The coastal habitats of Tairawhiti:

A review of the scientific, local, and customary knowledge

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1.0 Introduction

1.1 Purpose of this report

In Aotearoa/New Zealand, regional councils and unitary authorities have a range of responsibilities for decision making in the coastal and marine area (CMA). The New Zealand Coastal Policy Statement (2010), in policy 11, sets out requirements for avoiding significant adverse effects on species, habitats and ecosystems, and section 67 of the Resource Management Act (1991) indicates that regional plans must give effect to the New Zealand Coastal Policy Statement. For regional councils to be able to successfully manage indigenous marine biodiversity (composed of species, habitats and ecosystems) they must have some understanding of the types of biodiversity present within a region's CMA, and knowledge of the spatial distribution of that biodiversity. For regions such as Auckland and Northland biodiversity in the CMA has been relatively well described. For example, the Department of Conservation has compiled a marine habitat map for the Northland section of the Northeast Marine Bioregion, which covers an area of 1.34 million hectares of coastal habitat from Ahipara to Mangawhai (https://www.nrc.govt.nz/resource-library-summary/research-and-reports/coastal/).

This knowledge makes it much easier for councils to develop coastal plans that provide appropriate protections and management outcomes. In other regions, less information is available which can make it difficult to put in place appropriate environmental management.

The Gisborne Region (Tairawhiti) is a region for which there is comparatively little information available regarding marine biodiversity and the distribution of coastal habitats. The region has been under-represented in coastal research to date, which is largely a consequence of its remoteness to institutions conducting research in the CMA (Universities, CRIs and other research providers). Consequently the Gisborne District Council (GDC), the unitary authority responsible for Tairawhiti, does not have readily available and robust information about the marine and coastal environments of the region. This lack of knowledge spans the range of coastal habitats which GDC has the task of managing under the Resource Management Act (1991).

As a first step towards gathering the information required to better manage the Tairawhiti CMA, this report collates and summarises the available scientific, local and customary knowledge on the extent, location and state of marine and estuarine habitats within the Tairawhiti region. In addition to the collation of this information, additional objectives for this report include: identifying gaps in the information base; recording information that might explain how pressures and activities within the region may have altered coastal habitats; providing advice on priorities for additional work required to fill knowledge gaps; and where possible, include mātauranga Māori in accordance with tikanga. With this knowledge, GDC will be in a better position to facilitate the development of a Regional Plan for Tairāwhiti to set the strategic direction for growth, development and resource management over the next 30 years.

1.2 Structure of this report

The structure of the report is as follows.

Part 1 Introduction

Part 2 A description of the Tairawhiti Coastal environment;

Part 3 A summary of existing knowledge of marine and estuarine Habitats within the Tairawhiti Coastal Marine Area. This part of the report is broken into the following section:

- Offshore habitats
- Coastal (nearshore and intertidal) habitats
- Estuarine habitats

Part 4 A discussion mātauranga Māori in Tairawhiti

Part 5 A summary of anthropogenic stressors and pressures in the region

Part 6 Advice on work required to fill knowledge gaps

2.0 The Tairawhiti Coastal Environment

Primary data sources for section 2

Girborne District Council: Regional Coastal Environment Plan

Tairāwhiti Resource Management Plan (2017)

The Gisborne District comprises all the land and sea east of a line from Potaka in the North, running southwest along the ridge of the Raukumara Ranges but excluding Te Urewera National Park, turning south east at the headwaters of the Ruakituri River and generally following the line of the Ruakituri river and the Wharerata Ranges, finally meeting its southern limit just north of Mahia Peninsula (**Error! Reference source not found.Error! Reference source not found.**). The Region's boundaries extend out to the 12 Nautical Mile (NM) territorial sea boundary from the point where the land boundary intersects the coast. The 12 NM territorial boundary represents the eastern boundary of the Gisborne Region within which the Resource Management Act 1991 applies. Tairawhiti adjoins two other Regions; The Bay of Plenty region to the west and the Hawkes Bay region to the south. Tairawhiti has approximately 270 km of coastline. This excludes those parts of the CMA which are the tidal portions of rivers. The nature of the coastline is largely influenced by the geological history of the area, its climate, the vegetation in the catchments and to some extent changes brought about by human occupation.

2.1 Population

The major urban centre in Tairawhiti is the City of Gisborne with a population of 37,200, while the population of the entire region is only 50,700 (June 2020 based on the Statistics New Zealand population estimate tables). With more than 70% of the population concentrated in Gisborne, the majority of the coastline is relatively free from the usual urbanised population pressures. Outside of Gisborne the majority of the population is gathered in small townships including Te Araroa, Ruatoria, Tokomaru Bay, Tolaga Bay and the inland settlement of Te Karaka.

Tairawhiti's inland and eastern coast communities have historically lived in isolation from the rest of New Zealand due to the Region's geographical remoteness from adjoining regions. Tairawhiti is also distinctive due to the fact that the Maori population of the Region is very high at about 53%. In rural parts of the District the Maori population increases to approximately 90% in some locations. The lifestyle of these communities has been heavily influenced by beach and marine activities.

The coastal environment is a significant characteristic of the East Coast. There is a high demand by people and communities to carry out activities in the coastal environment to provide for their economic, cultural and social needs. The coastal environment is especially important for recreational activities and for coastal shipping. The coastal environment is also utilised for some activities such as temporary military training because of the nature of the coastal environment and requirements for coastal locations for these activities.

2.2 Physical characteristics

Tairawhiti's Coastal Environment forms a transitional zone between New Zealand's northern and central marine biogeographic regions. This is a transitional boundary between warm and cooler water marine flora and fauna. On the land component of the region's coastal environment, there are four distinct Ecological Districts; Pukeamaru, Waiapu, Turanga and Tiniroto. The Department of Conservation has published full Protected Natural Areas Programme Surveys for all the Ecological Districts in the region. The coastline of Tairawhiti has a distinct topographic pattern of open bays alternating with steep faced and cliffed coasts and prominent headlands. These features are formed of generally soft, weak rocks, mainly Tertiary mudstones and sandstones.

The topography reflects that of the inland hill country and river valleys, modified by forces of marine erosion and sand movement, and tectonic uplift of the land through successive earthquakes. Tūranganui-a-Kiwa/Poverty Bay and Tolaga Bay are broad bays where wide river valleys (Waipaoa and Uawa) meet the sea. Coastal dunes and beach ridges are backed by tidal estuaries and extensive fertile alluvial surfaces further inland.

The mouth of the other main river, Waiapu, is more abrupt onto an open coast. Hicks Bay and Te Araroa also feature extensive coastal flatlands where successive beach ridges have advanced seawards.

Figure 2-1 *Tairawhiti (Gisborne District).*

Tokomaru Bay and Waipiro Bay, where small stream valleys have created only limited areas of moderate-gently sloping land near the coast are more typical of the Gisborne Region. Earthquakes over the last few thousand years have raised a narrow coastal plain from these at the foot of the coastal faces at these bays and elsewhere. Wainui Beach, Whangara, Anaura and Hautai, east of Te Araroa are examples of this.

A longer history of tectonic uplift is shown by higher marine terraces, 80,000 - 120,000 years old, near Te Araroa and at Parikonohi between the Pouawa and Waiomoko rivermouths. Those that rise to a height of 300m just east of Te Araroa are the highest surviving marine terraces of this age in New Zealand. In general though, marine terraces are not characteristic of the Gisborne Region because the rocks are too weak to stand against the forces of erosion for that long. Instead the hill country terminates abruptly against the sea with steep slopes and crumbling or slumping cliffs.

One of the notable effects of this type of coast is that direct marine erosion, and inland erosion, of this soft rock coast and hinterland contributes to persistent high water turbidity. This turbidity has led to a distinctive ecology because of low light conditions for the greater part of the year and studies have also revealed a very significant problem of inundation by silts of important marine habitats.

In stark contrast to the turbid east coast of Tairawhiti, water clarity is high on the northern coast, from Matakaoa Point to Potaka, just west of Lottin Point. The coast consists of ancient, weathered basalts formed in the Matakaoa Orogeny from the ocean floor. These now form steep but stable hills lying very close to the rocky coast separated by narrow discontinuous marine terraces. No rivers cut through these hills, which contributes to the characteristic water clarity in this part of the region. This area of the coast is the second closest land point to the continental shelf edge of New Zealand. Consequently, clear and warm oceanic water washes the shore from time to time. Lottin Point has been described as, ecologically and physically, having all the characteristics of a deep water offshore volcanic island that just happens to be attached to the mainland. Certainly, many of the marine species present in this area are not commonly found on mainland New Zealand and at least one species found here has not been recorded elsewhere on the mainland of New Zealand at all.

There are twelve small, steep-sided islands along the Tairawhiti coast, most notably Tuamotu in Tūranganui-a-Kiwa/Poverty Bay, Te Ana-a-Paikea at Whangara, Pourewa and several nearby islands south of Tolaga Bay, Moturoi in Anaura Bay and Whangaokena Island (East Island) off the East Cape.

With the exception of a few places such as Tūranganui-a-Kiwa/Poverty Bay, where the supply of sand allows the coast to prograde seaward, and Lottin Point area, where the coast is hard volcanic basalt, the coast is generally in long-term retreat and has been so for many thousands of years. Eroding cliffs and edges of the narrow “recently” uplifted coastal plains are characteristic. Wide intertidal rock platforms and offshore reefs are also a notable feature, diversifying the coastal marine area which is otherwise dominated by a silty sediment-covered seafloor.

The region's coastal environment is very exposed to occasional storms from easterly and southerly quarters. The climate is otherwise moderate, with mild winters and very warm summers. Annual rainfall is at a minimum of 1000mm in Tūranganui-a-Kiwa/Poverty Bay, increasing both to the north and the south. However, there is a high degree of unreliability of rainfall, and droughts are common.

2.3 Land uses

Land uses on the Tairawhiti coast are mainly an extension of the inland uses. Most of the land has been cleared for pastoral farming, though some has since reverted to secondary forest and scrub. Remnants of original vegetation are extremely limited. There are only minor areas of exotic forestry on coastal faces adjoining inland areas with the exception of forestry plantings in the Lottin Point area.

Pre-European gardening of fertile alluvial pockets along the coast was significant but most of the flatter lands are exposed and have poor sandy soils. Then as now conditions were more suitable slightly inland. Today there is little intensive horticultural use of coastal land in the region. Coastal settlements have a servicing function relating to their hinterlands, as well as being marine focused and traditional settlement sites. Recreation and tourism based mainly on the attractions of the coast and coastal marine area are popular uses of the coastal environment and are steadily becoming a more significant component of the region's economy. Gisborne itself represents a sizeable area of residential, tourist, industrial and Port developments on the land, and a variety of marine uses including disposal of effluent and dredgings as well as recreational uses.

2.4 Early-history

Primary data sources for section 2.4

Spedding M (2006) The Turanganui River: A brief history. Department of Conservation

Halbert R (2012) Horouta: The History of the Horouta Canoe, Gisborne and East Coast Auckland: Oratia Books.

Te Ara Encyclopedia of New Zealand

The GDC Coastal Environment Plan, which was replaced by the Tairawhiti Resource Management Plan, included a history section providing no detail of history prior to the arrival of Cook in 1769. The GDC website also appears to provide little information about the pre-colonisation history of Tairawhiti. It would be ideal if GDC documents describing the history of the region included a more detailed Māori history. East Coast oral traditions offer differing versions of Tairawhiti's establishment by Māori. The account provided below is derived from the above data sources (Spedding 2006, Halbert 2012, Te Ara 2020). It would be useful to work with Tairawhiti iwi to develop a summary of the history of the region, as this will provide context with which to engage with holders and practitioners of mātauranga Māori, to facilitate meaningful engagement and develop partnerships that will support sustainable management of the CMA.

2.4.1 Ngāti Porou and Nukutaimemeha

Māui's canoe Nukutaimemeha is the foundation canoe of Ngāti Porou which takes its name from the ancestor Porourangi. According to tribal tradition Nukutaimemeha lies upturned in stone on Mt Hikurangi. Fundamental to Ngāti Porou's history is the godlike figure of Māui-tikitiki-a-taranga. Māui is the ancestor who binds Ngāti Porou descendants to the beginnings of human existence. It was he who fished up the North Island from the ocean depths. This fantastic feat is commemorated in the songs and haka of Ngāti Porou. Other canoes that brought some of the Ngāti Porou ancestors are Horouta, whose captain was Pāoa, Tākitimu, captained by Tamatea, and Tereanini, captained by Rongomaituaho, who had followed his father Paikea from Hawaiki.

Hamoterangi, Porourangi's wife, came with the Ikaroa-a-Rauru canoe migration. Other canoes such as Mangarara, Kurahaupō, and Ārai-te-uru are sometimes named in association with Ngāti Porou, but the information is fragmentary.

2.4.2 Tūranganui-a-Kiwa

Tūranganui-a-Kiwa/Poverty Bay has been settled for over 700 years by the tribes of Te Aitanga-a-Māhaki, Rongowhakaata, Ngāi Tāmanuhiri and Te Aitanga-a-Hauiti. Their people descend from the voyagers of the Te Ikaroa-a-Rauru, Horouta and Tākitimu waka. By one account, the great navigator Kiwa, in the 1300s, landed at the Tūranganui River first on the waka Tākitimu after voyaging to the region from Hawaiki and that Pāoa, Captain of the waka Horouta, followed later. An alternative legend recounts that Kiwa waited so long for the Horouta canoe to arrive that he called its final landing place Tūranganui-a-Kiwa (The long waiting place of Kiwa).

However, a more popular version of events is that Horouta preceded Takitimu. In 1931, Sir Āpirana Ngata stated that Horouta was the main canoe that brought the people to the East Coast and that Ngāti Porou always regarded Takitimu as "an unimportant canoe". Māori historian Rongowhakaata Halbert affirmed this account, stating that Pāoa's crew on the Horouta were the first inhabitants of the East Coast after migrating from Ahuahu (Great Mercury Island). Pāoa gave his name to various places across the region, most notably the Waipāoa River (Wai-o-Pāoa), Te Kuri-o-Pāoa (Young Nick’s Head) and Te Tuahenitanga-a-Pāoa (Tuaheni Point).

The people of Tūranganui-a-Kiwa primarily trace their ancestry from Māui, the ancestor Toi, and from three main groups of migrants from Hawaiki. Toi is often mentioned as the earliest ancestor living in this country prior to the arrival of the Hawaikian migrants, and is sometimes a descendant of Māui-tikitiki-a-Taranga. Sir Apirana Ngata says that during the two or three centuries preceding 1350, the history of much of the North Island including the East Coast may be written on the assumption of a wholesale merging of the pre-Toi and Toi peoples.

2.4.2.1 Horouta

Ngāti Porou tohunga, Pita Kapiti, maintains that the Horouta waka sailed first from Aotearoa to Hawaiki, then made a return voyage, with its primary objective being to acquire the kumara for Toi and the people of Aotearoa. Other East Coast oral traditions offer differing versions, whereby the Horouta sets out in the first place from Hawaiki. Pāoa is mostly remembered as the ancestor who captained the Horouta during its journey to Aotearoa. Most versions recount the Horouta capsizing at Ohiwa in the Bay of Plenty, and after making the necessary repairs, continuing its journey around East Cape toward the Tūranganui-a-Kiwa/Poverty Bay district. These events are remembered in the waiata and haka, ‘Haramai a Pāoa’ often performed by tangata whenua of Tūranganui-a-Kiwa. According to many accounts, the captain Pāoa led a group overland from Ohiwa eventually rendezvousing with the Horouta and its crew somewhere near Tūranganui-a-Kiwa. Some believe the Horouta came to rest on the West Bank of the Tūranganui River near the present Gladstone Road Bridge. The crew having disembarked set about following the appropriate rituals, and then proceeded to lay claim and ownership to the district. The Horouta eventually made landfall at Muriwai where Pāoa’s sister, Hinehakirirangi, was the first person ashore. Ngata says the Horouta came much earlier than the supposed migration of 1350 and some generations before the Takitimu waka. However, many historians couple those canoes as being complementary, the same waka, or left and right hulls of the same waka.

2.4.2.2 Takitimu

The story of the Takitimu waka is largely associated with the ancestors, Tupai, Ruawharo and Tamateaarikinui. Some versions mention Kiwa as captain, however most accounts agree the Takitimu was an extremely sacred vessel entrusted with a cargo of “sacred axes and stones and the Gods of the heaven and earth, and the Gods of the whare wananga (ritual house of learning), and other sacred paraphernalia”. Respected tribal historian and elder, Hetekia Te Kani te Ua states that Tamateaarikinui was in charge of the canoes that travelled with the sacred canoe, Takitimu. They were stocked with provisions, water, chattels, personal belongings and the wives and children of the priests.

When the Takitimu landed, Tupai and Ruawharo made sacred fires at different places, which became shrines and remained sacred afterwards. Writer and tribal historian Mitchell states that on approaching the mouth of the Tūranganui River and observing the hill nearby to be similar to Titirangi, the hill on which their canoe first took shape, they bestowed the name Titirangi on the hill.

2.4.2.3 Maia

The Maia narrative concludes the main phase of early waka migration, from which the Tūranganui-a-Kiwa people draw their ancestry. One account has Maia quarrelling with the great Uenuku in Hawaiki and escaping by sailing on a raft of gourds, which brought him to Tūranganui-a-Kiwa. Fowler states that Maia reached Tūranganui-a-Kiwa by the use of magical incantations, and landed on the eastern bank of the Tūranganui River at a spot near the Cook Monument, while Halbert suggests Maia landed at Tauararo, or Schnapper Bay at the eastern end of Kaiti Beach. Later, Maia built a house called Puhi-kai-iti, where the Cook Monument now stands, in reference to the cord, which bound his raft of gourds. That particular house is still remembered and used in the naming of the Kaiti suburb, beach, school and other sites. Halbert says that Maia built a latrine called Parahamuti, which was situated on the eastern bank near the mouth of the Tūranganui River, and obtained his drinking water from a hillside-stream, which he named Murimuri-mai Hawaiki. Regarding the early settlement of the Tūranganui-a-Kiwa district Ngata says, “portions of the crews of Horouta, Takitimu and Te Ikaroa-a-Rauru settled at the mouth of the Tūranganui River, occupying both sides of it and up the Wai-weherua or the forking tributaries, Taruheru and Waimata. They also spread east and west of the mouth of the river; east towards Tuamotu and west along Waikanae”.

2.5 European arrival

Cook recorded in 1769 that the coastline at Anaura Bay was thick with settlements, and there was evidence of many more slightly further inland. At this time, Maori in the region had an economy based on fishing and the cultivation of kumara, yams and taro. Muriwai (southern Tūranganui-a-Kiwa/Poverty Bay) is also said to have been densely populated and studded with fortified settlements. Archaeological sites are recorded throughout the region (including pa and middens), although there are probably many more that have not been uncovered, surveyed or recorded along the coast and river mouths.

Cook first landed in New Zealand at Gisborne in 1769. The landfall site is commemorated now in a National Historic Reserve in Gisborne City. A significant trading centre was established on the Tūranganui River at Gisborne in the early 1830's but it was not until the late 1860's that the nucleus of the town was purchased by the Crown. There was a rapid increase in population during the early 1870's as settlement of the interior gained momentum.

Coastal trading stations were established along the coast from the 1830's and soon ships were exporting food crops to early Auckland. While pastoral farming developed inland of the Coastal Environment, freezing works developed at Gisborne, Hicks Bay and Tokomaru Bay, along with wharves at Tokomaru, Tolaga and Hicks Bay.

Armed conflict has also featured in the history of the Gisborne Region's Coastal Environment beginning with early tribal conflicts, moving on to the musket wars involving northern iwi in the early 19th Century, and later the New Zealand Wars between the Crown and tangata whenua (notably between the Crown and Te Kooti).

2.6 Indigenous Flora and Fauna

Very little of the original vegetation or habitat has survived on the land within the Coastal Environment and marine habitats have been strongly modified as well though it is less clear to what extent. Remaining coastal forests feature combinations of pohutukawa, karaka, tawa, puriri, kohekohe and tawapou, with the natural southern limits of pohutukawa and tawapou near Tolaga Bay. Only minor remnants are left, most notably at Hicks Bay, east of Te Araroa, East Cape, Port Awanui, Waimahuru Bay Scenic Reserve (east of Te Puia), Anaura Bay Scenic Reserve, and Wharekakaho Stream, south of Young Nicks Head. Others are very small and scattered, including treelands.

Secondary forest and scrub (Kanuka-Manuka dominated) is locally extensive in the north and south of the Gisborne Region's Coastal Environment and these may be especially significant where they are buffering areas of primary forest and treelands. In general though, the Coastal Environment of the Gisborne Region has a strikingly "bare" look in comparison with the Coastal Environments of adjacent Regions.

Unstable coastal slopes and cliffs have notable scrub and herbfield communities which, in places, include the threatened species *Rorippa divaricata*, *Plantago spathulata* subsp. Picta, or the shrub daisy raukumara (*Brachyglottis perdicioides*), the latter two species being endemic to this Region's Coastal Environment. Kowhai ngutukaka/kakabeak has recently been rediscovered on coastal slopes at Te Araroa.

Dunelands have never been very extensive in the Coastal Environment of the Gisborne Region. Modified indigenous dune vegetation survives, however, with significant examples at Hicks Bay, Hautai, Whangara and the Waiomoko and Pouawa rivermouths. The uncommon species *Austrofestuca littoralis* and pingao are present. Dune systems and the foreshore are important habitats for lizards and invertebrate fauna.

Several species of endemic skinks are found in the sand dunes of Whangara and Wainui Beach and are likely to be present in other dunelands. The indigenous katipo spider is also found throughout the Gisborne Region. Driftwood and interstitial organisms on beaches are common but little understood and virtually no research has been undertaken to describe or characterise these organisms.

Estuaries are generally small, including that of the Wharekahika (Hicks Bay), Karakatuwhero (Te Araroa) and Waiapu Rivers. Estuaries in the region often take on the distinctive form of ribbon estuaries coinciding with low lying and subsequently low flowing river systems. Examples of these types of estuaries include the confluence of the mouths of the Tūranganui and Waimata Rivers (Gisborne). The larger Kaitawa estuary at Tolaga Bay and Wherowhero lagoon in Tūranganui-a-Kiwa/Poverty Bay are the most significant estuarine habitats for wading and other water birds. They are also important as habitat for soft sediment shellfish such as cockles. Awapuni Lagoon (Tūranganui-a-Kiwa/Poverty Bay) - a tidal estuary associated with the Waipaoa River mouth - was destroyed by drainage and farm development as recently as the late 1950s - 1960s.

