concentrations above certain known levels pose a threat to seabed animals; reducing concentrations below those levels reduces the threat.

- **Objective WQ8:** 95% of intertidal and subtidal seabed with heavy-metal concentration above threshold effects level (TEL) have concentration below the TEL within 30 years, and 95% of intertidal and subtidal seabed with heavy-metal concentration above probable effects level (PEL) have concentration below the PEL within 30 years.
- **Objective WQ9:** All intertidal and subtidal seabed with heavy-metal concentration below the threshold effects level (TEL) remain below the TEL.

A key objective is to maintain and improve the health and functioning of seabed fauna. Abundant and diverse seabed fauna supported by appropriate habitat will underpin the functioning of the wider estuarine and marine ecosystems and provide a range of benefits to people.

- **Objective WQ10:** No decline in benthic ecological health from present day and improvement in benthic ecological health at 25% of monitoring sites within 15 years.

This will be achieved by protecting seabed habitats from loss and physical disturbance, and by reducing sediment and heavy-metal runoff to the coastal marine area. Map 7.6 includes maps showing heavy metal trends in the Auckland Region for copper, lead, and zinc.

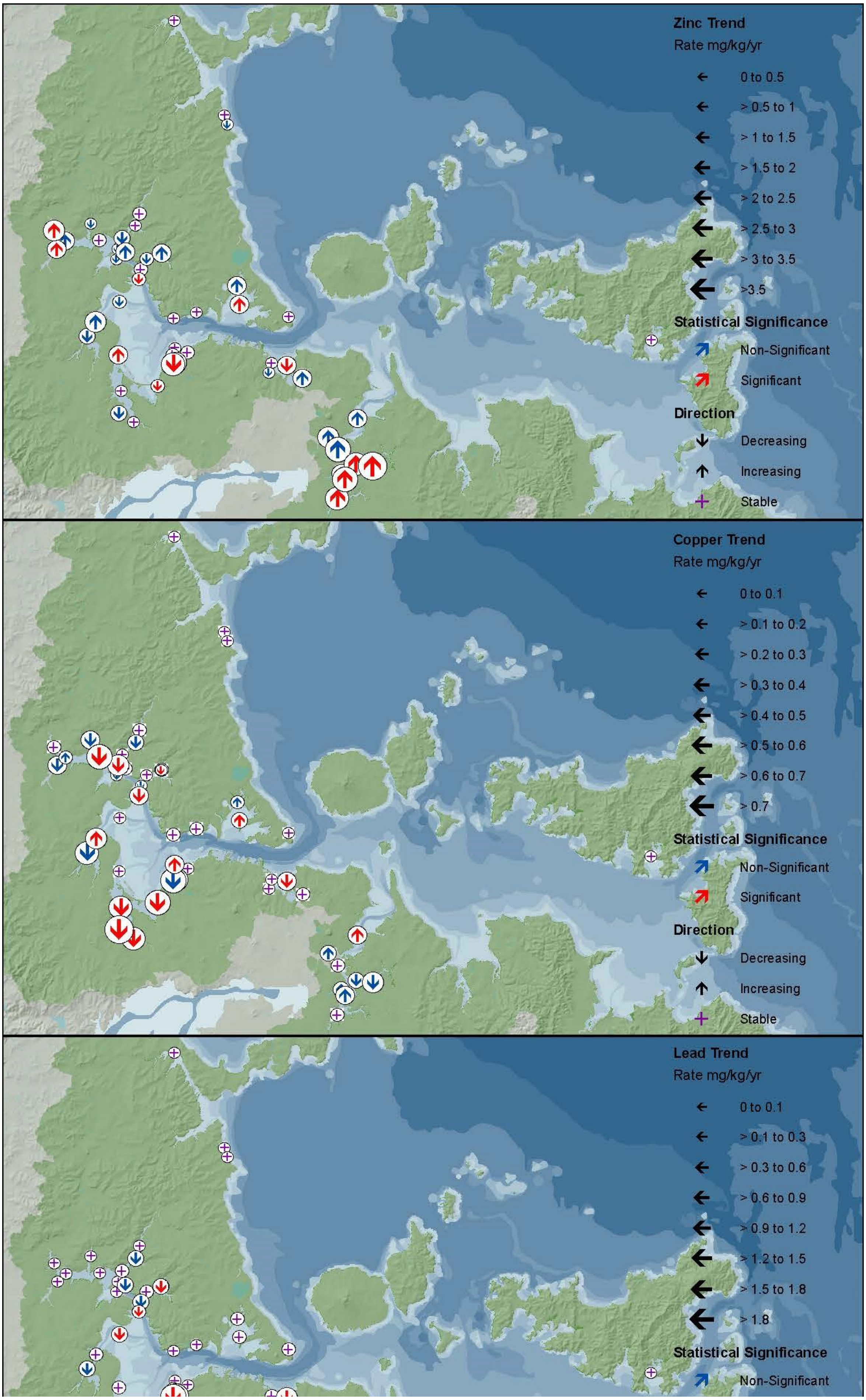
Benthic ecological health

Animals that live in and on the seabed (shellfish, crabs, worms and so on) underpin the proper functioning of the wider estuary and marine ecosystems and the benefits derived from those ecosystems by people. "Benthic ecological health" is assessed from routine measurements of seabed fauna. Assessments focus on species abundance and diversity, and the resilience of benthic communities to withstand disturbances such as excessive sediments and heavy metals. There are different indicators or metrics available for assessing benthic ecological health from monitoring data; some apply to intertidal flats only, others are more generally applicable.

Good benthic ecological health means that things are right with the habitat and that stressor levels (e.g., sediments, heavy metals) are low. Conversely, a poor or declining benthic ecological health signifies that something is going wrong, for example, a buildup of heavy metals in the seabed.

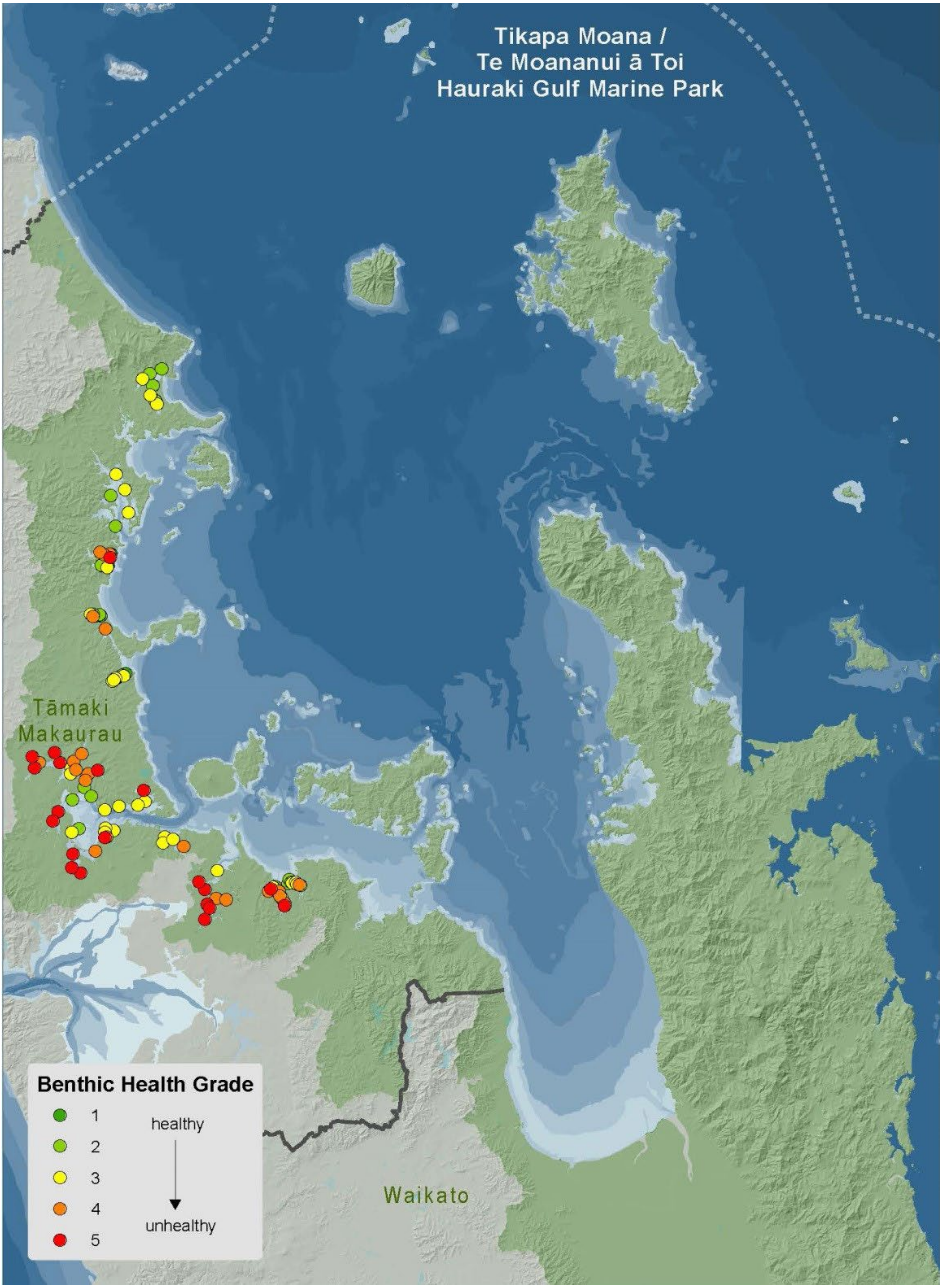
Auckland Council assesses the benthic ecological health grade from seabed monitoring data (see Map 7.7). The grade combines information on seabed mud content and metal concentration and the types and abundances of animals in the seabed. Sites are scored from 1 (healthy) to 5 (unhealthy). In 2015, all harbours and estuaries had monitoring sites that were scored as only moderately healthy and most had sites scored as unhealthy. Most sites near the older urban centres scored as unhealthy (scores of 4 to 5), particularly within the Waitematā Harbour and Tāmaki Inlet, where the issue is elevated concentrations of at least one heavy metal. However, sites further away from urban Auckland were also rated as unhealthy, which was attributed to sediment runoff from rural land.

A key objective is to maintain and improve the health and functioning of seabed fauna. Abundant and diverse seabed fauna supported by appropriate habitat will underpin the functioning of the wider estuarine and marine ecosystems and provide a range of benefits to people. This will be achieved by protecting seabed habitats from loss and physical disturbance, and by reducing sediment and heavy-metal runoff to the coastal marine area.



Map 7.6 Trends in concentrations of heavy metals.

Trends in the concentrations of A) copper, B) lead, and C) zinc in coastal sediments around the Auckland urban isthmus. Arrow colour indicates whether the trends are statistically significant (red) or not (blue). Arrow size is proportional to the rate of change (mg/ kg/yr). Concentrations were obtained using strong acid digestion of the <500 μm sediment fraction. Data provided by Auckland Council.



Map 7.7 Marine ecology health grades, 2012-2014.

This is a combination of the Benthic Health Index (Mud and Metals) and the Traits Based Indicator. Reproduced from Auckland Council State of the Environment Report 2015.

THEME D. MICROBIAL PATHOGENS

Microbial pathogens ("disease-causing") are microscopic organisms that live within the waters of the Hauraki Gulf Marine Park.

What is the problem?

Microbial pathogens are capable of causing illness and disease in humans and animals that swim or otherwise come into contact with polluted water. In addition, consumption of contaminated shellfish can cause illness in humans. Microbiological contamination is also an issue for marine farmers, affecting suitability of sites and the ability to harvest. Any untreated human or animal waste entering waterways is offensive in terms of tikanga Māori. This includes disposal of human remains into the marine environment, which should be immediately banned.

Much of central Auckland is connected to a system that carries both wastewater (sewage and washing water) and stormwater together in the same pipes. This system, and some other urban systems, are unable to cope during large storms and are designed to overflow during these events. Untreated wastewater and its pathogens then runs into the sea directly or via streams and rivers.

Runoff from the land, particularly during and soon after storm events, also contains pathogens from animal faeces and wastewater from poorly functioning individual on-site wastewater systems. As a result, some locations are unsafe for swimming and shellfish gathering because there is too much bacteria in the water (see Map 7.8). This is of considerable concern to mana whenua and the broader community.

What do we need to achieve?

Our objective for pathogens is to avoid the discharge of untreated sewage into the marine area, except in exceptional circumstances.

How will we do it?

1. **Ensure adequate wastewater infrastructure**
   q) Ensure that properly functioning wastewater systems are in place for all communities in the Hauraki Gulf Marine Park:
   i. Urgently proceed with the Auckland's Central Interceptor upgrade, which will collect, store and convey wastewater to the Mangere Wastewater Treatment Plant.
   ii. Significantly reduce overflows to a minimal level including by installing adequate holding tanks to ensure that overflows do not occur in heavy rainfall events.
   iii. Ensure that all on-site wastewater systems are properly maintained and operated.
   iv. Assist communities without (or with failing) sewage systems to upgrade their wastewater treatment facilities.
   v. Separate and effectively maintain sewage and stormwater piping networks.
   vi. Disallow further subdivision unless a proper sewage system, with adequate capacity, is in place.

Wastewater infrastructure

The Central Interceptor Project aims to significantly reduce the major wastewater overflows into the Meola Creek catchment, and it will provide the opportunity to further reduce existing wastewater overflows from the combined sewer system into urban streams and the Waitematā Harbour. Environmental benefits will include significant reduction in potentially harmful pathogens, reduced nutrient and organic loads, improvements in water quality, and reduction in the likelihood of conditions that cause ecological stress and adverse ecological change in the Meola Creek, Meola Creek estuary and associated coastal waters. Amenity and cultural benefits are also anticipated.

Investment in wastewater infrastructure is important if overflows are to be reduced. Reticulated systems are preferred but not always affordable. Good maintenance of septic tanks is important, and in some areas can be covered by rates so that the council can ensure they are operating correctly. Appendix 1 discusses the use of innovative technologies and habitat wetlands in municipal new treatments.

2. **Address sewage discharge from recreational vessels**

r) Work towards eliminating raw sewage discharges from recreational vessels in inshore areas by:

i. Avoiding the discharge of untreated sewage from vessels within areas that have been identified as inappropriate due to the proximity to shore, marine farms, marine reserves, or shallow water depth while providing for the health and safety of vessels and their occupants.

ii. Providing encouragement and assistance to boat owners to install appropriate equipment on board, acknowledging that not all vessels will have room for holding tanks.

iii. Requiring provision of sewage collection and disposal facilities for vessels at ports, marinas and other allied facilities, or at the time of significant upgrading of these facilities.

iv. Promoting the installation of public toilet facilities at high use boat ramps and boating destinations, at construction, or during significant upgrades of such facilities.

3. **Reduce pathogen runoff from agricultural and conservation land**

s) Encourage uptake of good management practice to reduce pathogen runoff from agricultural and conservation land in conjunction with riparian management practices for the prevention of sediment loss to waterways. This would include:

i. Effective effluent management systems and onsite wastewater treatment systems.

ii. Livestock excluded from waterways and the coast.

iii. Effective pest and wild fowl management.

iv. Control of populations of feral mammals in forest and bush areas.

4. **Immediately ban all disposal of human remains into the coastal marine area**

Disposal of human remains to water is culturally offensive to Māori. According to tikanga Māori, human remains (including ashes) are considered tapu and must be kept separate from any food gathering areas or places where humans could come into contact with them. For this reason tangata whenua seek to avoid the practice of scattering ashes into the sea.

How will we know when we've got there?

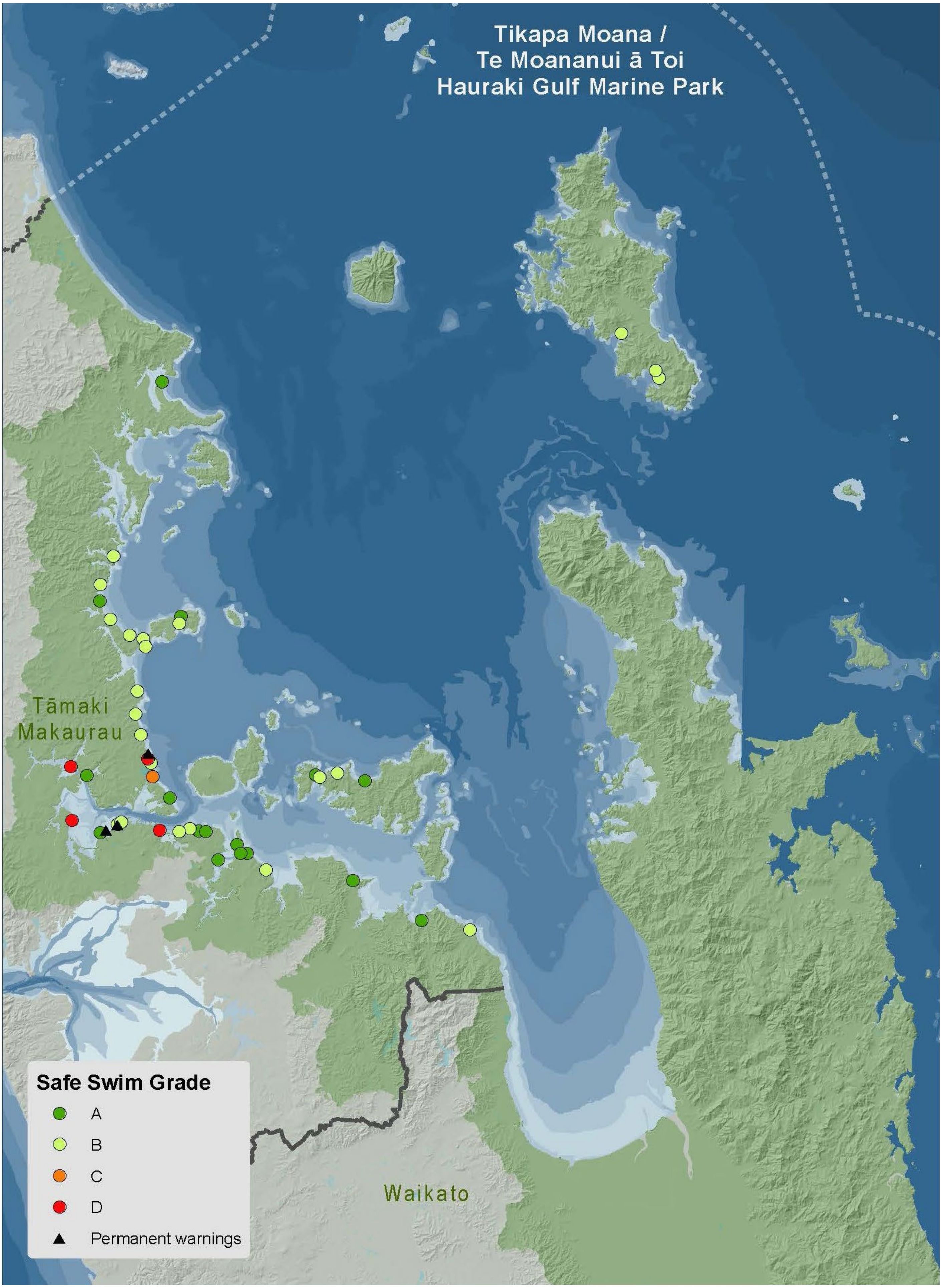
A safe and enjoyable swimming experience at all popular swimming spots in the Hauraki Gulf Marine Park.


Photo: Raewyn Peart

Figure 7.14 Boats at Islington Bay

Discharges from recreational vessels

The discharge of raw sewage from recreational vessels can create a health hazard in crowded anchorages and is of cultural concern to mana whenua. The Auckland cruising fleet consists mainly of boats more than 30 years old which were built without holding tanks being installed.



Map 7.8 Swimming safety within Auckland Council.

Swimming safety within Auckland Council, from data collected over the three summer seasons (2011 – 2014). Reproduced from Auckland Council-State of the Environment Report-2015. Waikato Regional Council does not currently monitor swimming safety.

Three microbial objectives

Objectives WQ11 and WQ12 aim to reduce microbial pathogens in the coastal marine area in order to achieve the goal of providing safe swimming for people, while WQ13 relates to seafood being safe for human consumption.

- Objective WQ11: All popular swimming spots in the Hauraki Gulf Marine Park (see Map 7.8) to be in Microbial Assessment Category A by 2030.
- Objective WQ12: People can swim at any beach within the Hauraki Gulf Marine Park Marine Park 95% of the time by 2025.
- Objective WQ13: aims to provide for safe kaimoana. Objective WQ14: Kaimoana is safe to eat from anywhere within the Hauraki Gulf Marine Park Marine Park by 2025.

RISKS AND THREATS

What is the problem?

Infrequent events such as ship sinking, chemical spills and major sewage discharges are risks. Actions to reduce the impact on the marine area from storm and flood events are often not anticipated in advance and planned for. Consequently the damage is greater. Poor regulation or enforcement, inadequate monitoring and poor coordination between agencies are also risks to water quality.

Lack of information is also a risk. For many areas of the Hauraki Gulf Marine Park there is insufficient water quality monitoring. This means that early detection of water quality issues and reversal of negative changes may not occur.

What do we need to achieve?

Our objectives for risks and threats are that:

- All significant risks are identified and minimised.
- Rapid response measures are in place.

How will we do it?

1. **Understand the risks**
   t) By 2018 Auckland Council and Waikato Regional Council, in consultation with the Hauraki Gulf Forum, need to instigate a formal audit of water quality risk factors, particularly storage facilities.
2. **Reduce the risks**
   u) By 2020, have in place plans, and implement mitigation actions, to address water quality risks affecting the Hauraki Gulf Marine Park including the potential damage from large storms, ship grounding, oil leaks, flooding and tsunami:
   i. Determine the volume of oil on the Niagara wreck and remove it if required.
   ii. Ensure Maritime New Zealand has a plan and capacity for prompt removal of oil from an above-surface wreck e.g. the Rena in coordination with Northland Regional Council [7].
   iii. Enforce designated shipping routes.
   iv. Ensure equipment and trained personal are in place and available to respond to emergencies.
   v. Ensure monitoring is sufficient to report on trends or incidents.

How will we know when we've got there?

Significant risks in the Hauraki Gulf Marine Park will have been identified and planned for. All reviews of responses to events like those described find that agencies have been optimally prepared.

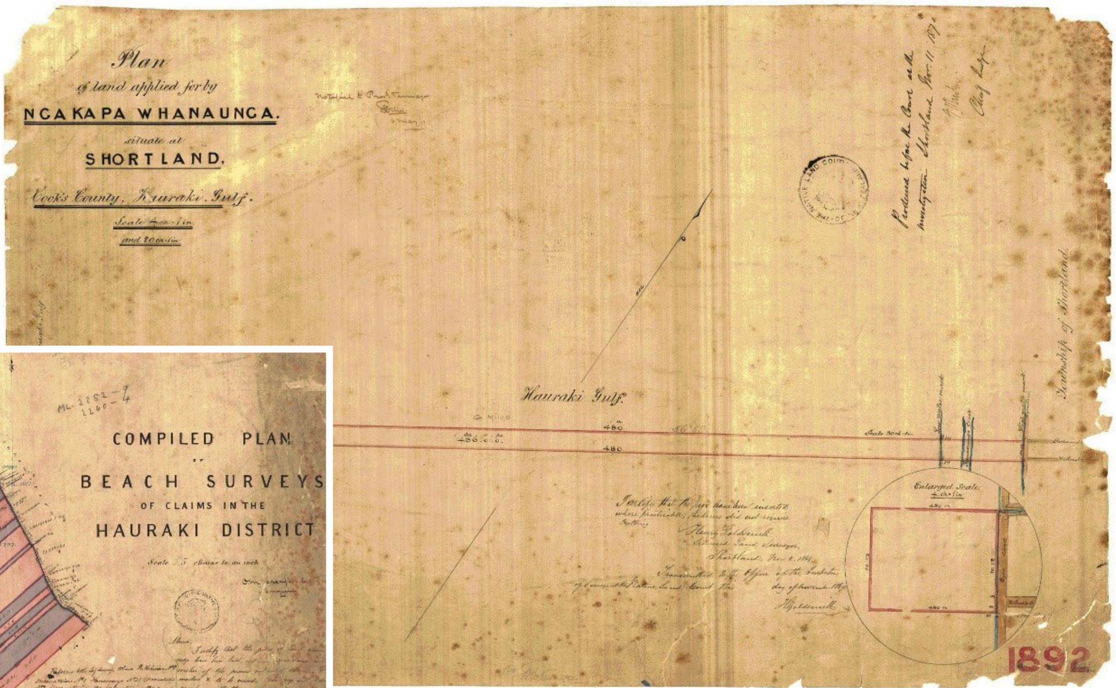
7 The Niagara was in Northland until the regional boundary was moved in 2010 so the Northland Regional Council has previous experience with monitoring the wreck.

PLACE STUDY: KAUAERANGA (THE THAMES MUDFLATS), MANA WHENUA, AND WATER QUALITY

The Kauaeranga (Thames) mudflats, adjacent to the mouth of the Waihou River, hold an important place in Sea Change. This is where the Waihou dumps its thousands of tonnes of sediment into Tīkapa Moana / Te Moananui-ā-Toi. The Waihou channel is navigable at low tide, and the area is a prized fishery today, as it was in pre-colonial times. It is prime potential aquaculture space, as evidenced by the large wild beds of pacific oysters crowding the mouths of the Waihou and Piako Rivers. It is also on the edge of an internationally protected RAMSAR site that supports rare migrating seabird populations amongst wetlands and large stands of old mangroves.

Kauaeranga and mana whenua

While iwi and hapū typically hold discrete sections of coastline across Tīkapa Moana / Te Moananui-ā-Toi, the Thames Foreshore is an example of a location prized for its rich resources, where there were complex interests. The area is under the mana of Marutuahu, but other hapū had long-standing access to certain places and resources on the Kauaeranga mudflats. These arrangements were formalised into legal boundaries when the mudflats were the first Māori foreshore lands put before the Native Land Court. Hori Ngakapa Whanaunga claimed a strip from the mountains to the middle of the Firth, bounded by Willoughby Street on the south and Richmond Street on its north, as shown in Figure 7.15.



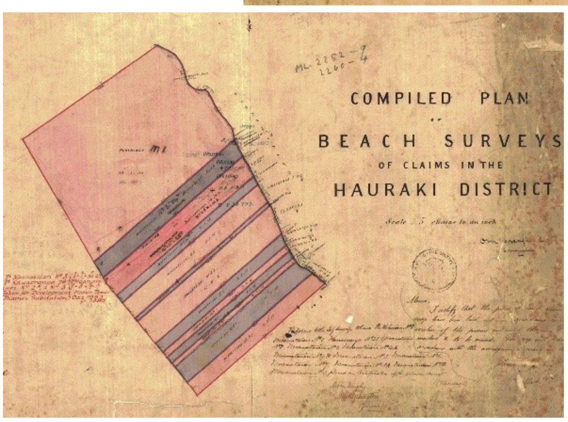


Figure 7.15 Native Land Court survey number ML 1892, 1869. Inset ML 2252-9

Others commissioned surveys, some shown in the inset of Figure 7.15. In the Marlborough Sounds case more than 150 years later, which triggered the 2004 Foreshore and Seabed Act, Kauaeranga was argued to have confirmed Māori legal rights to the seabed. Sinclair referred to the cases as “a major precedent for non-territorial Māori fishing rights” (Sinclair, 1999). These parcels still extend into the Firth of Thames, and some remain in Māori ownership, as shown in Map 7.9.

Map 7.9 Kauaeranga foreshore showing sediment plumes.

Kauaeranga foreshore showing sediment plumes from the Waihou and Piako Rivers, legal parcel boundaries (yellow lines), remaining Māori-owned land (red), and Ahu Moana (light blue). Map is drawn south-north. (Sources. CRS LINZ NZ, Māori Land data Māori Land Court. Photo Google Earth 2016).

Historic loss and degradation

Local iwi gave lands for the establishment of Thames, and leased land for mining, forestry and fishing. But within a few years it became clear that Māori were being deprived of their prized fisheries, they witnessed degradation of their ancestral lands and waters. Māori sought to defend their fishing places, as expressed in this 1869 petition against the Thames Beach Bill by Te Moananui and other Hauraki chiefs to the Governor:

“The word has come to us that you are about taking our places from high-water mark outwards. You, the Government have asked for the gold of Hauraki; we consented. You asked for a site for a town; you asked also that the flats of the sea off Kauwaeranga should be let; and those requests were acceded to and now you have said that the places of the sea that remain to us will be taken.

O friends, it is wrong, it is evil. Our voice, the voice of the Hauraki, has agreed that we shall retain the parts of the sea from the high water-mark outwards. These places were in our possession from time immemorial; these are the places from which food was obtained from the time of our ancestors even down to us their descendants. ... It was thought that the taking of land by you ceased at Tauranga and other places; but your thought has turned to Hauraki."

The petition fell on deaf ears, and an ever increasing fleet of ships obliterated the rich fishery, as described by Sinclair (1999):

"The foreshore opposite the towns of Shortland and Grahamstown (now Thames) was a broad mudflat formed by sediments from the Waihou and Kauwaeranga rivers. It was an important flounder fishing ground. Godwits and shellfish were also taken. In times past, stakes had been driven into the mud to support fishing nets. By 1870, these had mostly been broken off by ships, but there apparently remained some stone walls associated with fishing. It seems that the mudflat was difficult to cross by foot except near the beach, and there had been some encroachment by the sea over what had once been dry ground."

Already in 1870 colonial efforts had significantly degraded the Thames foreshore, and expanding mud was encroaching on fisheries in the Firth of Thames. This remains one of the most polluted sites in the Hauraki Gulf, and mana whenua still maintain their efforts for meaningful participation in its management. Sediment plumes from the Waihou and Piako can be seen below. Pending Treaty settlements are expected to create a new mana whenua-council co-management body for the Waihou, Piako, and Coromandel Peninsula streams. This will be an important vehicle for reducing the sedimentation of Tīkapa Moana / Te Moananui-ā-Toi.

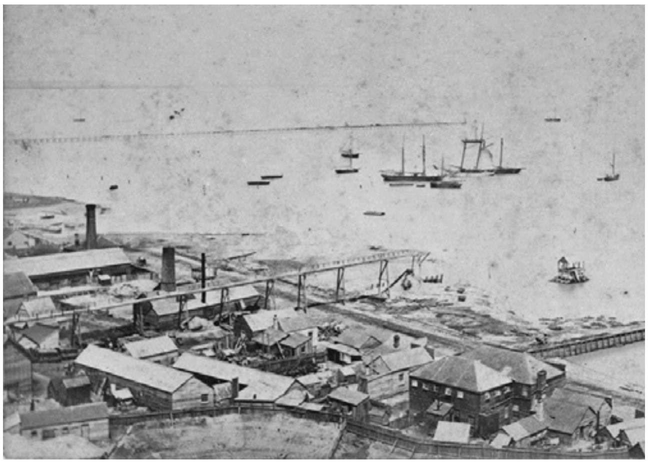


Figure 7.16 Photograph of Thames Foreshore in 1869.
(Source Sir George Grey Special Collections, Auckland Libraries, 7-A11453)

Figure 7.17 Matai Whetu Marae at Kopu south of Thames (Source. Te Korowai Hauora o Hauraki, 2015)

PART FOUR: PROSPEROUS COMMUNITIES

WĀHANGA TUAWHĀ: KOTAHITANGA

8

INSPIRING THE HAURAKI GULF MARINE PARK COMMUNITY.
HE WHAKAHAU I TE HĀPORI O TĪKAPA MOANA / TE MOANANUI-Ā-TOI.

If winning minds is a science, winning hearts is an art.

9

PROVIDING ACCESS TO THE HAURAKI GULF MARINE PARK.
HE TUKU URUNGA ATU KI TĪKAPA MOANA TE MOANANUI-Ā-TOI.

10

DESIGNING COASTAL INFRASTRUCTURE.
HE WAIHANGA AHOAHO PŪNAHA TAKUTAI.

Tungia te ururua, kia tupu

Burn the overgrowth to allow the flax shoots to grow through

11

IMPLEMENTATION OF THE PLAN.
WHAKATINANA I TE MAHERE.

The last Part of the Plan is entitled Kotahitanga – Prosperous Communities. Kotahitanga means unity, or collective action, and Part Four is concerned with people and communities, and their connection to and relationship with the Hauraki Gulf Marine Park. It seeks to balance growing strong and prosperous communities, including those of mana whenua, the infrastructure needed to provide access to the Park, and the need to safeguard and restore the marine environment.

Kotahitanga - Prosperous Communities consists of three short chapters, Chapter 8, Inspiring the Hauraki Gulf Marine Park Community, Chapter 9, Providing Access to the Hauraki Gulf Marine Park, and Chapter 10, entitled Designing Coastal Infrastructure. Each chapter provides an overview of issues, lists a number of related objectives, discusses how these might be achieved, and proposes specific actions. Kotahitanga, bringing together neighbouring and diverse communities in a combined effort, is a continual theme throughout these chapters.

8. INSPIRING THE HAURAKI GULF MARINE PARK COMMUNITY

HE WHAKAHAU I TE HĀPORI O TĪKAPA MOANA TE MOANANUI-Ā-TOI

If winning minds is a science, winning hearts is an art.

The Hauraki Gulf Marine Park is an icon, a taonga that must be preserved and restored for future generations. The coast, the water and the islands provide places for work, recreation and adventure, peace and tranquility, and for learning about and sharing knowledge of the rich cultural history and natural values of this place. But the mauri, the life force, of the Hauraki Gulf Marine Park is in decline and the deterioration must be turned around.

Making the substantive changes that are needed cannot be achieved through rules and regulations alone. The changes that must happen are the responsibility of every person who loves or depends on the Hauraki Gulf Marine Park. We must all embrace, and take part in, ensuring our knowledge, understanding, commitment and passion work towards the restoration of this special place.

Kaitiakitanga and guardianship obligations mean that the health of the Hauraki Gulf Marine Park lies in the hands of us all. Harnessing the hearts and minds of the community and mana whenua and unifying a 'sense of place' and purpose are the keys to the future health of the Hauraki Gulf Marine Park. We will all have to make concessions to deliver the right outcomes.

It is in our hands to see that Kaitiakitanga / guardianship is practiced by all to ensure:

- The Hauraki Gulf Marine Park is valued.
- The Hauraki Gulf Marine Park retains a sense of place for future generations.
- The Hauraki Gulf Marine Park provides a quality experience for all.

In identifying the future directions for the Hauraki Gulf Marine Park the community and mana whenua have overwhelmingly told us that preserving and restoring the Hauraki Gulf Marine Park through kaitiakitanga / guardianship is essential. This includes promoting understanding of and connection with the Hauraki Gulf Marine Park through education, conservation, advocacy, recreation, volunteering, and accessibility to popular places – as evidenced in the selection of quotes following.

WHERE ARE WE – WHAT ARE THE ISSUES AND OPPORTUNITIES?

It is important that everyone is able to access the Hauraki Gulf Marine Park. It is also important to provide for mana whenua to undertake customary activities within their respective rohe.

These are some of the many factors that influence our objectives and recommendations:

- The population for the Auckland Region is predicted to increase to 2.5 million by 2041.
- The changing and growing population will require planning to ensure places remain accessible while managing those pressures to avoid over-reaching the capacity of those places to absorb more people.
- Recreational boat ownership is linked to population growth and household numbers and will place increasing demands for infrastructure at many access points and marine places
- Water-based recreational activities on the coastal fringe bring people together, offering an important connection between recreation and the environment. Growing demand will require management of associated infrastructure to ensure the best use of available space.
- Emerging trends towards recreation corridors on the land could potentially be mirrored on the sea. Walking is the most accessible and most popular activity throughout the coastal area and the provision of high quality, well-used and safe walkways and cycleways is important.
- Environmental education is important for both present and future generations both in and outside the classroom and must be encouraged.
- The mauri of the moana, freshwater, coastal and terrestrial ecosystems, wāhi tapu sites and other identified taonga need to be protected from adverse impacts caused by accessibility and use.
- More and better infrastructure to be provided for people with disabilities.

Value statement – some of the things you have told us include:

Kaitiakitanga

- A healthy Gulf, clean, clear water
- We must conserve this for the future, we can't lose its beauty
- We must be conscious and caring

Escape and Tranquillity

- A tranquil place and breathing space
- A coast with special and peaceful qualities
- A spiritual place that nourishes people

Unpredictable and irresistible adventure

- A place to experience wilderness and nature
- Where you feel expectation and anticipation of what you might see out there
- Where you meet all sorts of people

Intergenerational Stories

- A historic place
- A place of memories and where traditions are recognised and created
- Full of old characters, local colours and good stories

An icon

- A gem, incredible headlands and vistas
- It's nice to know it's there, even if we can't get to it

A learning ground

- The ocean and coast is our classroom
- Everyone can have boat stories and the boat and water are connecting points

Live, work, eat, play

- A way of life where we can practice our customs and traditions
- Inclusive for locals and visitors
- A place to catch dinner
- A bridge between the urban and rural divide
- Where we connect with our neighbours and community
- Where recreation creates business opportunities

Objective 1.

Engage 'hearts and minds'

We need to celebrate our sense of place and connection to the Hauraki Gulf Marine Park in order to inspire and implement kaitiakitanga and guardianship initiatives. This can be achieved in a variety of ways - from collecting stories and sharing them through the arts, tourism and commercial sectors, to hands-on involvement in the many restoration projects on islands, around the coastline and in the catchments. We need to come together with ongoing programmes to 'engage the hearts and minds', implement kaitiakitanga and guardianship and instil pride and wellbeing.

Action:

1) By 2019, implement a multi-agency, community, and mana whenua led media and marketing campaign to engage 'Hearts and Minds'.

Objective 2.

Embrace volunteering

Kaitiakitanga / guardianship activities around the Hauraki Gulf Marine Park, on the islands, and in the catchments, provide a vast network of opportunities for people to be involved in projects that are actively restoring essential habitats to protect our native species. Examples of these conservation activities range from re-planting islands and restoring mussel beds to keeping beaches clean, controlling plant and animal pests and monitoring shellfish.

Many of the Hauraki Gulf islands are free of animal pests and provide safe havens for a number of our endangered species. Many kilometres of catchments are fenced and planted, and thousands of people are involved in volunteer activities throughout the park. This collective action is to be celebrated, encouraged and expanded. This is kaitiakitanga in action.

Action:

2) By 2018 set up a coordinated network of programmes and volunteers to provide opportunities for involvement in kaitiakitanga and guardianship activities that restore the mauri of the Hauraki Gulf Marine Park.

Objective 3.

Expand marine education opportunities

Early childhood engagement with the Hauraki Gulf Marine Park can help engender a lifelong connection with the place and willingness to care for it. It is therefore important that as many children as possible are able to have positive experiences interacting with the marine area. There are currently several marine education programmes operating within the Park, and these need to be supported, but additional opportunities to increase capacity need to be investigated.

Action:

3) By 2017, undertake a stock take of current marine education facilities and programmes within the Hauraki Gulf Marine Park.
4) By 2018, develop a marine education strategy for the Hauraki Gulf Marine Park which identifies how best to meet current and likely future demand, and how to better engage mana whenua, children from low decile schools, and people from new immigrant communities.

Kayak trail

Te Awa Moana – the seagoing pathway – is the first formally developed and promoted kayak trail along the coast. Of the 2500km long Hauraki Gulf Marine Park coastline 58% is adjacent to publically owned land or roads, including an outstanding network of parks and open spaces. These all protect natural values that are enjoyed, free of charge, by residents and visitors alike and can be accessed by kayak.

http://regionalparks.aucklandcouncil.govt.nz/articles/te-ara-moana-the-sea-going-pathway

Objective 4.

‘One Gulf one message’ strategy

> *“Kia kaha, kia māia, ki te tiaki i ēnei taonga tuku iho hei oranga mo ngā uri whakatipu”*
>
> *Be strong, be steadfast, and nurture those treasures handed down from the ancestors, for us to build up.*

A ‘One Gulf One Message’ strategy will involve a multi-agency delivery of education campaigns, such as learn-to-swim programmes and rock fishing awareness programmes, to ensure that the population is safe while enjoying the coast. These could include:

- Restoration initiatives, community events and campaigns
- Opportunities to participate in kaitiaki/guardianship activities such as community shellfish monitoring, and planting on islands or in catchments
- Opportunities to become involved in local decision making, such as the development of coastal management strategies (See the Ahu Moana initiative)
- Marine safety messages for those on the water such as awareness of shipping lanes, and advice for managing conflicts between recreational activities
- Widely distributed fisheries management regulations and information about harvesting protocols

Action:

5) By 2018, start implementing a ‘One Gulf One Message’ Strategy to increase the availability of public information relating to the Hauraki Gulf Marine Park.

Environmental education

Environmental education includes ‘Adventure Education’ and ‘Education Outside the Classroom’ and provide curriculum based learning that extends beyond the classroom. Such activities are provided at outdoor coastal education camps like the Marine Education and Recreation Centre (Long Bay), Motutapu Outdoor Education Camp, on Rotoroa Island and at Cape Rodney – Okakari Point Marine Reserve and in popular programmes such as Waterwise, educational sailing programmes and Sea Scouts. All use the marine environment to deliver a range of water based activities to provide safe, fun, challenging and adventurous programmes to develop life and water safety skills. Programme costs and, proximity to the activity may limit involvement of lower decile schools and is an issue that needs addressing.

PLACE STUDY: REVIVE OUR GULF – THE MUSSEL REEF RESTORATION TRUST

One of the many existing groups undertaking restoration initiatives within the Hauraki Gulf Marine Park is the Mussel Reef Restoration Trust and their Revive our Gulf programme.

Green-lipped mussel[1] beds once covered much of the Firth of Thames and Tāmaki Strait (as much as 500 km^2), down to around 30 m deep. The reefs disappeared under the pressure of commercial dredge fishing between about 1910 and 1968 to mainly supply the Auckland market. Since the fishery collapsed in the late 1960s, no regeneration of the beds has occurred. Three especially important ecological services were lost.

Filtering

Mussels helped to maintain water quality in the Hauraki Gulf Marine Park to a high standard by their filter-feeding activities. Oxygen, phytoplankton and fine sediment particles are removed from water that the mussel pumps through its mantle cavity. The oxygen is used for respiration, and the phytoplankton is used for food; while suspended sediments that have no food value are packaged with mucus and deposited on the seabed as "pseudo-faeces". In this way, the water is cleared of fine sediments, and phytoplankton that otherwise could accumulate in blooms with associated adverse effects, are consumed. McLeod (2009) estimated that the historic mussel beds could have filtered the entire water volume of the Firth of Thames in less than a day, compared to over a year on the basis of current mussel biomass. Without this filtering, the Hauraki Gulf Marine Park has become more turbid and more susceptible to adverse effects associated with nutrient enrichment.

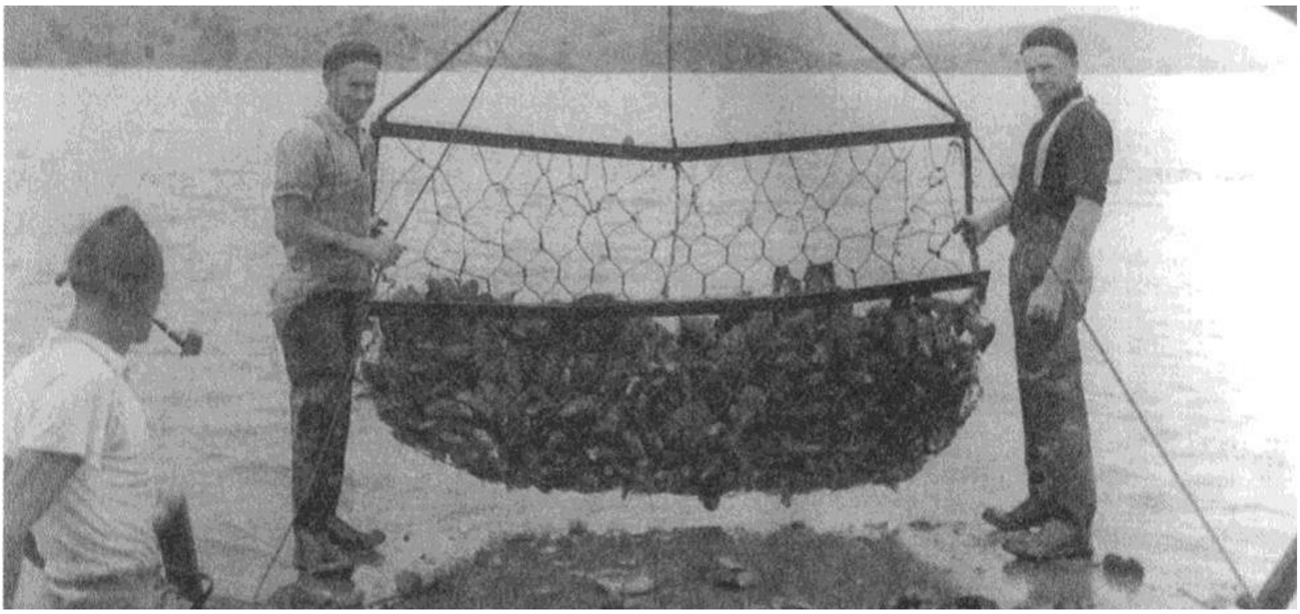
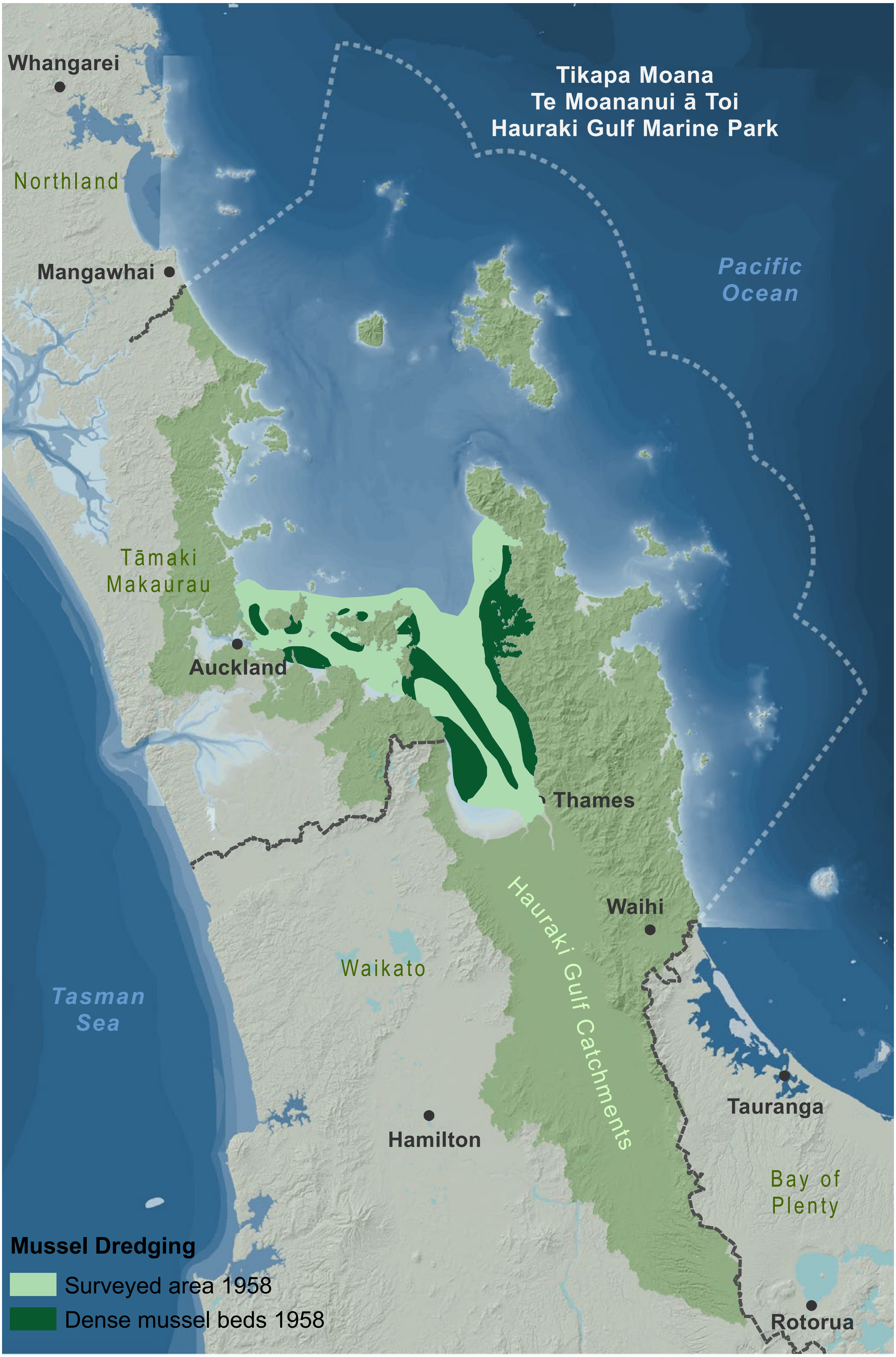


Figure 8.1 Mussel dredging in the 1950s

1 Perna canaliculus, which is one of sixteen species of mussel species found in New Zealand. It is endemic to New Zealand.



Map 8.1 Extent of mussel dredging within the Hauraki Gulf in 1958

Nursery habitat

Mussel reefs provide habitat for fishes and invertebrates to shelter and grow. These extensive beds of green-lipped mussels provided food for many species, and habitat for a wide range of marine life including sponges, sea squirts, bryozoans, small invertebrates, starfish, crabs, fish (including snapper), eagle rays and octopuses. The Hauraki Gulf Marine Park has also lost other biogenic habitats that supported this function, such as (subtidal) seagrass meadows and horse mussel beds.

Productivity

Mussel reefs have the highest secondary productivity (generation of biomass) of any marine habitat yet recorded in New Zealand. Measures of remnant beds found them to have on average ten-fold higher small fish densities, four times the average invertebrate density and seven times the biomass, six times the invertebrate productivity, and greater species richness than adjacent bare sediment areas (McLeod 2009, McLeod et al. 2014). McLeod et al. (2012) noted that, even though dredging never recommenced, the mussel reefs have not recovered. They investigated two potential reasons for this: firstly, increased sedimentation and associated suspended sediments, which reduce the ability of mussels to survive, and secondly, limited recruitment due to low larval supply or reduction in habitat suitable for larval settlement and post-larval survival.

The Mussel Reef Restoration Trust's 'Revive our Gulf' project seeks to restore these important services. Supported by the aquaculture industry and regulatory agencies, the Trust has deposited 77 tonnes of green-lipped mussels on the seafloor in areas where they were once abundant. The latest research from these beds shows that the surviving mussels are growing but there are still challenges to overcome.

Figure 8.2 Seeding a reef (Source. NIWA, permission granted by M. Morrison)

The Revive our Gulf project has the following goals:

- Research units established with universities and Crown Research Institutes within one year to provide scientific support for the restoration, and attract and engage young scientists into marine research.
- One square kilometre of seabed restored within 15 years.
- Ten "seed" beds independently established by local communities within ten years.
- Large scale mussel restoration areas formally designated in the Hauraki Gulf Marine Spatial Plan within three years.
- Three 800 m^2 demonstration beds with habitat suitable for further colonisation established within three years
- Purchase or establishment of a mussel farm within 10 years to provide an ongoing source of adult stock.

Figure 8.3 Before and after mussel restoration photos - Visit the Mussel Reef Restoration Trust at http://reviveourgulf.org.nz/

9. PROVIDING ACCESS TO THE HAURAKI GULF MARINE PARK

HE TUKU URUNGA ATU KI TĪKAPA MOANA / TE MOANANUI-Ā-TOI

Our experiences of the Hauraki Gulf Marine Park take in a myriad of spaces, whether we are paddling along traditional waka routes, walking along the coast, snorkelling around an island, mooring in a cove, seeking out the best fishing spot, harvesting kaimoana, accessing ancestral wāhi tapu, learning to sail, surf or kayak, hiking up hills to experience the Hauraki Gulf Marine Park vista, or simply finding a tranquil patch to sit, relax and connect to Papatūānuku (Earth mother) and Tangaroa and Hinemoana (God and Goddess of the Sea).

Reducing the vulnerability of the Hauraki Gulf Marine Park to the impacts of increasing population and visitors is essential, whilst at the same time recognising the importance of providing for mana whenua customary rights. This can be achieved through kaitiakitanga/guardianship driven management.

Objective 5.

A place-based decision making approach

A place-based decision making approach would enable mana whenua and local communities to guide the development of their places, ranging from creating busy hubs to the protection of quiet and secret places. It would identify the appropriate level of protection, scale of development and infrastructure for each place, as well as the level of accessibility and awareness that the community sees as appropriate.

Place-based management should take a precautionary approach to inform planning responses for particular places aimed at developing or retaining quality visitor destinations, providing the process for collective discussion in a structure way, and assisting with transparency in decision-making and communications.

The values statements drawn from the Listening Posts, the Mātauranga Māori Survey and the Uses and Values survey underpin the development of this tool. The primary focus of place-based management for mana whenua and communities is to:

- Identify their values from their ‘sense of place’.
- Identify the places that need to be protected.
- Identify the visions, goals and objectives for the area.
- Protect and provide for cultural landscape and sites/areas of importance.
- Define community based outcomes for education and restoration initiatives.
- Identify hubs of activities.
- Identify type of infrastructure associated with those hubs.
- Identify different experiences in different places and what infrastructure is required for those activities.
- Take stock of existing infrastructure, use, services and projected requirements.
- Identify appropriate management and legislative responses for the area.

Action:

6) By 2020 agencies should develop and implement a Place Based Initiative that provides a means for mana whenua and communities to plan for the future of their places by:
   - Identifying cultural landscapes, sites, areas and activities of significance to mana whenua.

- Undertaking a stock-take of what is available, current trends, and existing infrastructure.
- Setting the vision and aspirations for each place – from busy hubs to the 'secret' places that need protection.
- Considering appropriate management regimes to give certainty to future planning decisions.

Objective 6.

Managing visitor experience

Place-based management should inform specific planning responses for particular places that are aimed at maintaining and expanding quality visitor destinations, involving local communities and mana whenua in visitor-related discussions, ensuring transparency in decision-making, and effective communications. It would help with:

- Identifying the visions, goals and objectives for an area.
- Protecting mana whenua cultural landscapes, sites and areas.
- Taking stock of existing infrastructure, use, services and projected requirements.
- Appropriate management tailored for each area.

