Managing our estuaries

August 2020

Parliamentary Commissioner for the Environment
Te Kaitiaki Taiao a Te Whare Pāremata

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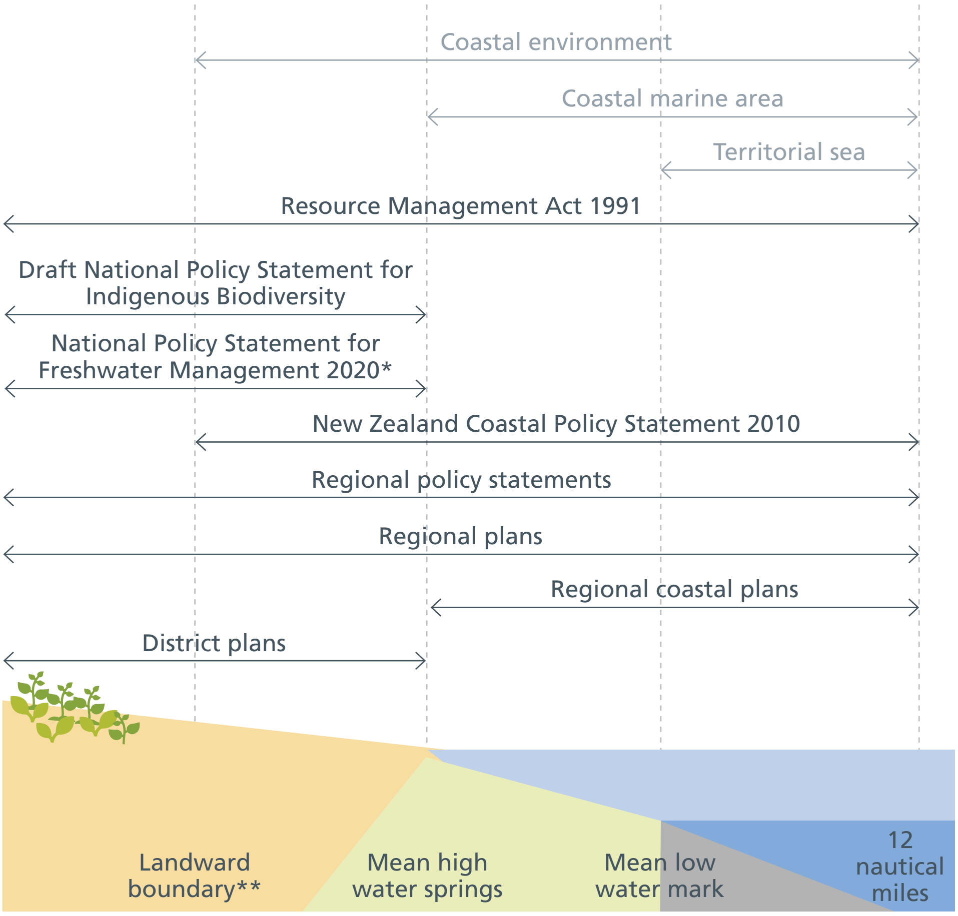
Overview

This report makes two modest recommendations. They are set out in chapter five.

The first is that all estuaries should be included in freshwater management units under the National Policy Statement for Freshwater Management. Currently we apply a distinct management framework to freshwater up to the point where it enters something known as the coastal marine area. That area starts at the high tide mark (technically known as mean high water springs) and goes all the way out to 12 nautical miles from the coast. It is managed under the New Zealand Coastal Policy Statement.

The following figure from chapter four visually describes the complexity that surrounds the management of a single interconnected ecosystem that we have sliced and diced for all manner of managerial and bureaucratic reasons.



* The application is variable as regional councils can decide whether to manage lakes and lagoons that are intermittently open to the sea and coastal wetlands as coastal or freshwater.
** The landward boundary of the coastal environment varies according to local geography.

