

# 2 The Gulf and its Catchment

## 2.1 How the Gulf was Made<sup>4</sup>

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

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

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

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

coastline and harbours. The meandering and branching shape of these former river valleys is still recognisable in the extensive headwaters of places like the Mahurangi and Waitemata Harbours, and Tamaki Estuary.

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

## 2.2 The Gulf Today

### 2.2.1 Coastal Currents and Water Movements

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

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

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

<sup>5</sup> N. Broekhuizen (NIWA) pers comm., (citing Zeldis et al. in review; Zeldis and Smith 1999).



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

### 2.2.2 Nutrient Upwellings and Marine Productivity

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

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

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

In general terms the Gulf is a net source of dissolved inorganic phosphorus as more inorganic phosphorus is exported from the Gulf to the open shelf than is imported

from the ocean. In contrast, the system is a net sink for dissolved inorganic nitrogen.

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

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

### 2.2.3 Coastal Dynamics

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

Figure 4.

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

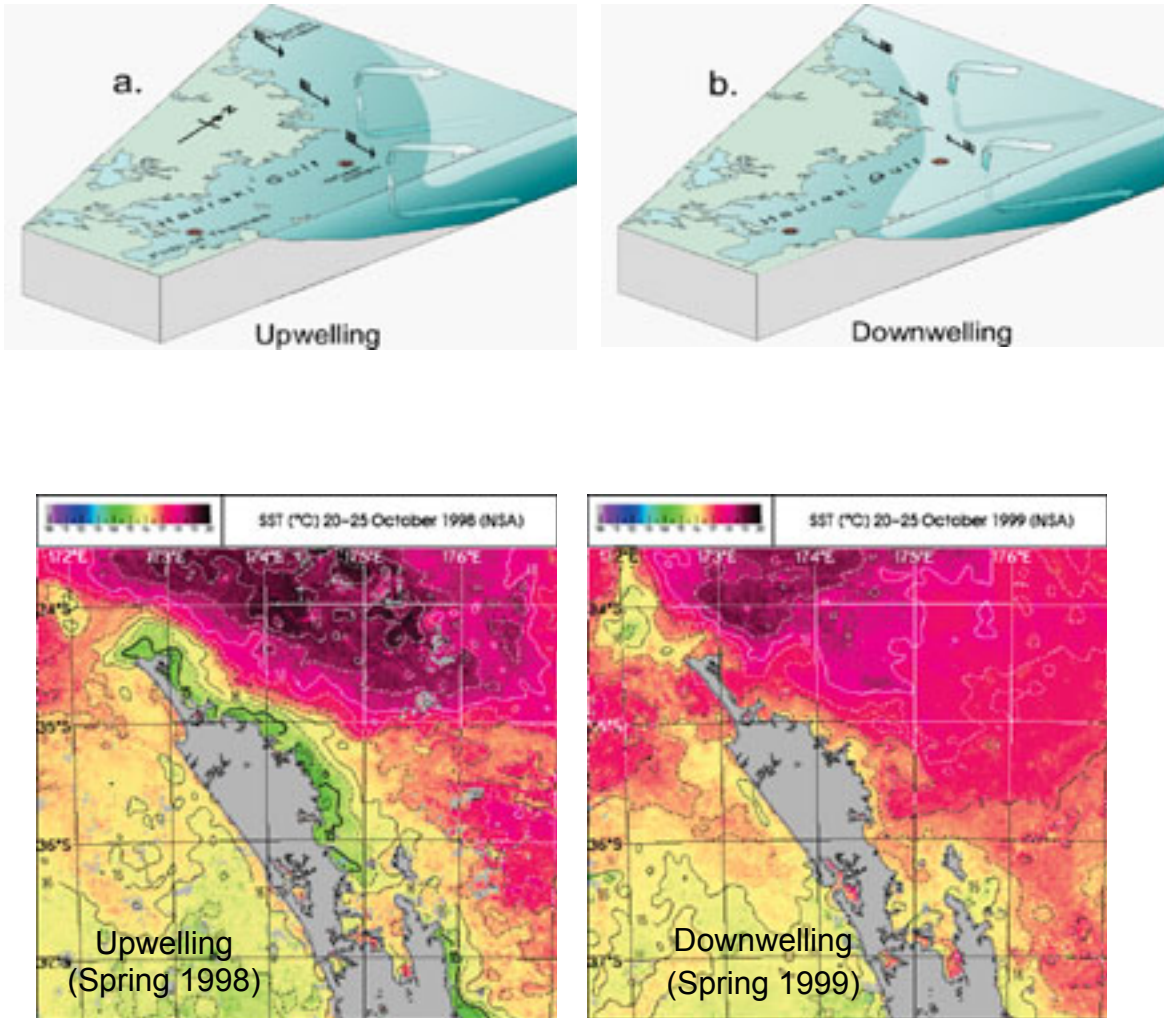


Figure 2.2 Wind, Current and Circulation Patterns in the Gulf

Source: Environment Waikato Technical report 02/09, ARC Technical Publication 182

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

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

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

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

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

#### 2.2.4 Sand and Sediment Transport and Deposition

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

sand between the embayments and they essentially operate as closed systems.

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

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

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

#### 2.2.5 Freshwater Inputs

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

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

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

<sup>6</sup> ARC, 1999, State of the Auckland Region Report 1999.