A Visitor Strategy should:

- Be developed with community and mana whenua input.
- Provide authentic experiences based on the unique values of each place within the park.
- Identify reasons for visitors to stay, to value the Hauraki Gulf Marine Park, and to support Gulf communities.
- Address the unique challenges facing some areas, for example capacity issues and the need to manage visitor numbers for the Coromandel Peninsula, and branding and marketing strategies for Great Barrier and Waiheke Islands.

Action:

7) By 2018, complete a Visitor Strategy for the Hauraki Gulf Marine Park, in association with mana whenua and communities, based on the place-based decision making approach. The strategy should set out a pathway that recognises and preserves the rights of mana whenua, the mauri of special places and protects the values of key destinations while creating important opportunities for expanding local economies.

Objective 7.

Create and implement a Hauraki Gulf Marine Park transport strategy

A transport strategy would provide for well-publicised and regular public transport options to the islands and to a range of locations throughout the Hauraki Gulf Marine Park. This would include passenger and car ferry services, buses/trains and mobility access and would support local community economic opportunities by connecting remote communities to markets. The transport strategy would be guided by the place-based decision making approach and embrace the concept of a 'Blue Highway' (see below).

Action:

8) By 2020 develop a Hauraki Gulf Marine Park transport strategy with the communities and mana whenua that plans for future population growth and economic prosperity and provides guidance on future infrastructure requirements.

Objective 8.

Create a 'Blue Highway'

The Blue Highway goes hand-in-hand with the Transport Strategy and decisions about 'what should go where'. There are a number of communities and locations that are difficult and/or expensive to reach for both locals and tourists. In large measure, the current approach to sea transport is focused on a central Auckland 'hub and spoke' model, which is a radial model of transport, where the city center is the hub of activity.

The potential exists to create a series of interconnected regional hubs - a 'Blue Highway'. The creation of 'hubs' should enhance current access to the Hauraki Gulf Marine Park by creating an expanded infrastructure network. This is not a short-term project, as significant investment in infrastructure is required. An example of the current 'hub and spoke' model and the contrasting potential 'Blue Highway' network is shown in Map 9.1.

Action:

9) By 2020 integrate the Blue Highway concept into the Hauraki Gulf Marine Park Transport Strategy.

Map 9.1 Elements of a Hauraki Gulf Marine Park transport strategy

Objective 9.

Supplement Blue Highway with 'Walking on Water' strategy

'Walking on water' runs alongside the Blue Highway and builds on the provision of easy access to the marine environment and islands of the Hauraki Gulf Marine Park for walking, kayaking, cycling, and camping.

Walking on Water is aimed at developing low cost options for accessing the Hauraki Gulf Marine Park, marine hubs and the public parks along the coast while protecting areas of cultural significance. This would reduce possible cost barriers for lower socio-economic communities and also enable new migrant communities to access, and create a relationship with, the coast. Sustainably designed, high quality, well used and safe greenways/ walkways and cycleways enable communities to access the coast, providing access to affordable play along the coast or in the water.

Action:

10) By 2018 develop a 'Walking on Water' strategy to promote coastal walking and provide easy access to islands and island hopping. This needs to include provision of walkways, cycle ways, and camping grounds.
11) By 2018 define and implement a 'Camping Strategy' to ensure access to sustainable and affordable extended stay options for the community.
12) By 2020, undertake a stocktake of public coastal land that can be made accessible, while protecting sites of cultural significance and natural values, to provide access to a wide range of quality destinations.

Population pressure

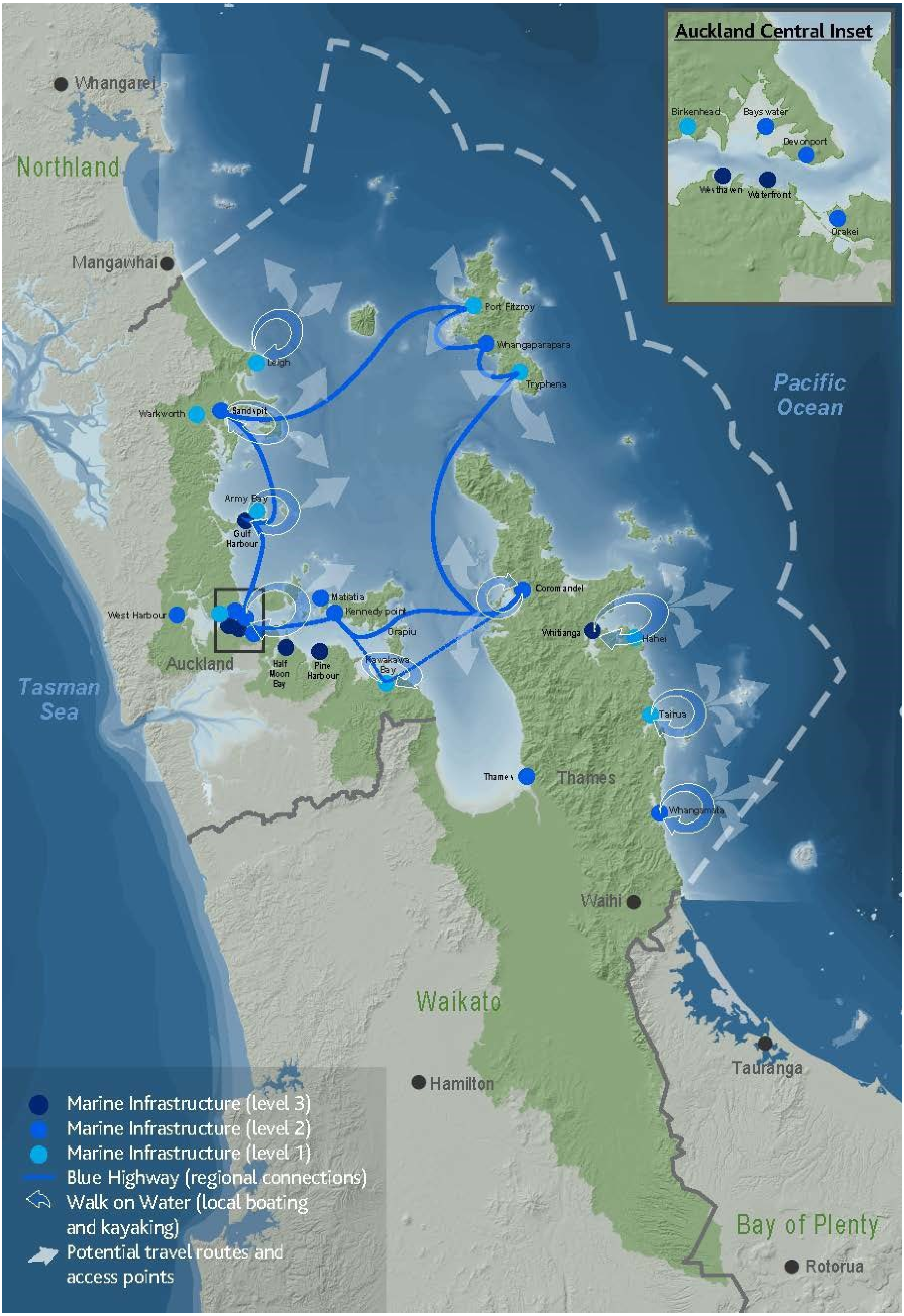
Recreation use data shows informal settings are important for the bulk of the population. However, with increasing population there is increasing demand and pressure to develop land and control/allocate use of land and water for private and commercial use.

To secure access along the coastline means -

- de-cluttering spaces where possible – removing structures that are no longer needed
- planning to ensure that there are areas free of commercial activity (in so far as this takes away the opportunity for informal play)
- enable cheap/low cost/incidental play areas.

Share with care approach

Rules and regulations should generally be avoided in favour of a 'share with care approach' that is enabling and responsive to changing recreation demands in the Hauraki Gulf Marine Park. Providing some spaces for particular recreation activities through spatial allocation in order to minimise on-water conflicts, may be appropriate. This could result in some rationalisation, such as the co-location or relocation of pole moorings for example which are an important and legitimate recreational use but none-the-less occupy space that impacts other activities.



Map 9.2 Example of 'Blue Highway' Showing Inter-Connected Transport Links and Access to Hauraki Gulf Communities

10. DESIGNING COASTAL INFRASTRUCTURE

HE WAIHANGA AHOAHO PŪNAHA TAKUTAI

Tungia te ururua, kia tupu

Burn the overgrowth to allow the flax shoots to grow through

Coastal infrastructure connects us to the water. It spans our major international port, local wharves and marinas, small jetties and boat ramps. All of these require associated land-based infrastructure such as roads, car parks and utilities. They all have an impact on the Hauraki Gulf Marine Park.

Coastal infrastructure occupies space that may be used for other purposes. It is often large scale and can be intrusive and unattractive. But we need it for our marine industries and to provide people with access to the marine space. It is therefore important that the Park's infrastructure is wisely planned, designed and constructed to maximise effectiveness while minimising environmental impacts. Boat ramps are a good example. As the population increases so will the demand for boat ramps. Managing this demand will require innovation when planning and designing required infrastructure.

Poorly designed and located infrastructure can create more problems than it solves. For example, a poorly built sea wall or groyne can create erosion problems elsewhere, or simply create an eyesore. On the other hand, well planned infrastructure can be enormously beneficial - it can provide multi-faceted benefits for the community and the economy, while also contributing to the restoration of the mauri of the Hauraki Gulf Marine Park. As the population surrounding the Park grows, so will demand for coastal infrastructure. It is therefore important that we have a clear strategy for future infrastructure that minimises adverse effects to the environment, community, and customary activities.

This plan is not prescriptive about where infrastructure should or should not be located. Infrastructure can be very controversial, as we have seen with the debate over proposed extensions to the Auckland Port, and the Mātiatia marina proposal. These are difficult problems that communities have struggled to solve.

The key mechanism for determining the location of infrastructure should be through consultation with mana whenua and communities, and strategic planning under the Local Government Act and Resource Management Act. This plan has concentrated on identifying mechanisms to ensure good design for all infrastructure constructed within the Hauraki Gulf Marine Park, the application of Blue Design Principles and the establishment of a Hauraki Gulf Marine Park Design Panel.

A selection of quotes from members of the public at listening posts

Mana whenua

Minimise business and charter operations to certain times of the year to ensure sustainability for the marine, ecosystems, biodiversity life to restore.

Engage in actual conversation and genuine consultation with mana whenua; not paper based, not project based, but genuine conversations.

St Marys Bay

We need to think about design – water is so integral and important – we need to look at slowing down its passage and use of treatment techniques before it leaves a structure or enters a waterway.

Whangamata

Councils should think 100 year plans NOT short term plans – think future sustainability

Welcome all the people and not put brakes on innovative ideas that can make a living here. We don't have to have rules about everything without some foresight – be progressive.

The parking is inadequate, launching is OK, but getting back in is worse. There is a line of boats out to sea waiting to come back in.

Hamilton

Fuel, fresh water and rubbish disposal are problems on the Gulf. There used to be a floating rubbish barge system.

Mahurangi

There's an awful lot of land around the coast that we need to keep in the regional park domain. Everyone wants a place with a view, on the ridges, on the edges.

Ramp rage – pressure on ramps at Omaha

Are there enough boat ramps to meet demand?

Parking is one of the biggest problems.

Point England

There are more and more launches and power vessels. They are quicker and don't want to learn about the sea. They don't need to learn to sail. It's like being in a washing machine sometimes.

Lack of appreciation of how serious the sea level rise is going to be – particularly the public piece.

We need to release the pressure on the local parks by linking the regional parks better.

The Summary and Outcomes of Sea Change – Tai Timu Tai Pari Community Engagement (January 2014 – February 2015) included the following feedback:

- Develop recreational and commercial infrastructure that will enhance the environment and support connection between people and communities.
- Erosion, natural and human, is an issue.
- Upgrade existing infrastructure 'at place' where practicable, to cope with ever growing demands.
- There needs to be balance between different users between over-use, use and the needs of the natural environment.
- Connect the Hauraki Gulf Marine Park by building a network of places linked by a 'blue highway' of water transport options.
- There is a willingness to accept pay-per-use at boat ramps and marinas but more research options are required before general consensus is reached.
- There is a need for more/improved/ more rational use of boat access and moorings.

Objective 10.

Create and implement blue design principles

Whakahoki mai te mana rangatiratanga o te moana nei ki te iwi.

Restore the chiefly authority over our ocean to the tribes/people

Councils should collaborate with mana whenua and the community to develop a set of tikanga/values based principles that will apply to infrastructure within or relating to the coastal marine area. The principles need to encourage designs that work with nature, minimise environmental impacts, and avoid problems for future generations. The Blue Design Principles need not be prescriptive, and should be designed to foster innovation and creativity in achieving desired outcomes. They should encourage innovative design in the use of materials including:

- The use of environmentally-friendly materials.
- Alternatives to copper based antifoul.
- Alternatives to marine dumping of dredging spoil.
- Alternatives to materials contributing to marine debris issues
- Retrofitting stormwater systems to include pollutant traps and filters.

The principles should encourage the development of infrastructure that performs a wide range of functions. For example, in addition to its primary purpose - infrastructure can create new ecological habitat, provide access for the community, and improve the ability of mana whenua to interact with their moana.

There should be clear benefits provided for projects that embody the principles, such as a more streamlined consenting process.

Stormwater wetland treatment systems protect the coastal environment by filtering out heavy metals and sediments from road run off, provide habitat for fish and birds and provide the community with the opportunity to interact with natural systems.

Action:

14) By 2018, develop a set of 'Blue Design Principles' for infrastructure that impacts on the Hauraki Gulf Marine Park.

Figure 10.1 An Example of Blue Infrastructure

Objective 11.

Establish a Hauraki Gulf Marine Park Design Panel

The Hauraki Gulf Marine Park advisory panel will advise applicants for major infrastructure projects within the Park, for example marinas, boat ramps, ports, undersea cables, and the like. The advisory panel would inform applicants on the unique Hauraki Gulf environment and the physical and legal issues. It would also provide project-planning advice to ensure good outcomes for the applicant, the whole community and Gulf. The Urban Design Panel has been put forward as a model but the Hauraki Gulf Marine Park Design Panel will likely sit with the Hauraki Gulf Forum or its successor.

Taking lessons from the Auckland Urban Design Panel and Te Aranga Principles (see text box below) a streamlined consent process could incorporate Blue Design principles. The Hauraki Gulf Marine Park Design Panel would provide consistent advice to, and coordination of, agencies to ensure complex issues are dealt with in a timely manner.

At times, decisions regarding the location and design of coastal infrastructure have been made without the involvement of mana whenua, and have resulted in significant cultural impacts. A Hauraki Gulf Marine Park Design Panel would ensure the engagement of mana whenua in planning and decision-making, so that adverse effects on the mauri of the Park, wāhi tapu and culturally significant sites/places and customary activities can be avoided.

Identifying space that could be considered for the development of tauranga waka (waka mooring and storage places) is a good example. In the Tauranga harbour space was already set aside as tauranga waka but there is no similar facility in Tāmaki, despite the coastline having many significant tauranga waka prior to more than a century of reclamations. This is the type of situation where the design panel would lead applicants through a process, the mauri of the Gulf is improved and the result is a win-win for everyone.

Action:

15) By 2020, create a 'Hauraki Gulf Marine Park Design Panel', with mana whenua representation, to provide streamlined resource consent processes for large and medium scale projects that meet the Blue Design principles.

Auckland Urban Design Panel

Good urban design is critical in enabling Auckland to become the world's most liveable city. As part of meeting aspirations for a better built environment, an Auckland Urban Design Panel has been established. This Panel provides independent design review of significant projects, for both private and public developments across the region, and is informed by Te Aranga Principles. This means that developers can get an independent peer review and free advice from the Panel before applying for consent. Complex issues can be dealt with early on, meaning that time delays are reduced when resource consent applications are lodged. In addition it helps to ensure consistent advice during the consenting process and, where needed, co-ordination of council departments.

Te Aranga Principles

The key objective of Te Aranga Principles is to enhance the protection, reinstatement, and development of mana whenua cultural landscapes enabling all of us to connect to and deepen our 'sense of place'. The Principles seek to foster and guide both culturally appropriate design processes and design responses that enhance our appreciation of both the natural landscape and built environments. Te Aranga Principles also provide other stakeholders and the design community with a clearer picture as to how iwi/hapū are likely to view and wish to participate in the design and development of the built environment within their ancestral rohe.

11. IMPLEMENTATION OF THE PLAN

WHAKATINANA I TE MAHERE

Each of the objectives and associated actions in the Plan are important in their own right, and must be seen collectively as the pathway to restore the mauri of the Hauraki Gulf Marine Park.

It is clearly not possible to undertake all the actions immediately, and agencies and stakeholders will need to prioritise them as a time-staged implementation. This is consistent with our generational perspective; it took several generations to create the current impacts on the Hauraki Gulf Marine Park, so we expect that restoration to our desired outcomes may also take decades.

This Chapter outlines how agencies can stage implementation. Included are some attributes of future governance of the Hauraki Gulf Marine Park that we believe are essential for the implementation of this Plan, along with monitoring and research needs, the use of cultural health indicators, and some commentary on prioritisation. We do not attempt to prescribe specific priorities for monitoring, research or indicators, this should be done by the respective agencies, and overseen by the Governance Entity.

HAURAKI GULF GOVERNANCE ATTRIBUTES

Strong, effective co-governance is the key element that will influence the success and implementation of the Plan.

Governance is already in place through statutory agencies, and much of the implementation will occur through these agencies; in particular the Auckland Council, Waikato Regional Council, the Ministry for Primary Industries, and DOC.

An overarching perspective is provided by the Hauraki Gulf Forum. This body is currently considering its future structure and attributes, and its new form may provide the coordinating co-governance entity that is essential for the implementation of the Plan.

We describe here the attributes of governance the Stakeholder Working Group strongly believes must be adopted for long term implementation of the Plan, but do not attempt to design an explicit future governance structure or funding model.

Membership of the governance entity

- The make-up of the Governance Entity should reflect co-governance principles with membership from mana whenua and the community at large.
- All members should bring the ability to make decisions, to influence people. They need to be community leaders, with considerable courage and the ability to drive outcomes for the Hauraki Gulf Marine Park.
- The size of the Governance Entity should be manageable but large enough to allow for sufficient representation of the various groups, and the range of skills required.
- Central and local government agency staff should act as advisors to the Governance Entity.
- The governance body should be sufficiently mandated to be able to contribute meaningfully to the outcomes sought in this Plan for the Hauraki Gulf Marine Park.
- The entity may initiate "Action Committees" with wider membership to oversee and report on the various initiatives undertaken.

Functions

The Governance Entity needs to be the champion for the Hauraki Gulf Marine Park and focus on the acceptance, adoption, and implementation of the Marine Spatial Plan. This includes the following:

- Leading strategic Gulf-wide initiatives described in the Plan that are clearly not the role of any particular statutory agency, and/or facilitating inter-agency cooperation to ensure priority Initiatives are implemented.

- Overseeing the design of a detailed implementation plan (within 6 to 9 months of adoption of the Spatial Plan), which could commence with prioritised fisheries reviews, the development of key performance indicators, and commitment to monitoring and review protocols being established.
- Overseeing and coordinating research, information gathering, and reporting for the Hauraki Gulf Marine Park, as well as providing a central place where Gulf information[1] is held.
- Establishing a public awareness and education campaign on the implementation of the Spatial Plan and other relevant issues associated with the Hauraki Gulf Marine Park.
- Coordinating and supporting the community initiatives and restoration groups actively engaged with the care of the Hauraki Gulf Marine Park
- Providing recommendations to the Minister for Primary Industries on fisheries sustainability measures and regulations applying to the Hauraki Gulf Marine Park. This includes working with the Minister for Primary Industries and local mana whenua groups in establishing customary fisheries tools such as mātaitai, taiāpure, and rāhui.
- Supporting mana whenua and local communities in the establishment of Ahu Moana.
- Assisting iwi to realise their goal of greater participation in the governance, management and kaitiakitanga of the marine space.
- Working closely with DOC, iwi/hapū, and local stakeholder groups and communities to help establish the network of MPAs identified in the Plan and providing support to iwi/hapū and local communities to ensure MPAs are successfully managed in the long term.
- Ensuring that all government agencies and stakeholders consider potential impacts on the Hauraki Gulf Marine Park's ecosystems, and document their process as an integral part of their decision-making systems.
- Developing guidance material on how an ecosystem-management / Mātauranga Māori management approach should be applied to fisheries, conservation, and resource management decision-making in the Hauraki Gulf Marine Park and its catchments.
- Producing a five-yearly "State of the Hauraki Gulf Marine Park" report, which would include a review of the effectiveness of the Marine Spatial Plan and the extent to which targets are being met.
- Revising the Marine Spatial Plan to respond to issues raised in the review. The Governance Entity should be responsible for approval of each revised Spatial Plan, which could then be given statutory recognition under a revised Hauraki Gulf Marine Park Act, with agencies required to give effect to it under their various statutory instruments.
- Reviewing relevant draft statutory documents prepared by agencies prior to public notification to ensure that they give effect to the Spatial Plan and the Hauraki Gulf Marine Park Act. These would include plans prepared under the Resource Management Act, the Conservation Act and in Initial Position Papers prepared under the Fisheries Act.
- Leading regular meetings with statutory agencies to track implementation progress.

A CO-ORDINATED APPROACH TO RESEARCH AND MONITORING

We define research here as specific human activities designed to create new fundamental and applied knowledge and understanding of how the Hauraki Gulf Marine Park functions, encompassing the biophysical, economic, social, and/or cultural realms. Monitoring is defined as the repeated measurement of variables that can be used to quantify trajectories of temporal and spatial changes in the context of the Gulf (e.g. increasing, decreasing, static, and/or random). Monitoring in itself is not research, but the data generated by monitoring can be used to assess the effectiveness of different management regimes, and test different hypotheses of how we think the systems work. 'Monitoring for monitoring's' sake is discouraged, and a poor use of resources. Monitoring should be undertaken with a clear understanding of how it will help inform management over time; is water clarity improving in an estuary following change to land management practises in a catchment, has the ability of local communities to harvest kaimoana improved following changes in spatial fisheries management. Monitoring should also be made as 'future/proof' as possible, as changing monitoring approaches or methods

1 Information in the sense of reports, maps, papers, and metadata; primary databases and associated raw data remain the direct responsibility of the various statutory agencies.

can seriously undermine the value and effectiveness of data collected, for example comparing results over time and space.

A coordinated approach to monitoring and reporting, and the learnings we can take from this, is an important element in an "adaptive management" approach, whereby we modify our management direction as we learn what works and what does not.

Cultural indicators and iwi approaches to environmental monitoring and evaluation

Cultural indicators are used to protect and manage ngā taonga tuku iho (treasures handed down to us), and to aid mana whenua in monitoring, management processes, and decision making. These should be used as part of plan-effectiveness monitoring, to recognise and incorporate mana whenua values. Cultural indicators required to monitor and understand the issues facing the Gulf will need to be determined with mana whenua, but might include:

- Mauri – All elements of the natural environment, including people, possess mauri and all forms of life are related.
- Kaitiakitanga – An ancestral obligation on Māori to protect and enhance the mauri of elements of the natural world. An essential element of kaitiakitanga is the maintenance of a balance between the needs of the environment and those of humans, and the needs of current generations with those yet to be born.
- Ki uta, ki tai – A holistic way of managing the environment. All species are taonga and their habitats are protected, restored, enhanced and managed, consistent with the tikanga and mātauranga of mana whenua. Taonga species sustain mana whenua, providing food and other resources, and contribute to their spiritual well-being. The maintenance of a relationship with treasured ancestral places is essential for keeping mātauranga, cultural knowledge, and tikanga alive and relevant. Waterways are viewed holistically, from their source (mountains, springs, wetlands) to the sea.
- Hauhake, Kohikohi (harvest and gather) – The use of flora and fauna to sustain the people.

More detail is provided in Appendix Six.

Research and monitoring committee

For the purposes of the Plan, a research and monitoring committee should be established, under the 'umbrella' of the Governance Entity. This should be constituted of experts from Crown Research Institutes, universities and wānanga, other research organisations, management agencies (especially Auckland Council and Waikato Regional Council), iwi, industry/sector groups, community representatives, and businesses dependant on the Gulf.

Included in this mix should be practising scientists with solid technical skills, who can help evaluate the practicality of the work proposed, and ensure that it allows New Zealand at large to gain the best science advances from the work (e.g., in its wider application to similar issues in other regions). A suitable code of conduct should be adopted/developed to identify and mitigate any major conflicts of interest that might arise for individuals serving on the committee, and to avoid dominance of the committee by any one sector or individual/s.

The committee should be tasked with facilitating and co-ordinating the development of a research and monitoring plan for the Hauraki Gulf Marine Park, focusing on the science and monitoring needed to fill knowledge gaps and reduce uncertainty. The monitoring plan should, at a minimum, include a list of recommended projects with accompanying outputs, contingencies, data requirements, timelines, indicative costs, and potential providers.

However, it should not be so prescriptive as to discourage innovative and new thinking by research providers, and 'thinking outside the square', including higher risk for higher potential gains, should be encouraged. The research and monitoring plan should explicitly underpin the delivery of objectives and management actions in the Plan.

The purpose of the committee should be to act as a broker and hub for all research activities in the Hauraki Gulf Marine Park, including:

Funding

- Identifying and promoting research projects that can be conducted within existing MBIE-funded, National Science Challenge, Crown Research Institute core-funded, university-funded, and local government-funded research programmes.
- Looking for opportunities to partner the committee's

research and monitoring plan with organisations that are planning research proposals, for example, by serving on technical steering groups, and assisting in networking across agencies and other organisations.

- Working with tertiary education institutes to attach students to research projects.
- Partnering with industry research organisations to co-fund projects.
- Finding opportunities for citizens to contribute to the research effort.
- Presenting strong reasoning to philanthropical organisations to provide research support.

Leadership

- Working with central government to ensure adequate research funding.
- Seeking opportunities to add value to research projects, for example, by involving local industry and community groups, and developing opportunities for key stakeholder groups to manage research programmes collaboratively.
- Helping co-ordinate research across different programmes.
- Providing a liaison role between research programmes and management agencies, to ensure important results are noticed and taken up by management.

Strategy and management

- Keeping abreast of timelines, including bidding processes, regional plan reviews and collaborative planning processes, looking to assist research funders in the development of their Requests for Proposals, and to ensure that research opportunities are well publicised to as many potential research providers as practical.
- Identifying future opportunities for synergies between stakeholder and research agencies.

Examples of potential research and monitoring prioritisation

Research is used to fill in gaps in our understanding and reduce uncertainty, as well as expanding knowledge of how things work. It is an adaptive process, and as such, research may often lead to new questions as it unfolds. Good research is essential to underpin the delivery of objectives and management actions for the Plan. For example:

- Determining catchment nutrient load limits for maintaining water quality and ecosystem health of the Firth of Thames requires an understanding of the ability of the Firth to 'assimilate' nutrients without having associated adverse effects. Ultimately, an integrated biophysical–economic model for exploring potential nutrient load limits is required.
- Restoring benthic habitats, including green-lipped and horse mussel beds, will require research into effective ways of achieving this, including developing new and innovative on-the-ground methods for habitat restoration.

Brood-stock source populations for scallop and green-lipped mussels need to be identified, so that effective management strategies are developed to ensure that healthy breeding populations are maintained, to help replenish other areas throughout the Hauraki Gulf Marine Park. Prioritising and staging research projects over time will be essential in implementing the Plan, given the resources likely to be available, and New Zealand's relatively small research sector. Most research can be developed as a series of clearly staged steps, where a step needs to be completed before it is possible to commence the next one. For example:

- Rebuilding fish stocks requires a prioritisation of what key harvested species to work on. Factors which can be used to prioritise might include to what extent different fish species are locally depleted, the uncertainty of stock estimates, the significance of different species to the functioning of the ecosystem, and the economic, recreational and/or cultural significance of different species. A discussion of this with respect to coastal fish-habitat interactions research is given in Morrison et al 2014c.

- Contaminant-generation models, such as those used in the Waikato Regional Prioritisation Project, need to be linked to models that predict transport, dispersal, fate, and effects of land-derived contaminants in the coastal marine area receiving environment. Where such contaminants accumulate in, or otherwise pass through, sensitive or valuable habitats in the coastal marine area, and cause adverse effects on the ecosystem and/or loss of human amenity, this information can be used to prioritise spending on mitigation in the catchment (using cost/benefit analyses).

Monitoring programmes need a similar prioritised approach, but usually run much longer than research projects, so also require 'future-proofing'[2] so that they do not diminish in value over time as our understanding of the world moves on. Potential prioritised monitoring examples might include:

- A programme of data collection in the Firth of Thames to underpin the development of a biophysical–economic model for exploring potential nutrient and sediment load limits, examining specific habitats to assess processes rather than state. The parameters measured might include primary and secondary production, seabed nutrient fluxes, and ocean upwelling.
- Data on fisheries population age and size structure, spatial abundance and depletion, and cyclical and seasonal changes to inform to understand the mechanisms driving population change, set catch limits, and assess the success (or otherwise) of management actions.

Assessment protocols for research prioritisation

Criteria that could be applied to prioritise research are:

- Does the research fit with the strategies of the Plan?
- Is the research timely?
- Does the research recognise the historic, traditional, cultural, and spiritual relationship of tangata whenua with the Hauraki Gulf Marine Park and its islands (as per the Purpose of the Hauraki Gulf Marine Park Act)?
- Does the research fill a key knowledge gap?
- Will the research be taken up and applied?
- Does the research need to be undertaken in the Hauraki Gulf Marine Park?
- Will the benefits of the research exceed the cost of the research?
- Is there a high probability of the perceived research benefits being realised?
- Is there a critical dependency on the research?

2 For example, using technologies which are likely to become obsolete in the near future, or failing to collect key variables which may not appear important/critical at the present time, but which might conceivably become of central importance in the future. Future-proofing is not perfect, and there is always a level of risk that monitoring may over time become 'unfit-for-purpose' or even redundant in some circumstances. Regular reviews of the monitoring schemes as part of the five year reviews will help minimise such likelihoods.

Table 11.1 Research topics identified in the Plan

BIODIVERSITY AND BIOSECURITY
Mapping and description of seafloor habitats
Interrelationships between habitats and species
Links between shorebirds and seabird foraging behaviour, state of fish stocks and other environmental indicators
Ecosystem services provided by different habitats and species
Cumulative impacts of pressures on the wider Gulf system
Impacts of light and sound pollution on marine species
Impacts of set netting on vulnerable or at risk species
Risk and impacts of disposal of spoil on marine biodiversity
Identifying areas suitable for restoration
Innovative ways of restoring degraded habitats
Seabird foraging habits
Recreational fishing seabird bycatch
Effectiveness and feasibility of spatial and/or temporal closures when most at risk seabirds are foraging and breeding
Necropsies of dead Bryde's whales to identify the cause of death (iwi kaitiaki to ensure cultural sensitivity)
Identifying and remediating barriers to fish passage, which may significantly impact on taonga species that have a diadromous life cycle
Identifying īnanga spawning habitat

WATER QUALITY
Risk assessment of the RMS Niagara
Linking models that predict transport, dispersal, fate, and effects of contaminants in the coastal marine area receiving environment to contamination-generation models and economic assessments for prioritisation of mitigation
Developing sediment attributes applicable to the estuaries and inner coastal waters of the Hauraki Gulf Marine Park that can be converted into objectives and then catchment sediment load limits
Models for calculating catchment sediment load limits
Identifying land and landuse practices which are generating disproportionally high amounts of sediment
Options to cap sediment with waste shells or other hard substrates
Effects of nutrients and nutrient assimilative capacity of the Firth of Thames
Sources of nutrients to the Firth of Thames
Seabed nutrient processes in the Firth of Thames
Biophysical model of Firth of Thames for calculating catchment nutrient load limits
Future-proofing nutrient and sediment load limits for climate change
Trends in Hauraki River nutrient loads
Auditing of water quality risk factors
Innovative technologies for boat anti-fouling
Opportunities for large-scale re-creation of natural wetlands
Opportunities for consolidating and hydraulically linking wetland restoration schemes
Remnant and historical wetlands
Artificial sediment traps
Opportunities for converting simple stormwater treatment ponds in urban areas to fully-functioning wetlands
Cost–benefit analysis for implementation of drain-trap technology and maintenance to remove plastic from stormwater runoff
Risks associated with carcinogens and endocrine disruptors in fish
New biodegradable materials
The impacts of effluent systems on water quality indicators and potential to reduce associated impacts
New technologies for on-site wastewater treatment
Baseline sedimentation rate
Monitoring methods for sedimentation rate
Metrics for seabed benthic health
Protocols and methods for measuring seabed muddiness

FISH STOCKS
Priority fish species
Evidence-based target stock levels for each stock
Crayfish review
Hāpuku review
Tools to monitor health and abundance of kaimoana beds
Review impact of purse seining
Review controls on harvested non-QMS species
Brood stock source populations for scallop and green-lipped mussel beds
Benefits of increasing the minimum size of snapper
New bulk-scale fishing methods
Transition of scallop fishers to other methods
Historical and current extent of culturally and ecologically important habitats
Ecosystem services valuation of the habitats
Rapid identification of potentially successful approaches to active restoration
Additional sources of stock and spat collection mechanisms
Population age and size structure, spatial abundance and depletion, cyclical and seasonal changes
Cultural health indicators for fisheries

AQUACULTURE
Environmental enhancement
New species
New technologies
Climate change mitigation
Opportunities for scallop aquaculture
Suitable sites to zone for aquaculture

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13. ACRONYMS, AND MĀORI TERMS KUPU RĀPOTO, KUPU MĀORI

LIST OF ACRONYMS

AC	Auckland Council
ASCV	Area of Significant Conservation Value
DOC	Department of Conservation
FMA	Fisheries Management Area
HGMP	Hauraki Gulf Marine Park
IFAW	International Fund for Animal Welfare
LINZ	Land Information New Zealand
MACA	Marine and Coastal Area (Takutai Moana) Act 2011
MPA	Marine Protected Area
MPI	Ministry for Primary Industries
RAMSAR	The Convention on Wetlands of International Importance
SMA	Special Management Area
SWG	Stakeholder Working Group
TACC	Total Allowable Commercial Catch
UBA	Underwater Breathing Apparatus
HCMP	Whangapoua Harbour and Catchment Plan
WRC	Waikato Regional Council

KUPU MĀORI - MĀORI TERMS

A

Ātua: Gods

Ahu Moana: Ahu – to build up or restore, Moana – ocean. Ahu Moana are mana whenua/community coastal co-management areas

Ariki: Paramount chiefs

Aotea: Great Barrier Island

H

Hāpu: Sub-tribes

Hauraki: Literally warm winds, refers to the favourable north wind on the Hauraki plains and Coromandel Peninsula. Also used to refer to the collective hapū/iwi of that area.

Hauturu: Little Barrier Island

Hui-a-Iwi: Tribal meetings

I

Inanga: The main 'whitebait' species (Galaxias maculatus,

Iwi: Tribes

K

Kaimoana: Seafood

Kāinga: Home

Kaitiaki: Guardian

Kaitiakitanga: Guardianship, including stewardship; the processes and practices of looking after the environment. Guardianship is rooted in tikanga.

Karakia: Prayer

Ki Uta Ki Tai: Conceptual term meaning 'from the mountains to the sea' or 'from ridge to reef' and used in Sea Change – Tai Timu Tai Pari as a similar concept to Integrated Catchment Management

Kōrero: Talk, discuss

Kotahitanga: Unity, togetherness, solidarity, collective action

Kūpenga: Nets

M

Mahinga Kai: Food gathering places (rivers, bush, sea, gardens etc.)

Mana: Authority, status, prestige

Manaakitanga: Hospitality, generosity

Mana moana: Tribal authority over ancestral coasts and oceans

Mana whakahaere: Governance, authority, jurisdiction, management, mandate, power

Mana whenua: Māori with ancestral rights to resources (in this case for the Hauraki Gulf Marine Park) and responsibilities over their tribal lands, waterways and other taonga. Mana whenua are represented by iwi authorities. Defined as tangata whenua in the RMA.

Manuhiri: Guests, people from outside the tribal area

Māori title: Land held collectively and administered under the Te Ture Whenua Māori Act 1993

Marae: The courtyard or open area in front of the wharenui, also general term for the wharenui, grounds and associated buildings

Mātau: Knowing

Mātauranga Māori: Māori knowledge, knowledge systems and world views

Mauri: Life force / Spiritual essence

Mohio: Understanding

O

Oi : Grey Faced Petrels (Hauraki dialect)

P

Pātaka Kai: Pantry, food storage

Pēpeha: Tribal sayings

R

Rangatiratanga: This term has various definitions and interpretations including chieftainship, right to exercise authority, chiefly autonomy, chiefly authority, ownership, and leadership

Rāhui: Spatial or resource closures. May be a temporary ritual prohibition, closed season, ban, or reserve. Traditionally a rāhui was placed on an area, resource or stretch of water as a conservation measure or as a means of social and political control for a variety of reasons which can be grouped into three main categories: pollution by tapu, conservation and politics. Death pollutes land, water and people through tapu. A rāhui is a device for separating people from land, water and the products from these. After an agreed lapse of time, the rāhui is lifted. A rāhui is marked by a visible sign, such as the erection of a pou rāhui, a post. It is initiated by someone of rank and placed and lifted with appropriate karakia by a tohunga.

Rohe: Region, district or area

Ruamaahua: The Alderman Islands

T

Taiko: Black Petrel (Ngāti Rehua dialect)

Tai Timu Tai Pari: The tidal cycle, from high tide to low tide

TAKE – UTU – EA: Take – utu – ea is expressed in the Water Quality chapter to mean that when events result in an injury a response commensurate with the scale of the offending action is required, in order to return to a state of equilibrium. The model was articulated by Hirini Moko Mead.

Tāmaki Makaurau: The Auckland area – Tāmaki, sought after/prized by many

Tangata tiaki: Resource managers

Taniwha: Water spirit, monster, dangerous water creature, powerful creature, chief, powerful leader, something or someone awesome - taniwha take many forms from logs to reptiles and whales and often live in lakes, rivers or the sea. They are often regarded as guardians by the people who live in their territory, but may also have a malign influence on human beings.

Taonga: Treasure/s

Taonga tuku iho: Ancestral treasures handed down

Tapu: Be sacred, prohibited, restricted, set apart, forbidden, under atua protection

Tikanga: Customary lore and practices, Māori protocols

Tohu: Sign, mark, symbol

Tohunga: High priests, experts, specialists

Tūpuna/Tīpuna: Ancestors

W

Wāhi tapu: Sacred or significant ancestral sites

Waiata: Song

Waiora: Purest form of water, rain or spring water

Waimāor: Water that is running freely or unrestrained, which is clear or lucid

Waitai: The sea, the surf, or the tide

Waimataitai: Estuarine waters between rivers and the ocean

Waikino: Water which has been polluted or debased, spoilt or corrupted

Waimate: Water which has lost its mauri, or life force, unable to sustain life

Wh

Whai Kōrero: Oratory

Whakaae: Acceptance

Whakapapa: Genealogy

Whakatauākī: Proverbs

Whanau: Family

Wharenui: Ancestral tribal meeting house

Whare Wānanga: Places of learning

PART FIVE: APPENDICES

TE WĀHANGA TUARIMA: RIPANGA

1

APPENDIX 1: FISH STOCKS OF THE HAURAKI GULF
PIRINGA 1: IRA IKA O TĪKAPA MOANA / TE MOANANUI-Ā-TOI

2

APPENDIX 2: AREAS IDENTIFIED FOR FUTURE AQUACULTURE DEVELOPMENT
PIRINGA 2: NGĀ ROHE KUA TOHUA HEI WHANAKE AHUMOANA MŌ ĀMURI

3

APPENDIX 3: BIODIVERSITY AND MARINE PROTECTED AREAS
PIRINGA 3: RERENGA RAUROPI ME NGĀ ROHE RĀHUI MOANA

4

APPENDIX 4: WATER QUALITY
PIRINGA 4: ORANGA PŪMAU O TE WAI

5

APPENDIX 5: CULTURAL HEALTH INDICATORS
PIRINGA 5: NGĀ TOHU ORANGA Ā-IWI

APPENDICES

LIST OF APPENDICES MAPS

LIST OF APPENDICES FIGURES

APPENDICIES LIST OF TABLES

APPENDIX 1: FISH STOCKS OF THE HAURAKI GULF
PIRINGA 1: IRA IKA O TĪKAPA MOANA / TE MOANANUI-Ā-TOI

This appendix provides a short background to the Fish Stocks chapter. It is not an information review, which would need to cover a very wide range of themes and body of literature; however, some key references are provided at the end of part 4 for readers who wish to learn more.

INTRODUCTION TO FISHERIES MANAGEMENT

Marine fisheries are an integral component of New Zealand's economic and social framework, encompassing commercial, recreational, and customary harvesting. Western fisheries management has evolved over time, with the most significant change being the introduction of the Quota Management System (QMS) in 1986, which set annual Total Allowable Catch (TAC) limits for species, and along with these, created private property rights to commercially catch these fish (fish referring to any kind of harvested organism, including finfish, invertebrates, and algae). This commercial catch is a subset of the TAC, and is called the Total Allowable Commercial Catch (TACC). The rest of the TAC is composed of catch allowances made for recreational and customary fishing, and other sources of mortality. A range of what are called 'input controls' have also been developed and implemented over time, such as limits to vessel sizes in certain areas, minimum mesh sizes, hours of operation, open and closed seasons, and spatial exclusions. These are designed to minimise unwanted effects such as the capture of under-sized/juvenile fish (e.g. snapper), avoid times of the year when fish are in poor condition and hence require many more individuals to be harvested per unit weight of catch (scallops), and to reduce conflict between different fisheries sectors (e.g. the setting aside of recreational scalloping only areas). For example, the trawl exclusion zones areas in the inner Hauraki Gulf were created to avoid significant bycatch of juvenile snapper, as well as reduce spatial overlap with recreational fishers; similarly, Kawau Bay area is set aside as an area where commercial scallop dredging is not permitted, and only recreational and customary fishers may harvest scallops.

Collectively, this management is designed to keep fish stocks at levels agreed to produce sustainable yields that look to maximise economic returns while ensuring that the fish stock maintains sufficient spawning biomass to successfully replace itself over time. A range of data sources and modelling tools are used to determine what that level of yield should be, and where sufficient information exists, stock assessments are carried out for individual species, to determine appropriate yield setting. Generally, the most valuable stocks receive more research and modelling effort, while lower value stocks receive less resourcing and are generally less well understood, due to cost constraints. MPI uses its Harvest Strategy Standard to set the management target for each species. Working groups exist for each grouping of species or areas (e.g. deepwater, shellfish, and inshore finfish), composed of MPI staff, research providers, industry, recreational, and customary sector representatives, NGOs and other interested parties. These working groups meet regularly to assess research and management, along-side the internal MPI processes. In some cases, small Technical Working Groups may be set up for particular tasks, usually around more complicated numerical modelling.

The research and data inputs that go into stock assessment and setting harvests fall into two groups; fisheries-dependent, and fisheries-independent. Fisheries dependent methods are those that directly involve the fishery in some way – examples include the recording of catch and effort data and its use in Catch-Per-Unit-Effort modelling, the presence of Fisheries Observers on board commercial vessels, the sampling of fish catches in commercial processing sheds for size and age; and the use of combined aerial counts and boat ramp interviews, as well as fixed boat ramp cameras, to estimate recreational catch and effort. Fisheries-independent methods are research approaches which are not based on the fisheries operations; examples include research trawl, dredge and diver surveys to estimate the abundance, spatial distribution and size structure of fished populations; the use of tagging to estimate fish movement and/or population size, and surveys and experiments to determine habitat use and effects.

Fish stocks are ideally set as spatial units that encompass a population that is largely self-contained, i.e., it contains the full life cycle of the species (spawning, larval settlement, juveniles, adults) and does not have significant interactions with other stocks of the same species (e.g. very limited immigration and emigration). However, stock/population boundaries are poorly known for many species, and many of the stock boundaries are pragmatically set on distinctive geographic features. For example, the SNA1 stock is comprised of three sub-stocks: East Northland, Hauraki Gulf and the Bay of Plenty, with the latter two having a significant but poorly estimated level of mixing. More broadly, John dory, red gurnard and tarakihi in the Hauraki Gulf Marine Park fall in the JDO1, GUR1, and TAR1 stocks, which span both the west and east coasts of the upper North Island. The spawning areas and nursery areas for these stocks are poorly known and understood. For tarakihi, juveniles (<20 cm) are rare in northern New Zealand, and the main nurseries are thought to occur further south, in particular along the west coast of the South Island (three stocks are suspected around New Zealand). Similarly, while school shark are managed across a series of fisheries areas, it is acknowledged that a number of these do not hold known spawning/pupping areas (i.e., may not be self-sustaining units) (Francis 2010), and that the stock is likely to operate as one at the national scale (along with some connections to the East Australian coast, as shown by tag returns from both sides of the Tasman).

Full details of the latest state of most QMS stocks can be found at the MPI Plenary website http://fs.fish.govt.nz/Page.aspx?pk=61&tk=212. A broader review of coastal finfish life histories and habitat use is provided by Morrison et al. (2014a).

The Hauraki Gulf Marine Park

Around 75 species of finfish are caught commercially in the Hauraki Gulf Marine Park, strongly dominated by snapper, followed by jack mackerel, pilchard, John Dory, gurnard, kahawai, flatfish, tarakihi, trevally, yellow-bellied flounder, and leatherjackets (State of the Gulf 2014). Over the five year period of 2007–2012, commercial landings of the top 16 fish species caught ranged from 4150 to 4620 tonnes. The commercial catch of fish in the Gulf was estimated to generate around $41 million in earnings in 2011, with most of it coming from exports (around $36 million) (Barbera 2012). Invertebrate catch is also significant, with commercial fishers annually harvesting around 105 to 134 tons of kina, and 33 to 73 tons (meat-weight) of scallops over the 2007–08 to 2011–12 fishing seasons (data provided by MPI, in State of the Gulf 2014). Commercial crayfish catches ranged from 104 to 115 tons between the 2009–10 and 2013–14 fishing seasons. Recreational fishing is also significant within the Gulf, with the most recent aerial/boat ramp survey of recreational fishing indicating that the recreational catch of snapper was greater than commercial catch in the 2011-12 fishing year (MPI 2013).

Recreational fishing is mainly concentrated along the coast, with the heaviest concentrations of effort in Kawau Bay, Rangitoto Channel, Motuihe Channel, Wilsons Bay, around Pakatoa and Tiritiri Matangi islands, and in the Motukahaua and Motuoruhi island groups north of Coromandel Harbour. Most of the effort and associated catch is undertaken in the warmer summer months, especially during the time period when snapper move into the inner Gulf as a seasonal migration. Significant variations in catch and effort may occur from year to year (Hartill et al. 2016).

The commercial catch of finfish is mainly taken through bottom trawling, Danish seining and bottom long-lining, which together provided 85–90% of the combined catch of snapper, gurnard, tarakihi, kahawai, rig, trevally and John dory (Hauraki Gulf Forum 2011). A smaller proportion of the fish catch is obtained by set netting, which is mainly used to target parore, flatfish and mullet (State of the Gulf 2014).

Current state of fisheries in the Hauraki Gulf Marine Park

The State of the Gulf (2014) report summarised the current state of fisheries in the Gulf, based on information provided by MPI, and its findings are reproduced below, as little new knowledge is available. This assessment does not take account of customary and localised knowledge which indicates localised depletion for many species.

The status of fisheries and stocks is characterised by MPI in the following way:

- Overfishing: If average fishing mortality is higher than the rate that will produce the MSY (or another appropriate target), overfishing is deemed to be occurring. If overfishing continues, such stocks will ultimately be depleted below the biomass that produces the MSY.
- Depleted (below the soft limit): If stock levels reach less than 50% of the biomass that will produce the MSY, or 20% of unfished stock levels (whichever is higher), they are depleted (or overfished) and in need of rebuilding.
- Collapsed (below the hard limit): If stock levels reach less than 25% of the biomass that will produce the MSY, or 10% of unfished stock levels (whichever is higher), they have collapsed.

The Harvest Strategy Standard for New Zealand fisheries specifies that for stocks falling below the soft limit, a formal, time-constrained rebuilding plan is triggered, whereas fisheries closures should be considered if stocks fall below the hard limit (Ministry of Fisheries 2008).

The State of the Gulf report (2014) notes that of the 15 key finfish species fished:

- 2 species (**red gurnard** and **kahawai**) are at or above target levels and are not considered to be depleted or at risk of collapse.
- **Snapper** is below the target level and needs rebuilding. It is not at risk of collapse in the short term, but a reduction in catch is likely to be required to prevent the stock declining towards collapse over the medium to long term.
- **John dory** is likely to be below its target level in the North East New Zealand – Hauraki Gulf sub stock, and about as likely as not to be at or above the target in the Bay of Plenty sub stock. Neither of these sub stocks are considered to be depleted or at risk of collapse.
- 3 species (**pilchard**, **barracoutta**, and grey mullet) are not considered to be at risk of collapse, but not enough is known about these stocks to assess their status against targets and limits.
- Overfishing of trevally is about as likely as not to be occurring, but this cannot be confirmed because of a lack of reliable data [although anecdotal reports are that stocks are very low]. Not enough is known about this stock to assess its status against targets and limits.
- For the remaining 7 species (**jack mackerel, tarakihi, flatfish, yellow-bellied flounder, leatherjacket, rig and parore**) the status of the stocks is unknown, because an appropriate quantitative analysis has not been undertaken or because the analyses that have been carried out have not been definitive enough to assess their status.

Fisheries modelling indicates that the total biomass of crayfish has been reduced to around 33% of its 1945 level in the CRA2 stock (Paul Breen pers. comm.), which covers the fishery from the Hauraki Gulf to East Cape. The biomass of crayfish above the legal size limit (i.e. the recruited biomass) has been reduced to around 20% of its 1945 level. The stock is estimated to be 36% above the biomass required to produce the maximum sustainable yield (BMSY), but 20% below its current management target of 459.6 tonnes (BREF). The current target is based on the biomass of legal sized males for the period 1979 to 1981. Neither the current nor the projected biomass are estimated to be near the soft limit of 20% of the unfished Spawning Stock Biomass (SSB0, i.e., the unfished biomass of mature females), which would trigger the need for the stock to be re-built (State of the Gulf 2014). However, there have been successive declines in Catch-Per-Unit-Effort since the last stock assessment and the CPUE for this FMA is the lowest in the country (MPI 2016 Plenary).

Crayfish monitoring programs at the Leigh, Tawharanui and Hahei marine reserves show consistent declines in crayfish numbers over the last 10 years.

In 2016, crayfish densities at sites outside the reserves were the lowest they have been since monitoring began in the mid-1990's. Based on this data crayfish biomass at fished sites in the region are estimated to be <5% of unfished biomass, using reserve populations as a reference (Nick Shears, University of Auckland, pers. comm.).

Scallops are managed on an annual basis, as their biomass is subject to large natural variations.

SOME FISHERIES ISSUES

While the QMS system bought in limits to the biomass of fish that could be sustainably harvested each year, there are many outgoing management questions, along with the need to collect data and do research to answer those questions and inform evolving management strategies.

Incidental mortality of undersize fish

Most fishing methods are not able to select only the size of fish targeted, and catch varying numbers of smaller fish. If these fish cannot be safely returned to the water and suffer mortalities, then they are lost from being able to potentially contribute to future fisheries production. Even fish that are returned to the water healthy may not survive, due to potential predation while they are away from their seafloor habitats, as well as having likely been moved a considerable distance from their selected habitats (e.g. juvenile finfish from potential territories, scallops from preferred seafloor substrates). Measures such as minimum mesh sizes, closed areas, and move-on rules are all used by fisheries managers to minimise such losses. The 90 mm minimum size for commercial scallops in the Coromandel Fishery (which includes almost all the Hauraki Gulf), was reduced down from 100 mm in the 1990s, following research that showed a) that a significant proportion of smaller animals were being killed by the dredges, and lost from production (e.g. estimates of 1.7 and 2.8 undersize scallops lost for each legal sized scallop harvested, from two beds experimentally fished adjacent to Colville (Morrison 1999), and b) that Individual Based Modelling of 'incidental mortality' of undersize scallops found a substantial loss of yield, which could be avoided by lowering the minimum take-able size (Cryer et al. 2009). As scallops were not commercially viable for sale below 90 mm, the minimum size limit was reduced to 90 mm, to reduce the wastage of fish from incidental mortality.

Age / Length Truncation

All full exploited fisheries have gone through a 'fishing down' phase, where a significant proportion of the virgin biomass of the stock is removed, and older, larger fish are removed, resulting in a change to the age/length structure of the population. If the stock is fished too heavily, then 'recruitment overfishing' may occur, where the spawning stock is greatly reduced, there is a decreasing proportion of older fish in the catch, and generally recruitment (the number of young fish entering the population/stock) falls to very low levels. Combined with poor environmental conditions, this may ultimately lead to a stock collapse. Fisheries managers avoid this by setting targets for Spawning Stock Biomass, to maintain these at levels that ensure that sufficient breeding fish exist to replenish the stock through reproduction.

However, evidence is accumulating that larger, older fish play a disproportionate role in both maintaining populations, and in their ecological roles. In terms of spawning success, a number of new themes are being researched. One of these is the value of big old fat fecund female fish (BOFFFFs) (also known as 'maternal effects') in fostering stock productivity and stability. Hixon et al. (2014) reviewed this topic, and concluded that:

- Compared with smaller mature females, BOFFFFs produce far more and often larger eggs that may develop into larvae that grow faster and withstand starvation better.
- BOFFFFs in batch-spawning species tend to have earlier and longer spawning seasons and may spawn in different locations than smaller females. This indicates bet-hedging strategies in response to variable environments
- BOFFFFs can outlive periods that are unfavourable for successful reproduction and be ready to spawn profusely and enhance recruitment when favourable conditions return (the storage effect).
- Fishing differentially removes BOFFFFs, typically resulting in severe truncation of the size and age structure of the population.
- In the worst cases, fishing mortality acts as a powerful selective agent that inhibits reversal of size and age truncation, even if fishing intensity is later reduced. Age truncation is now known to destabilize fished populations, increasing their susceptibility to collapse.
- A growing body of knowledge dictates that fisheries productivity and stability would be enhanced if

management conserved old-growth age structure in fished stocks, be it by limiting exploitation rates, by implementing slot limits, or by establishing marine reserves, which are now known to seed surrounding fished areas via larval dispersal.