Source: PCE

Figure 4.3: Areas where different RMA instruments apply in the coastal space.

Needless to say, the plants and animals that inhabit this space are strangers to our thinking. What comes off the land ends up in the estuary so unless we manage this in a genuinely integrated way we will always have things falling between the cracks.

The report's second recommendation is even more banal: I am recommending that estuaries and the catchments that feed into them need to be robustly monitored so that we know what is going on and can take management decisions that are informed decisions.

Faced with a 200-page report, any reader could reasonably ask why two simple recommendations required such a big report to support them. Is this a case of a huge whale of an enquiry begetting a minnow?

I don't mind admitting that this has been a very difficult report to land. The more we read, and the more we talked to estuary managers, the more we felt that in some ways there was little new to say. It is not as though the problems facing our estuaries and the shortcomings of the ways we manage them have not been documented. On the contrary. Absolutely everyone agrees that estuaries are on the receiving end of numerous different pressures and that they have to be managed in an integrated way.

The trouble is, there is nothing naturally integrated about the wide range of activities that go on in a catchment, the conflicting interests of businesses, recreationists and residents whose lives impinge on these places. Many conversations with well-motivated and well-informed groups of people striving to clean up our estuaries ended with the reflection that finding a way forward is all very complicated.

A report that tells people what they already know – that these are complex ecosystems with complicated and conflicting human demands on them – is of limited value. And that may ultimately be a fair judgement of this report. I believe that really good information about what's going on and an insistence that we manage estuaries as part of catchments *would* make a difference. But I can't claim that these are original proposals or that there is some hidden secret to galvanising action. There are a lot of entities, communities and governance arrangements to be navigated.

My best hope is that this report describes the forces at work (or not at work) in a fresh way, and encourages people to ask themselves, once more, whether we are likely to make useful progress continuing on the track we are on. It may be that we are doing as well as it is humanly possible, although I doubt it. But before we conclude that, let's at least look at the state of things as they exist.

There will be readers who ask why they should read a report if the author himself describes its two recommendations as modest. The answer is that the report gathers much that is fascinating about how our estuaries come to be in the state they are in. It is not just an environmental assessment. It is a human and cultural assessment. It had to be. Estuaries are where humans have tended to cluster from the very first arrival of Māori on these shores. The way they have been treated has reflected the values of estuary dwellers – values that have changed over time and are still changing.

There are over 400 estuaries of different shapes and sizes in Aotearoa New Zealand and they are obviously not all in the same state. Those found in national parks or remote and relatively untouched corners of the country will be as close to pristine as anything can be in the twenty-first century. But many more are disfigured by reclamations and foreshore hardening for residential and commercial developments and transport arteries.

The overwhelming majority are receiving sediment at many times pre-settlement levels. Sediments smother shellfish and seagrass and make the water cloudy. Nutrients from agriculture and wastewater treatment plants can trigger algal blooms and reduce the level of dissolved oxygen in the water. Pesticides, heavy metals, anti-fouling paints, timber treatment substances, plastics, household detergents, solvents and pharmaceuticals all find their way into our estuaries and combine to form a cocktail whose consequences can persist long after their use has ceased.

Any one of these pressures would be a matter for concern. But it is the *cumulative* effects that make them particularly worrying – especially when in many cases we know very little about cause and effect. It is one thing to know that a single pressure causes a particular change – for instance, more sediment equals more mangroves. But when there are multiple pressures acting together the outcome can be quite unexpected. The result of reducing both sediment and nutrients simultaneously depends on the level and the relationship between the two. An ecosystem that is already disrupted won't automatically bounce back to some desirable equilibrium. Chapter two explains some of these complexities.