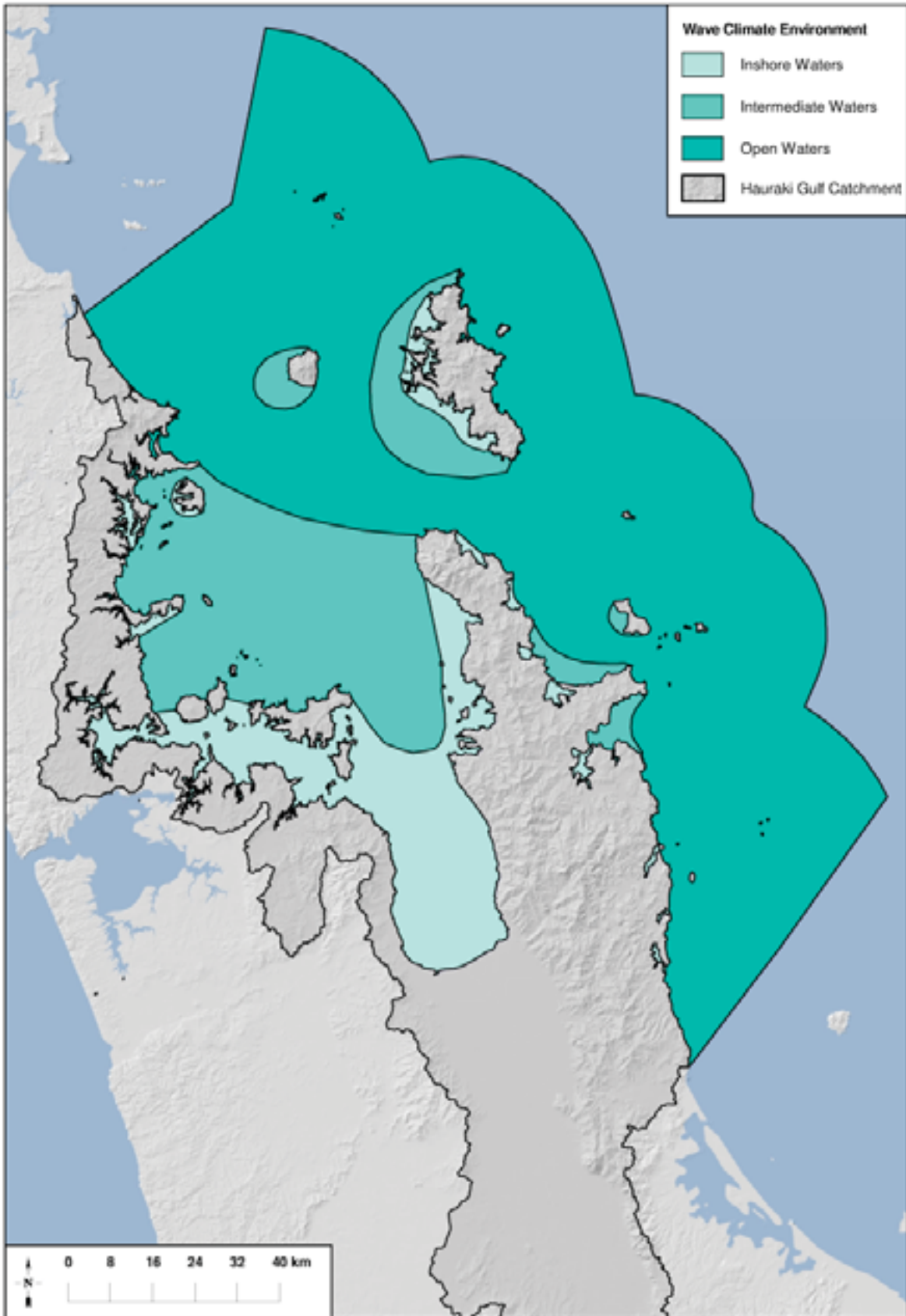


Figure 2.3 Wave Environments in the Hauraki Gulf

### 2.2.6 Climatic Features

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

## 2.3 Marine Environments

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

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

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

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

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

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

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### Box 2–1

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#### Sedimentation

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

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

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

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

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

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reports will be able to make better use of this tool.