- Networks of marine reserves are likely to be the most effective means of ensuring that pockets of old-growth age structure survive throughout the geographic range of demersal species (Hixon et al. 2014).

Such effects have not yet been widely explored in the New Zealand context. Most fully exploited coastal fisheries are likely to have been truncated in age and size population structure. Stewart (2011) examined the age compositions of the landings of major reef-associated finfish fisheries species in south-eastern Australia, including snapper, kingfish, sweep, and a sister species to New Zealand's trevally species. For long-lived species (potential to live for 20–50 years) with long histories of exploitation, the age compositions had relatively few fish greater than 5 years old. It was suggested that that the removal of older age classes had lowered their resilience to environmental change, and that remedial management action might be required to rebuild reserves of older individuals. Management options suggested included, reducing rates of exploitation to very low levels, protecting larger/older fish through regulated maximum length limits and/or changes to gear selectivity and no take MPAs.

Such effects also extend to invertebrates. Lobster/crayfish populations in suitable marine reserves in the Hauraki Gulf are dominated by lobsters above the legal size limit, with relatively high numbers of old and large animals. In contrast, fished populations are characterised by low numbers of sub-legal animals. Large male and female lobsters have been shown to make a disproportionate contribution to reproduction by producing more sperm and eggs, mating more frequently, and defending access to favourable mates (MacDiarmid 1989, MacDiarmid & Butler 1999). Large lobsters also display different behaviours than small sized ones. This includes regular foraging for extended periods on offshore sandflats, where they form defensive aggregations for mutual protection during the daytime (Kelly et al. 1999). In contrast, sub-legal lobsters in the Hauraki Gulf appear to mainly remain within reef habitat (State of the Gulf 2014).

Brood-stock populations

For species which are largely sedentary in nature as adults, dense aggregations are often found e.g. for scallops, green-lipped mussels, and paua. As these species are unable to move any appreciable distances as adults, this is a strategy to ensure that reproduction success is maximised (e.g. Hobday et al. 2000, Mendo et al. 2014). Known as broadcast spawners, these species tend to synchronise their spawning, so that the eggs and sperm released into the water column have the best change of meeting, and successful fertilisation occurring. Broadly speaking, the closer individuals are to each other, the better the change of reproductive success. This means that a small component of the overall population may produce most of the reproductive output, and that individuals that are more widely dispersed, even if they dominate in overall numbers, may be reproductively irrelevant. Unfortunately, these dense aggregations are also targeted by fisheries, as they offer the greatest economic returns per unit effort of fishing. The concept of leaving brood stock areas alone to promote reproductive success and subsequent juvenile recruitment to scallop stocks has been suggested in some overseas northern hemisphere scallop fisheries (e.g., Beukers-Stewart et al. 2005).

Some 'naturally protected' potential brood stock areas may remain in the Gulf, such as dense scallop beds which occur in a relatively small area on the southern side Little Barrier Island, where 'ridges' of low relief rocky reef extend out into soft sediments, and prevent dredging (MM, pers. obs.). Other areas of dense scallops may remain undiscovered by fishers: e.g. until recently, the large scallop bed in the central Gulf, west of Cape Colville (see figure 6.9 in State of the Gulf 2014), now fished down; and within the non-commercial fishing areas around Kawau Bay, though with increasing fishing effort and improving technology such as GPS the chances of significant dense beds remaining undiscovered is likely to be low.

To add to this complexity, source and sink populations may also exist. Sources refers to beds or areas that provide high larval abundances, which are then transported oceanographically to other areas (or back to the source areas), where the larvae settle and replenish (or create new) scallop beds. Sinks are places which rely on larval settlement from other areas, and which are unable to replenish themselves through 'self-recruitment' of their own larvae (e.g. they might be transported away to unsuitable areas for larval settlement). Overall, populations may form a series of sources and sinks (which may be temporally variable, and reverse in their roles through time); some populations may be both (self-recruiting). Quite limited beds/areas may act as the main spawning populations (sources) for a series of down-stream beds (sinks), with potentially major cascade effects (and possible multiple population collapses) should they be eliminated. Such dynamics might explain why some scallops beds/areas are consistently present year-after-year, with multiple year-classes present; while others only occur intermittently across years, and are dominated by the recruitment of one large year class only). Some work has been done overseas on the connectivity of scallop populations through larval dispersal (e.g., Tian et al. 2009a, b, Gilbert et al. 2010), but the concept of sources and sinks is an evolving research area.

Current knowledge of these potential connectivities in the Gulf is very poor. Large-scale hydrodynamic modelling, in tandem with spatially targeted work on the spawning, and settlement dynamics of such sedentary species, would directly inform the most effective management framework to address such potential issues.

Localised Depletion

Fish stocks are generally managed at large spatial scales, and as such deal with fish abundance across entire regions. A fish stock is ideally set as a region that encompasses a population that is self-contained, i.e., it contains the full life cycle of the species (spawning, larval settlement, juveniles, adults) and does not have significant interactions with other stocks/areas of the same species (e.g. very limited immigration and emigration). Stock/population boundaries are however, poorly known for many New Zealand species, and many stock boundaries are pragmatically set on distinctive geographic features, which may or may not be biologically relevant. For example, the SNA1 stock is comprised of three sub-stocks: East Northland, Hauraki Gulf, and the Bay of Plenty, with the latter areas having a significant but poorly estimated level of mixing, while East Northland is largely separate.

More broadly, John dory, red gurnard, tarakihi, and school shark in the Hauraki Gulf fall within the JDO1, GUR1, TAR1 and SCH1 stocks respectively, which span both the west and east coasts of the upper North Island. The spawning areas and nursery areas for these four species stocks are poorly known and understood. John Dory are thought to have five stocks nationally, including one spanning East Northland and the Hauraki Gulf, and another in the Bay of Plenty (Dunn & Jones 2013). Within the Gulf, red gurnard are suggested to have a nursery ground in the Colville Channel area, though searching for juveniles in this area have been unsuccessful (Elder 1976).

Tarakihi juveniles (<20 cm) are rare/absent in northern New Zealand, and the main nurseries are thought to occur much further south, in particular along the east coast of the South Island (three stocks are suspected around New Zealand). Similarly, while school shark are managed across a series of fisheries areas (SCH), it is acknowledged that a number of these do not hold known spawning/pupping areas (i.e., cannot be self-sustaining units), and that the stock is likely to operate as one at the national scale (along with some connections to the East Australian coast, as shown by tag returns from both sides of the Tasman) (Francis 2010). These differing scales of organisation result in species being managed at different spatial management scales (and also in temporal scales, due to differences in time to maturity, maximum ages, and other factors).

Managing these stocks at large spatial scales largely ignores issues around 'spatial depletion'. This is where smaller local areas may hold less fish than other areas in the stock, making access and catching of fish by some sectors, such as recreational and customary, more difficult. These depletions can be caused by both natural variation (e.g. yearly climate effects) and/or over-fishing of some areas.

As some sectors have less mobility and/or are relatively fixed as communities, localised depletion makes catching fish more difficult and expensive. Examples of localised depletion issues in other parts of New Zealand include blue cod in the Marlborough Sounds and in Fiordland, which in both cases resulted in directed management actions to address conflicts/over-exploitation. Localised depletion issues are not well documented formally in the Hauraki Gulf Marine Park, but have anecdotally included issues around kahawai, snapper, trevally, parore, crabs, flounder, mullet, crayfish and scallops.

A further issue of having large stock areas is that harvesting is able to be undertaken anywhere within the stock area. This can mean that catch per unit effort data, that may appear stable across the entire quota management area, can mask stock declines.

Localised depletion also impacts recreational fishers, who are entitled to fish anywhere, subject to the various constraints of fisheries regulations. An example of such conflict has been in the Kaipara Harbour for flatfish and grey mullet, with these two species falling within FLA1 and GMU1 respectively (both of which include the upper west and east North Island coasts). Small dory fishers using gillnets and/or ring-nets are able to fish anywhere within these stocks, and a perceived focus of small dories from outside the Kaipara region on the putatively high abundances of these species in the Kaipara Harbour led to conflict between 'locals' and 'outsiders' (Hartill 2004). Further improvements in the fish stocks of the Hauraki Gulf could be subject to similar issues and conflicts under the present management regime.

Gut hooking and barotrauma

Line fishing with hooks also capture small fish below legal and/or economic sizes. Even when returned alive to the sea promptly, mortality of these fish may occur through gut hooking and/or barotrauma, as well as other factors such as predation. Gut hooking occurs where the hook is swallowed, rather than hooking in the lip area; many fish hooked this way on long-lines die before being retrieved. Hook size can have a strong influence on the size of fish caught, and where they are hooked. Barotrauma occurs in species with swim bladders, where the rapid change in pressure that occurs as they are bought up from depth is too fast for them to adapt to, and the swim bladder inflates, sometimes protruding from the mouth or vent. For deeper water species such as hāpuku and bass, this may cause the fish to pop up to the surface once a critical expansion point is passed, and fatal physiological and physical damage occurs. For other species such as snapper, deflation of the swim bladder using a large gauge needle can relieve the pressure, allowing the fish to swim down in the water column and return to the seafloor; this is a standard practise in fish tagging programmes. Work in Australia has looked at barotrauma in snapper caught to depths of c. 120m (Butcher et al 2012). They found evidence of barotrauma in some fish recreationally angled from 11m water depth, and in all fish retrieved from greater than 20m. Fish were considered to have barotrauma if they had a prolapsed cloaca combined with a distended coelomic cavity and/or gastric herniation into the buccal cavity. Despite similar clinical signs among fish held in cages for three day, none died, however the associated trauma was considered to raise fish welfare concerns. Experiments assessing the effects of needle venting, and the use of weights to rapidly return fish to depth after capture, both showed benefits over no treatment (fish returned to the surface of the sea).

Willis and Millar (2001) looked at the value of using longline hooks modified with a wire extension to avoid both gut hooking, and the catching of undersize snapper (Pagrus auratus). Using standard Tainawa 16R longline hooks, they used two experimental hook treatments (simultaneously fished on the same longline), of hooks modified with 20mm and 40mm wire appendages (plus a control of unmodified hooks). The experimental design also included three bait types. Gut-hooking rates were markedly lower on the modified hooks. Normal hooks gut-hooked 17% and 30% (pooled across baits) of snapper (January and June trials respectively); the 20mm modified hooks gut-hooked 7% and 12%; and the 40mm hooks gut-hooked only 2% (both seasons). Overall catch rates were significantly lower on the modified hooks, however most of the loss of catch comprised undersized fish and dead on retrieval fish (unsuitable for export). There was no significant reduction in the weight of export-quality snapper landed using modified hooks. Modified hooks reduced both the catch rate and the gut-hooking rate of undersized snapper. Scaling this up to the level of the fishery, Willis and Miller (2001) calculated that if it was assumed that all gut-hooked discards were likely to die, the estimated annual reduction in discard mortality at the stock level would be 78% if 20mm hook modifications are used, and 96% if 40mm modifications were used (for scenarios where minimum legal size was set at both 25cm and 27cm). They assumed that the observed catch and mortality rates from their trials were representative of the commercial fishery.

In a study on blue cod (Parapercis colias) in the Marlborough Sounds, the survival rate of sub-legal fish (<33 cm) was assessed after capture by recreational fishing using two types of hooks (6/0 and 1/0) (Carbines 1999). As a second treatment factor, as fish were caught they were subjected to either good or poor handling techniques and then placed into holding pots.

A control group of fish was caught using commercial potting, and also kept in the holding pots. These pots were lowered to the seafloor, and monitored during daylight hours for two weeks. No mortality of blue cod occurred with the 6/0 hooks, but fish caught using 1/0 hooks suffered 25% mortality over the two week period. No control fish died during the experiment, and the type of handling technique used had no detectable effect on blue cod survival. All fish mortality occurred within 26h of capture, and combined with behavioural observations of the fish, suggested that mortality was induced by blood loss rather than disease. The location of the hook wound was related to hook size, small hooks lodged in the gut or gill usually proved fatal. It was concluded that the mortality of released blue cod would be minimized if fishers used larger rather than small hooks (Carbines 1999).

Fishing impacts on seafloor assemblages

The first documented concerns about the use of towed fishing gear on benthic habitats were from UK fishermen in the fourteenth century (Lokkeborg 2005). These concerns related to the capture of juvenile fish and the detrimental effects on food sources for harvestable fish. Despite this long history of concern, it is really only since the 1990s that international research has focused on the effects of fishing on benthic communities, biodiversity, and production. The rapid expansion of studies in this area, and the controversy associated with the effects of fishing has led to numerous reviews, summarizing the research and identifying overall patterns (Gislason 1994, Dayton et al. 1995, Jennings and Kaiser 1998, Lindeboom and de Groot 1998, Hall 1999, Collie et al. 2000, Gislason et al. 2000, Kaiser and de Groot 2000, Dayton et al. 2002, Thrush and Dayton 2002, Lokkeborg 2005, Department of Fisheries and Oceans 2006, Kaiser et al. 2006, Rice 2006, Watling et al. 2014). These reviews are in general agreement, concluding that benthic disturbance from mobile fishing varies in relation to the habitat, fishing gear, and environment, and is likely to have predictable and potentially substantial effects on benthic community structure and function. These effects can lead to regional-scale reductions in some components of biodiversity, reduce benthic community productivity (Jennings et al. 2001, Hiddink et al. 2006), alter natural sediment fluxes and reduce organic carbon turnover (Pusceddu et al. 2014), and modify the shape of the upper continental slope (Puig et al. 2012), reducing morphological complexity and benthic habitat heterogeneity. The effects of fishing on the seabed can be divided into geotechnical (the physical contact of the gear on the seabed) and hydrodynamic (the suspension of sediment into the water column) components, and vary with both fishing gear and benthic habitat (Ivanovic et al. 2011, O'Neill et al. 2011). Heavier fishing gears tend to penetrate deeper into the seabed (Ivanovic et al. 2011), while larger gears towed at faster speeds generate more drag, suspending greater quantities of seabed material, particularly in softer sediment (muddy) habitats (O'Neill et al. 2011). The likely effects and dispersal of this sediment will vary locally, depending on oceanographic conditions.

Within coastal regions, scallop dredges are generally considered to have a greater impact on benthic communities (per area fished) than trawls or Danish seines, as the gear is heavier and penetrates further into the seabed (Kaiser et al 2006). Habitats with relatively low natural levels of disturbance are generally considered to be more sensitive to fishing impacts than habitats in areas of frequent natural disturbance (Lokkeborg 2005). However, biogenic habitats (created by animals and plants) may occur in such areas (e.g., Spirits Bay), and are particularly sensitive to fishing impacts (e.g., Tuck and Hewitt 2013). Typically, larger, longer lived, slow growing, fragile, erect, sedentary species (e.g., sponges, sea pens, corals, horse mussels) tend to be more sensitive to the physical impacts of fishing gear than smaller, faster growing, less fragile species living below the sediment surface (Tuck and Hewitt 2013). Sensitivity to re-suspended sediment is likely to be related to different life history characteristics, with species and habitats relying on photosynthesis (e.g. rhodolith beds) or vulnerable to smothering (e.g., sponges) probably most at risk.

Three studies on the impacts of fishing have been completed in the Hauraki Gulf Marine Park. Thrush et al. (1995) conducted a small scale, short term (up to three month) experiment looking at scallop dredging effects, at the individual dredge track scale. Two shallow (24m) sites were assessed; with one site regularly commercially fished and the other not. Community composition differed between the sites, but both were dominated by small and short-lived species. Assessing experimental dredge tracks across the two sites, the density of common infaunal species, total abundance and species richness at each site decreased following dredging, with some species still significantly different after three months. Significant differences in community assemblage structure between the dredge and control plots were also recorded over the experiment, with stronger effects at the site previously commercially fished. The bivalve Nucula nitidula (a 'nut-shell') and tube building polychaetes were consistently sensitive to the effects of fishing, showing significant reductions in abundance at both sites following dredging.

Thrush et al. (1998) examined benthic communities from 18 locations within the Gulf using video (for epifauna) and grab, suction dredge and core (for infauna) approaches. The benthic communities were examined across gradients of fishing pressure (and environmental variables) on the basis of rankings of potential habitat disturbance by commercial demersal trawling and dredging, estimated from fisheries legislation and anecdotal information from fishery managers and scallop fishers. The fishing pressure gradient accounted for 15–20% of benthic community structure, and also had a significant effect on species richness and benthic community diversity. Increases in fishing pressure significantly reduced the density of large (and long lived) epifauna and echinoderms, and significantly increased the density of small opportunist species, with the effect on deposit feeders varying with the sampling approach. No effect on scavengers was observed. While scavenger attraction to disturbed areas to feed on damaged fauna has commonly been observed in manipulative studies (e.g., Kaiser & Spencer 1994; Ramsay et al. 1996), such effects are likely to be very transient in time, and unlikely to be observed in broad scale studies.

Morrison et al. (2016) used video transects to examine the distribution and abundance of benthic epifauna and fish species in five areas inside and up to 2.5km outside the Hauraki Gulf Cable Protection Zone (CPZ), considered to have been an effective closed area to fishing/anchoring since 1999. CPZ status (inside or outside) had a significant effect on common species abundances and univariate community diversity measures, in the main drivers of community composition and species abundance appeared to be location and depth, with CPZ status only explaining 1.4% of total variance. There was no discernible effect of the CPZ on fish assemblages.

Tuck et al. (in press) provide a comprehensive analysis and review of the impacts of fishing on soft sediment systems in New Zealand, including the Hauraki Gulf. They concluded that:

"The magnitude of the effects of fishing (% variability explained) varied between studies, and as would be expected, greater effects were detected over stronger effort gradients. The levels of effect detected were reasonably consistent between dedicated sampling approaches (within study), while opportunistic data sets were less effective at detecting effects. When effects were detected, fishing was associated with reductions in the number of taxa, diversity and evenness of both epifaunal and infaunal communities, but more consistently for epifauna. Fishing appears to have reduced epifaunal biomass and productivity (whole community and fish prey) by up to 50% in some of the study sites, but effects on infauna were less consistent (increasing by up to 20% in the one area an effect was detected). The species that were most consistently identified as being negatively correlated with fishing pressure were those that either stand erect out of the seabed (e.g., horse mussels, sponges, bryozoans, hydroids, sea pens, tube building polychaetes), or live on the sediment surface, and thus are particularly sensitive to physical disturbance through either direct physical impact (e.g., Echinocardium), smothering (e.g., small bivalves) or increased vulnerability to predation following disturbance (e.g., brittle stars). Where examined, even relatively modest levels of fishing effort (i.e., fishing an area between once and twice per year, estimated at the 5km * 5km scale) reduced the density of the combined group of long lived sedentary habitat forming species and individual species group densities of holothurians, crinoids, cnidarians and bryozoans by at least 50%".

Some species which are heavily depleted and probably functionally extinct in most of the Gulf

Pack-horse crayfish

The packhorse (green) crayfish is the largest crayfish in the world, and is largely restricted to the northeastern waters of New Zealand, and the east coast of Australia. Different genetics stocks are suggested between the two countries (Brasher et al. 1992). In New Zealand, females with eggs are now seldom found south of Whangarei Heads, although they were historically found in large numbers around the Mercury Islands and in parts of the Bay of Plenty during the 1960s (Booth 1984). Since the 1960s there has been an ongoing reduction in the proportion of legal-sized and mature specimens from east coast areas south of North Cape, and the species is thought to be in decline (Booth 1984). The most important current fishery and concentration of breeding lobsters is within 25km of Cape Reinga (Booth 1997).

It appears that the lifecycle of this species is structured at the spatial scale of northeastern New Zealand, from the Three Kings down to the Gisborne region (Kensler 1967, Booth 1997). Large scale tagging work along the northeastern New Zealand coast found that 99% of migratory movements (defined as movements greater than 15km) were to the north, towards

Cape Reinga, with no evidence of return. All of the tagging sites (Whangarei Heads, Mercury Islands, Matakaoa Point (East Cape), Gisborne, and Mahia Peninsula) showed migratory movements of at least 200km, with the greatest distance travelled being 1,070km (Booth 1997).

There was a limited movement of lobsters tagged at North Cape down the west coast, with three tag returns from the southern end of Ninety Mile Beach. Undersize lobsters in pots increase as a proportion of total catch down the east coast of the North Island, while overall mean lengths decrease. Juveniles of less than 100mm carapace length are found along the entire east coast, but most diver reports of animals less than 40mm carapace length are from the East Cape area (Booth 1986). The small numbers of pelagic mid- and late-stage phyllosoma sampled have come from the east coast of the North Island, in particular from south of the Mercury Islands (Booth 1986). It is thought that the semi-permanent eddies off the east coast (Denham et al. 1984) retain larvae in the near-shore environment, which later recruit to reef areas, and migrate as adults back up to Cape Reinga.

This species is probably now functionally extinct on Hauraki Gulf reef systems, due to its very low abundances. As the Gulf is only part of its range, and does not appear to provide either spawning or larval recruitment areas, any new management actions to fundamentally increase its abundance are likely to be most effective at the spatial scale of the north-eastern coast. Restoration of the spawning females once found in large numbers around the Mercury Islands and parts of the Bay of Plenty would be one potentially key action.

Figure A1.1 Packhorse crayfish (Source. Ministry for Primary Industries)

Hāpuku

Hāpuku occur off southern Australia and around New Zealand, as well as having been recorded from islands in the southern Indian Ocean, and off the Pacific coast of South America (Paul 2000). Bass, another species of Polyprion (known as 'wreckfish' elsewhere) tend to occur in deeper waters than hāpuku – though the two species are collectively grouped together as 'groper' in fisheries reporting and management. While now regarded as a deeper water species in New Zealand, hāpuku were once relatively common in shallow waters in New Zealand, and there are a number of historical accounts of them being caught by land-based fishers, both from rocks, and up estuaries with the tide. It was also reported as being seen in surf breaks and other habitats. Graham (1939) described hāpuku movements off the Otago coast, when shallow water populations were still present before heavy exploitation removed them. In May and June, ovaries matured, and fish undertook an outward migration into deeper water to spawn, where spawning occurred in July and August. In October and November a return movement occurred. Hāpuku were also historically seen by divers at the Poor Knights Islands in groups of up to 30 fish in 40–50m water depth around the islands during winter, when they moved into shallower waters for spawning, but these groups are no longer seen (Ayling & Schiel 2003). Today hāpuku are extinct from such habitats, due to fishing having extirpated them from the shallower water component of their historical distribution.

Some limited tagging work has been done at the Poor Knights Islands, East Northland, where 106 fish were tagged (1987–1989 years) and 20 (18.9%) recaptured. Most tagged fish were between 70 to 94 cm length, with about 33% of tagged fish being mature, and 50% of recaptures. The average recapture depth was 93m (23–200m), with 60% between 80–100m. Only two fish were recaptured within 100 days of release, with 65% made within 400 days, and 95% within 1000 days. No large scale movements were recorded, with 8 (40%) being made at the tagging site ('resident'), and 16 (80%) within 10km of the tagging site, with the maximum distance moved being 51km northwest to Cape Brett. However, work in other areas of New Zealand suggests that large scale movements and mixing may be common, although seasonal homing back to particular reefs is also suggested (Beentjes & Francis 1999, Paul 2000a, b).

Figure A1.2 Hāpuku

Fishing pressures in shallow waters are now such that hāpuku are unlikely to return to shallower water habitats without directed management interventions. They are a relatively slow growing fish, taking 10–13 years to reach sexual maturity at a size of 80–85cm, but may live to 60 years of age, and up to 1.78m in length (Francis et al. 1999). As seen in other similar species overseas (Sáenz-Arroyo et al. 2005), shifting baselines may also be working for this species, with the average size of fish shown in catch photographs in recreational fishing magazines appearing to decline over the decades. All fishers may now accept catches of smaller fish much more readily than in the past. These include juveniles (also known as pups) which may play an important role in establishing new abundances in habitats which they have been 'fished out' in the past. If a management goal is to work to re-establish shallow-water hāpuku populations in some areas, then attention will need to be focussed on allowing these juveniles to be removed from fishing pressure, and subsequently the adults they grow into.

Intertidal shellfish (mainly pipi and cockles)

Non-commercial intertidal shellfish fisheries, especially cockles and pipis, are also under strong pressure from over-harvesting in all the more accessible areas of the Gulf, along with wider impacts from habitat and environmental degradation, with increased sedimentation and muddiness being the most likely drivers (Hartill 2005, Morrison et al. 2009). Closures of beaches to harvest has not resulted in these populations recovering, suggesting that other factors are at play such as degraded environmental conditions and/or lack of larval sources. For a number of beaches, juvenile recruitment still occurs, but these animals do not grow through to adult sizes for reasons that are unknown. This experience indicates that we can no longer always assume that stocks will recover once harvesting pressure is reduced, and that a broader ecosystem approach needs to be applied to management.

SIGNIFICANT HABITATS FOR FISHERIES

Traditionally the role of habitat has been largely ignored in fisheries management. However, in recent decades the impacts of fishing activities on seafloor habitats and associated assemblages (beyond just the targeted species) has become the focus of a great deal of research (e.g., Auster et al. 1996, Auster & Langton 1999, Kaiser 1998, Watling & Norse 1998, Hall 1999, Ball et al. 2000, Collie et al. 1997, Collie et al. 2000a, b, Kaiser & de Groot 2000). While impacts vary across different systems, assemblages, and fisheries types, the overall consensus is that impacts are generally significant in magnitude and extent, and are one of the greatest human impacts on both coastal and deep-water ecosystems (Thrush & Dayton 2002, Kaiser et al. 2006, Tillin et al. 2006). One of the key collective findings of such studies is that large, emergent three-dimensional organisms (biogenic habitat formers) are especially vulnerable to damage and loss from bottom trawling and dredging. The question now emerging is 'so-what'? The link between habitat presence, extent, and quality and the abundance and production of fisheries species, although intuitively obvious, is not yet a well-developed concept in the realm of fisheries research and management. Habitat considerations are not yet included in the stock assessment of major species, either in New Zealand or internationally (e.g., Armstrong & Falk-Petersen 2008). Incorporating habitat knowledge into population dynamics, especially at the scales at which fisheries management operates, remains a major challenge. This omission automatically gives such issues less weight, as stock assessments are the central tools in fisheries management (Armstrong & Falk-Petersen 2008).

As noted by these authors (who are resource economists), a key task required for better incorporation of habitat values into management is to tie together the modelling of human behaviour from an economic perspective, with biological or ecological models, focussing on the interaction between habitat and fisheries. Such a focus allows the 'use value' from fisheries to be directly tied to the ecosystem goods and services that habitats may provide. This allows for any negative impacts of fishing on habitats, which flow on to negative impacts on fish stocks, to be quantitatively linked to the use value derived by fishers undertaking the fishery (known as a 'negative externality'). This cascade is shown in Figure A.3. (adapted from figure 1 of Armstrong & Falk-Petersen 2008). Stock assessments are generally focussed on pure harvest effects on stocks (pathway 1). More recently, quantitative and qualitative damage assessments of gear impacts have received attention (pathway 2), but the consequent cascade effect of habitat loss onto stocks (pathway 7), and then into associated fisheries yields (pathway 6) have been largely neglected.

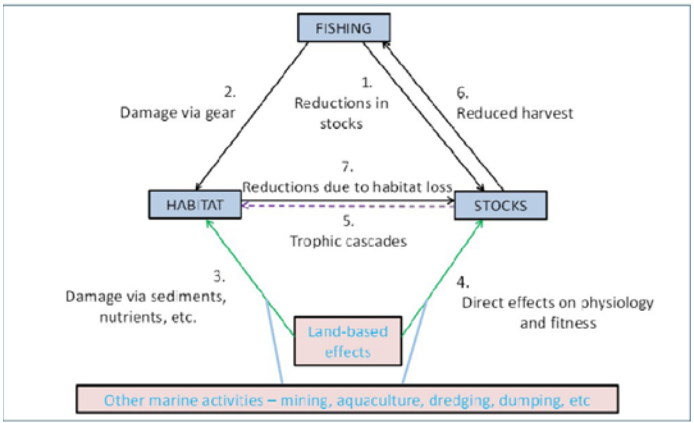
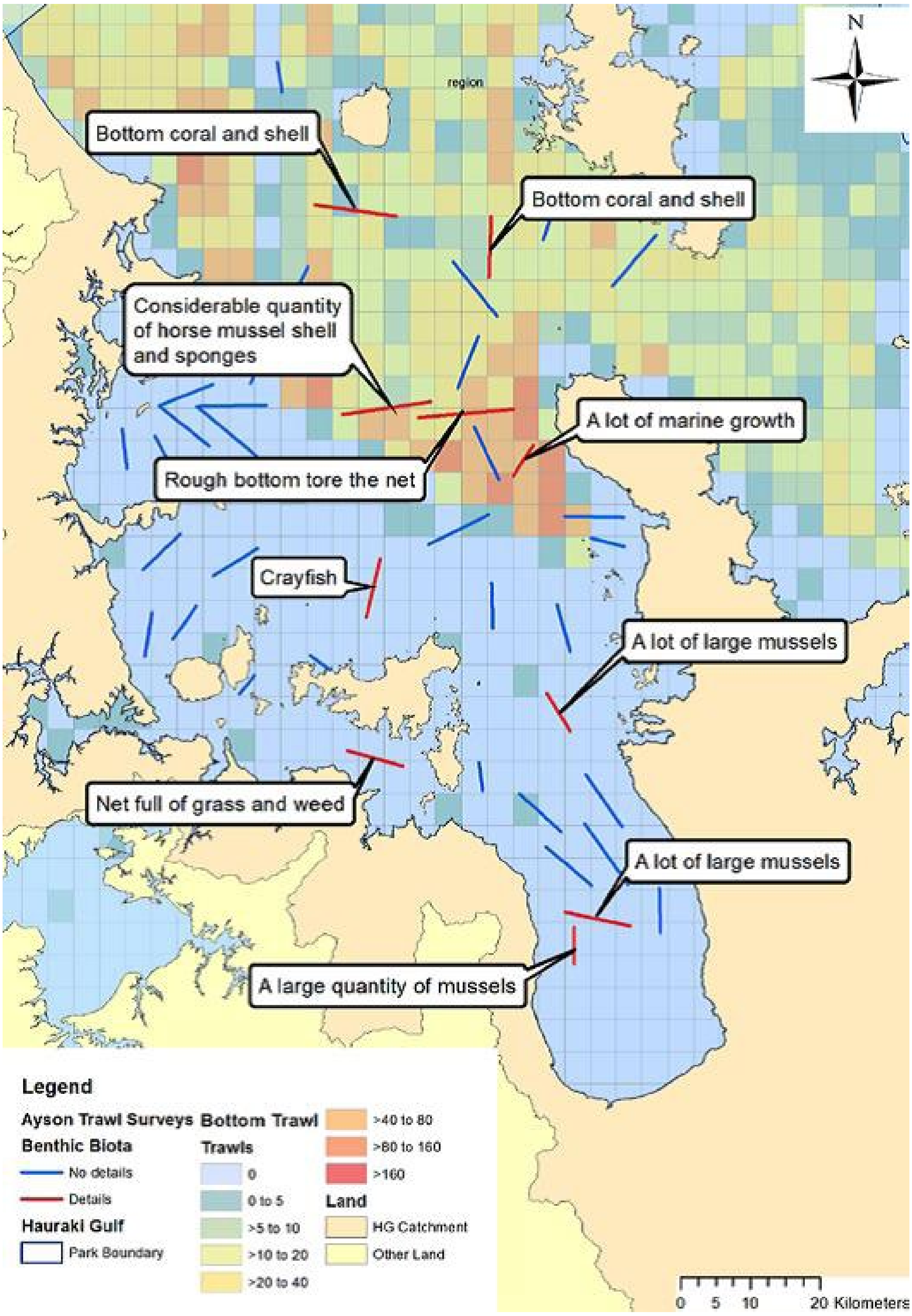


Figure A1.3 Inter-relationships between fishing, habitat, stocks, and land-based effects.

Reductions in harvest (pathway 6) result from stock effects due to harvest (pathway 1) and habitat effects (pathway 2 and 7). Land-based impacts interact with this dynamic; including damage to habitats (pathway 3) and direct effects on harvested stocks (pathway 4). In some situations, fishing and land-based effects may interact directly, e.g. the re-suspension of fine land-derived sediments through disturbance of the seafloor by bulk fishing methods. Feed-back loops are also possible between stocks and habitat (pathway 5, the dotted line) through trophic cascades, such as seen in some situations between lobsters/large carnivorous reef fish, urchins, and kelp forests. (Source. Adapted from Armstrong & Falk-Peterson 2008).

In Figure 1, we have also added another major and important stressor, land-based impacts, in particular increased sedimentation and nutrient (eutrophication) effects; as well as other marine industries. These can include both impacts on habitats (e.g., smothering, clogging of filter-feeding habitat formers, reductions in light penetration and competitive regimes for plants) (pathway 3), and direct impacts on the fisheries species themselves (e.g., reduction in physiological fitness, and impacts on foraging success (pathway 4) (see Morrison et al. 2009 for a New Zealand focussed review of these issues). While these land-based impacts do not have the same direct economic 'negative externality' back to the industries/activities creating them (e.g. farming, forestry, urbanisation), more broadly speaking the 'agents' (people) involved in those industries may still be impacted, if they value recreational fishing and marine recreation; and by a societal level loss of economic value from marine systems. Finally, in some situations there are also feedback loops from the reduction of some stocks (in abundance and size structure) into reductions in habitat type and associated productivity (pathway 5). A well-documented example in New Zealand are trophic cascades where high level predators such as snapper and rock lobsters are fished down to low levels on shallow rocky reef systems, removing their control of sea urchins by predation pressure, who then graze down kelp forests, converting them into 'urchin barren' habitats (Babcock et al. 1999), which have lower primary productivity (Salomon et al. 2008). However, it should be noted that such effects are context-dependent and not universal – see Shears et al. (2008) for Hauraki Gulf examples.

The Gulf has experienced large declines in the abundance of many habitats (e.g. Greenway 1969, Reid 1969, Morrison et al. 2009, Paul 2012, Morrison et al 2014b, c, State of the Gulf 2014, Jones et al., in press), in particular through the loss of biogenic (living) habitats, which provide numerous ecosystem goods and services, including supporting fisheries. Also known as 'foundation species' where they create habitat for other species (e.g. Bracken et al. 2007), examples include horse mussel and green-lipped mussel beds, kelp forests, soft and hard corals, sponge garden, bryozoan fields, polychaete worm meadows, and red algal beds. Some habitats, such as subtidal seagrass meadows and green-lipped mussels, are now effectively functionally extinct in the Gulf – in the first case, probably due to land-based sedimentation and extensive capital works around Auckland, rather than fishing per se (Powell 1937). Map A1.1 shows some trawl bycatch data collected more than 100 years ago in the Gulf, and is notable for stations containing foundation habitat species that are uncommon/absent today on much of the Gulfs soft sediments (e.g. coral, horse mussels, 'marine growth', and mussels (probably green-lipped).



Map A1.1 Bottom biota recorded during exploratory trawl surveys carried out in 1901 and 1907 by the Inspector of Fisheries, L. F. Ayson (see Ayson 1901, 1908).

Trawl lines are overlaid on a grid showing the number of bottom trawls undertaken between 1 January 2011 and 1 January 2014. Details about the bottom biota were provided for the red trawl lines, as indicated (Source. Figure 6.8 of Kelly et al. 2014).

Research in other regions where such habitats still exist, such as some of East Northland's harbours (e.g., Parengarenga and Rangaunu), and the coastal sea of Te Rawhiti Strait, Bay of Islands, show that these biogenic habitats support high abundances of juvenile fish. Such habitats are likely to generate a disproportionately large component of fish recruitment for species such as snapper. In Figure A1.4 Top, in Tāmaki Strait the net was recorded "full of grass and weed". Based on the very similar 'coastal sea' area of Te Rawhiti Strait further north, which is a much better ecological state than Tāmaki Strait, it is likely that this description was for either subtidal seagrass and/or the green algae Caulerpa sp. Both of these species require clear water and coarse sediments grow, which Tāmaki Strait probably had historically, but does not possess in the present day. If so, then the seafloor and associated small fish assemblages of Tāmaki Strait may have historically looked like Figure A1.4 Bottom.

Figure A1.4 Present day biogenic seafloor habitats in Te Rawhiti Strait, Bay of Islands.

Top, mixed seafloor cover of subtidal seagrass and algal turfs with juvenile snapper (0+); Bottom, Caulerpa sp. (a fleshy green macro-algae) bed on soft sediment with juvenile snapper. (Source. NIWA)

Habitat recovery / restoration

While international and New Zealand research has now shown how trawling and dredging impacts on soft sediment seafloor habitats, there is (rather surprisingly) little published research on how habitats and environments recover once such impacts are removed (as opposed to fished target species). Time scales of recovery and re-establishment of associated key ecological functions are likely to be slow. Sainsbury et al. (1988) presented a widely cited example of using a large scale experiment to link fisheries catches and benthic structure (sponges). On the North West Shelf region of Australia, research surveys between 1962 and 1983 (Sainsbury 1987,1988,1991) found that the abundance of high valued fish (Lethrinus and Lutjanus genera in particular, tropical snappers (not related to New Zealand snapper) had declined with the development of trawling, while the abundance of some lower valued fish (Nemipterus and Saurida in particular) had increased. Concurrently, the catch rates of epibenthic organisms, such as sponges, greatly decreased between 1963 and 1979. Photographic surveys in the 1980s showed the higher valued species to occur significantly more often in areas with epi-benthos >25cm in height, while the lower valued species were significantly more frequent in areas without large epi-benthos.

To test this experimentally, in 1985 an area was closed to trawling while an adjacent area was left open to trawling (each covering about 80 miles of coastline on the adjacent shelf), and surveyed each year from 1986 to 1991 for fish and benthos. In the closed area, both the density of fish and the abundance of small benthos increased, and the abundance of large benthos stayed about the same or increased slightly. In the area that remained open to trawling, the abundance of fish decreased, and the abundance of both large and small benthos decreased. A Bayesian analysis based on prior probabilities for four alternative a priori hypotheses found that the information from the experiment increased the probability of the habitat limitation hypothesis (i.e. that habitat availability drove fish abundance) to about twice that of the next highest hypothesis.

It was concluded that "this indicates a substantially increased possibility that a high valued Lethrinus and Lutjanus fishery could be established on the North West Shelf if the habitat could also be protected". As an additional point, Sainsbury (1988) also noted that the observed change in abundance of large (over 25cm) and small (under 25cm) benthic organisms in the empirical field experiment was inconsistent with the assumed settlement and growth rates in the initial model. In that model, it was assumed that epibenthic organisms could grow to 25cm in about 6–10 years; but the experiment indicated that a period of at least 15 years was needed for this growth, and that settlement rates were also probably lower than expected. Video cameras mounted on the net also found that where the fate of benthic organisms over 15cm encountering the net were observable, 89% of interactions removed the organism from the substrate. There was a very low occurrence of removed organisms being retained by the trawl, meaning that "most removals would not be apparent from trawl catches of benthic organisms" (Sainsbury et al. 1988).

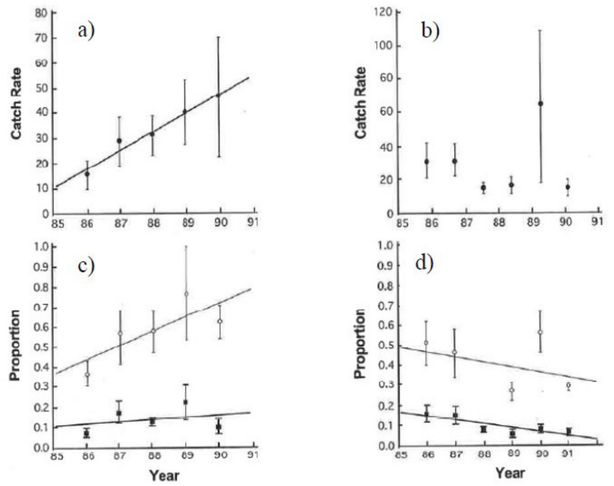


Figure A1.5 Total catch rates of Lethrinus plus Lutjanus (kg/30 min trawl).

Based on annual research data for a) the zone closed to trawling in October 1985, b) the zone open to trawling; for c) and d), the proportion of seabed with large (closed square) and small (open circle) benthos based on annual research data for c) the closed zone, and d) the open zone. Standard errors and lines of best fit are shown. (Source. Sainsbury et al. 1988).

The Hauraki Gulf has been intensively and extensively fished for a number of decades, and much of the seafloor structure was probably removed in the early days of industrial fishing. Combined with large scale land-derived issues, especially sedimentation, ongoing fishing has probably worked to prevent regeneration of habitats. In some areas, such as the heavily sedimented area of the inner Firth of Thames, the system may have irreversibly moved to a new (degraded) state. Restoration science is in the early days as a science endeavour, both internationally and in New Zealand. The rehabilitation and restoration in the Gulf is an important objective, which offers the potential to not only increase fisheries production, but also increase the overall health and functioning of the Gulf. This can take both passive and active forms. Passive restoration involves the retirement/mitigation of key stressors (e.g. high seafloor fishing gear impacts and/or sedimentation in areas of high importance) to allow natural regeneration; while active restoration involves the transplanting/establishment of new habitat patches/areas through direct human intervention. While the scale of issues are significant, initial restoration attempts for cockles and seagrass in Whangarei Harbour and elsewhere have shown promise; and green-lipped mussel restoration efforts in the Gulf are uncovering key biophysical and social hurdles to overcome in re-establishing beds. The most effective approach going forward will be a nested approach, with larger areas used for passive restoration, within which active restoration efforts can be moved forward. Moving towards an ecosystem based approach to fishing, where habitat management is seen as central to producing fisheries production, is likely to allow for higher longer term fisheries yields, within a fundamentally more productive and healthy ecosystem.

Food supply for seabirds

The Hauraki Gulf Marine Park is the seabird capital of the world. However the breeding success of many species is dropping and adult birds are foraging further afield. There are concerns that food supplies within the Gulf may not be sufficient for seabirds breeding here. There is currently no scientific data with which to test whether this issue is real, or significant. One proposed mechanism is that reductions in kahawai and trevally numbers by purse seining has led to fewer surface feeding aggregations of these species (also known as 'boil-ups' or 'work-ups'), where they drive up and concentrate small baitfish or euphausiids. In turn, this might reduce the availability of small baitfish/pelagic invertebrates to foraging seabirds, for those species associated with such features. For example, shearwaters, prions and gulls feed on the euphausiids that are targeted by trevally, while shearwater species (especially fluttering shearwaters) feed on the bait fish that kahawai pursue. However, there is no information available to assess whether such a mechanism is operating, nor whether kahawai and trevally have been/remain depleted through targeted purse seining.

For example, Buller's shearwater (Ardenna bulleri) is endemic to New Zealand, and nests only on the Poor Knights Islands group, north-eastern North Island. It is classified as Vulnerable (IUCN Red List) and At Risk, Naturally Uncommon (NZ Threat Classification System). The foraging behaviour and diet of Buller's shearwaters is relatively unknown (Taylor 2013). Based on at-sea observations, including recent trials to investigate seabirds interacting with baits from fishing vessels, Buller's shearwaters spend less time diving during foraging bouts than other species. This is particularly so compared to other shearwater species although they are still capable of diving to reasonable depths. Unlike many seabirds that hunt prey underwater, it appears that Buller's shearwaters, although they can catch prey by diving, primarily capture prey at or close to the surface in association with fish schooling surface activity ('workups'). This potentially greater reliance on fish predators for hunting, relative to other seabird species, suggests that Buller's shearwaters are likely to be subject to strong secondary (indirect) effects of the fishing industry

Evidence suggests that foraging times during the incubation period of breeding Buller's shearwaters may have increased in the past 40 years, up from 4 to 14 days (Harper 1983, Taylor 2013). Additionally, new at-sea records of adults suggest they could be traveling further south in single foraging bouts during chick provisioning. This change in foraging locations is evidenced by increased sightings by observers off Kaikoura (Richard et al 2014). These ecological changes, together with recent poor breeding seasons (G. Taylor, pers. comm.), suggest that the population may be under stress. Also, recent visits (2011-2012) to the Poor Knights Islands (Aorangi Island) during breeding indicate that previous population estimates appear to be far too high (Carboneras et al 2016). Gaining a better understanding of the foraging and migratory behaviour of Buller's shearwaters is critical in understanding the bottom-up effect that fishing may have on this secondary top predator.

Figure A1.6 Prions and shearwaters interacting with a 'boil-up

Figure A1.7 Buller's shearwater's feeding in association with a trevally school, Poor Knights Islands

Figure A1.8 Red-billed gulls feeding around and in the wake of a trevally school on crustaceans, Mokohinau Islands (Source A7, A8, A9. Chris Gaskin, Karen Baird)

ECOSYSTEM SERVICES AND NATURAL CAPITAL

In addition to the scientific perspectives provided above, an economic study into the value of ecosystem services and natural capital needs to be undertaken as part of implementation of Sea Change.

Natural capital

All of the activities that occur in and around the Hauraki Gulf Marine Park and its catchment are underpinned by the area's natural resources and the 'services' they provide. In this sense, it can be considered as a type of 'natural capital', which, along with other types of capital is needed to create the things we value. Broadly speaking, natural capital encompasses both non-renewable resources (such as land, fossil fuels and other minerals) and renewable[1] resources (such as forests, water, and fish)[2], and how these resources collectively function as a system. In Treasury's 2011 report, Working Towards Higher Living Standards for New Zealanders, the concept is illustrated as shown in the figure below:

Natural capital, on its own, or combined with other types of capital, provides a means of creating the things enjoyed by people. This process is often referred to as the provision of 'ecosystem services'. The idea of natural capital and ecosystem services is analogous to the wealth we hold in financial or physical capital, which generates a flow of financial incomes. The Hauraki catchment itself can be thought of as our stock of 'wealth', which generates a flow of ecosystem services.

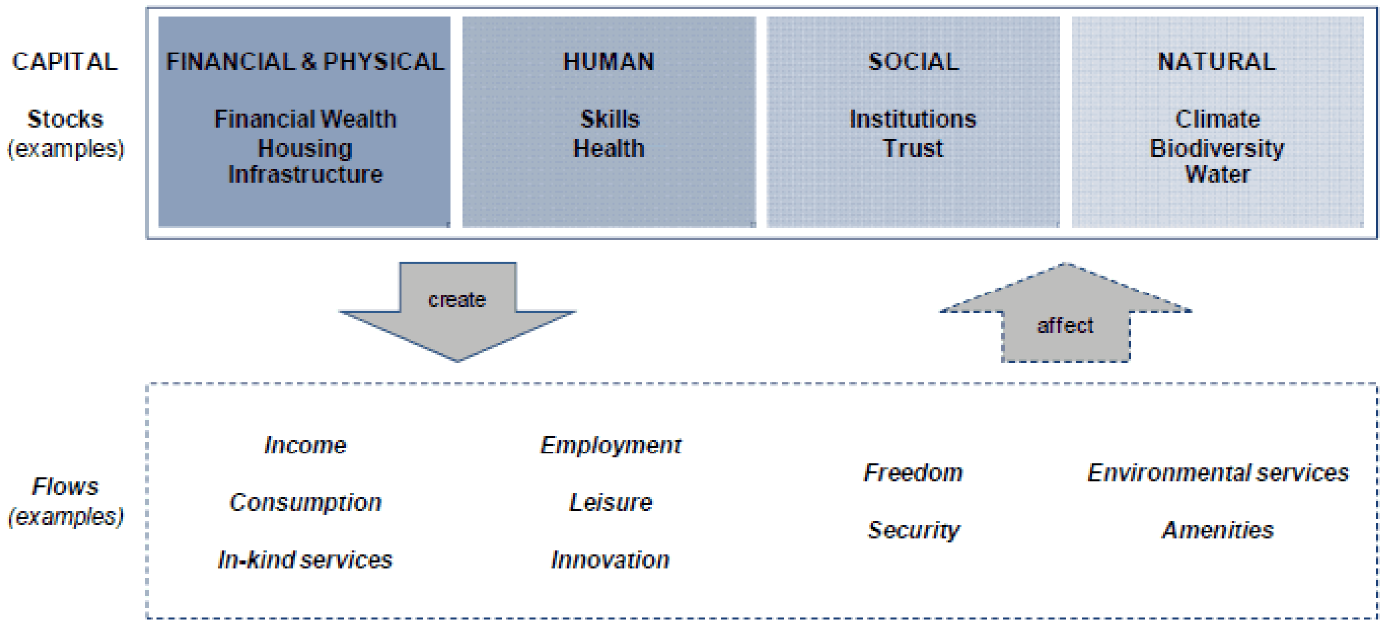


Figure A1.9 Representation of Natural Capital concept (Source. New Zealand Treasury, 2011 Working Towards Higher Living Standards for New Zealanders)

1 These are sometimes referred to as 'conditionally renewable, since, if they are over-used, they may be unable to be renewed and can be depleted in the same way as non-renewable resources.

2 See Statistics New Zealand's 2009 report, Framework for Measuring Sustainable Development, for a full description.

Ecosystem services

Ecosystem services are typically divided into four categories[3]: provisioning, regulating, supporting, and cultural. Perhaps the most obvious of these are the 'provisioning' services. These are typically tangible outputs like the material or energy products of natural capital. These include food, water, raw materials like timber and minerals, and medicinal resources.

'Regulating' services are those functions that the environment undertakes to control the quality of air, soil and water, or to regulate hazards such as flooding and disease. Examples of this type of service include the cycling of nutrients, the assimilation of wastes, or the buffering against extreme events (such as coastal margins or wetlands acting as a buffer against flooding or storm surges).

'Supporting' services represents the provision of habitats that enables a healthy, well-functioning ecosystem. In a sense, this underpins all of the other types of services that are derived from natural capital. 'Cultural' services cover a wide range of values that enhance our wellbeing. They include the particular values recognised by tangata whenua, but also incorporate other recreational and amenity values. Note that cultural services might seem intangible and hard to pin down, but they are also important inputs to businesses in the tourism and recreation sector.

A warning: depreciation or depletion of natural capital

It is important to recognise that there are also feedbacks from our use of resources (represented by the 'affect' arrow in the figure above). In the case of non-renewable resources, this is obvious: extracting minerals reduces the stock of natural capital available to us. But it also applies to renewable resources: if we use, or otherwise affect them at a rate faster than they can be renewed we erode our stock of natural capital. In the same way that we might wear out a piece of artificial capital, if we do not provide for the maintenance of our natural capital, we may find that it depreciates over time, and so is less able to provide the services we are used to.

A framework for the Hauraki Gulf

As noted above, it can be helpful to think of natural capital as a functioning system, rather than a collection of 'things'. We use this system – sometimes directly (such as when we harvest fish), or indirectly (such as when we use the marine habitat to support fish farming) – to provide us with things that are valuable to us. Sometimes, our use of the system has a damaging effect on it – such as when we use it to dispose of some of the by-products (e.g., sediment) of our activities. Recognising how we use these ecosystem services, and understanding these interconnections is critical to being able to manage the Hauraki Gulf Marine Park well.

The development of an ecosystem services matrix for the catchment will be an important step to understanding the costs and benefits of our actions, including in terms of how they affect the natural capital of the gulf – for better or worse.

3 See, for example, The Economics of Ecosystems and Biodiversity project website at http://www.teebweb.org/resources/ecosystem-services/.

APPENDIX 2: AREAS IDENTIFIED FOR FUTURE AQUACULTURE DEVELOPMENT

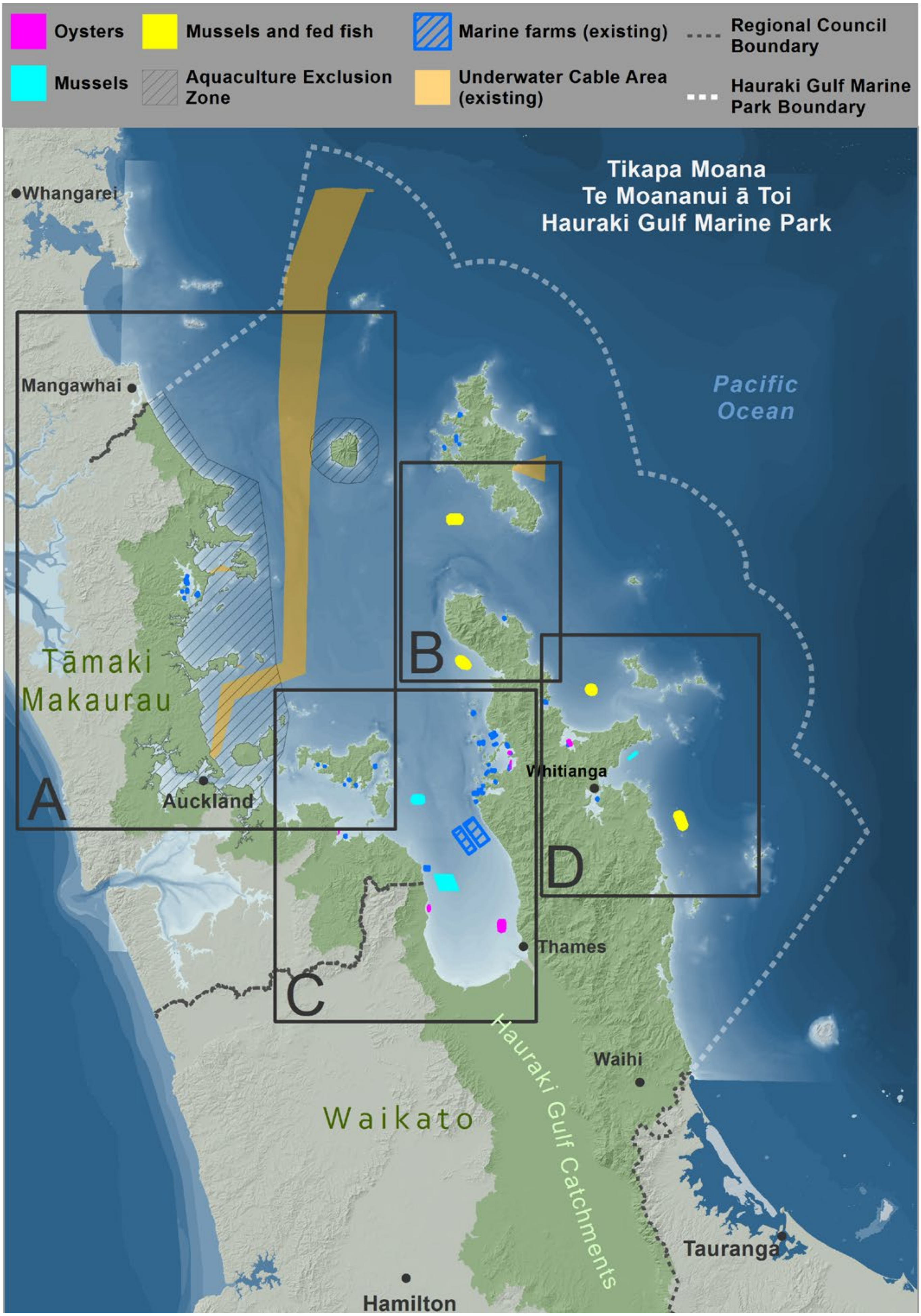
PIRINGA 2: NGĀ ROHE KUA TOHUA HEI WHANAKE AHUMOANA MŌ ĀMURI

Each area in the Table below was subject to an assessment against the criteria identified by the Aquaculture Round-Table. The proposed areas were initially developed by the Aquaculture Round-Table during a series of discussions in late 2014 and early 2015. The proposals were further developed by the Stakeholder Working Group and its Aquaculture Sub-Group during 2016. Of an initial suite of 19 sites, several were rejected and some new ones were added. Several sites are proposed as combined shellfish and fish areas.