Narrow freshwater wetlands lie between lines of beach ridges at Hicks Bay and Te Araroa, and smaller examples are found elsewhere. The river mouths and their tidal reaches are key sites in the life cycles of many freshwater fish, providing passage to and from the sea and in some cases spawning habitat (galaxids/whitebait). Estuarine fish include mullet, flounder, kahawai and parore.

Forest bird habitat has been severely limited. Notable surviving bird species are generally of wetland-estuary-scrub margin habitat or they are shore birds – the threatened North Island weka, fernbird, banded rail, spotless crake, bittern, White-Faced Heron, and rarely white and reef herons, New Zealand banded dotterel, variable oyster catcher, caspian tern and royal spoonbill. Seabirds breeding in the area include gannet, blue penguin, and various shearwater and petrel species including the black-wing petrel.

The sub-tidal area of the Gisborne Region's Coastal Environment is an area where little research has been undertaken and the description of organisms and habitats within this area is limited. The diversity and richness of marine algae are striking feature of the Gisborne Region. Several other features are able to be identified as well.

Marine mammals migrate through the waters of the Gisborne Region. The Common Dolphin, Sperm Whales, Orca and the New Zealand Fur Seal are the most frequently sighted marine mammals. Sightings of rarer marine mammals have occurred including the Humpback Whale, the Southern Right Whale, the Minke Whale and other unidentified baleen whales and several species of beaked whale have either been sighted or have stranded in the region. Similarly, sightings of Leopard seals have occurred throughout the Region. Sightings of the New Zealand Fur Seal in recent years have most frequently been of juveniles but such sightings have been rapidly increasing over the past few years and more adult New Zealand Fur Seals have been sighted with one anecdotal record of up to six seals sunning themselves on rocks north of Anaura Bay and it is expected that, within the next ten years, haul out colonies of the New Zealand Fur Seal are likely to become established at isolated points of the Coastal Environment.

Several species of marine flora and fauna find their southern and northern limits on the East Coast of New Zealand at the Lottin Point area. Black Angel fish are thought to reach their southern limit in this area though rare sightings of them have been made further south.

Bull Kelp, *Durvillea antarctica*, reaches its northern limit on the east coast of New Zealand at Cape Runaway, just to the West of Lottin Point. Crayfish, *Jasus edwardsii*, is commercially harvested within the Gisborne Region and the highest rate of recruitment of juvenile crayfish in New Zealand has been recorded in the vicinity of the Port of Gisborne. Kina, *Evechinus chloroticus*, are also commercially harvested within the Gisborne Region. Several species of wetfish are also commercially harvested within the Gisborne Region.

2.7 Marine Areas of Coastal Significance in Tairawhiti

The following coastal areas have been defined as being significant in the Coastal Environment and Tairāwhiti Resource Management Plans. Key coastal interface issues as described in the plans are also listed.

- *Lottin Point/Matakaoa* (Site 05-013)
- *Hicks Bay* (Site 05-014)
- *Karakatuwhero River Estuary* (Site 05-015)
- *Kaka East Island/ Whangakenonui* (Site 05-017)
- *Waiapu Estuary* (Site 05-018)
- *Waiamahuru Bay* (Site 05-019)
- *Anaura Bay* (Site 05-021)
- *Uawa River* (Site 05-022)
- *Cooks Cove* (Site 05-023)
- *Waiomoko River Estuary* (Site 05-025)
- *Areil Rocks* (Site 05-026)
- *Wherowhero/Waipaoa Estuary* (Site 05-027)
- *Whareongaonga* (Site 05-028)

2.8 Marine Protected Areas in Tairawhiti

There are two marine protected areas in Tairawhiti

2.8.1 Te Tapuwae o Rangokako Marine Reserve

Te Tapuwae o Rongokako Marine Reserve was established in November 1999 as a result of a joint application between Ngati Konohi and the Director-General of the Department of Conservation (DOC & Ngati Konohi 1998). It is a no-take marine reserve within which it is prohibited to fish, remove or disturb any marine life. Te Tapuwae o Rongokako protects 2452 ha of coastal and marine habitats that are representative of the coast between East Cape and Mahia Peninsula, and is located approximately 16 km north of Gisborne, in the rohe moana of Ngati Konohi (**Figure 2-2**).

2.8.2 Te Tapui Mātaitai O Hakihea

The Hakihea Mātaitai was established in 2011. It adjoins the northern boundary of the Te Tapuwae o Rongokako Marine Reserve and covers 4.1 km^2 of coastal and marine habitats. Mātaitai reserves are one management tools available to tangata whenua to help them sustainably manage traditional customary fishing grounds. Mātaitai recognise and provide for traditional fishing through local management. They allow customary and recreational fishing but usually don't allow commercial fishing. Within the Hakihea Mātaitai, commercial fishing is prohibited while fishing for customary food gathering purposes may take place with authorisation from the Tangata Kaitiaki/Tiaki who are appointed under Regulation 24 of the Fisheries (Kaimoana Customary Fishing) Regulations 1998.

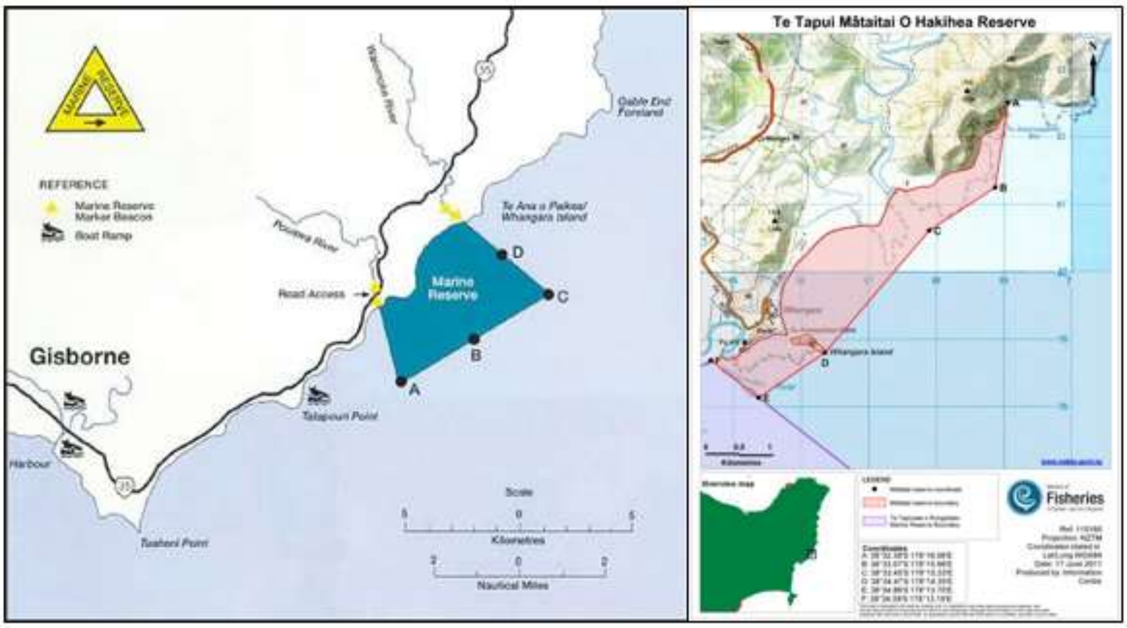

Figure 2-2 The Te Tapuwae o Rangokako Marine Reserve (left) and Hakihea Mātaitai (right)

3.0 Marine and Estuarine Habitats within the Tairawhiti Coastal Marine Area

Tairawhiti is under represented in coastal research in New Zealand. While the region has a relatively large coastline (270 km) in comparison to many other regions, there is not a lot of published information about the biology, ecology, or distribution of habitats in the region's CMA. A number of studies have, however, been conducted and there is some information on the distribution of habitats, which is summarised in this report. For the purposes of this report, the available habitat information has been broken into the following classes: offshore (section 3.1), coastal (section 3.2) and estuarine (section 3.3). Despite the obvious accessibility issues associated with water depths of greater than 50 m, the Tairawhiti's offshore and deeper waters are where the most detailed information is available.

As we move into coastal waters (nearshore and intertidal) there is detailed habitat information available for East Cape and the Te Tapuwae o Rongokako Marine Reserve and for some sites around Uawa / Tologa Bay (Kaiaua Bay and Tatarahake) thanks to a 2015 Uawa/Tolaga Bay Biolblitz. In many parts of New Zealand, estuaries are the most studied coastal environment, because this is where some of the most significant and manageable human impacts occur. For Tairawhiti, however, estuaries are not a prominent feature of the coastal landscape on account of the geography and geological history of the area. As a consequence there is very little information available about estuarine biodiversity or habitats in the region, apart from some biodiversity data from the Kaitawa Estuary, also captured during the Uawa/Tolaga Bay Bioblitz.

3.1 Offshore

Primary data sources for section 3.1

Jones et al. (2016) Biogenic habitats on New Zealand's continental shelf. Part I: Local Ecological Knowledge. New Zealand Aquatic Environment and Biodiversity Report No. 174. 95 p.

Jones et al. (2018) Biogenic habitats on New Zealand's continental shelf. Part II: National field survey and analysis. New Zealand Aquatic Environment and Biodiversity Report No. 202. 261 p.

The offshore environments of Tairawhiti are surprisingly well described. In fact, there is more information about distribution of habitats and biodiversity at depths of 50 – 200 m than there is for Tairawhiti's estuaries, intertidal and shallow coastal habitats combined. This is largely thanks to two pieces of research conducted by NIWA and funded by MPI through the Biodiversity Research Advisory Group (BRAG) Fund (Jones et al. 2016, Jones et al. 2018). These BRAG funded projects aimed to map biodiversity and determine the significance of biogenic habitats around the New Zealand coast and were conducted in two steps.

The first step involved mapping habitats based on (1) information contained in existing scientific literature, and (2) from the Local Ecological Knowledge (LEK) of commercial fishers (**Figure 3-1 and Figure 3-2**) (Jones et al. 2016). Fifty trawl fishers around New Zealand were interviewed to record their knowledge of biogenic habitat, with charts being marked by the fishers themselves before being digitised and collated to provide a national map of fisher-drawn areas of possible biogenic habitat. A total of 496 areas were digitized, along with a further 92 observations that were not marked on charts.

Many of these sites were memorable for the distinctive habitats or species that were caught as bycatch, sometimes in sufficient amounts to damage gear or make cleaning the net difficult. Of the areas marked on charts, 66% were classed as potential biogenic habitat (327) with a further 15% classed as "Foul" or "Reef". The most commonly mentioned biogenic habitats were corals (likely to include bryozoans), sponges, kelp, horse mussels and bryozoans. Areas within the Gisborne District included in this work were Ranfurly Bank (the area offshore from East Cape) and much of the seafloor between Tokamaru Bay and Mahia Peninsula.

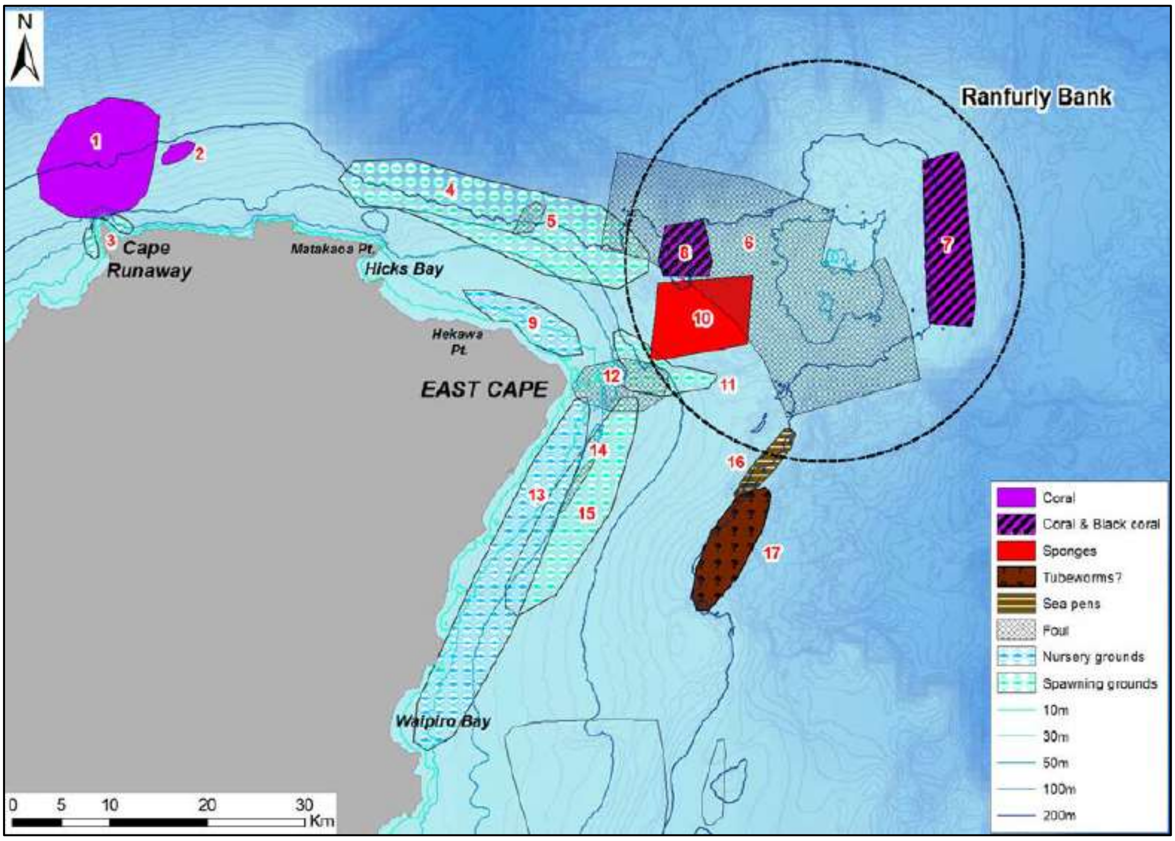

Figure 3-1 *East Cape local ecological knowledge (LEK) map from Jones et al. 2016. Map displays knowledge of biogenic marine habitat derived from existing literature and LEK of commercial fishers.*

The second component of this project involved field surveys (**Figure 3-1**Figure **3-3**) to ground truth and map the key biogenic areas identified by fisher LEK and existing data sources (Jones et al. 2018). This second component involved a series of research voyages carried out on NIWA's research vessel, the RV Tangaroa, to map biodiversity using multibeam echo soundings, seafloor photography, trawl and dredge surveys, and sediment sampling. The field surveys in Tairawhiti included Ranfurly Bank, reefs offshore of Tokomaru and Tolaga Bays, Ariel Bank offshore from Gisborne and Table Cape (NE of Mahia Peninsula). Ranfurly Bank was one of three areas around New Zealand chosen for analyses to be conducted in greater detail (the other regions were North Taranaki Bight and the east coast of the South Island).

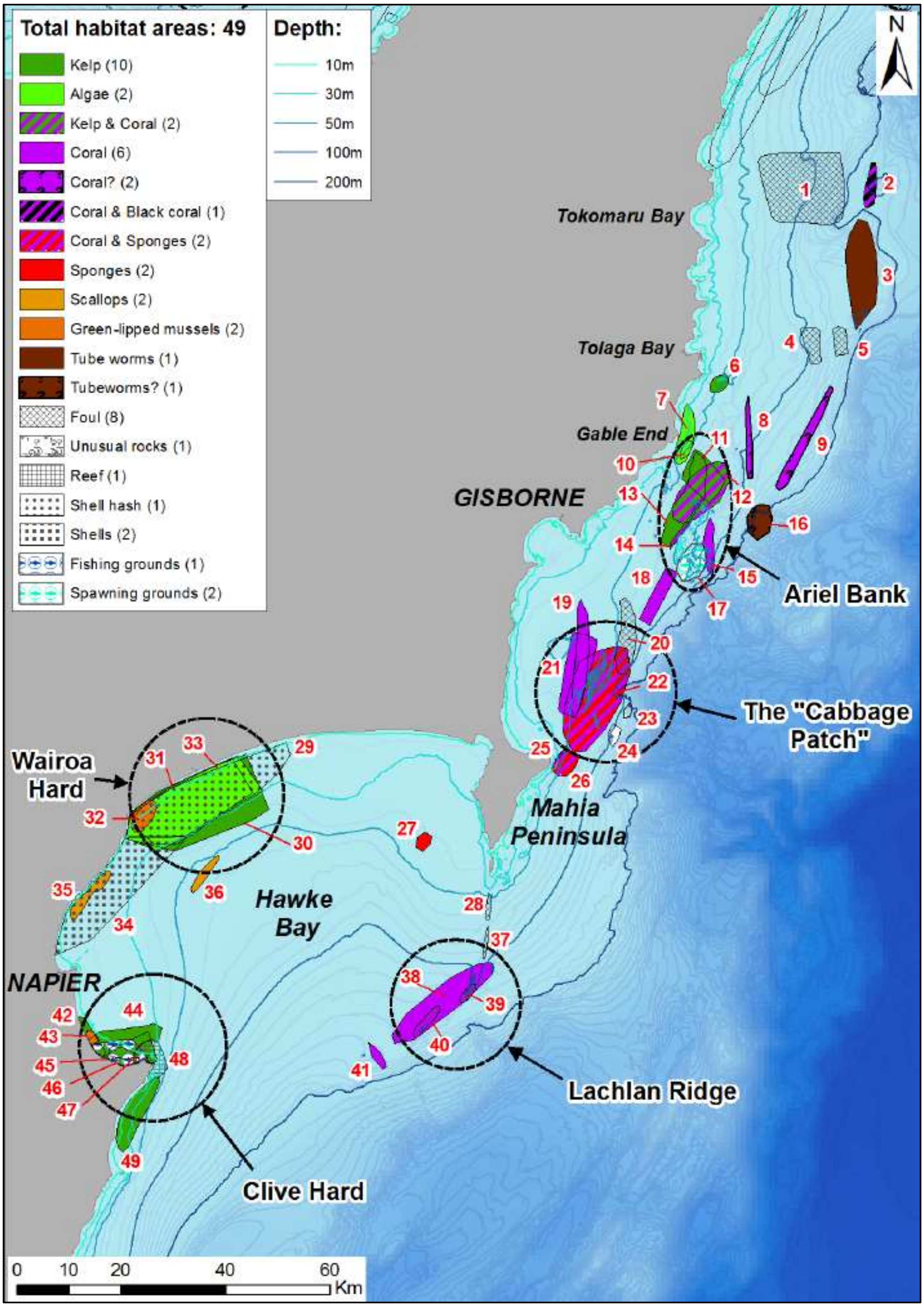

Figure 3-2 *Hawkes Bay/Gisborne region local ecological knowledge (LEK) map from Jones et al. 2016. Map displays knowledge of biogenic marine habitat derived from existing literature and LEK of commercial fishers.*

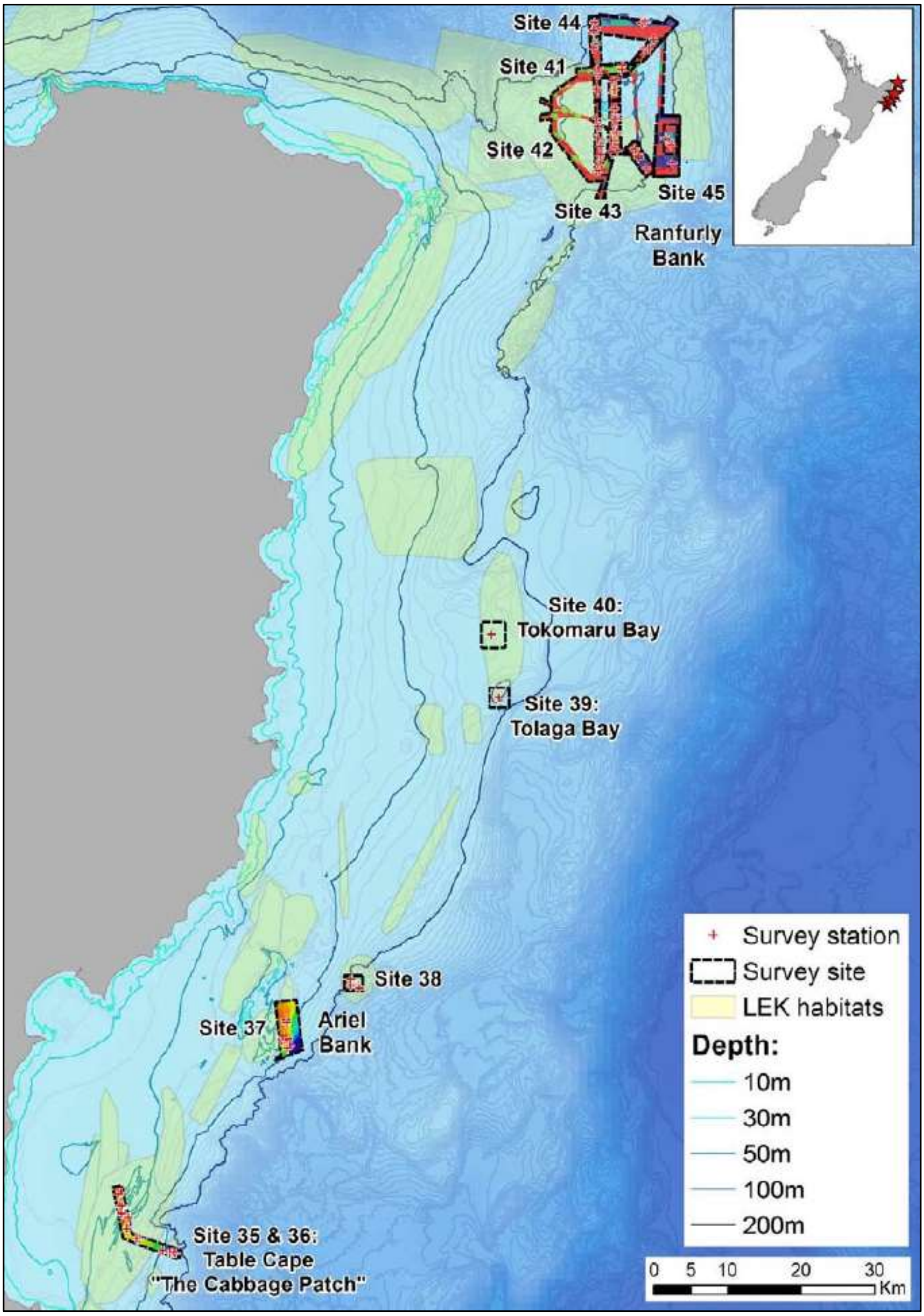

Figure 3-3 *Map of East Cape to Mahia showing locations field surveys to ground truth and map the key biogenic areas identified by fisher LEK and existing data sources (Jones et al. 2018). Fisher drawn areas (LEK habitats) are shown in light yellow.*

3.1.1 East Cape

3.1.1.1 Local Environmental Knowledge

Seventeen LEK areas were marked on the charts around East Cape (**Figure 3-1**), along with three unmarked sites (mentioned verbally, but not drawn on the chart), by eight fishers. This region was dominated by the large areas of foul ground, sponge and coral bycatch, mainly on and around Ranfurly Bank. Soft mud sediments characterized the rest of the area, with fishers commenting that nets were liable to become bogged down in the mud in deeper areas. A series of tarakihi spawning and snapper and tarakihi nursery areas were also marked along the coast of East Cape and Cape Runaway. To the south of Ranfurly Bank, a bycatch of tubeworms and sea pens on the softer mud were described.

