OCEANS MANAGEMENT IN A CHANGING CLIMATE

Otago Oceans Reform Case Study

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Environmental Defence Society

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1 Introduction

Saint Kilda Beach, Dunedin

In 2021, the Environmental Defence Society (EDS) embarked on a project to explore options for reform of Aotearoa New Zealand's oceans management system. Phase 1 was completed in May 2022 and examined the current system, identified problems with it, and developed options for reform. The options included new models for spatial protection, integrated management, legislative design and institutional arrangements.[1]

EDS is currently undertaking Phase 2 of the project which is focused on developing concrete recommendations for oceans reform. As part of that work, the Society is undertaking a series of case studies to obtain better understanding of marine management challenges, how they are being responded to on the ground, and the utility of options developed during Phase 1 of the project.

This report sets out the findings of the Otago Coast case study. This case study has a focus on marine management within a changing climate and is intended to illustrate the challenges this creates and possible responses. It is designed to help inform thinking about broader oceans policy and how climate change will need to be factored into policy design.

1.1 Methodology

The case study draws on a review of relevant literature and discussions with 12 people with knowledge of and involvement in the area. They included staff from Fisheries New Zealand and the Otago Regional Council, scientists from the University of Otago and NIWA, representatives from the commercial and recreational fishing sectors, a Māori consultant and a seabird conservationist. In addition a researcher spent four days in the area, attending a meeting of the East Otago Taiāpure Management Committee and visiting the Portobello Marine Laboratory.

Our discussions were held in confidence to encourage frankness. We would like to thank all those who generously gave their time to meet with us. We circulated a draft report to all those we met, for comment, before finalisation.

1.2 Structure of report

The report has been structured into six main chapters. Chapter 2 describes the physical characteristics of the Otago marine area and chapter 3 some key biological elements. Chapter 4 then explores the historical context to settlement and use of the Otago coastal area. Chapter 5 describes the range of extraordinary threatened species that live on the coast and chapter 6 describes the current state of several key fish stocks. Finally, chapter 7 examines two key challenges facing management of the Otago Coast: sedimentation and spatial marine protection.

Endnotes

1 See Severinsen G, R Peart, B Rollinson, T Turner and P Parson, 2022, *The breaking wave: Oceans reform in Aotearoa New Zealand*, Environmental Defence Society, Auckland

Port Chalmers looking out to the heads of the Otago Harbour

2 Physical characteristics

Blueskin Bay, north of the Otago Peninsula, receives a counter-clockwise eddy of oceanic water

The Otago Region spans some 480 kilometres of coastline, from the Waitaki River north of Oamaru, south to Wallace Beach in the Catlins area. Near the midway point sits the Otago Peninsula and Harbour, formed by the erosion and flooding of an ancient shield volcano (see Figure 2.1 on page 4).[1]

2.1 Narrow continental shelf and canyons

The width of the continental shelf narrows to just 10 kilometres off the Otago Peninsula, increasing to around 30 kilometres to the north and south. Seawards, the shelf rapidly drops off into the Bounty Trough which reaches depths of nearly five kilometres (see Figure 2.2 on page 4).[2] A series of deep canyons dissect the outer edge of the continental shelf, possibly carved out by rivers when the shelf was dry during the last ice age.[3] The canyons support diverse fauna (some yet to be discovered) and are hotspots for marine mammal and seabird activity.[4]

The Otago coastline is punctuated with estuaries, sandy beaches and cliffed and rocky headlands. The coastal strip of seabed is largely sandy, comprised of sediment brought down by the Te Mata-Au / Clutha and other rivers. Running along the outside edge of the sand are old gravels deposited during the last glacial period. Shelly material, sourced from the skeletons of generations of benthic marine organisms, sits on the far edge of the continental shelf.[5]

2.2 Warm subtropical water

Bathing the coast are two oceanic currents of very different origins. Subtropical Surface Water originates from the Tasman Sea, with its warm salty water forming a narrow flowing band, that wraps around the mainland coast. It moves southwards past Fiordland, around the southern end of the South Island and northwards up the Otago coast, where it becomes the Southland Current.[6] This Tasman Sea origin has meant that Otago coastal waters (along with those in Fiordland) have been subject to significant marine heatwaves in recent years.

2.3 Intrusion of Otago Peninsula

The Otago Peninsula juts out into the Southland Current, causing the seawater to flow at a much faster rate around it, and generating a counter-clockwise circular eddy of oceanic water into Blueskin Bay to the north. The Peninsula also serves to narrow the Southland Current, resulting in periodic upwellings of deeper and more nutrient rich waters near Cape Saunders (on the south-east corner of the Peninsula) thereby enhancing marine productivity there.[7] The Peninsula protects areas to the north from large swells originating from the Southern Ocean, creating more settled conditions for marine life.

2.4 Cold subantarctic water

Further out to sea lies the much colder and less salty Subantarctic Surface Water. The presence of this cold water off the Otago coast makes the climate cooler than in areas to the west and north. The band along which the two oceanic water masses meet is called the Southland Front. This is a major biogeographic boundary, with warm-water and cold-water species occurring on either side of the Front.[8] It is also an area of increased productivity, due to the mixing of warm macronutrient poor (and relatively iron-rich) subtropical waters, with cold macronutrient rich (but iron and silicate poor) subantarctic waters.[9]

Figure 2.1 Otago region coastal marine area (Source: NIWA)[14]

2.5 High freshwater discharge

Te Mata-Au / Clutha River discharges into the Otago marine area south-east of Balclutha. It has a mean flow of around 600 m^3 per second, the highest in the country, and almost twice that of the Waikato River. This enormous inflow of freshwater reduces the salinity of seawater along the nearshore Otago coast. It also delivers a critically important element to the marine environment – silica – which is required by many plankton and other species to form skeleton structures.[10] This serves to stimulate phytoplankton growth. But silica can be limited in quantity, in times of low river flow, impeding marine productivity.[11]

All these biophysical characteristics shape the distinctive characteristics of the Otago coastal marine environment, which is highly productive, and has a wide diversity of cold and warm water (and shallow and deep water) marine species.[12] For example, in 1990 a total of 159 different fish species were recorded from the Otago Peninsula region. This was considered an undercount due to rough weather and poor water visibility impeding the survey.[13]

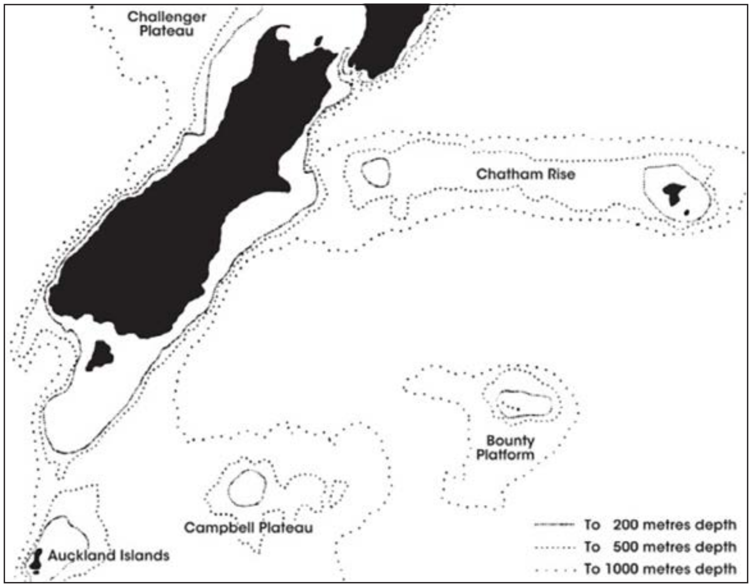

Figure 2.2: Water depth around the South Island (Source: Waitangi Tribunal)[15]

Aramoana Beach, located just outside the entrance to the Otago Harbour

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3 Biological characteristics

Taieri Estuary showing mud accumulation as a result of sediment discharged by the river

> "Otago's coastline is home to a wide range of diverse and unique ecosystems. These ecosystems are biodiversity hotspots with deep sea canyons, bryozoan reefs, rhodolith beds, gravel/boulder fields and kelp forests."[1]

The Otago coastal marine area is renowned for its diversity of habitats. This was highlighted, by a collation of local ecological knowledge provided by trawl fishers, which identified some 52 areas containing "unusual" benthic habitats. They included kelp forests, sea tulips, tube worms, sea cucumbers, sponges, bryozoans, scallops, horse mussels and blue mussels.[2]

Subsequently, a group of scientists sought to 'ground-truth' this knowledge through benthic surveys. One of the areas investigated was the "Hay Paddock", an area north-east of Moeraki, where trawlers regularly brought up dense clumps of living material described as being "like straw". Scientists found that "the dominant epifauna were sponge species, at times very dense, growing on polychaete (wire-weed) tubes. The associated assemblage included at least a dozen ascidian [sea-quirt] species, nudibranchs …. large anenomes, holothurians [sea cucumbers] and starfish …"[3]

In this section we explore some of the more notable biological characteristics of the Otago marine area.

3.1 Abundant krill

A distinctive characteristic of the Otago marine environment is the seasonal appearance of kōura rangi / red lobster krill (*Munida gregaria*). These small juvenile squat lobsters form dense swarms during spring and summer, turning the seawater and beaches red, particularly on the northern side of the Otago Peninsula.[4] They provide an important food source for fish, birds and marine mammals in the area.[5] The krill are so notable that the Portobello Marine Laboratory named its first purpose-built research vessel (launched in 1965) RV *Munida*.[6]

Also significant are the large swarms of white krill (*Nyctiphanes australis*), which develop off the coast in late summer and autumn, and feed large schools of barracouta (as well as jack mackerel and slender tuna). In addition, they are an important food source for red and black-billed gulls. The krill is found in much greater abundance in the band of low salinity seawater flowing north from the Te Mata-Au / Clutha River outlet and around the Otago Peninsula.[7]

3.2 Bryozoan thickets

> "The Otago shelf frame-building bryozoan fauna is strikingly diverse compared to most other New Zealand localities."[8]

The physical impact of the Otago Peninsula on water flow has created conditions to support the formation of dense thickets of bryozoans (lace corals) to the east of the Peninsula and extending to the north side of Blueskin Bay. The thickest areas lie between depths of 75 and 100 metres.[9] The faster water flow around the Peninsula, not only provides greater quantities of passing food for these filter feeders, but also reduces the amount of disruptive sediment deposited on the seafloor.[10]

Bryozoan beds are a rare habitat type globally and they are uncommon in New Zealand. Over 100 bryozoan species are known to occur on the Otago shelf, many endemic.[11] They have a variety of growth forms including branches, honeycombs, nets and tubular chimneys. Bryozoans provide important habitat for many other invertebrates (including sponges, anemones, worms, crabs, snails, sea stars and sea squirts) and fish species such as juvenile red and blue cod.[12] New Zealand sea lions and yellow-eyed penguins are known to forage over the beds.[13]

The biggest threat to the bryozoan beds is physical damage and bycatch in trawl fisheries, with bottom trawling for queen scallops occurring in the vicinity of the beds, although generally at greater depths. Interestingly, juvenile queen scallops are frequently found attached to fragments of bryozoa and other biogenic debris,[14] indicating a potential link between the two habitats.

Commercial fishing vessels berthed at Careys Bay

Queen scallop trawling is likely to have impacted the bryozoan beds. In particular, a stock assessment survey of queen scallops (reported in 2004) using industry-standard trawl gear, generated more than 50 per cent bycatch by weight. Of the 10.8 tonnes of invertebrates harvested as bycatch, 60 per cent were habitat forming species including bryozoans.[15]

Bottom trawling also resuspends sediment into the water column which can impede filter feeding and smother animals when the sediment re-deposits on the seabed. The destabilisation of seabed sediment by trawling, can also impede the recolonisation of damaged areas, as frame-building bryozoans preferentially grow on sediments stabilised by tubeworms or other benthic organisms.[16]

A spotlight on the queen scallop fishery

The queen scallop fishery does not appear to be in good health. The most recent recorded catch was 12.03 tonnes for the 2022-23 fishing year, less than half the 27.46 tonnes harvested the previous year, and the lowest catch since 2014-15 (see Figure 3.1). There is no estimate of current biomass of the fishery and the total allowable commercial catch, which is set many times higher than catches over the past two decades, provides no practical constraint on harvest levels.[17] A benthic survey undertaken in 2011, of the “Otago shelf scallop patch”, found live scallops distributed across the area but not at consistently high densities (ie greater than one per square metre).[18] Being broadcast spawners, low densities can inhibit successful reproduction. It seems questionable whether the continuation of this small intermittent fishery is wise, given potential impacts on the long-term reproductive capacity of the scallops, as well as on nearby ecologically significant bryozoan beds.