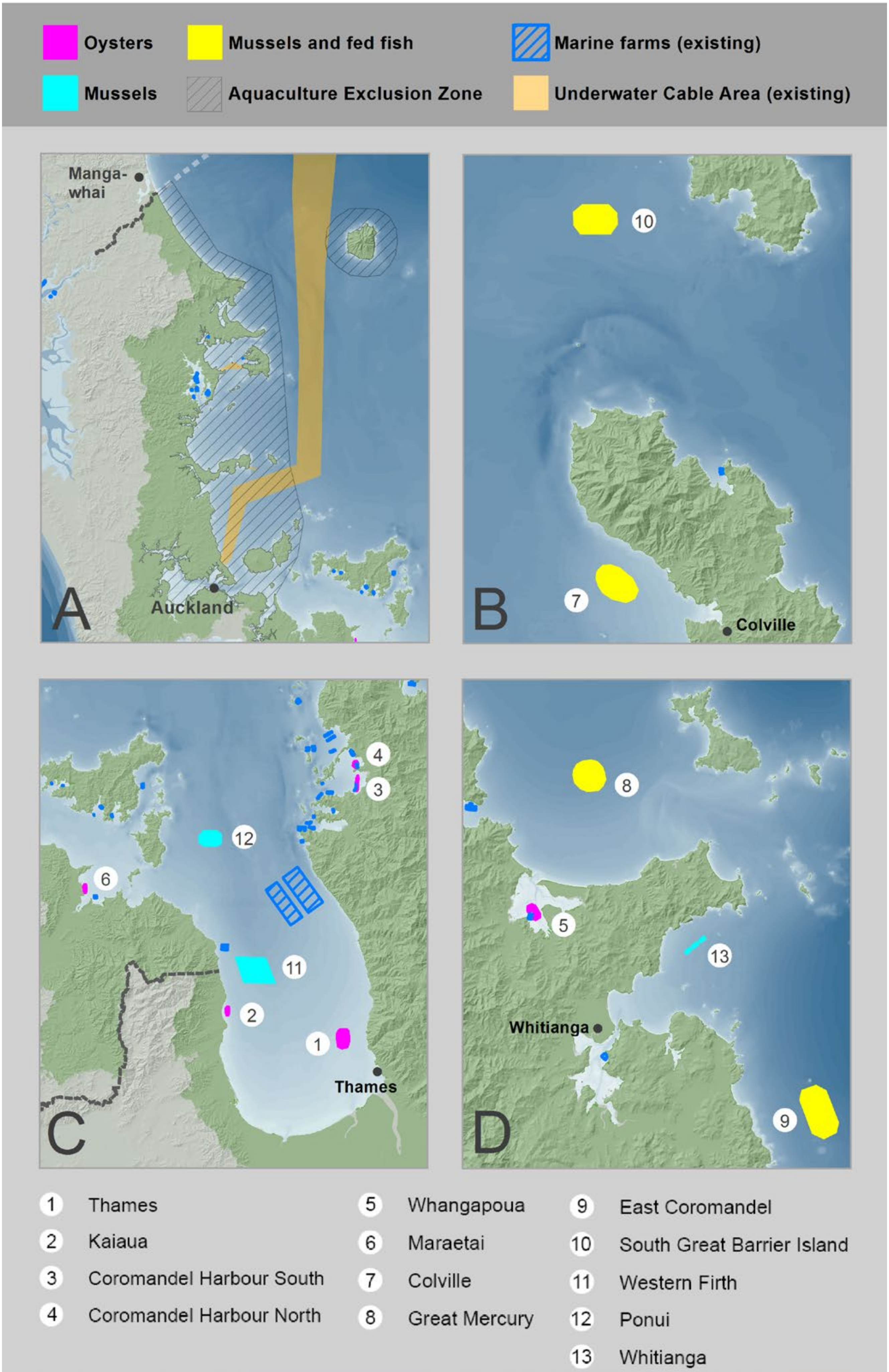
Table A2.1 identifies areas that are considered likely to be appropriate for future aquaculture development, and this Appendix provides detailed analysis that underpins the recommendations. The areas identified are a preliminary guide, based on our initial assessment which indicated that aquaculture is likely to be suitable in the vicinity of these locations. The boundaries have been carefully drawn to exclude areas where farms would likely have negative locational effects. It is not envisaged that marine farming would occupy all or even the bulk of these areas.

Table A2.1 Indicative aquaculture areas

SITE	LOCATION	SPECIES
1	Thames	Inter-tidal shellfish (oysters)
2	Kaiaua	Inter-tidal shellfish (oysters)
3	Coromandel Harbour South	Inter-tidal shellfish (oysters)
4	Coromandel Harbour North	Inter-tidal shellfish (oysters)
5	Whangapoua	Inter-tidal shellfish (oysters)
6	Maraetai	Inter-tidal shellfish (oysters)
7	Colville	Subtidal shellfish (mussels and fish)
8	Great Mercury	Subtidal shellfish (mussels and fish)
9	East Coromandel	Subtidal shellfish (mussels and fish)
10	South Great Barrier Island	Subtidal shellfish (mussels and fish)
11	Western Firth	Subtidal shellfish (mussels)
12	Ponui	Subtidal shellfish (mussels)
13	Whitianga	Subtidal shellfish (mussels)



Map A2.1 Proposed Aquaculture Areas



Map A2.2 Locations of proposed aquaculture and aquaculture exclusion areas

Site 1 – Thames

This shellfish farming area is located in shallow sub-tidal waters towards the southern end of the Firth of Thames, offshore from Tararu. The initial proposal was further south but was relocated northward to increase its separation from the Ramsar site in the southern Firth of Thames.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Creates potential for aquaculture jobs in a new area, possibly serviced out of Thames.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients.
BIOPHYSICAL SUITABILITY FOR FARMING	Appears to be ok. May have high sediment loads and potential for bacterial pollution from land based runoff. Possible heavy metal contamination of sediments from historic mining activities.
WATER DEPTH	2-5m
SUBSTRATE	Mud and sandy mud.
MEAN SIGNIFICANT WAVE HEIGHT	0.05m
CURRENT (METRES/SECOND)	0.23-0.31
SALINITY	27-33 ‰ (Broekhuizen & Zeldis 2005)
BIOTA	Sparse sub-tidal macro-fauna. The area between 1-5m depth is an important habitat for adult sand (Rhombosolea plebeia) and yellow-belly flounder (R. leporina) in the Firth of Thames (Morrison et al. 2014).
NATURAL CHARACTER	Over 2km from a high natural character area.
NATURAL FEATURES AND LANDSCAPES	Over 2km from an outstanding natural feature or landscape
COMMERCIAL FISHING	Within a flounder fishery area.
RECREATIONAL FISHING	Low level of recreational fishing (very shallow water).
COMMERCIAL BOAT TRAFFIC	Adjacent to shipping route for gravel barge from Kopu. Otherwise no conflict due to shallow water.
YACHTING ROUTES AND ANCHORAGES	Minimal conflict (no routes or anchorages, very shallow).
SEABIRDS	Fivekm from a Ramsar site. Over twokm from sites of importance for shorebirds on the Thames Coast.
MARINE MAMMALS	No conflict (very shallow water). One recorded sighting of killer whales.
SWELL CORRIDORS FOR SURF BREAKS	No surf breaks in vicinity.

Site 2 – Kaiaua

This shellfish farming area is located between Whakatiwai and Wharekawa, on the western side of the Firth of Thames, in shallow sub-tidal waters. The initial proposal was further south but was relocated northward because it was too close to the Ramsar.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Creates potential for aquaculture jobs in new area, possibly serviced out of Kaiaua or Wharekawa (ex-quarry landing).
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients.
BIOPHYSICAL SUITABILITY FOR FARMING	Appears ok. May have high sediment loads and potential for bacterial pollution from land based runoff.
WATER DEPTH	1-5m
SUBSTRATE	Mud, shell and sandy mud.
MEAN SIGNIFICANT WAVE HEIGHT	0.05-0.07m
SALINITY	33-35 ‰ (Broekhuizen & Zeldis 2005)
CURRENT (METRES/SECOND)	0.29-.033
BIOTA	Morrison et al. (2002) completed nine side-scan sonar transects with 10 associated ground-truth stations in the western Firth of Thames. Fish schools were very abundant in the surveyed block. Sonar imagery varied across the block, with higher patches of substrate variability in the south and central regions of several transects. In general the bottom is composed of muds with variable amounts of shell material. Live cockles (Austrovenus stutchberyi) occurred at some stations. The only station at which appreciable numbers of remnant greenlipped mussels (Perna canaliculus) were encountered anywhere in the Firth of Thames was located in this block, although the percentage cover of mussels was low (≤ 5%). No horse mussel (Atrina zelandica) beds were encountered in the ground-truth stations, and no side-scan imagery similar to that seen in areas where dense horse mussel beds were observed was obtained. Fishes commonly recorded in research trawls in the general area include: rig (Mustelus lenticulatus), snapper (Pagrus auratus), jack mackerel (Trachurus novaezealandiae), kahawai (Arripis trutta), John dory (Zeus faber), sand flounder and barracouta (Thyrsites atun) (Morrison et al. 2002). High catch rates of juvenile John dory have sometimes been recorded in research trawls in the western Firth of Thames (Morrison et al. 2014).
NATURAL CHARACTER	Over 5km from a high natural character area.
NATURAL FEATURES AND LANDSCAPES	Over 2km from an outstanding feature and landscape area.
COMMERCIAL FISHING	Within a flounder fishery area.
RECREATIONAL FISHING	Minor level of recreational fishing (very shallow water).
COMMERCIAL BOAT TRAFFIC	No conflict.
YACHTING ROUTES AND ANCHORAGES	No conflict (very shallow water).
SWELL CORRIDORS FOR SURF BREAKS	No surf breaks in vicinity.

Site 3 – Coromandel Harbour South

This inter-tidal shellfish farming area is located on the inter-tidal flats in the southern part of Coromandel Harbour and includes several existing oyster farms. The area is intended to provide for expansion of the existing operations without predetermining the precise location and scale of the expansion.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Allows for expansion of existing oyster farming area and potential for additional jobs.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients.
BIOPHYSICAL SUITABILITY FOR FARMING	Ok, currently farmed.
WATER DEPTH	Intertidal – 2m.
SUBSTRATE	Sand, and mud and broken shell. Small amount of seagrass in northern part of area.
MEAN SIGNIFICANT WAVE HEIGHT	0.1m
SALINITY	34-35 ‰ (Broekhuizen & Zeldis 2005)
CURRENT (METRES/SECOND)	0.08-0.11
CONTAMINANTS	Sediments in Coromandel Harbour are potentially contaminated with toxins contained in run-off from historical gold mining in the surrounding catchment (Coffey 2011). There is potential for these toxins to be released into the water column by activities, such as capital and maintenance dredging, which disturb the sediments.
BIOTA	Inner Coromandel Harbour is identified as an Area of Significant Conservation Value (ASCV12) in the Waikato Regional Coastal Plan due to its significance to Hauraki iwi, its saltmarsh, eel grass and mangrove communities and the presence of resident and migratory rare and threatened waders and coastal bird species (Waikato Regional Coastal Plan 2005, Appendix IV: Areas of Significant Conservation Value). The intertidal and subtidal communities present within the proposal are considered characteristic of similar habitats elsewhere in lower Coromandel Harbour (Coffey 2011). The shoreline is characterised by active and relic wave- built chenier ridges which create a complex and biologically diverse chenier vegetation zone at the top of the shore. Rushland and other communities generally occur only in sheltered areas landward of cheniers. Seaward of this the intertidal area is characterised by mangrove, seagrass and open intertidal flat associations (Graeme & Dahm 2006). Dense seagrass patches occur between 0.2-0.7m above mean level of sea (MLOS) Coromandel (Graeme & Dahm 2006). Shorebirds feeding on the intertidal flats include variable oystercatcher (Haematopus unicolor), South Island pied oystercatcher (Haematopus finschi), New Zealand dotterel (Charadrius obscurus); banded dotterel (Charadrius bicinctus); and bar-tailed godwit (Limosa lapponica) (Dowding 2013).
NATURAL CHARACTER	No natural character in the vicinity of this area.
NATURAL FEATURES AND LANDSCAPES	Over 3km from an outstanding feature and landscape area.
COMMERCIAL FISHING	Within a flounder fishery area.
RECREATIONAL FISHING	No conflict (inter-tidal).
COMMERCIAL BOAT TRAFFIC	No conflict (inter-tidal).
YACHTING ROUTES AND ANCHORAGES	No conflict (inter-tidal).
SWELL CORRIDORS FOR SURF BREAKS	No surf breaks in vicinity.

Site 4 – Coromandel Harbour North

This inter-tidal shellfish farming area is located on the inter-tidal flats in the northern part of Coromandel Harbour and includes two existing oyster farms. The area is intended to provide for expansion of the existing operations without predetermining the precise location and scale of the expansion.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Allows for expansion of existing oyster farming area and potential for additional jobs.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients.
BIOPHYSICAL SUITABILITY FOR FARMING	Ok, currently farmed.
WATER DEPTH	Intertidal – 1m
SUBSTRATE	Sand, and mud and broken shell. Seagrass beds in northern and eastern part of area.
MEAN SIGNIFICANT WAVE HEIGHT	0.1m
SALINITY	34-35 ‰ (Broekhuizen & Zeldis 2005)
CURRENT (METRES/SECOND)	0.12-0.13
CONTAMINANTS	Sediments in Coromandel Harbour are potentially contaminated with toxins contained in run-off from historical gold mining in the surrounding catchment (Coffey 2011). There is potential for these toxins to be released into the water column by activities, such as capital and maintenance dredging, which disturb the sediments.
BIOTA	Inner Coromandel Harbour is identified as an Area of Significant Conservation Value (ASCV 12) in the Waikato Regional Coastal Plan due to its significance to Hauraki iwi, its saltmarsh, eel grass and mangrove communities and the presence of resident and migratory rare and threatened waders and coastal bird species (Waikato Regional Coastal Plan 2005, Appendix IV: Areas of Significant Conservation Value). The shoreline is characterised by active and relic wave-built chenier ridges which create a complex and biologically diverse chenier vegetation zone at the top of the shore. Rushland and other communities generally occur only in sheltered areas landward of cheniers. A rare manuka-dominated freshwater wetland community occurs immediately north of Huaroa Stream. Seaward of this the intertidal zone is characterised by mangrove, seagrass and open intertidal flat associations (Graeme & Dahm 2006). Seagrass beds occur at or below 0.4m above mean level of sea (MLOS) Coromandel in the northeast corner of the proposal (Graeme & Dahm 2006). Shorebirds feeding on the intertidal flats include variable oystercatcher (Haematopus unicolor), South Island pied oystercatcher (Haematopus finschi), New Zealand dotterel (Charadrius obscurus); banded dotterel (Charadrius bicinctus); and bar-tailed godwit (Limosa lapponica) (Dowding 2013). New Zealand dotterel nest and a variety of other species roost on the chenier ridges at the top of the shore near Whangarahi Stream mouth (Dowding 2013).
NATURAL CHARACTER	One kilometre from an area of high natural character.
NATURAL FEATURES AND LANDSCAPES	Over 2km from an ONFL.
COMMERCIAL FISHING	Within a flounder fishery area.
RECREATIONAL FISHING	No conflict (inter-tidal).
COMMERCIAL BOAT TRAFFIC	No conflict (inter-tidal).
YACHTING ROUTES AND ANCHORAGES	No conflict (inter-tidal).
SWELL CORRIDORS FOR SURF BREAKS	No surf breaks in vicinity.

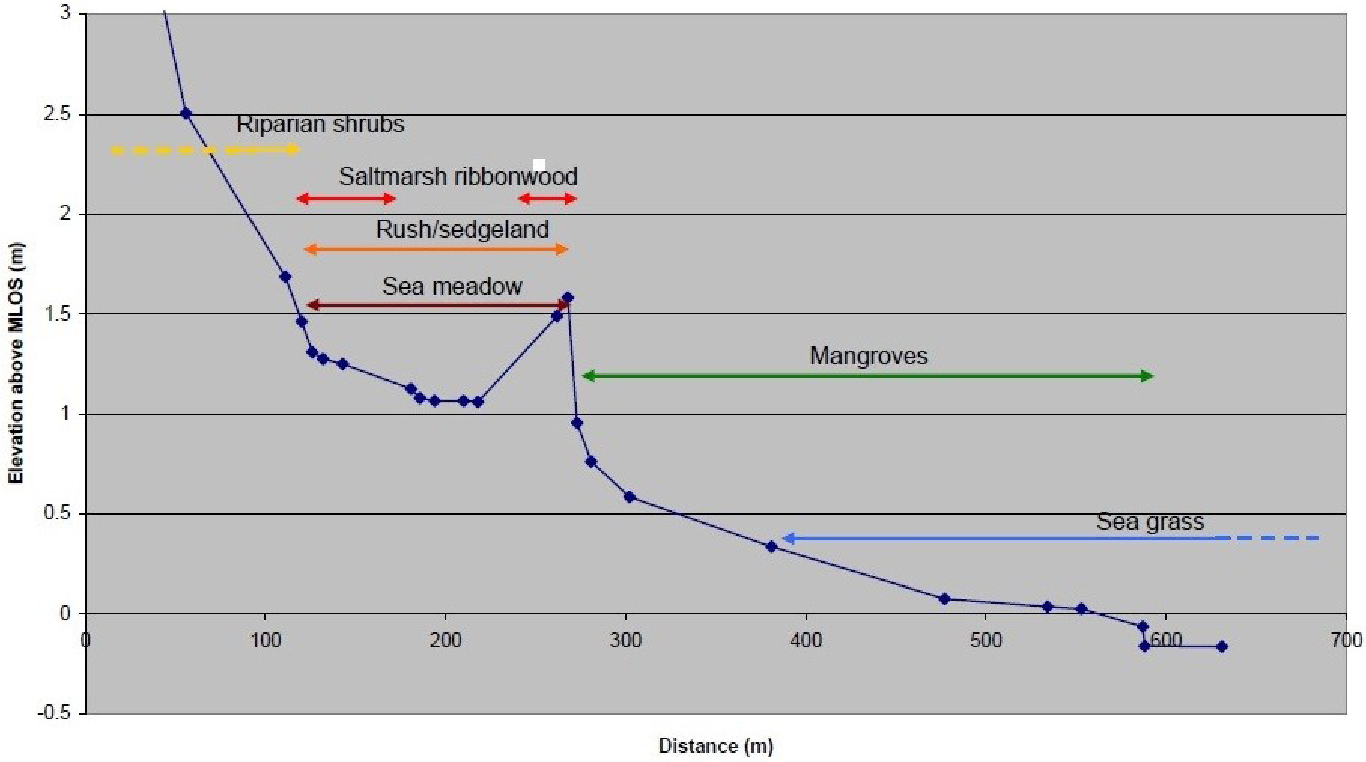


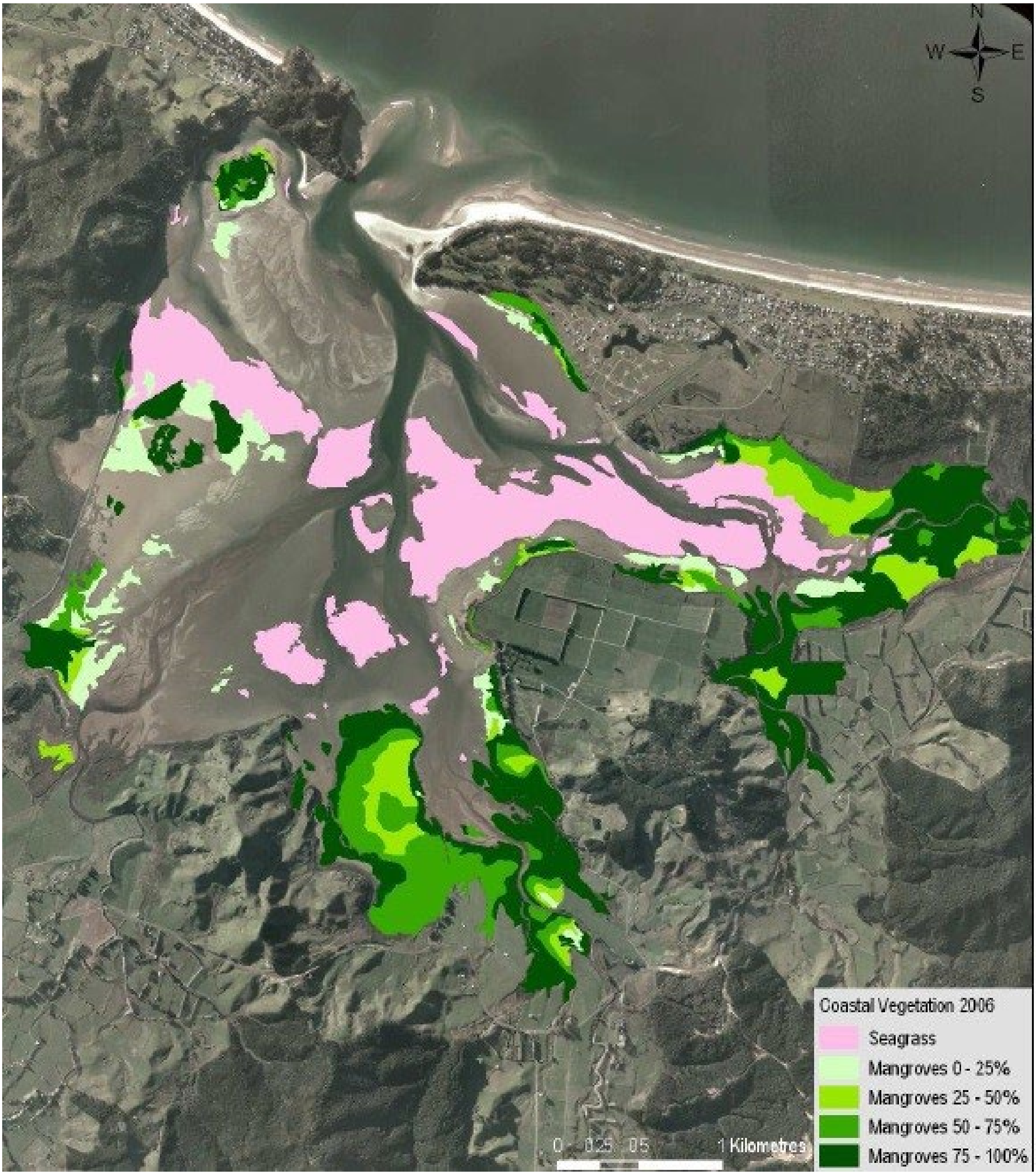
Figure A2.1 Section showing the vertical distribution of coastal vegetation types at this site (Source. Section F, Graeme & Dahm 2006)

Site 5 – Whangapoua

This inter-tidal shellfish farming area is located in Whangapoua Harbour and includes two existing oyster farms of 4ha each. It was determined that this Harbour had the potential to accommodate more inter-tidal farming and the expanded area provides flexibility to position farms in locations that avoid areas of siltation, sea grass and tidal channels.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Allows for expansion of existing oyster farming area and potential for additional jobs.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients.
BIOPHYSICAL SUITABILITY FOR FARMING	Ok, currently farmed**.**
WATER DEPTH	Intertidal flats and two shallow tidal channels
SUBSTRATE	Sand with small mud and gravel fractions (Halliday et al. 2006). Seagrass beds and mangroves within area.
TURBIDITY	0.5-3.7 NTU
CURRENT (METRES/SECOND)	no data
CONTAMINANTS	Elevated faecal bacteria levels can occur following heavy rainfall events (Lewis & Britton 2015; see also www.waikatoregion.govt.nz, estuarine water quality monitoring map)
BIOTA	Whangapoua Harbour contains a range of intertidal and shallow subtidal estuarine habitat types including rocky reef, open sand flats supporting dense beds of cockles, pipi and wedge shells, extensive intertidal seagrass (Zostera muelleri) meadows that extend subtidally in places, mangroves and marginal wetlands (Halliday et al. 2006; Needham et al. 2014; Lewis & Britton 2015). Although intertidal seagrass meadows are used by juvenile fishes during high tide the subtidal beds are the more important as juvenile fish habitat, particularly for species such as snapper (Pagrus auratus), trevally (Pseudocaranxx georgianus) and parore (Girella cuspidata) (Morrison et al. 2014a). The harbour receives sediment inputs from erosion in the catchment caused by natural processes and human activities (e.g. forestry, coastal development) and both individual species and species assemblages show a number of changes related to sediment loading (Halliday et al. 2006; Lewis & Britton 2015). Most of these changes have not been sufficient to drastically alter the macrofaunal communities but there has been a substantial decrease in the total area of seagrass and an increase in the area occupied by mangroves between 1945-2006. Much of this change occurred prior to 1993 but ongoing effects of sedimentation are detectable (Halliday et al. 2006). Despite this, water clarity remains high and the harbour retains high ecological values (Halliday et al. 2006). These include regionally significant examples of indigenous coastal wetland and saltmarsh vegetation, nationally rare subtidal sea grass beds, and regionally important wading and shore bird habitat (Halliday et al. 2006; Schwartz et al. 2006; Turner & Schwarz 2006; Rowden et al. 2012; Lewis & Britton 2015). The observed changes in the composition of the benthic communities in the harbour have the potential to alter basic ecosystem functions such as nutrient recycling and oxygen flux between the water column and the sediments (Halliday et al. 2006). These changes and habitat loss are likely to have flow-on effects on other ecological groups such as fishes and wading birds (Halliday et al. 2006; Lewis & Britton 2015). The maintenance of subtidal seagrass beds in the harbour is dependent on the maintenance of high water clarity (Morrison et al. 2014 a, b).
NATURAL CHARACTER	This is in a high natural character area.
NATURAL FEATURES AND LANDSCAPES	No identified natural features or landscapes near this area
COMMERCIAL FISHING	Within a flounder fishery area.
RECREATIONAL FISHING	No conflict (inter-tidal).
COMMERCIAL BOAT TRAFFIC	No conflict (inter-tidal).
YACHTING ROUTES AND ANCHORAGES	No conflict (inter-tidal).
SEABIRDS	Within area of importance to shorebirds.
MARINE MAMMALS	No conflict (inter-tidal).
SWELL CORRIDORS FOR SURF BREAKS	No surf breaks in vicinity.



Map A2.3 Distribution of sea grass and mangroves in Whangapoua Harbour (Source. Halliday et al. 2006)

Site 6 – Maraetai

This inter-tidal shellfish farming area was proposed by the Round-Table during their first consideration of the aquaculture areas. It is in the vicinity of existing oyster farms and applications for additional oyster farms.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Allows for expansion of existing oyster farming area and potential for additional jobs.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients.
BIOPHYSICAL SUITABILITY FOR FARMING	Ok, currently farmed.
WATER DEPTH	Inter-tidal.
SUBSTRATE	Mud, muddy sand
MEAN SIGNIFICANT WAVE HEIGHT	0.02m
SALINITY	34-35 ‰ (Broekhuizen & Zeldis 2005)
CURRENT (METRES/SECOND)	0.09-0.12
CONTAMINANTS	PAHs below detectable levels (Tricklebank & Stewart 2001)
BIOTA	The proposed aquaculture area lies within Significant Ecological Area 41a (SEAM2) in the Proposed Auckland Unitary Plan. A total of 55 bird species have been recorded from the Wairoa River estuary and tidal flats. The intertidal banks are a feeding ground and important mid-tide roost for several thousand international migratory and New Zealand endemic wading birds, including a number of threatened species. Moderate numbers of wading birds feed on the mudflats, including bar-tailed godwit (Limosa lapponica), red knot (Calidris canutus), whimbrel (Numenius phaeopus), variable oystercatcher (Haematopus unicolor) and banded dotterel (Charadrius bicinctus). Banded rail (Gallirallus philippensis) and fernbird (Bowdleria punctata vealeae) are associated with mangroves and vegetated margins of estuary (Appendix 6.1 Schedule of Significant Ecological Areas Marine, The Proposed Auckland Unitary Plan - notified 30 September 2013). Subtidal habitats in Wairoa Estuary and Tamaki Strait are affected by very high sedimentation rates (2-8 mm/year) (Swales et al. 2002). Much of this sediment is thought to originate from the Wairoa River (Swales et al. 2002). The protistan shellfish parasite Perkinsus olseni was found in cockles (Austrovenus stutchburyi) from Wairoa Estuary, as well as Okura Estuary, Waitemata Harbour, Tamaki Estuary, and Mangemangeroa Estuary in 2000 by Tricklebank & Stewart (2001).
NATURAL CHARACTER	Adjacent to a high natural character area.
NATURAL FEATURES AND LANDSCAPES	Adjacent to ONFL
COMMERCIAL FISHING	Within a flounder fishery area.
RECREATIONAL FISHING	No conflict (inter-tidal).
COMMERCIAL BOAT TRAFFIC	No conflict (inter-tidal).
YACHTING ROUTES AND ANCHORAGES	No conflict (inter-tidal).
SWELL CORRIDORS FOR SURF BREAKS	No surf breaks in vicinity.

Site 7 – Colville

This area is located close to the western coastline of the Coromandel Peninsula, north of Colville.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Creates potential for aquaculture jobs in new area, possibly serviced out of Colville or from existing facilities at Coromandel.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients. Structures in water create shelter and habitat for wildlife. Shell drop adds structure to seafloor.
BIOPHYSICAL SUITABILITY FOR FARMING	Ok. Water depths around 20m. Some exposure to north-west. Mud and muddy sand substrate.
WATER DEPTH	15 to 30m
SUBSTRATE	Mud and sandy mud. Reef and dog cockle beds to north. Area reduced and moved offshore to avoid reef. Horse mussel beds present in some areas.
MEAN SIGNIFICANT WAVE HEIGHT	0.3m
SALINITY	>35‰ (Broekhuizen & Zeldis 2005)
CURRENT (METRES/SECOND)	0.20-0.37
BIOTA	The area is commercially fished for scallops (Pecten novaezelandiae). Dog cockle (Tucetona laticostata) and large, relatively dense horse mussel (Atrina zelandica) beds occur in some areas, although the extent of these beds has been substantially reduced by scallop dredging and trawling (Thrush et al. 1998). The presence of dog cockle and horse mussel beds increases infaunal invertebrate diversity, and live in-situ horse mussels are colonised by macroalgae and a variety of sessile invertebrates including sponges, anemones and ascidians increasing both epifaunal diversity and habitat complexity (Cummings et al. 1998; Dewas 2008). Dead horse mussels are colonised by a variety of mobile invertebrates, including juvenile rock lobster (Jasus edwardsii), and small fishes (Allan & Walshe 1984). The increased habitat complexity created by horse mussels and their epibionts has also been shown to provide nursery habitat for juvenile snapper and significantly reduce mortality of post-settlement scallops (Thrush et al. 1998; Morrison et al. 2014a, b). The area does not include any critical seabird habitat. Seabirds known to forage in the general area of the proposal include Australasian gannet (Morus serrator), fluttering shearwater (Puffinus gavia) and little penguin (Eudyptula minor). Common dolphins (Delphinus delphis) regularly occur in this area and there are occasional sightings of bottlenose dolphin (Tursiops truncatus), killer whale (Orcinus orca) and Bryde's whale (Balaenoptera edeni).
NATURAL CHARACTER	Adjacent to a high natural character area. Twokm from an outstanding natural character area to south.
NATURAL FEATURES AND LANDSCAPES	Twokm from an ONFL.
COMMERCIAL FISHING	Adjacent to high intensity trawling areas and moderate intensity longline fishing.
RECREATIONAL FISHING	Low level of recreational fishing.
COMMERCIAL BOAT TRAFFIC	No commercial traffic in this area.
YACHTING ROUTES AND ANCHORAGES	Inshore from recognised cruising route (running north to south).
SWELL CORRIDORS FOR SURF BREAKS	No surf breaks in vicinity.

Site 8 – Great Mercury

This proposed mussel and fish farming area is lies between Great Mercury Island and the Coromandel Peninsula, about 8km east of Kennedy Bay.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Creates potential for aquaculture jobs. Possibly serviced from Kennedy Bay or Whitianga.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients. Structures in water create shelter and habitat for wildlife. Shell drop adds structure to seafloor.
BIOPHYSICAL SUITABILITY FOR FARMING	Exposed and in deep water (40m). High wave energy environment.
WATER DEPTH	50m
SUBSTRATE	Sand and muddy sand
MEAN SIGNIFICANT WAVE HEIGHT	0.53-0.68m
ORBITAL VELOCITY	0.05-0.08 m s^{-1} (Hadfield et al. 2014)
CHLOROPHYLL (CHLA)	1.46 milligrams per m^3
CURRENT (METRES/SECOND)	0.03-0.09 (SeaSketch; Hadfield et al. 2014)
BIOTA	Very little is known of the biology of this site. A benthic sample taken from sand at 22m depth off Kennedy Bay contained a diverse bivalve shellfish assemblage dominated by the morning star shell (Tawera spissa), with Nucula nitidula, Dosinia subrosea, Scalpomactra scalpellum and Longimactra elongata also present (McKnight 1969a). This assemblage is widespread in shallow sandy sediments in the Hauraki Gulf and elsewhere around the North Island (McKnight 1969a; Morrison et al. 2014 a). A large, dense (>100 per 25 m^2), horse mussel bed occurred inshore of the proposal in the early 1980's but the area deeper than about 22m depth was not surveyed (Allan et al. 1984; Allan & Walsh 1984). Common dolphins (Delphinus delphis) and killer whales are reported from this area, and bottlenose (Tursiops truncatus) dolphins are likely to pass through it from time to time (sightings reported in SeaSketch). Bryde's (Balaenoptera edeni), humpback whale (Megaptera novaeangliae) and southern right whale (Eubalaena australis) have occasionally been recorded in the area.
NATURAL CHARACTER	Over 5km from areas of high natural character.
NATURAL FEATURES AND LANDSCAPES	Over 10km form an ONFL.
COMMERCIAL FISHING	Moderate level of longline fishing. Adjacent to a commercial scallop ground.
RECREATIONAL FISHING	Low levels of recreational fishing in this area.
COMMERCIAL BOAT TRAFFIC	Some commercial traffic nearby, but not through proposed area.
YACHTING ROUTES AND ANCHORAGES	Lies between recognised routes but thought to obstruct some boat traffic.
SWELL CORRIDORS FOR SURF BREAKS	On swell corridor for multiple breaks (Whangapoua, Matarangi, Kuaotunu).

Site 9 – East Coromandel

This proposed mussel farming area is located over 4km offshore from the coast.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Creates potential for aquaculture jobs in new area, possibly serviced out of Whitianga or Tairua.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients. Structures in water create shelter and habitat for wildlife. Shell drop adds structure to seafloor.
BIOPHYSICAL SUITABILITY FOR FARMING	Exposed and in very deep water (60-70m). High wave energy environment. Sand and muddy sand substrate.
WATER DEPTH	About 60m.
SUBSTRATE	Fine sand and broken shell, muddy sand, rocky reef
MEAN SIGNIFICANT WAVE HEIGHT	0.28-0.74m
ORBITAL VELOCITY	0.02-0.05 m s^{-1} (Hadfield et al. 2014)
SALINITY	>35 ‰ (Hadfield et al. 2014)
CHLOROPHYLL (CHLA)	0.72-0.77 milligrams per m^3
CURRENT (METRES/SECOND)	0.02 (SeaSketch; Hadfield et al. 2014)
BIOTA	Very little is known of the biology and ecological values of this area. The seafloor is predominantly fine sand and broken shell but it also covers about 1km^2 of predominantly deep (i.e. >50m depth) low relief reef. No information is available on the biological assemblage occurring on these reefs. The soft sediment fauna has not been surveyed but is likely to be dominated by species that are widespread at similar depths in the western Bay of Plenty and Northland. Species likely to occur in the area are included in McKnight's (1969a, b) descriptions of the Tawera spissa – Venericardia purpurata and Nemocardium pulchellum – V. purpurata communities. No recognised commercial scallop grounds occur in this area. Castle Island is a steep pinnacle rising abruptly from mid-shelf depths (c. 60m), the sides of which represent the only shallow rocky reef (c. 0.06km^2) in the area. The sides of the island are covered with dense kelp (Ecklonia radiata) forest and encrusting invertebrates due to low levels of suspended sediment. The island attracts large schools of pelagic fishes including kahawai (Arripis trutta), trevally (Pseudocaranx georgianus), and kingfish (Seriloa lalandi). Schooling planktivorous reef-associated species such as blue maomao (Scorpis violaceus) and pink maomao (Caprodon longimanus) are also abundant. Pelagic sharks (Isurus oxyrinchus, Carcharhinus brachyurus, Prioance glauca) and a variety of migratory pelagic fishes including marlin and giant manta ray (Manta birostris) have been observed at Castle Island. Common dolphins are the only cetacean species recorded in vicinity of this proposed aquaculture site. Bottlenose dolphins and killer whales have been observed closer to the coast but are also likely to occur in the area.
NATURAL CHARACTER	Twokm from a high and outstanding natural character area.
NATURAL FEATURES AND LANDSCAPES	Fivekm from an outstanding natural feature and landscape area.
COMMERCIAL FISHING	In a medium to high intensity area of commercial fishing, mainly seine and longline fishing.
RECREATIONAL FISHING	Moderate levels of recreational fishing inshore from this area and high levels around Castle Island.
COMMERCIAL BOAT TRAFFIC	Cargo shipping routes one kilometre east of the area.
YACHTING ROUTES AND ANCHORAGES	Lies offshore from recognised route.
SWELL CORRIDORS FOR SURF BREAKS	On swell corridor for multiple breaks (Hot Water Beach, Sailors Grave).

Site 10 – South Great Barrier Island

This area is located on the western side of Great Barrier Island, about 10km west of Typhena. It is intended to provide for growth in aquaculture employment on the Island. There is about 30ha of mussel farms on the western coat of the Island, but because of the small scale of operations, they are often serviced from the Coromandel.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Creates potential for aquaculture jobs on Great Barrier Island.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients. Structures in water create shelter and habitat for wildlife. Shell drop adds structure to seafloor.
BIOPHYSICAL SUITABILITY FOR FARMING	Deep and exposed site. Sheltered from north and east.
WATER DEPTH	43-47m
SUBSTRATE	Mixed sediment.
MEAN SIGNIFICANT WAVE HEIGHT	0.63-0.65m
SALINITY	>35 ‰ (Hadfield et al. 2014)
CURRENT (METRES/SECOND)	0.08-0.14
BIOTA	Little is known of the benthic species assemblages occurring in this area. Hayward et al. (1986) described a number of invertebrate assemblages from subtidal soft sediments around the Broken Islands to the north of the proposed aquaculture area. These included assemblages characterised by the bivalve shellfishes Corbula zelandica and Venericardia purpurata, and C. zelandica and Pleuromeris zelandica in shelly, fine to coarse sand at 23-32m depth; and an association characterised by the brittle star Amphiura and the bivalves Saccella bellula, Notocallista multistriata and Cuspidaria willetti in muddy, shelly, fine to medium sand at 31-59m depth. Predicted biogenic potential at the site is low to moderate (Townsend et al. 2014). Demersal fishes characterising deep sandy habitats in the outer Gulf include rough skate (Zearaja nasuta), red gurnard (Chelidonichthys kumu), scaly gurnard (Lepidotrigla brachyoptera), opal fish (Hemerocoetes monopterygius), blue mackerel (Scomber australasicus), snapper (Pagrus auratus), blue cod (Parapercis colias), witch (Arnoglossus scapha), lemon sole (Pelotretis flavilatus) and crested flounder (Lophonectes gallus), as well as arrow squid (Nototodarus gouldi) (Kendrick & Francis 2002). These species are widespread in the central and outer Gulf (Kendrick & Francis 2002). Snapper are known to spawn south and northwest of the proposed site (Zeldis & Francis 1998). The area does not include any critical seabird habitat. Seabirds known to forage in the general area of the proposal include Australasian gannet (Morus serrator), fluttering shearwater (Puffinus gavia), Buller's shearwater (Puffinus bulleri), black petrel (Procellaria parkinsoni), flesh-footed shearwater (Puffinus carneipes), fairy prion (Pachyptila turtur) and New Zealand storm petrel (Fregetta maoriana). Gannets breed on the Broken Islands, black petrels breed on Great Barrier and Little Barrier Islands, fluttering shearwaters and New Zealand storm petrels breed on Little Barrier Island (New Zealand Birds Online http://nzbirdsonline.org.nz/). Cetacean species observed in the vicinity of the proposal include humpback whale (Megaptera novaeangliae), Bryde's whale (Balaenoptera edeni), blue whale (Balaenoptera musculus), common dolphin (Delphinus delphis) and bottlenose dolphin (Tursiops truncatus). Contemporary records indicate that the most abundant species occurring in the area are Bryde's whale, common dolphin and bottlenose dolphin. Humpback whales historically migrated through Hauraki Gulf, including Colville and Craddock Channels, in large numbers (Gibbs & Childerhouse 2000). The Whangaparapara whaling station captured 317 humpback whales between 1956 and 1962 (Prickett 2002; Torre et al. 2013). The station closed in 1962 following the collapse of the stock but recent sightings in Hauraki Gulf and elsewhere in the New Zealand region indicate the population is slowly recovering (Gibbs & Childerhouse 2000; Torre et al. 2013).
NATURAL CHARACTER	Over 5km from a coastal natural character area.
NATURAL FEATURES AND LANDSCAPES	Over 5km from an outstanding natural feature and landscape (The Pigeons).
COMMERCIAL FISHING	High levels of commercial fishing, mainly trawling, longline and seine fishing.
RECREATIONAL FISHING	Minor levels of recreational fishing observed in this area.
COMMERCIAL BOAT TRAFFIC	Near significant route for cargo vessels and liners transiting through to Tauranga.
YACHTING ROUTES AND ANCHORAGES	Lies between recognised cruising routes, but may obstruct some traffic.
SWELL CORRIDORS FOR SURF BREAKS	No surf breaks in vicinity. Minor interaction with swell corridor for breaks near Leigh.

Site 11 – Western Firth

This area is located on the western side of the Firth of Thames, in a location that is subject to a large number of existing consent applications for aquaculture.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Allows expansion of existing farms in an area favoured by marine farmers.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients. Structures in water create shelter and habitat for wildlife. Shell drop adds structure to seafloor.
BIOPHYSICAL SUITABILITY FOR FARMING	Sheltered and nutrient-rich waters. May be a bit shallow (15m).
WATER DEPTH	11-20m
SUBSTRATE	Predominantly mud and sandy mud with a small amount of mixed sediment.
MEAN SIGNIFICANT WAVE HEIGHT	0.13-0.16m
SALINITY	34-35 ‰ (Broekhuizen & Zeldis 2005)
CURRENT (METRES/SECOND)	0.4-0.46
BIOTA	Morrison et al. (2002) completed nine side-scan sonar transects with 10 associated ground-truth stations in the western Firth of Thames. Fish schools were very abundant in the surveyed block. Sonar imagery varied across the block, with higher patches of substrate variability in the south and central regions of several transects. The ground-truth data did not fully cover this variability, and poor underwater visibility limited the sites that could be assessed with video. In general the bottom is composed of muds with variable amounts of shell material. Live cockles (Austrovenus stutchberyi) occurred at some stations. The only station at which appreciable numbers of remnant greenlipped mussels (Perna canaliculus) were encountered anywhere in the Firth of Thames was located in this block, although the percentage cover of mussels was low ($\leq$ 5%). No horse mussel (Atrina zelandica) beds were encountered in the ground-truth stations, and no side-scan imagery similar to that seen in areas where dense horse mussel beds were observed was obtained. Fishes commonly recorded in research trawls in the western Firth of Thames include: rig (Mustelus lenticulatus), snapper (Pagrus auratus), jack mackerel (Trachurus novaezealandiae), kahawai (Arripis trutta), red gurnard (Cheilidonichthys kumu), John dory (Zeus faber), yellow belly flounder (Rhombosolea leporina), sand flounder (R. plebia) and barracouta (Thyrsites atun) (Kendrick & Francis 2002; Morrison et al. 2002). High catch rates of juvenile John dory have sometimes been recorded in research trawls in the western Firth of Thames (Morrison et al. 2014). Seabirds foraging in this area include Australasian gannet (Morus serrator), fluttering shearwater (Puffinus gavia) and Buller's shearwater (Puffinus bulleri). Common dolphins (Delphinus delphis) have been observed foraging in the outer Firth of Thames but are not resident.
NATURAL CHARACTER	Twokm from a high natural character area.
NATURAL FEATURES AND LANDSCAPES	Twokm from an ONFL.
COMMERCIAL FISHING	Medium level of commercial fishing, mainly net and longline fishing.
RECREATIONAL FISHING	Low to medium level of recreational fishing. Close to fishing hot spot at existing Waimungu Point mussel farms.
COMMERCIAL BOAT TRAFFIC	No commercial shipping traffic in this area, apart from a gravel barge from Kopu.
YACHTING ROUTES AND ANCHORAGES	No recognised routes in this area, but reduces clearway into the Firth to about 5km.
SWELL CORRIDORS FOR SURF BREAKS	No surf breaks in vicinity.

Site 12 – Ponui

This area lies to the west of Ponui Island, and is proposed for shellfish farming only. The initial proposal was positioned closer to the Island but after consideration of potential impacts on boating and fish spawning grounds it was relocated further from the Island.

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Provides from establishment of aquaculture in new area. Likely to be serviced from Coromandel.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients. Structures in water create shelter and habitat for wildlife. Shell drop adds structure to seafloor.
BIOPHYSICAL SUITABILITY FOR FARMING	Sheltered to west and south. Exposed to north and north-east. Good water depth.
WATER DEPTH	23-30m
SUBSTRATE	Mixed sediments with some fine silty sand and mud.
MEAN SIGNIFICANT WAVE HEIGHT	0.20-0.22m
SALINITY	≥ 34 ‰ (Broekhuizen & Zeldis 2005)
CURRENT (METRES/SECOND)	0.31-0.33
BIOTA	Morrison et al. (2002) sampled ground-truth stations (503, 601) north and south of the proposed site. No conspicuous epifauna was recorded at station 503, seaward of the proposal. At station 601, located inshore and southwest of the proposal, the epifauna included amphipod tubes, sponges, bryozoans, occasional ascidians, anemones, half crabs and unidentified starfish (Morrison et al. 2002). The most abundant fishes in trawl surveys in this area are snapper (Pagrus auratus), jack mackerel (Trachurus novaezealandiae), trevally (Pseudocaranx georgianus), red gurnard (Cheilidonichthys kumu) and John dory (Zeus faber) (Kendrick & Francis 2002; Morrison et al. 2002). Sand flounder (Rhombosolea plebeia) spawn east of Waiheke and Ponui Islands in 27–36 m depth from June to November (Morrison et al. 2014). Snapper spawn in the area from October to January, with maximal egg densities occurring in November and December (Zeldis 1993; Zeldis & Francis 1998). Seabirds foraging in this area include Australasian gannet (Morus serrator), fluttering shearwater (Puffinus gavia) and Buller's shearwater (Puffinus bulleri). Common dolphins (Delphinus delphis) and killer whales (Orcinus orca) have been observed in the vicinity of the proposal.
NATURAL CHARACTER	Over 4 km from a high natural character area on Ponui Island.
NATURAL FEATURES AND LANDSCAPES	Over 4 km from an outstanding feature and landscape area on Ponui Island.
COMMERCIAL FISHING	Moderate level of commercial fishing, mainly longline and net fishing.
RECREATIONAL FISHING	Moderate to low level of recreational fishing.
COMMERCIAL BOAT TRAFFIC	No commercial shipping traffic in this area.
YACHTING ROUTES AND ANCHORAGES	Lies between recognised cruising routes. May cause some conflict with boating traffic.
SWELL CORRIDORS FOR SURF BREAKS	On swell corridor for Orere Point break.

Site 13 – Whitianga

The area is located about 1.7km offshore and is proposed for small scale (in the order of 30ha) shellfish farming

Assessment of the proposed area

CRITERIA	COMMENTS
SOCIO-ECONOMIC	Provides for establishment of aquaculture in new area. Likely to be serviced from Whitianga.
ECOLOGICAL BENEFITS	Filtering of water by shellfish removes sediment and nutrients. Structures in water create shelter and habitat for wildlife. Shell drop adds structure to seafloor.
BIOPHYSICAL SUITABILITY FOR FARMING	Sheltered to west and north. Exposed to east, south and south-east. Coarse sediment substrate. Good water depth.
WATER DEPTH	18-26m
SUBSTRATE	Mainly coarse sediment with some muddy sand at western edge of area.
MEAN SIGNIFICANT WAVE HEIGHT	0.61-0.67m
ORBITAL VELOCITY	0.15-0.20 m s^{-1} (Hadfield et al. 2014)
SALINITY	33 to >35 ‰ (Hadfield et al. 2014)
CHLOROPHYLL (CHLA)	1.35 milligrams per m^3
CURRENT (METRES/SECOND)	0.03-0.04 (SeaSketch; Hadfield et al. 2014)
BIOTA	No information on the biota of this site could be located. Research on the effects of scallop dredging on benthic invertebrate assemblages conducted in Opito Bay and Te Whanganui A Hei Marine Reserve suggests that common epibenthic animals in this area are likely to include the sea stars Astropecten polyacanthus and Luidia varia, hermit crabs (Paguristes setosus), the spotted whelk (Cominella adspersa) and scallops (Pecten novaezelandiae) (Thrush et al. 1995). These are all common, widespread soft sediment species. The infaunal invertebrate assemblages of both sites were significantly different from each other, relatively diverse and sensitive to disturbance (Thrush et al. 1995). Godfriaux (1974) found that the invertebrates recorded in the diet of snapper sampled in Mercury Bay were widespread at similar depths in the Western Bay of Plenty. Marine mammal species recorded from Mercury Bay include common and bottlenose dolphins, killer whales and Bryde's whales.
NATURAL CHARACTER	Lies on the edge of a high natural character area and just over 2km from an area of outstanding natural character (Motukoranga Island).
NATURAL FEATURES AND LANDSCAPES	No ONFLs in the vicinity.
COMMERCIAL FISHING	In an area of moderate commercial fishing intensity, primarily longlining.
RECREATIONAL FISHING	In an area of moderate recreational fishing intensity.
COMMERCIAL BOAT TRAFFIC	No commercial boat traffic in the area.
YACHTING ROUTES AND ANCHORAGES	Near a recognised recreational boating route.
SWELL CORRIDORS FOR SURF BREAKS	Not in any swell corridors for known surf breaks.

APPENDIX 3: BIODIVERSITY AND MARINE PROTECTED AREAS PIRINGA 3: RERENGA RAUROPI ME NGĀ ROHE RĀHUI MOANA

Biodiversity is a broad term which at its simplest can be viewed in terms of the Hauraki Gulf Marine Park as 'the variety of plant and animal life in the Hauraki Gulf Marine Park'.

THE HAURAKI GULF SYSTEM

The Gulf extends from shallow tidal creeks and estuaries, out to the edge of the continental shelf. Geomorphically, this includes a relatively large estuary (the Waitematā Harbour) as well as many smaller ones, numerous beaches and rocky headlands, peninsulas, shallow embayments, the large Firth of Thames, and inshore and offshore islands. This relatively complex topography, combined with currents and marine climate (especially the prevailing wind directions), creates a diverse range of environments and habitats, which in turn support a wide range of plant and animals species. Seafloor sediments are predominantly terrigenous (i.e. derived from the land) muds and sands, although there are localised areas of calcareous sediments (formed from the shells and skeletons of marine organisms) in shallow bays and areas of high tidal flow. Extensive shallow rocky reefs occur around much of the coastline, except in the Firth of Thames which is dominated by soft sediments, particularly muds. Deep rocky reefs are located on the outer shelf northeast of Mokohinau Islands, east of Great Barrier Island and the Coromandel Peninsula and west of Little Barrier Island.

Pelagic component

Pelagic biological productivity throughout the Hauraki Gulf Marine Park is strongly influenced by seasonal and interannual variation in the East Auckland Current (EAUC) (Stanton & Sutton 2003), which originates in the Tasman Sea, northeast of North Cape, and flows south-east along the upper continental slope. Offshore of the EAUC is a large-scale permanent warm core eddy (the North Cape Eddy), which extends down to 1500m water depth. This eddy re-circulates about 50% of the EAUC flow, and probably serves as a larval retention mechanism (Roemmich & Sutton 1998). The EAUC-North Cape Eddy system is highly variable, driven largely by variation in the position, configuration and magnitude of the North Cape Eddy core (Stanton & Sutton 2003). Temperature variability in the surface mixed layer of the EAUC is dominated by the annual cycle, with differences between years highly correlated with the Southern Oscillation Index (SOI, a measure of the strength of the El Niño-Southern Oscillation) and wind speed and direction (Sutton & Roemmich 2001).