Early in this project we decided to choose some specific estuaries and describe their history, their state and how they are managed. These were written up as case studies and accompany this report as appendices. I am tempted to recommend reading them *before* reading the main body of the report because there is no such thing as a general estuary. Each one has its special qualities, its particular history and its own too-hard basket. The five estuaries chosen (with the main urban centres in brackets) were:

- New River Estuary (Invercargill city)
- Pelorus Sound/Te Hoiere (Havelock)
- Tauranga Harbour (Tauranga city, Mount Maunganui, Katikati, Bowentown)
- Te Awarua-o-Porirua Harbour (Porirua city, Whitby, Pāuatahanui)
- Whāingaroa Harbour (Raglan).

It is worth mentioning the major settlements on these estuaries because they span towns of all shapes and sizes with a wide range of industrial and port activities. And the activities in their catchments cover almost all the major land uses that characterise New Zealand's biological economy (horticulture, pastoral farming, forestry), as well as commercial and recreational fishing and aquaculture.

Each case study is written up in the same way. First the pre-human, physical setting is described. Estuaries are by definition very recent. They are, for the moment, those places where the sea has reached inland in response to rebounding sea levels following the end of the last ice age. The land is moving as well so these are physically very dynamic places. Human-induced climate change will continue that process.

Next the human history of the estuaries is sketched. In each case it starts with their discovery by the earliest Polynesian arrivals. Over half a millennium of undisturbed settlement gave Māori a finely detailed understanding of the living processes at work in these estuaries. Their arrival was not without disruption for the ecosystems they encountered. But it was nothing compared with the up-ending of land cover, drainage, reclamation and artificial hardening of estuary margins that came in the wake of European settlement.

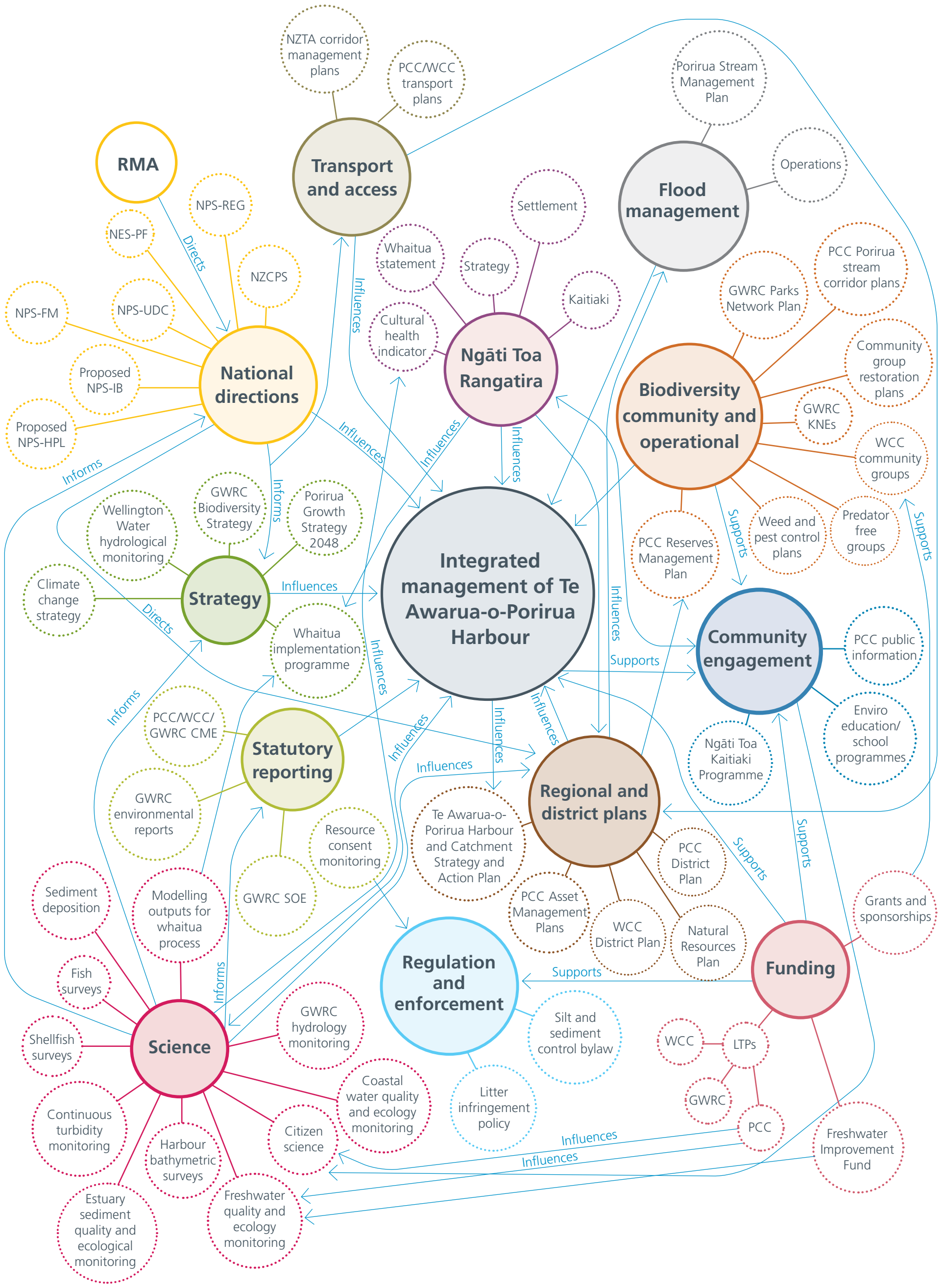
The following section of each case study details its current state and what monitoring can tell us about the trend of its health. Monitoring, as a conscious attempt by estuary managers to understand what is going on, is surprisingly recent. Serious monitoring really only dates back to the creation of regional councils in the late 1980s. The depth of monitoring varies significantly. Of the five estuaries, Tauranga has the most comprehensive array of indicators – perhaps unsurprisingly, given the resources that a major port city and prosperous hinterland can provide.