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

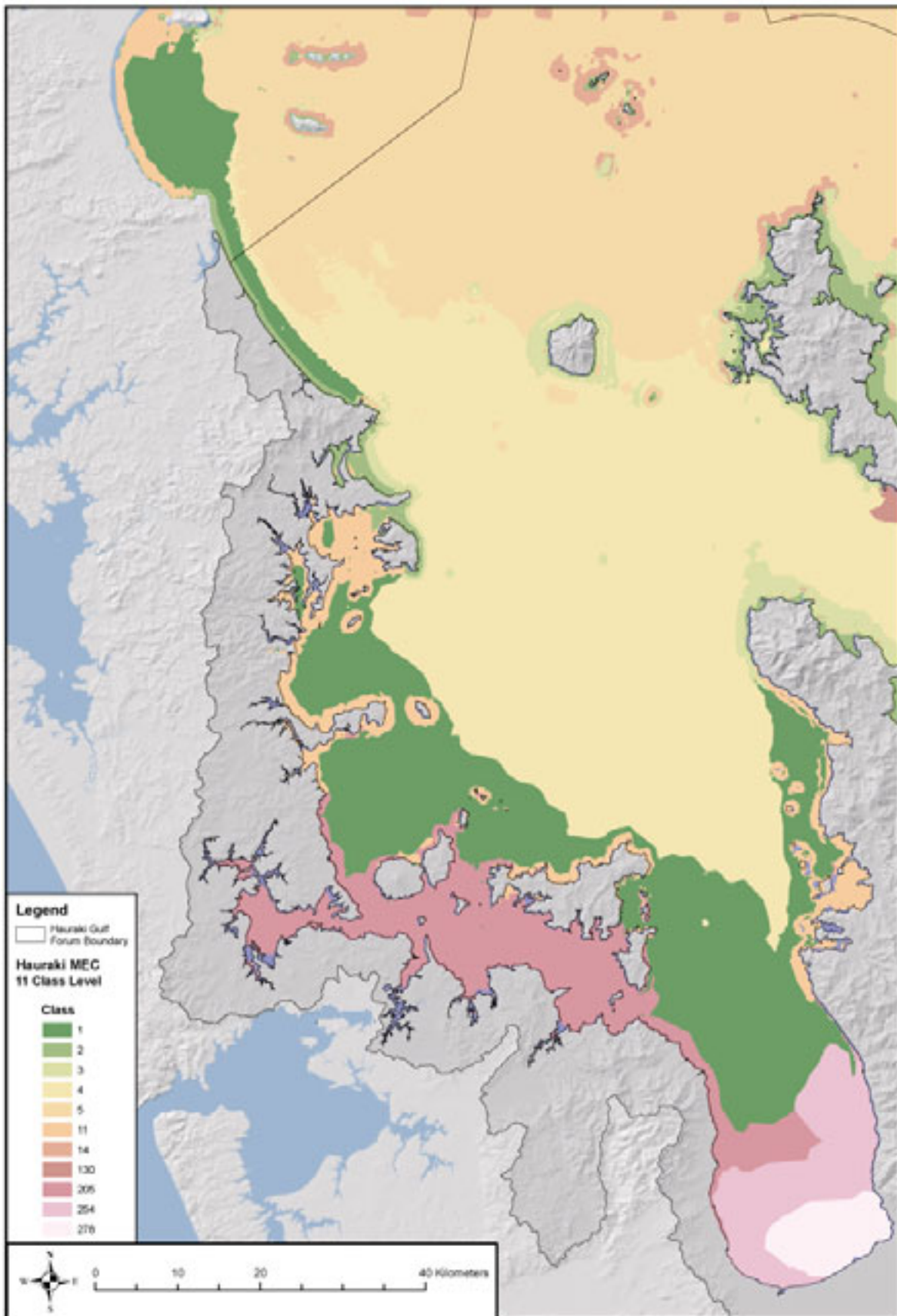


Figure 2.4 Marine Environments Classification for the Gulf

## Description of Classes

### Class 1 – Deeper water of the inner Gulf

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

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

### Class 2 – Shallow coastal water of the outer Gulf

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

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

### Class 3 – Deeper coastal water of the outer Gulf

Locations in Class 3 have average depths of 34 metres with moderate tidal flows and orbital velocities. Freshwater Fraction is low, indicating that the class is

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#### Box 2-2

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### Marine Environments Classification

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

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

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

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

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

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

### Class 4 – Shallower offshore water of the outer Gulf

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

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

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

#### **Class 5 – Deepest water of the outer Gulf**

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

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

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

#### **Class 11 – Shallow water of the inner Gulf**

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

The class is highly heterogeneous due in part to variation in substrates, and contains some diverse and productive habitats. However, the class is also

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

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