The EAUC is forced up towards the surface over the upper continental slope by along-shelf winds, resulting in upwelling's that are nutrient rich (particularly nitrates), making this one of New Zealand's most productive shelf regions (Sharples & Greig 1998, Zeldis et al. 2001, 2004, Zeldis 2004, Bradford-Grieve et al. 2006). Circulation over the inner continental shelf is dominated by tides, local winds, and the southeast flow of the EAUC (Sharples & Greig 1998; Stephens 2003). Episodic upwelling of slope water onto the shelf and into the Hauraki Gulf during autumn and winter is driven by along-shelf southeast winds. The relative strength of up-welling or down-welling over time varies with wind speed and direction. The El Niño phase of the Southern Oscillation favours upwelling and associated high productivity; whereas the La Niña phase favours down-welling that suppresses phytoplankton production (Zeldis et al. 2001, 2004, 2005; Chang et al. 2003; Zeldis 2004; Bradford-Grieve et al. 2006; Hall et al. 2006). During spring and summer, water column stratification de-couples the surface layer from the rest of the water column, which shuts down upwelling. This results in nutrient depletion of the upper water column by phytoplankton, but an internal tide present in summer has the capacity to mix nutrients across the pycnocline (the horizontal boundary between different density water masses), and drive sub-surface production (Sharples & Greig 1998; Hall et al. 2006).

In contrast to the outer Hauraki Gulf, circulation and productivity in the Firth of Thames are strongly catchment driven. Freshwater inflow, tides and local winds exert a strong influence on the flow in the Firth of Thames (Stephens 2003; Oldman et al. 2007; Hadfield et al. 2014). The Waihou, Piako and Kaueranga rivers input significant amounts of freshwater, sediments and nutrients into the Firth, resulting in strong vertical and horizontal gradients in salinity, suspended sediments, and nutrients (Hadfield et al. 2014). Phytoplankton blooms in spring and early summer support a relatively high biomass of large zooplankton (particularly euphausiids, hyperid amphipods, salps, siphonophores, and pteropods)

High concentrations of fish eggs and larvae have been recorded over the shelf in a number of places consistent with the observed high primary productivity (Crossland 1981; Bailey 1983; Zeldis et al. 2005). Crossland (1981) recognized three spatial patterns of fish spawning in the Hauraki Gulf: those species where spawning was concentrated in the Firth of Thames (e.g. ahuru, flatfish), those that spawned in the inner ('central') Gulf (e.g. anchovy, sprat, jack mackerel, yellow eyed mullet, snapper) and those with spawning grounds located in the outer Gulf (e.g. pilchards, red gurnard, blue mackerel). For snapper, the inner Hauraki Gulf is an important spawning area, with seasonal spawning aggregations concentrated in the Whangaparaoa Bay, between Rangitoto Island and the Whangaparaoa Peninsula, and between Waiheke Island and the Coromandel Peninsula. Snapper spawning also occurs southwest of Great Barrier Island (Zeldis & Francis 1998; Zeldis et al. 2005).

Benthic component

Despite the intensive use of the Hauraki Gulf Marine Park by humans, there is a fundamental lack of baseline knowledge for most of the Park. While there have been a number of small-scale benthic surveys, either for geology or for species-habitat purposes, there has never been any large-scale systematic survey/series of surveys made of the Hauraki Gulf Marine Park to quantify 'what is out there' (i.e. provide a fundamental resource inventory and classification of habitats), beyond the species that we value economically (e.g. fish), or socially (e.g. sea-birds). The old adage of 'you can't manage what you don't measure' holds strongly here, both in terms of what is present, and monitoring it over time to detect any significant changes, natural or anthropogenic. Some representative smaller area seafloor assemblage's reports are briefly summarised below.

Subtidal benthic communities of the Waitematā Harbour and inner Hauraki Gulf were first examined and characterised by Powell (1937), using a small dredge. Hayward et al. (1997) resurveyed Powell's dredge stations to examine faunal changes between the 1930s and 1990s. In both studies, samples were dredged and associations were intuitively deduced largely on the basis of molluscs and echinoderms, following Powell's 1930s methods. Hayward et al. found that, away from the wharves and marinas, the soft-bottom fauna was still remarkably rich, and retained a similar gross pattern to the 1930s, with the urchin (Echinocardium) dominated community type still being widespread, and the bivalve (Tawera + Venericardia (now Purpurocardia)) dominated community remaining more localised. However, fourteen mollusc species (mainly carnivorous gastropods) were considered to have disappeared or suffered major reductions in abundance within the harbour by 1997. This resulted in two of Powell's associations (Tawera-Tucetona (morning star & dog cockle), Amalda (olive shell) disappearing from the outer harbour. There was also a reduction in the abundance and range of the turret shell Maoricolpus roseus (a filter feeding gastropod) and a number of associated species from the shelly channel sediments in the centre of the harbour. Hayward et al. also noted that since the 1930s, at least nine New Zealand mollusc species (mostly deposit- and suspension-feeders) and one crab species appeared to have colonised the harbour, and nine others had increased in abundance within the harbour sites. The establishment of extensive horse mussel beds north-east of North Head was the most significant change. Three invasive bivalve species (Limaria orientalis, Theora lubrica, Musculista senhousia) introduced in the 1960s and 1970s had become so abundant in the harbour that they had become co-dominant, characterising species of six of the eight faunal (invertebrate animal) associations recognised in the 1990s (Hayward et al. 1997).

Chiaroni et al. (2008) described the habitats and species found in Kawau Bay. This area comprised of bays and estuaries of various sizes, sheltered coastal environments, and more exposed rocky and soft sediment habitats. The species assemblages supported by these diverse habitats varied from rocky reefs dominated by large macrofauna, to soft-sediments supporting diverse infauna (living in the seafloor) and sometimes dense epifauna (living on the seafloor), with many of these taxa being long-lived. Many areas displayed high taxonomic diversity at both a species and order level, with an estimated 400 infaunal species being present in the system. A number of ecological functions and services from the assemblages of Kawau Bay were identified: including species contributing to benthic productivity, nutrient fluxes and water column productivity (i.e., bioturbating, suspension feeding, macroalgal and deposit feeding communities); affecting sediment stability and water clarity (e.g. suspension feeding and tube worm communities); providing refugia for juvenile and small fishes (habitat structuring communities such as Atrina (horse mussels), sponges and macroalgae); providing food for predatory and herbivorous fishes (most communities); and proving food and recreational values for humans (e.g., cockles, pipis, scallops, sponge gardens, kelp and turfing gardens (Chiaroni et al. 2008)

Taylor & Morrison (2008) sampled the benthic fauna (<4mm) of Greater Omaha Bay, in the north-western Hauraki Gulf. One hundred and thirty eight subtidal (1–41m) stations were sampled using suction sampler, grab, and dredge. Omaha Bay stations were mostly comprised of sand and gravelly-sand. Two-hundred-and-thirty-six taxa representing 13 phyla were recorded, with molluscs, arthropods and annelids being the most speciose. The annelids (worms) were identified to Family level only, so the true species number may be considerably higher. Seven discrete animal assemblages were identified, each represented by 6 to 40 stations, and clearly differing from one another according to one or more of the physical variables of sediment type and depth, and/or the presence of high densities of the bivalves Tawera spissa (morning star shell) and Atrina zelandica (horse mussels).

The horse mussel cluster was the most distinct of the seven assemblages, in that it shared the lowest number of common taxa with other clusters. The Tawera spissa-dominated assemblage was less distinct from the others in terms of taxonomic composition, but was remarkable for very high densities of T. spissa, averaging 907 individual's m^{-2}, and reaching 3476 individuals m^{-2} at one station. Omaha Bay's single T. spissa-dominated patch/bed of c. 1.5 km^2 contained c. 1.4 billion individuals.

Several notable taxa were encountered. A single specimen of the congrid eel Scalanago lateralis was caught, the first recorded from outside Australia (P. Castle pers. comm.). Several secretive species whose ecological roles may have been under-appreciated were also quantified. For instance, the rarely encountered worm-eel Scolecenchelys australis (Fam. Ophichthidae) occurred at an average density of 0.09 individual's m^{-2}, equivalent to c. 4 million individuals in the bay, and was suggested to be one of the more abundant fish in coastal New Zealand if such a density is typical. Night-time towed-video surveys have since identified high densities of this species (or very similar) in both East Northland (Jones et al. 2010), and from other locations within the Hauraki Gulf (Morrison et al. 2016).

The value of more complex habitat types

Different habitat types vary in their complexity, represented by the heterogeneity in physical structure, which may be geological, and/or of biological form. Evidence from a wide range of studies on different marine ecosystems indicate that as habitat complexity increases (at multiple scales), so does a given unit of area's value for biodiversity, e.g. species richness, abundance, age/length composition, provision of settlement surfaces, juvenile survivorship/growth, bentho-pelagic coupling, and base trophic production) (Heck & Wetstone 1977, Connell 1978, Luckhurst & Luckhurst 1978, Dean & Connell 1987, Connell & Jones 1991, Tupper & Boutilier 1995, Klitgaard 1995, Rooker at al. 1998, Charton & Ruzafa 1998, Lindholm et al. 1999, Cummings et al. 2001, Norkko et al. 2001, Caddy & Defeo 2003, Buhl-Mortensen et al. 2010, Beazley et al. 2013, Rogers et al. 2014).

Biogenic habitats are habitats formed by living (or once living) species that create emergent three-dimensional structure (e.g. large erect sponges and kelp forests) or provide physical structure for other animals (e.g. shell debris). Biogenic habitats that provide three-dimensional structure have been shown to be especially important to many fish and other associated invertebrate species (e.g. Luckhurst & Luckhurst, 1978, Bell & Galzin 1984, Ebeling & Laur 1985, Roberts & Ormond 1987, Carr 1989, Connell & Jones 1991, Rooker et al. 1998, Heifetz 2002, Gratwike & Speight 2005, Abookire et al. 2007, Pérez-Matus & Shima 2010, Rabaut et al. 2010, Humphries et al. 2011, Baillon et al. 2012, Laman et al. 2015). Similarly, remnant shell debris can provide an essential substratum for many sessile species (e.g. bryozoans, and encrusting sponges and algae) (Beaumont et al. 2013), where it may substantial increase local biodiversity and may provide the only available hard substrata in otherwise expansive soft-sediment areas (Hewitt et al. 2005, Beaumont et al. 2013; Lomovasky et al. 2015). In the context of marine ecosystem management, more diverse assemblages are likely to be more productive, sustainable, and / or more resilient (Millennium Ecosystem Assessment 2005, Worm et al. 2006, Sala & Knowlton 2006, Palumbi et al. 2008). Unfortunately much of this understanding has come from studies assessing the impact of habitat loss on species diversity. Structurally complex habitats are becoming rarer in many parts of the world (Airoldi et al 2008).

Seagrass as a biogenic habitat example

Seagrass meadows are considered to be one of the most productive ecosystems in the world, ranked ahead of coral reefs (Constanza et al. 1997, Grech et al. 2012, Matheson & Wadhwa 2012), yet they are relatively unknown and often under appreciated by the general public. Whilst prior research has shown that seagrasses provide a variety of ecosystem services encompassing both economic and ecological functions, the relative importance of these functions can vary appreciably between different estuarine and coastal systems (Beck et al. 2001, Orth et al. 2002, Heck Jr et al. 2003).

Seagrasses commonly occur in sheltered areas, away from strong currents and wave action, where they can grow on a variety of substrata ranging from mud through to sand and bedrock (Hemminga & Duarte 2000, Green & Short 2003). However, the most extensive meadows are found on soft substrata, often forming continuous expanses over several square kilometres. Alternatively, they can form mosaics of discrete patches (often in areas with more wind-generated wave exposure) (Inglis 2003, M.L. & M.M., NIWA, pers. obs.). Seagrasses are typically found in intertidal (to mid-tide level) and shallow subtidal waters at depths between 2 and 12 m, but can occur down to 50–60 m, depending on water clarity (Turner & Schwarz 2004). Seagrasses require some of the highest light levels of any plant group (about 25% incident radiation compared to up to 1% for other angiosperms; Dennison et al., 1993). Seagrasses are thus acutely responsive to environmental changes, especially those altering water clarity and are considered 'sentinels' for these types of environmental changes.

New Zealand has one species of seagrass, Zostera capricorni, which grows mainly in the intertidal zone; with limited populations growing within sheltered subtidal areas in clear water (the maximum depth recorded is 7 m). Morrison et al. (2014a) surveyed seagrass around New Zealand, assessing small fish (including the juveniles of economically valuable species) and invertebrate associations, seagrass genetics, and seagrass secondary (animal) productivity. Unfortunately seagrass beds in the Hauraki Gulf Marine Park were not included in that research, effectively because very few seagrass areas (especially subtidal) remain in the Hauraki Gulf Marine Park (Powell 1937; Morrison et al. 2014a, d, M.M. pers. obs.). Seagrass extent in the Hauraki Gulf Marine Park, while poorly documented from the past, has fundamentally reduced in extent over time, especially its subtidal component. This includes the loss of extensive seagrass meadows from the Waitematā Harbour and out through the Tamaki area (Powell 1937), and probably much more widely (Morrison et al 2014d).

Limited historical evidence suggests that New Zealand has experienced extensive declines in seagrass habitats nation-wide since the late nineteenth and early twentieth centuries (Inglis 2003). These analyses/observations have largely been restricted to the past 40 to 50 year period, due to the limited availability of qualitative survey or photographic data (Inglis 2003, Turner & Schwarz 2006). The loss of the subtidal component in particular has almost certainly resulted in the associated loss of significant levels of juvenile fish production (see the Fish Stocks Appendix), invertebrate biodiversity, as well as the many other ecological functions seagrass provides (Schwarz & Turner 2006, Morrison et al. 2014a). Encouragingly, recently there has been some limited recovery and expansion of seagrass areas within the inner Gulf, including from Meola Reef to the harbour bridge, at Kohimarama, and at Snell's Beach (MM, pers. obs.). Although the Meola Reef area includes some limited subtidal seagrass, exploratory fish sampling in 2014 found only a few juvenile fish in this habitat (Morrison, pers. obs.), suggesting that greater amounts of seagrass and/or time may be required to support the return of abundant juvenile fishes. Outside the inner Hauraki Gulf region, limited subtidal seagrass meadows still persist at Great Mercury Island, and around the south side of Slipper Island, where they collectively support diverse invertebrate assemblages and abundant juvenile fishes (Schwarz et al. 2006).

Seagrasses are a unique group of flowering plants that exist fully submerged in the sea. Seagrasses are distributed globally, but unlike terrestrial angiosperms exhibit low taxonomic diversity (approximately 60 species worldwide), with 12 genera. All species share similar architecture and physiology, and perform similar ecosystem functions. Seagrasses are a characteristic component of many coastal areas ranging from subarctic to temperate and equatorial regions, reaching their most southerly global distribution at Stewart Island, New Zealand (Hemminga & Duarte 2000, Turner & Schwarz 2006).

Loss of seagrass from intertidal and subtidal areas can have profound effects on ecosystem health and services (Costanza et al. 1997, Hemminga & Duarte 2000). Ecosystem services provided by seagrasses include high primary productivity to both detrital and grazing food webs (Keough & Jenkins 1995, Turner & Schwarz 2004, 2006, Connolly et al. 2005), nutrient recycling (see review Turner & Schwarz 2006), attenuating water flow (Eckman 1987, Foncesca & Koehl 2006, Widdows et al. 2008), trapping and stabilisation of bottom sediments (Foncesca et al. 1983, Gacia & Duarte 2001), providing refuge from predation (Attrill et al. 2000, Hindell et al. 2000, 2001), increasing biodiversity and providing crucial nursery habitat (including feeding/foraging) for a variety of taxonomic and functionally-important groups, including the juveniles of important recreational and commercial fisheries species (Orth et al. 2006, Grech et al. 2012). Other important services performed by seagrasses include being a significant repository for what is termed "blue carbon" (i.e. as a marine primary producer) (Matheson & Wadhwa 2012), the release of oxygen, and the trapping of nutrients.

Seagrasses in New Zealand have been shown to have an effect on macrofaunal communities, which differ from surrounding unvegetated sediments (van Houte-Howes et al. 2004). Studies of the communities associated with seagrasses have described both meiofauna (e.g. Hicks 1986, 1989, Bell & Hicks 1991) and macrofauna (e.g. Henriques 1980, Woods & Schiel 1997, Turner et al. 1999).

The role of seagrass meadows as nursery areas for fishery species has only recently been acknowledged and investigated within New Zealand. New Zealand wide estuarine fish surveys undertaken by Francis et al. (2005, 2011) first identified the association of small fishes (e.g. snapper, trevally, parore, spotties) with subtidal seagrass, followed by further work on subtidal meadows from Slipper and Mercury Islands, off the Coromandel Peninsula (Schwarz et al. 2006). These studies showed that subtidal seagrass (i.e., that permanently submerged) was the important seagrass component, with a much less pronounced effect (if any, in some circumstances) when only intertidal seagrass was present. Beyond the simple division of intertidal and subtidal seagrass, international studies have shown that other seagrass related factors including landscape metrics (e.g. patch size, perimeter to area ratios) (Boström et al. 2006), and within patch metrics of seagrass condition (e.g. blade density & height) (Horinouchi 2007) also influence the use of seagrass by juvenile and adult fishes. However, in comparison with other countries, fine scale observational and experimental work in New Zealand is limited. Morrison et al. (unpubl. data) used artificial seagrass units (ASU) in Whangapoua Harbour, Coromandel, and found that increasing blade densities resulted in increasing fish densities (although the patterns of response varied depending on the fish species) and species diversity (see summary in Morrison et al. 2014b). Further research by Parsons et al. (2013) confirmed the effect of blade density, and also found that the position of the ASU's within the harbour (i.e. upper/lower) affected the abundance of juvenile fish (notably snapper and spotties), with greater fish densities found towards the mouth of the Whangapoua harbour. The body condition of juvenile snapper was also found to be greatest in ASU units with the highest blade densities. Given that one of the initial responses of seagrass meadows to environmental degradation (prior to complete loss) is a reduction in blade density, this habitat quality effect (i.e. seagrass blade density) is an important component to consider in assessing the health and functional role of seagrass meadows as fish nurseries (Morrison et al. 2014a–c).

Recent experimental research on factors affecting settlement dynamics and olfactory cues within seagrass and other habitats for larval snapper has also been undertaken (Radford et al. 2012, Sim-Smith et al. 2012, 2013). Tank experiments revealed that larvae preferentially swam towards water taken from over seagrass beds, rather than water that had been taken from the harbour entrance, or from artificial seawater (chemically created 'pure' saltwater without prior biological influence) in which seagrass had been soaked.

These results strongly suggest that biological chemical cues from sources other than seagrass, such as from prey or conspecifics present in the seagrass habitat, may also be involved as a pre-requisite for juvenile fishes.

There have been several small scale seagrass restoration studies undertaken within New Zealand. Attempts within the Manukau Harbour had limited success (Turner 1995), but subsequent seagrass restoration in Whangarei Harbour has been more successful with recent anecdotal reports of the reestablishment and expansion of large seagrass meadows (Reed et al. 2004, Matheson et al., in prep.). However, this significant seagrass expansion, including an extensive 3.5 km^2 area of patchy subtidal seagrass, although starting around the same time period (2008) as the small-scale transplants, is likely to be too widespread to have been generated by transplants alone.

A widely recognised function of seagrass beds is the provision of sheltered habitats and elevated food supplies for fish and macrofaunal communities. Seagrasses in New Zealand have been shown to have an effect on macrofaunal communities which differs from surrounding unvegetated sediments (e.g. van Houte-Howes et al. 2004). Henriques (1980), showed that seagrass habitats in the Manukau Harbour had a higher species diversity and abundance of macrofauna than comparable non-vegetated habitat. Other studies of the animal communities associated with seagrasses include meiofauna (e.g. Hicks 1986, 1989; Bell & Hicks, 1991) and macrofauna (e.g. Henriques 1980, Alderson 1997, Woods & Schiel 1997, Turner et al. 1999; Schwarz et al. 2006). Higher macrofaunal density, biomass and productivity, has also been observed for subtidal seagrass areas, relative to intertidal seagrass in northern (Ellis et al. 2004; van Houte-Howes et al. 2004; Alfaro 2006; Schwarz et al. 2006) and southern New Zealand (e.g. Mills & Berkenbusch 2009). This may be a result of the large fluctuations in environmental conditions (i.e. periodic desiccation and fluctuating temperatures), experienced by intertidal habitats, resulting in stunted growth (shorter blade lengths), and lower overall diversity and productivity (Schwarz et al. 2006). In contrast, subtidal habitats are more environmentally benign and stable, and are characterized by more complex structure, with higher density and longer stems providing up to 20 times more surface area for epifaunal animals to graze (Schwarz et al., 2006).

Rapid large scale seagrass losses reported in both tropical and temperate regions of the world have increased almost tenfold over the past 40 years (Orth et al. 2006). Worldwide, seagrass meadows declined at a rate of 110 km2 yr^{-1} between 1980 and 2006, with 15% of seagrass species now considered threatened (Waycott et al. 2009, Short et al. 2011, cited in Grech et al. 2012). Biological, environmental, and extreme weather events have been identified as causes of seagrass losses which can interact at varying temporal and spatial scales (Orth et al. 2006). Nonetheless, a recent global review of the 6 seagrass bioregions acknowledged that anthropogenic activities including urban/industrial runoff, urban/port infrastructure development, agricultural runoff, and dredging had the greatest impact on seagrasses (Grech et al. 2012). These terrestrially and coastal based activities highlight the growing need for land-based coastal management to be incorporated into conservation and protection of seagrass habitat.

THE PAST

Today's marine environment may be far removed from what original marine ecosystems were like; both in terms of the spatial extent and configuration of habitats, and of the associated plant and animal populations they supported (e.g., Dayton et al. 1998, Jackson 2001, Jackson et al. 2001). Past human impacts have been profound, but have often gone unnoticed – as each succeeding human generation has a different view of what 'natural' is, based on their own observations. This results in diminishing expectations of what is 'natural' in the oceans, termed "sliding environmental baselines'' by Dayton et al. (1998), and so the magnitude of change is usually seriously underestimated. At present, there seems to be limited public, political, and even scientific awareness of the extent, importance, and consequences of such a long history of coastal habitat loss and ecosystem decline (Lotze 2004).

For instance, Airoldi & Beck (2007) found that the coastal biogenic marine habitats of Europe, including wetlands, seagrass meadows, shellfish beds and biogenic reefs, had been virtually eliminated over the last several hundred years, with less than 15% of the European coastline considered to remain in 'good' condition. They also noted that historical loss estimates were conservative as these assessments were based on recent distributions "with little recognition of the compounding impact of centuries and millennia of habitat loss". Similarly, Lotze et al. (2006) assessed impacts in North America and European ecosystems, and found human impacts to have depleted more than 90% of formerly important species, destroyed 65% of seagrass and wetland habitat, degraded water quality, and accelerated species invasions. They concluded that "the structure and functioning of estuarine and coastal habitats has been fundamentally changed by the loss of large predators and herbivores, spawning and nursery habitat, and filtering capacity that sustains water quality". They offered some hope for restoration, noting that as overexploitation and habitat destruction were responsible for most historical changes, their reduction should be a major management priority; and that despite some extinctions, most species and functional groups still persisted, albeit in greatly reduced numbers, and so recovery potential remained. Where human efforts focussed on protection and restoration, recovery had occurred, although usually with significant time lags (see also Lotze et al. 2011).

New Zealand, including the Hauraki Gulf Marine Park, has not escaped such impacts, despite its short history of human settlement. Morrison et al. (2009) concluded that the impacts of past human land use have been significant for coastal systems and species, especially through sedimentation. Parsons et al. (2009) found evidence of large reductions in the abundance and size of snapper from estuarine and very near-shore habitats where once they were commonly caught in the Hauraki Gulf Marine Park, and the probable loss of some behavioural groups. Taylor et al. (2011) used long-term diver recollections of the Poor Knights Islands Marine Reserve to show large and steady long term declines in abundances of black corals, tube sponges, packhorse lobster, and large predatory fishes. Shears (2010) highlighted changes on the intertidal part of Meola Reef, Waitematā Harbour (Figure A3.1), from clean rocks with tube-worm colonies, to a muddier seafloor cover, with a dominance of Pacific oysters (an invasive species). Given the existence of sliding environmental baselines, marine resource management (including fisheries) should be viewed not only in the context of managing what currently exists (at an arbitrary point in time), but also in the context of what was historically present, and what the system might look like in the future, given pragmatic and realistic mitigation and/or restoration research and management strategies.

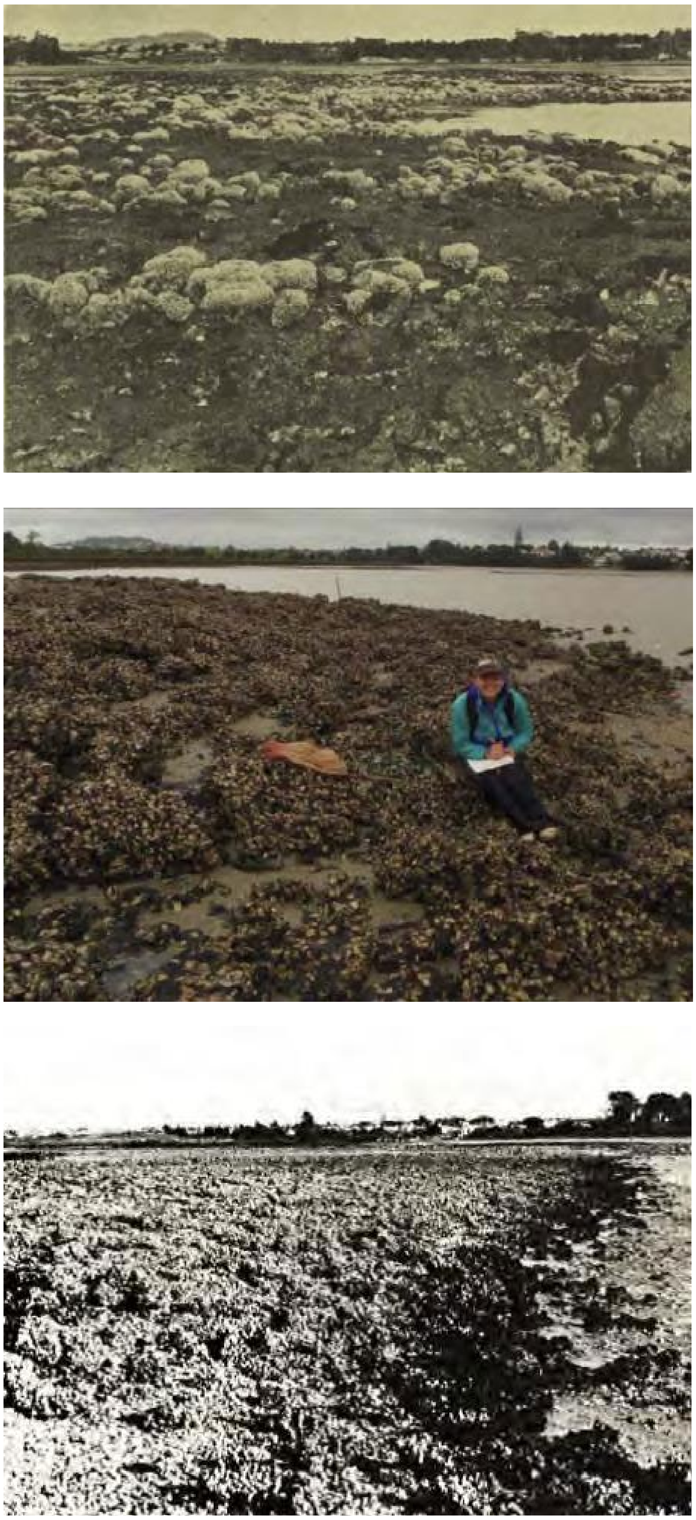


Figure A3.1 Example of a sliding baseline.

Western side of Meola Reef; top, 1920s with tubeworm mounds and rock with little sediment and no Pacific oysters (Oliver 1923); middle, 1982 with Pacific oysters and little sediment (Dromgoole & Foster 1983); bottom, 2010 with Pacific oysters and large patches of consolidated sediment. Mangroves can also be seen to appear in the background (Source: figure 16 of Shears 2010).

A large multi-focused research programme on the historical reconstruction for the Hauraki Gulf and the Catlins Coast, Otago has been undertaken to "determine the effects of climate variation and human impact on the structure and functioning of New Zealand marine shelf ecosystems over the timescale of human occupation in New Zealand from about AD 1250 to the present day" (nearing completion). Some 18 separate reports are included in this programme; including an overall findings and synthesis report (MacDiarmid et al 2016), and another including oral histories of the Hauraki Gulf (Maxwell & MacDiarmid 2016).

CURRENT THREATS AND STRESSORS TO BIODIVERSITY

The Hauraki Gulf faces a range of threats and stressors that are impacting on its benthic and pelagic marine biodiversity. It is important to emphasise that these do not act in isolation from each other. For example, impacts on benthic habitats from fishing interact with sedimentation derived from the land, and populations stressed by one factor are generally more susceptible to additional stresses caused by other factors (Buchbaum et al. 2005).

Fishing impacts on seafloor assemblages

The first documented concerns about the use of towed fishing gear on benthic habitats were from UK fishermen in the fourteenth century (Lokkeborg 2005). These concerns related to the capture of juvenile fish and the detrimental effects on food sources for harvestable fish. Despite this long history of concern, it is really only since the 1990s that international research has focused on the effects of fishing on benthic communities, biodiversity, and production. The rapid expansion of studies in this area, and the controversy associated with the effects of fishing has led to numerous reviews, summarizing this research and identifying overall patterns (Gislason 1994, Dayton et al. 1995, Jennings and Kaiser 1998, Lindeboom and de Groot 1998, Hall 1999, Collie et al. 2000, Gislason et al. 2000, Kaiser and de Groot 2000, Dayton et al. 2002, Thrush and Dayton 2002, Lokkeborg 2005, Department of Fisheries and Oceans 2006, Kaiser et al. 2006, Rice 2006, Watling et al. 2014).

These reviews are in general agreement, concluding that benthic disturbance from mobile fishing varies in relation to the habitat, fishing gear, and environment, and is likely to have predictable and potentially substantial effects on benthic community structure and function. These effects can lead to regional-scale reductions in biodiversity, reduce benthic community productivity (Jennings et al. 2001, Hiddink et al. 2006), alter natural sediment fluxes and reduce organic carbon turnover (Pusceddu et al. 2014), and modify the shape of the upper continental slope (Puig et al. 2012), reducing morphological complexity and benthic habitat heterogeneity. The effects of fishing on the seabed can be divided into geotechnical (the physical contact of the gear on the seabed) and hydrodynamic (the suspension of sediment into the water column) components, and vary with both fishing gear and benthic habitat (Ivanovic et al. 2011, O'Neill et al. 2011). Heavier fishing gears tend to penetrate deeper into the seabed (Ivanovic et al. 2011), while larger gears towed at faster speeds generate more drag, suspending greater quantities of seabed material, particularly in softer muddier sediments (O'Neill et al. 2011). The likely effects and dispersal of these sediments will vary locally, depending on oceanographic conditions.

Within coastal regions, scallop dredges are generally considered to have a greater impact on benthic communities (per area fished) than trawls or Danish seines, as the gear is heavier and penetrates further into the seabed (Kaiser et al 2006). Habitats with relatively low natural levels of disturbance are generally considered to be more sensitive to fishing impacts than habitats in areas of frequent natural disturbance (Lokkeborg 2005). However, biogenic habitats (created by animals and plants) may occur in such areas (e.g., Spirits Bay), and are particularly sensitive to fishing impacts (e.g., Tuck and Hewitt 2013). Typically, species that are larger, longer lived, slow growing, fragile, erect, and/or sedentary species (e.g., sponges, sea pens, corals, horse mussels) tend to be more sensitive to the physical impacts of fishing gear than smaller, faster growing, less fragile species living below the sediment surface (Tuck and Hewitt 2013). Species sensitivity to re-suspended sediment is likely to be related to different life history characteristics, with species that photosynthesise (e.g. rhodolith beds), filter feed (e.g. gorgonians, bryozoans and infaunal bivalves), or are vulnerable to smothering (e.g., sponges) are most at risk.

Three studies on the impacts of fishing have been completed in the Hauraki Gulf Marine Park. Thrush et al. (1995) conducted a small scale, short term (up to three months) experiment looking at scallop dredging effects, at the individual dredge track scale. Two shallow (24 m) sites were assessed; with one site regularly commercially fished and the other not. Community composition differed between the sites, but both were dominated by small and short-lived species. The experiment assessed the density of common infaunal species, total abundance and species richness between the two sites, and found that both density and species richness decreased following dredging, with some species still significantly different after three months. Significant differences in community assemblage structure between the dredge and control plots were also recorded over the experiment, with stronger effects at the site previously commercially fished. The bivalve Nucula nitidula (a 'nut-shell') and tube building polychaetes were consistently sensitive to the effects of fishing, showing significant reductions in abundance at both sites following dredging.

Thrush et al. (1998) examined benthic communities from 18 locations within the Hauraki Gulf Marine Park using video (for epifauna) and grab, suction dredge and core (for infauna) approaches. The benthic communities were examined relative to both gradients of fishing pressure and environmental variables, based on rankings of potential habitat disturbance by commercial demersal trawling and dredging - estimated from fisheries legislation and anecdotal information from fishery managers and scallop fishers. The fishing-pressure gradient accounted for 15–20% of benthic community structure, and also had a significant effect on species richness and benthic community diversity. Increases in fishing pressure significantly reduced the density of large (and long lived) epifauna and echinoderms, and significantly increased the density of small opportunist species, with the effect on deposit feeders varying with the sampling approach. No effect on scavengers was observed. While scavenger attraction to disturbed areas to feed on damaged fauna has commonly been observed in manipulative studies (e.g., Kaiser & Spencer 1994, Ramsay et al. 1996), such effects are likely to be very transient in space and time, and unlikely to be observed in broad scale studies.

In another localised spatial study, Morrison et al. (2016) used video transects to examine the distribution and abundance of benthic epifauna and fish species in five areas inside and outside (up to 2.5 km) the Hauraki Gulf Cable Protection Zone - considered to have been an effective closed area to fishing and anchoring since 1999. Cable Protection Zone status (inside or outside) had a significant effect on common species abundances and univariate community diversity measures, in the main drivers of community composition and species abundance appeared to be location and depth, with Cable Protection Zone status only explaining 1.4% of total variance. There was no discernible effect of the Cable Protection Zone on fish assemblages.

Tuck et al. (in press) provides a comprehensive analysis and review of the impacts of fishing on soft sediment systems in New Zealand, including the Hauraki Gulf. They concluded that:

"The magnitude of the effects of fishing (% variability explained) varied between studies, and as would be expected, greater effects were detected over stronger effort gradients. The levels of effect detected were reasonably consistent between dedicated sampling approaches (within study), while opportunistic data sets were less effective at detecting effects. When effects were detected, fishing was associated with reductions in the number of taxa, diversity and evenness of both epifaunal and infaunal communities, but more consistently for epifauna. Fishing appears to have reduced epifaunal biomass and productivity (whole community and fish prey) by up to 50% in some of the study sites, but effects on infauna were less consistent (increasing by up to 20% in the one area an effect was detected). The species that were most consistently identified as being negatively correlated with fishing pressure were those that either stand erect out of the seabed (e.g., horse mussels, sponges, bryozoans, hydroids, sea pens, tube building polychaetes), or live on the sediment surface, and thus are particularly sensitive to physical disturbance through either direct physical impact (e.g., Echinocardium), smothering (e.g., small bivalves) or increased vulnerability to predation following disturbance (e.g., brittle stars). Where examined, even relatively modest levels of fishing effort (i.e., fishing an area between once and twice per year, estimated at the 5 km * 5 km scale) reduced the density of the combined group of long lived sedentary habitat forming species and individual species group densities of holothurians, crinoids, cnidarians and bryozoans by at least 50%"

Sedimentation

Sedimentation has arguably been of the most significant impacts on the estuaries and coastal fringes of the Hauraki Gulf Marine Park, and may also have impacted in areas further from the coast. In estuarine environments, sedimentation effects over longer time scales are often captured in stratified sediment layers, and can be used to calculate Sediment Accumulation Rates (SAR). Core sampling from numerous estuaries around New Zealand all show the same trend towards significantly increased sedimentation rates following large-scale deforestation. Coromandel estuary examples include Wharekawa Estuary, with pre-Polynesian SAR of 0.09–0.12mm yr^{-1}, rising to 3.0–7.2mm yr^{-1} during catchment deforestation (1880–1945), and 5.0–8.0mm yr^{-1} more recently (1945–1999) (an exotic pine production forest was established during this time) (Swales & Hume 1995); Whangamata Estuary, with pre-Polynesian (about 700 B.P.) SAR rates of about 0.01mm $yr^{-1,}$ increasing to 11mm yr^{-1} after 1880 (Sheffield et al. 1995) due to clearance of relatively steep catchment and commercial forestry development, and estimated to be around 5mm since the 1940s (Swales & Hume 1984); Whangapoua Estuary, with pre-Polynesian SAR rates of 0.03–0.08mm yr^{-1}, increasing to 0.12–0.13mm yr^{-1} following Māori occupation, and to 0.89–1.5mm yr-^{1} following European forest clearances.

Within the Hauraki Gulf, around Auckland city, work in the Tamaki Estuary found early to late Holocene (the last 10 000 years) SAR to be about 0.11–1.6mm yr-^{1}, when the surrounding catchments were vegetated in podocarp hardwood forests. Following Māori settlement and associated forest clearance, SAR rates increased to 2.4mm yr^{-1}, and following European land clearances from about 1840 onwards, SAR increased to 6.25mm yr^{-1}, with significant increases of heavy metals (Cd, Cu, Pb, and Zn) in the most recent layers (Abrahim 2005). In the Papukura Estuary, pre-human SAR rates ranged from 0.2–0.5mm yr^{-1}; these rates increased three-fold to 0.8–1.6mm yr^{-1} following European forest clearance and subsequent agriculture in the mid-1800s, and at the top of the estuary have averaged 32.6mm yr^{-1} since 1960 (Swales et al. 2002).

In the Mahurangi Harbour, following catchment deforestation (1850–1900), 3 metres of sediment has accumulated at the head of the harbour, 70% of this since 1900 (Swales et al. 1997). Infrequent floods were found to drive much of the erosion, with one-third of the total catchment erosion being generated from nine floods from 1953 to 1995. In Lucas Creek, in the upper Waitematā Harbour, rates increased from less than 1.5mm yr^{-1} before human arrival, to 2.5mm yr^{-1} during Polynesian forest clearance (700–110 BP), and then to 3mm yr^{-1} after Europeans arrived, associated with the advent of logging, gum digging and land clearance (AD 1841 to the present (Hume & McGlone 1986)).

An extensive review of land-based effects on coastal fisheries and associated biodiversity is provided by Morrison et al. (2009). In New Zealand, arguably the most important land-based stressor is sedimentation, including both suspended sediment and deposition effects, and associated decreases in water clarity (which may also be driven by nutrient effects). Ongoing re-suspension and deposition events (e.g., by storms, currents, and fishing gears) may shift sediments between these two states (suspension; seafloor deposits). Suspended sediments can directly impact on species by clogging the gills of filter feeders and decreasing filtering efficiencies as loads increase (e.g., cockles, pipi, scallops, horse mussels) (Ellis et al. 2001, Nichols et al. 2003, Hewitt & Pilditch 2004), reducing settlement success and survival of larval and juvenile phases (e.g., paua, kina) (Phillips & Shima 2006), and by reducing the visual foraging abilities of finfish (e.g., juvenile snapper, Lowe et al. 2016). Species may also be indirectly effected via the modification or loss of important nursery habitats, especially those composed of habitat-forming (biogenic) species (e.g. green-lipped and horse mussel beds, seagrass meadows, bryozoan and tubeworm mounds, sponge gardens, kelps/seaweeds, and a range of other 'structurally complex' species) (Morrison et al. 2009, 2014a-c). These effects do not act in isolation from each other, and may produce additive or multiplicative outcomes.

Eutrophication

International work has shown that eutrophication has the potential to initially increase primary productivity (phytoplankton and macrophytes), and then to create profound cascades of effects into marine ecosystems. These include loss of seagrasses, and eventually macrophytes, increases in phytoplankton blooms that reduce light levels reaching the sea-floor, subsequent oxygen depletions as blooms die and increase detrital levels on the seafloor, and large-scale losses of benthic prey assemblages that support finfish fisheries (Cloern

2001). Factors that moderate the influence of these processes include tidal streams, the degree of water transport across different areas, and the presence of large numbers of filter-feeding bivalves (e.g. oysters). Loss of such bivalve populations, e.g., from over-harvesting or sediment impacts, may exacerbate other land-based stressors, such as eutrophication, by reducing the underlying resilience of local systems (Cloern 2001). Little research has been done on the potential impact of eutrophication in New Zealand's coastal systems, though it may be modest due to our lower population size relative to other areas of the world. The Water Quality chapter and appendix discuss nutrients in some detail.

Infrastructure

The development of the city of Auckland has resulted in fundamental changes to the coastal fringe: including extensive reclamation of the approaches to the harbour bridge and the area from the Wynyard Quarter to the Ports of Auckland; along with the creation of motorways, the 'enclosure' of Hobson Bay by Tamaki Drive, and the creation of marinas, wharves, break-waters, and swing mooring areas. Smaller but similar developments have occurred through the mainland fringes of the Hauraki Gulf Marine Park, especially where human settlements have been created, along with the roads and other infrastructure required to service them. Generational memory means that a number of past activities around this may have now being largely forgotten, such as the quarrying of gravel from many island's beaches around the Hauraki Gulf Marine Park as building materials for Auckland, and the demolition by dynamite of the small 'tor' island that once existed in the sea off Bastion Point, to make way for the road, and to provide road building material. Collectively, such actions have probably significantly affected the ecology and biodiversity of the coastal fringe, both through direct removal of areas of marine habitat, and the effects on the adjacent environments. Such impacts are hinted at through an observation by a marine scientist around 80 years ago. Powell (1937) wrote that "Unfortunately there is no prior account of the bottom conditions in the harbour… the Zostera (sea-grass), once abundant in the bay, has now almost entirely disappeared… Tide-deflectors and reclamation works elsewhere have considerably reduced the areas of Zostera… marked effect on the frequency of carnivorous fishes… may be a more important factor than either over fishing or assumed harbour pollution." As Auckland continues to develop and expand, new infrastructure will be required, yet even seven decades' later we are still lacking a formal baseline or 'prior account' of the benthic ecosystems for the broader Hauraki Gulf.

Invasive species

Introduced marine species pose a serious threat to marine ecosystems throughout the Hauraki Gulf. At least six Non-Indigenous Species with the potential to cause serious harm to the marine environment have already become established in the Hauraki Gulf, with five of these arriving in the past 15 years. Another four new species have been reported since 2011, one of which (the Mediterranean fan worm Sabella spallanzani) is a high risk species capable of causing serious problems. The Port of Auckland is a key entry point for invasive species and the large amount of boating and other marine-based activities centred on it serve as vectors for the rapid spread of exotic species throughout the Marine Park and to other regions. Controlling the spread and growth of established marine pests is extremely difficult and to date no successful programmes have been implemented. Management is therefore focussed on preventing their arrival and early detection. Little is known about the potential long-term impacts of non-native species on the indigenous biodiversity of the Hauraki Gulf Marine Park

Climate change and ocean acidification

Global climate change represents a chronic, long-term disturbance to marine ecosystems. Environmental changes associated with climate change include increasing sea surface temperatures, changes in the frequency and intensity of storms and climate phenomena such as the Southern Oscillation (the El Nino-La Nina cycle), and changes in ocean circulation and ocean acidification. The latter is likely to adversely affect organisms with calcium carbonate exoskeletons such as some types of phytoplankton, corals, bryozoans and shell fishes, and will be exaggerated by acidification of coastal waters caused by nutrient inputs from terrestrial run-off. Sea-level rise will also create challenges for the conservation of coastal biodiversity through impacts on intertidal habitats and the composition of coastal vegetation types (in response to changes in immersion-emersion and salinity regimes).

Negative effects of global sea-level rise on marine biodiversity will be greatest in estuarine and coastal ecosystems. The most obvious effect will be the loss of existing coastal lagoons and wetlands; shorebird nesting, roosting and foraging areas; and intertidal habitats unless the ecological effects of coastal inundation are anticipated and planned for. Currently much of the advice around planning for sea-level rise is focussed on coastal infrastructure and property damage. Increased coastal erosion may also result in increased amounts of terrestrial sediment entering the coastal zone.

MARINE DEBRIS

Marine debris includes litter (which comes in many forms, including plastic, glass bottles, and aluminium cans) as well as discarded or lost fishing gear, aquaculture equipment, and abandoned vessels and structures. Plastic litter is the biggest problem.

Litter, especially plastic litter, is a global concern due to its environmental persistence, large volume and widespread dispersal. Litter injures and kills marine life, interferes with navigation safety, poses a threat to human health, and reduces the amenity of beaches and the coastline. Plastics photo biodegrade in UV light but do not biodegrade, so they persist in the environment. Plastics weaken and kill seabirds through starvation and false feelings of satiation, irritation of the stomach lining, and failure to put on fat stores necessary for migration and reproduction. Seabirds that feed on small prey near the surface can mistakenly ingest plastic pellets floating on the water.

Of principal concern to the community regarding plastic litter in the Hauraki Gulf is contamination of the marine food chain. Plastics are consumed by fish and the chemical components are absorbed into the flesh of the fish, which can end up affecting human health through exposure to carcinogens (cancer causing chemicals) and endocrine disrupters (which negatively affect human development).

The majority of the litter entering the coastal and marine environment comes from stormwater drains; litter also comes from the shoreline and recreational activities such as picnicking and beach-going. Abandoned and discarded fishing gear is also a major problem, since it can entangle, injure, maim, and drown marine wildlife, and damage property.

Since 2002 the Watercare Harbour Clean-up Trust (WHCT – previously called the Waitematā Clean-up Trust) and Sea Cleaners, with the help of Sustainable Coastlines and other dedicated volunteer groups, have removed over four million litres of rubbish from the shore, estuaries and mangroves of Waitematā Harbour, Tamaki Strait, and islands in the Auckland region. This equates to more than 140 shipping containers filled with loose litter and over 100,114 volunteer hours.

The amount of effort put into rubbish collection has been fairly steady since 2006 (with the exception of 2011, where Rugby World Cup games were being played in Auckland) whereas the annual volume of rubbish collected has declined since 2008 and the focus of clean-up actions has changed. This has been due, in part, to the sheer quantity of rubbish removed and upgrades to stormwater catchpits retaining large pieces of debris. Anecdotal evidence however suggests that the amount of rubbish discarded on beaches and coastal reserves by recreational fishers and picnickers is increasing.

The distribution of litter and debris on the seafloor is far less clear. Old dumping sites still hold material, including off the Rangitoto Lighthouse and on the north-western side of Kawau Bay (large steel frames, cables and other metal items, M.M. pers. obs.), along with old ammunition dump sites further out in the Hauraki Gulf Marine Park, as marked on charts. Popular recreational anchorages such as Bon Accord Harbour, Kawau Bay, have significant volumes of old brown beer bottles and other items distributed across the seafloor, which may last indefinitely in such environments. Lost fishing gear, including monofilament lines and lead sinkers, are common at rocky reef sites fished from the shore. The lead sinkers are usually un-colonised by marine organisms, probably due to their toxic nature.

MARINE PROTECTED AREAS

Marine Protected Area is an umbrella term used to describe a wide range of areas protected for marine conservation. The Convention on Biological Diversity (CBD) defines marine and coastal protected areas as "an area within or adjacent to the marine environment, together with its overlying waters and associated flora, fauna, and historical and cultural features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine and/or coastal biodiversity enjoys a higher level of protection than its surroundings".

The New Zealand Marine Protected Areas Policy and Implementation Plan (MPA Policy) reflects the commitment by the Government through its ratification of the CBD and development of the New Zealand Biodiversity Strategy (NZBS) to help stem the global loss of biodiversity. The MPA Policy is intended to assist government achieve Objective 3.6 of the NZBS which is to protect a full range of natural marine habitats and ecosystems to effectively conserve marine biodiversity, using a range of appropriate mechanisms, including legal protection. The MPA Policy recognises that a range of management tools, including marine reserves and Fisheries Act 1996 tools, can be used to protect marine biodiversity. The MPA Policy Protection Standard provides an outcomes-based definition of an MPA. To satisfy the protection standard a management tool must enable the maintenance or recovery of a site's biological diversity at the habitat and ecosystem level to a healthy functioning state. In order to do this the management regime must provide for the maintenance and recovery of:

a) Physical features and biogenic structures that support biodiversity;

b) Ecological systems, natural species composition (including all life-history stages), and trophic linkages; and

c) Potential for the biodiversity to adapt and recover in response to perturbation. Management tools recognised as meeting these requirements are marine reserves established under the Marine Reserves Act 1971 (Type I MPAs) and Fisheries Act 1996 prohibitions on dredging, trawling, Danish seining, purse seining, gillnetting and potting (when on sensitive biogenic habitats) (Type II MPAs).

Other tools that may meet the requirements of a Type II MPA include cable protection zones, marine mammal sanctuaries, Resource Management Act, possibly in combination with tools available under other acts (pp. 12–13, Marine Protected Areas Classification, Protection Standard and Implementation Guidelines 2008). The 2012 International Union for the Conservation of Nature (IUCN) definition of an MPA is "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values".

In general the purpose of all MPAs is the conservation of biodiversity, or in some cases cultural heritage, whereby they provide a higher level of protection than surrounding areas.

There are differences between the Marine Reserve Act 1971 and Fisheries Act 1996 tools. The most important difference between marine reserves established under the Marine Reserves Act 1971, and the Fisheries Act 1996 tools, is that marine reserves are able to protect the habitat from disturbances unrelated to fishing such as discharges, dumping, mining and structures. Fisheries Act tools can offer more flexibility to a variety of fishery uses that may be compatible with varying degrees of marine protection.

Existing marine protection within the Hauraki Gulf Marine Park

There are six marine reserves (Type I MPAs) within the Marine Park, they are: Cape Rodney-Okakari Point Marine Reserve (529.8 ha), Tawharanui Marine Reserve (394.2 ha), Long Bay-Okura Marine Reserve (962.7 ha), Motu Manawa-Pollen Island Marine Reserve (500.5 ha), Te Matuku Marine Reserve (687 ha) and Te Whanganui-A-Hei (Cathedral Cove) Marine Reserve (886.7 ha). Collectively they cover 0.28% of the total area of the Marine Park. In addition there are three cable protection zones that are recognised as Type II MPAs. The largest of these is the Hauraki Gulf Submarine Cable Closure (HGSCC) which covers a total area of 74,342 ha. At its narrowest point off Takapuna the HGSCC is 1.6 km across. At its widest in the outer Gulf it is over 10 km across. The combined coverage of Type II MPAs is 5.46% of the Marine Park, of which 96.7% is the HGSCC. The biological assemblages in all of the marine reserves have been documented in some way, either in the original application or in monitoring programmes and research projects since their establishment. In contrast, very little is known of the biology of any of the Type II MPAs, aside from some limited soft sediment work in the cableway by Morrison et al. (2016). The total area covered by existing Type I and II MPAs is 80,827 ha, or 5.74% of the Marine Park.

Jackson (2014) developed a habitat classification based upon substrate information developed for the Hauraki Gulf Marine Spatial Plan and the New Zealand Coastal Classification (MPA Policy Guidelines 2008) and used this to assess the representativeness of the existing MPA network in the Marine Park. This classification identified 46 coastal and marine habitat types within the Marine Park, of which only two (sheltered coarse and mixed sediments below 30 m depth) have 10% or more of their extent protected within Type I or Type II MPAs. In both cases this is attributable to the amount of these habitats occurring within the HGSCC. In contrast, half of the identified Gulf habitats were not protected within any MPA (Jackson 2014). The most extensive habitats within the Marine Park are muddy and sandy mud substrata occurring between 30–200 m depth. Currently very few habitats occurring deeper than 30 m are protected within no-take marine reserves as only a small proportion of marine reserves exceed 30 m maximum depth (Jackson 2014).

Two comprehensive reviews of the use of MPAs in the New Zealand context have recently been published (Thomas & Shears 2013, Willis 2013).

Marine Protected Area network design principles

New Zealand's marine reserves were established individually and independently to protect local-scale marine wildlife, rather than systematically as a coherent network designed to protect national-scale biodiversity and ecosystem services (Thomas & Shears 2013). The New Zealand Marine Protected Areas Policy and Implementation Plan (MPA Policy) and the Marine Protected Areas Classification, Protection Standard and Implementation Guidelines (MPA Policy Guidelines) were developed to address the NZBDS objectives, particularly the development of network of MPAs that is comprehensive and representative of New Zealand's marine habitats and ecosystems (pg. 10, para. 13). In this context comprehensive means capturing as much as possible of the full range of biodiversity present within New Zealand's marine environment, and representative means containing a representative selection of habitats and ecosystems.

There is a large scientific literature on the design of MPA networks, much of it relating to the use of MPAs as fishery management tools (e.g. Martell et al. 2000; Bentley et al. 2004; Pelletier & Mahévas 2005; White et al. 2010). However, using spatial tools to manage or eliminate human activities that adversely affect the marine environment is also an effective way of contributing to the long-term ecological viability of marine ecosystems (Marine Parks Authority 2008). Guidance on ecological principles for the design of MPAs and MPA networks is contained in the MPA Policy (2005) and MPA Policy Guidelines (2008), and reviews such as IUCN (2008), Gaines et al. (2010), Fernandes et al. (2012) and Thomas & Shears (2013).