Areas of Ranfurly Bank had been avoided by retired fishers (Areas 5, 6, 7, 8, 10 in **Figure 3-1**) but had been “opened up” by current fishers, who reported a bycatch of yellow sponges, coral and black coral on the deeper slopes of the bank where they targeted tarakihi (Areas 7, 8, and 10 in Figure 3-1). To the west of the main bank, an isolated patch described as a “big rock” surrounded by soft mud was also avoided (Area 5 in **Figure 3-1**).

A long rectangular fisher-drawn area located along the eastern side of the bank in 200–400 m water depth was described as an area of sponge and black coral by-catch (Area 7 in **Figure 3-1**). A smaller area on the western side of the bank (Area 8 in **Figure 3-1**), also in 200–400 m water depth in a bathymetric ‘notch’ feature was also thought to have similar habitat.

Inshore of Ranfurly Bank (Areas 12, 14 in **Figure 3-1**), tows passing along the 100 m contour were clear, but inside of this was described as “all foul”. Further south off Whakariki Point was another bank of low-lying foul was targeted with hand-lines for grouper and tarakihi. Tarakihi spawning grounds in 50 – 200 m+, historically heavily targeted by trawlers (Areas 4, 11, 15 in **Figure 3-1**). Blue moki spawning grounds (August – September) were marked either side of Cape Runaway (Area 3 in **Figure 3-1**). Inshore of the spawning grounds, areas where large numbers of “juvenile” tarakihi and snapper were caught around June were described.

Fishing grounds were described with a bycatch of what were thought to be sea pens (Area 16 in **Figure 3-1**) which “glowed green in the dark”. Further south (Area 17 in **Figure 3-1**), what was believed to be tubeworms were caught as a bycatch, coming up in clumps, described as "white straw, yellowy-white in colour, about 1–2 feet long, solid, but bendy and slimy”.

3.1.1.2 Ground Truthing Surveys

Ranfurly Bank is a broadly rectangular 'mega-feature' (**Figure 3-3** and **3-4**) off East Cape, connected to the Cape by a shallow broad bank on part of its western side, and dropping off into deeper waters on its other sides. The core area of the bank is roughly square and sits in less than 100 m water depth, surrounded by a more rectangular (north–south) area of 100–200 m deep area, which also includes the bank to the mainland (about 105–127 m depth). Outside this, the bank steepens from 200 m to 500 m water depth around its other three sides, and then extends as a gentler slope out from 500 to 1000 m, especially to the east.

The large size and relatively shallow average depths of Ranfurly Bank limited the survey vessel (RV Tangaroa) multi-beam swath width. Consequently, a series of 'wide' transects were mapped, with discrete blocks 'filled in' to target putative reef and other features identified from initial transects and available nautical charts, such as the low relief wall buttresses seen on the multibeam on the northern bank side. Thirty one Deep Towed Imaging System (DTIS), four beam trawl and five rock dredge stations were sampled. A wide of range of seafloor types were observed, including gentle rock flat slopes, steep bedrock drop-offs and walls, gravels, sands, and muds.

There was clear evidence of significant sediment transport in the shallower areas (bare bedrock being uncovered, as well as biogenic assemblages being buried by advancing sediments), as well as actual *in-situ* breakages of the presumably soft sandstone edges in some places. Biogenic habitats were species diverse, including large deep-water *Ecklonia radiata* forests (3 m high single blade morphology), many species of foliose and turfing red algae, sponges including some large basin forms, bryozoans, hydroids, gorgonian and crinoid fields, corals, and sea pens (e.g., **Figure 3-5**).

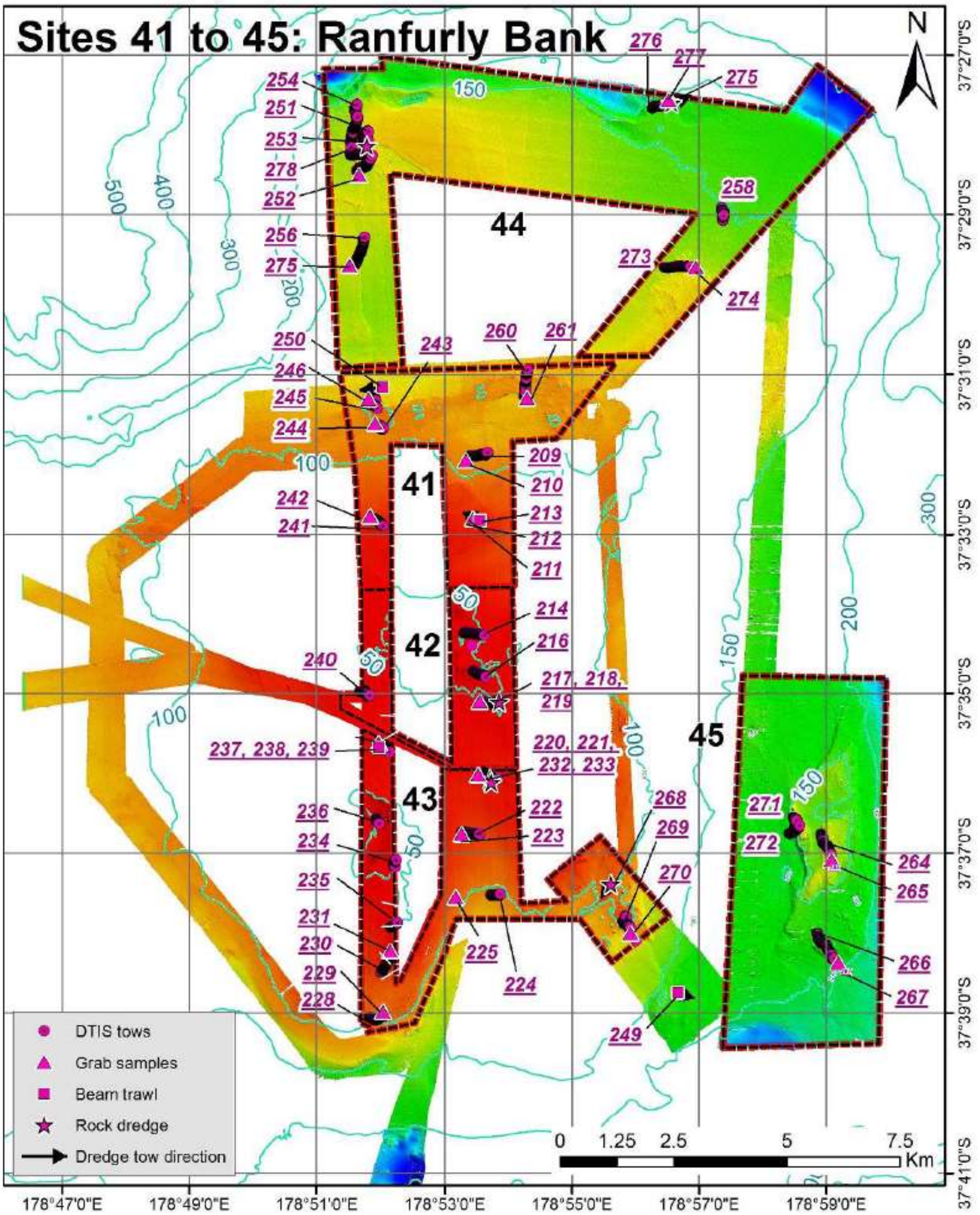

Figure 3-4 *Multibeam mapped area of Ranfurly Bank from Jones et al. 2018. Labelled area refer to sampling stations.*

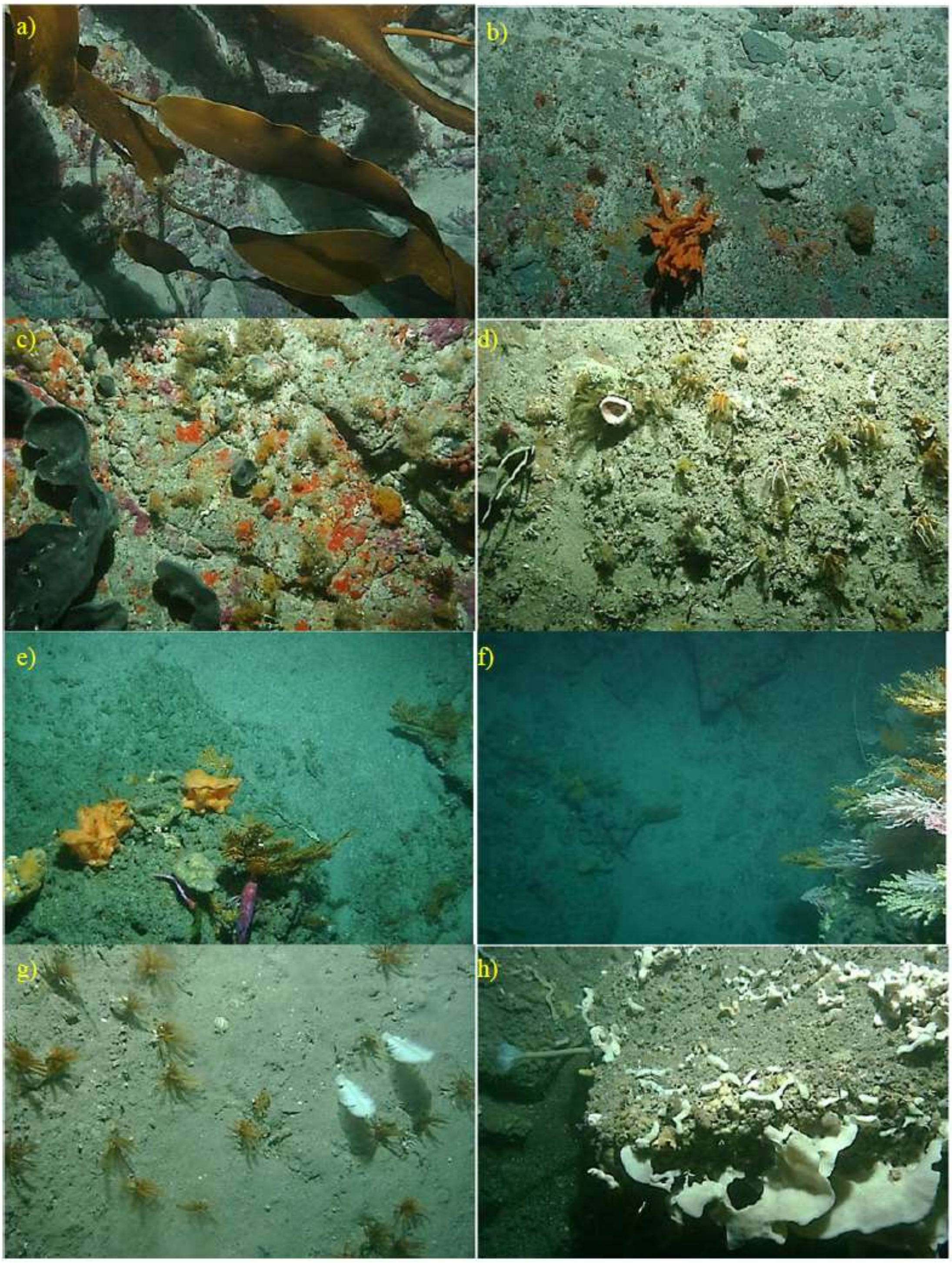

Figure 3-5 *Seafloor habitats on Ranfurly Bank. NB: Only a sub-set of the high diversity present is shown here. a) E. radiata deep-water form; b) sponges on eroding mud-stone; c) sponges and bryozoans on bedrock; d) crinoids and sponges on rubble; e) glass sponges and gorgonians; f) hard corals on wall; note lost rope below in background; g) crinoids and sea-feathers; h) deeper water sponges, and tubeworm (from Jones et al. 2018).*

3.1.1.3 Biodiversity of East Cape

In sampling stations covering the 40–160 m depth range, sponges dominated by weight, with 67 species identified, of which up to 28 were likely to be new species. High species diversity was also observed amongst the bryozoans, with 81 species recorded, including many epizoic species. Hydroids were abundant with 20 species identified, the most common being *Crateritheca insignis* (n=155), *Crateritheca zelandica* (n=148), *Lytocarpia incise* (n=130), and *Nemertesia elongate* (n=101). Crinoids were abundant, with *Comanthus novaezealandiae* and *Argyrometra mortenseni* identified, along with a new species of Comatulida. Ophiuroids were also numerous, associated with sponges, bryozoans, and gorgonian corals. The most common species collected were *Ophiactis resiliens* and *Macrophiothrix oliveri*.

Two new records of tropical species in New Zealand waters were also collected, *Ophiobyrsa intorta* and *Ophiotreta valenciennesi*. A tropical holothurian *Holothuria integua*, rare in New Zealand, was collected from two of the deeper stations to the north (and appeared common on DTIS video). Dog cockles (*Tucetona laticostata*) were the most commonly collected bivalve.

Algae were collected at six stations, from depths of 40 to 110 m. The highest diversity was seen in the red algae, with a number of specimens likely to represent new species (at least six). From the Halymeniaceae family, a new genus (*Galene* D'Archino & Zuccarello) has been proposed (D'Archino et al. 2014), which includes an undescribed species, *Galene* sp., based on the samples found only at Ranfurly and probably observed on DTIS. Attached *E. radiata* was sampled down to 70 m, and observed in photos at depths of up to 105 m on the northern slope of the bank.

Dense beds of kelp were recorded along some transects, with stipe densities of between 30–40 m^{-2}, and single thalli estimated at more than 1.5 m length. The morphology of specimens growing on Ranfurly Bank is different to that of shallower-dwelling specimens, with linear, flattened blades missing the lateral lobes found in shallower specimens (Nelson et al. 2015), and estimated heights of up to about 3 m.

Numerous fish species were recored on Ranfurly Bank. Red scorpion fish were the most frequently caught, and were present at all depths. The second most common species was initially identified as the redbanded weever, *Parapercis binivirgata*, but subsequently found to be a new sand perch (weever) species, now known as the black-fin sea perch, *Parapercis nigrodorsalis* (Johnson et al. 2014). Also included in the total of 16 species were two species rare to the New Zealand mainland; the luminescent cod and the red little gurnard perch. The most common fish observed on DTIS tows at Ranfurly Bank were pink maomao, with just over 1000 fish counted. They were particularly abundant around the deep rocky outcrops to the north of the main bank, but also the most common species observed at the shallower stations at less than 50 m depth. Sea perch were not observed at the shallow stations, but were abundant deeper than 50 m. Morid cods, including bastard codling were also commonly observed at the deeper stations. Over the softer sediment areas, cucumber fish and silver conger eels were frequently observed

3.1.2 Tokomaru to Mahia coast

3.1.2.1 Local Environmental Knowledge

Nine fishers marked a total of forty-nine areas, along with three unmarked sites mentioned verbally (**Figure 3-2**). The most commonly mentioned categories were kelp, “corals”, and foul. A series of offshore areas of foul were described as banks or pinnacles where “coral” and sponges were picked up in the nets. Many of these areas were sites that had been targeted by gillnetters for blue moki.

Fishers variously described coral as “*bushes*”, “*fern-like*” and “*twisted and very fragile*”, often being retrieved attached to flat papa rock, and recognized images of a variety of corals, including black corals (*Leiopathes* spp), stony branching and cup corals, and gorgonians. Soft yellow sponges, and pale yellow finger-like sponges with a stalk and large grey sponges “*like elephants feet”* were also described. The most frequently mentioned locations were Ariel Bank and “*The Cabbage Patch*”. These inshore reefs were characterized mainly by the presence of sometimes dense kelp, along with patches of greenlip mussels and scallops.

Fishers described banks, pinnacles and untrawlable ground off Tokomaru Bay, Tolaga Bay and Gable End, mostly in 100+m depth (Areas 1, 2, 4, 5, 8 and 9 in **Figure 3-2**). Coral was mentioned as a bycatch from these areas that were targeted by gill netters for blue moki. Ariel Bank itself (Areas 11, 12, 13, 14, 15, 17 and 18 in **Figure 3-2**) was noted as a moki spawning site that had been “hammered” by gill-netters. Adjacent to the bank were trawlable areas where “coral”, sometimes attached to slabs of rock and kelp were brought up in the nets.

The “Cabbage Patch” was avoided by some fishers but targeted by others. They described Grey sponges “like elephant feet” and fishers identified pictures of stony corals, bryozoans and gorgonian fans. Further offshore, two small areas were also marked as moki spawning grounds (Area 23 in **Figure 3-2**) and a site where pumice-like “barrels” were picked up (Area 24 in **Figure 3-2**).

3.1.2.2 Ground Truthing Surveys

Photographs of the areas fishers identified off shore from Tokomaru and Tolaga Bays revealed a hard seafloor, largely covered with small irregular rocks and coarse sediments (**Figure 3-6**), with some patches of larger rocks, and bare bedrock (very limited). The epibenthos was generally modest; small patchily distributed encrusting species, with few larger forms. Small red macro-algae and coralline algae were present in the shallower transect section, but no kelp was seen.

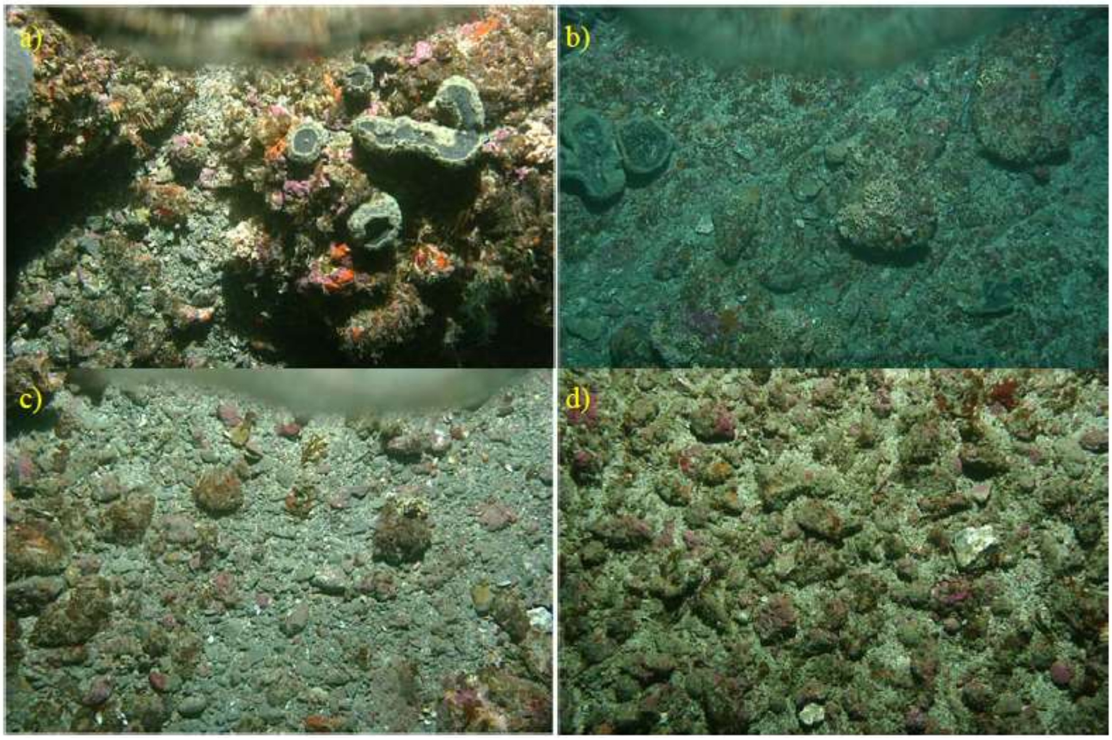

Figure 3-6 *Site 39 (Tolaga Bay) seafloor imagery (some images contain an air bubble artefact): a–b) bedrock at start of feature, with sponges, bryozoans, hydroids; c–d) irregular rocks/cobbles with coarse sediment, and variable epibenthic cover of sponges, ascidians, and coralline algae (from Jones et al. 2018).*

Water depths across Ariel Bank ranged from about 50 m on the bank, down to about 140 m in the south-eastern block corner (**Figure 3-7**). A reef feature was apparent as a broad promontory extending to the east, while north of this was a broader gently sloping flat, with the slope increasing more steeply at the 80 m depth contour. The southern reef areas (Stations 194, 196, 198) were composed of low bedrock often veneered in irregular rock/cobbles and sediments, with some low-relief outcrops. To the north, Station 198 was similar but with a greater proportion of flat bedrock habitat. Station 194 showed pronounced sedimentation and relatively high water turbidity compared to other stations (**Figure 3-8**). The rock in these transects appeared to be a soft mudstone prone to breakage, with some fractured slabs observed on video. Much of the smaller material observed was not embedded, making it susceptible to being moved around during storms, with the general impression that the reef was erosion-prone.