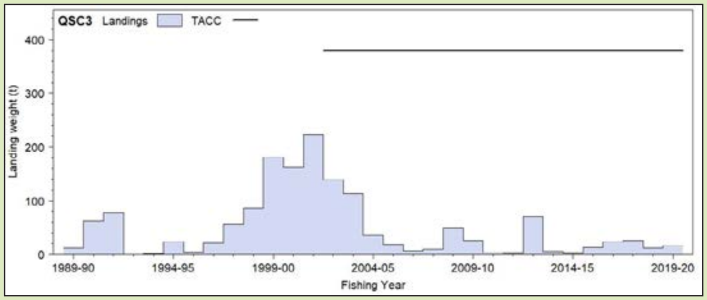

Figure 3.1: Reported commercial landings for QSC3 *(Source: Fisheries New Zealand)*[19]

It is unclear what past damage has been caused to the bryozoan beds by trawling but scientists have concluded that "fishing on the Otago shelf is expected to have reduced the distribution of habitat dominated by bryozoans, and potentially decreased the structural complexity of the benthos, even within areas where bryozoans remain in habitat-forming quantities".[20] Bryozoans are slow growing, and can take 30 to 60 years to develop habitat forming colonies, so any recovery "is likely to be of the order of decades".[21]

The Otago bryozoan beds remain unprotected from trawling. In 2013, Wood and Probert noted that a 'voluntary' closed area covering the zone of high bryozoan abundance was agreed in the early 2000s, but is not formally recorded. Fishing "is not monitored at a sufficiently fine scale that the effectiveness of the agreement can be assessed".[22] Part of the area is proposed to be protected by the Papanui Marine Reserve along with a more extensive seabed protection area (called Type 2). However, at the time of writing, the creation of the marine reserve had been halted by legal proceedings and government has yet to commit to creating the Type 2 protected areas proposed as part of the south-east marine protection proposals.

Otago's ecologically significant bryozoan beds remain susceptible to trawling damage in the absence of any formal protection mechanisms being in place.

3.3 Extensive kelp forests

"Anecdotes describe kelp forests along the Otago coast that once supported large populations of pāua, southern rock lobster, kina, blue cod and greenbone."[23]

The Otago coast supports extensive kelp forests that serve as important primary producers, moderate wave and tidal action, provide important habitat for larval settlement, and act as refuges for juvenile species. Kelp forests have been found to host more than 100 different species[24] and their primary production can directly contribute around half the biomass of coastal fish.[25] They support a number of commercially important species including rock lobster, pāua, kina, blue cod, red cod, blue moki and butterfish.[26] However their predominantly inshore-coastal location makes kelp forests particularly susceptible to land-based impacts.

Beds of rimurimu / bladder or giant kelp (*Macrocystus pyrifera*) populate the more sheltered coast north of the Otago Peninsula.[27] There are extensive beds off the Waikouaiti coastline (near Karitāne) which "possibly represent the biggest populations in New Zealand".[28] Bladder kelp forest has been largely lost from Otago's southern coastline. Loss from reef systems along the coastline north of Taieri Island (where the Taireri River discharges into the coast), which had been formerly known as "The Kelp", was observed during the 1970s and 80s.[29] The beds were once so dense that fishing boats had to go around rather than through them.[30]

Bladder kelp is one of fastest growing photosynthetic organisms in the world capable of increasing in size by up to 60 centimetres in a day.[31] The species forms large structures attached to the seafloor with blades up to 45 metres long. Small air bladders underneath each blade suspend them up to 20 metres high in the water column and forming enormous floating canopies.[32]

To the south of the Peninsula, and in shallower water, are beds of rimurapa / bull kelp (*Durvillaea antarctica*) with long, thin, whip-like blades up to 10 metres long. A honeycomb structure inside the blades keep them buoyant in the water column.[33] This species is of particular cultural significance to Ngāi Tahu, with the blades being used to make containers for the preservation of food, and being so effective that they are referred to as "the traditional equivalent of the modern-day refrigerator".[34]

Kelp forest off Brighton

Spotlight on the lifecycle of kelp

Kelp has an unusual lifecycle with both asexual and sexual reproductive stages, and microscopic and macroscopic life forms. This means that abundance and survival of kelp can be affected by a range of environmental factors that impact any or all of the lifecycle stages:[35]

- Microscopic *zoospores* are asexually developed on the blades of the mature kelp, and released into the water column, dispersing into seawater for hours or days
- Once suitable habitat conditions are found, the zoospores settle on the seabed, and develop into either male or female microscopic *gametophytes*
- When the female gametophytes mature they release eggs into the water column, along with a pheromone which induces the male gametophytes to release sperm. These track the eggs and fertilise them
- Fertilised eggs develop into tiny *sporophytes* which photosynthesise and eventually grow into adult kelp

Historical kelp dieback along the coast is thought largely due to sedimentation, which causes 'coastal darkening', and inhibits the ability of kelp to photosynthesise. Such darkening is particularly damaging for juvenile kelp (gametophytes and sporophytes) which grow deep down in the water column. Research indicates that light levels in seawater adjacent to agricultural areas is much reduced to that in seawater bordered by indigenous forest. The reduction is by up to half in seawater 10 metres deep.[36] Sediment can also cover reef surfaces preventing the attachment of kelp holdfast structures, settlement and the growth of germlings.[37]

Coastal darkening can also favour invasive seaweed species. A study undertaken during 2012-13 found that *Undaria pinnatifida* (an invasive Asian kelp species) made up 77 per cent of the total macroalgal biomass at Aramoana (located at the head of the Otago Peninsula). This was possibly due to *Undaria* having more efficient photosynthesis abilities, and therefore the ability to grow more quickly in lower light conditions, than native kelp species.[38]

"Warm sea surface temperatures are a major threat to the stability of *Macrocystis* forests in the Otago region."[39]

More recently, dieback of both bladder and bull kelp has been observed during marine heatwaves, with the localised extinction of bull kelp and substantial declines in bladder kelp. In particular, on the north Otago coast, bladder kelp declined in area by an average of 54 per cent after the 2016-17 marine heatwave, with a decline in one area (an offshore reef south of Shag Point) of 93 per cent.[40] Sea-surface water temperatures off the Otago coast generally peak at just over 14ºC in summer. Once seawater temperatures rise above 15ºC, kelp fertility decreases, with adult plants dying if temperatures exceed 18-19ºC for more than a few days.[41] Once temperatures reduce, kelp forests can recover, but such recovery will likely be impeded as seawater warms and marine heatwaves become more frequent.

Spotlight on warming seas in Otago

The seas along the east coast of the South Island (and Stewart Island) are warming at a greater rate than anywhere else in the country, currently measured at 0.34 ºC per decade. In addition, of the oceanic water bodies affecting the New Zealand coast, the Tasman Sea (water from which flows up the Otago coast) has the highest rate of ocean sea-surface warming (at 0.26 ºC per decade) and is a global warming hotspot.[42]

In 2022, the Tasman Sea spent over 60 per cent of the year in a marine heatwave (see Figure 3.2).[43] Modelling has indicated that, even under a low emissions scenario, up to 150 marine heatwave days are predicted to occur in the Tasman Sea each year by 2050. Under a high emissions scenario, severe heatwaves may be an annual occurrence by 2060.[44]

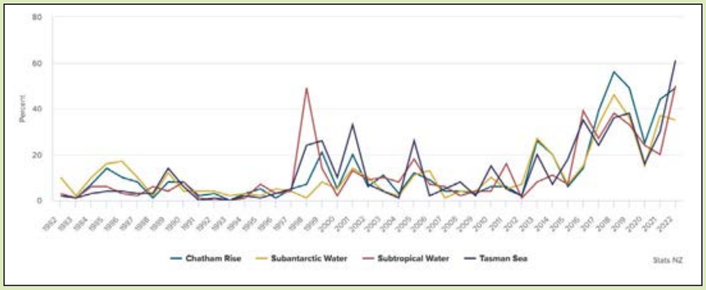

Figure 3.2: Percentage of year spent in a marine heatwave by oceanic region, 1981-2022 *(Source: Stats NZ)*

All this means that seawater is rapidly warming along the Otago coast, and this is being exacerbated by regular marine heatwaves, which are likely to be much more frequent in future. For example, the number of days per year that waters in the Otago Harbour have experienced marine heatwave conditions has already doubled between 1967 and 2020, from around 19 to 40 days per year.[45] Such ongoing warming and more frequent heatwave events are likely to profoundly impact marine life and ecosystems.

Where kelp has been impacted by marine heatwaves, sedimentation has served to exacerbate the impacts, causing greater die-back.[46] This is thought due to warmer temperatures creating greater metabolic demand within the kelp plants, which cannot be met in low light conditions caused by sedimentation, due to photosynthesis being impeded.[47]

Both bladder and bull kelp species are classified as threatened – at risk – declining. The loss of kelp forest has been associated with a gradual decline in the local abundance of rock lobster, pāua, kina, blue cod and butterfish.[48]

"Fisheries in particular would feel the economic impacts of degradation of kelp forests. Many key fisheries (e.g., pāua, kina, kōura and many finfish) rely on healthy functioning kelp forests. Loss of kelp forests would quickly lead to declining fish stocks."[49]

Bladder kelp was introduced into the quota management system in 2010 with a total allowable commercial catch of 1,238 tonnes. However, the annual reported catch from KBB 3G (the south-east coast) has never exceeded 94 tonnes.[50] In the Otago area there is a small harvest off Shag Point. Its impacts are unknown, but harvest can only add to other stressors. Harvest is prohibited within the East Otago Taiāpure and a proposed kelp protection area (under the south-east marine protection proposals) runs from the north side of the Otago Peninsula, and along the entire coastal strip up to Timaru. This area would prohibit commercial harvesting of bladder kelp.[51]

Efforts are currently underway to culture climate-resilient strains of bladder kelp which could be reseeded on the coast.[52] In addition, several of the proposed marine reserves for the region would protect kelp habitat from fishing activity,[53] although this is not the main threat to the ongoing persistence of the kelp forests.

"Management interventions that focus on improving water clarity will likely improve the resilience of kelp forests to climate change stressors."[54]

3.4 Shallow harbour habitats

The Otago Harbour is long and thin, being around 21 kilometres long and two kilometres wide. It has a surface water area of some 46 square kilometres at high water. But when the tide is out, up to 30 per cent of the seabed is exposed, and the seawater is mostly less than three metres deep.[55]

A "string of shell islands is unique in Otago Harbour and very rare locally, nationally and internationally with birds using the banks in the harbour for roosting."[56]

This shallow and swell-protected marine area, on an otherwise largely exposed coast, provides important marine habitat. Extensive areas of intertidal seagrass beds (around 32 hectares) provide refuge for small and juvenile fish as well as feeding grounds for birds. There is also a large saltmarsh area at Aramoana which is the most extensive and least modified in the region. Larvae of flounder and speckled sole are common in the harbour as are juveniles.[57] The harbour is believed to have the largest biomass of tuaki / cockle beds in the country, estimated to exceed 30,000 tonnes.[58] The sheltered waters of Blueskin Bay to the north also provide important nursery areas for juvenile fish and the Bay supports a trawled flatfish fishery.[59]

Spotlight on Southern Clams harvesting system

Southern Clams was founded in 1984. Harvesting of cockles was initially undertaken by manually digging the beds in Papanui Inlet (located on the outer coast of the Otago Peninsula). But it later moved to Blueskin Bay, to the north, where the cockles were suitable for live sale. There is now also harvesting in the Otago Harbour, which was closed for several decades, after 1986, due to water quality and food safety concerns.

The company has developed a manual 'body-dredge system' where the harvesters pull an open metal lattice through the upper-levels of the substrate. This harvests cockles which are big enough to take, while allowing juveniles to pass through the bars of the dredge. This manual system has less environmental impacts than other shellfish harvesting systems used around the country, which deploy a machine dredge to suck up the seabed substrate, separate the cockles, and eject the substrate back into the marine area.[60]

Otago Harbour which provides sheltered waters on an otherwise largely exposed coastline

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4 Historical context

Deborah Bay on the shores of the Otago Harbour just north of Port Chalmers

> Otago is an anglicised version of Ōtākou which was the original name of the waterway now known as the Otago Harbour. The harbour was originally referred to as an awa (river) because of its river-like appearance. More recently Ōtākou has become recognised as referring to both the harbour and the small settlement near the end of the Peninsula where the Ōtākou marae is situated. This was one of the places where Te Tiriti o Waitangi (the Treaty) was signed. Otago eventually became the name used for the entire southern region.[1]

4.1 Arrival of Ngāi Tahu

The first peoples to occupy the South Island, and the Otago region specifically, are known as Waitaha. They trace their history back to Rakaihautu who made landfall in the *Uruao* waka. During the sixteenth century, Ngāti Mamoe started moving from their east coast base in the North Island, south across Cook Strait and eventually into the Otago region.