Design principles emphasised in these documents are:

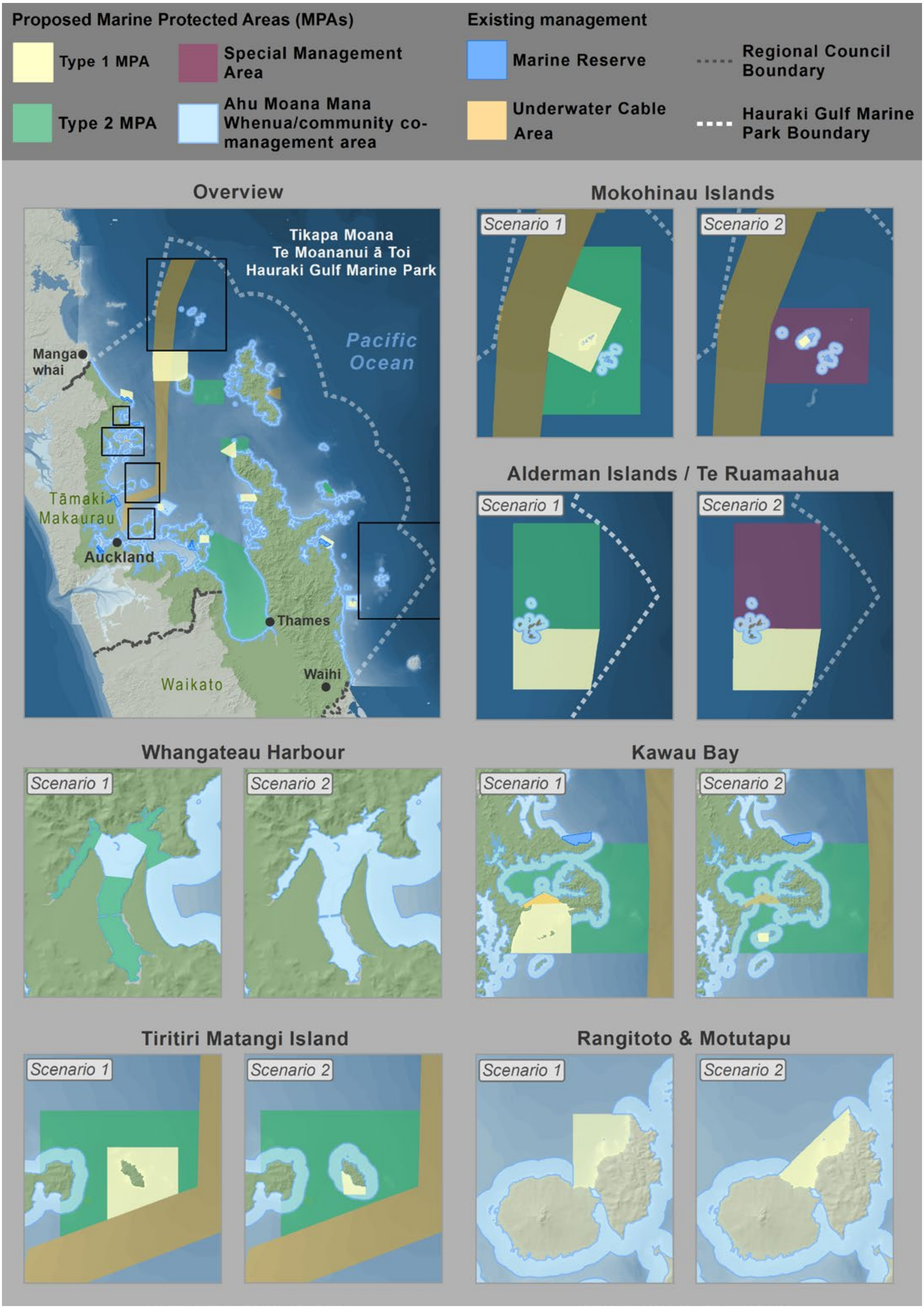
4. Inclusion of the full range of biodiversity present in a biogeographic region through:
    - representation of all habitats and ecosystems.
    - replication of protection for each habitat and/or ecosystem within the network.
    - protection of habitats that exhibit resilience or resistance to long-term environmental change.
    - increasing resilience to other stressors (e.g. sedimentation, raised temperatures).
5. Ensure ecologically significant areas are incorporated by:
    - protecting unique or vulnerable habitats (e.g. biogenic habitats).
    - protecting critical habitats such as foraging or breeding grounds.
    - protecting source populations, i.e. those that export larvae, juveniles and adults to other areas.

6. Maximise the contribution of individual MPAs to the network through careful consideration of their:
    - Size – in general larger MPAs will protect a greater variety of habitats and biodiversity, as well as providing a buffer against edge effects of fishing; some studies recommend large numbers of smaller MPAs for fisheries management objectives – to enhance spill-over; although many reef fishes are physically capable of swimming long distances, some of these are home ranging or territorial (e.g. McCormick 1989; Cole et al. 2000; Parsons et al. 2010) making spill-over effects less likely (Moffitt et al. 2009).
    - Spacing – optimal spacing will vary depending on the objectives of MPA management and the species involved; while many marine species have long-lived pelagic larvae capable of dispersing hundreds to thousands of kilometres, many species, including habitat-forming species, such as seaweeds, sponges and bryozoans, have short-lived larvae that may stay in the plankton for less than an hour to just a few days, while other species brood their young. As a result, larval dispersal distances of these species may vary from a few metres to a few kilometres. Although other dispersal factors, such as rafting, may significantly increase dispersal potential (Grantham et al. 2003).
    - Shape – boundaries should reflect natural ecological boundaries and be simple (to facilitate compliance and enforcement); the design of individual reserves should aim to minimize the area to boundary length ratio in order to minimize edge effects.
7. Consider hydrographic and ecological linkages between the land and sea – it is particularly important to consider potential land-based impacts on the marine environment when thinking about establishing MPAs in enclosed coastal waters or estuaries, MPAs are unable to directly influence activities occurring in adjoining catchments.
8. Minimise adverse economic and social impacts on existing users.

The Convention of Biological Diversity (CBD) and New Zealand Biodiversity Strategy establish a target of 10% of the marine environment protected within MPAs. However more recent research predicts that maximum benefits for biodiversity conservation and fisheries are likely to occur between 30–50% coverage by MPAs. In most cases extension of MPA coverage to more than 50% coverage of a fishery is predicted to adversely impact fishery yields due to the displacement of fishing effort into the remaining unprotected areas (Gaines et al. 2010). In this context, it is important to note that geographic coverage of a specific area such as the Hauraki Gulf Marine Park is unlikely to equate to the spatial coverage of a fishery. For example rocky reefs represent only a relatively small proportion of the total area of the marine park (actual area unknown). As a result the spatial extent of fisheries for reef-associated species such as kina and rock lobster will be much smaller than the area of the park, and usually much less than the total area of reef due to the habitat requirements of the species involved.

The use of conservation planning software or spatially explicit fishery models allows objective assessment of the cost-benefits (and therefore trade-offs) between conservation goals and exploitation of marine resources (e.g. Bentley et al. 2004; Pelletier & Mahévas 2005; Leathwick et al. 2008). Leathwick et al. (2008) demonstrated the use of conservation planning software (Zonation) to design MPA networks in New Zealand's Exclusive Economic Zone. Using predicted distributions of 96 demersal fishes sampled by research trawls and information on the location of commercial bottom trawling, they demonstrated that protecting 10% of the habitat based solely on estimated conservation value, without regard for the impact on fishing, would on average protect 27.4% of the geographic range of each fish species and reduce fishing opportunity by 22%.

Using the algorithm to select high conservation value sites but avoiding important fishing areas, produced a solution that on average protected 23.4% of the range of each species (marginally lower than the solution that ignored fishing effort) but had no impact on fishing. Increasing the level of spatial protection to 20% but still avoiding heavily fished areas produced a solution that would increase average species protection by 50% with minimal cost to the fishing industry (Leathwick et al. 2008, fig. 5). This solution had greater predicted conservation benefits and less impact on fishing opportunity than the Benthic Protected Areas, which were developed using expert opinion and a physical classification of the marine environment (Helson et al. 2010; Reiser et al. 2013).



Map A3.1 Overview/location maps for proposed MPA network and alternative scenarios.

DESCRIPTION OF EACH PROPOSED MARINE PROTECTED AREA

Fifteen MPA sites have been identified across the Hauraki Gulf Marine Park. All of these were identified for their habitat and ecological values, and were based on the information provided by our science advisors. Nine Type 1 marine reserves and ten Type 2 benthic protection areas were agreed and recommended by the Stakeholder Working Group.

Five areas - Mokohinau Islands, Tiritiri Matangi, Kawau, Motutapu / Rangitoto, and the Alderman Islands - were also agreed and recommended by the SWG as areas that would benefit from protection, but a decision was not reached on a single size, location, or shape for the Type 1 MPAs and which other type of protection would be applied. The Stakeholder Working Group (SWG) members arrived at two options for each of these areas, which include both Type 1 MPAs as well as Type 2 protection. A different option, at the Alderman Islands, is Scenario 2, which provides for a Special Management Area (SMA) (no commercial fishing with restricted recreational fishing) bordering a Type 1 MPA. As well, the Whangateau Harbour has two options for co-management between Mana Whenua and the local community. In order to gain consensus or sufficient support to select and progress one of the options, discussions with mana whenua and local communities will be required for all these areas.

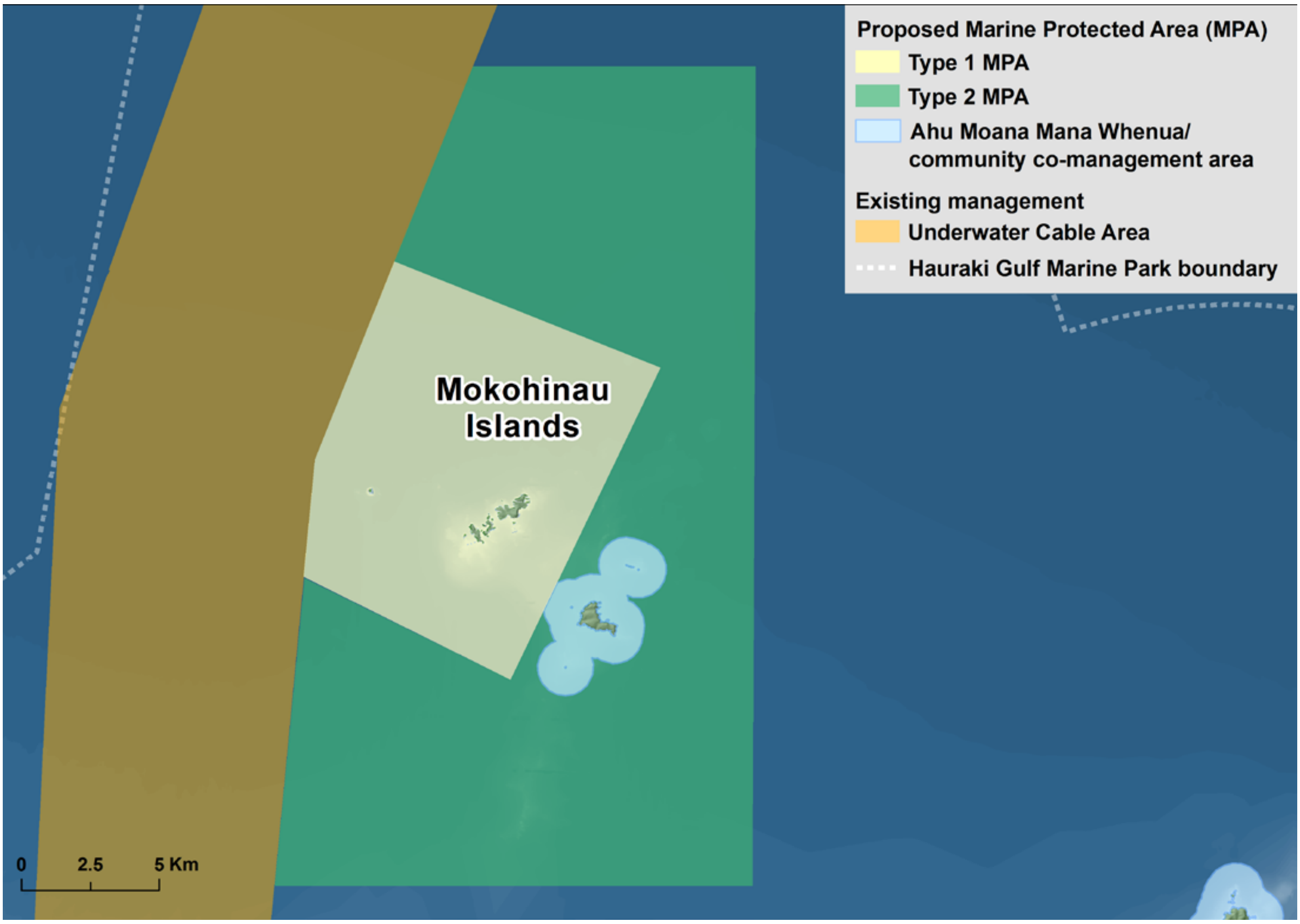
There are four types of Marine Protected Area:

- Type 1: no take marine reserves (other than for customary purposes).
- Type 2: benthic protection – restrict all commercial and recreational fishing methods that impact with the benthic habitat.
- Special Management Areas (no commercial fishing allowed and restricted recreational fishing allowed).
- Ahu Moana (Mana Whenua and community co-management areas) covering the entire coastline from mean high water to 1km, with buffer zones around some Type 1 areas

1. Mokohinau Islands

The Mokohinau Islands, the northernmost islands in the HGMP, include good examples of shallow to deep-water outer shelf reef systems and abundant and diverse marine wildlife. Like the Poor Knights Islands the Mokohinau's are also influenced by the subtropical waters of the East Auckland current and high biological productivity driven by seasonal upwelling along the continental shelf edge. As a consequence, the rocky reefs surrounding the islands are characterised by diverse, colourful benthic assemblages, with deeper reefs supporting populations of vulnerable species such as large sponges, gorgonian and black corals; large schools of planktivorous fish; and species once abundant throughout the Gulf such as hapuku. Clear, oceanic water supports kelp forest growth down to a depth of 40 m. The marine assemblages found around the archipelago show little evidence of degradation by land-based pressures (e.g. sedimentation) observed elsewhere in the HGMP. The pest-free Mokohinau Islands are also known for their importance to seabirds, with a high density and diversity of species breeding on them.

SCENARIO 1



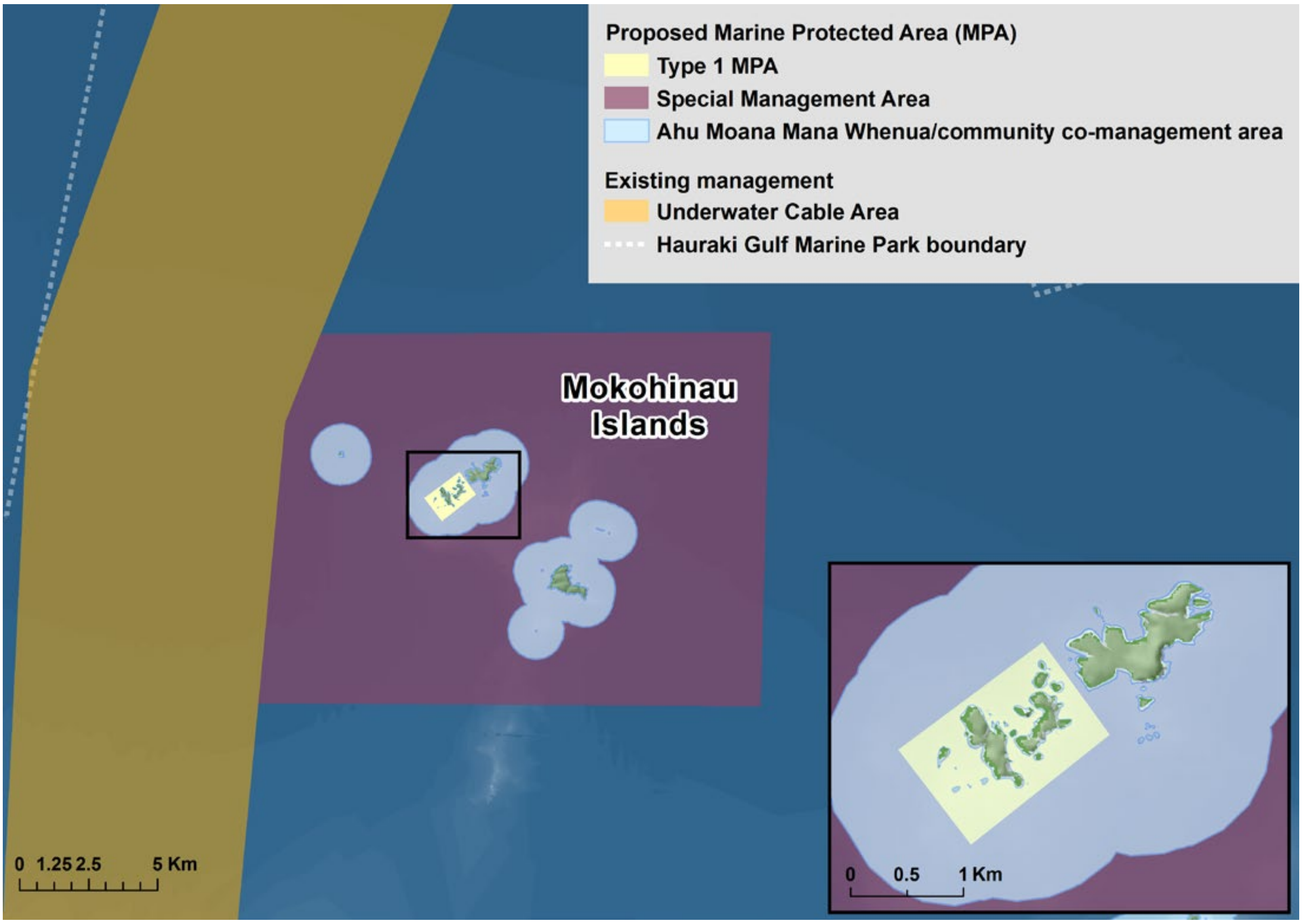
Map A3.2 Mokohinua Islands MPA Scenario 1

Plan elements

a) Type 1: no take marine reserve centered around Burgess Island (Pokohinu), Atihau, Hokoromea and spanning to the Cable Protection Zone in the west, including examples of deep reefs in the north.

b) Type 2: designed to protect benthic habitats associated with the shallow to deep reef system of the archipelago. Excludes all benthic impacting fishing methods, including trawling

SCENARIO 2



Map A3.3 Mokohinua Islands MPA Scenario 2

Plan elements

a) Type 1: no take marine reserve centered around Hokoromea and Atihau Islands

b) Type 2: Special Management Area (SMA) – no commercial fishing and restricted recreational fishing

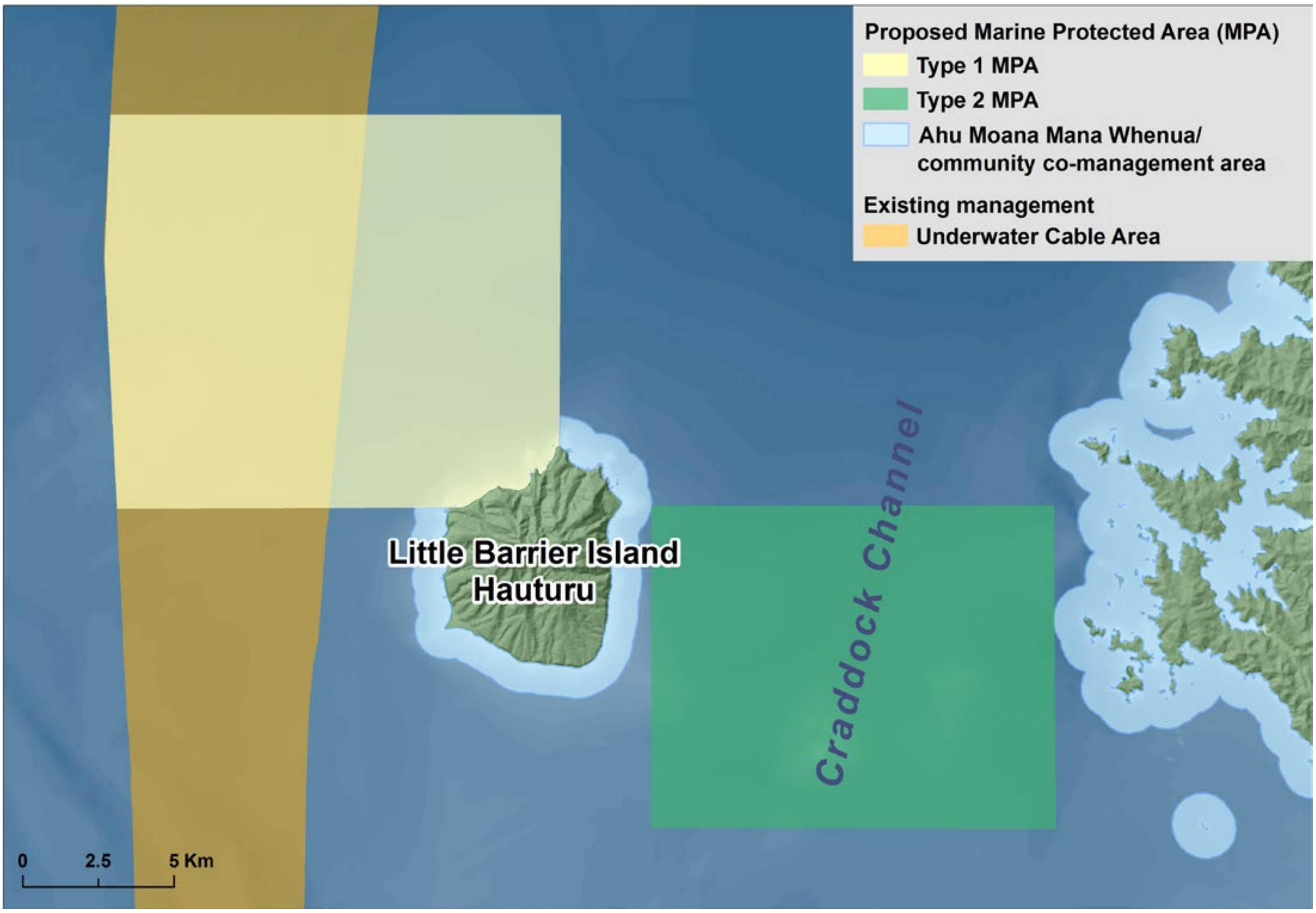
2. Little Barrier Island and Craddock Channel - Hauturu

LBI/Hauturu is surrounded by a variety of intertidal and subtidal habitats ranging from the predominantly rocky shoreline to mid-shelf-depth soft sediments and reefs. The island is encircled by an extensive system of sheltered shallow rocky reefs up to about 30m depth. These reefs support a diverse array on seaweeds, invertebrates and fishes typical of the northeast North Island.

Commercially exploited scallop beds are found around the western and southern side of the island, and the area is an important part of the commercial rock lobster fishery. Anecdotal evidence provided by SWG members indicates that the sea floor between the deep reefs north of LBI/Hauturu and the island once supported dense sponge assemblages, which were progressively removed to allow bottom trawlers to fish the area.

Remnants of these sponge dominated assemblages persist on Northwest Reef (within the cable protection zone and included within the T1) and three small patch reefs found north of the island. The largest of the latter is known as the 'Coral Patch' (also within the T1). Juvenile hammerhead sharks can be abundant over summer months, particularly off the northwestern end of the island. LBI/Hauturu is pest free, covered in native vegetation and of international importance for seabirds.

Craddock Channel covers a submarine saddle extending between LBI and GBI and is an area of high tidal current whilst still being relatively sheltered. The area was identified for its rich benthic environments including shallow and deep rocky reefs, holding diverse and productive inshore reef assemblages, high primary production (kelp forests), and biogenic habitats (e.g. sponges). The channel area is important for Bryde's whale and provides critical habitat for the nationally endangered bottlenose dolphin.



Map A3.4 Little Barrier – Hauturu MPAs

Plan elements

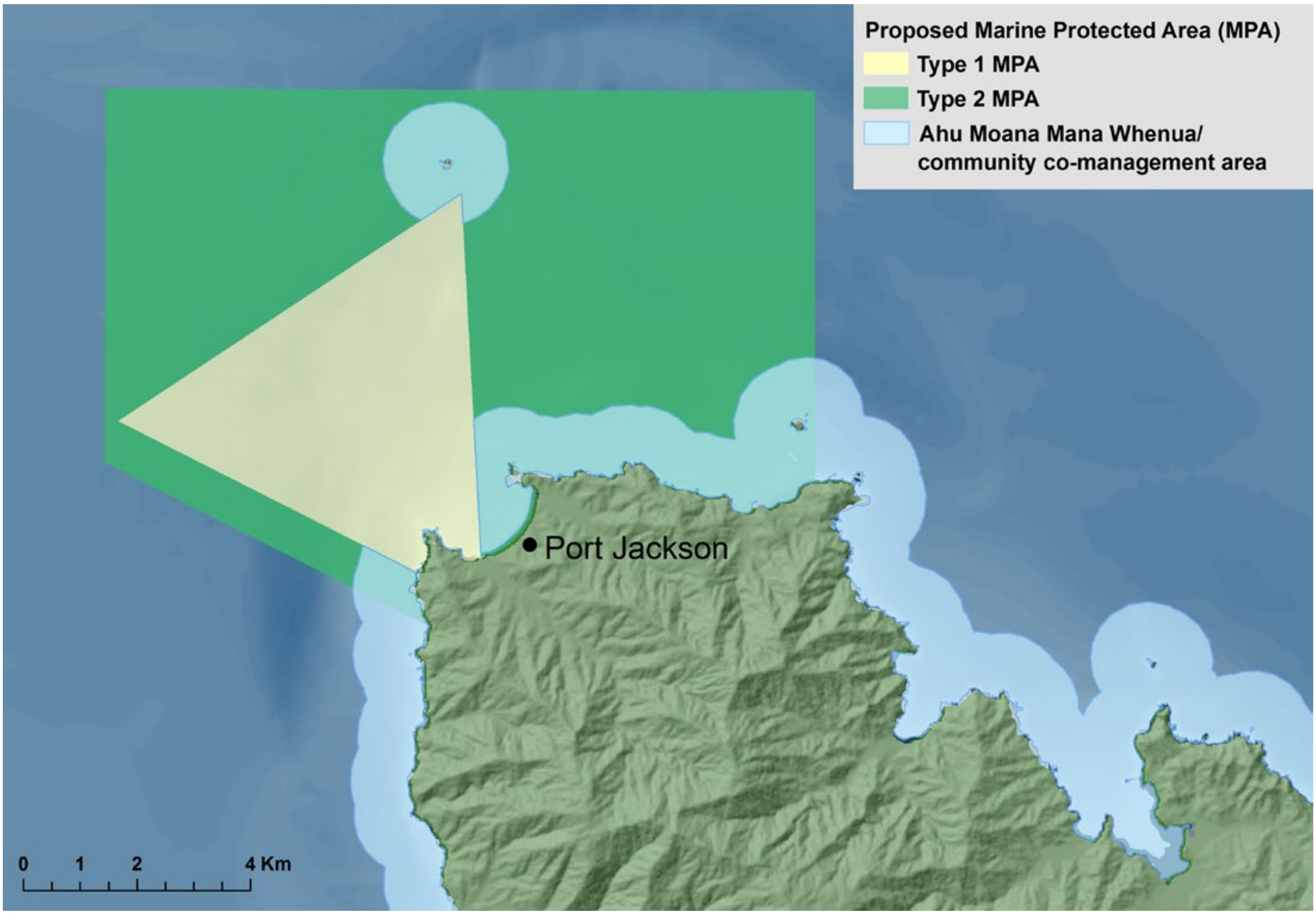
a) Type 1: no take marine reserve extending from the northwest corner of the island west to include the cable protection zone and north to take in several deep reefs.

b) Type 2: protection of diverse benthic habitat associated with Craddock Channel. Excludes all benthic impacting fishing methods, including trawling.

3. Cape Colville - Moehau

The strong currents associated with Colville Channel create a current-swept benthic habitat with high biodiversity associated with a mixture of coarse sand and muddy sediments, as well as numerous deep rocky reefs. Extensive dense dog cockle beds with epifaunal sponges and ascidians occur in soft sediments between the reefs. The reefs are dominated by massive sponges, hydroids and anemones. They support large schools of planktivorous fishes, (predominantly pink maomao, two-spot demoiselles and sweeps) as well as a representative range of reef species such as snapper, wrasses, moki, blue cod and goatfish. SWG members report that benthic habitats in the area have been adversely affected by bottom trawling. The reefs are commercially fished for rock lobster, and are an important part of commercial longline and set net fisheries.

The area is popular with land-based fishers who access the area from Port Jackson. Hapuku historically occurred on rocky reefs in the channel.



Map A3.5 Cape Colville MPAs

Plan elements:

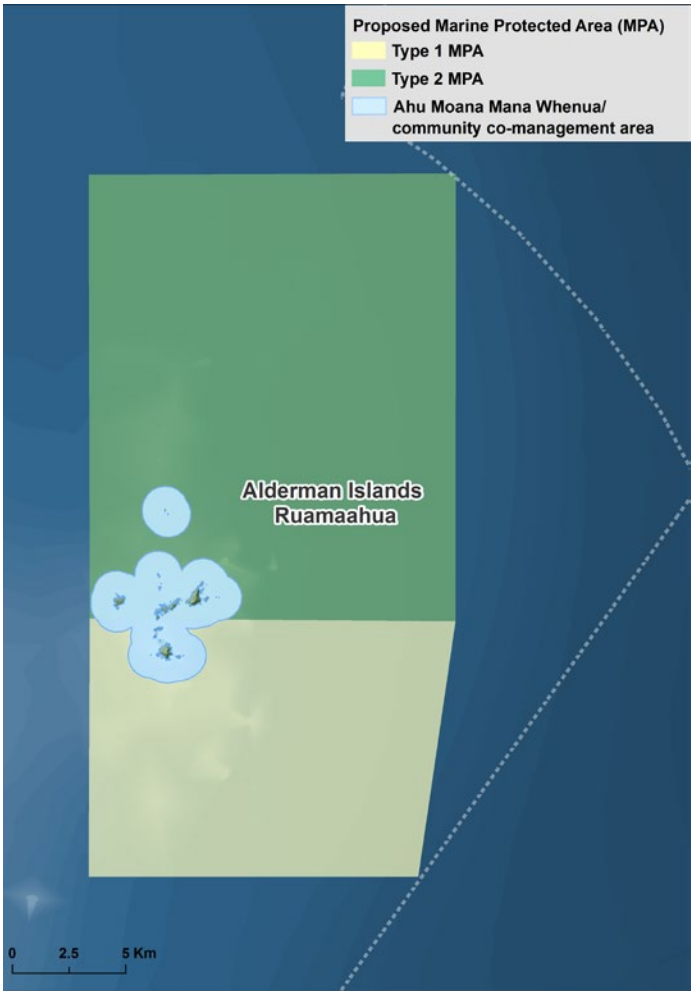
a) Type 1: no take marine reserve reaching out to the channel whilst providing easy access to swimmers, kayakers etc.

b) Type 2: protection of benthic habitats associated with the deep Colville Channel. Excludes all benthic impacting fishing methods, including trawling.

4. Alderman Islands – Te Ruamaahua

The Alderman Islands are surrounded by an extensive and complex system of rocky reefs extending from the shoreline to about 100 m depth. Clear, oceanic waters derived from the subtropical East Auckland Current, and seasonal upwelling along the shelf edge, exert a strong influence on the marine biodiversity of the archipelago. The area supports diverse shallow reef assemblages typical of offshore islands off the northeast North Island. Hapuku, large kingfish and snapper occur on the deep reefs. Seasonal aggregation of short-tail stingrays (possibly related to breeding) has been observed around Ruamahuaiti Island. Sediment transport models suggest that reefs deeper than 90m may be adversely impacted by land-derived sediments. The islands are pest free and of high importance to nesting seabirds. The area is a popular recreational fishing destination and important part of the commercial rock lobster fishery. Mana whenua have guaranteed access to customary fisheries and other taonga in the archipelago.

SCENARIO 1



Map A3.6 Alderman Islands – Te Ruamaahua MPAs Scenario 1

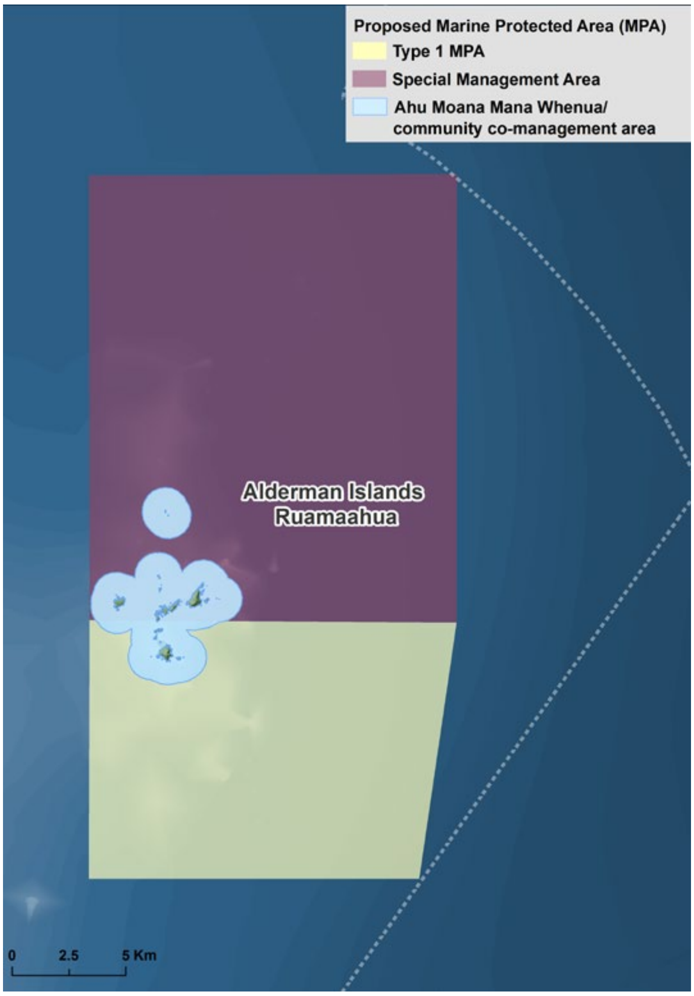
Plan elements

a) Type 1: no take marine reserve centered around Ruamahuaiti Island to Nga Horo in the north, including complex reef system to the south and spanning east towards the 200 m depth contour.

b) Type 2: rest of the archipelago and reef system extending northward. Excludes all benthic impacting fishing methods, including trawling

c) Ahu Moana Mana Whenua community co-management area extending 1 km around Islands.

SCENARIO 2



Map A3.7 Alderman Islands – Te Ruamaahua MPAs Scenario 2

Plan elements

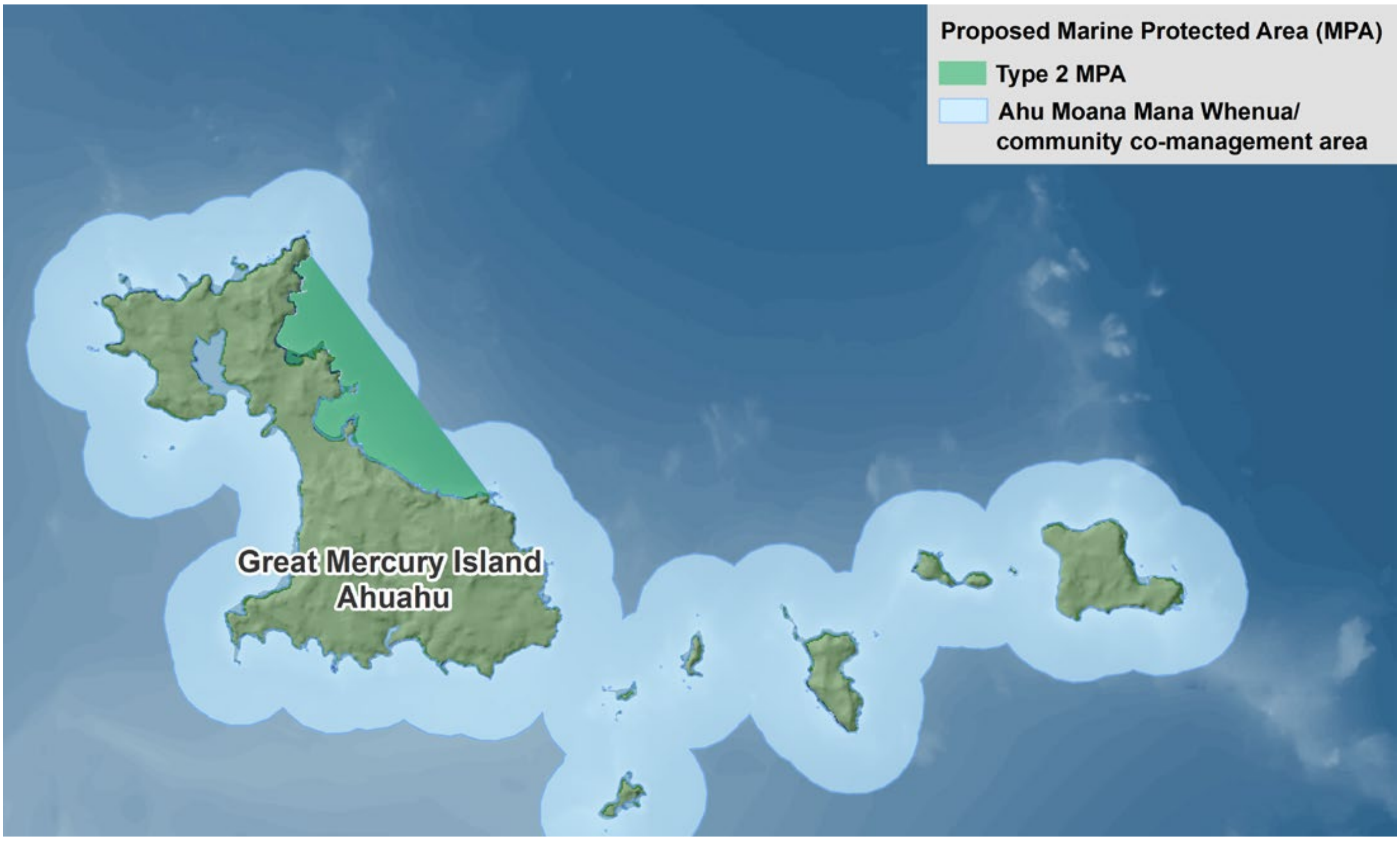
a) Type 1: no take marine reserve centered around Ruamahuaiti Island to Nga Horo in the north, including complex reef system to the south and spanning east towards the 200 m depth contour.

b) Type 2: special management areas

c) Ahu Moana Mana Whenua community co-management area extending 1 km around Islands.

5. Mercury Islands – Ahuahu / Whakau

This area represents a relatively uncommon sequence from shallow–coastal to deep outer shelf habitats. The complex bathymetry and varying shelter provided by the islands and adjacent mainland make this an area of high habitat diversity, which is reflected in the diversity of species found in the surrounding waters. The influence of the subtropical East Auckland Current and high water clarity result in diverse algal and encrusting invertebrate assemblages. Shallow rocky reefs are dominated by large brown seaweeds, mainly Ecklonia radiata, to 30-40 m depth. Rhodolith beds occur on coarse sands between the islands and between the islands and the mainland. Below 40 m depth rocky reefs are dominated by diverse sponge assemblages. These also support protected black and gorgonian corals. Video sled observations of reefs deeper than 80 m suggest that although these are still dominated by sponges, including several rarely seen species, they are being adversely affected by terrestrially derived sediments (as predicted by NIWA sediment transport and deposition models). The islands are pest free and of high importance to nesting seabirds



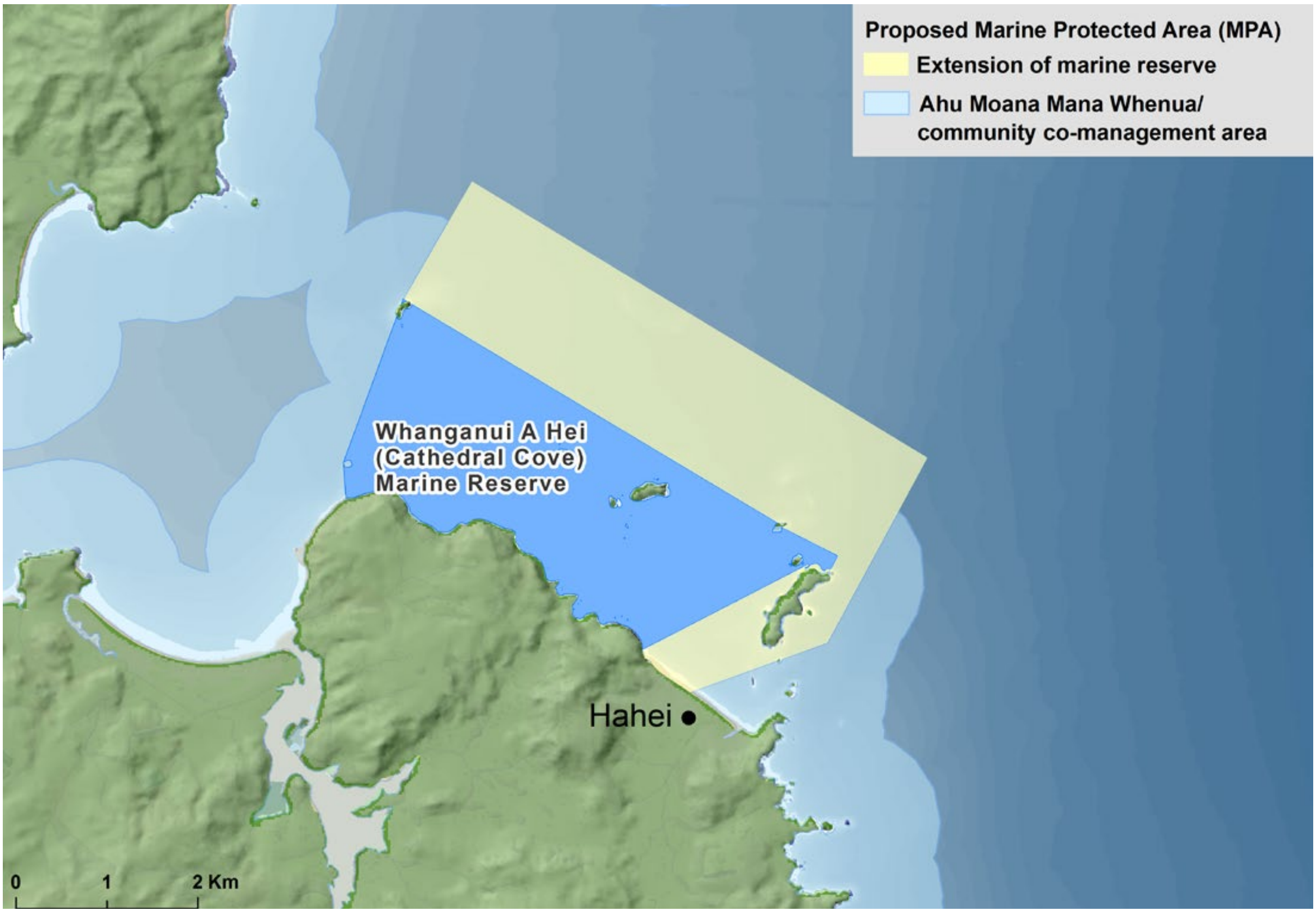
Map A3.8 Mercury Islands – Ahuahu / Qhakau MPAs

Plan elements

a) Type 2 MPA spanning from Te Koru to Rocky Bay and including Coralie Bay.
b) Excludes all benthic impacting fishing methods - trawling, dredging etc.
c) Excludes all ring netting (set netting).
d) Excludes all cray potting.
e) Excludes all commercial fishing.
f) Ahu Moana Mana Whenua community co-management area 1 km around islands.

6. Hahei

The proposal is to extend the boundary of the marine reserve offshore 1.5 km to account for offshore rock lobster movements, the same reason for the proposed extension to the Cape Rodney to Okakari Point (Goat Island) Marine Reserve. The proposed boundary extension includes South Sunk Rock, all of the coastline of Mahurangi and Te Tio Islands (and associated reefs), and part of Hahei Beach.



Map A3.9 Hahei MPAs

Plan elements

a) Type 1: Hahei marine reserve extension. Designed to provide easy access to the reserve from Hahei beach whilst providing for shore fishing from beach.

Sites for launching boats from the beach to be decided at the time of implementation.

7. Slipper Island – Whakahau

Slipper Island includes one of the only known examples of subtidal seagrass within the Hauraki Gulf Marine Park. High water quality combined with a mosaic of rocky reefs, coarse sand and subtidal seagrass habitats results in an area of high biodiversity (i.e. elevated species richness and abundance). The islands are important seabird nesting habitat. Rocky reef assemblages are typical of those found at similar exposures along the northeast North Island.

Map A3.10 Slipper Islands - Whakahau MPAs

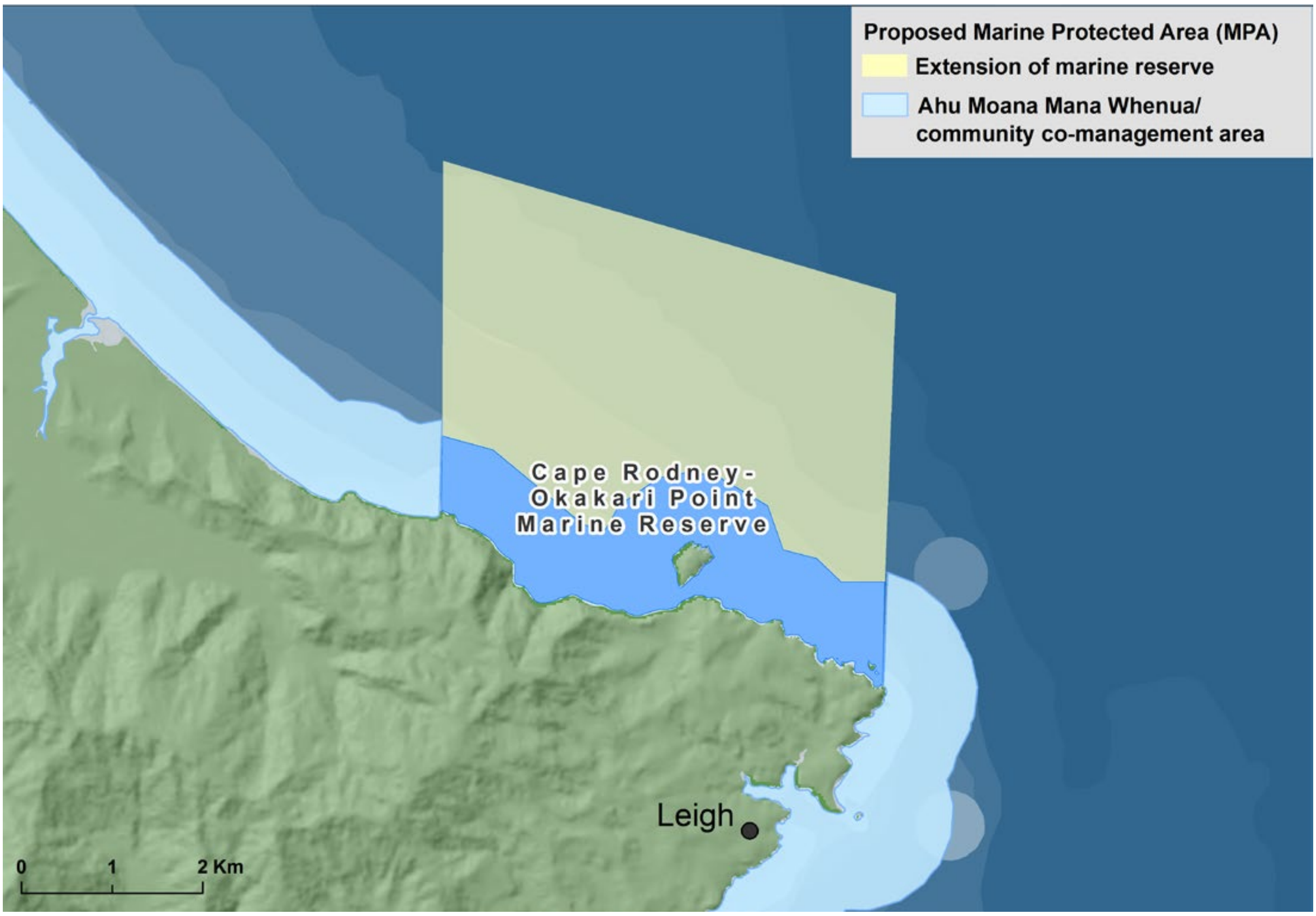
Plan elements

a) Type 1: no take marine reserve over half of Slipper Island, spanning examples of reef systems and associated biodiversity and subtidal seagrass habitats.

b) Ahu Moana Mana Whenua community co-management area around Type 1. This area was initially envisioned as a Type 2 to provide a level of benthic habitat protection around the type 1. Proposed to exclude all benthic impacting fishing methods, including trawling.

8. Pakiri Leigh

This proposal extends Leigh Marine Reserve 3 km offshore to cover most of the movement range of rock lobster in order to better protect the integrity and functionality of the marine reserve ecosystem as a whole. The proposed extension covers an offshore reef and area of shallow sand habitat used by foraging rock lobster located seaward of the existing outer boundary of marine reserve.



Map A3.11 Pakiri Leigh MPAs

Plan elements

a) Type 1 – Leigh marine reserve extension.

9. Whangateau Harbour

Whangateau Harbour is notable for the range of relatively intact estuarine habitats contained within a relatively small area. These include a variety of reef types, sandy intertidal and subtidal seabed, muddy habitats, mangrove forests, a variety of algal and seagrass beds, and saltmarsh. The variety of and quality of marine and coastal habitats are reflected in the harbour's ecological diversity and productivity. The harbour represents the best remaining example in Auckland of a coastal vegetation sequence running from kahikatea swamp forest to saltmarsh and estuarine flats. The harbour is of importance for juvenile fish, including parore and trevally. It is also a shorebird area of importance. The harbour supports dense shellfish beds.

SCENARIO 1

Map A3.12 Whangateau Harbour MPAs Scenario 1

Plan elements

a) Ahu Moana Mana Whenua community co-management area around Horseshoe Island. Previously proposed as a mātaitai with a shellfish removal restriction.

b) Type 2: benthic protection throughout the harbour surrounding the Co-management area, including entrance to harbour and the southern arm of the harbour (Waikokopu Creek).

SCENARIO 2

Map A3.13 Whangateau Harbour MPAs Scenario 2

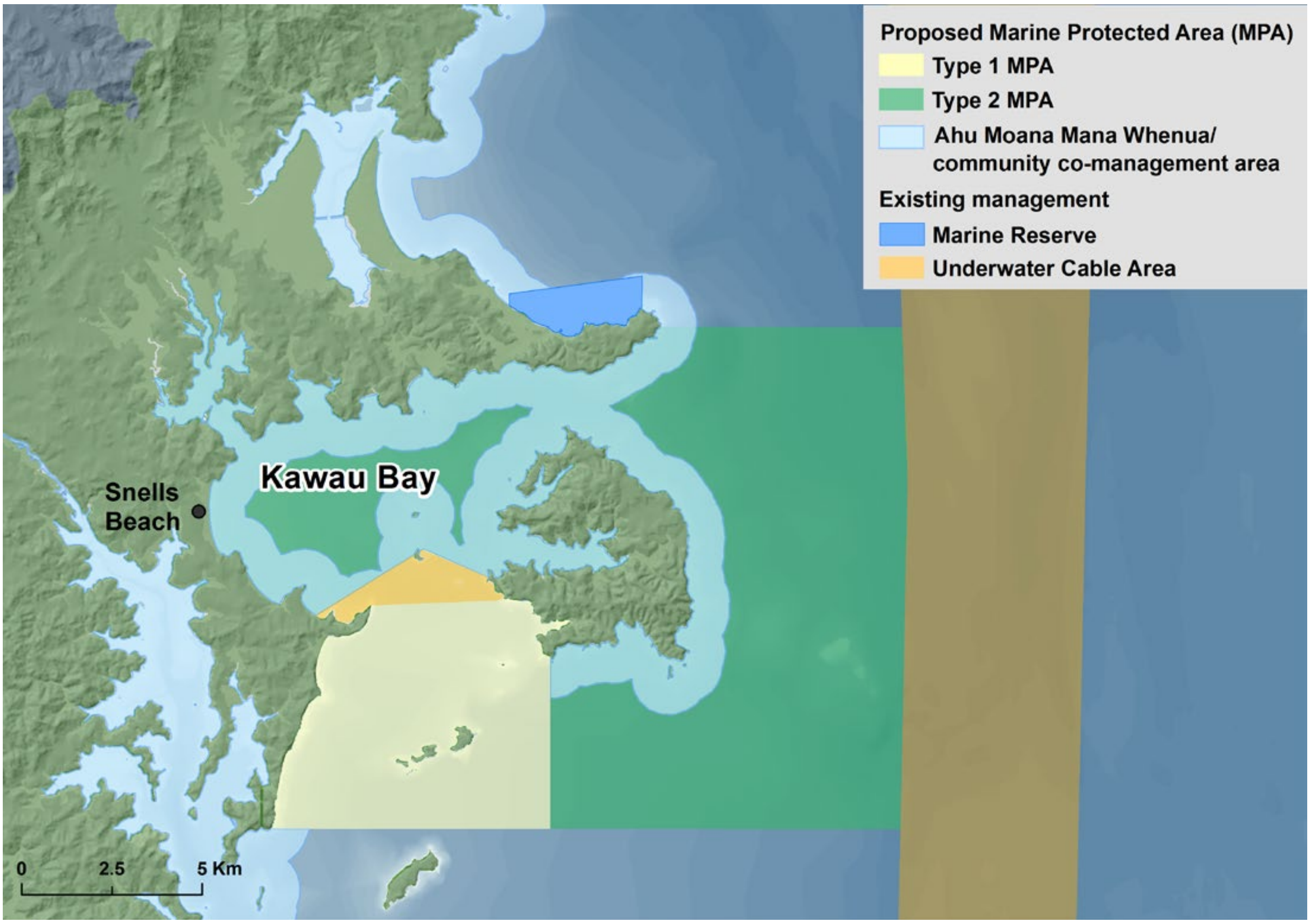
Plan elements

a) Co-management area throughout entire harbour, with benthic restrictions and restrictions on harvesting shellfish.