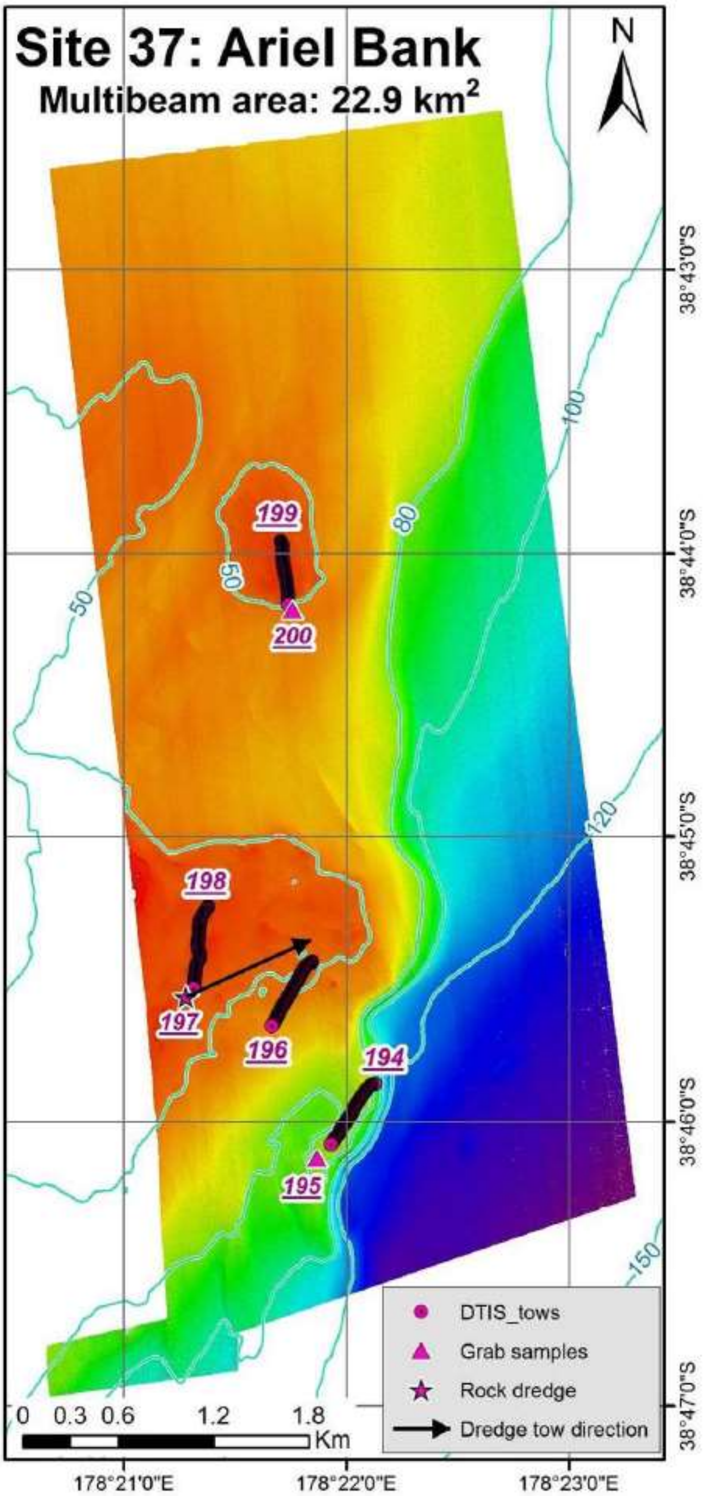

Figure 3-7 *Bathymetry of the Eastern side of Ariel Bank from Jones et al. 2018. Map show locations of 4 DTIS, 1 rock dredge, 2 sediment sampling stations*

In general, biogenic habitats were patchy and relatively sparse, with most of the larger epibenthos present on areas of raised bedrock, or the tops of larger rocks. These included large grey sponges, and modest patches of smaller encrusting sponges and bryozoans, while clumps of brachiopods and some cup corals were present at greater depths in Station 194. Sparse kelp (*E. radiata*) and patches of *Caulpra* sp. were found in the shallowest parts of Stations 198 and Station 199, with coralline algae widely present in these shallower areas (**Figure 3-8**).

Station 194 generally held less epibenthos than the other stations, probably attributable to the higher sedimentation level, and loose rubble/lack of elevated bedrock. Large trevally were observed at Stations 194 and 196, along with large numbers of small pelagic fish (myctophids) feeding in the water column. Pink maomao were also present in modest numbers; this was the furthest south this warm temperate species was observed during the NIWA surveys.

At Table Cape (**Figure 3-9**), existing broader scale resolution Navy multibeam data was used to select features to target. This resulted in a 'jointed' multibeam transect (18.8 km^2) extending from around 50 m to 200 m depth. In shallower water, a faulted syncline reef series with interspersed overlying soft sediments was apparent, with deeper reef ridges surrounded by sediments also mapped, including a feature thought to be a moki spawning spot by one fisher (**Figure 3-9**).

The seafloor was found to be composed of low rock ridges alternating with soft sediment flats, with apparent heavy sedimentation of the seafloor, and poor water column visibility in general. The epibenthos was generally quite modest, with more diverse and abundant assemblages seen only on the highest elevations of the overall reef system, covered by stations 180 and 191 (**Figure 3-9**). These included bryozoans, finger and other sponges, and coralline algae (Figure 3-10a–e). In the deeper parts of these stations, and the surrounding stations in deeper water and/or where the reef ridges were much less pronounced, the fauna was very sparse and species limited (**Figure 3-10** f–h). Collectively, these patterns imply a system degraded by sedimentation, with 'healthier', though still probably impacted remnants occurring only on the parts of the reef most elevated from the surrounding sediment flats.

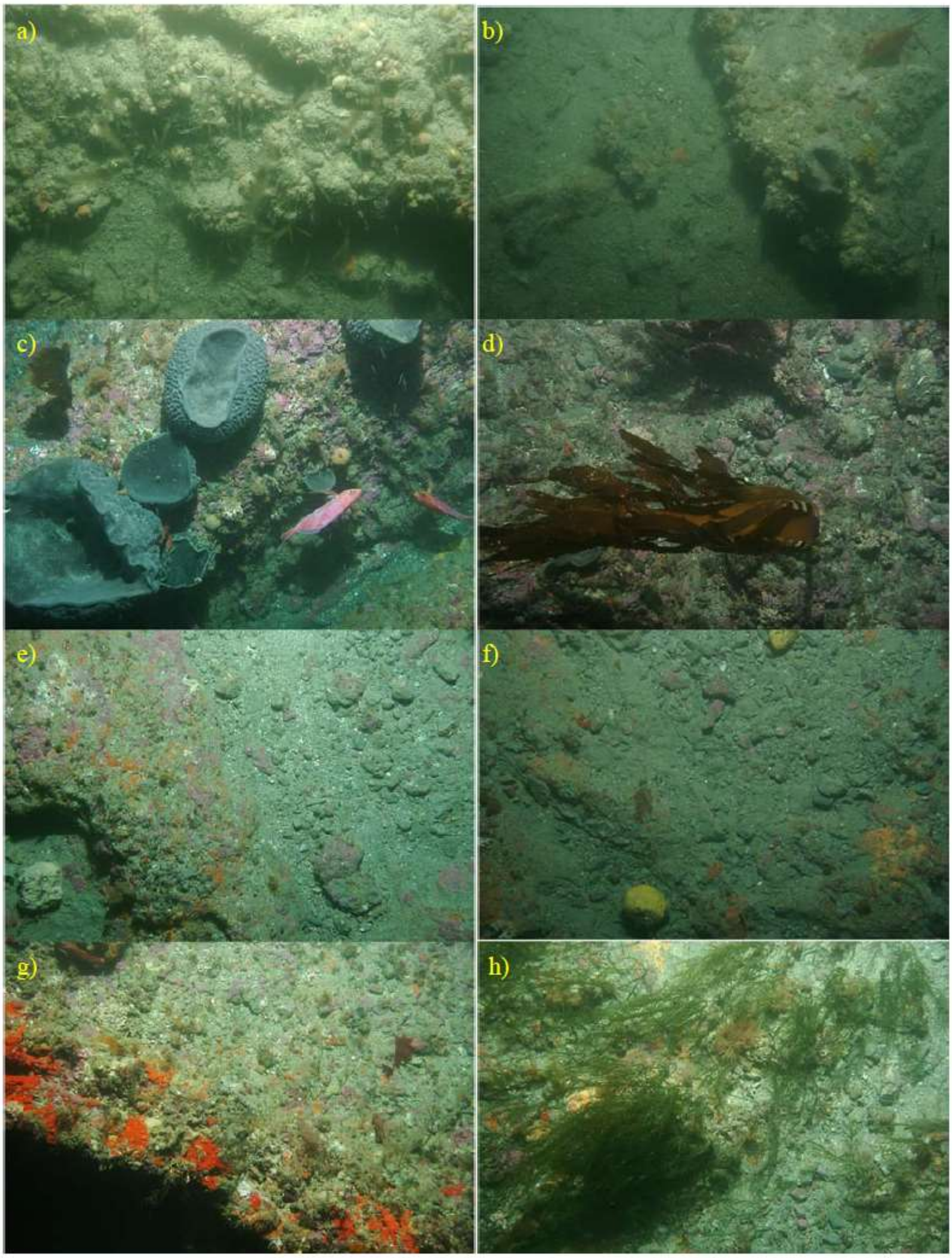

Figure 3-8 *Ariel Bank seafloor imagery: a–b) sedimented reef at Station 194, with brachiopods, cup corals, sponges, and bryozoans; c) large grey cup sponges and pink maomao; d) E. radiata and corallines; e–g) low reef and rubble with sponges and corallines; h) Caulerpa sp. (from Jones et al. 2018).*

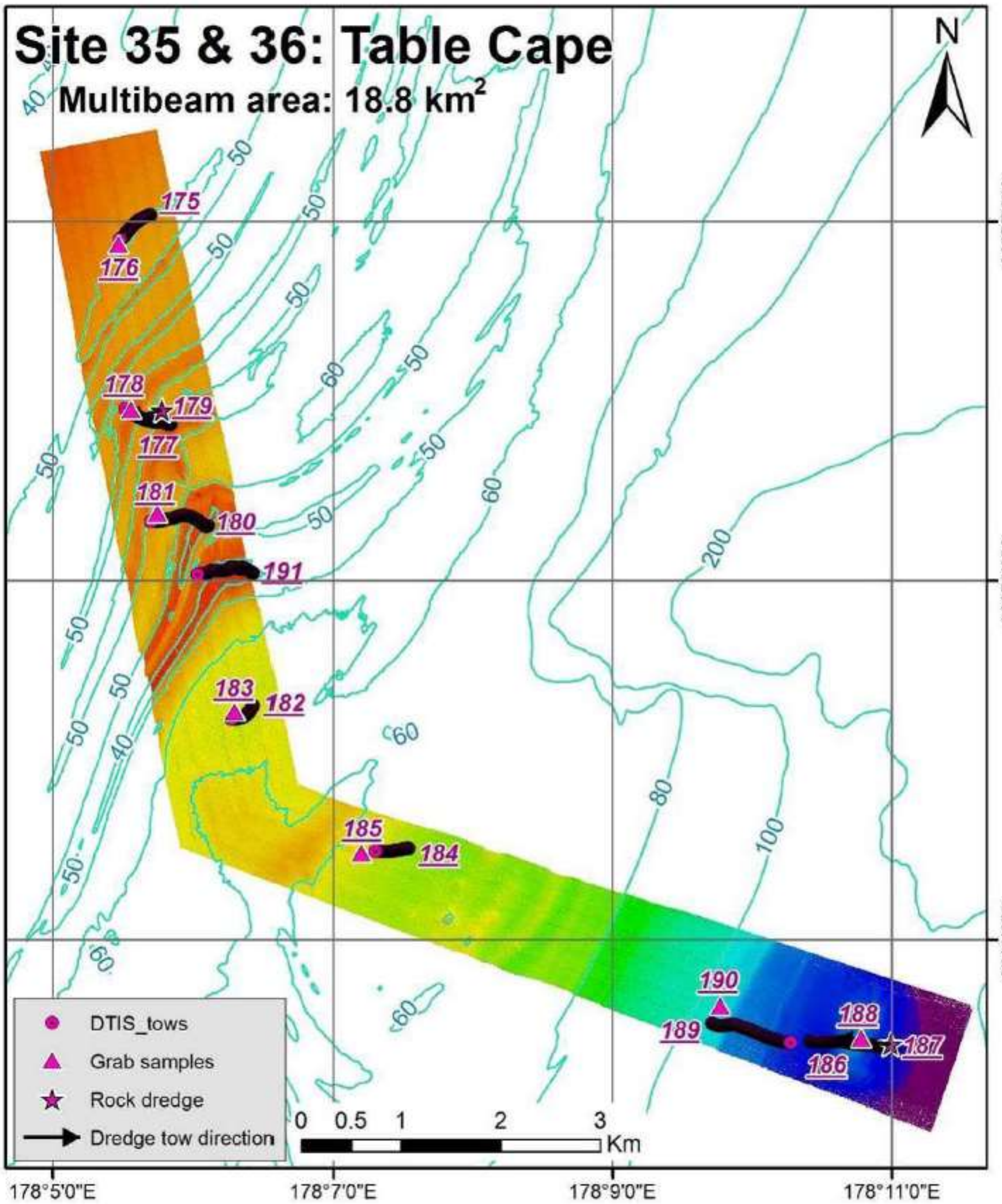

Figure 3-9 *Bathymetry of Table Cape, off Mahia Peninsula from Jones et al. 2018. Map shows locations of 8 DTIS, 2 rock dredge, 7 sediment sampling stations (from Jones et al. 2018).*

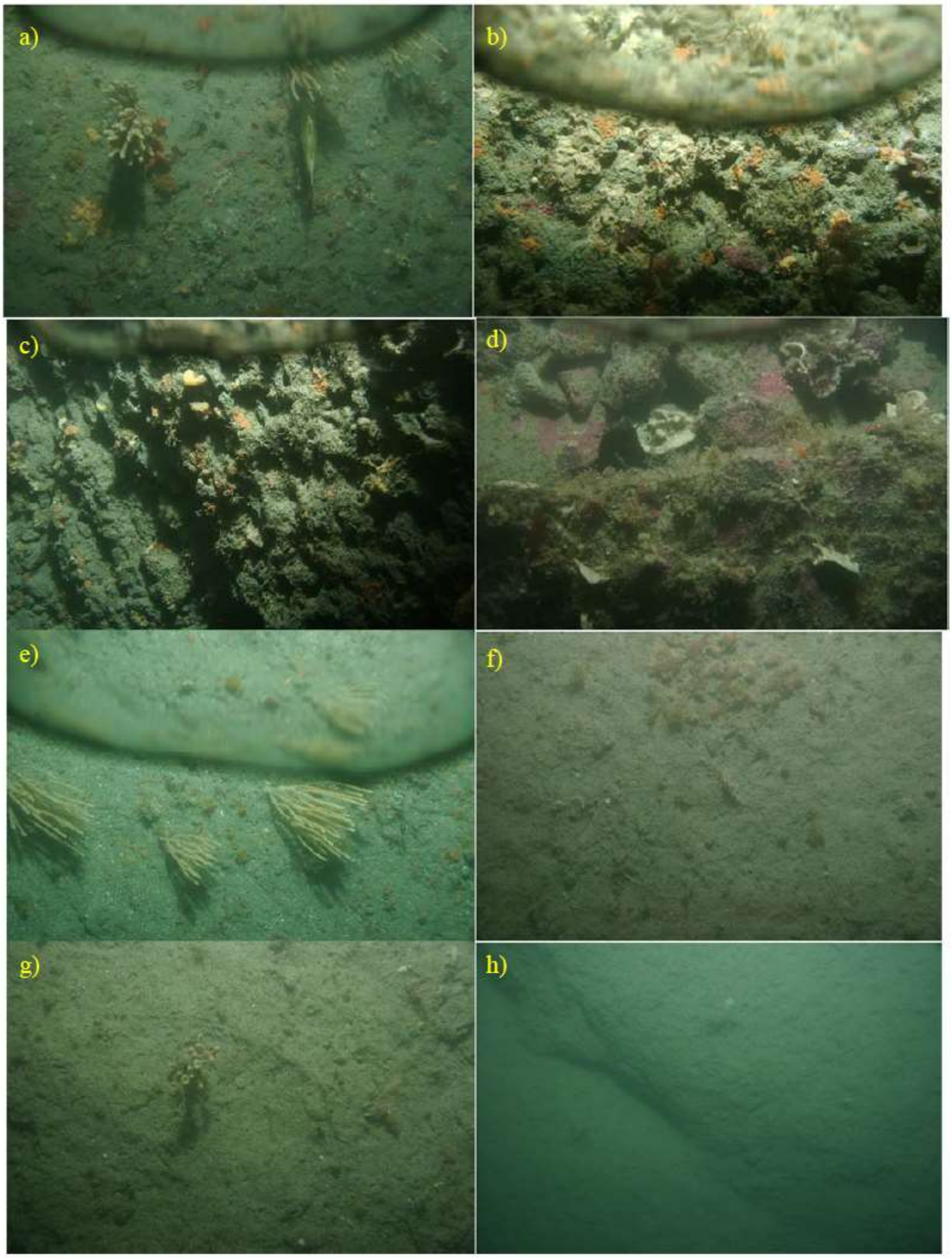

Figure 3-10 *Table Cape, off Mahia Peninsula, seafloor imagery (there is an air-bubble artefact in some images): a) sponges with sleeping leather-jacket; b–c) bryozoans and sponges; d) sponges, bryozoans, coralline algae; e) finger sponge and bryozoans; f) sponge on sedimented rock flat; g) sponge on sedimented rock flat; h) bare sedimented rock flat (from Jones et al. 2018).*

3.2 The Coast

Primary data sources for section 3.2

ASR (2005) East Cape biological habitat survey: A Drop-Camera Survey of East Cape Sub-tidal Areas. A report prepared for the Department of Conservation – East Coast Hawke's Bay Conservancy.

Wilson C, Freeman D, Hogan K, Thompson K (2007) Maori methods and indicators for marine protection: Summary of research findings. Ngāti Kere, Ngāti Kōnohi, Ministry for the Environment, Department of Conservation. 59 p.

Shears NT, Babcock RC (2007) Quantitative description of mainland New Zealand's shallow subtidal reef communities Depatment of Conservation, Science for Conservation 280.

AWC (Allan Wilson Centre) (2015) Uawa/Tolaga Bay Bioblitz 2015 summary.

3.2.1 East Cape

The East Cape region is known to be an important biogeographic feature influencing the distributions of many taxa (Roberts & Stewart 2006 and references therein). The fish communities of inshore reefs along the coastline were sampled by Roberts and Stewart (2006), who described the reefs as hard sandstone and softer mudstone (papa), supporting a variety of macroalgae, sponges and bryozoan clumps, although some areas were noted to be heavily sedimented. Cole et al (2003), sampled four sites for reef-fish fauna on either side of Cape Runaway as part of a wider survey of the Bay of Plenty, and noted greater sediment loads on the western side, along with an absence of the kelp *Lessonia variegata*.

The East Cape region has a complex geology while Te Araroa to Whangaokena Island (East Island) are predominantly Miocene sedimentary reef (intertidal and subtidal), characterised by very calcareous sandy siltstone (lower unit – Pohutu formation) and fossiliferous silty sandstone (upper unit – Paeoneone Formation). Contact between the two is gradual (Kenny and Hayward 1996). Around East Cape, shore platforms are interdispersed by alluvial plains and sand beaches of the Turanui Catchment. Huatai Beach is the only significant beach in the area between Horoera Point and Te Wharenaonao Point, extending inland to the base of marine terraces. It is approximately 5 km in extent. The beach is accreting and is derived of material predominantly from the Waiapu River system.

The shore at Te Araroa is comprised of soft sandstones and siltstones and extensive intertidal platforms occur to the south. A small sandy beach occurs at Maruhou and just west of Horoera Point, Orutua River crosses the foreshore. Reef platforms create small inshore lagoons and channels. The area between Te Araroa and Horoera is backed by sedimentary cliffs rising to 200 metres.

Whangaokena Island is a predominant feature of East Cape. It is located 2 km offshore from the Cape and is steep-sided rising to 129 m, being 8 ha in extent. Whangaokena Island is surrounded by intertidal siltstone reefs eroded by wind and waves. These give way to harder reef, boulders and cobbles areas below the immediate subtidal.

Intertidal and subtidal communities of the survey area are influenced by three main rivers Orutua, Awatere and Waiapu, and numerous small streams. Their associated sediment loadings have been proposed to affect shore and reef systems (Seymour et al. 1990). Intertidal areas and near-shore subtidal regions are also subject to harvesting (recreational and commercial) particularly kina and paua, reef fish (e.g., snapper, blue cod, trevally) and lobster (see notes in Seymour et al. 1990; ASR 2005).

The only detailed habitat information for this area comes from a bathymetry and drop-camera survey, conducted in 2005, which mapped reef habitats down to a depth of 40 m (ASR 2005). The survey included 820 video drops between Te Araroa and Whangaokena Island and a qualitative analysis of footage taken on the northwestern side of Whangaokena Island (intertidal and subtidal).

The biological habitats identified in this study were broadly similar to those described for Cape Runaway by Mead *et al.* (2003) and were in accordance with the range of habitats identified by Shears *et al.* (2004) for south-eastern North Island subtidal communities (**Figure 3-11**). Notably, the presence of dense beds of *Carpophyllum maschalocarpum* in shallow-water and the absence of urchin barrens habitat.