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

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

#### **Class 130 – Water of southern tip of Great Barrier**

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

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

Locations in Class 205 have average depths of five metres with moderate tidal flows and low orbital velocities (although variability is high) due to sheltered conditions. Freshwater fraction is moderate, indicating that the class is influenced by freshwater inputs. The seabed within Class 3 is

characteristically flat and comprises heterogeneous substrates, with patchy rocky reefs and areas with muddy sand substrates (except Firth of Thames where mud predominates). In areas with stronger currents (e.g., Rangitoto and Waiheke channels) the substrates are scoured with a predominance of surface shell. The proximity of the class to urban area and moderate freshwater influence means it is subject to sedimentation and contamination. A gradient in these pressures exists from the coast where effects are often high to more open areas where sediment and water quality are high.

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

#### **Class 254 – Sheltered upper reaches of the Firth of Thames**

Locations in Class 254 have average depths of five metres with moderate tidal flows and orbital velocities. Freshwater fraction is high, indicating that the class is highly influenced by freshwater inputs from the agricultural hinterland. Water in this class tends to

be turbid as a result of fine sediment resuspension (moderate orbital velocities and shallow depth) and fresh water inflows. The seabed within Class 254 is characteristically flat and comprises substrates that transition from shelly to muddy moving higher up the Firth.

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

#### **Class 278 – Estuarine headwaters of the Firth of Thames**

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

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