10. Kawau Bay

Kawau Bay is an area of high habitat diversity, encompassing bays and estuaries of various sizes, sheltered coastal environments and more exposed rocky and soft-sediment areas. Research indicates that area is a highly diverse coastal ecosystem. The types of species found are those commonly associated with relatively pristine environments (e.g. sponge, rhodolith and horse mussel beds, kelp forests, scallops and pipi). The bay includes nursery habitats and areas important for juvenile fish including snapper. It was historically a nursery area for sharks, notably rig (spotted dogfish) and school shark. Kawau Bay is extensively used for recreational pursuits. Threats to the area identified are largely related to existing and expected urbanisation of the catchments, and the cumulative impact of increasing recreational use (e.g. trampling of intertidal habitats, anchoring, fishing, scallop dredging, chronic noise pollution and disturbance, etc.).

SCENARIO 1



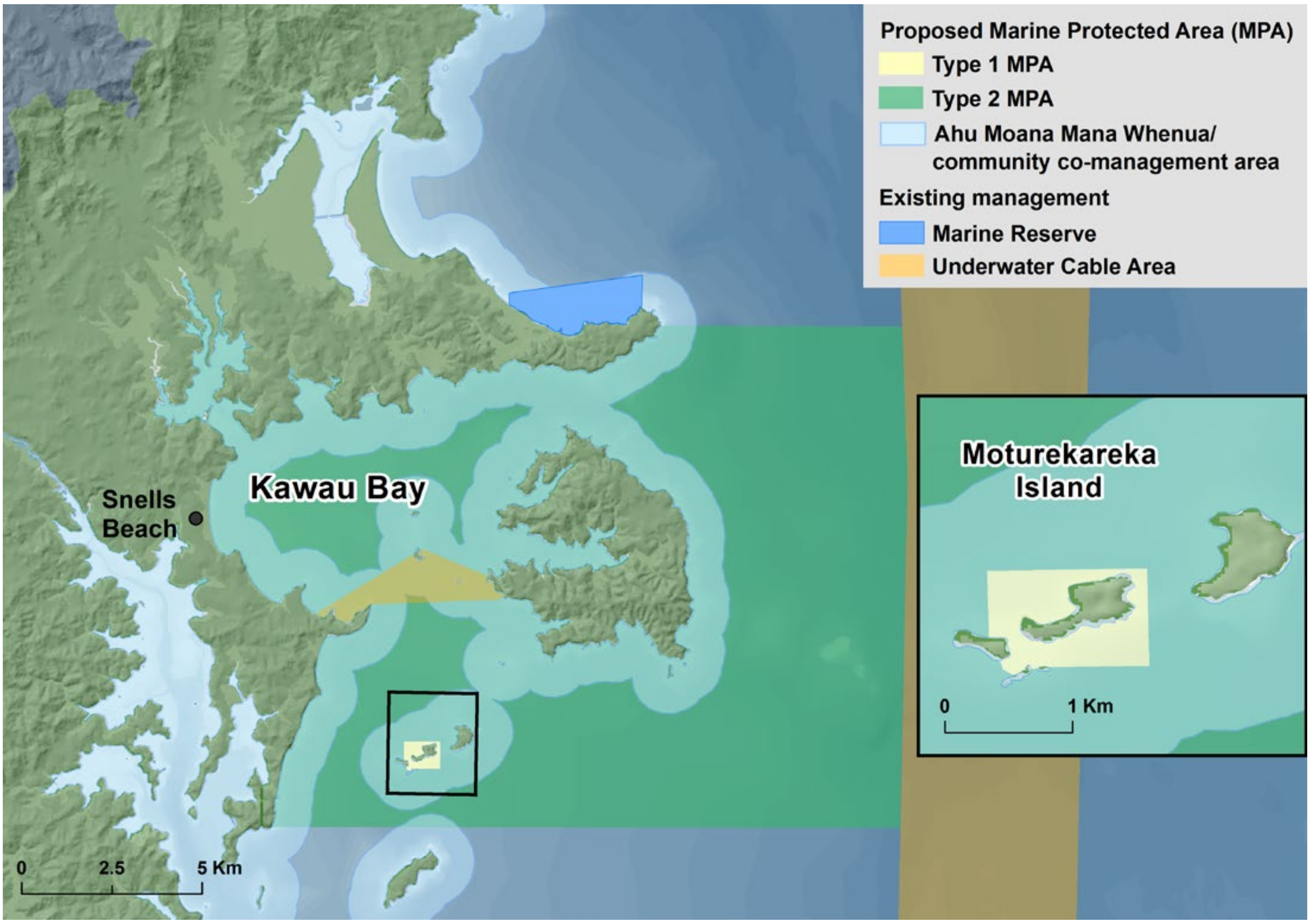
Map A3.14 Kawau Bay MPAs Scenario 1

Plan elements

a) Type 1: no take marine reserve spanning the cable protection zone in the north and Beehive, Motuketekete and Moturekareka islands in the south.

b) Type 2: protection of benthic habitats. Excludes all benthic impacting fishing methods, including scallop dredging.

SCENARIO 2



Map A3.15 Kawau Bay MPAs Scenario 2

Plan elements

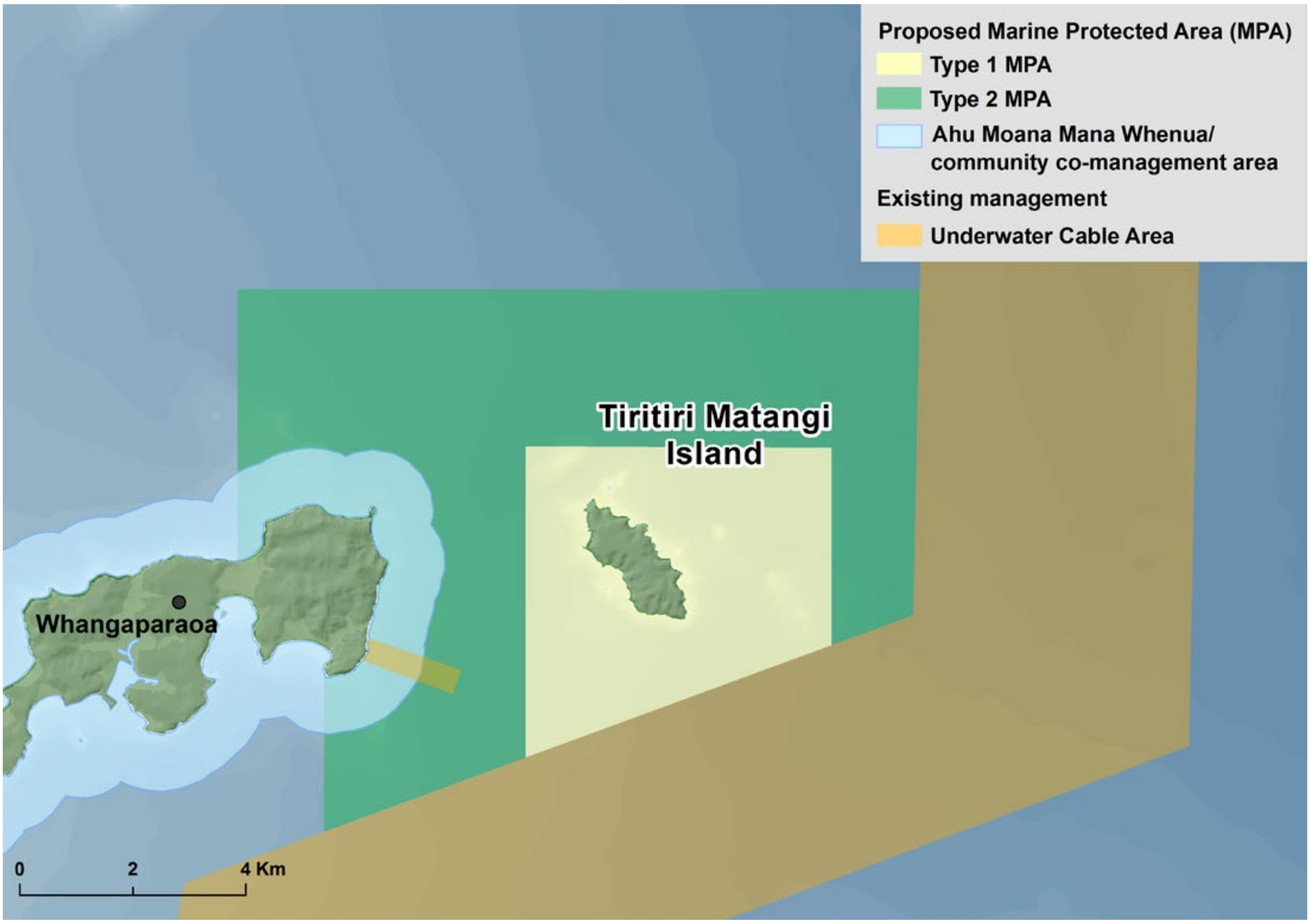
a) Type 1: no take marine reserve centered around Moturekareka and Motutara Island.

b) Type 2: protection of benthic habitats (same as scenario 1) Excludes all benthic impacting fishing methods, including scallop dredging.

11. Tiritiri Matangi

The Tiritiri Matangi and Whangaparaoa area includes a range of habitats including sheltered and exposed reefs to a high current channel. Strong water flow in the channel is associated with extensive biogenic habitats, particularly rhodolith beds. Sheltered shallow rocky reefs have large brown algae, coralline algae and large sponges. Deeper reefs are dominated by kelp and sponges. Species found in the area include dog cockles, green-lipped mussel, juvenile snapper, eagle rays, and pelagic species (e.g. kahawai, kingfish, and various shark species). Due to heavy recreational use and land-based impacts (i.e. sedimentation), the health of the area is considered degraded. Kina barrens are observed and once abundant species such as crayfish and Hapuku are rarely seen or absent. Tiritiri Matangi Wildlife Sanctuary is a highly popular tourist destination within the Hauraki Gulf Marine Park.

SCENARIO 1



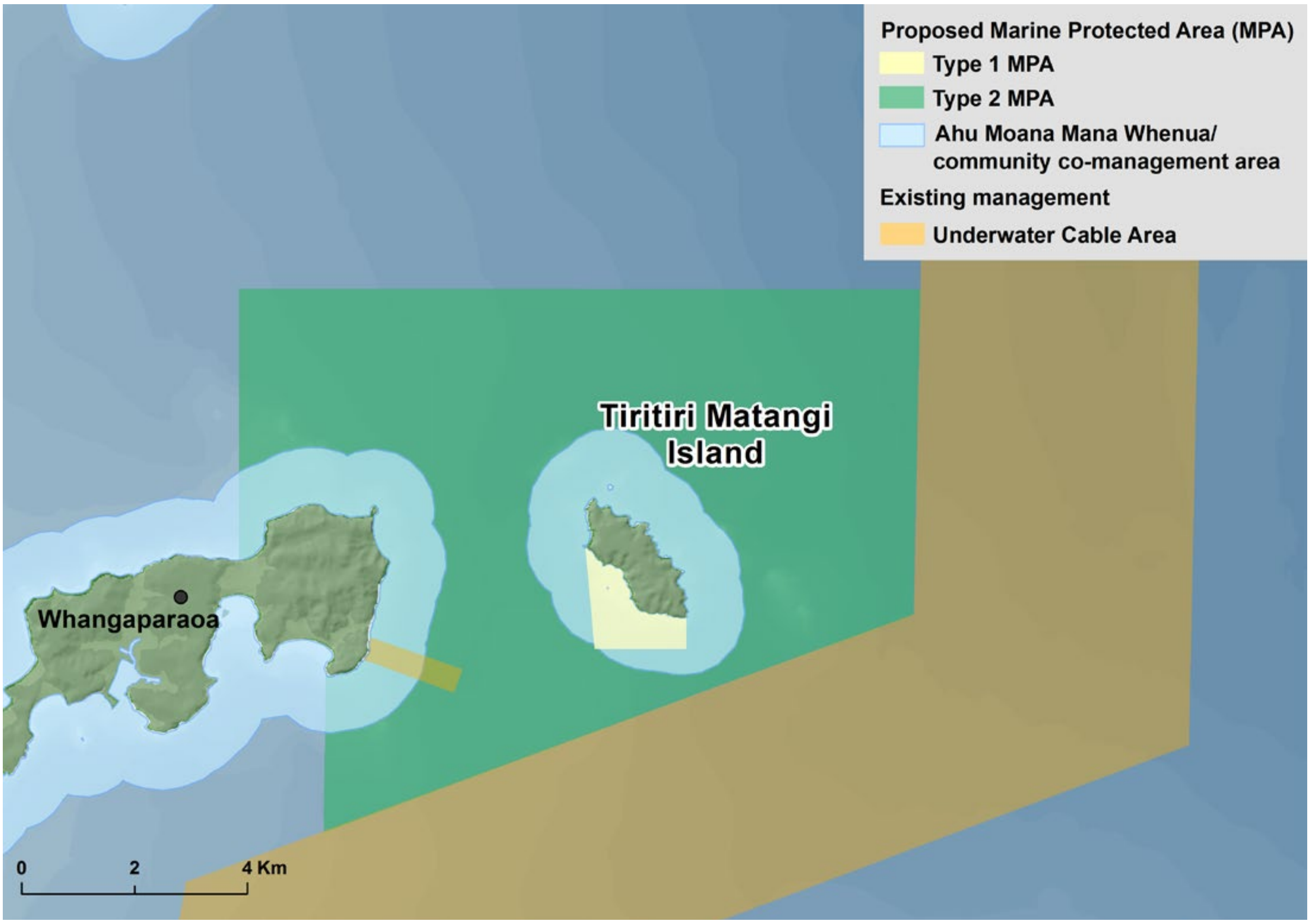
Map A3.16 Tiritiri Matangi MPAs Scenario 1

Plan elements

a) Type 1: no take marine reserve around Tiritiri Island, including Shearer Rock.

b) Type 2: protection of benthic habitats extends north from Army Bay and East and South to join the cable zone. Excludes all benthic impacting fishing methods.

SCENARIO 2



Map A3.17 Tiritiri Matangi MPAs Scenario 2

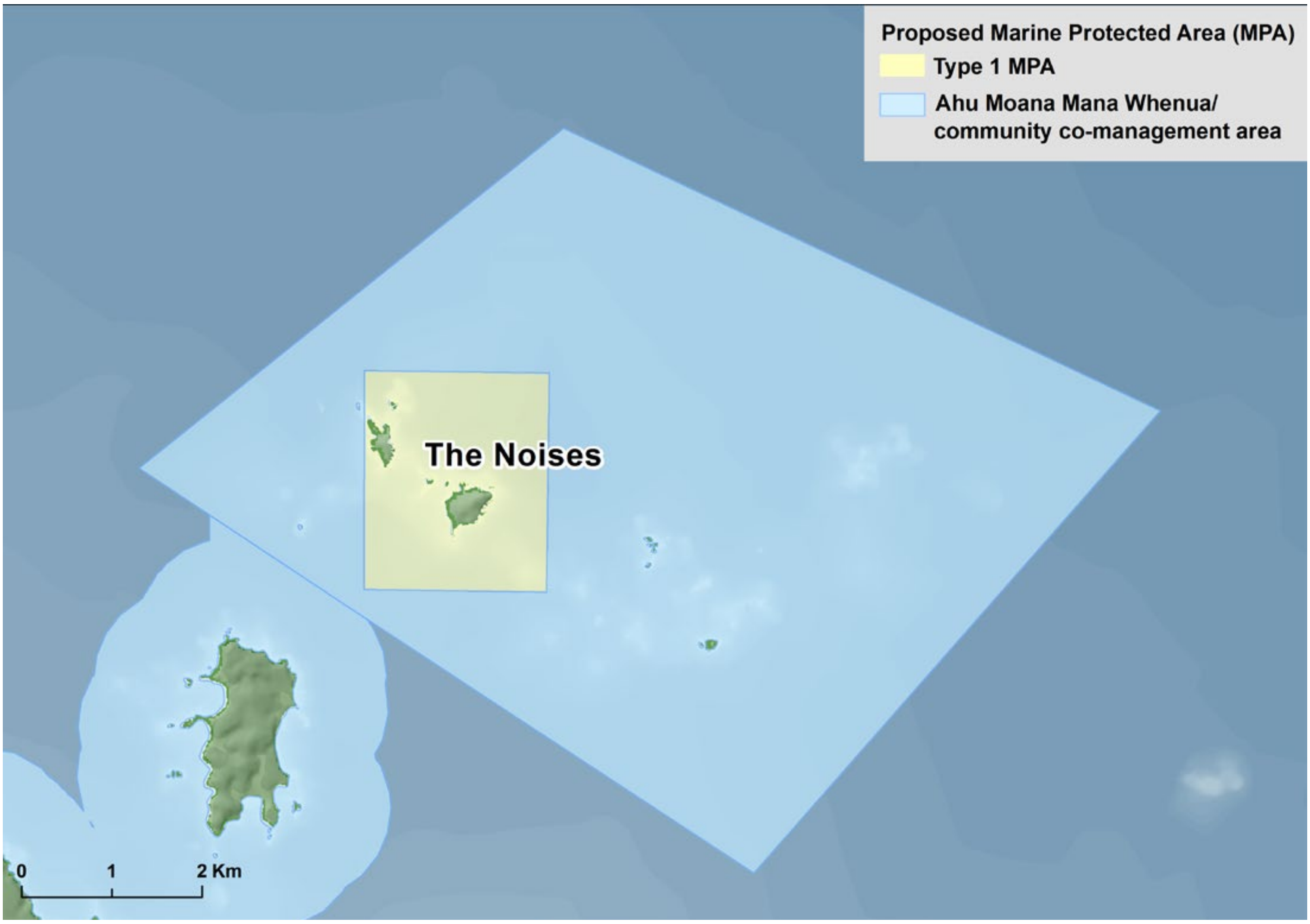
Plan elements

a) Type 1: no take marine reserve extending south from Northwest Point to southern point on Tiritiri Island.

b) Type 2: protection of benthic habitats extends north from Army Bay and East and South to join the cable zone. Excludes all benthic impacting fishing methods.

12. The Noises - Otata Motuhoropapa

The Noises are a collection of small islands surrounded by very sheltered and shallow rocky reefs, with muddy/sandy substrates found in deeper areas. Common inshore reef species are found, and biogenic habitats (particularly dog cockles and rhodoliths) growing on soft sediments provide nursery habitat for juvenile snapper and scallops. Kina barrens however appear to be prominent in the area. This areas is heavily used recreationally



Map A3.18 The Noises – Otata Motuhoropapa MPAs

Plan elements

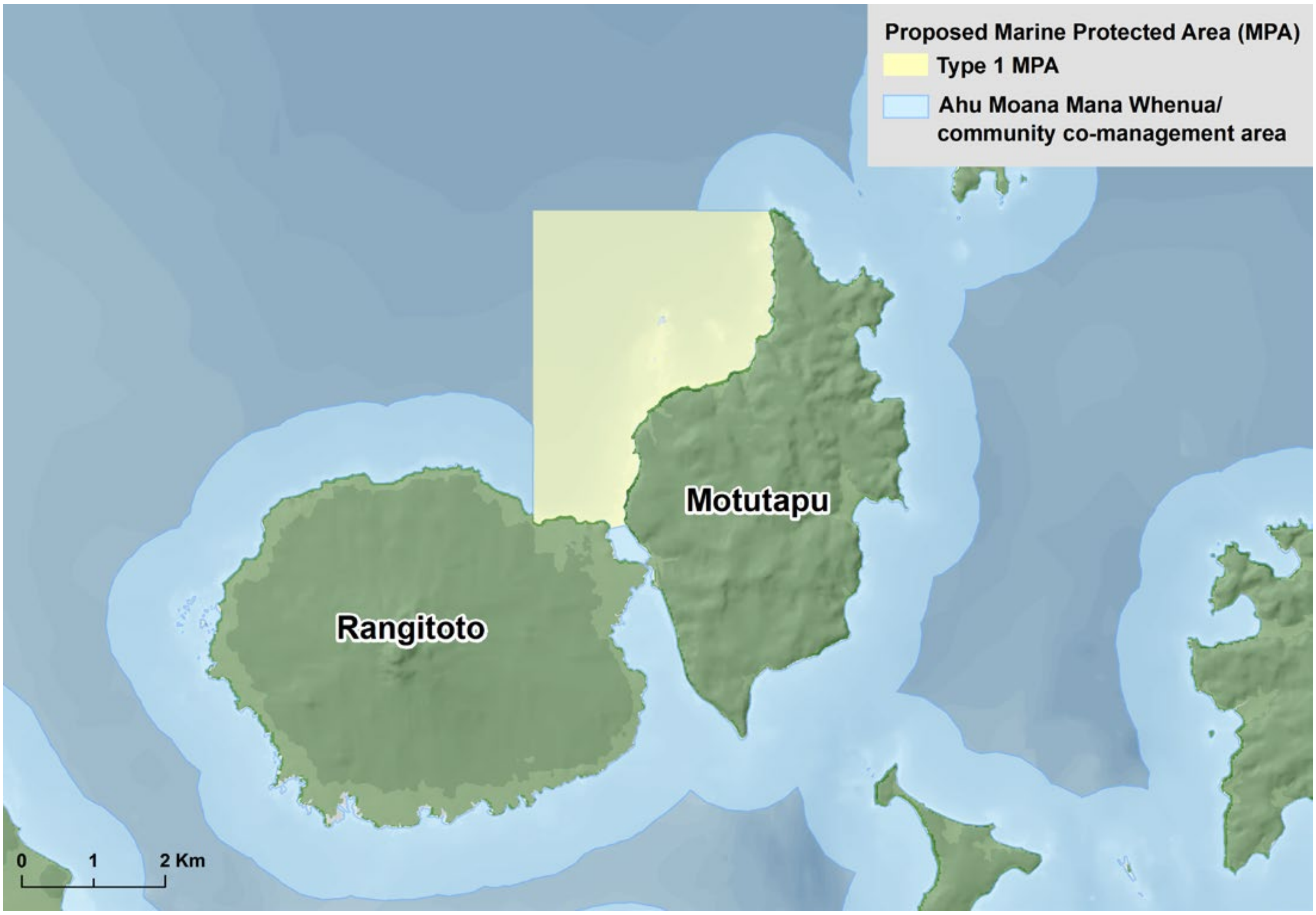
a. Type 1 no take marine reserve centered around Otata and Motuhoropapa islands.

b. Ahu Moana Mana Whenua community co-management area around the islands. Area previously envisioned as Type 2 to protect benthic habitats and provide a level of protection around the high-level protection Type 1 area. Excludes all benthic impacting fishing methods.

13. Rangitoto & Motutapu

Shallow patch reefs provide nursery habitat for juvenile snapper and kahawai. Shallow reefs are dominated by large brown algae, crustose coralline algae and sponges. Common northeast North Island coastal reef fishes are present. The area appears to be degraded and prominent kina barrens on reefs have been observed.

SCENARIO 1



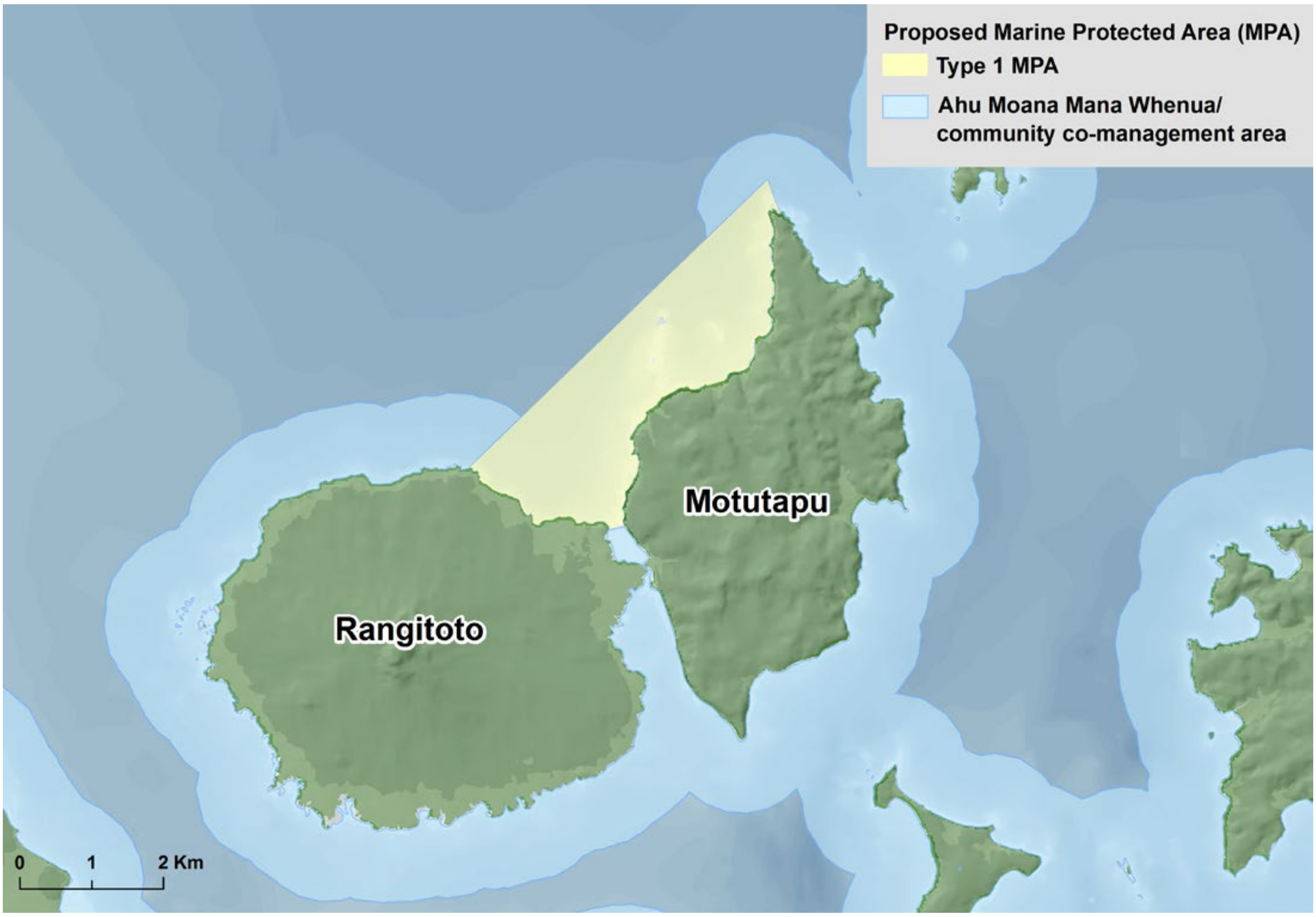
Map A3.19 Rangitoto and Motutapu MPAs Scenario 1

Plan elements

a) Type 1: no take marine reserve on northern side of Motutapu

b) Ahu Moana Mana Whenua community co-management area around Rangitoto and Motutapu

SCENARIO 2



Map A3.20 Rangitoto and Motutapu MPAs Scenario 2

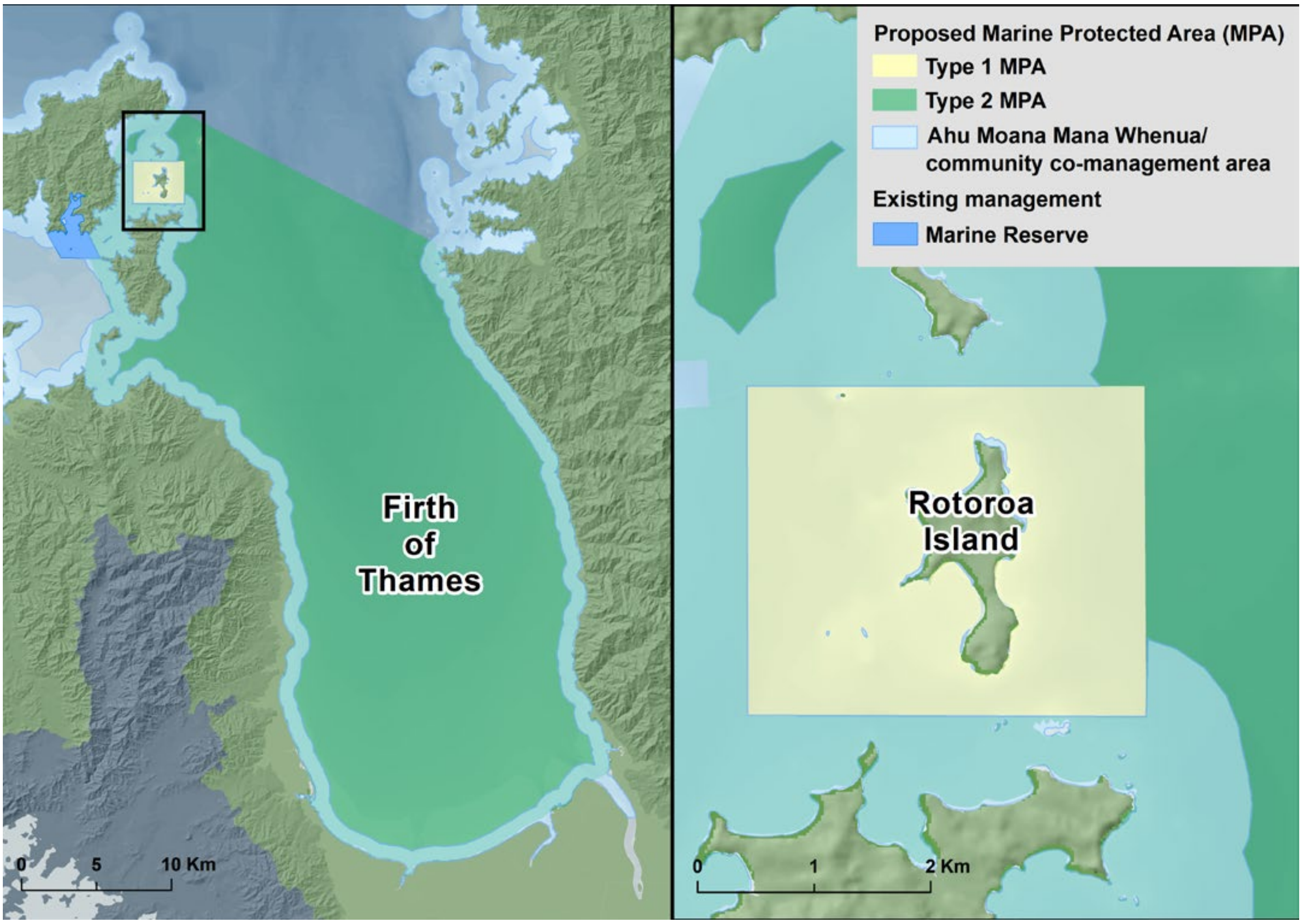
Plan elements

a) Type 1: no take marine reserve on northern side of Motutapu.

b) Ahu Moana Mana Whenua community co-management area around Rangitoto and Motutapu.

14. Firth of Thames

As a whole and within the New Zealand context, this large embayment and the extensive mussel beds once found in the area would have been quite unique. A near collapse of all hard, biogenic reefs composed of green-lipped mussels, sponges, ascidians and cnidarians brought on by heavy dredging was observed by the 1960s. There are ongoing water quality issues. The Firth of Thames is considered important for juvenile snapper and spotted dogfish (rig), and is a nationally important nursery area for smooth hammerhead shark. The southern end of the Firth is of international significance for migratory birds.



Map A3.21 Firth of Thames - Tīkapa Moana and Rotorua Island MPAs

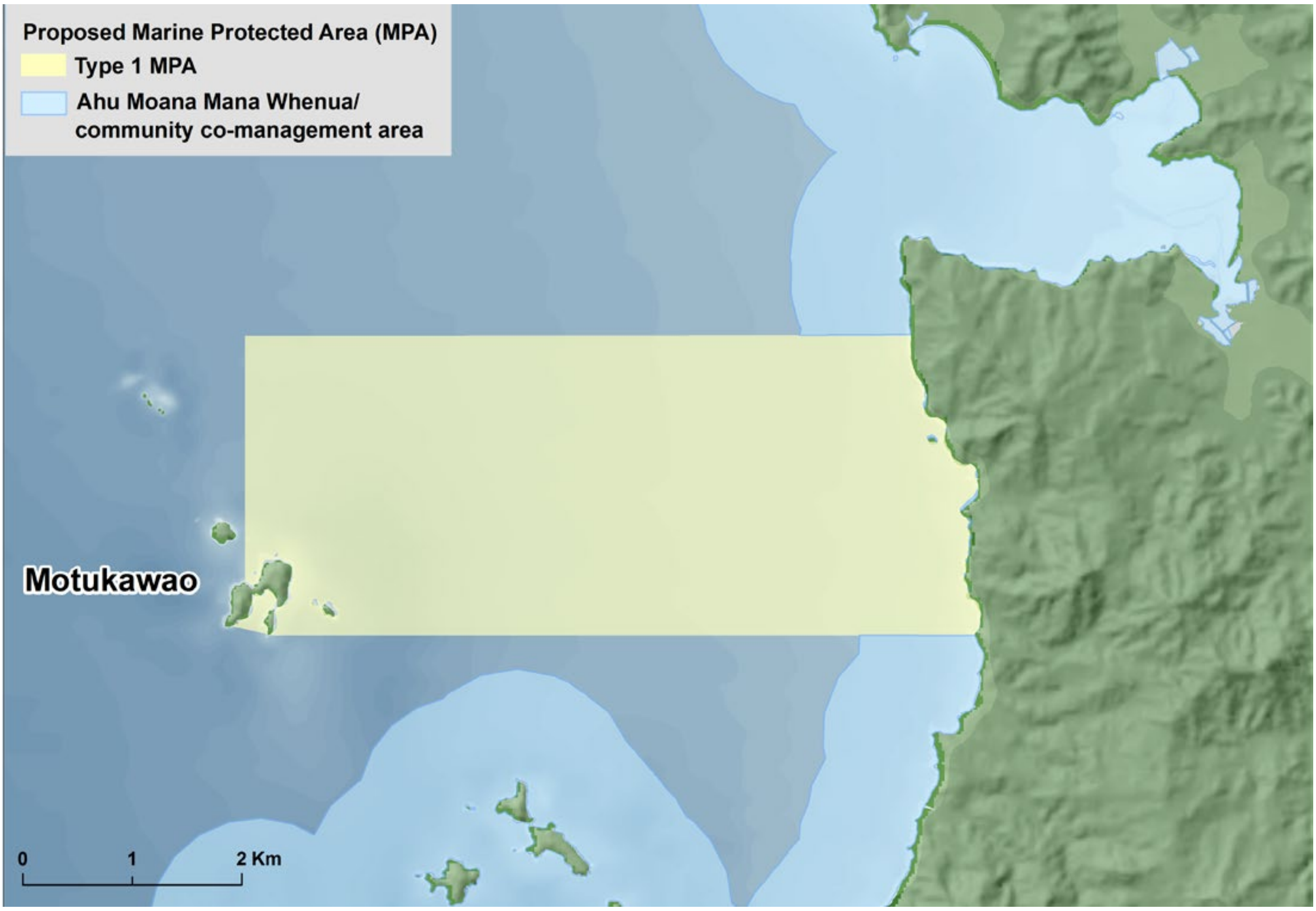
Plan elements

a) Type 1: no take marine reserve around Rotoroa Island.

b) Type 2: protection of Firth of Thames benthic environments to support regeneration efforts of historic mussel beds in the area. Excludes all benthic impacting fishing methods.

15. Motukawao Group

The Motukawao Group is formed by several islands roughly running in parallel to the western Coromandel Coast. Relatively high tidal currents and a diverse underwater topography have resulted in high biodiversity including big sponges and hydroid trees; and kelp in exposed locations. Spawning of snapper has also been recorded in the area. Historically as in most parts of the southern inner Gulf, the area would have held extensive green-lipped mussel beds. From time to time there are occasional observations of subtropical fish species, and Bryde's whales have been sighted in the area.



Map A3.22 Motukawao Group MPAs

Plan elements

a) Type 1: no take marine reserve extending offshore to include Motuwhakukewa Island and half of Motukahaua (Happy Jack) Island but excludes Motumakareta Island along west coast of the Coromandel coast.

b) Ahu Moana Mana Whenua community co-management area – 1km.

APPENDIX 4: WATER QUALITY
PIRINGA 4: ORANGA PŪMAU O TE WAI

EXPLAINING SEDIMENT OBJECTIVES

Sedimentation Rate

Why: Estuaries and coastal embayments with a sedimentation rate that is high compared to the "baseline rate" (when the catchment was naturally forested) are sediment stressed, and suffer a wide range of adverse sediment-related effects. They are also rapidly shallowing and infilling with sediments.

Aim: Limit the sedimentation rate to reduce sediment stress and related adverse effects, and to slow down infilling with sediment.

- Objective WQ1: Sedimentation rate across the Gulf to be no more than 2mm per year above the baseline rate by 2050.

Explanation:

- Sedimentation rate is the rate at which the seabed is vertically accreting, or rising, due to deposition of sediment. It is typically expressed in millimetres per year.
- < 2mm per year above the baseline rate is an ecological adverse-effects threshold.
- The baseline rate is the rate when the catchment was fully forested.
- The baseline sedimentation rate (when the catchment was fully forested) varies from location to location within any given estuary or embayment, for example, 1mm per year on exposed intertidal flats, 2 to 4mm per year in tidal creeks.
- The 30-year timeframe recognises that sedimentation changes slowly in response to changes in catchment sediment runoff, and will also allow time for yearly variation in sedimentation to average out.
- The 30-year timeframe may be aspirational, but it is appropriate to set an ambitious target. The improved monitoring will inform future goals.

Where the objective applies: The objective applies across the Gulf.

Assessing achievement: achievement can only be assessed at representative monitoring sites, which need to be selected in consultation with agencies and mana whenua. monitoring sites will cover a range of estuaries and coastal embayments, and different habitats within those systems. auckland council, waikato regional council and mana whenua need to standardise measurement methods for sedimentation rate (in consultation with other regional councils and the Ministry for the Environment). Issues to consider include natural spatial and temporal variability of sedimentation rate, determining trends from limited datasets, acquiring baseline information, accuracy and cost of different measurement methods, representativeness of monitoring sites.

How the objective will be achieved: Reducing catchment sediment runoff to the coastal marine area.

Outcome: Reduced sediment stress with corresponding healthier estuarine ecosystems. Prolonged lifespan of estuarine and coastal systems.

Seabed Muddiness

Why: The amount of mud in the seabed has a profound effect on the types of animals and plants that are able to live and thrive within the sediment. For example, the muddier the seabed, the less suitable it is for a range of shellfish and other invertebrates. Seagrass that grows on intertidal flats also prefers a less muddy seabed. With less mud in the seabed, the water also tends to be clearer.

Aim: Prevent sandy seabeds from becoming muddy, and help already-affected seabeds return to their naturally sandy state.

- Objective WQ2: Proportion of intertidal area with seabed mud content greater than 25% not to expand in all estuaries of the Hauraki Gulf Marine Park.

Explanation:

- Seabeds with a mud content of 25% support a distinctly impoverished fauna compared to sandier seabeds.

- Some parts of estuaries are naturally very muddy, but encroachment of mud over previously sandy seabeds reduces biodiversity and impacts seagrass.

Where the objective applies: All estuaries of the Hauraki Gulf.

- Objective WQ3: Seabed muddiness to be less than 10% at 95% of intertidal flats that are exposed to winds and waves by 2050.

Explanation:

- “Mud” refers to sediment particle size less than 63 microns.
- “Exposed” means exposed to winds and waves, which naturally act to keep the seabed scoured of excessive mud buildup. Exposed intertidal flats are typically sandy, but increased fine-sediment runoff from the catchment encroaches on those areas turning them from sandy to muddy..
- Seabed muddiness of 10% (that is, seabed composed of 10% mud and 90% sand) is recognised as an “ecological threshold” above which shifts in benthic community composition and functioning begin to occur.
- Sandy seabeds that are already affected by mud may be cleansed of that mud by wave action once sediment inputs from the catchment are reduced.
- The 2050 timeframe recognises that the seabed changes slowly in response to changes in catchment sediment runoff.

Where the objective applies: Intertidal flats that are exposed to winds and waves. The objective may be expanded to subtidal areas if deemed appropriate.

Where the objective does not apply: This objective does not apply where the seabed is naturally muddy. This includes tidal creeks (e.g., Henderson Creek), sheltered upper arms of estuaries (e.g., landward of Okura Township, Okura estuary), subtidal channels (e.g., entrance channel to the Central Waitemata Harbour), subtidal embayments (e.g., inner Firth of Thames).

How the objectives relate to each other: Objective WQ2 seeks to prevent further expansion of mud over currently sandy seabeds. Objective WQ3 seeks to limit the amount of mud to a specific percentage on exposed intertidal flats.

Assessing achievement: Achievement can only be assessed at representative monitoring sites, which need to be selected in consultation with agencies. Additional monitoring sites will need to be established where the existing monitoring network is too sparse to assess the achievement of this objective. This may include subtidal monitoring if deemed to be appropriate. Auckland Council and Waikato Regional Council need to determine protocols and methods for monitoring seabed muddiness. Issues to consider include cost, the merits of different measurement methods (e.g., wet sieving, laser), representativeness of sites, avoiding bias in site selection, natural spatial and temporal variability of seabed muddiness.

How the objectives will be achieved: Reducing catchment sediment runoff to the coastal marine area.

Outcome: Sandy habitats where they are meant to be, supporting seagrass and a diverse and productive benthic ecology. Clearer water.

1. **Integrated harbour and catchment management plans**

The Whangapoua Harbour and Catchment Plan (HCMP)[1] is one of 3 plans[2] prepared by Waikato Regional Council for estuaries on the Coromandel Peninsula as part of delivering on the Coromandel Zone Plan. The HCMP, which has been developed with the local community and which draws on local and scientific knowledge, lays a foundation for integrated harbour and catchment management.

The Whangapoua HCMP provides a baseline (current) assessment of the harbour and catchment. Erosion and sedimentation are recognised as key issues, with sometimes inappropriate landuse practices and declining biodiversity also being of concern. Environmental priorities are identified, and practical and realistic actions are laid out that will make a difference to the state of the harbour and catchment. Actions are divided into themes (The People, Land, Water, Coast and Harbour, Biodiversity), and at the end of each of these theme sections are many excellent suggestions on “What can you do?” Actions are designed to be undertaken over a 10-year period, with regular review of priorities. Although the plan is nonstatutory, it nevertheless has the capacity to inform and support statutory documents.

1 http://www.waikatoregion.govt.nz/PageFiles/40291/TR201503.pdf
2 One other plan is currently being prepared.

Importantly, actions are budgeted for consideration by agencies in their respective annual planning processes.

Whangapoua Harbour and Catchment Management Plan

Sea Change endorses the Whangapoua HCMP as the top priority of the HCMPs developed by Waikato Regional Council to date due to the size of the harbour, the issues it faces, the good prospects of working productively with local communities, Mana Whenua and forestry operators, and the potential for multiple benefits as the plan is executed.

Auckland Council has previously identified priority catchments through their Sustainable Catchments programme for developing integrated catchment management plans and corresponding implementation plans. The priority catchments have been identified using a number of criteria including level of community engagement, perceived ability to make a difference and urgency of threats. The programme promotes and supports a wide range of on-the-ground actions; a summary of achievements over the life of the programme to 2015 is presented on the Environment Foundation's website[3].

Auckland Council is presently developing a new programme – the Wai Ora Healthy Waterways programme – which is being designed to implement the National Policy Statement for Freshwater Management and to align council activities around water. The Auckland region is being divided into catchments based on marine receiving environments such as the Waitemata Harbour and it is anticipated that limit setting under the National Policy Statement for Freshwater Management will be based on freshwater as well as marine receiving environment objectives.

Integrated harbour and catchment plans

Sea Change endorses the concept of the integrated harbour and catchment plan as a basis for communicating with communities, identifying issues, developing actions, achieving outcomes though community engagement, and feeding into local-government planning and budgeting processes.

2. **Prioritisation of spending**

Where regional council resources are required to help bring about change, obviously not everything can be done all at once. Prioritisation of spending requires careful consideration of ability to make a difference, cost, and capability and capacity of Mana Whenua and landowners to work with council. Co-funding of research and science with industry good body's is an important way to share the cost and access the technical expertise required. This will also increase the "buy in" of industry groups and their recognition of changes required.

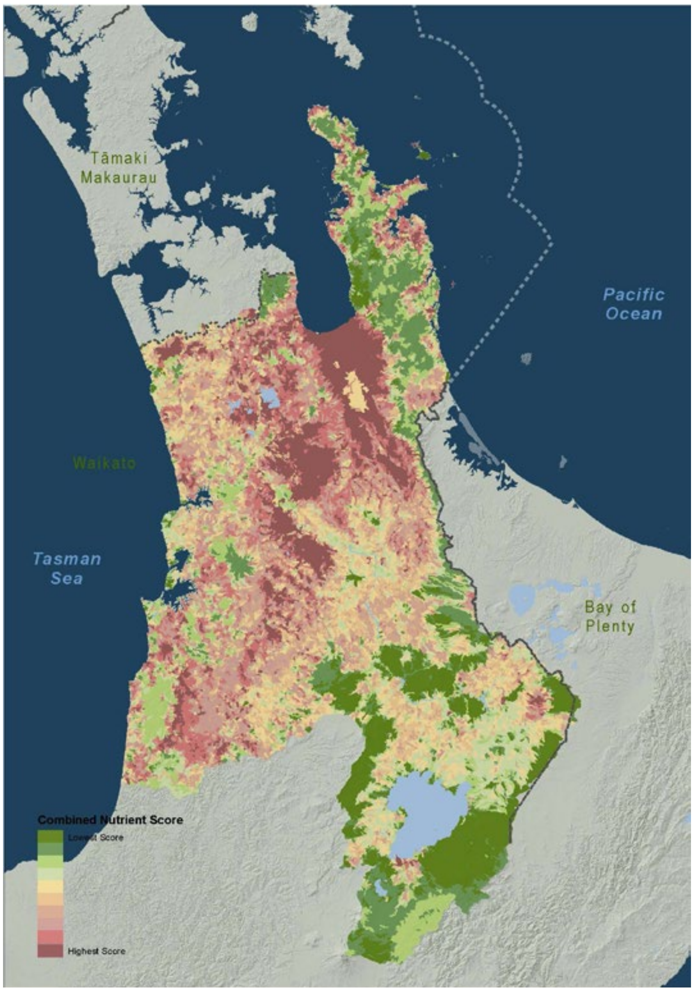
Models can be used to identify critical source areas in the catchment – areas where, for instance, sediment erosion or nutrient loss is greatest – and where these areas are connected by transport pathways to vulnerable aquatic receiving environments, they should receive priority attention. Models can also be used to estimate cost of applying mitigation, and likely improvements (reduction in sediment runoff or nutrient loss, for instance) following mitigation.

Waikato Regional Council's Regional Prioritisation Project aims to inform priorities for on-the-ground works designed to protect and enhance soil, biodiversity and water quality, which it does by identifying locations of highest risk and greatest opportunity. Spatial models are used to develop information that can be used – with other types of information, including expert knowledge of issues – to decide priorities for spending. Models used in the analysis include CLUES (sediment, nitrogen, phosphorus and E. coli generation) and SedNetNZ (sediment generation), which are linked to a number of spatial databases that describe various aspects of terrain, landcover and landuse to make predictions.

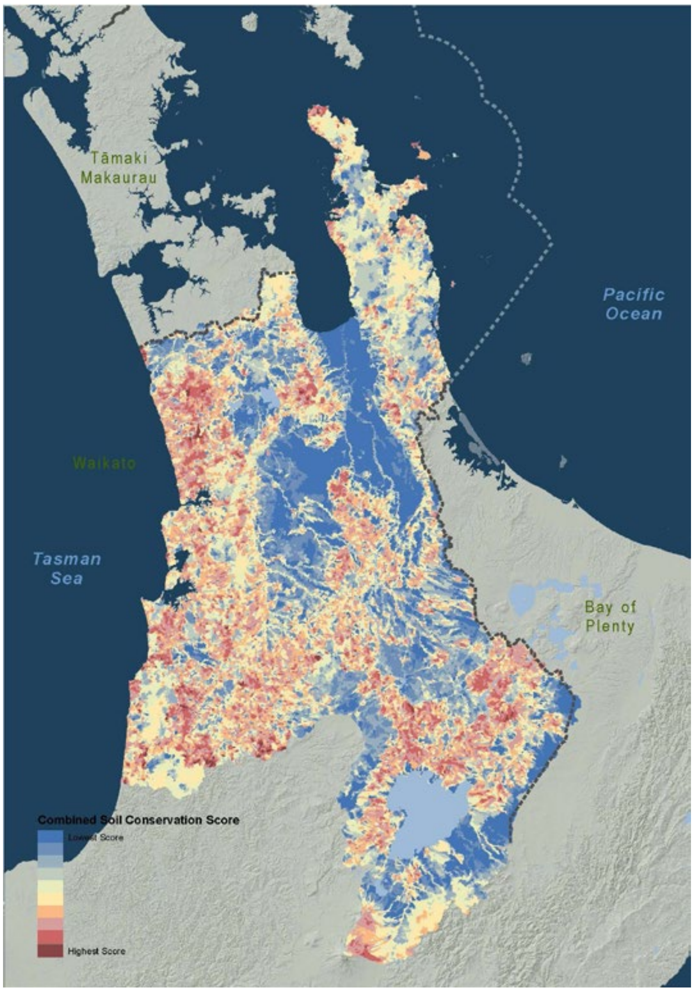
- An example of the project output is shown in the figure below, which is a spatial map of the "water quality combined score", which in turn is a weighted combination of "E. coli generation", "nitrogen generation" and "phosphorus generation" factor scores. (The weightings reflect the relative importance placed on each of the factors and are based on expert opinion.) The factor scores may be similarly mapped. The information shown in the figure potentially provides a basis for ranking the implementation of farm plans within Freshwater Management Units (defined for the purpose of implementing the National Policy Statement for Freshwater Management).

3 http://www.environmentguide.org.nz/issues/marine/catchment-based-activities/im:2133/

The “soil conservation combined score” (shown in Map A4.2) is a weighted combination of the “sediment”, “erosion”, “streambank erosion”, “vegetation protection”, “stock pressure” and “WRC works” factor scores.



Map A4.1 Combined nutrient scores



Map A4.2 Combined soil conservation scores

As before, the factor scores may be similarly mapped. Costs of sediment mitigation and associated reductions in sediment have also been estimated, with certain assumptions being made about “realistic implementation”. An annual-average reduction in sediment generation as a result of mitigation has been estimated, and this has been broken down into reduction due to hillslope soil conservation and reduction due to streambank mitigations. Factor scores, mitigation costs and sediment-reduction estimates have been used elsewhere in the Waikato Region, and could be used in the Hauraki Gulf catchments. Factor score maps were initially used to identify priority catchments for management. Mitigation and sediment-reduction estimates were used to further rank catchment work priorities and for basic cost–benefit assessment. Data gathered through these processes are ultimately intended to assist with developing priorities for inclusion in a restoration strategy, which is being done elsewhere in the Waikato using the INFFER (Investment Framework for Environmental Resources) process to assess cost–benefit assessment of potential restoration projects.

Contaminant-generation models such as those used in the Waikato Regional Prioritisation Project need to be linked to models that predict transport, dispersal, fate and effects of contaminants in the coastal marine area receiving environment. Where contaminants that originate on the land accumulate in or otherwise pass through sensitive or valuable habitats in the CMA causing adverse effects on the ecosystem, health or loss of human amenity, this information needs to be brought into any analysis of priorities for spending on mitigation in the catchment. For instance, nutrients lost to waterways in lowland areas may be more readily transported into the marine receiving environment, where they add to the nutrient burden, than nutrients lost from upland areas. In that case, even if the nutrient loss from the upland areas is greater, the lowland areas should receive priority for mitigation.

3. **Setting Sediment Load Limits**

The Resource Management Act is widely acknowledged as having provided the tools necessary for effectively managing the effects of point-source contaminants on aquatic ecosystems. However, the Act has been less successful at dealing with the effects of diffuse-source contaminants, which now are regarded as the major cause of degradation.

The central difficulty is managing the cumulative effects of diffuse-source contaminants. Cumulative effects, by definition, arise from many individual activities added together over time and throughout the catchment. To manage them requires a catchment-wide approach, which can be difficult to achieve by piecemeal granting or declining of individual applications for resource consent under the RMA which, individually, are expected to have "no more than minor" effects.

In their first report back in 2010, the Land and Water Forum established a link between cumulative effects and the need to set limits: "without limits it is hard to manage diffuse discharges… and impossible to deal with the cumulative effects on water bodies of water takes on the one hand and diffuse and direct discharges to water on the other". In response, government embarked on a programme of reforming freshwater management based on setting limits.

The National Policy Statement for Freshwater Management (NPSFM) (2014) establishes a legal and policy framework for building a national limits-based scheme for freshwater management. The Policy requires maintaining or improving overall water quality in a region, and safeguarding of the life-supporting capacity, ecosystem processes and indigenous species (including their associated ecosystems) of freshwater. Regional councils are required to have set freshwater objectives by 2030 that reflect national and local values; set flow, allocation and water quality limits to ensure freshwater objectives are achieved; address over-allocation; manage landuse and water in an integrated way; and involve iwi and hapū in freshwater decision-making. Councils and communities can choose the timeframes to meet freshwater objectives and limits.

The management process prescribed by the NPSFM centres on limiting resource use in "freshwater management units" in order to achieve specific, agreed values. The steps involved are:

- Agree on desired values, which are the intrinsic qualities that people appreciate or benefit from, or the uses to which people put freshwater. Examples are mahinga kai (Māori traditional food and other natural resources, including the places they are obtained and the practices around their acquisition) and swimming.
- Identify "attributes", which are the characteristics or properties of freshwater that have to be managed to provide for the value at hand. Examples are E. coli contamination, which is reflective of a health risk, or the concentration of nitrogen dissolved in the water, which has a bearing on aesthetics (e.g., by stimulating periphyton blooms).
- Decide on the "state" of each attribute. For instance, to provide for safe swimming, E. coli will need to be maintained at a lower level compared to providing for just wading.
- Convert the attribute states into "SMART" objectives, which are specific, measurable, achievable, realistic and time-bound.
- Formulate limits to resource use that will result in the achievement the objectives. These are of two types: limits to extraction (e.g., the amount of water taken for irrigation), and limits to disposal of contaminants (e.g., a catchment nutrient load limit).
- Develop a suite of management actions that, when implemented, will achieve the limits accordingly.