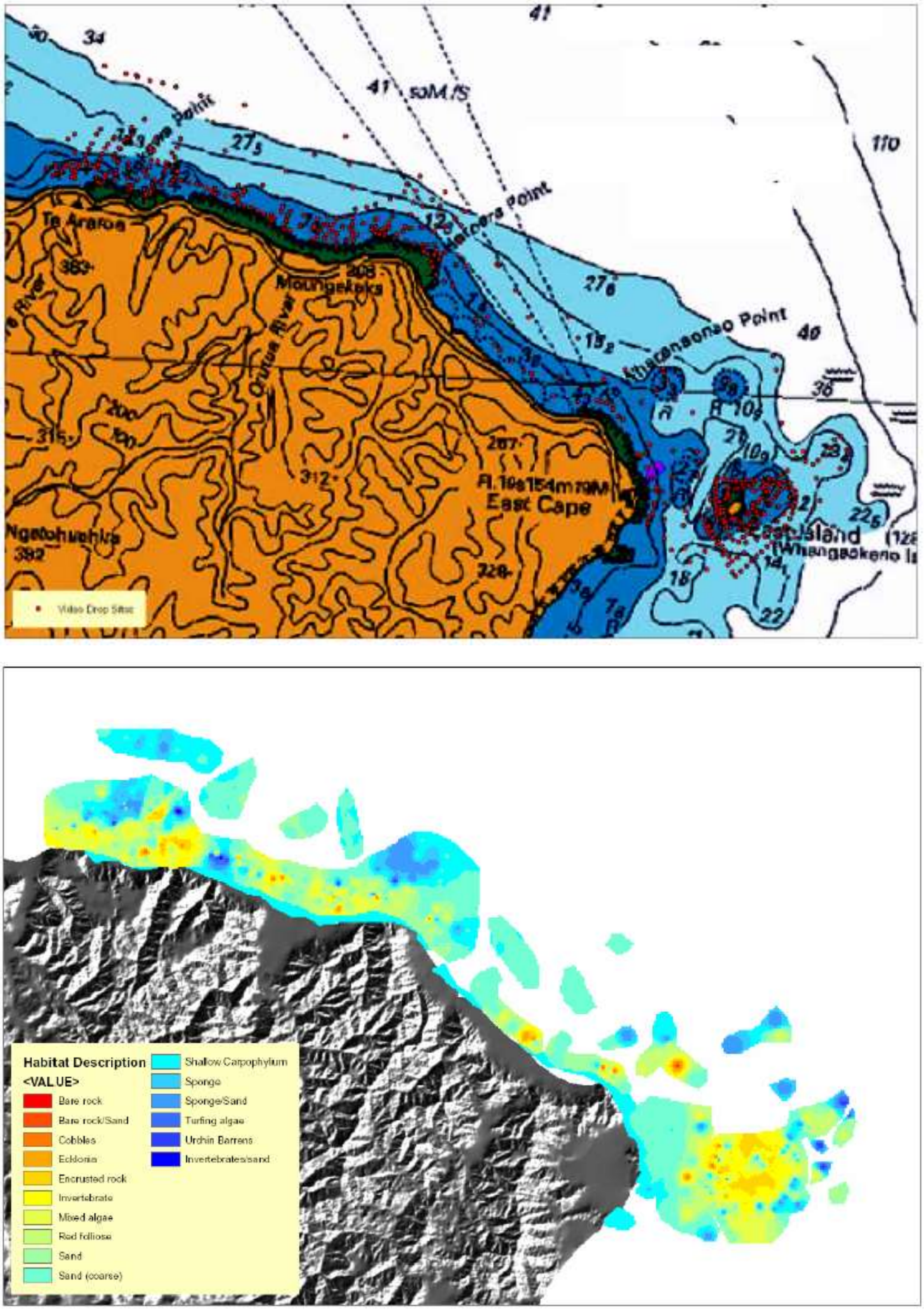

Figure 3-11 *Locations of 820 video drop sites (upper panel) and habitat distribution (lower panel) in the Whangaokena Island (East Island) Marine Survey area (ASR 2005).*

Figure 3-12 *Thick canopies of Durvillea Antarctica on intertidal platforms at Whangaokena Island (East Island) (ASR 2005).*

The subtidal biological habitats of Whangaokena Island, including the coastline between East Cape and Te Araroa are typical of that of northern New Zealand, having a degree of commonality with Cape Runaway (Mead *et al.* 2003) and Gisborne and Mahia (Shears 2003). Specifically, habitats include: dense bands of *Carpophyllum maschalocarpum* and *Durvillea antarctica* in shallow intertidal areas (**Figure 3-12**), and dense patches of *Carpophyllum maschalocarpum* in the shallow subtidal, giving way to stands of *E. radiata*, encrusted rock or bare rock, followed by sponge flat habitat.

Compared to Whangaokena Island, where *E. radiata* habitat is generally abundant between 5 and 12 m depth, the depth distribution of *E. radiata* habitat is extremely reduced between Te Araroa and East Cape. Furthermore, *E. radiata* habitat did not extend as far as kelp forest habitat at some nearby locations (for example, Cape Runaway where Mead *et al.* (2003) documented *E. radiata* forest down to 35 m). Shears and Babcock (2003b) suggest that depth distributions of broad zones (e.g., C*arpophyllum maschalocarpum*, urchin barrens, *E. radiata* habitat) tend to change with wave exposure. Shears and Babcock (2003b) also noted *E. radiata* forest intermixed with *Caulerpa articulata* at Gisborne, although no *Caulerpa* habitat was observed in the present study.

The lack of *E. radiata* beyond 15 m depth at Whangaokena Island and its low abundance between Te Araroa and East Cape was suggested to be an artefact of light limitation created by suspended solids in the water column (ASR 2005). Moreover, local accounts indicated a decrease in water quality (increased turbidity) in the survey area over the ten years to 2005. Generally, in areas not occupied by macroalgae, bare reef covered with sediment patches, encrusting algae, encrusting sponges and ascidians characterised subtidal rocky reef areas between East Cape and Te Araroa. A lack of *Evechinus chloroticus*, despite expansive areas of bare reef, was noted. Low urchin densities across the entire survey area were similar to patterns described for Mahia and Gisborne (Shears and Babcock. 2003b) and the eastern side of Cape Runaway (Mead *et al.* 2003).

Anecdotal evidence suggests that urchin barrens have, in the past, been a prevalent feature of subtidal reefs around Whangaokena Island and along parts of the East Cape coastline (ASR 2005). The subsequent reduction may be an artefact of intensive urchin harvesting, or gradual changes in environmental conditions, e.g., increased sedimentation through space and time. However, experiments have shown that factors such as sedimentation can severely inhibit *E. chloroticus* larval settlement (Walker 2007).

ASR (2005) suggested that recruitment inhibition on account of large fluvial inputs and sedimentation effects, particularly fine silt settling out onto reefs, and the removal of adults through harvesting may be a very likely cause of reductions in urchin abundance both at a localised and regional level (see Airoldi 2003). Diverse and expansive sponge habitat composed of encrusting and erect forms is particularly common in deep-reef habitats throughout the East Cape area e.g., around Horoera Point, and north-west, north-east and south of Whangaokena Island. The sponge communities within these areas were more-diverse than that described for Cape Runaway (Mead *et al.* 2003, ASR 2005) and are considered to provide important biogenic habitat and shelter for a range of species, particularly juvenile fishes.

Based on its rippled appearance, sand flats habitat in the survey area is likely to be highly mobile. Sandy areas within the survey area are relatively featureless and no bivalve communities were observed. Furthermore, in numerous areas the sand is silty in nature, no doubt due to the presence of streams and rivers that introduce silt-laden waters into this area after heavy rains.

3.2.2 Te Tapuwae o Rongokako

A habitat map of the Te Tapuwae o Rongokako Marine Reserve was produced as part of the Maori Methods and Indicators for Marine Protection report (**Figure 3-13**; Wilson et al. 2007). The map is based on a survey conducted by ASR (2003; no report was produced for this survey, only unpublished maps and raw imagery), plus some additional dropcam and diver surveys conducted by DOC.

Te Tapuwae o Rongokako Marine Reserve was demonstrated to contain seven distinct habitats: shallow Carpophyllum, coralline algal-covered reef, mixed algae, *E. radiata* (kelp) forest, sponge garden, deep cobbles and sand (Figure 3-13). The structurally complex deep cobble habitat surrounding the two pinnacles comprising Monowai Reef, which is located to the northeast of the marine reserve, and indeed Monowai Reef itself, are habitats that are not well represented in the reserve. The deep cobble habitat is potentially biologically diverse and may be an important area not only for foraging but also as a nursery habitat for juvenile fish.

Several studies have examined the abundance of key species at Te Tapuwae o Rongokako Marine Reserve. Reef fish, lobsters, and intertidal paua and kina populations were monitored over several years. Reserve and non-reserve sites were surveyed. Reef fish were surveyed using underwater visual census (Freeman & Duffy 2003; Freeman 2005), with divers recording species diversity, abundance and size. Lobsters were surveyed using divers and commercial pots. Paua and kina were monitored in channels and pools in intertidal reef platforms (Freeman 2006).

Shears and Babcock (2007) also conducted benthic surveys at sites in and adjacent to the Te Tapuwae o Rongokako Marine Reserve (Pouawa North, Pouawa South, Badley Reef and Makarori). The biodiversity at these sites was comparable to sites surveyed along the Northeastern coast of New Zealand, and their algal communities were typically dominated by the same few species (*E. radiata, Carpophyllum*

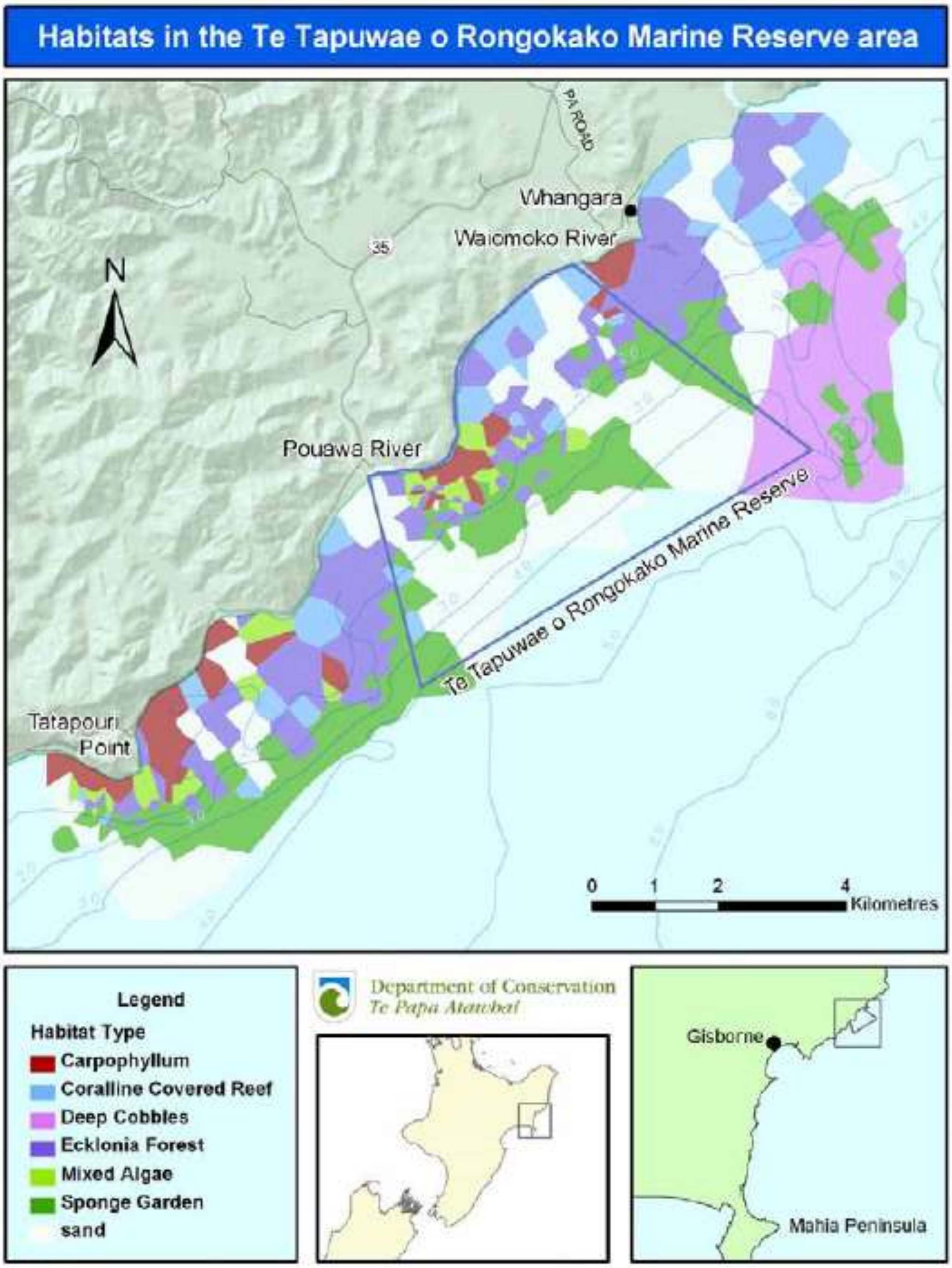

Figure 3-13 *Habitat map of part of the rohe of Ngati Konohi, showing the boundary of Te Tapuwae o Rongokako Marine Reserve. This area was mapped using diver, sidescan sonar and remote video surveys.*

maschalocarpum, C. flexuosum). Algal community structure was relatively similar between these sites and those surveyed at Mahia. Te Tapuwae o Rongokako sites sampled were described as highly exposed compared to most Northeastern locations. Wave exposure was estimated to be similar to Cape Reinga, with the most wave-exposed sites having reduced biomass of *E. radiata*.

Algal biomass declined with depth at Gisborne and Mahia, and *Evechinus chloroticus* was rare. *Carpophyllum maschalocarpum* dominated shallow depths down to *c*. 6 m. *E. radiata* forests were mixed with *C. flexuosum* and the green algae *Caulerpa articulata*. *Landsburgia quercifolia*, *Lessonia variegata* and *Cystophora* spp. were not recorded at any of the sampling sites in this region (**Figure 3-14**). *Durvillaea antarctica* was common in the intertidal and in some cases small plants did extend into the shallow subtidal. The small brown algal species *Zonaria* spp. and *Carpomitra costata* were common. Several red foliose algal species were also present, e.g. *Osmundaria colensoi, Pterocladia lucida* and *Plocamium* spp. The substratum was dominated by crustose coralline algae and the percentage cover of sediment increased with depth. Few mobile macroinvertebrates were recorded, with only low numbers of *Haliotis australis*, *Cantharidus purpureus*, *Cookia sulcata*, *Trochus viridis* and *Modelia granosa* being present. *Haliotis iris* was not recorded at the sites surveyed.

3.2.3 Uawa / Tologa Bay Bioblitz

In February 2015, scientists from the Allan Wilson Centre along with DOC, GDC, community members, and the Tolaga Bay Area School undertook a bioblitz at Uawa / Tolaga Bay. Over six main sites, and an additional three areas, scientists and students undertook field trips to identify and record species of plants and animals (**Figure 3-16**). Scientists and students also worked at the “Basecamp” in the school hall to identify species and learn from specialists. The focus of this bioblitz was on quick visits to a range of sites and a strong component of involving school students in science, rather than an intensive and complete species inventory.

The bioblitz was part of the Uawanui Project – a long term project to enhance the health of the whole Uawa River Catchment environment and people. It provides a benchmark of the range of species present and some of the opportunities available to the Uawanui Project to enhance important biodiversity. It also supported the Tolaga Bay Area School, Te Aitanga a Hauiti and the Uawa Tolaga Bay Community in their understanding of the key biological values and science of their place.

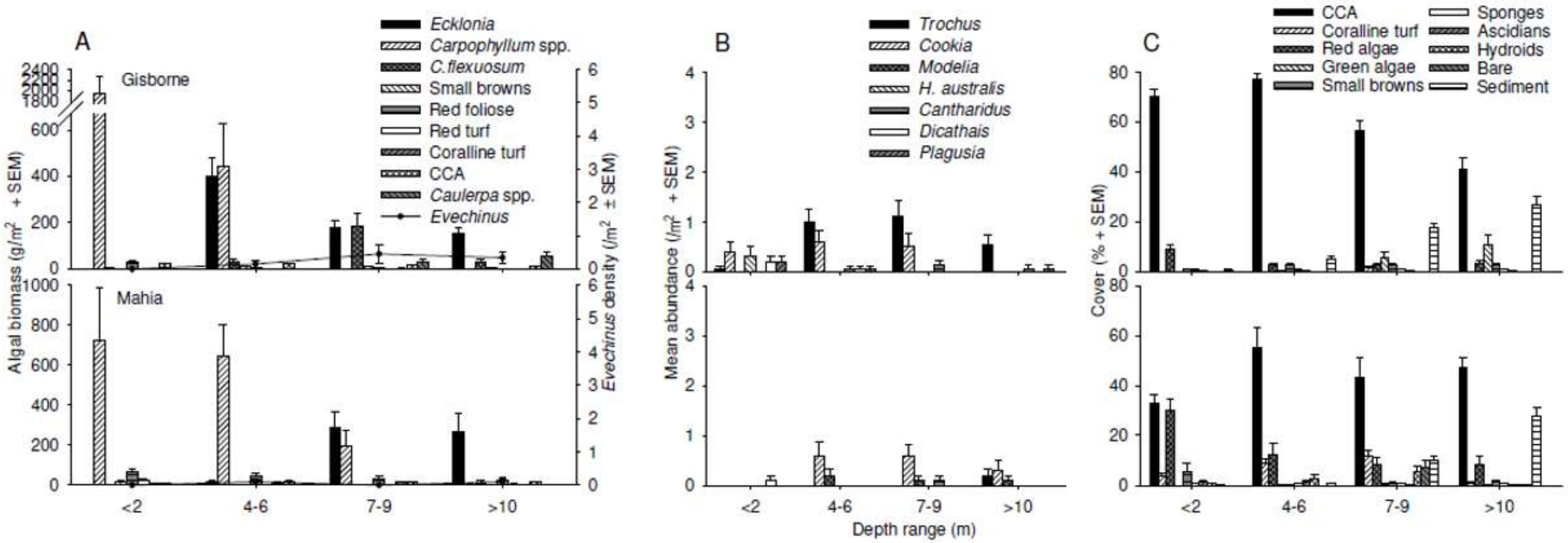

Figure 3-14 *Depth-related patterns in biomass (g AFDW/m2) of dominant macroalgal groups and density of Evechinus chloroticus (A), density of common mobile invertebrates (B) and cover of common encrusting forms (C) for sites at within the Portland bioregion (Te Tapuwae o Rongokako Marine Reserve and Mahia).(From Sears and Babcock 2007).*

Figure 3-15 *Field sites (indicated in red) for the 2015 Uawa/Tolaga Bay Bioblitz (From AWC 2015)*

Figure 3-16 *Coastal field surveys during the Uawa/Tolaga Bay Bioblitz (From AWC 2015).*

Coastal sites visited during the bioblitz included Kaiaua Bay, Opoutama Cooks Cove, Tatarahake, the coast adjacent to the Tologa Bay School and Kaitawa Estuary. Although coastal habitats were not mapped as part of this project, the bioblitz provides the only biodiversity record for these coastal sites. The study recorded a total of 526 species. Half were animals and half were plants (including marine algae).

3.3 Estuaries

Primary data sources for section 3.3

McClay, C.L (1976) An inventory of the status and origin of New Zealand estuarine systems. Proceedings of the New Zealand Ecological Society 23: 8-26.

Plew D, Dudley B, Shankar U, Zeldis J (2018) Assessment of the eutrophication susceptibility of New Zealand Estuaries. Prepared for the Ministry for the Environment. 64p.

AWC (2015) Uawa/Tolaga Bay Bioblitz

Ruru I (2007) Upstream migration of glass eels in the Waipaoa River. Report for Te Aitanga a Mahaki & Te Wai Maori Trust. 21p.

In his early inventory of the status and origin of New Zealand estuarine systems, McLay (1976), summarises the estuarine environment as the interface (link) between the freshwater and marine environment. By default these systems experience rapid environmental fluctuations associated with regular tidal cycles, flood events and wave surge, and are thus highly variable and dynamic environments. McLay (1976) describes many estuaries as highly productive systems due to the input of nutrient-rich freshwater (partly human-induced) and noting their physical diversity across New Zealand including lagoons, bar built, drowned river valley and fiord.

For the Gisborne District, there is little in the way of ecological description of estuarine habitats. McClay (1976) provided topographical classifications for many of the districts estuaries and area estimates for the Waiapu, Uawa river mouth and Wherowhero lagoon (**Table 3-1**). Plew et al. (2018) provide further classification of the regions estuaries in a study which set out to provide a body of knowledge that could help decision-makers effectively manage water quality and flows under the National Policy Statement for Freshwater Management (2014) (**Table 3-2**).

The study generated:

- Maps of ‘potential’ nitrogen concentrations (i.e., the concentration that would exist in the absence of biological processes that result in nutrient loss within estuaries) for all estuaries in NIWA’s coastal database, considering loads from land and processes of freshwater flow and mixing with salt water that depend on physical processes in each estuary;

- Maps of susceptibility to eutrophication as manifested by excess growth of macroalgae and phytoplankton for all these estuaries resulting from these nitrogen loads, using methods developed for the NZ Estuary Trophic Index (ETI);
- A comparison of nitrogen loading and susceptibility to eutrophication under current conditions with conditions before arrival of humans in New Zealand.

Plew et al. (2018) concluded that that physical characteristics of estuaries affect their response to nitrogen loading, in terms of water nitrogen concentrations and eutrophication susceptibility. Estuaries with high sensitivity to increases in nitrogen loads typically have high proportions of intertidal area, low dilution, or long flushing times. Few Tairawhiti estuaries fit this description.

Tairawhiti's estuaries are generally small (for example the Wharekahika, Karakatuwhero and Waiapu Rivers) and often take on the distinctive form of ribbon estuaries coinciding with low lying and subsequently low flowing river systems (**Figure 3-17**). Examples of these types of estuaries include the confluence of the mouths of the Tūranganui and Waimata Rivers. The Kaitawa estuary at Tolaga Bay and Wherowhero lagoon in Tūranganui-a-Kiwa/Poverty Bay are the largest estuaries in the district and the most significant estuarine habitats for wading and other water birds (**Figure 3-17**). They are also important as habitat for soft sediment shellfish such as cockles. Awapuni Lagoon - a tidal estuary associated with the Waipaoa River mouth - was destroyed by drainage and farm development as recently as the late 1950s - 1960s.