But in historical terms, three decades is just the last few minutes. It is Māori who have a sense of deep time about these places. The accumulated knowledge represented by mātauranga Māori is a precious link to that past and a means of understanding the present. Even there, the knowledge that goes with whakapapa has been degraded by the disruption and loss that European colonisation brought with it.

A final section surveys community concerns and the current arrangements governing the management of each estuary. These arrangements vary significantly. It is important to note that in presenting the concerns of the communities about their estuaries, no judgements have been made about the rights or wrongs of the views that were presented to us. Similarly, the strengths and weaknesses of the management of these five estuaries have not been discussed. The aim was, rather, to present a biophysical, cultural, social and economic snapshot of each place.

The research and detailed discussions that informed each case study helped us reach some wider conclusions about the way in which we manage estuaries. The value of the case studies to readers will, I hope, be to provide a sense of just how many moving parts there are and why these places that everyone loves, and no one owns, present such a challenge to us.

When I speak of moving parts I'm not just thinking of the landscape and the biota. It's every bit as true of communities. Chapter three outlines how we presently manage estuaries while chapter four tries to identify some of the hurdles that management system faces. The following figure from chapter four provides in visual terms what I describe as a tangle of legislation and entities.



Source: based on discussions with Nigel Clarke, Senior Advisor Partnerships, Porirua Harbour and Catchments, Porirua City Council, June 2020

Figure 4.4: One estuary manager's attempt to explain the maze of documents and entities that need to be considered in respect to a single estuary. Not all pieces or links are specified, for example, national legislation such as the Conservation Act 1987 and the Soil Conservation and Rivers Control Act 1941.

It is the sort of intimidating image that defies a summary. The report describes a wide range of problems – overlapping jurisdictions, overlapping responsibilities, ever-changing policy documents, and simple things like inadequate enforcement and compliance. But however the pieces of this complicated jigsaw are laid out, the question that keeps returning is: how can we achieve genuinely integrated management that puts estuaries at the centre of everyone's efforts?