A critical element of the process is the involvement of stakeholders, which begins with agreement on values, and includes understanding the consequences of agreeing to the limits and the management actions that are needed to meet limits.

Estuaries and coastal systems are specifically excluded from consideration in the NPSFM, but they must be "given regard to" when setting limits for freshwater. This means that limits that are set to achieve freshwater objectives should also result in the achievement of objectives at the coast.

Map A4.3 Auckland Council's Consolidated Receiving Environments

In some cases, the coastal objectives may actually take precedence over the freshwater objectives. For instance, an estuary ecosystem may be far more sensitive than the streams in the surrounding catchment to sediment runoff from the land, which might mean that catchment sediment load limits are set with the estuary objectives – not the freshwater objectives – in mind.

When setting limits, it is therefore crucial that the entire system – all the streams in the catchment and the coastal receiving environment at the base of the catchment – be analysed as one unit. What we need to avoid is the situation in which limits are set separately for, say, freshwater, and then these are found later on to be lacking when the coast is eventually looked at.

Recognising this, Auckland Council has defined Consolidated Receiving Environments (CREs) for implementing the NPSFM. Each CRE is centred on an either an estuary or a part of the coast, and will be used to set objectives and limits that are fully integrated across freshwater and the coastal marine area.

4. **Integrated Wetlands**

Map A4.4 Wetland complex on the Kauaeranga River near Thames

The design shown above (designed by Boffa Miskell for Waikato Regional Council) is for a wetland complex in a bend of the Kauaeranga River, near Thames, to serve multiple purposes. This is a bold, innovative design, which potentially will deliver multiple benefits.

Areas of open water, mangroves, saltmarshes, rushes, sedges and lowland swamp forest, including kahikatea and cabbage tree, would provide habitat for a wide range of wildlife, including fish and birds. An interesting feature of the design is the mix of freshwater and saline water habitats. Public amenity is provided for in the design through a range of features, including trails, observation points, a bird hide shelter, a kayak launching ramp, and educational information. Being close to a centre of population (Thames), the wetland complex would be expected to provide a substantial point of contact and engagement with the tidal river, which is otherwise difficult due to current limited public access.

There is a very wide range of wetlands type, including bogs, fens, peatlands, marshes, lowland swamp forests, flax swamps, saltmarsh and mangroves[4]. Wetlands occur where the water table is at or near the surface of the land, or where land is permanently or temporarily inundated (by tides or floods, for example). According to DOC, in New Zealand, wetlands “support the greatest concentration of wildlife out of any other habitat[5]”. Some endangered plant species depend totally on wetlands, as do many threatened bird species. Native fish also rely on wetlands, including short-finned eels, kokopu and bullies, and the whitebait fishery depends on spawning habitat provided by wetlands. By absorbing heavy rain and releasing flood waters gradually, impacts of flooding are reduced, and groundwater levels are maintained during periods of low rainfall. Wetlands offer a wider range of recreation opportunities including boating, fishing, swimming, bird watching, whitebaiting and hunting. Wetlands have always been important to Māori, providing food, weaving material, medicines and dyes. Wetlands have also been used as places to store taonga and as access for canoes.

Wetlands have been likened to kidneys in that they clean inflowing water, and subsequently release the “polished” water on its onward journey to downstream receiving environments, including in the coastal marine area. This is achieved by stilling the flow of water, which facilitates the removal of fine sediments from the water by settling and by sticking of sediment particles to leaves and stems of plants.

4 Johnson, P. and Gerbeaux, P. 2004. Wetland Types in New Zealand. Department of Conservation, Wellington.

5 http://www.doc.govt.nz/nature/habitats/wetlands/

Plants help to oxygenate the water, and take dissolved nutrients out of the water to build plant tissue, leaving outflows relatively depleted of nutrients. Wetlands also provide the anoxic conditions and abundant supply of organic matter needed for a certain class of bacteria to perform denitrification, which results in the nitrogen bound up in nitrates being released to the atmosphere as nitrogen gas. Furthermore, since denitrification is accompanied by the oxidation of organic matter, runoff is also scrubbed of excessive organic matter. Thus, wetlands naturally mitigate nutrient enrichment of freshwater runoff, which can reduce the eutrophication risk in the coastal marine area.

It has been estimated[6] that only about 10% of the New Zealand's original wetlands remain, although with great regional variation, and some particular wetland types have been lost forever; only very few examples of others remain (for example, kahikatea swamp forest and some kinds of flax swamp and salt marsh). In the Waikato, around 15% of unmodified wetlands remain.

There is a wealth of information and expertise around restoring wetlands. For example, Wetland Restoration: A Handbook for New Zealand Freshwater Systems, is an authoritative and practical guide that brings together information from specialists and groups that are actively engaged in restoration[7]. Mana whenua have substantial experience in wetland restoration using traditional knowledge, and both Waikato Regional Council and Auckland Council provide resources on wetland restoration[8].

The design shown above for the Kauaeranga River is on land already owned by Waikato Regional Council as part of the Waihou Valley Scheme (albeit presently leased in part for stock grazing), and makes use of borrow pits within the curve of the river and inside stopbanks. The potential benefits of a scheme of this size are many and varied, including for water quality, and not the least of which is the opportunity for the relationship of Mana Whenua with the location to be strengthened and for the public to re-engage with the river.

Pastoral, exotic and native forestry land

A need exists for universal adoption of good practice for all pastoral, exotic and native forestry land, including smaller landowners. Increasing areas of land are being used for "lifestyle" purposes with owners who may have less understanding of the need for good soil husbandry, riparian management and erosion protection.

5. **Much of the Auckland Region is rural**

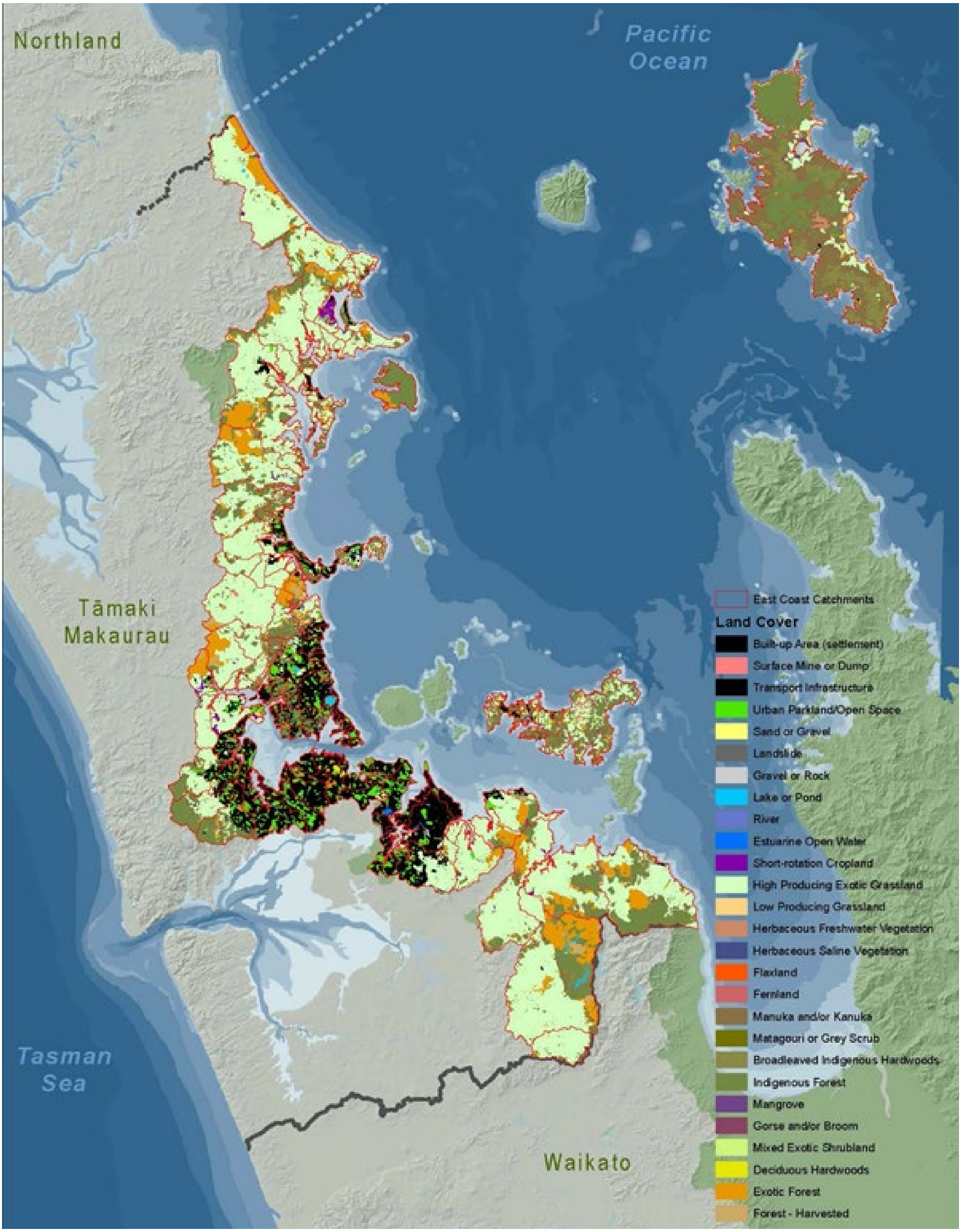
In the Auckland Region, the largest use of land that drains to the Hauraki Gulf Marine Park is "grassland" (that is, pasture) (37%). The next largest use of land is native forest.

Hence, sediment mitigations applied to pasture and improving the health of native forest in the Auckland Region stand to be effective at reducing sediment loss, even in this perceived "urban" area, to the coastal marine environment.

6 Cromarty, P. and Scott, D.A. (Eds), 1995. A Directory of Wetlands in New Zealand. Department of Conservation, Wellington. Available for download from http://www.doc.govt.nz/Documents/science-and-technical/nzwetlands00.pdf

7 Available for purchase under hardcover and as free download at http://www.landcareresearch.co.nz/publications/books/wetlands-handbook.

8 Waikato Regional Council – http://www.waikatoregion.govt.nz/Environment/Natural-resources/Water/Freshwater-wetlands/Restoring-a-wetland/Create-your-own-wetland-plan/
Auckland Council – http://www.aucklandcouncil.govt.nz/en/environmentwaste/biodiversity/pages/biodiversityonyourproperty.aspx



Map A4.5 Auckland East coast catchment landcover

6. **Chemical Flocculants**

Erosion and sediment control practices and methods[9] can be highly effective at reducing sediment loss from earthworking sites to streams and, ultimately, the coastal marine area. Nevertheless, as noted by Basher et al. (in prep.), even with a sediment removal efficiency in excess of 90%, levels of sediments in effluent and runoff discharged from construction sites can still be "markedly higher than environmental guidelines and/or background concentrations in receiving aquatic environments". Furthermore, typical practices are more effective at managing coarse particles than they are fine particles, which tend to cause a wider range of and more severe adverse effects in downstream receiving environments.

Various chemical treatments may be used to reduce sediment loss from earthworks. For example, chemical treatments are used to bind sediments at source, and they also are used to flocculate fine sediments, which enhances their capture in sediment retention ponds, thereby improving effluent quality.

Basher et al. (in prep.) reviewed the use of chemical treatment applied to enhance erosion control practices, and found that it did not significantly improve the performance of traditional physical practices such as mulching and grass seeding; furthermore, the effectiveness of chemical treatment was found to reduce with time since application. In contrast, chemical flocculation applied in retention ponds was found to significantly lower turbidity and total suspended sediment in effluent. Studies of the use of the chemical flocculant PAC[10] in New Zealand showed good performance and, very importantly, a greater difference to effluent quality discharged during larger events, when the performance of non-treated ponds is relatively poor. PAC was also found to be of benefit during winter, when the performance of untreated ponds tends to be poor. Basher et al. (in prep.) found that concentrations of residual aluminium from PAC treatment are generally, but not always, below relevant water quality guidelines.

Water-sensitive urban design

Sea Change endorses the concept of water-sensitive urban design espoused in the Proposed Auckland Unitary Plan. The principles, tools and technologies of WSD need to be used wherever possible in all municipalities that discharge into the Hauraki Gulf.

Chemical flocculants are more-or-less routinely used in sediment retention ponds on large earthworks sites in the Auckland region to increase pond efficiency at removing fine sediment from overland runoff from the site before it reaches streams and the coastal marine area.

7. **Guidelines for controlling sediment loss from earthworks sites.**

Detailed guidelines for controlling sediment runoff from earthworking sites have been produced for both the Auckland region[11]and the Waikato region[12], which are supplemented with training and education programmes for contractors, and regular newsletters to keep abreast of developments and changes in rules. Waikato Regional Council note that, since their Guidelines for Soil Disturbing Activities were published in 2009, there have been many significant changes and new innovations that are now being considered for inclusion in a revision to the Guidelines. In the meantime, WRC has updated sections of their Guidelines that deal with sediment control practices, sediment retention ponds, silt fences, hay bale barriers and decanting earth bunds as best practice has evolved. Auckland Council is also currently updating their Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Auckland Region. Auckland Council requires that earthworking be done in the driest season, that appropriate sediment retention devices be used, and that earthworks be co-ordinated with the provision of infrastructure to put in place erosion and sediment control measures. In both regions, resource consents may be required in certain situations to disturb the ground.

9 Erosion control practices seek to manage sediment generation at source; examples include the use of mulches and geotextiles to protect bare land, and stabilisation by hydroseeding. Sediment control practices, which include sediment retention ponds and silt fences, seek to manage sediments in effluent or runoff discharged from a site.

10 Polyaluminium chloride (PAC) is an aluminium-based liquid flocculant.

11 Technical Publication 90, available at http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/reports/technicalpublications/Pages/technicalpublications51-100.aspx

12 http://www.waikatoregion.govt.nz/earthworks/

DISCUSSION OF NUTRIENT OBJECTIVES ACTIONS AND PRIORITIES

Explaining Nutrient Objectives

Water-Column Nutrients

Why: High levels of dissolved nutrients in the water column can increase phytoplankton growth, resulting in blooms at certain times of the year when growing conditions are favourable. Phytoplankton is an essential component of the marine food web, but too much phytoplankton can cause problems such as discoloured and murky water, smothering of the seabed, depleted dissolved oxygen and acidification of the water. Some phytoplankton blooms can be toxic to humans.

Aim: Maintain nutrients to provide optimum phytoplankton levels.

- Objective WQ4: 80% of subtidal areas and coastal embayments with increasing trends in water-column ammonia-N, nitrate+nitrite-N, soluble reactive phosphorus and total phosphorus have the trend reversed within 15 years.

Explanation:

- High levels of nitrogen and phosphorus in different chemical forms dissolved in the water column fuel phytoplankton growth.
- Dissolved nitrogen and phosphorus are routinely monitored, and trends can be assessed from repeated measurements over time.
- Turning around (or reversing) trends that are currently increasing indicates a reduction in nutrients that can fuel phytoplankton growth.

Where the objective applies: The objective applies to coastal embayments (e.g., the Firth of Thames, Tamaki Strait) and subtidal parts of estuaries (e.g., in the middle of the Central Waitemata Harbour, around the entrance to Mahurangi Harbour).

Assessing achievement: Achievement can only be assessed at representative monitoring sites, which need to be selected in consultation with agencies. Additional monitoring sites will need to be established where the existing monitoring network is too sparse to assess the achievement of this objective. Waikato Regional Council, working from an understanding of regional issues and a review of Auckland Council's water-column nutrient monitoring programme, needs to assess the case for a monitoring programme to be able to identify trends in water-column nutrients. Issues to consider include cost, representativeness of sites, determining trends given seasonal and climate variability, and adapting monitoring to address issues that might arise in the future without compromising continuity of data.

How the objective will be achieved: Monitoring nutrient inputs to the coastal marine area and reducing where necessary.

Outcome: Phytoplankton at appropriate levels for supporting a diverse and productive marine food web.

Water-Column Chlorophyll a

Why: High levels of chlorophyll a in the water column are indicative of high levels of phytoplankton, which can result from excessive nutrients dissolved in the water, and which can cause a wide range of problems, including discoloured and murky water, smothering of the seabed, depleted dissolved oxygen and acidification of the water. Some phytoplankton blooms can be toxic to humans. Phytoplankton blooms in late spring and summer as the water warms up and the sun moves down over the southern hemisphere, exacerbating problems.

Aim: Limit phytoplankton at the height of the summer growing season.

- Objective WQ5: Within 10 years, chlorophyll a in the surface water (i.e., above the thermocline) of subtidal areas and coastal embayments does not exceed 5 mg m-3 during the summer when primary production is greatest.

Explanation:

- 5 mg m^{-3} of chlorophyll a is recognised as a threshold above which adverse effects associated with excessive primary production begin to be manifest.

Where the objective applies: The objective applies to coastal embayments (e.g., the Firth of Thames, Tamaki Strait) and subtidal parts of estuaries (e.g., in the middle of the Central Waitemata Harbour, around the entrance to Mahurangi Harbour).

The chlorophyll a threshold may be exceeded locally at some sites, for example, fish farms, which should be given special consideration and not be included in performance monitoring for this objective.

Assessing achievement: Achievement can only be assessed at representative monitoring sites, which need to be selected in consultation with agencies. Additional monitoring sites will need to be established where the existing monitoring network is too sparse to assess the achievement of this objective. Auckland Council and Waikato Regional need to determine rational and robust criteria for assessing achievement of the water-column chlorophyll a objective. Issues to consider include seasonal variation in primary production and oceanic upwelling, short-lived and infrequent exceedances, representativeness of sites, cost, and accounting for climate variability.

How the objective will be achieved: By achieving the Water-Column Nutrients Objective WQ4.

Outcome: Fewer and less extensive and prolonged phytoplankton blooms during times of the year when growing conditions are favourable.

Water-Column Dissolved Oxygen

Why: When phytoplankton levels are high due to excessive nutrients in the water column, dissolved oxygen can be reduced, which is life-threatening to marine animals, including shellfish and fish.

Aim: Ensure dissolved oxygen is maintained at a life-sustaining level.

- Objective WQ6: Within 20 years, dissolved oxygen concentration in subtidal areas and coastal embayments is no lower than 5 mg L-1.

Explanation:

- 5 mg L-1 of dissolved oxygen is internationally recognised as a "precautionary limit to avoid catastrophic mortality events, except for the most sensitive crab species, and effectively conserve marine biodiversity".

Where the objective applies: The objective applies to coastal embayments (e.g., the Firth of Thames, Tamaki Strait) and subtidal parts of estuaries (e.g., in the middle of the Central Waitemata Harbour, around the entrance to Mahurangi Harbour).

The dissolved-oxygen threshold may be failed locally at some sites, for example, fish farms, which should be given special consideration and not be included in performance monitoring for this objective.

Assessing achievement: Achievement can only be assessed at representative monitoring sites, which need to be selected in consultation with agencies. Additional monitoring sites will need to be established where the existing monitoring network is too sparse to assess the achievement of this objective. Auckland Council and Waikato Regional Council need to determine rational and robust criteria for assessing achievement of the water-column dissolved oxygen objective. Issues to consider include seasonal variation in primary production and upwelling, short-lived and infrequent exceedances, representativeness of sites, cost, and accounting for climate variability (e.g., ENSO cycles).

How the objective will be achieved: By achieving the Water-Column Nutrients Objective WQ4 and the Water-Column Chlorophyll a Objective WQ5.

Outcome: Water-column dissolved oxygen at all times of the year that is protective of marine life.

1. **Firth of Thames**

The Firth of Thames is central to the identity of Hauraki Mana Whenua. It contains important customary, commercial and recreational fisheries, includes a globally significant RAMSAR site, and is an aquaculture focus area. At the same time, the Firth ecosystem has been profoundly changed by green-lipped mussel dredging that ceased 50 years ago, and it is presently stressed by excessive nutrients and sediments.

The Firth is an example of a coastal embayment that has features that enhance susceptibility to eutrophication. It has a long residence time compared to the growth cycle of phytoplankton, and the upper water column is typically clear, which means primary production is not light limited. Furthermore, the water column becomes (thermally) stratified in the autumn, which enhances the depletion of oxygen from the water column caused by rotting organic matter at the end of the growth season. The problem is exacerbated in the lower water column below the thermocline, where contact with the atmosphere is shut off, which prevents re-aeration of the water.

A recent assessment has concluded that dissolved nitrogen and the proportion of small phytoplankton have increased in the outer Firth over the past 20 years, although they have been stable or slightly decreasing over the last 13 years of that 20 year period. Nitrogen from the land is one possible factor responsible for the higher phytoplankton levels. Other factors are oceanic sources of nitrogen and physical processes such as mixing and water-column stratification that enhance phytoplankton production through effects on nutrient and light availability. The available data show that the Firth of Thames is generally well oxygenated, but there are seasonal (autumnal) low-oxygen (60–70% saturation) events in the bottom waters in some parts of the Firth. Although there is no evidence that oxygen depletion has increased under the higher nitrogen and phytoplankton burdens, it is nevertheless prudent to manage nutrients to prevent it worsening in the future.

While total nitrogen loads in rivers draining to the Firth of Thames are significantly higher than in pre human times, they have been stable or increased only slowly for the past 20 years (Vant 2011).

DISCUSSION OF HEAVY METALS OBJECTIVES, ACTIONS AND PRIORITIES

Explaining Heavy Metals Objectives

Seabed Heavy Metals

Why: Heavy metals (primarily zinc, copper and lead) can build up in seabed sediments and become toxic to seabed-dwelling animals (shellfish, worms and crabs).

Aim: Limit the buildup of heavy metals in seabed sediments.

- Objective WQ7: 95% of intertidal and subtidal seabed with an increasing trend in heavy metals have trend arrested within 15 years.
- Objective WQ8: 95% of intertidal and subtidal seabed with heavy-metal concentration above threshold effects level (TEL) have concentration below the TEL within 30 years, and 95% of intertidal and subtidal seabed with heavy-metal concentration above probable effects level (PEL) have concentration below the PEL within 30 years.
- Objective WQ9: All intertidal and subtidal seabed with heavy-metal concentration below the threshold effects level (TEL) remain below the TEL.

Explanation:

Heavy metals in seabed sediments are routinely monitored, and trends can be assessed from repeated measurements over time.

“Arresting” an increasing trend means flattening or reversing the increase.

The 15-year timeframe recognises that seabed heavy-metal concentrations change slowly in response to changes in heavy metals from the catchment.

Explanation:

Seabed heavy-metal concentrations above the TEL and PEL pose a threat to seabed animals.

Where the objectives apply: The objectives apply to both intertidal and subtidal seabed.

How the objectives relate to each other: Objective WQ7 seeks to arrest increasing trends in seabed heavy metals within 15 years. Objective WQ8 seeks to reduce seabed heavy metals to specific levels within 30 years, and objective WQ9 seeks to prevent sites currently below the TEL exceeding that level.

Assessing achievement: Achievement can only be assessed at representative monitoring sites, which need to be selected in consultation with agencies. Waikato Regional Council, working from an understanding of regional issues and a review of Auckland Council’s seabed heavy-metal monitoring programme, needs to assess the case for expanding their regional monitoring of heavy metals to be able to identify trends and to be alert to exceedance of guideline concentrations. Issues to consider include cost and representativeness of sites. Additional monitoring sites in both regions will need to be established where the existing monitoring network is too sparse to assess the achievement of this objective. Additional monitoring sites may be established for assessing achievement of this objective in order to protect special values or particular locations, including locations that will be vulnerable to heavy-metal runoff from areas in the catchment designated for future urbanisation.

How the objectives will be achieved: Reducing heavy metals in urban stormwater runoff; reducing discharges such as antifouling contaminants from ports and marinas; reducing stormwater discharges directly into the coastal marine area.

Outcome: Seabed habitat that is not compromised by excessive levels of heavy metals.

Benthic Ecological Health

Why: Animals that live in and on the seabed (shellfish, crabs, worms and so on) underpin the proper functioning of the wider estuarine and marine ecosystems and the benefits derived from those ecosystems by people.

Aim: Maintain and improve the health and functioning of the seabed – or "benthic" – fauna.

- Objective WQ10: No decline in benthic ecological health from present day and improvement in benthic ecological health at 25% of monitoring sites within 15 years.

Explanation:

"Benthic ecological health" is assessed from measurements of seabed fauna. Assessments focus on species abundance and diversity, and the resilience of benthic communities to withstand disturbances such as excessive sediments and heavy metals. There are different indicators or metrics available for assessing benthic ecological health from monitoring data; some apply to intertidal flats only, others are more generally applicable.

Good benthic ecological health means that things are right with the habitat and that stressor levels (e.g., sediments, heavy metals) are low.

Conversely, a poor or declining benthic ecological health signifies that something is going wrong, for example, buildup of heavy metals in the seabed.

Any assessment of change (for example, a decline in benthic ecological health in a given monitoring year), will need to be judged against natural variability, which cannot be managed.

Where the objective applies: The objective applies to both intertidal and subtidal areas.

Assessing achievement: Achievement can only be assessed at representative monitoring sites, which need to be selected in consultation with agencies. Additional monitoring sites will need to be established where the existing monitoring network is too sparse to assess the achievement of this objective. Auckland Regional Council and Waikato Regional Council need to agree on metrics and indicators for assessing benthic ecological health in intertidal and subtidal habitats, and develop methods for assessing natural variability against which change can be assessed.

How the objective will be achieved: (1) Protecting seabed habitats from loss and physical disturbance. (2) Reducing sediment and heavy-metal runoff to the coastal marine area. (3) Achieving the Sedimentation Rate Objective WQ1, the Seabed Muddiness Objectives WQ2 and WQ3, and the Seabed Heavy Metals Objectives WQ7, WQ8 and WQ9.

Outcome: Abundant and diverse seabed fauna supported by appropriate habitat, underpinning the functioning of the wider estuarine and marine ecosystems and providing a range of benefits to people.

1. Benthic ecological health

Animals that live in and on the seabed (shellfish, crabs, worms and so on) underpin the proper functioning of the wider estuary and marine ecosystems and the benefits derived from those ecosystems by people. "Benthic ecological health" is assessed from routine measurements of seabed fauna. Assessments focus on species abundance and diversity, and the resilience of benthic communities to withstand disturbances such as excessive sediments and heavy metals. There are different indicators or metrics available for assessing benthic ecological health from monitoring data; some apply to intertidal flats only, others are more generally applicable.

Good benthic ecological health means that things are right with the habitat and that stressor levels (e.g., sediments, heavy metals) are low. Conversely, a poor or declining benthic ecological health signifies that something is going wrong, for example, buildup of heavy metals in the seabed.

Auckland Council assesses the benthic ecological health grade from seabed monitoring data. The grade combines information on seabed mud content and metal concentration and the types and abundances of animals in the seabed. Sites are scored from 1 (healthy) to 5 (unhealthy). In 2015, all harbours and estuaries had monitoring sites that were scored as only moderately healthy and most had sites scored as unhealthy. Most sites near the older urban centres scored as unhealthy (scores of 4 to 5), particularly within the Waitemata Harbour and Tamaki Inlet, where the issue is elevated concentrations of at least one heavy metal.

However, sites further away from urban Auckland were also rated as unhealthy, which was attributed to sediment runoff from rural land.

2. **Urban water design**

The Proposed Auckland Unitary Plan intends moving away from a focus on infrastructure and end-of-pipe management and towards an integrated approach to management of landuse and stormwater discharges, including emphasis on water-sensitive design (WSD), all intended to result in achievement of a wide range of environmental outcomes.

Provisions in the Unitary Plan designed to achieve a more integrated approach to land development and stormwater management include:

- overarching objectives and policies in respect of integrated management, WSD, water quality/flow, freshwater systems and hazards;
- controls on development, landuse and discharges for water quality, hydrology and flooding;
- controls on subdivision, including the application of WSD, management of development within flood hazard areas and water quality/quantity; stormwater management requirements for integrated planning processes such as structure plans, and within-precinct plans

Water-sensitive design is central to minimising the adverse effects of stormwater runoff on freshwater and coastal ecosystems. To achieve this, WSD seeks to, amongst other things: minimise impervious area on individual sites by site design, clustering of houses, use of pervious paving and provision of open or vegetated spaces; minimise the generation of contaminants, including by the use of building materials that have a low contaminant yield; and mitigating stormwater contaminants and runoff at or close to source.

Retention ponds

Sea Change endorses the use of innovative technologies to improve the performance of wastewater treatment plants, and encourages small- and medium-sized communities to seriously consider new technologies when existing WWTPs are due for upgrade or re-consenting.

3. **Boat Anti-Fouling**

Boat anti-fouling paints contain toxic substances – typically copper – that slowly leach out into the water over time, killing organisms that attempt to attach to the boat. A recent NIWA study found that antifouling paint is primarily responsible for copper accumulation in sediments around marinas at concentrations that are above the guidelines for protection of marine life. Furthermore, as much copper is exported from the four marinas in the Waitemata Harbour as from inputs of stormwater from the entire catchment of the Waitemata Harbour. Alternatives to copper-based antifouling paints do exist. For instance, Rentunder Drive-in BoatwashTM scrubs off fouling using brushes applied to the boat while it is contained in a pen, which contains all of the debris. Other innovations include ultrasonic cleaning systems, and coating hulls with materials that mimic the skin of sharks.

DISCUSSION OF MICROBIAL PATHOGENS OBJECTIVES, ACTIONS AND PRIORITIES

Explaining Microbial Pathogen Objectives

Enterococci

Why: Microbial pathogens (bacteria, viruses, protozoa) in human and animal faeces are capable of causing illness and disease in humans that swim in polluted water.

Aim: Provide safe swimming for people.

- Objective WQ11: All popular swimming spots in the Hauraki Gulf to be in Microbial Assessment Category A by 2030.

Explanation:

- Enterococci are bacteria that are an indicator of faecal contamination. They are generally not harmful themselves, but they indicate the possible presence of pathogenic bacteria, viruses and protozoans that are associated with human and animal faeces.
- Microbial Assessment Category A is designated when the Hazen 95-percentile of the previous 5 years of monitoring data is ≤40 enterococci per 100mL of water (MfE, 2003[13]). This is the highest level of water quality for bathing.

Where the objective applies: The objective applies to all popular swimming spots in the Hauraki Gulf.

Assessing achievement: Waikato Regional Council, working from an understanding of regional issues, needs to assess the case for a beach-monitoring programme to be able to assess and report swimming safety. Issues to consider include cost and representativeness of sites.

How the objective will be achieved: Different actions depending on source of contamination, for instance, reducing wastewater overflows and eliminating stormwater cross-connections, maintaining septic tanks, excluding stock from streams, controlling discharges from boats.

Outcome: Safe and enjoyable swimming experience at all popular swimming spots in the Hauraki Gulf.

13 Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas, MfE 2003, http://www.mfe.govt.nz/publications/fresh-water/microbiological-water-quality-guidelines-marine-and-freshwater-recreatio-13#twod4

1. **Innovative technologies for municipal wastewater treatment.**

For many decades, oxidation ponds have been used to treat wastewater in most small and medium-sized communities. The conventional ponds work well at removing suspended solids and reducing biochemical oxygen demand. They are cost effective and require little maintenance. However, when it comes to removing pathogens and nutrients, they are highly inconsistent[14]. As an alternative to a costly upgrade to a mechanical system, it now possible to upgrade conventional systems with an Enhanced Pond System (EPS), which uses natural physical, chemical and microbiological process to treat wastewater more effectively and cost-efficiently[15]. The EPS consists of a series of ponds that work together: covered anaerobic ponds, high rate algal ponds, algal harvest ponds, a covered digester pond, maturation ponds and rock filters.

EPS provide significant benefits and advantages compared to traditional pond systems, including improved natural disinfection and nutrient removal, with nutrients being recoverable in the form of algal biomass, which in turn may be used for fertiliser, feed or biofuel feedstock; recovery of wastewater energy (by anaerobic digestion of wastewater solids and harvested algae) as biogas; the ability to reuse the treated effluent; and reduction in greenhouse gas emissions. In addition, EPS take up about the same amount of land area, virtually eliminate sludge disposal, and produce less odour.

NIWA is currently collaborating with Waipa District Council to demonstrate, over a three-year period, the use and benefits of a full-scale EPS at the Cambridge Wastewater Treatment Plant[16].

14 https://www.niwa.co.nz/freshwater-and-estuaries/freshwater-and-estuaries-update/freshwater-update-62-september-2014/niwa-advances-wastewater-treatment

15 NIWA estimates capital costs of EPS to be only a quarter those of electromechanical treatment systems removing both BOD5 and nutrients, while operating costs of EPS are less than half.

16 Craggs, R., Park, J., Sutherland, D. and Heubeck, S., 2015. Economic construction and operation of hectare-scale wastewater treatment enhanced pond systems. Journal of Applied Phycology, 27: 1913–1922.

A key component of the system is the two 1-hectare high rate algal ponds, augmented with carbon dioxide addition during the day to promote algal growth when it is often carbon-limited[17]. The high rate algal ponds aerobically treat and remove nutrients from the anaerobic pond effluent through the production of algal biomass, and algal harvest ponds settle and concentrate the algal biomass which is then pumped into a covered digester pond to recover energy as biogas and nutrients as a concentrated digestate.

Further effluent polishing is provided by maturation ponds and rock filters. With the enhanced pond system, the WWTP is expected to exceed current performance and meet future consent conditions. Actual performance will be verified during the demonstration period, and will vary seasonally.

The main objectives of the Cambridge project are to showcase the technology by demonstrating efficiency and consent compliance; algal production and harvest; biogas production; and the use of algal digestate as a soil fertiliser. The expected benefits are many: cost savings (capital and operating); reduced environmental impact; and future cultural benefits, including a final habitat pond providing habitat and a nursery for native fish (e.g., eels, bullies, whitebait) and invertebrates (e.g., koura).

On-site wastewater treatment systems

Sea Change recognises that there is a strong need for ongoing proactive planning to manage the key risk areas associated with proper design, maintenance and operation of on-site wastewater treatment systems. Councils need a system to ensure good maintaenance of septic tanks; either a requirement for a regular pump out and compliance inspections, or incorporating it in the rates and the council doing it.

17 Craggs, R., Park, J., Heubeck, S. and Sutherland, D., 2014. High rate algal pond systems for low-energy wastewater treatment, nutrient recovery and energy production. New Zealand Journal of Botany, 52(1): 60–73.

2. **Use of habitat wetlands in municipal wastewater treatment.**

A project between Ngāti Koroki Kahukura, Ngāti Haua, Raukawa, Waikato Tainui, Waipa District Council and NIWA seeks to showcase a more culturally appropriate treatment of wastewater using habitat wetlands[18]. A demonstration habitat wetland is being developed at the Cambridge WWTP, being installed as the final stage of the Enhanced Pond System.

The habitat wetland will further cleanse effluent by contact with the land, and will provide habitat for native plants, fish and invertebrates, some which could have economic value.

3. **On-site wastewater treatment systems.**

On-site wastewater treatment systems, which are typically used on properties in rural or coastal areas which are not serviced by sewerage systems, are used for the treatment of domestic wastewater, which includes water from the toilet, bathroom, kitchen and laundry[19].

There are two parts to the systems: treatment and disposal. Treatment is primary (for example, by septic tanks) and secondary (for example, by aerated wastewater treatment systems). Treated wastewater is discharged to land, where physical filtering, chemical reactions and biological processes in the soil provide further treatment and removal of contaminants. In addition, plants growing in the disposal field take up water and nutrients. The disposal field needs to be properly sized so that it does not become overloaded, and there must be the means for distributing wastewater evenly over the field. In addition, the disposal field must meet minimum separation distances from surface water, drains and property boundaries.

Under-designed, faulty and poorly maintained on-site wastewater treatment and disposal systems can pollute groundwater and streams – and eventually the coastal marine area – with nitrogen and phosphorus, and create public health risks due to escape of pathogenic microbes.

Rules in the regional plan are the main vehicle for managing on-site wastewater discharges.

18 Funded by the Waikato River Authority. For more information, go to http://makearipple.co.nz/Action-groups/ripples/Habitat-wetland-wastewater-treatment/

19 http://www.aucklandcouncil.govt.nz/EN/ratesbuildingproperty/consents/buildingstructures/Documents/onsitewastewatermanagementintro.pdf

In the Auckland region, a building consent is required to install or alter a septic tank or other on-site wastewater management system. A resource consent may also be needed for discharging the treated wastewater onto or into the land. Resource consents are typically issued for periods of 10 to 15 years, and will have conditions which must be complied with, including limits to the volume of wastewater discharged each day and standards for quality of the wastewater. The latter may include total suspended solids, biochemical oxygen demand and faecal coliforms. Typically, council officers will monitor compliance every five years, and there is a charge for this monitoring.

The Waikato Regional Plan has permitted activity rules for existing on-site wastewater discharges, new septic tank systems and new improved systems with secondary treatment. The conditions that must be satisfied relate to a number of design considerations, discharge volume, and discharge quality.

A review by Trebilco et al. (2012)[20] concluded that Waikato's permitted-activity conditions are "at least as rigorous as most other regions, and which adequately manage the effects of on-site wastewater discharges". Nonetheless, they also identified some conditions that may not be stringent enough, and recommended that some review was required. Trebilco et al. (2012) noted that "The single biggest outstanding issue with on-site systems is wide-spread lack of maintenance. Few councils in New Zealand have monitoring programmes in place. It is suggested that where adverse effects do occur from on-site systems, lack of maintenance is generally the primary cause (assuming of course that the system was correctly installed in the first place).

Lack of maintenance has been the message conveyed by the on-site industry in recent conferences in NZ and Australia, and is nearly always a central theme in studies about management of on-site systems". Furthermore, they noted "it is evident that the risk of adverse effects increases as on-site systems become more numerous and older.

20 http://www.waikatoregion.govt.nz/PageFiles/23921/TR201209.pdf

Sea Change recognises that there is a strong need for ongoing proactive planning to manage the key risk areas associated with proper design, maintenance and operation of on-site wastewater treatment systems. Councils need a system to ensure good maintaenance of septic tanks; either a requirement for a regular pump out and compliance inspections, or incorporating it in the rates and the council doing it.

4. **Discharge of sewage from vessels.**

The Proposed Auckland Unitary Plan (PAUP) recognises that the direct discharge of untreated human sewage from vessels reduces water quality and can have localised adverse effects on the values and uses of coastal waters. Sewage discharge is culturally offensive to Māori, who value the coastal marine area as taonga, and who recognise that the degradation of water quality as a result of sewage discharge adversely affects the Mauri or life force of the water. Furthermore, there is a wide range of potential adverse effects on food gathering, swimming, tourism and aquaculture. The PAUP recognises that boats can be a problem in this regard, especially where they congregate in anchorage areas with poor tidal circulation and limited capacity to flush contaminants, and seeks to safeguard activities in coastal waters from the effects of untreated sewage discharge from vessels.

Three policies are proposed in the PAUP to give effect to two objectives relating to protecting the values of the coastal marine area and activities that rely on high water quality, and maintaining recreational and amenity values of the Inner Hauraki Gulf:

1. Avoid the discharge of untreated sewage from vessels within areas that have been identified as inappropriate due to the proximity to shore, marine farms, marine reserves, or shallow water depth while providing for the health and safety of vessels and their occupants.
2. Require provision of sewage collection and disposal facilities for vessels at ports, marinas and other allied facilities, or at the time of significant upgrading of these facilities (3) Promote the installation of public toilet facilities at high use boat ramps and boating destinations, at construction, or during significant upgrades of such facilities.

In the rules, standard F2.21.8.2 establishes that the discharge of untreated sewage from a vessel or offshore installation will be permitted only where it complies with the following:

1. The discharge must be in water depths greater than 5m.
2. The discharge must be more than 500m (0.27 nautical miles) from mean high water springs.
3. The discharge must be more than 500 m (0.27 nautical miles) from an aquaculture activity.
4. The discharge must be more than 500 m (0.27 nautical miles) from a mātaitai reserve.
5. The discharge must be more than 200 m (0.108 nautical miles) from a marine reserve.
6. Notwithstanding F2.21.8.2 (1) to (5) the discharge must not be inside two headlands (point to point) of the following specific locations:
    a) Waitemata Harbour from North Head to Orakei Wharf;
    b) Mahurangi Harbour from Pudding Island to Sadler Point;
    c) Bostaquet Bay Kawau Island, from Brownrigg Point to Challenger Island;
    d) Port Fitzroy Great Barrier Island, inside Paget rock in Man O War Passage to a line between the NE tip of Kaikoura Island and Kotutu point;
    e) Nagle Cove Great Barrier Island from Tortoise Head and Wood island; or
    f) Tryphena Harbour Great Barrier Island from Tryphena Point to Bird Islet.
7. Notwithstanding in harbours, bays and embayments listed in F2.21.8.2(6), during rough weather conditions when wind conditions at the mouth of the harbour, bay or embayment exceed 15-18 knots untreated sewage may be discharged as necessary for health and safety reasons.

These rules correspond to the Resource Management (Marine Pollution) Regulations (1998) with an additional restriction on discharges in the bays and harbours listed in point (6). When it was notified, the Plan included a limit of 2 km from the shoreline. However, the submissions and hearing process raised several issues with that approach. There were legal challenges to the ability of a council to introduce a region-wide distance increase. Submitters also questioned the workability of the rules because it is difficult to identify instances of non-compliance, some boats cannot be retrofitted with holding tanks, it can be difficult to access pump-out facilities, there are safety issues with requiring vessels to move further offshore to discharge, and more onerous requirements may actually lead to less compliance if the control is too difficult to comply with. The council changed its approach from a blanket distance increase to identifying particular harbours and bays where the other controls leave small gaps where it was lawful to discharge but could cause adverse effects. The Independent Hearing Panel supported the revised approach.

It is expected that education about the discharge controls and promotion of holding tanks and pump-out facilities can be used to induce behavioural change among boating communities to further reduce discharges of untreated sewage.

Untreated sewage discharges from vessels

Sea Change endorses the policies and rules in the PAUP concerning untreated sewage discharges from vessels. A priority is a review of the objectives, policies, rules and methods in the Waikato Regional Plan around discharge of sewage from vessels with a view to identifying any particular bays and harbours where the Marine Pollution Regulations leave gaps and the controls should be strengthened as has occurred with the Proposed Auckland Unitary Plan.

5. The need for Integrated Catchment Modelling

The Hauraki Gulf and its wider catchment constitute a complex and dynamic structure of natural and artificial systems that interact with each other like a giant, ever-changing puzzle. When making policy and management decisions about such a system, we often think about particular pieces of the puzzle. But there is a danger that decisions aimed at outcomes for one part of the puzzle will have unintended consequences for another part. One way of trying to overcome such issues is to develop an 'integrated model' that incorporates all the key features of the catchment, and the ways in which they interact with each other.

The overall question that this type of modelling tries to answer is how do values change as a result of our policy decisions? The figure below, taken from a water quality project, illustrates the process. In step one, we gather information that characterises all the values we associate with something (in our case, this would be all those values generated by the Hauraki Gulf Marine Park). Step two is to develop with a scenario that changes the system – this could, for example, be a regulatory constraint on some activities or their effects. Step three is to work out how this might be achieved, and given this, step four is to determine how those changes affect our values. Two broad approaches to this kind of modelling are described below.

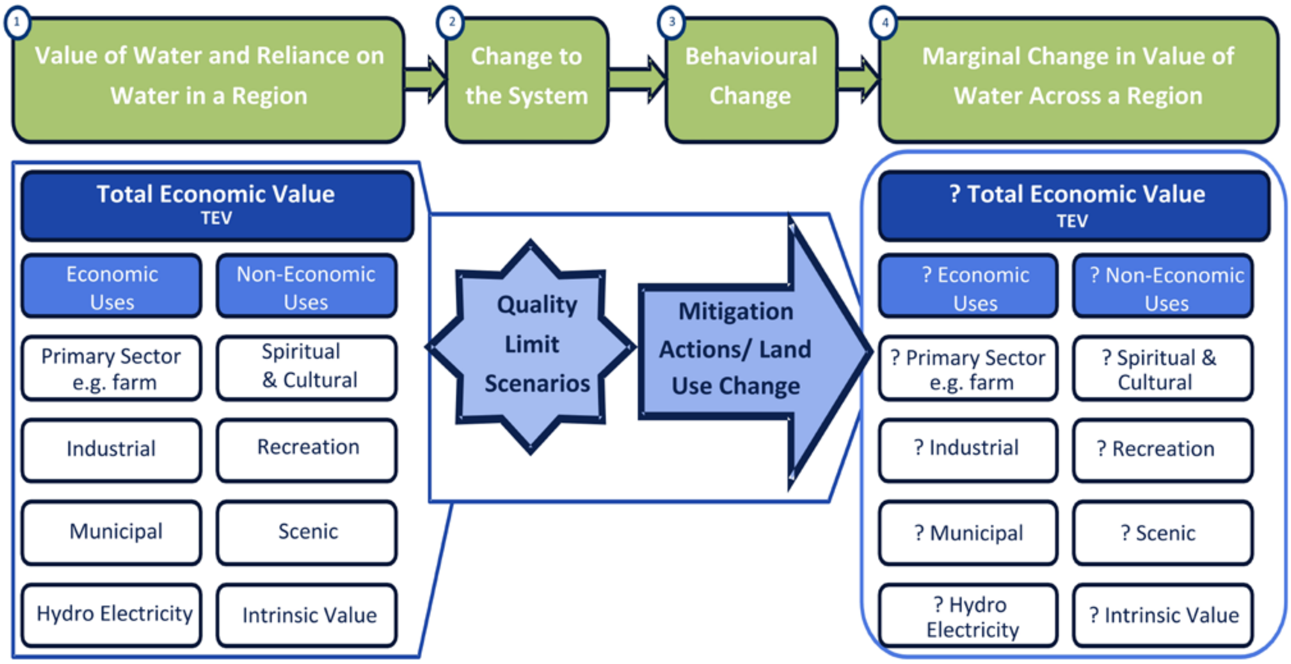


Figure A4.1 Integrated Catchment Modelling

Extended Input-Output modelling approach

An 'input-output' (or I-O) model is a method that has been used by economists to understand the changes in an economy by incorporating the way different industries interact with each other. For example, if a change happens in the dairy farming sector, this will also have flow-on effects on businesses in other sectors – including their customers (like dairy manufacturers) and their suppliers (like fertiliser companies, vets or agricultural consultants) and their communities schools, local services and shopping.

Input-output models can be extended to environmental features too. A study in 2006 developed a an I-O model for the Waikato region covering all the industries in the region, but also incorporating information on land use, delivered energy, air emissions, and solid waste21. It notes too that accounts for other natural resources and emissions (such as water use and discharges, biodiversity and soils) could, in principle, be incorporated.

The idea is to be able to model scenarios of the future and look at the implications in a wider sense.
For instance, looking at how the growth in forest planting in a catchment may impact on different industries, but also on discharges of sediment, water takes, carbon sequestration or habitat. It is noted, however, that while we have a well-established I-O model for the Waikato that covers the narrowly defined economy (and incorporates land use), we do not have these other accounts at present - and developing them is neither a straightforward nor small undertaking.

Constrained optimisation modelling – estimating the costs of policy

Another approach to catchment modelling is to develop an 'optimisation' model. This approach allows for a model that provides information about how to manage a system so as to optimise some objective variable. Generally, there are constraints imposed on this system – for example, by

21 Waikato Region Economy-Environment Futures Report, 2006. Technical Report 2006/51.

biophysical limits, or by limits imposed by policy choices. For example, we may choose to model a catchment according to the land uses and biophysical processes that exist there. We could use the model to determine the maximum profits available from land use, subject to biophysical constraints (such as the availability of water as an input) and policy choices (discharges to water must be below a certain level to achieve water quality targets).

A recent joint project involving the Waikato Regional Council, the Waikato River Authority, central government, and DairyNZ used such a modelling approach to look at the management of nutrient discharges in the Waikato-Waipa catchment. This approach was subsequently picked up and advanced by the Healthy Rivers/Wai Ora plan change process.

The models described in the previous paragraph were used to provide information about the cost (in terms of changes to the profitability of land use) of setting targets and limits for discharges to the Waikato and Waipa rivers. Such an approach might be able to be developed to consider the costs of managing discharges into the coastal marine environment. This would require models of representative land use types to be developed – including information on the profitability of land use, the discharges associated with the different types of land use, and the efficacy and cost of mitigations – and aggregated to the catchment scale. If this approach was feasible, we could use it to help inform questions such as 'if we want to reduce sediment loads in the receiving environment by X, what mitigation actions will that require on the land – and how much will that cost?'

It should be noted, however, that there are issues with this type of modelling. It is very data-intensive, and there is likely to be considerable uncertainty and debate around some of the information inputs required (for example, estimates of sediment loads from different land uses). The model also measures the cost of policy as a change in profitability of land use. In the cases of urban or conservation land, which are not managed for profit, the optimisation approach would have to be altered.

It should also be noted that this approach only considers the costs of meeting targets – and only a subset of total costs at that (albeit a very important subset!). It needs to be considered alongside other information about the benefits that are being achieved. In the Healthy Rivers/Wai Ora process, this was done through a complementary 'integrated assessment' approach, which essentially involved an expert assessment of the broader effects of meeting targets and limits.

APPENDIX 5: CULTURAL HEALTH INDICATORS

PIRINGA 5: NGĀ TOHU ORANGA Ā-IWI

A comprehensive and location/hapū-specific Cultural Indicators Framework is required for the Hauraki Gulf Marine Park in order to properly implement Sea Change Tai Timu Tai Pari. Iwi/hapū need to be closely involved in the development of the Cultural Indicators Framework. It will identify Māori environmental performance indicators. These will serve to bring together and better accommodate Mana Whenua values. They will assist in determining catchment impacts and enable the establishment of holistic integrated management approaches (recognising the intimate connection of all parts of the system such that they cannot exist independently), for restoration and monitoring programmes. Cultural perceptions of the entire catchment are the basis of the Cultural Indicators Framework, encouraging participation in monitoring programmes and transference of cultural knowledge.

- The Cultural Indicators Framework needs to be specific to different rohe.
- Iwi/hapū need to be closely involved in determining the threshold for the level of quality for natural resources, and to identify the attributes and measures for significant sites utilising both quantitative and qualitative data.
- Criteria for selecting cultural monitoring sites should be determined by ki uta ki tai methodology applied to case studies.
- Cultural indicators may be primarily a dichotomous choice (e.g., AE/KAO). Qualitative scales may also be used (e.g., Cultural Health Indicator scale) and other Likert-type scales such as Pai Rawa (Outstanding) to Aue (Very Poor).
- Biophysical and Likert-type scale data ought to be augmented with narrative kōrero to add another layer of detail to assessments.

It is intended that local iwi and hapū develop their own cultural indicators, with support from agencies as part of the implementation of the Plan. Examples of social and cultural indicators – to be revised following community and Mana Whenua engagement:

- Ability for local hapū and marae to feed manuhiri.
- Number of times fisheries and swimming beaches are closed.
- Number of reported water-contact-related health issues.
- Community satisfaction with access arrangements for the Hauraki Gulf Marine Park.
- Modification or destruction of culturally significant places.
- Ability of coastal people to gather enough kai to feed their whānau.
- Ability of local artisanal fishermen to make a living.
- Number of times kaitiaki have to restrict take from a local fishery.
- Number of infringement notices for illegal fishing.
- Affordability of Hauraki Gulf activities to Mana Whenua, tourists, visitors, and local residents.
- Gentrification and exclusion of the public and Mana Whenua across the Hauraki Gulf Marine Park.

Previously, Mana Whenua stated expectations for involvement in monitoring and reporting, which include:

- Acknowledgement of and response to the holistic nature of Mana Whenua world views, values and knowledge from traditional knowledge to contemporary knowledge.
- Mana Whenua tikanga and mātauranga in resource management, research and monitoring is retained, shared and understood.
- All tribal members, including kaumātua, kuia and rangatahi should be able to participate in resource management through kaupapa Māori environmental monitoring tools.

- Develop Mana Whenua capacity to be able to actively participate in and lead and/or partner with community, government agencies and other stakeholders in management, research and monitoring programmes.
- Establish Mana Whenua leadership and collaborative relationships with other stakeholders in the Hauraki Gulf Marine Park, enabling empowerment of Mana Whenua and communities and more effective environmental management, research and monitoring.
- Mana Whenua and wider communities establish holistic integrated management approaches for restoration and monitoring programmes.

Previously-used frameworks can provide an initial picture, such as Gail Tipa and Laurel Teirney's (2003) Cultural Health Index for Streams and Waterways Indicators for Recognising and Expressing Māori Values, developed with Ngai Tāhu, and Garth Harmsworth's (2002) Māori Environmental Performance Indicators for Wetland Condition and Trend.

Indicators relating to mauri of waterways, Mana Whenua and wāhi tapu were gathered together in Kennedy and Jefferies' (2005) Māori and Indigenous Environmental Performance Outcomes and Indicators and their (2009) Ngā Mahi: Kaupapa Māori Outcomes and Indicators Kete.

Ngā Mahi: Kaupapa Māori Outcomes and Indicators Kete 2 - Mauri of Water includes 5 indicators of mauri protection:

1. extent to which local authorities protect mauri,
2. extent to which tangata whenua protect mauri,
3. extent to which other agencies protect mauri,
4. extent to which actions of the wider community affect mauri, and
5. physical evidence that mauri is protected.

The physical evidence indicators include characteristics of water, characteristics of the holding environment, characteristics of inhabitants, presence of pressures and threats. For each of these there are multiple measures, each with a set of criteria.

The qualitative nature of cultural indicators-derived data raises the expectation that an adequate level of collaboration with iwi/hapū will occur to evaluate natural resources utilising the proposed Māori values framework. We recommend that entities developing policy for Tai Timu Tai Pari work closely with iwi/hapū to identify the attributes and measures for significant sites utilising both quantitative and qualitative data-deriving methods.

A rohe-specific Cultural Indicator Framework can only be defined by Mana Whenua. The Tai Timu Tai Pari process needs to engage with Mana Whenua to identify cultural indicators, and to grow their capacity to engage in monitoring.

Criteria for selecting cultural monitoring foci will be determined by 'ki uta ki tai' methodology, with a dual focus on habitat and taonga species, and aimed at identifying impacts to mauri, determining best where monitoring efforts should go, and ultimately developing optimum restoration approaches.

Tai Timu Tai Pari

Sea Change

Hauraki Gulf Marine Spatial Plan

www.seachange.org.nz

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