Information on biodiversity in Tairawhiti's estuaries is very limited. The Uawa / Tologa Bay Bioblitz included the Kaitawa estuary at the mouth of the Uawa River identifying 18 bird species, three bivalves two crab species, two amphipods, five estuarine snails and numerous terrestrial plants and animals living around the estuary (AWC 2015). At the Waipaoa River, Ruru (2007) examined the arrival patterns of shortfin (*Anguilla australis*) and longfin (*A. dieffenbachii*) glass eels and compared arrival frequency to environmental conditions. It was suggested the future eel management initiatives would include prudent harvest measures, restocking, and habitat restoration to rebuild numbers and sizes of eels available for customary use.

Figure 3-17 *Major estuaries and river mouths in Tairawhiti*

Table 3-1 *Summary data from McClay 1976 describing key features of Gisborne District's estuaries and river mouths (n.e. = not estimated; n.k. = not known).*

Estuary	Area (ha)	Topographic classification	Degree of stratification	Condition	Change in condition since 1965
Hicks Bay (Wharekahiki. and Mangatutu Stream mouths)	n.e.	Bar built	n.k.	n.k.	n.k.
Karakatuwhero river mouth	n.e.	Lagoonal	n.k.	n.k.	n.k.
Awatere river mouth	n.e.	Lagoonal	n.k.	n.k.	n.k.
Waiapu river mouth	159	Lagoonal	n.k.	n.k.	n.k.
Uawa river mouth	2,178	Bar built	n.k.	n.k.	n.k.
Pakarae river mouth	n.e.	Bar built	n.k.	n.k.	n.k.
Turanginui river mouth	n.e.	Drowned River	n.k.	n.k.	n.k.
Waipaoa river mouth	n.e.	Lagoonal	n.k.	n.k.	n.k.
Wherowhero Lagoon	118	Bar built	n.k.	Slightly polluted	Similar

Table 3-2 *Summary data from Plew et al. 2018 describing key features of Tairawhiti's estuaries and river mouths and modelled susceptibility to eutrophication. SIDE = Shallow intertidal dominated estuaries; SSRTRE = Shallow, short residence time river and tidal river with adjoining lagoon estuaries; NZCHS = New Zealand Coastal Hydrosystems Classification; ETI = Estuary Trophic Index. Macroalgae, phytoplankton and ETI susceptibility band descriptions (A = Minimal eutrophication; B = Moderate eutrophication; C = High eutrophication; D = Very high eutrophication).*

Estuary	Regional Council	NZCHS code	ETI class	LAT (WGS 84)	LON (WGS 84)	Tidal prism spring tide (m^3)	Volume spring tide (m3)	Intertidal area (%)	Catchment Area (ha)	Mean freshwater inflow (m^3/s)	Flushing time (days)	Freshwater fraction (%)	TN load (T/yr)			Estuary TN Concentration (mg/m^3)			chl-a (µg/l)			Macroalgae Band			Phytoplankton Band			ETI Susceptibility Band		
													Pristine	Pre-human	Current	Pristine	Pre-human	Current	Pristine	Pre-human	Current	Pristine	Pre-human	Current	Pristine	Pre-human	Current	Pristine	Pre-human	Current
Pouawa River	GDC	6B	SSRTRE	-38.617	178.190	81407	135668	8	4254	0.67	1.1	48	6.070	13.225	25.935	18	308	596	0.0	0.0	0.0	A	C	D	A	A	A	A	C	D
Turanganui River	GDC	6B	SSRTRE	-38.676	178.022	869183	895593	0	32355	4.39	1.0	42	39.577	86.226	176.563	130	272	546	0.0	0.0	0.0	B	C	D	A	A	A	A	A	A
Waipaoa River	GDC	6B	SSRTRE	-38.716	177.945	1529244	4675430	2	218313	39.92	0.1	4	271.200	590.864	1229.427	25	35	57	0.0	0.0	0.0	A	A	A	A	A	A	A	A	A
Wherowhero Lagoon	GDC	7A	SIDE	-38.748	177.952	655772	1052427	23	2478	0.18	10.1	15	2.512	5.473	12.785	80	158	350	6.5	15.4	37.2	A	B	D	B	C	D	B	C	D
Maraetaha River	GDC	6A	SSRTRE	-38.792	177.937	82547	139987	1	7841	1.88	0.6	71	11.982	26.104	54.215	17	319	658	0.0	0.0	0.0	A	C	D	A	A	A	A	A	A
Maungawhio Lagoon	GDC	7A	SIDE	-39.072	177.908	829969	1034215	79	7384	2.46	1.8	37	11.259	24.530	48.457	64	127	242	0.0	0.0	0.0	A	B	C	A	A	A	A	B	C
Wharekahika River	GDC	6D	SSRTRE	-37.576	178.297	66886	99537	34	16157	12.31	0.1	100	32.575	70.972	109.239	84	183	281	0.0	0.0	0.0	A	A	A	A	A	A	A	A	A
Karakatuwhero River	GDC	3C	SSRTRE	-37.618	178.346	40895	66045	0	8403	7.31	0.1	100	19.465	42.409	58.201	84	184	253	0.0	0.0	0.0	A	A	A	A	A	A	A	A	A
Uawa River (Tolaga Bay)	GDC	6B	SSRTRE	-38.374	178.314	1475920	3216449	23	55860	14.11	1.3	50	87.928	191.568	326.513	22	225	378	0.0	0.0	0.0	A	C	D	A	A	A	A	C	D
Pakarae River	GDC	6B	SSRTRE	-38.562	178.253	381278	645017	0	24437	5.12	0.8	57	38.620	84.143	182.108	20	303	648	0.0	0.0	0.0	A	C	D	A	A	A	A	A	A
Waiomoko River	GDC	6B	SSRTRE	-38.584	178.226	170479	288697	0	7199	1.37	1.2	48	10.190	22.201	58.199	18	254	651	0.0	0.0	0.0	A	C	D	A	A	A	A	A	A

4.0 Mātauranga Māori

Primary data sources for section 4

Science Learning Hub (2020) (https://www.sciencelearn.org.nz/resources/2545-matauranga-maori-and-science) (Accessed June 2020)

Ruru I, et al. (2020) Wastewater Overflows in Wet Weather Storm Events and in Dry Weather Report on Tangata Whenua Engagement. Report prepared by the Kiwa Group for Gisborne District Council. 331p.

Wilson C, Freeman D, Hogan K, Thompson K (2007) Maori methods and indicators for marine protection: Summary of research findings. Ngāti Kere, Ngāti Kōnohi, Ministry for the Environment, Department of Conservation. 59 pp

Mātauranga Māori is a modern term for the combined knowledge of Polynesian ancestors and the experiences of Māori living in the environment of Aotearoa. The term takes many forms, such as language (te reo), education (mātauranga), traditional environmental knowledge (taonga tuku iho, mātauranga o te taiao), traditional knowledge of cultural practice, such as healing and medicines (rongoā), fishing (hī ika) and cultivation (mahinga kai) (Science Learning Hub 2020).

In a traditional sense, mātauranga Māori refers to the knowledge, comprehension or understanding of everything visible or invisible that exists within the universe. Early Māori culture was based on oral lore and had a justice system based on chiefs and tohunga (the knowledge experts). Such experts were chosen from an early age and educated within wānanga (learning institutions) to remember vast amounts of knowledge. The knowledge of the hapū (tribe) and iwi were entrusted to these experts, who would then pass their knowledge on to future experts. The way to memorise such a volume of complex material involved using a whakapapa (genealogical) framework. Whakapapa is used to explain genealogies and taxonomies, to create categories and families of flora and fauna and to describe environmental and life issues (SLH 2020).

Retaining understanding in this way has enabled Māori knowledge to be passed on from one generation to another. This body of knowledge arises from the experiences of Māori living in the environment of Aotearoa. Many people have realised that mātauranga Māori contains potentially useful knowledge, for example, about utilising and preserving the environment (SLH 2020).

There is considerable knowledge of coastal ecosystems held by tangata whenua in Tairawhiti. This may include:

- Cultural practices, beliefs and tikanga;
- Key areas for harvesting kai moana;
- Environmental condition of mahinga kai
- Histories of the coastal ecosystems contained within purakau, whakatauki, waiata, korero tuku iho and held by tangata kaitiaki.

Regional Councils around New Zealand generally have limited understanding of, and access to mātauranga Māori but have a growing appreciation for the value of this knowledge and a desire to better understand mātauranga and incorporate it into resource management (Boffa Miskell Limited 2017). This information is at present largely inaccessible to but would be hugely value in terms of understanding changes that have occurred in the coastal ecoystems of Tairawhiti and in developing monitoring programmes with indicators that are meaningful to the people of the district.

The GDC is already working with Ian Ruru who has considerable expertise in bringing together mātauranga and academic science for environmental management purposes. Ian was involved in the development of the Māori Compass, an innovative environmental tool designed by Te Rūnanga o Tūranganui ā Kiwa and the Gisborne District Council to start conversations about mauri and restoring waterbodies. Ian has worked with GDC on numerous projects involving freshwater and coastal ecosystems. Much of this work is not published in easily accessible documents and GDC will need to work with Ian to get a better understanding of the various projects he has been involved with. Recent work includes a report on overflows of wastewater from the public wastewater network (Ruru et al. 2020). This report which documents tangata whenua engagement on the topic of wastewater overflows. While the purpose of this report was not to document changes in coastal ecology, the report contain numerous references to changes that have occurred coastal habitats over time. For example:

> *"The Waikanae Stream and the numerous rock formations sit within the Tūranganui River, such as Te Toka a Taiao, combined with the tidal flows to make a habitat for a variety of; tuna, inanga, kahawai, fish, kina, paua, koura, pipi, kanae, patiki and kutae flourishing abundantly in its reef like environment."*
>
> *"Not a lot compared to what one would expect in a natural environment. Lots of habitat transformed / degraded. Spartina again has a big impact by transforming mudflats. Increased muddiness will have affected habitat."*
>
> *"Although estuarine environments generally are soft-bottomed, the majority of the beds of the waterbodies have become unnaturally muddy (elevated 'muddiness') compared to a native state. Benthic conditions have been affected by flood management works (including excavation ion parts). Significant changes. Muddiness expected on account of a channel in very soft recently deposited*

sediments of an historically swampy floodplain…. mud content at all sites was in the range considered to cause significant persistent stress on a range of aquatic organisms"

These are references to habitats and places where scientific data is scarce and incorporates knowledge of ecosystems which pre-dates the collection of ecological data in Tairawhiti. Further discussions with these knowledge holders may yield more detailed and very useful information.

4.1 Māori methods and indicators for marine protection

> **Primary data source for section 4.1**
>
> Wilson C, Freeman D, Hogan K, Thompson K (2007) Maori methods and indicators for marine protection: Summary of research findings. Ngāti Kere, Ngāti Kōnohi, Ministry for the Environment, Department of Conservation. 59 pp

The main published scientific document containing Mātauranga Māori, relating to Tairawhiti coastal habitats, is Wilson et al. 2007 – *Maori methods and indicators for marine protection* Wilson et al. 2007. This MRST funded project aimed to understand (1) how marine reserves and alternative methods of marine management contribute to meeting iwi/hapu objectives, and (2) how marine reserves and alternative methods of marine protection contribute to meeting conservation objectives at a range of trophic levels. The purpose was to assist in determining how iwi/hapu and conservation objectives can be met through either a particular management method or a suite of methods. An additional outcome was promoting an appreciation and understanding of iwi/hapu interests, values and knowledge associated with marine management.

This was a collaborative project between Ngati Kere (Southern Hawke's Bay), Ngati Konohi (Whangara Mai Tawhiti), the Department of Conservation (DOC) and the Ministry for the Environment (MfE). The project explored the Māori marine management systems that were already implemented in the rohe of each hapu as well as considering the ways in which different management tools could works. Ngati Konohi noted that it is important to consider how indigenous and western management approaches can work together in the rohe moana, which led to the development of a concept of marine management known as the 'Tangaroa Suite'. Following the interviews with Ngati Konohi, the community research team developed a proposal for an integrated management system for the Ngati Konohi rohe moana (**Figures 4-1** and **4-2).**

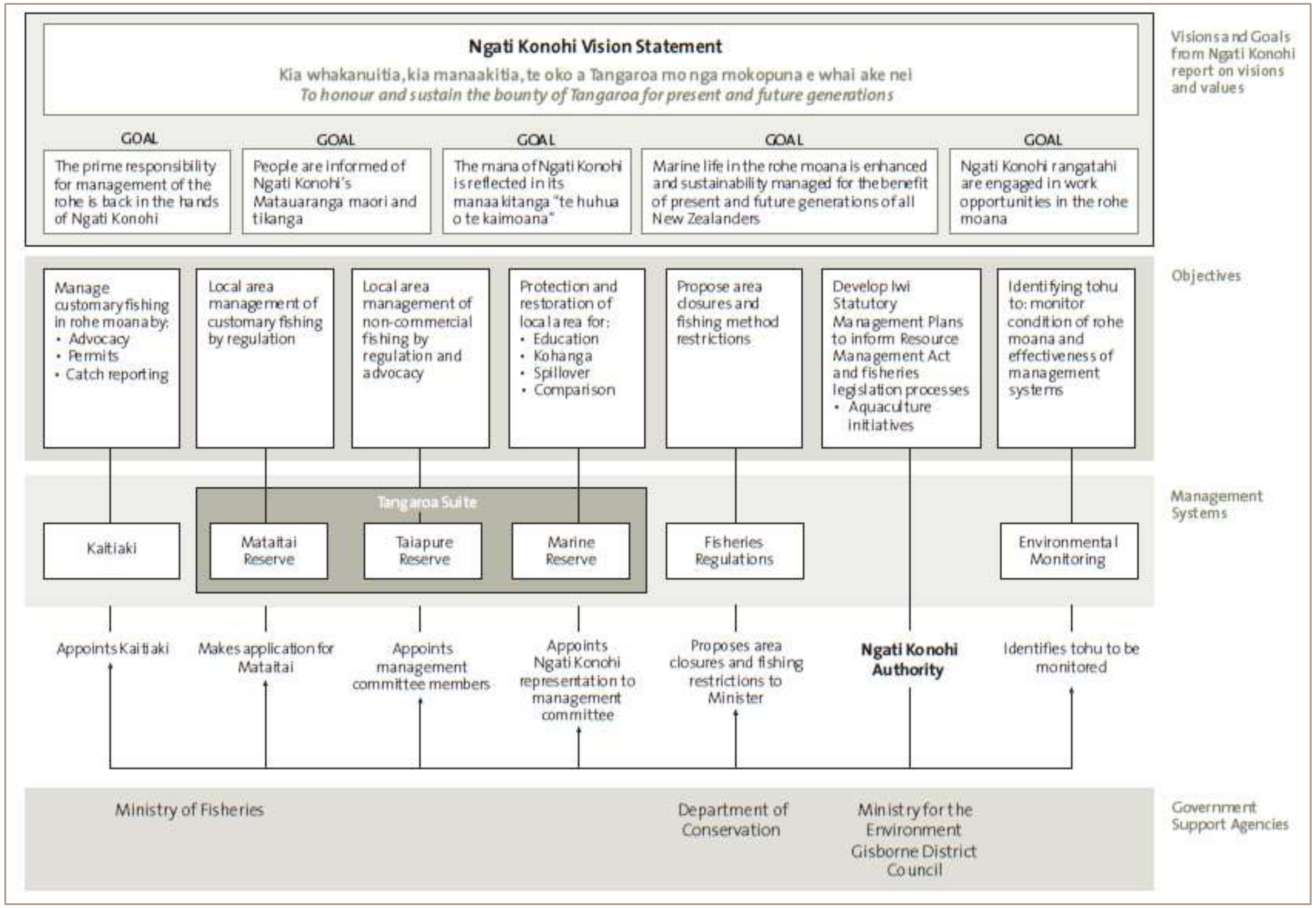

Figure 4-1 Ngati Konohi vision statement (From Wilson et al. 2007)

Primary tohu and monitoring methods

1. The mana of Ngati Konohi is reflected in its manaakitanga:
   Te huhua o te kaimoana—the abundance of seafood.

Species tohu monitor the availability, accessibility, abundance and quality of key species identified by Ngati Konohi as underpinning manaakitanga—koura, kina, pupu, parengo and ika, these being the species that are 'put on the table' for the manuhiri.

SPECIES-FOCUSED TOHU	MONITORING METHOD
Availability: Can kaimoana be readily harvested, in season, to provide for customary needs?	Information collected from customary fishing permit holders is collected and reported back to tangata whenua and MFish by Kaitiaki twice per year
Accessibility: Can kaimoana be harvested easily (in shallow water) in season?	
Abundance: Can sufficient quantities of kaimoana be harvested, in season, to meet reasonable customary needs?	
Quality: Is the appearance, size, colour, smell and taste of kaimoana 'right' in season?	

2. Marine life in the rohe moana is enhanced and sustainably managed for the benefit of present and future generations of all New Zealanders.

Process tohu monitor the condition and presence of processes that are indicative of a healthy marine environment and reflect the Ngati Konohi holistic view of the moana.

PROCESS-FOCUSED TOHU	MONITORING METHOD
A series of land-based signs (kowhai bloom, pohutukawa flowering, karaka berry colour, and ti kouka flowering) can be used to indicate kina ripeness and readiness for harvesting	Information collected from customary fishing permit holders is collected and reported back to tangata whenua and MFish by Kaitiaki twice per year
The presence of a natural and diverse range of marine species	
The presence of a natural diversity of marine species in intertidal areas including seashore birdlife	
The seasonal observation of feeding aggregations of 'bait fish' (kahawai, trevally and tarakihi) together with predators, such as tuna, marine mammals, and sea birds	
Harvesting success is positively linked to lunar phases, as identified in the Maori fishing calendar (Maramataka)	

Secondary tohu and monitoring methods:

Baseline measurements for secondary tohu are established and re-measured as and when required over time.

SECONDARY TOHU	MONITORING METHOD
A series of plots are established at various locations in the rohe moana to quantify the quantity, size and location of key indicator species: koura, kina, paua, pupu, parengo and ika	A baseline survey and database is established by hapu members or other agencies, and future measurements are completed when necessary
Gisborne District Council marine environmental monitoring data is utilised to monitor water quality, shellfish health, beach bathing standards, etc.	Data obtained from the council as required

Figure 4-2 *Ngati Konohi tohu (indicators) for their rohe moana (From Wilson et al. 2007)*

This suggests how Ngati Konohi's vision 'to honour and sustain the bounty of Tangaroa for present and future generations' could be addressed with the assistance of modern management systems.

Ngato Konohi and Ngati Kere both raised serious concerns about the decline in the quantity and diversity of many species and the health of the rohe moana, and thus the ability to sustain traditional use and maintain the mauri of the rohe. Kaimoana is connected to mana, particularly with regard to being able to provide kai for visitors and manaakitanga/hospitality. As well as providing kaimoana, local flora and fauna are important for sustenance, tradition, education, and providing tools and inspiration for weaving, carving and crafts. They can be a source of income and can also be used for medicine and decoration.

Through the project Ngati Konohi developed a number of tohu (indicators) to be used as signs to indicate the health of the marine environment (see **Figure 4-2**). These tohu can be used to measure change in the marine environment, lead the hapu in sustaining their vision for the environment, promote better relationships between Māori and non-Māori when managing the environment and gauge the success of environmental management systems.

Primary tohu were observations of the health of the kaimoana and of the natural processes that denote the health of the marine environment with information collated via customary fishing permit holders and kaitiaki. Secondary tohu are scientific measurements of the kaimoana present and other things that denote the health of the marine environment with information collected by hapu members or in collaboration with environmental managers.

Once tohu were developed there were significant barriers to implementing these monitoring programmes. These included having Tangata Kaitiaki established in their role as managers of customary fishing and then developing the capability to collect, collate, analyse and report against the tohu. Ngati Konohi acknowledged that more information was needed to provide a detailed picture of the quality of the marine environment, particularly with regard to the abundance of the most sought after species, their accessibility, and the quality or condition of the resource gathered.

These are many of the same challenges faced by GDC in managing the CMA. It was concluded that to produce the information required for implementation of the tohu that data collected from customary users by the Tangata Kaitiaki may need to be supplemented by information from other sources.

The approach used in this project is a good example of environmental management agencies engaging and collaborating with tangata whenua. This is an approach that should be used in the future in Tairawhiti.

4.2 Other mātauranga projects in Tairawhiti

There are at least three ongoing projects funded by the Sustainable Seas National Science Challenge and focused on Tairawhiti that are Māori led and focus on using mātauranga Māori for enhancing and managing the CMA.

4.2.1 Ngā Tohu o te Ao: Utilising maramataka as a framework for marine management, *Caine Taiapa, Manaaki Te Awanui.*

The Maori moon calendar or Maramataka is an ancient knowledge system developed over many millennia though an intimate connection with the environment. Maramataka is a natural timekeeping system that utilises the movement of the moon through any given month or season to determine appropriate times for various customary activities. Although maramataka are not as widely applied in the present day, the knowledge and practices surrounding moon calendars have been preserved in indigenous communities across and Pacific. In Aotearoa, maramataka is still applied by indigenous practitioners and it continues to inform interaction with the environment and guide ecosystem management practices. The survival of maramataka throughout time has established it as a recognised instrument for indigenous ecological knowledge development and preservation.

This research program aims to inform EBM through reclamation of maramataka theory and practice. Maramataka will be used as a tool to explore indigenous ecological knowledge specific to coastal and marine ecosystems. This project will investigate the use of maramataka as a framework for development of cultural coastal indicators and will look to inform culturally responsive practice in marine monitoring.

This project will be developed over three case study areas throughout Aotearoa. One of these case study areas is Tokomaru Bay in Tairawhiti. These case study groups will set the foundation for collective inquiry into maramataka and indigenous ecological knowledge. Wananga will be utilised as the method for indigenous knowledge inquiry. A series of wananga will be held throughout the program with the research collective to explore maramataka and indigenous knowledge based coastal indicator development.