A century later Ngāi Tahu, who were based in the Poverty-Hawkes Bay region, also started moving south in several waves. This resulted in a series of clashes whereby Ngāti Mamoe was pushed further and further south. Eventually Ngāi Tahu gained control of much of the South Island through conquest, inter-marriage and assimilation. The tribe takes its name from Tahupotiki, a descendant of Paikea, and close relation to a Ngāti Porou ancestor.[2]

Ngāi Tahu (Kāi Tahu in local te reo dialect) comprises a confederation of rūnaka and whanau groupings. Each has a different whakapapa reflecting the mixed origins of the larger tribe. There are three rūnaka whose takiwā (districts) are centred on the Otago Coastal region:

- *Te Rūnaka o Moeraki*, whose interests centre on Moeraki and extend northwards to the Waitaki River.
- *Kāti Huirapa Rūnaka ki Puketeraki*, whose interests centre on Karitāne, and extend south to include Ōtepoti / Dunedin and Ōtākou / Otago Harbour.
- *Te Rūnaka o Ōtākou* whose interests centre on Ōtākou / Otago Harbour and extend south to Te Mata-Au / Clutha River.

Historically, the tribal population along the Otago coast was relatively small. In 1840, there were an estimated 535 Ngāi Tahu living on the east Otago coast with the largest settlements at Moeraki (200), Ōtākou (160) and Waikouaiti (101).[3] However, by this time populations had been decimated by disease and warfare, and so they were likely considerably larger during the 1700s.

For coastal Māori, the Otago marine area provided critical food resources. Muaūpoko / Otago Peninsula was particularly abundant in cockles (tuaki), flounder (patiki) and duck (pateke). Regular schools of barracouta, harvested by trolling, provided a major source of kai as did red cod and ling harvested by line. Seals and sea lions were a significant food source as were hāpuku, with a celebrated hāpuku fishing ground located off Moeraki.[4]

> "Fishing for barracouta was a major tribal activity which was undertaken by southern Māori from their earliest habitation of the island. Barracouta fishing had a role in Ngāi Tahu social and economic life not evident elsewhere."[5]

4.2 Sealers and whalers

European sealers started appearing in southern New Zealand during the 1790s. They brought with them new crops (potatoes and onions) and European diseases including measles and tuberculosis.[6] By the early 1810s, seal populations on the mainland rookeries were severely depleted, and the sealing industry collapsed during the 1820s.[7] The sealers were soon replaced by whalers. Sperm, humpback and Southern right whales migrated along the east coast of the South Island. Bay whalers, which operated inshore but processed whales at sea, started operating during the 1830s.[8]

The first shore whaling station in the region started operating to the north of the current Ōtākou settlement on the Otago Peninsula in 1833. It was likely the largest shore-based station in the country, during the 19th century, with ten boats operating at its peak and 85 employed.[9] Both Māori and Europeans worked at the station where 103 whales were killed during the 1835 season.[10] Other whaling stations in Otago were established at Moeraki, Molyneaux, Purakanui, Taieri, Tautuku and Waikouaiti.[11]

4.3 Loss of land

Once the Treaty was signed in 1840, Māori were dispossessed of almost all their land in the Otago region due to the Ōtākou Deed (1844) and Kemp Deed (1848). The Ōtākou purchase was undertaken after the Crown waived pre-emption and allowed the New Zealand Company to purchase land directly from Māori. It included a strip of land encircling Ōtākou / Otago Harbour in the north and extending south to Tokata / Nugget Point.

Reserved from the sale were three 'native reserves'; a large block of land on the heads of the Otago Peninsula (Pukekura) and smaller areas at Taieri and Te Karoro / Molyneux to the south.[12] These only provided for bare subsistence and were not sufficient to enable Ngāi Tahu to develop an economic base.[13] The subsequent Kemp Deed purported to alienate the large part of the centre of the South Island, including the entire northern Otago Coast, with only small reserves set aside for Māori in the region (at Kakanui, Moeraki, Waikouaiti and Purakaunui).[14]

4.4 Treaty settlements

Ngāi Tahu filed a claim with the Waitangi Tribunal in 1986. The Tribunal reported in 1991, found repeated breaches of the Treaty by the Crown in its land dealings with the tribe, and recommended substantial

Moturata / Taieri Island was the site of a shore whaling station that commenced operations in 1839 compensation. A year later, the Tribunal reported on the Ngāi Tahu Sea Fisheries Claim. In 1987, the tribe signed a Deed of Settlement with the Crown that provided compensation valued at $170 million (including the transfer of commercial, forestry and farm properties) as well as an apology from the Crown, and statutory acknowledgements among many other things. The whole of the Otago coastal marine area (Te Tai o Arai Te Uru) is a statutory acknowledgement area recognising the strong Ngāi Tahu associations with the area.[15]

A final settlement of Treaty fisheries rights for all iwi, was reached in 1992, when the Crown provided $150 million for Māori to purchase a half share in the fishing company Sealord Products Limited, and promised that 20 per cent of all new quota species brought into the system would be given to Māori. This was on top of an interim settlement whereby the Crown agreed to transfer $10 million and 10 per cent of existing quota to Māori.[16] This has resulted in Ngāi Tahu receiving significant amounts of fisheries quota. The tribe now has an asset base of around $1.7 billion and operates significant farming, forestry, seafood, tourism and property business units.[17]

As part of addressing Treaty rights to non-commercial customary fishing, statutory provision was also made for the establishment of mātaitai reserves and taiāpure over traditional fishing grounds or areas of special cultural significance.[18] There are currently four mātaitai established on the Otago Coast at Moeraki, Waikouaiti, Ōtākou and Puna-wai-Toriki (north of Nugget Point) and one taiāpure (the East Otago Taiāpure near Karitāne).

A Treaty settlement has also been reached for aquaculture which is enshrined in the Māori Commercial Aquaculture Claims Settlement Act 2004. As a rule of thumb, the settlement provides 20 per cent of aquaculture space to iwi (mirroring the 20 per cent of new quota passing to iwi under the Māori fisheries settlement). However, the practical implementation of the settlement has been complicated by the constantly shifting statutory framework applying to aquaculture.[19]

Under current arrangements, iwi are to receive settlement assets equivalent to the value of 20 per cent of the representative value of all aquaculture development in their region, after 1 October 2011, through entering into 'Regional Aquaculture Agreements' with the Crown. This is based on forecasts of demand for aquaculture in each region by species. Iwi can receive the settlement assets as authorisations for space inside an 'Aquaculture Settlement Area' (which give iwi the exclusive right to apply for consent for aquaculture activities within that space), cash or a combination of both.

Six Aquaculture Settlement Areas were recently Gazetted off the Otago coast including three offshore sites north of Dunedin, two inshore sites adjacent to Moeraki and one adjacent to Karitāne (see Figure 4.1).[20]

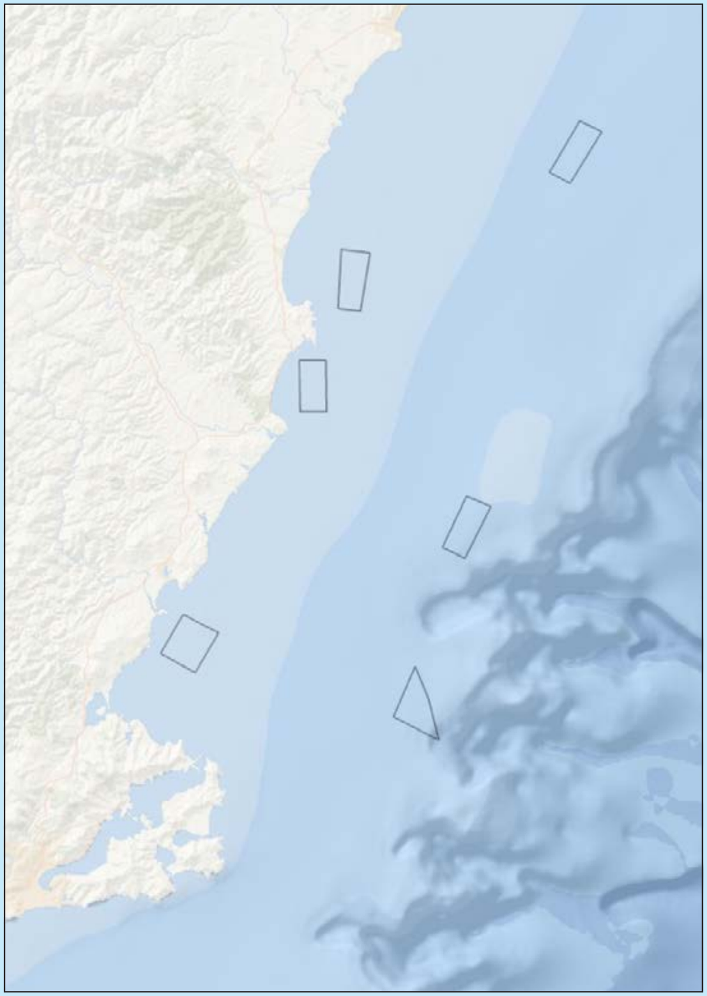

***Figure 4.1 Aquaculture Settlement Areas off the Otago coast** (Source: NABIS)*

In addition, Sanford Limited is proposing two large aquaculture areas off the Otago coast, totalling 40 hectares in size, under Project East (see Figure 4.2). These would enable farming of up to 24,000 tonnes of salmon per year, increasing Sanford's current salmon farming of 5,000 tonnes, nearly five times. [21] Ngāi Tahu is the largest individual shareholder of Sanford holding just under 20 per cent.[22] The proposal is a listed project under the Fast Track Approvals Act 2024.[23] It is not clear what cumulative impact all these aquaculture areas will have on the marine environment, if developed.

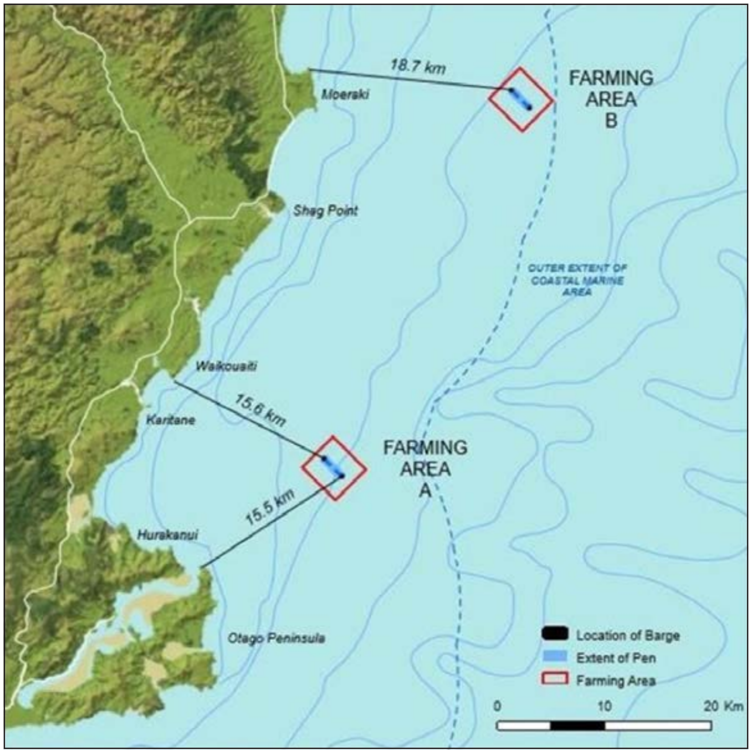

Figure 4.2 Project East proposed salmon farming areas *(Source: Sanford Limited)*

4.5 Development of settlements

There are two main urban areas along the Otago Coast – Dunedin (around 136,000 residents) and Oamaru to the north (around 14,000). Land at the head of the Otago Harbour, and at Port Chalmers, has been reclaimed and drystone walls built around much of the harbour margin. Port activity has had a major impact on the natural harbour environment. A kilometre long mole was built out from the heads during the late 1880s, to maintain a navigable entrance, and this has disrupted tidal flows and sediment movement up the coast.

There is also regular dredging of the navigation channel within the harbour (which has been ongoing since 1865) with dredged sediment disposed of just outside the harbour entrance.[24] This activity is currently managed through monitoring and conditions attached to a resource consent.[25] Port Otago is fully owned by the Otago Regional Council.

It could be valuable to regularly report the results of the monitoring undertaken by Port Otago, under the terms of its sediment disposal resource consent, in a manner accessible to the general public, to provide greater clarity on the impacts of the ongoing sediment disposal programme.