Consultations with Māori revealed for me a very clear impression that this struggle for integration is a very Pākehā problem. If you decide to fragment ownership and slice and dice the estuary and its landscape, you will sap the mauri, the life force of the place. One of the strongest threads running through this report – which finds its roots in the case studies – is a sense on the part of the hapū, whānau and kaitiaki who engaged with the study, that the landscape and the people within it are inseparable.

In different degrees and in different ways, the peoples whose roots run back centuries in these places are reasserting their role as kaitiaki. There is a deep undercurrent of unfinished business under the Treaty of Waitangi. But there is also an awareness in the wider community that notions such as ki uta ki tai (from the mountains to the sea) can say with astonishing brevity what much wordier documents often fail to crystallise. The question is whether we can get beyond putting phrases like this in aspirational documents and manage as though we mean them. Certainly, my recommendation that estuaries should be fully integrated within freshwater management units in the National Policy Statement for Freshwater Management would go a long way in that direction.

Drawing on a more holistic way of thinking about estuaries can only help. But this is not some warm bath we can gently immerse ourselves in and relax. Because climate change and the acidification of the oceans are likely to disrupt so many relationships we think we understand. This is the subject matter of the final chapter.

Describing what lies in store for our estuaries can, in scientific terms, appear to be a somewhat clinical exercise. The real impacts will be anything but – and they won't be even. In places where the physical and financial capital at stake is large enough, we will no doubt find the resources to defend those assets. But it will be at a further cost to the plants and animals that live in our estuaries. As estuarine margins are hardened, their ability to retreat and adapt is constrained.

Adaptation will come at a significant cost for humans as well. Māori in particular are likely to be disproportionately affected by climate change because so many natural features and significant cultural sites where Māori connect through whakapapa are coastal. And in some of the most vulnerable regions, it is not just climate hazards to which people are exposed. Away from our largest cities, communities often have substandard infrastructure and limited financial resources. Even 20 centimetres sea-level rise will have profound consequences for flooding, sedimentation and erosion.

Left to their own devices, estuaries will adapt their shape and their characteristics. Human adaptation to that change is likely to be much more difficult. It will help if we can make ourselves better-informed about what is happening and integrate the way we respond. Which, in a single sentence, encapsulates the two recommendations I described at the outset: firstly, construct a robust management framework that treats estuaries and their catchments as a single identity, and secondly, ensure there are high-quality data available to ensure that any decisions we take are wise and enduring. I hope this report adequately makes the case for these proposals. They are neither aspirational nor comprehensive. But both would make a difference. I hope their modesty commends them.