4.2.2 Te Tāhuhu Matatau o Tangaroa, mai Tauranga Moana ki te Ao: Empowering the kaitiaki of Tangaroa from Tauranga Moana to Aotearoa and beyond

Reclaiming and reframing mātauranga Māori enables kaitiaki to develop relevant and meaningful tools based on their world view. These tools help streamline kaitiaki responses to marine degradation and increase efficiencies in the capture and dissemination of reclaimed knowledge to assist decision-making. Phase one of the project developed an online resource for kaitiaki. The project is now focussed on the reclamation of mātauranga Māori, through hapū engagement, wānanga and kaitiaki interviews. Reframing the learnings from that reclamation process, using pou matua (guiding principles) developed with kaitiaki, helped to enhance the expression of kaitiakitanga by connecting kaitiaki to trusted sources of knowledge and tools.

Wānanga and kaitiaki interviews highlighted the importance of engagement with tangata whenua and led to the emergence of key questions for future developments:

- How might the specific tools of marine spatial mapping encourage the capture and storage of mātauranga Māori to streamline kaitiaki responses to marine degradation?
- How might scientific reports and articles be produced to increase efficiencies of kaitiaki capture and dissemination?
- How might future developments of digital storage and sharing of mātauranga Māori be implemented in a fast changing technological world?, and
- How might Māori frameworks and tools, assist academic researchers and governing bodies, in building trusting relationships with kaitiaki?

4.2.3 Huatuakina o hapu e! *Ngarangi Walker, ESR & Ian Ruru*

To date I have not been able to talk with the leaders of this project or access any documentation describing the research. I suggest that GDC contact project leaders Ian Ruru and Ngarangi Walker to discuss their research plans. I understand a major component of this project is establishing baselines and environmental monitoring around coastal habitats, including looking at the distribution of urchin barrens.

5.0 Anthropogenic stressors

Primary data sources for section 5

Berkett N et al. (2015) Guiding coastal and marine resource management: The Coastal Special Interest Group Research Strategy. Prepared for C-SIG. 16 pages. plus appendices.

Haggit and Wade (2016) Hawke's Bay Marine Information: Review and Research Strategy

To manage ecosystems and resources, it is necessary to understand how the CMA and associated organisms and habitats respond to various stressors (both natural and anthropogenic; Berkett et al. 2015). Coastal waters are the ultimate receiving environment for a range of contaminants derived from upstream catchments and sea-based industries. Activities such as agriculture, horticulture, fishing, shipping, coastal development and other land-based activities present multiple stressors that cumulatively interact with each other and with natural processes. Particular challenges are the management of the synergistic effects of multiple stressors and cumulative environmental change. This is further complicated by the fact that many activities (and in their turn effects) operate on different spatial and temporal scales.

This is a very complex issue. Research and data collection will need to target specific areas and indicators need to be developed that enable more informed decisions and policy development. In addition, research is needed around the development of tools for identifying key drivers of change, elucidating complex interactions and supporting resource management. This will help councils prioritise those issues that can be addressed in the short term, versus those that need to be planned for in the long term (Berkett et al. 2015).

A key first step in managing anthropogenic stressors is the identification of stressors impacting on the CMA. The subsequent, and often more difficult steps include understanding the effects of these stressors within both a spatial and temporal context, and then gaining an understanding of the synergistic and cumulative effects of multiple stressors. With this knowledge it increasingly possible to develop tools and policies to manage those effects. Some of the major anthropogenic stressors in Tairawhiti are described below.

5.1 Sedimentation

One of the major threats to coastal habitats throughout New Zealand is that derived from terrigeneous sediment which can enter the coastal environment from multiple sources (Airoldi 2003; MacDiarmid et al. 2012). The effects of sedimentation are multifaceted and range from direct deposition and smothering of habitats and species, reduced water clarity due to increased suspended sediment loads, to increased nutrient enrichment and contamination (from sediment bound nutrients and contaminants). Due to intensive modification of the coastal landscape for pastoral livestock farming, and exotic plantation forestry there are numerous examples of areas of active erosion throughout Tairawhiti. These primarily take the form of cliff-line attrition through to catchment, stream, river, and estuary bank erosion (Haggitt and Wade 2016).

Rates of sedimentation are clearly high in Tairawhiti (**Figure 5.1**). Pre-human sedimentation rates were probably quite high anyway but this has been increased through practices on land that destabilise sediment. The offshore habitat surveys conducted by NIWA (Jones et al. 2018), demonstrate that even in deeper waters (50 – 200 m deep) there is evidence of significant quantities of terrestrial sediment. Observation made during this study identified that biodiversity on some offshore reefs is higher on elevated rock features while low lying surfaces and troughs are inundated with sediment and support much lower levels of biodiversity.

Figure 5-1 *The Waipaoa River in flood discharges a plume of muddy water into Poverty Bay (Photo by Dave Peacock, GDC).*

The impacts of sedimentation on inshore coastal areas in Tairawhiti are largely unknown. From research conducted in other parts of New Zealand we know that sedimentation can prevent the recruitment of invertebrate larvae (Walker 2007), can make habitat unsuitable for certain species which provide key ecosystem services, such as water filtration (McLeod et al 2014) and reduce productivity in coastal algal and kelp forests (Alestra et al. 2014).

The impacts of sedimentation in New Zealand estuaries are well documented and include altered biodiversity and reduced productivity and denitrification potential (Thrush et al. 2004, Jones et al. 2011, Douglas et al. 2019). Given that estuaries in Tairawhiti are generally small and have not been adequately described it is difficult to predict the severity and significance of sedimentation impacts in this interface between terrestrial and coastal ecosystems.

5.2 Nutrients

Coupled with terrigeneous sediment, river plume outwellings, particularly in flood, can deliver substantial amounts of nutrients (Nitrogen and Phosphorus) and heavy metal contaminants into the marine environment. Cornelisen (2013) reports that rivers and streams in the nearby Hawke Bay Region collectively contribute an estimated 6,021 tonnes of nitrogen per annum. However, this will vary considerably among years depending on variability in rainfall and river flows. The sources of nutrients to waterbodies are diverse, ranging from atmospheric deposition, groundwater flow, agricultural runoff, fertiliser use, aquaculture discharges and sewage (Rees, 2009; Haggitt and Wade 2016; **Figure 5-2**).

The impacts of nutrients and eutrophication in New Zealand estuaries are well described (Thrush et al. 2017, Douglas et al. 2019). Plew et al. (2018) predict that the Tairawhiti estuaries that are most susceptible to eutrophication are those that have high proportions of intertidal area, low dilution, or long flushing times (Uawa, Pouawa, Wherowhero Lagoon and Maungawhio Lagoon). Based on the available information it is not possible to assess the possible impacts of nutrients in these estuaries.

5.3 Stormwater

With increasing urbanisation and development comes the predictable change from natural landforms and vegetative cover to an invariable increase in impervious surfaces. During rain events, this transition typically results in increase in water quantity (urban hydrology) and change in water quality (non-point source pollution). As excess water flows into storm water networks (drains and pipes) it collects various contaminants including - suspended sediments, oxygen demanding substances, pathogens, metals, hydrocarbons and oils, toxic trace organics and organic pesticides, nutrients, and litter **(Figure 5-3**). These may be augmented when combined with sewage and/or other contaminants (Auckland Council 2010; Haggitt and Wade 2016).

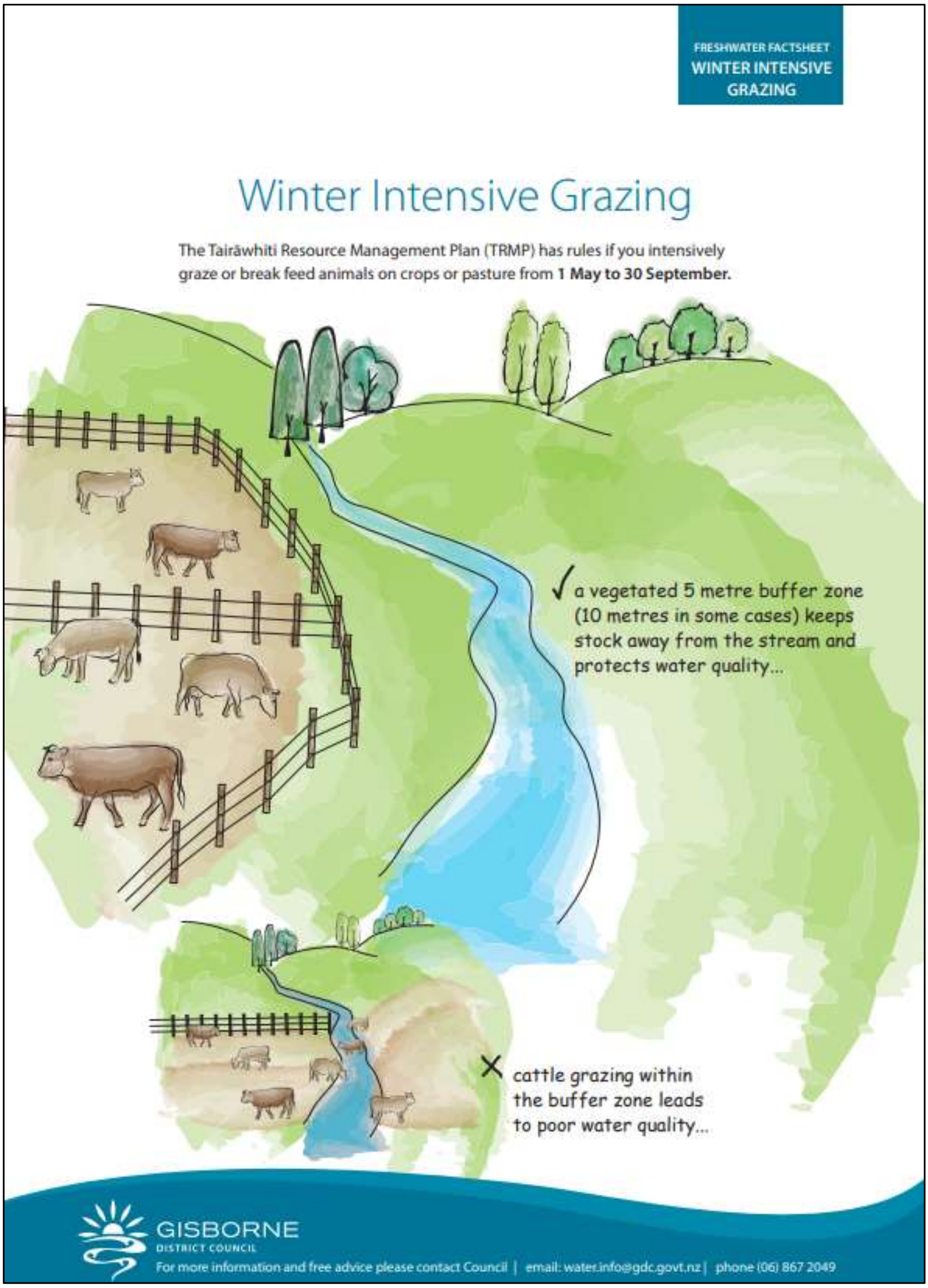

Figure 5-2 *GDCs Winter intensive grazing freshwater fact sheet.*

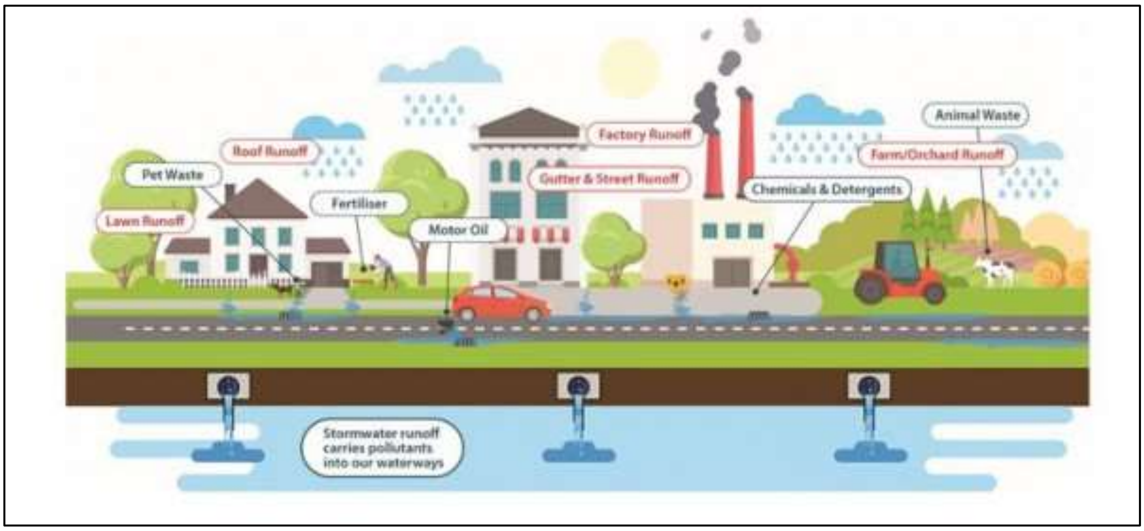

Figure 5-3 *Stormwater infographic from GDC website.*

5.4 Wastewater

Domestic and municipal wastewater can cause increased secondary productivity, eutrophication, heavy metal contamination, reduced oxygen levels, and biodiversity which can lead to ecological disturbances in the natural aquatic ecosystems (Barbaranti et al. 2019 and references therein). The flow of wastewater into the CMA is a known issue for Gisborne **(Figure 5-4**). Dry weather overflows typically occur as a result of a pipe blockage generally due to fat, sanitary wipes or foreign objects (such as clothing and children’s toys) in the wastewater network. Dry weather overflows can also result from failure of a system component, for example pump station faults or pipe breakages, or operational error (very rare). A large portion of the piped network is relatively flat, resulting in a build-up of material in pipelines and increasing the risk of dry weather overflows.

Wet weather overflows occur as a result of excessive rain or stormwater entering the wastewater network. A wastewater network is designed and sized to accommodate some stormwater as over time, stormwater ingress is inevitable. Where the volume of stormwater entering the wastewater network exceeds the capacity of the system, a combination of stormwater and wastewater will be discharged – either through formal (designed) overflow points or via informal overflow points such as manholes and private gully traps. The opening of formal overflow points into rivers is to prevent or minimise informal overflows especially on private property, which presents a greater health risk.

Figure 5-4 *Temporary health warning issued by the GDC in response to wastewater overflow (GDC).*

Overflow frequency is not directly comparable from year to year as it is rainfall event related overflows will occur more often in years with a larger number of heavy rainfall events and less often in years with fewer heavy rainfall events. There has been a maximum of four overflow events in any one year and the average number of overflows per year is approximately 2.4 since 2006. GDC's DrainWise Implementation Programme is the umbrella programme that seeks to progressively reduce stormwater ingress into the wastewater network and reduce the frequency and volume of overflows. Information on the programme can be found at: https://www.gdc.govt.nz/drainwise/.

5.5 Dredging

Effects associated with dredge disposal are relatively similar to that associated with sedimentation such as direct smothering of benthic organisms, potential changes in sediment texture and composition, and increase in sediment contaminants. Water column effects such as increased turbidity may lead to reduced productivity although this is likely to be localised. Ultimately, the severity of effects will depend on the volume being disposed relative to the size of disposal area, level of contaminants within the dredge spoil, and the nature of the receiving environment (seabed characteristics) (Haggitt and Wade 2016).

Gisborne Port is a commercial port zone within which dredging is a mandatory requirement to maintain gazetted port depths (**Figure 5-5**). Dredged material is deposited approximately 2km offshore at the existing Outer Spoil Disposal Ground (OSDG). Dredged materials have been described as '…*clays and fine silts, silts and sands* *and very weak siltstone and mudstone…'* and surficial sediment removed by maintenance dredging has been shown by routine ongoing monitoring elsewhere in the port to contain low levels of heavy metals. The estimated average annual maintenance dredging requirement is between 100,000m^3 and 140,000m^3 (4Sight 2017). The impacts of dredging have been assessed in a number of reports (de Lange 2017, Halliday et al 2008, Healy et al. 2002, Kensington 1990, Merrett 1994, Miller 1981)

Figure 5-5 *Specialist dredging vessel Albatros working in Port Gisborne to deepen the channel.*

5.6 Fishing

5.6.1 Trawling and dredging impacts

Trawling of the seabed has been demonstrated to disturb both physical and biotic elements in many ways. Direct effects can range from injury, death, and burial of surface-dwelling individuals (**Figure 5-6**), to the removal of non-target organism (bycatch), and an increase in scavengers preying on damaged or exposed organisms (Ramsay et al. 1996; Thrush et al. 1998). Areas that were once avoided due or considered unfishable have more recently been opened up to fishing. Probably a consequence of improved fishing technology and increased motivation to fish in new areas to increase catches. Apart from anecdotal accounts from commercial fishers, as to what is contained within their trawl gear, it is largely unknown how the method of fishing may have altered the seabed structure of Tairawhiti (Jones et al. 2016, Jones et al. 2018, Haggitt and Wade 2016).

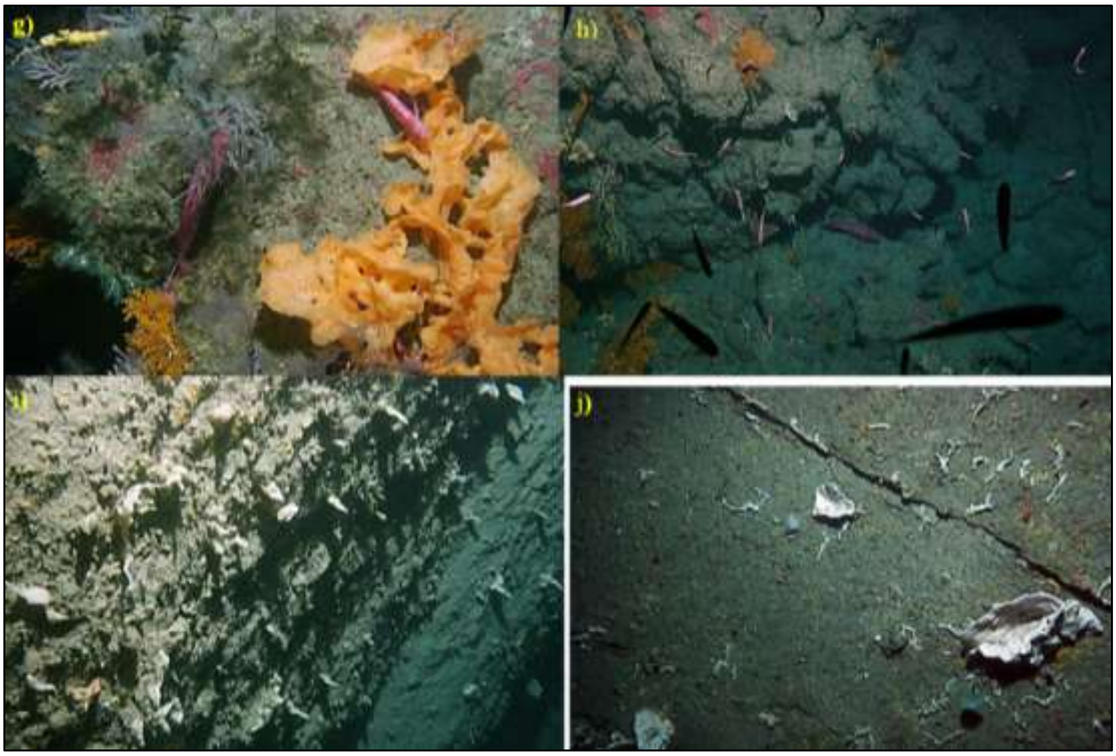

Figure 5-6 *Example images of sessile community clusters found at Ranfurly Bank. (g–h) deep northern rocky outcrops with sponges (Symptella rowi), black corals (g), plexaurid and primnoid sea fans (h); (i–j), sponge and ascidian-encrusted rock faces of the eastern outcrop (sponges including Xestospongia corallodies and Coscinoderma. sp. 2). (Jones et al. 2018).*

Within New Zealand, studies on the effects of trawl gear on the nearshore benthos are limited. Thrush et al. (1998) provides some evidence of the likely effects within the Hauraki Gulf sampling a variety of seabed types and depth-strata. The study indicated that that between 15 to 20 % of the variability in macrofaunal community composition could be attributed to trawl fishing. Decreases in the density of deposit feeders, small opportunists, and, the ratio of small to large individuals of the infaunal heart urchin *Echinocardium australe* were observed whereas, in areas of reduced fishing pressure there were increases in the density of echinoderms, long-lived surface dwellers, total number of individuals, and richness.

Studies done elsewhere have demonstrated increases in the migration, abundance and feeding activity of the hermit crabs *Pagurus bernhardus* following experimental beam trawling (Ramsay et al. 1996), although this was not apparent for the co-occur species *Pagurus prideaux* (Haggitt and Wade 2016).

Jones et al. (2016) provides numerous accounts of biogenic habitats being directly impacted by trawling. For example, areas of Ranfurly Bank that previously been avoided and considered unfishable, had more recently been "*opened up*" by current fishers, who reported a bycatch of yellow sponges, coral and black coral on the deeper slopes of the bank where they targeted tarakihi.

5.6.2 Indirect effects of fishing

Fishing can have indirect effects where the reduction in abundance of a targeted species has consequences for other components of an ecosystem. In New Zealand, the predator – urchin – kelp trophic cascade is the most well-known indirect effect of fishing. The concept of cascading trophic interactions predicts that if predator abundance is reduced through fishing, herbivores will be released from top-down control. Herbivore abundance will increase (as will herbivory) and kelp biomass will be reduced through increased grazing intensity (Shears and Babcock 2003a).

Alongside bycatch and mechanical modification of the seafloor, this predator – urchin – kelp trophic cascade is widely considered one of the most significant indirect effects of fishing and has led to calls for the introduction of ecosystem-based fisheries management. While urchin barrens habitat (a consequence of this trophic cascade) is common throughout northeastern New Zealand, there are no records in the ecological literature of urchin barrens occurring in Tairawhiti (ASR 2005, Wilson et al. 2007, Shears and Babcock 2007). However, there are anecdotal accounts of urchin barrens occurring in the northern part of the region (ASR 2005, J. Tibble *pers. comm.*). Other possible indirect effects of fishing in Tairawhiti are unknown.

5.7 Climate change

Climate change is already causing unprecedented and enduring change in our oceans.

Primary data sources for section 5.7

Ministry for the Environment (2019) Our marine environment. Issue 4: Climate change is affecting marine ecosystems, taonga species, and us.