4.6 Development of fisheries

When Europeans first arrived in the region the fishery was abundant and healthy. Jacquinot who accompanied D'Urville on his visit to Otago Harbour in 1840 recorded that the "fish is so plentiful that the net nearly always comes in full."[26] Notably observations in the early years of European arrival include:

- Copious fish stocks observed in the Otago Harbour including baracoutta, hāpuku, ling, rock cod and rock lobster.[27]
- Blueskin Bay was said to swarm with fish, principally flounders, in 1875.[28]
- Enormous shoals of sprats, around the reefs at Moeraki, which were followed by mutton birds, prior to 1875[29]
- Hāpuku commonly available close to shore and a short distance from the Otago heads in the 1860s.[30]
- Enormous quantities of rock lobster harvested from the Otago heads in 1862.[31] A good source of rock lobster from rocky headlands around Blueskin Bay in 1868.[32] Large hauls of rock lobster taken by early steam trawlers on sandy seabed some distance from the coast with 6-7 tonnes landed at Port Chalmers.[33] In 1912, crayfish was reported as still extremely abundant in the harbour near Portobello.[34]
- Flat oysters harvested from the Otago Harbour and Blueskin Bay in the 1860s.[35] They were still present in the harbour in 1956.[36]
- In 1905, 67 different fish species harvested inside the harbour near the Portobello Marine Laboratory.[37]
- Enormous shoals of red cod in the Otago Harbour feeding on krill in 1910.[38]

Early commercial fishing was undertaken largely by Māori with the fish sold mainly being dried or smoked barracouta caught by line. Blue cod, hāpuku and ling were also taken by line fishing. In addition, an early commercial seine fishery developed in the harbour targeting flounder.[39]

The first trawling off the Otago coast, which was the first in the country, occurred in 1868 when a net was towed between Port Chalmers and the Otago heads. It caught a wide variety of fish including trumpeter, flounder, rock lobster, skate and sharks. However, the wear and tear on the nets was too great (likely indicating a rough bottom) so trawling soon stopped. It started again in 1899 using an otter trawl.[40] As early as the 1890s there were concerns about decline in the fisheries.

Despite this, the fishing industry continued to grow. Operating off the coast by the 1920s were two steam trawlers, four motor trawlers, 40 line boats and 29 seine boats. Total catch rose to 3,000 tonnes and then declined and stabilised at around 2,000 tonnes annually. The development of an export market for rock lobsters during the 1950s resulted in a rapid growth in that fishery.[41]

After the removal of part-timers from the industry, and the introduction of the quota management system in 1986, fishing vessel numbers dropped to around 38. By 2008 this had halved to just 19. Many of these were owned and operated by fishers associated with Ngāi Tahu, with a 1988 review revealing that Ngāi Tahu owned 40 per cent of all fishing vessels in the South Island fishery.[42] Many were third or fourth generation fishers and traced their lineage directly back to the early European sealers and whalers.[43] This has resulted in a small and relatively cohesive fishing community. Vessels operate from fishing ports at Oamaru, Moeraki, Karitāne, Port Chalmers and the Taieri mouth.

"Virtually all of the present Ngāi Tahu fishermen whakapapa back to Pākeha whalers, and have an unbroken family history of involvement in the fishery since the collapse of whaling in the early 1840s."[44]

Commercial fishing vessels berthed in Careys Bay

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5 Threatened species

Pakahe / New Zealand Sea lions (shown here at Sandfly Bay) are breeding on the Otago coast and increasing in numbers

Otago's diverse and productive marine environment supports multiple iconic and threatened seabird and marine mammal species.

5.1 Hoiho / Yellow-eyed penguin

Hoiho is one of the rarest penguins in the world and is the largest penguin living in a temperate region. The major breeding sites of the northern population are in Otago, with a southern population breeding in the sub-Antarctic islands. The species is nationally endangered. The mainland population has reduced from around 480 breeding pairs, in the early 1980s, to a current historic low of only some 150 pairs. This is despite intensive conservation efforts at breeding sites including habitat restoration, predator control, disease treatment, supplementary feeding and rehabilitation.[1] If current population trends continue, the mainland population could be functionally extinct within 20 to 40 years.

The penguins nest in coastal dune vegetation, shrubland and forest. They forage during daylight hours, at sea, bringing food back to the chicks in the late afternoon. During the breeding season the birds mainly forage on gravelly seabeds, out to 35 kilometres from the coast, and in waters up to 80 metres deep. They target small (often larval or juvenile) finfish as well as arrow squid.[2] Prey availability is a major determinant of the penguin's breeding success. Because the birds forage on the seafloor, they rely on an intact benthic ecosystem that supports adequate biodiversity and prey abundance, to sustain local populations.

The predominant method of fishing off the Otago Coast is bottom trawling which can impact prey abundance on the sea floor.[3] Trawling is known to reduce seafloor biodiversity, and reduce the complexity of benthic communities, so has likely impacted penguin food sources.[4]

In addition, warmer sea surface temperatures increase the stratification of the water column, reducing the mixing of the higher nutrient-laden surface waters (enriched by land run-off) with the bottom waters, and thereby also impacting the productivity of benthic areas where the penguin prey is located.[5]

> "Alterations of benthic ecosystems likely affect Yellow-eyed penguins significantly, be it through climate change-related system-wide shifts, increased sedimentation, or fisheries-related habitat degradation (eg bottom trawling, dredging)."[6]

Rising seawater temperatures have been identified as a key problem for the penguins, with adult survival reducing during years with warmer seawater. This is thought due to the impact of warmer seas on the abundance of key prey species such as red cod (see spotlight). This climate stress in turn makes the penguin population less resilient to non-climate related impacts such as fisheries interactions, habitat degradation and human disturbance.[7]

Spotlight on changes to hoiho diet

During the mid-1980s, red cod, opalfish and sprat dominated the mainland hoiho diet. But since the 1990s, the relative importance of blue cod has increased and red cod has much reduced.[8] Blue cod requires more energy to catch. It is also much larger than red cod and therefore harder to digest and break down into small parts to feed to their chicks.[9]

Red cod is a fast-growing short-lived fish that undergoes significant population fluctuations due to varied recruitment. Good recruitment is observed in years of lower sea surface temperatures but the reasons for this are not known (with very little known about spawning location, larval development and larval transport of the species).[10] This means that recruitment has likely been negatively impacted by increased sea surface temperatures off the south-east coast of the South Island since the mid-1990s.[11]

In addition, red cod was heavily bottom trawled during the mid-1990s. The peak landing of 13,919 tonnes was during the 1998-99 fishing year in RCO3 which includes most of the south-east coast of the South Island, the southern coast and Fiordland. The catch dropped off to under 5,000 tonnes the following year, and has never returned to its former abundance, with the 2022-23 year commercial harvest being only 1,145 tonnes.[12] The heavy catches during the mid to late 1990s may have significantly reduced the spawning biomass (see Figure 5.1).[13]

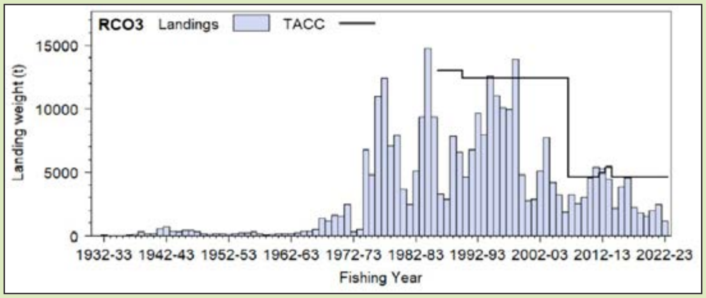

Figure 5.1: Reported commercial landings and TACC for RCO3 *(Source: Fisheries New Zealand)*

Such a conclusion is supported by research undertaken in the Barents Sea which indicated that under warmer conditions, population growth of high latitude (equivalent to low latitude in the southern hemisphere) stocks becomes increasingly dependent on recruitment, which in turn depends mostly on age structure. The structure is adversely impacted by fishing activity due to reducing the larger and more productive size classes of the stock. This means that fishing activity can reduce the resilience of fish stocks to a warming climate.[14]

Hoiho are also regularly caught in set nets placing further pressures on population numbers. Between 1979 and 1997, there were 72 known yellow-eyed penguin deaths through set netting activities, an average of four per year. 70 per cent of the deaths occurred off the Otago Peninsula or in north Otago. Additional captures were thought likely due to under-reporting.[15]

"...rehabilitating penguins and sending them back out into the marine environment is akin to patching up soldiers and sending then back to the front ... Because the most significant unmanaged threats are almost all marine-based ... bottom-set gillnetting, bottom contact trawling, and the deposition of dredged substates all occur in the foraging areas of hoiho."[16]

There is currently a four nautical mile set net ban along the Otago Coast but this has not been sufficient to reduce penguin bycatch. More recent figures indicate a similar mortality rate to that recorded in the past, with five fisheries-related deaths during the 2023/24 fishing year and four the previous year.[17] This is no doubt because the penguins forage much further from the coast than four nautical miles (up to around 20 nautical miles).

Project East (described earlier), which seeks to establish salmon farms in two large offshore areas, has the potential to impact hoiho as their foraging areas overlap Farming Area A (as shown on Figure 4.2).[18]

"As the population declines, the impact of even small number of fishing related mortalities increases..."[19] There is a need to reduce, and ideally eliminate, hoiho fisheries bycatch.

5.2 Hector's dolphin

The nationally vulnerable and endemic Hector's dolphin, commonly called tutumairekurai or ocean dweller by Māori, is one of the smallest dolphins in the world and also one of the rarest. The estimated national population size is 15,000 individuals with approximately 9,100 living on the east coast of the South Island and 330 on the south coast. There are five local populations off the east coast with a small grouping of just 100 to 200 animals off Otago[20] (see Figure 5.2). Hector's dolphins have small home ranges (of only approximately 30 to 50 kilometres alongshore) meaning there is likely little intermixing between local populations.[21]

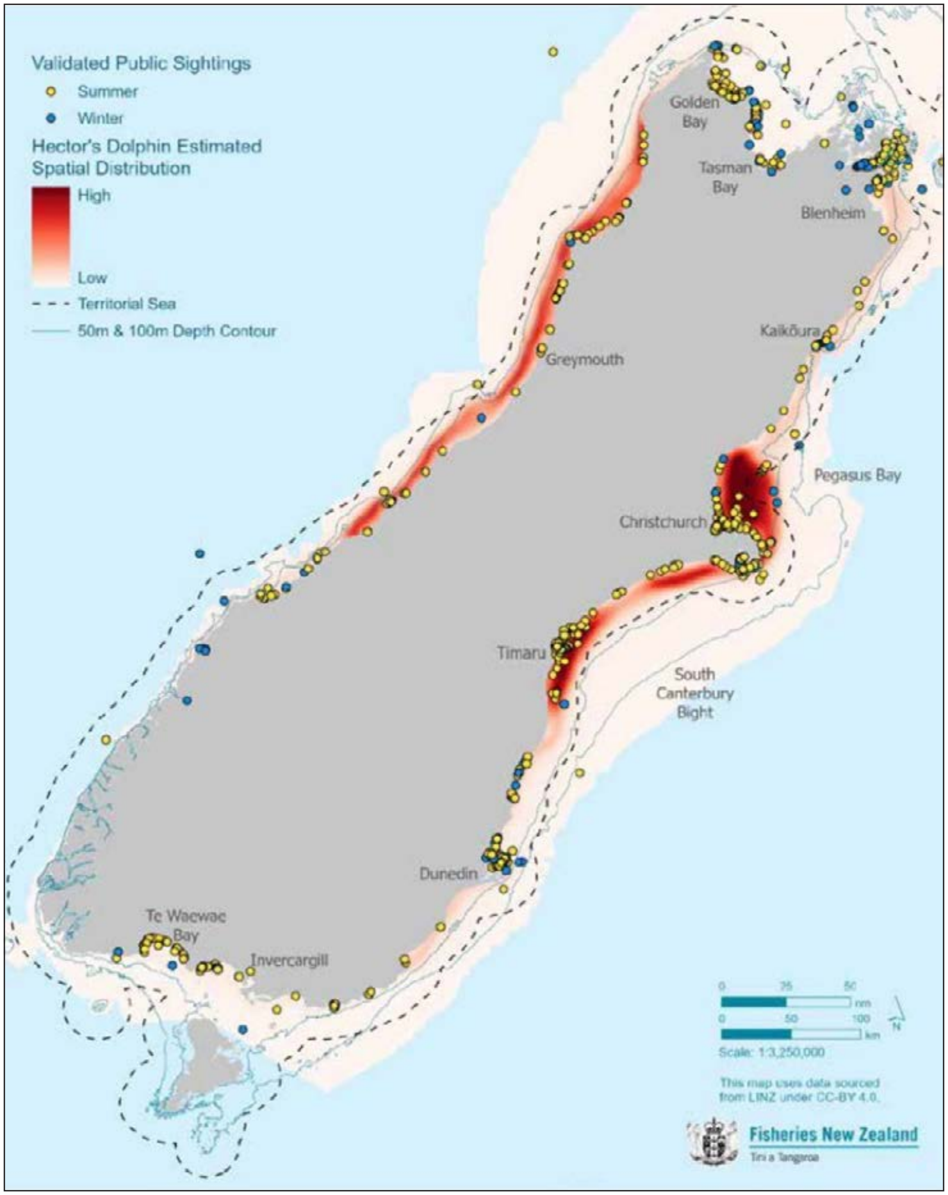

***Figure 5.2 Estimated spatial distribution of Hector's dolphins** (Source: Fisheries New Zealand)*

Similar to the case with hoiho, red cod has been of particular importance in the diet of the dolphins. An analysis of stomach contents of animals caught in fishing equipment or beach cast, between 1984 and 2006, found that red cod was the most frequently eaten prey and contributed the greatest amount of food mass, followed by ahuru.[22] Although the current diet composition of the dolphin is not known, the stark reduction in the biomass of red cod may have impacted the dolphins in a similar manner to the hoiho.

"The [Hector's] dolphins might need to travel farther to find enough red cod or they may have shifted to another prey item that is more readily available but not necessarily as nutrient or calorie rich. Either of these scenarios would have energetic consequences for the dolphins and might contribute to various forms of nutritional stress."[23]

Hector's dolphins are particularly vulnerable to nutritional stress given their physical and behavioural characteristics. They are small, meaning they need to obtain food regularly to fuel their fast metabolism. They live in cold water, and have a high surface to volume ratio, meaning that more energy is required to compensate for heat loss. They produce big calves which are about a quarter of the weight of their mother. Being unable to store significant energy as fat, the mothers must continuously feed throughout pregnancy and lactation, in order to meet increased energetic demands.[24]

As well as a potential reduction in food supply from climate change and harvesting pressure, the dolphins are particularly susceptible to being caught in set net and trawl gear and are impacted by the parasitic disease toxoplasmosis.

Hector's dolphins have regularly been reported as washing up dead on the Otago coast since the 1980s but, until last year, had rarely been reported as being caught in fishing gear.[25] Taking into account likely under-reporting, a 2021 analysis estimated that an average of 1.12 dolphins are killed in set nets each year in the region, with an additional dolphin killed in a commercial trawl net.[26] This is despite a set net prohibition out to four nautical miles from the Otago coast (but excluding the Otago Harbour). However, bottom trawling is permitted right up to the shoreline although a low headline height trawl net must be used within two nautical miles from the shore.

More recently, fisheries related mortality limits have been set for the Hector's dolphins. Off the Otago coast this is two dolphins per year (around the estimated current bycatch rate). A single Hector's dolphin was recorded as being caught in a set net off the Otago coast in April 2023 (4 nautical miles north of Taiaroa Head) and there was a further dolphin caught in November 2023 (just 4.13 nautical miles north of Taiaroa Head).[27] This indicates that the dolphins were caught just seawards of the 4 nautical mile set net ban area, with fishers likely 'fishing the line' along the set-net ban.

5.3 Pakahe / New Zealand sea lion

Pakake / New Zealand sea lions are endemic and the rarest sea lion in the world. Although they used to range right around the mainland, their main breeding stronghold is now in the sub-Antarctic islands, due to strong harvesting pressure. The sea lions began breeding again on the Otago Peninsula following the arrival of a single female who, in 1993, produced a pup there. During the last summer's breeding season, 29 pups were born on the Peninsula, a significant jump from 21 the previous season. There are now thought to be 34 breeding females in Dunedin and sea lions are a common sight on the Otago coastline.[28] In a study undertaken during 2008 and 2009, females were found to forage mostly in coastal waters and in the deeper bryozoan thickets off Otago Peninsula.[29]

Their main food source is barracouta and jack mackerel. Barracouta, in particular, is in much better shape than the red cod that hoiho and Hector's dolphin rely on, which may explain the relative breeding success of the sea lions. As their numbers expand, there is a growing problem with conflicts between the sea lions and humans, with recent incidents of sea lions being shot.[30]

Pukekura /Taiaroa Head (shown here) is the only mainland breeding site in the world for the Toroa / Northern royal albatross

5.4 Toroa / Northern royal albatross

Toroa / Northern royal albatross is one of the largest and longest-living seabirds in the world. Adults regularly reach up to 40 years in age and have been known to continue breeding into their 60s. The main breeding population is on the Chatham Islands, but there is a small colony on Pukekura / Taiaroa Head, the only mainland breeding site in the world. It was established in 1937 when one breeding pair nested there and, under careful management, has slowly increased to 70 breeding pairs. All chicks there are hatched in incubators and are often provided with supplementary feed.[31] The species is endemic to New Zealand and is categorised as nationally vulnerable.[32] Birds are particularly vulnerable to being caught on fishing longlines.

5.5 Matapo / Otago shag

The threatened Matapo / Otago shag is an endemic species, which was once present all along the east cost of the South Island but is now only found on the Otago coast where there are six breeding colonies. The bird was only recognised as a separate species in 2016.[33] A 2021 survey counted around 1,300 breeding pairs remaining with the largest colony at Sumpter Wharf in Oamaru. The birds forage in water up to 30 metres deep eating fish living on the seabed such as flounder (as well as invertebrates including crabs, shrimps and worms).[34] They are susceptible to capture in set-nets.[35] Somewhat alarmingly, in 2023, the Oamaru, Moeraki and Otago Peninsula nesting colonies dropped in size by nearly 75 per cent possibly due to warming seawater affecting their food sources.[36]

5.6 Wildlife tourism

Wildlife tourism is an important component of the Otago economy with visitors viewing a wide range of marine mammal and bird species. In 1987, just 15,000 people were engaged in wildlife viewing on the Otago Peninsula, but this increased to as many as 200,000 by 2006.[37] A 2007 study estimated that wildlife tourism contributed in excess of $100 million to the local economy and 800-1000 full-time equivalent jobs.[38]

No doubt this figure has increased significantly over the subsequent 17 years, but we have been unable to find any more recent estimates. In 2007, each pair of albatross was estimated to have a total economic impact of $1-2 million annually and each pair of hoiho $250,000. Interestingly, at the time of the study, hoiho viewing was found to generate twice the revenue of the Royal Albatross centre, highlighting the popularity of the penguin with tourists. This is further reinforced by hoiho recently being named the 2024 Bird of the Year.[39]

A more recent tourism attraction on the Peninsula is the kororā / little blue penguin colony at Takiharuru Beach. The nature reserve is now managed by the Pukekura Trust which has restored the area with replanting and predator control. The colony has grown to over 300 pairs.[40] A 2021 survey of marine ecotourism identified 20 operators in Otago, making it the fourth most popular region in the South Island. The most frequent activity was wildlife viewing which included watching seals, whales and dolphins along with seabirds.[41]

Spotlight on Otago Biosphere Reserve proposal

There has been a recent proposal to seek international recognition for an 'Otago Biosphere Reserve'. If successful, it would be the first such area recognised in New Zealand.[42] Biosphere reserves are sponsored by UNESCO and have international status as "learning places for sustainable development".[43] They seek to integrate conservation, sustainable economic and social development and cultural diversity at place. They also provide support for local projects, education, research and monitoring.

Biosphere reserves are collaborative efforts designed to advance both the well-being of humans and nature through testing solutions to shared challenges.[44] Through focusing on local leadership and community-led decision-making, biosphere reserves are designed to complement rather than duplicate existing frameworks.

There is a growing worldwide network of hundreds of such reserves but the model has yet to take root in New Zealand. The concept, as proposed for Otago, spans an area of 6,892 square kilometres, extending from Moeraki in the north down to the Taieri River in the south, landwards to the Maniototo in Central Otago, and seawards out to edge of the territorial sea. It has a strong nature positive orientation seeking to build economic strength alongside environmental protection. Wildlife tourism is one area where such connections are particularly strong.

Creating a biosphere reserve could help unify existing efforts on the Otago coast under a cohesive vision. These could include management of the proposed south-east marine reserves, protection of significant marine ecological areas and habitats of particular significance for fisheries management, kelp restoration and catchment rehabilitation efforts.

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6 Fish stocks

Rock lobster which support a significant fishery along the Otago coast

> "...homogenisation of marine fish communities has been previously linked to bottom trawling and ocean warming, with consequences for ecosystem function."[1]

6.1 Finfish

An analysis of the results of fisheries-independent trawl surveys from 1991 to 2018, indicated that most finfish species off the east coast of the South Island have increased in biomass, and have generally stable or increasing catch rates over time. This indicates that the fishery may have reached "a relatively steady state community".[2]

However, the structure of the fish community has undergone significant changes. In general, fish stocks have become more homogenous in their location (including across different depth levels), and the average trophic level has decreased, indicating that higher tropic level species had become relatively less abundant.[3]

The analysis revealed a decrease in relative biomass of jack mackerels and red cod, which feed on small fish at the mid trophic level, and a large increase in relative biomass of spiny dogfish, barracouta and ghost shark which feed at a lower trophic level (mainly on crustaceans, bivalves and other benthic dwelling invertebrates). More profound changes likely took place in the fishery prior to the early 1990s after experiencing decades of unregulated fishing.[4]

> Changes to the structure of the fin-fishery off the Otago coast, due to ongoing harvest by trawling, has likely impacted the diet of protected species such as hoiho and Hector's dolphin which preferentially feed on mid trophic species which have become relatively less abundant over time.

6.2 Pāua

Pāua are a species of abalone endemic to New Zealand. They are herbivores and form large aggregations on reefs in shallow subtidal coastal habitats (up to 15 metres deep) that make them easily accessible to harvesters. They largely feed on drift algae. They are long-lived, reaching 20 to 30 years of age. They are largely sedentary making them particularly susceptible to localised depletion. In addition, they are broadcast spawners meaning that a certain density of animals is required (with no more than 1.5 metres to a nearest neighbour) for eggs to be successfully fertilised.[5] Localised depletion is therefore a major risk for pāua stocks from which recovery is uncertain.

Harvesting is not the only stressor on pāua stocks. Studies have indicated that pāua are also impacted by sedimentation, habitat loss and low recruitment.[6] Sedimentation can smother pāua, increase larval mortality and reduce suitable substrate for settlement. It also impacts the health of their major food source, kelp forests, as described above. Sedimentation will likely increase with climate change due to more intense storm events.

Such events can also directly damage pāua, as well as decrease salinity of the seawater, due to large pulses of freshwater discharging into the marine area.[7]

The vulnerability of pāua to predicted future climate change effects is very high. Increasing ocean temperatures will likely reduce growth rates and adult sizes and negatively impact their kelp food sources. Increasing ocean acidification will likely affect shell development, and reduce the prevalence of coralline algae, which is both a food source and provides a settlement cue.

Pāua stocks have undergone significant decline in areas accessible to recreational fishers, along the Otago coast, where fishing restrictions and stock enhancement efforts have had little success in rebuilding stocks. This is despite the hands-on management of the stock in the East Otago Taiāpure (see spotlight) and may indicate the danger of inadvertently exceeding tipping points for sensitive species in a climate changing world.[8]

Waikouaiti Estuary, Karitāne which is part of the East Otago Taiāpure

"Māori associated the depletion of pāua with loss of cultural identity, hospitality, tradition, practices, emotional and spiritual connection to their environment."[9]

Spotlight on pāua management in the East Otago Taiāpure

The East Otago Taiāpure, established in 1999, covers 22 square kilometres and stretches along a 20 kilometre length of coastline just north of the Otago Peninsula (and adjacent to Karitāne) (see Figure 5.3). It includes Blueskin Bay and the Pūrākaunui Estuary on the northern edge of the Otago Peninsula. The Taiāpure is supported by the Waikouaiti Mātaitai located over the estuarine area at Karitāne and extending further upstream into the Waikouaiti River. Both are within "the cultural landscape of Kāti Huirapa ki Puketeraki who hold mana whenua and mana moana in the area."[10]

The Taiāpure was first applied for in 1992, due to concerns over depleted pāua stocks, and the wish of mana whenua to reassert rangatiratanga over the area to ensure its health and well-being. Providing accessible and relatively sheltered waters close to Dunedin, within an otherwise largely exposed coastline, the area had proved popular with recreational fishers.[11] The vision is for "a sustainable, healthy, abundant and accessible fishery inside the Taiāpure that provides for the community's customary, recreational and commercial needs.'[12]

The area is managed by the East Otago Taiāpure Committee which has equal representation from Kāti Huriapa Rūnaka ki Puketeraki and the local community. There has been a variety of restrictions on the harvest of pāua within the Taiapure. A temporary two year closure on take around the Huriawa Peninsula was put in place in 2010 and renewed twice. The closure area was then extended to include the Mapoutahi Peninsula in 2016. The entire Taiāpure was closed to the harvest of pāua in 2019 as well as to the take of seven kelp species. There is also a prohibition on set netting and filleting of fish at sea throughout the area.