The consequences of climate change on the marine environment are not fully understood. For example, we benefit from the role oceans have in regulating our climate and storing carbon but these benefits may be compromised by climate change. Marine species and people experience the effects of climate change across New Zealand, but effects vary by region. Some changes are not well understood. Others show unprecedented rates of change and differ significantly from pre-industrial conditions.

Measurements of the sea-surface temperatures in New Zealand's coastal and ocean areas have been recorded by satellite from 1981 to 2018. This data provides a comprehensive record of change. Climate projections suggest that sea-surface temperatures will increase 0.8–2.5 degrees Celsius by 2100 (Law et al, 2018a).

On average, coastal waters have warmed by 0.2 degrees Celsius per decade since 1981 (Pinkerton et al. 2019). Also, there are now more years when the average temperature of the sea around New Zealand was greater than the long-term average temperature (see annual deviation from average temperature 1981–2018). Ocean waters throughout our EEZ showed significant warming between 1981 and 2018. The ocean has an important role in removing carbon dioxide from the atmosphere, but as oceans warm, they lose their capacity to absorb as much carbon dioxide, which may result in further increases in atmospheric carbon dioxide concentrations.

The ways in which climate change could impact coastal ecosystems includes:

- Increased sea temperatures
- Rising sea levels
- Increases in the frequency of extreme wave events
- Ocean acidification
- Changes in ocean productivity

5.7.1 Consequences of climate change

5.7.1.1 Species distribution and populations will change

Warmer sea-surface temperatures affect phytoplankton abundance and therefore primary production of oceans. Near-surface stratification is a natural phenomenon, but ocean warming from climate change is expected to strengthen this effect (Capotondi et al. 2012). Stratification may reduce the supply of nutrients needed for phytoplankton growth in subtropical waters in the northern parts of New Zealand. The effect may be smaller in the south, where primary production is more limited by other factors such as light intensity (Pinkerton et al. 2019).

Changes to primary productivity have implications for the whole food web, including fish species and top predators like seabirds, marine mammals, and commercially valuable fish (Fig. 5-7). Increasing abundances of phytoplankton in parts of the Chatham Rise may be positive for fisheries in this region (Pinkerton et al, 2019). Increased primary productivity can also have negative impacts on fisheries when phytoplankton blooms die off, potentially causing oxygen depletion in the water column (Morrison et al, 2009).

New species are being observed in our waters as climate change brings warmer water inshore. Gambierdiscus, the small plankton responsible for ciguatera fish poisoning, was recently observed for the first time in the subtropical northern region of New Zealand (Rhodes et al, 2017). Eating fish contaminated by this toxin triggers neurological, gastrointestinal, and cardiovascular symptoms (Armstrong et al, 2016).

Marine heatwaves can reduce the range of some species or cause others to disappear locally. During the 2017/18 marine heatwaves in the South Island, bull kelp suffered losses in Kaikōura and was completely lost from some reefs in Lyttelton (Thomsen et al, 2019). Following these losses, the empty spaces were rapidly colonised by Undaria, an introduced non-native species (Thomsen et al. 2019). Bull kelp acts as a carbon sink, dampens the effects of waves on the coastline, and provides structure and shelter for many species.

Warming waters in summer are already affecting fish. The reproduction of some fish species (like snapper and hoki) appears to be affected by sea-surface temperature. Warming and other changes to the marine environment could affect other species, and increases and decreases in stocks are possible (Ministry for Primary Industries, 2017).

Past approaches to fisheries management and catch levels may no longer work for some species and stocks. As coastal and ocean temperatures increase, wild fisheries can expect to see greater numbers, dominance, and distribution of warmer water species. Temperature-sensitive species may move south to cooler waters (Law et al, 2018a). In aquaculture, heatwaves can lead to increased mortality and an associated loss of revenue (New Zealand King Salmon 2018; Sanford Limited 2018; **Figure 5-7**).

Increased erosion and wave exposure associated with sea-level rise can impact seaweeds and animals living on exposed rocky reefs. Seaweeds may be particularly vulnerable to increased movement of sediment and reduced light levels. Local losses of large seaweeds can reduce protection from flow and reduce settlement of young seaweeds (Willis et al, 2007). Large wave forces can break or remove mussels, resulting in death if they cannot reattach. Mussel beds that are already thinned or less tightly packed are even more vulnerable (Hunt & Scheibling, 2001).

5.7.1.2 Ocean acidification increases stress on our taonga species

The western United States provides an example of increased ocean acidity with a natural upwelling of cold, nutrient-dense water. The incident shows what could happen as New Zealand waters increase in acidity. This observation found that periods of increased acidity limited the growth of carbonate shells in settling oyster larvae, and caused high mortalities (Clements & Chopin, 2017). Although this upwelling does not occur in New Zealand to the same extent, the acidity observed in the western United States could happen here under current projections.

In 2017, the aquaculture industry’s estimated total revenue was $557 million, with 62 percent of this from mussels (Aquaculture New Zealand, 2018). Pāua, cockles, kuku, and kina are taonga species with carbonate shells that are valued for recreational and cultural reasons. All of these shellfish are vulnerable to increased ocean acidity.

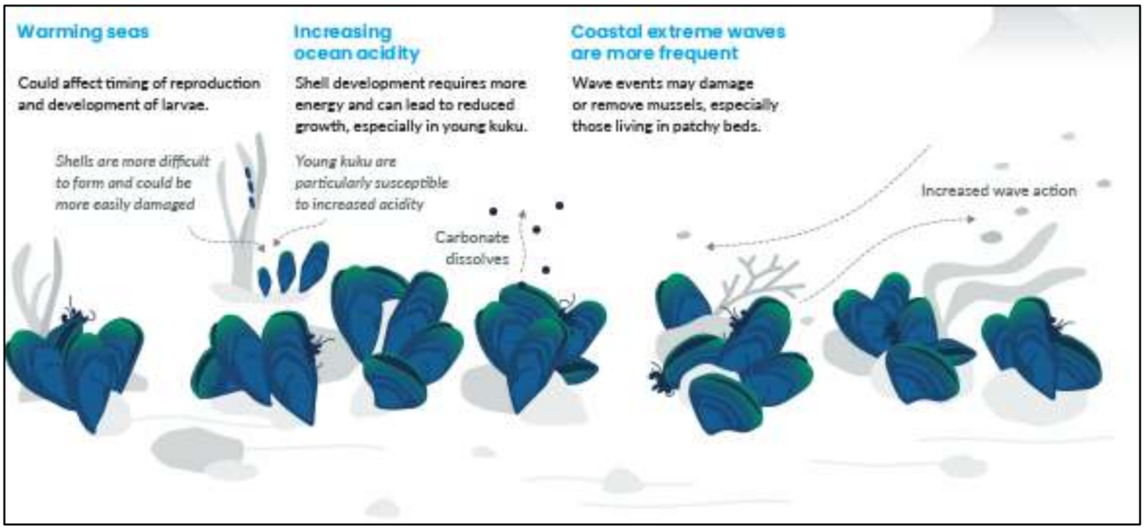

Figure 5-7 *The pressures associated with climate change have impacts on kuku at difference life stages. Warming seas - Could affect timing of reproduction and development of larvae. Increasing ocean acidity - Shell development requires more energy and can lead to reduced growth, especially in young kuku. Coastal extreme waves are more frequent - Wave events may damage or remove mussels, especially those living in patchy beds (Ministry for the Environment 2019).*

5.7.1.3 Mātauranga Māori and kaitiakitanga may be lost

Māori marine knowledge and practices that are passed from one generation to the next, are unique to Aotearoa New Zealand. They are deeply ingrained in our identity as a people and as a country. These long histories in kaitiakitanga may help us recognise the impacts of long-term environmental changes, although climate change may be creating a situation with no precedent.

Some traditional Māori tohu or marine indicators can no longer be used in the same way. Māori scientific knowledge is based on observation and is evolving in response to current changing seasonal patterns. This includes observations of seasonal change used to indicate harvest periods. For example, traditionally when pōhutukawa bloomed, it was time to harvest kina. Today, the reproductive period of kina occurs at a different time due to changes in sea temperatures. Kaitiakitanga and traditional management methods and commercial practices are changing because of the different environmental conditions.

6.0 Research to fill knowledge Gaps

Primary data sources for section 6

Haggitt T, Wade O (2016) Hawke's Bay Marine Information: Review and Research Strategy. A report prepared for Hawke's Bay Regional Council. 121p.

Paul-Burke K, Paul-Burke J, Te Ūpokorehe Resource Management Team, Bluett C, Senior T (2018) Using Māori knowledge to assist understandings and management of shellfish populations in Ōhiwa harbour, Aotearoa New Zealand. New Zealand Journal of Marine and Freshwater Research 52: 542-556.

Given the paucity of ecological data available for Tairawhiti, the opportunities to generate new knowledge are almost limitless. Research priorities will depend on the GDCs management priorities. But regardless of those priorities, an understanding of the spatial distribution of biodiversity is a prerequisite for any attempt to manage impacts on habitats and biodiversity within the CMA. While offshore, deeper water habitats are relatively well described, knowledge of the distribution of coastal and estuarine habitats is more limited. Consequently, mapping of coastal habitat should be a priority.

Recent court decisions, relating to the soon to be implemented Motiti Protection areas, have indicated that the RMA has a role to play in managing indigenous biodiversity. While this has previously been the role of the Department of Conservation, and to a lesser extent the Ministry of Primary Industries, it has now been made clear that Councils have obligations set out in the NZCPS (Policy 11) to manage biodiversity and have the tools (the RMA) to implement spatial management.

The Department of Conservation's marine habitat map for the Northland section of the Northeast Marine Bioregion, covering an area of 1.34 million hectares of coastal habitat from Ahipara to Mangawhai (https://www.nrc.govt.nz/resource-library-summary/research-and-reports/coastal/northland-marine-habitats/) is an excellent example of habitat mapping at a regional scale (**Figure 6-1**). This map makes it much easier for councils to develop coastal plans and spatial management strategies that provide appropriate protections and management outcomes. Any management strategies will of course need to be underpinned by an understanding of the impacts of anthropogenic stressors.

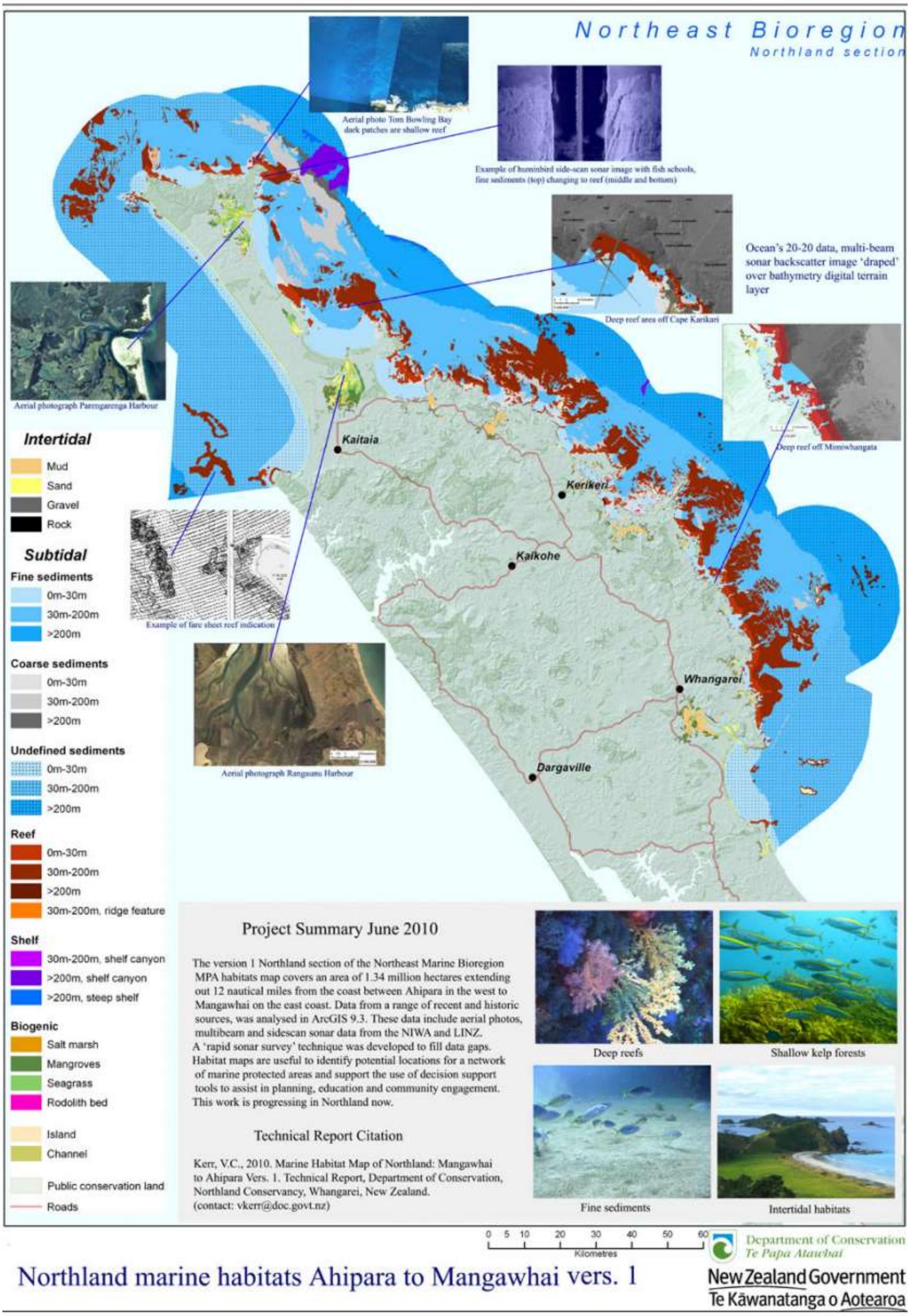

Figure 6-1 *The Department of Conservation's marine habitat map for the Northland section of the Northeast Marine Bioregion, covering an area of 1.34 million hectares of coastal habitat from Ahipara to Mangawhai*

Berkett et al. (2015) summarise the research needs for Councils to better understand the response of coastal ecosystems to stressors in order to effectively manage the CMA as follows:

- Characterise the existing CMA by collecting appropriate data for establishing baselines.
- Identify the effects of stressors within both a spatial and temporal context. Understand the synergistic and cumulative effects of multiple stressors and develop tools to manage these effects.
- Predict and measure the impact of freshwater flows, loads and limits on the coastal receiving environment.
- Develop approaches for the enhancement and restoration of degraded environments in the CMA.
- Identify indicators and determine the response of ecosystem attributes (e.g. biodiversity, biological and physical processes, water quality) to stressors (individual and cumulative).
- Investigate the feasibility and ecological implications of potential biodiversity offsetting in the CMA.
- Research environmental thresholds and establish appropriate and relevant limits and standards for stressors impacting on the CMA, including those derived from land-based activities.

A review of marine knowledge was recently conducted for Hawke's Bay Regional Council (Haggitt and Wade 2016). Many of the knowledge gaps identified in for Hawke's Bay, with respect to habitat, are equally relevant for Tairawhiti. The bullet point lists summarised below combine gaps identified by Haggitt and Wade (2016) with additional gaps identified for Tairawhiti.

6.1 Estuaries

Although estuaries are not a key feature of the landscape of Tairawhiti, there are estuaries of various size and type in the region for which almost no information exists. Some knowledge gaps are bullet pointed below:

- Understanding of the various functions and values of estuarine systems;
- Understanding current water quality and how it has been modified by activities in the catchment;
- Identifying sources and downstream effects of nutrient enrichment;

- Identifying what biodiversity exists in Tairawhiti estuaries;
- Understanding how key or biogenic habitats (seagrass, horse mussel beds, wetland vegetation) have changed over time;
- Understanding the role of estuarine habitats for species transitioning through different life stages;
- Determining where key species, particularly bivalves (pipi, tuatua, horse mussels), birds, and fishes have disappeared or changed in abundance and distribution over time;
- Understanding the effects of various land use practices on the wider environment including cumulative impacts;
- Identifying the most appropriate approaches to estuarine restoration where required and gaining an understanding of timeframes for recovery;
- Most effective restoration techniques.

6.2 Coastal (nearshore and intertidal) ecosystems

There are good habitat maps for East Cape and the Te Tapuwae o Rongokako Marine Reserve but very little information for other parts of the coast.

- Knowledge of the distribution of coastal habitats;
- Understanding of the various functions and values of coastal systems;
- Understand the linkages between intertidal and subtidal environments;
- Quantify the abundance of kaimoana species and the condition of populations;
- Map habitat distributions and community composition within rocky reef and soft-sediment habitats;
- Data on the abundance and biomass of dominant species (kelp, mussels, kina, crayfish, reef fish) for rocky reef habitat;
- Understand how habitats and species abundance has changed over time;
- Understand effects of stressors on species habitats and ecosystems;
- Change in soft-sediment benthic composition at region-wide scales.

6.3 Offshore ecosystems

The NIWA studies have provided a good understanding of seafloor habitats and biodiversity for the offshore areas of Tairawhiti.

- Understanding of the various functions and values of coastal systems ;
- Understand the linkages between offshore and coastal environments;

- Understand effects of stressors (sedimentation and fishing) on species, habitats and ecosystems.

6.4 Mātauranga Māori

Many of the knowledge gaps identified above revolve around gaining an understanding of how habitats and the abundance and distribution of biodiversity have changed over time. For the most part, scientific data to address the timeline of change do not exist. However, there is considerable information about change in coastal ecosystems in the mātauranga Māori of the people of Tairawhiti.

Mātauranga Māori has been described as a complex and dynamic knowledge system originating from Māori ancestors, which adapts and changes but does not lose its integrity nor sense of origin. It encompasses not only what is known but how it is known and includes Māori world views, language, perspectives, principles, ethics and cultural practices (Paul-Burke 2016, Paul-Burke et al. 2018). There is an enormous potential for the use of mātauranga Māori to more widely enhance the understanding of aquatic ecosystems, underpin culturally-appropriate restoration approaches, and provide a more holistic and integrated perspective for activity in this realm, including research, monitoring, planning, and policy and resource development (Clapcott et al. 2018).

Individual hapū (sub-tribe) and iwi (tribe) have their own localised mātauranga which is specific and relative to their environmental contexts, experiences, observations and understandings of species interactions and patterns of use which have been accumulated and grounded in the existence of people who have resided in one place for many consecutive generations (Cheung 2008, Paul-Burke et al. 2018).

A Māori perspective of the natural world encompasses a biological-cultural (bio-cultural) perspective which positions humans within nature and focusses on ways in which cultural understandings and intergenerational connections between people and their biophysical context assist in the retention and protection of biodiversity and ecologically sustainable ecosystems (Paul-Burke 2016). Using mātauranga Māori to co-develop understandings of ecosystem stability, recoverability and resilience across consecutive generations, including cultural managerial approaches, is increasingly recognised as an important tool for contemporary resource management (Forster 2012, Lyver et al. 2016).

This information is presently largely inaccessible to the GDC but would be hugely value in terms of understanding changes that have occurred in the coastal ecosystems of Tairawhiti and in developing monitoring programmes with indicators that are meaningful to the people of the district. Accessing mātauranga Māori is not as simple as taking a book out of the library or downloading a file from the internet. For one, very little mātauranga Māori is recorded in published reports. Two, many iwi/hapu are in the process of reclaiming their mātauranga and may not be in a position to share. Three, mātauranga Māori doesn't tend to be something that is just given away. Paul-burke et al. (2018) describe their research examining ecological change in Ohiwa Harbour, Bay of Plenty, and the positioning of the project within a kaupapa Māori research paradigm. Their guiding principles for researchers as described by Te Awekotuku (1991) are:

1. Aroha ki te tangata – be respectful of yourself and others
2. Kanohi kitea – the seen face, present yourself in person
3. Titiro, whakarongo, kōrero – look, listen then speak
4. Manaaki ki te tangata – share the research space, host other ideas, be generous
5. Kia tūpato – be cautious
6. Kaua e takahia te mana o te tangata – do not trample over the mana or personal prestige of others
7. Kia mahaki – be humble, be open to other knowledge perspectives, the sharing of knowledges leads to shared understandings

For GDC to be able to incorporate mātauranga Māori into their management of coastal ecosystems the first step will be establishing relationships with iwi/hapu across Tairawhiti. GDC will then be in a position to better understand the research and management needs of tangata whenua and identify opportunities to collaborate on research and management in the CMA. This may, or may not, be a daunting prospect but there are practitioners of mātauranga Māori already working in the Tairawhiti CMA in Tairawhiti that may be able to assist with this process - Ian Ruru and Ngarangi Walker who GDC have already worked with and Caine Taiapa and Regan Fairlie from Manaaki Te Awanui who are working in Tokomaru Bay. The establishment of the Te Tapuwae o Rongakako Marine Reserve is a good example of a collaborative project between tangata whenua and government environmental management agencies and GDC should work with Ngati Konohi and DOC to learn from this process.

Because the population of much of the region is predominantly Māori and much of the land is Māori owned, in Tairawhiti there may be unique opportunity to use traditional Māori resource management tools (e.g. Rahui) alongside modern instruments such as customary fisheries regulations, the Resource Management Act and the Marine Reserves Act to manage coastal habitats and biodiversity. The key to this process will be establishing relationships and trust. Hepi et al. (2018), describe obstacles that were overcome to enable mātauranga-informed management of the Kaipara Harbour:

"The central attribute to enabling mātauranga-informed management of the Kaipara Harbour is leadership held by the indigenous Māori peoples Te Uri o Hau. This leadership enabled an approach to be steeped in Māori cultural identity, values and aspirations such as whakapapa, historical contexts, kaitiakitanga, and mauri to understand, explain and influence the management of the Kaipara Harbour……

Relevant to all indigenous cultures within colonised nations, indigenous people's leadership of an integrated catchment harbour group addresses the power issues between Western science and indigenous knowledge as it ensures that indigenous peoples knowledge and practices are viewed as a valid contribution to decision-making."

Finally, Hepi et al. (2018) make the case that the challenge to cross cultural environmental management is not so much "*how to integrate indigenous knowledge into resource management' but 'how to integrate indigenous knowledge holders into planning and decision-making' to enable indigenous knowledge holders to articulate management in their own terms as an expression of self-determination.*

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