Despite these closures the pāua population has not recovered. This may be due to habitat loss or fishing pāua down to such low levels that the remaining population cannot successfully recruit.[13] It indicates that an ecological tipping point may have been passed. There have been efforts to re-seed hatchery grown pāua within the Taiāpure, in order to help restore the stock, but these have yet to prove successful with poor survival rates.[14]

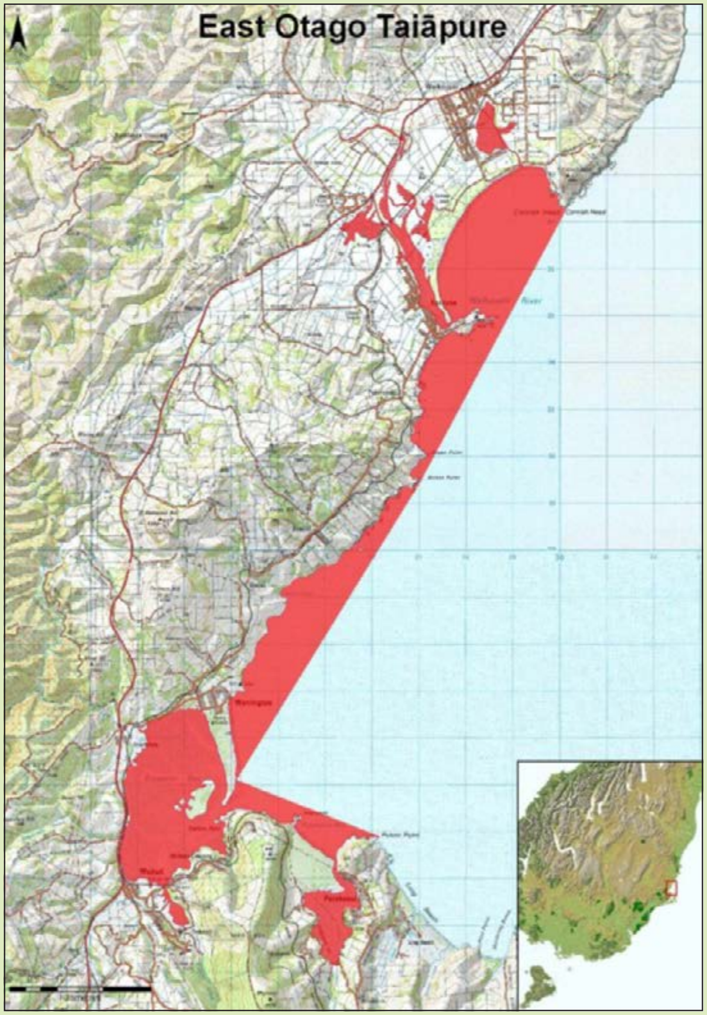

Figure 6.1 East Otago Taiāpure *(Source: Ministry for Primary Industries)*

Currently recreational and commercial fishing of pāua is not permitted within the East Otago Taiāpure. Commercial fishing (including of pāua) is not permitted in the Moeraki Mātaitai and recreational pāua fishing is excluded from two areas within it. Commercial fishing of pāua is also excluded from an area off the south coast of the Otago Peninsula (along with other shellfish) as well as within the harbour and off some river mouths.

The Otago Peninsula closures were put in place during the mid-1980s, initially due to food safety concerns about discharges from meat works, sewage outfalls and rivers,[15] but they have served to reduce harvest pressure on the stocks. When the commercial sector attempted to lift some of the closures (on parts of the Otago Peninsula and around the Te Mata-Au / Clutha River mouth) in 2013, there was an outcry from recreational fishers, and they were retained. An area of pāua habitat off the Otago Peninsula south coast is now proposed to be protected by the Ōrau Marine Reserve.

Overall, the PAU5D stock (which extends along the Otago coast) is thought to have decreased significantly in size until 2015, where there was little over 25 per cent of virgin biomass remaining, followed by a slow rebuild to the current size of around 40 per cent.[16] This rebuild is likely due, at least in part, to the efforts of commercial pāua fishers who shelved around two-thirds of their annual catch entitlements for eight years and increased the minimum harvest size.[17]

This demonstrates what can be achieved if commercial fishers work collaboratively together to manage local stocks. However, harvest levels at around 60 tonnes a year are now the second lowest in the country and just slightly higher than that off the Canterbury coast (PAU3) part of which was impacted by the Kaikōura earthquake (see Figure 6.1). Conservative management will be needed, going into the future, given the susceptibility of pāua to a range of climate change impacts, along with ongoing sedimentation and habitat loss.

Coast off Karitāne which is part of the East Otago Taiāpure

6.3 Rock lobster

As indicated above, rock lobster were once highly abundant within the Otago Harbour and along the Otago coast. But heavy fishing pressure has reduced stocks to a small fraction of their original biomass. Harvest in the Otago fishery (CRA7) peaked during the 1950s, at around 900 tonnes a year, but is now currently only just over 100 tonnes. Harvest levels have been slowly increasing, along with the size of the stock, from a low of 44 tonnes in 2013-14 (see Figure 6.2).[18] The number of vessels harvesting rock lobster has dropped dramatically over the past four decades. There were 79 to 90 vessels operating in the Otago fishery during the early 1980s but this has now dropped to just 10 vessels.[19]

Rock lobster was brought into the quota management system in 1990. This was preceded by very heavy harvests to establish catch history on which quota was allocated. This bump in harvest during the mid 1980s can be seen in Figure 6.2. This would no doubt have served to further deplete an already stressed stock, which is seen in the decline of harvest in the 1997-98 year to a record low of 36 tonnes, and with a standardised CPUE of just 0.176 kgs a pot lift. In 1999, the combined CRA7 and CRA8 stocks were estimated at just five percent of virgin biomass.[20]

The Otago commercial rock lobster fishery has been managed somewhat differently to others around the country. In particular, much smaller animals are harvested. This approach was apparently introduced in the mid-1900s to support a market for canned rock lobster tails.[21] The market no longer exists but the smaller harvest size has endured.

Normally a minimum size length is set so that animals in the population have the opportunity to breed at least once before being harvested. The minimum legal size in CRA7, established during the 1950s, is based on tail length rather than width (which is applied to all other stocks). In CRA7 the minimum legal size is 127 millimetres tail length for both sexes which roughly corresponds to a tail width of 47 mm for males and 48 mm for females. In other stocks the minimum legal size for females is 60 mm (58mm in Fiordland CRA8) and 52 mm for males.[22]

In addition, research indicates that the size rock lobsters off the Otago coast need to reach in order to breed, is larger than in other areas (aside from Stewart Island).[23] This suggests that animals off Otago may be harvested prior to reaching breeding age thereby reducing the potential of any local recruitment. Another incentive for harvesting smaller animals is the indication from tagging studies that small males and immature females migrate out of CRA7, during spring and early summer, by walking against the current towards Fiordland (and into CRA8). It is reported that very few mature females are caught in Otago.[24]

Overall, this means that virtually all settlement of rock lobster on the Otago coast is sourced from the Fiordland stock (CRA8) with larvae carried around the bottom of the South Island and up the Otago Coast by the Southland current. To the extent that rock lobster breed in CRA7, larvae would be carried northwards on the Southland Current to the east coast of the North Island and the Chatham Islands.[25] It also means that recruitment in CRA7 has an impact on CRA8 through the migration of sub-mature females.

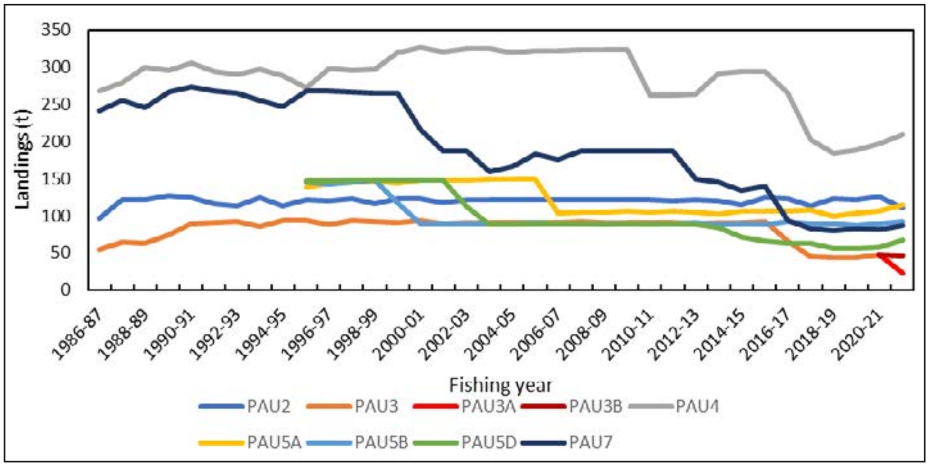

Figure 6.2 Historical landings for pāua stocks from 1986-87 to present *(Source Fisheries New Zealand)*

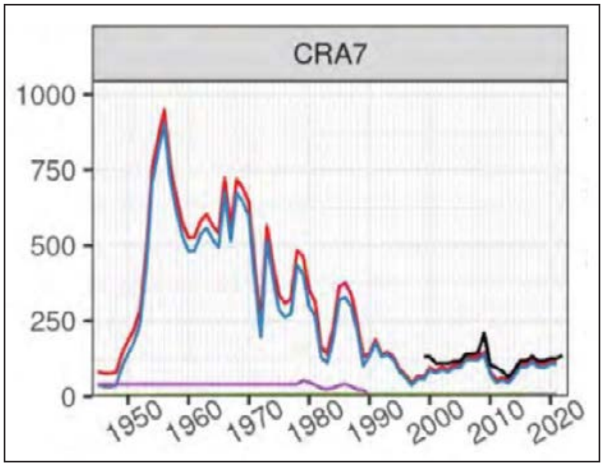

Figure 6.3: Historical landings for CRA7 from 1945 to 2022 *(Source: Fisheries New Zealand)* Black line is total allowable commercial catch

Spotlight on the lifecycle of rock lobster[26]

The female rock lobster can lay up to 1 million eggs and the male extrudes a short lived spermatophore during copulation that the female uses to fertilise her eggs. The eggs stay attached to her tail for up to six months. When the eggs are ready to hatch, the females congregate on the deep seaward edge of coastal reefs, releasing larvae at dawn over a three to five day period.

Once released, the naupliosoma larvae swim vigorously to the surface and moult into stage 1 phyllosoma larvae, forming swarms on the seawater surface. The larvae spend 12 to 14 months in the open ocean, some tens to hundreds of kilometres offshore, carried along by oceanic currents. During this time they undergo 11 developmental stages where each moult cycle marks a transition between larval forms.

Near the edge of the continental shelf they eventually metamorphose into a post-larvae puerelus, which is a stronger swimmer, and they actively swim towards coastal reefs before settling. They are likely drawn to the coast by sounds of breaking surf. Settlement takes place on seaweeds, or in holes and crevices in rocks, where the puerelus moult into juvenile rock lobsters. At 5 to 10 years of age, they mature into adults which start breeding, and may live for up to 30 years.

This dependence on CRA8 for recruitment has proven fortuitous for the Otago fishery. This is, first, because Fiordland crayfishers decided not to fish their stock as hard as the Otago fishers. In Otago, a management rule was adopted in 2007 that enabled them to fish stocks hard when they were abundant, and more quickly reduce catch when stocks declined. In contrast, the Fiordland fishers adopted a more conservative rule that maintained higher long-term stock abundance and required fewer changes in allowable catch.[27]

Secondly, Fiordland fishers who became concerned about the poor state of the rock lobster stock formed a fisheries group to do something about it. This morphed into the Guardians of Fiordland and the establishment, in 2005, of a network of eight new marine protected areas that closed13.5 per cent of the inner fiord area to all fishing along with the exclusion of all commercial fishing from the inner fiords.[28] In contrast, there are currently no protected areas along the Otago coast.

This significant Fiordland marine protection appears to have supported the rebuild of the fishery.[29] CRA8 now has by far the highest standardised CPUE of all the stocks around the country at more than 5kgs of rock lobster per pot lift. The CRA7 fishery had a lagged rebuild, with a significant increase in the 2013-14 fishing year, seven years after the marine reserves were put in place. By this time, stocks had the opportunity to rebuild within the reserves, thereby increasing larvae production.[30] A comparison of the graphs in Figure 6.2 highlights the results of the different harvest and protection strategies in the two areas, with CRA8 being a more stable stock, retaining higher abundance and achieving a stronger rebuild than CRA7, despite the evident biological connections between the two stocks.

Because of the interdependence between the stocks it is not possible to assess the status of CRA7 independently from CRA8 (which is thought to be in a healthy state). However, recent catch per unit effort data suggests the biomass in CRA7 has been increasing over the past decade. In 2024 it was 3.105kg of rock lobster per potlift (compared to just 0.625kg in 2012).[31]

Despite this positive outcome, the Minister for Oceans and Fisheries declined to increase the total allowable commercial catch in the 2025 April sustainability round. This was due to concerns about the abundance of kina in parts of CRA7, and the risks of kina barren formation, particularly in the context of recent heatwaves.[32] Although there is not solid evidence of kina barren formation along the Otago coast, a survey undertaken in 2024 by local fishers indicated possible high abundances of kina in parts of the north Otago coastline.[33]

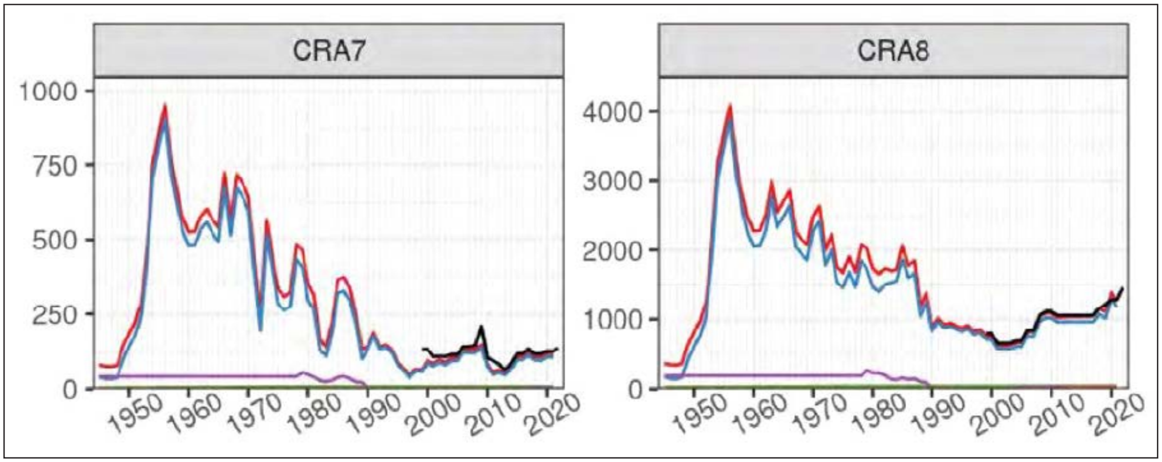

Figure 6.3: Comparison of historical landings for CRA7 and CRA8 from 1945 to 2022 (Source: Fisheries New Zealand) The black line shows the total allowable commercial catch.

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7 Current responses

Sediment from catchments, including the Taieri Plains shown here, are impacting the health of the Otago coastal marine area

In this section we investigate two key challenges: sedimentation and spatial protection of the marine environment.

7.1 Reducing sedimentation

> "The consequences of poor land management and high levels of sediment runoff must be urgently addressed in the face of increasing occurrences of MHWs [marine heat waves]".[1]

Sedimentation is a key environmental threat in Otago coastal waters and some estuaries. As indicated above, bladder kelp dieback along the southern coast is thought due to 'coastal darkening' by sedimentation. Where kelp has been impacted by marine heatwaves, sedimentation has served to exacerbate the impacts, causing greater die-back.[2]

The biggest contributor of sediment to the Otago coast, by far, is Te Mata-Au / Clutha River which deposits around 3.8 million tonnes of sediment each year. About half of this discharge comprises mud (ie 1.9 million tonnes).[3] The Taieri River, the fourth longest river in the country, currently contributes around 0.6 million tonnes of sediment. All this sediment is transported northwards on the Southland Current impacting a large extent of the coast. The Otago climate is characterised by long dry spells, followed by heavy rain, which can generate large pulses of sediment intermittently coming out of the rivers.[4]

An analysis of climate change impacts on the Taieri River catchment has identified a shift towards more and heavier rainfall in the catchment. There will likely be increases in the magnitude of heavy rainfall events as well as an increase in the number of heavy rain days. There will generally be less water in the Taieri River during extended dry periods but high flow and flood events will likely be larger.[5] This will mean larger and more frequent pulses of sediment being discharged by the river into coastal waters.

There is also evidence of sedimentation directly impacting estuaries, particularly those at the base of catchments where significant exotic forestry plantations have been established. For example, Te Hakapupu / Pleasant River estuary (to the south of Palmerston) has dense algal mats, anoxic water conditions and mud accumulation.[6]

Just over a quarter (26%) of the catchment is in exotic forestry with pine harvest areas having 69-fold higher topsoil yields than pasture and fodder crops.[7] An area downstream of recently harvested forestry was found to have sedimentation deposits, 77 percent of which had the signature of pine forest harvest.[8] The Otago Regional Council was notified of poor water quality in the river after a significant rainfall event, and the cause was found to be a nearby forestry block.[9]

Spotlight on restoration of Te Hakapupu / Pleasant River catchment

The Toitū Te Hakapupu project, a partnership between Kāti Huirapa Rūnaka ki Puketeraki and the Otago Regional Council, is seeking to restore and enhance the mauri and health of the Te Hakapupu / Pleasant river system and estuary. The project was funded by Jobs for Nature and has an initial focus on developing a catchment restoration action plan.[10]

Akatore Estuary, south of the Taieri Mouth, is also being impacted by fine sediment. Three quarters of the catchment is in exotic forestry making it the most highly forested catchment in Otago.[11] In addition, the Otago Regional Council has been notified of large sediment discharges into the Waianakarua River, to the north of Moeraki, which was found to have originated from road run-off within a forestry block.[12]

Council investigations into forestry compliance have indicated that sediment issues typically stem, not from removal of the trees themselves, but from associated earthworks such as the construction of haul roads, harvest machinery tracks and landings and skid sites.[13]

Clusters of forestry blocks have been increasing in the catchments draining into the Otago coast. Since the late 2010s there has been a trend for whole sheep and beef farm sales for conversion into forestry.[14] This is in addition to woodlots on farms, which are commonly located in marginal farming areas that are more subject to slipping, such as steep gullies.[15]

Increasing areas of land being planted in exotic forestry, combined with projected climate change impacts, means that coastal sedimentation issues will likely get worse unless natural systems such wetlands are restored and a more rigorous management approach is applied to forestry harvesting and earthworks.

Most land in the Otago Region is categorised as green (low erosion susceptibility) or yellow (moderate erosion susceptibility) under the Erosion Susceptibility Classification system. This means that, under the National Environmental Standards for Commercial Forestry (NES-CF), forestry planting and harvesting are from the outset permitted activities subject to meeting standards in the regulations.[16]

There is currently provision for councils to adopt more stringent rules including to give effect to the National Policy Statement for Freshwater Management or specific policies in the New Zealand Coastal Policy Statement.[17] Amendment 2 (NES Plantation Forestry) of the Otago Regional Plan: Water (which came into effect in 2018) put in place more stringency in terms of riverbed disturbance (to protect indigenous non-migratory fish) and sediment discharge limits.[18]

The Otago Regional Council had planned to beef up these rules in its new Land and Water Plan. In the proposed version of the Plan, which the Council was poised to notify in October 2024, consents would had been required for harvesting of commercial forestry (as a controlled activity) from 1 November 2026 and replanting more than a small area would have become a restricted discretionary activity.[19]

However, the public notification of the plan was stopped at the eleventh hour by government, which introduced an amendment to the RMA blocking councils from notifying new freshwater plans until a new National Policy Statement on Freshwater Management was in place, or 31 December 2025, whichever was sooner.[20] The amendment came into law on 25 October 2024, but was backdated to apply from 22 October, the day before the Otago Regional Council was scheduled to meet to vote on notifying its plan. This indicates that the coming into force of the RMA amendment may have been timed to stymie notification of the Otago Plan. There had been strong push back from the forestry sector on further restrictions on their activity within the region.[21]

The RMA amendment only stops notification of new plans which give effect to the National Policy Statement on Freshwater Management.[22] The New Zealand Coastal Policy Statement also provides national policy on sediment matters, requiring under Policy 22, that councils “control the impacts of vegetation removal on sedimentation including the impacts of harvesting of plantation forestry”. This means that the Otago Regional Council could notify a plan change that further constrains forestry harvesting and afforestation activities in order to give effect to national coastal policy.

A recent review of forestry compliance by the Otago Regional Council highlights the difficulties the Council faces in undertaking effective monitoring of forestry activity under the current regime and ensuring compliance with the rules. Under the NES-CF, there is a requirement for the Council to be notified of various permitted forestry activities.

Illustrating the extent of forestry activity in the region, the Council received 238 forestry notifications during the 2022-23 financial year, of which 123 related to harvesting and earthworks.[23] Of the 199 audits the Council completed between 2018 and 2023, 56 revealed non-compliance with the rules. Almost half of these related to soil stabilisation and stormwater control, and in a third of cases, there were noticeable sedimentation issues. Even when the national regulations were being complied with, sedimentation issues were still occurring, highlighting the difficulties with a one size fits all approach for forestry.[24]

"… compaction of soil may be appropriate stabilisation for forestry blocks located within green ESC zones and on gentle slopes but insufficient for other forestry blocks located in areas more prone to erosion, on steeper gradients and in closer proximity to waterbodies– however, both scenarios would meet compliance requirements …"[25]

The future health of the Otago coastal marine area is dependent on more effective sediment controls being put in place in Otago catchments. Proposed strengthening of controls on commercial forestry in the Land and Water Plan has been stymied (at least until 31 December 2025) by recent amendments to the RMA. However, sediment controls (including on forestry harvesting activities) could be strengthened via a plan change in order to give effect to the New Zealand Coastal Policy Statement.

7.2 Spatial marine protection

Spatial marine protection can help manage the direct impacts of activities on marine habitats and species. Such activities can include fishing, aquaculture, dredging, mining, dumping, renewable energy and tourism. Protected areas can also help increase resilience of marine ecosystems to other stressors, which spatial protection cannot address directly, such as sedimentation and climate change.[26]

The main spatial marine protection initiative underway along the Otago coast is the South-East Marine Protection Project. This commenced in 2014, when the South-East Marine Protection Forum was established to deliver recommendations to government on a marine protected area network for the south-east coast of the South Island.

The Forum consisted of 14 people (plus two alternates) including an independent chair. Three were rūnaka representatives (including the deputy chair), three were commercial fishers, two were recreational fishers, two were environmentalists, and there was one person each from the tourism, community and marine science sectors.[27]

In the end, consensus could not be reached, and the Forum's recommendations (released in February 2018) included two different options. Network One (which protected 14.2 per cent of the bioregion) was supported by the environment, tourism, community and science sectors, as well as one recreational fishing representative. Network Two (which protected just 4.1 per cent of the area) was supported by the commercial fishing representatives and the second recreational fishing representative.

The Forum's recommendations included a 25-year generational review and co-management of the new marine reserves between the Crown and Ngāi Tahu. Provision was also to be made for Ngāi Tahu to access the areas for practices that enhance their mātauraka Māori (traditional knowledge) and to retrieve koiwi tākata (ancestral remains), artefacts and marine mammal remains.[28] In this way, the tribe could keep traditional knowledge and skills alive, and connect their youth to their rohe moana (tribal marine areas).[29]

In 2019, the Ministers of Conservation and Fisheries decided to proceed with Network One. They put this option out for further public consultation, in 2020, under the Marine Reserves Act provisions. This time 4,056 submissions were lodged indicative of the growing interest in the proposals which proved controversial. In October 2023, the Ministers jointly announced the creation of six new marine reserves (see Figure 7.1):[30]

1. The *Waitaki Marine Reserve* in the north of the Otago region which is designed to protect kelp and rhodolith beds established on the cobble substrate south of the Waitaki River outlet, which provide important juvenile fish habitat and a foraging are for blue penguins and Hector's dolphins. It is also one of the densest swarm areas for red lobster krill.

2. The *Te Umu Kōau Marine Reserve* just north of the Pleasant River outlet which protects shallow and deep reef areas supporting bladder kelp and pāua.

3. The *Papanui Marine Reserve* which protects the bryozoan beds and deep canyons off the Otago Peninsula

4. The *Ōrau Marine Reserve* which protects bull kelp and pāua populations on the south coast of the Otago Peninsula

5. The *Okaihae Marine Reserve* which protects rocky reefs around Green Island along with bull kelp

6. The *Hākinikini Marine Reserve* which protects exposed schist rock platforms which are accessible to the public.

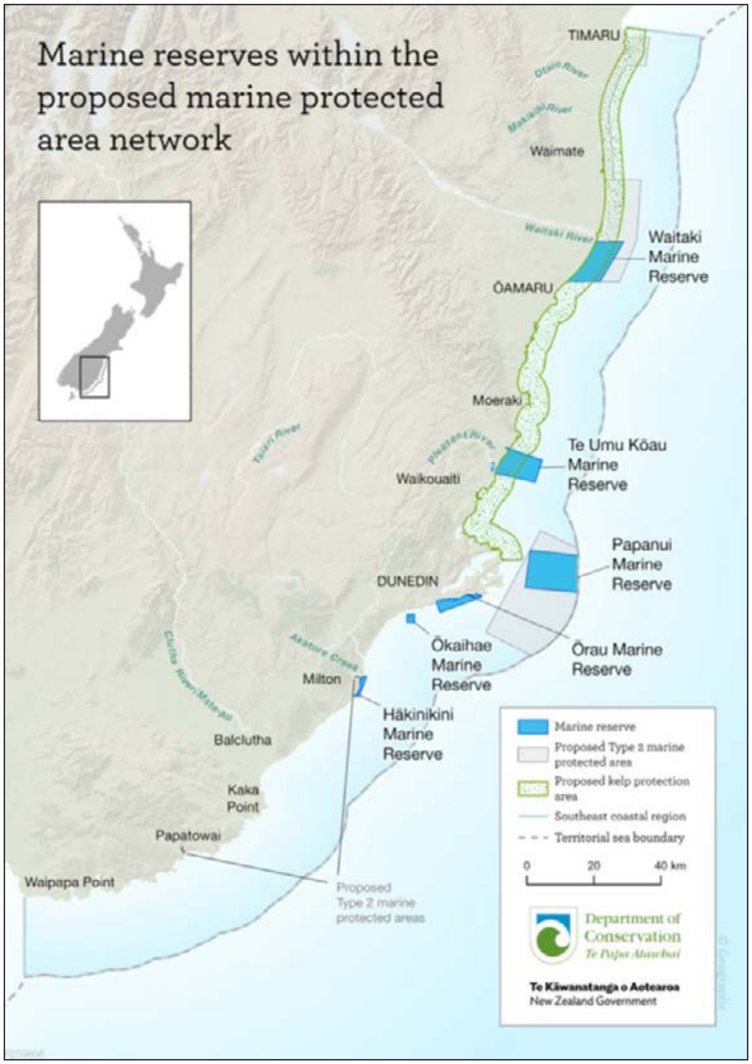

Figure 7.1: Proposed south-east spatial protection measures *(Source: Department of Conservation)*

There are also Type 2 marine protected areas proposed adjacent to the Waitaki and Papanui marine reserves, which would be implemented through controls under the Fisheries Act. They would help alleviate bottom trawling pressure on these areas of the coast. As indicated earlier, the proposed kelp protection area (which would also be a Fisheries Act protection) would also alleviate harvesting pressure on bladder kelp in its last stronghold along the northern Otago coast.

Judicial review proceedings were filed against the Ministers' decision, in June 2024, by the Otago Rock Lobster Industry Association so it is unclear when or if the proposals will proceed. In addition, the government has not yet committed to implementing the Fisheries Act elements of the proposals (ie Type 2 marine protected areas and kelp protection area).

The establishment of the marine reserves under the Marine Reserves Act, and Type 2 marine protected areas under the Fisheries Act, would be a significant step forward in managing fishing impacts on the Otago coast.

At the same time as the marine protected area network has been progressed by DOC and Fisheries New Zealand, the Otago Regional Council has initiated a process to identify significant ecological areas within the Otago coastal environment. These are candidate areas for management under the Otago Regional Coastal Plan. This is to fulfil the Council's obligation to protect areas of significant indigenous vegetation and significant habitats of indigenous fauna under section 6(c) of the Resource Management Act (RMA).

The review process led by NIWA was initiated by a stakeholder workshop, in December 2021, which helped identify where datasets and other useful information could be located. This data was critically reviewed and weighted according to reliability, with the decision support tool Zonation used to map more than 100 significant ecological areas. Threats to the biodiversity values in each area were also identified. A final stakeholder workshop for the project was held in May 2022.[31]

It is now over two years since the conclusion of the review and these significant ecological areas still remain unprotected. Most notably, the Otago Regional Coastal Plan is well out of date. The current Plan was first notified in 1994 (over 30 years ago) and became operative in 2001. Significantly, it was written prior to the revised New Zealand Coastal Policy Statement, which came into force in 2010. This significantly strengthened requirements on councils for coastal management, with policy 11 requiring councils to protect indigenous biodiversity in the coastal environment.

Under the RMA, the Council is required to amend its planning documents to give effect to this policy (along with others) "as soon as practicable".[32] This clearly has not happened in this case. A review of the Regional Coastal Plan is now underway, but is proceeding slowly, with notification of a proposed plan not likely until July 2028. It will be important that the Council includes the significant ecological areas identified in the NIWA report in the new plan, and rules that protect them from adverse impacts, including from fishing activity where this threatens biodiversity values.

Some uncertainty has been created by the government's proposed replacement of the RMA with two new statutes – a Planning Act and a National Environment Act, with each Act including new National Policy Direction.[33] It is currently unclear what the statutory and policy framework will be for coastal management by the time a regional coastal planning document is developed.

Under the Fisheries Act "habitat of particular significance for fisheries management" is to be protected.[34] However, such habitats have yet to be formally identified within the Otago coastal area, let alone protected. Fisheries New Zealand recently issued guidance for identifying such habitats and "taking into account how they should be protected".[35] It is working on the establishment of an online register of such habitats to inform fisheries management advice. This will also be designed to inform the actions of other agencies, such as regional councils, which manage non-fisheries impacts on these important areas.[36]

"Habitat of particular significance for fisheries management" has been defined by Fisheries New Zealand as "an area or areas, and their attributes, that are important for fisheries management in that they are of especially great importance in supporting life-history stages of fisheries resources, including nursery areas for larvae and juveniles, adult feeding areas, spawning areas, migratory corridors, and specific areas to which species are highly restricted."[37]

The Otago regional coastal plan needs to be updated to provide protection for the significant ecological areas identified in the recent review. Habitats of particular significance for fisheries management in the Otago coastal area also need to be identified and protected by Fisheries New Zealand.

Saint Kilda Beach, Dunedin which is proposed to be protected by the Ōrau Marine Reserve

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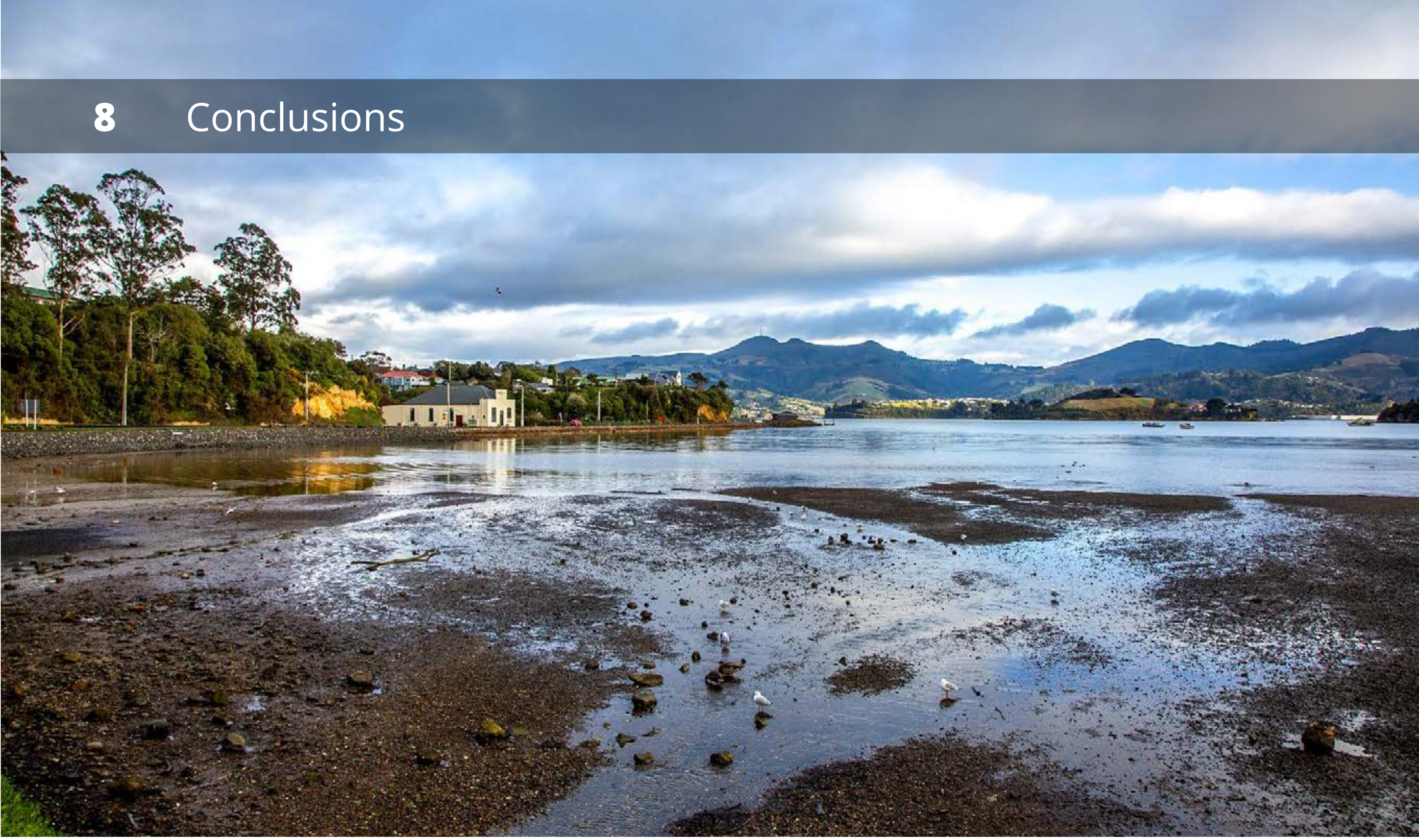
8 Conclusions



Portobello, Dunedin

The Otago coastal area is home to Ngāi Tahu. It has extraordinary marine biodiversity as a result of its unique bio-physical characteristics. Several endemic species are now threatened with extinction. The area is subject to some of the most intense ocean warming experienced anywhere in the country, and keystone species such as bull and bladder kelp are suffering badly with likely cascading impacts for other marine life.

The impacts of climate change are more extreme, than would otherwise be the case, because they overlay existing pressures on the marine environment including sedimentation and the impacts of fishing activity.

Exotic forestry plantations, which have been identified as a major cause of sedimentation along the coast, are increasing in extent. The Council's attempts to apply more rigorous rules to the sector, to address sedimentation issues, have been stymied (at least in the short term) by RMA amendments.

The creation of the proposed South-East Marine Protected Areas has stalled due to legal proceedings. The update of the Regional Coastal Plan by the Otago Regional Council is proceeding very slowly with notification not expected before mid 2028. By that time there may be a different regulatory framework for coastal planning in place. Fisheries New Zealand has recently released guidance on protecting habitats of significance to fisheries management but has yet to identify (and protect) those on the Otago coast.

The future health of Otago's coastal marine area will depend on the implementation of an integrated strategy that effectively deals with these cumulative pressures. This could be achieved through the development of an integrated marine spatial plan or similar. Such a collaborative exercise could be undertaken under the auspices of the Otago Biosphere Reserve should that proceed.

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The Otago coastal area is home to Ngāi Tahu and has extraordinary marine biodiversity due to its unique bio-physical characteristics. Several endemic species are now threatened with extinction. The area is subject to some of the most intense ocean warming experienced anywhere in the country, and keystone species such as bull and bladder kelp are suffering badly, with likely cascading impacts for other marine life.

The impacts of climate change are more extreme, than would otherwise be the case, because they overlay existing pressures on the marine environment including sedimentation and the impacts of fishing activity.

The future health of Otago's coastal marine area will depend on the implementation of an integrated strategy that effectively deals with these cumulative pressures. This could be achieved through the collaborative development of an integrated marine spatial plan or similar which could be undertaken under the auspices of the Otago Biosphere Reserve should that proceed.

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