Simon Upton

Parliamentary Commissioner for the Environment

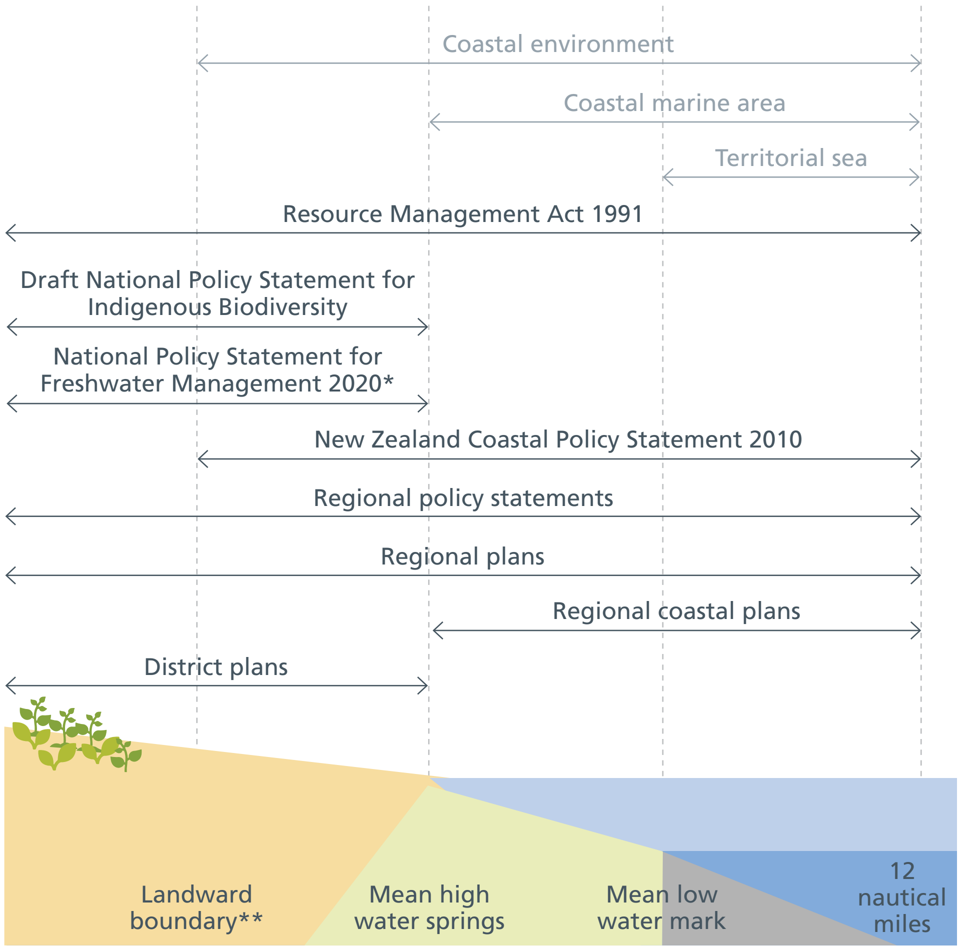
Cystophora scalaris

Tirohanga whānui

E rua ngā tūtohi paku a tēnei pūrongo. E whakatakotohia ana ki te upoko tuarima.

Ko te mea tuatahi me whakauru i ngā pūahatanga katoa i roto i ngā wāhanga whakahaere wai māori i raro i te Tauākī Kaupapa Here Ā-Motu mō te Whakahaere Wai Māori. Ināianei, e whakarite ana mātou i te anga whakahaere rerekē ki te wai māori i mua tonu i te wā e uru ai ki tētahi mea e tapaina ana ko te takiwā takutai moana. Ka tīmata taua takiwā ki te tohu tai teitei (ko te tino ingoa ko ngā puna wai teitei toharite) ā, ka tae ki te pito 12 māero ā-moana atu i te takutai. E whakahaeretia ana i raro i te Tauākī Kaupapa Here Takutai o Aotearoa.

E whakaahutia ana te āhua e whai muri mai nō te upoko tuawhā e te whīwhiwhi e pā ana ki te whakahaere i te pūnaha hauropi pāhekoheko kotahi kua tapahia, kua kotikotia mō te maha o ngā kaupapa whakahaere, kāwanatanga hoki.



* He rerekē te whakarite nā te mea mā ngā kaunihera ā-rohe e whakarite mēnā me whakahaere roto, pūroto rānei e tuwhera ai i ētahi wā ki ngā rohe kōreporepo moana, takutai moana hoki hei wai takutai moana, wai māori rānei.
** He rerekē te rohenga taiwhenua o te taiao takutai moana e pā ana ki te āhua o te takotoranga papa ā-rohe.

Mātāpuna: PCE

Āhua 4.3: He takiwā e whaimana ana ngā taputapu RMA rerekē i roto i te takutai moana.

Kāore e kore, ko ngā tipu me ngā kararehe kei tēnei takiwā he tauhou ki ō tātou whakaaro. Ina heke mai ētahi mea i te whenua ka tae atu ki te wahapū, nā, ki te kore e whakahaeretia pāhekohekotia ana e mātou kāore e kapia katoahia ngā mea katoa.

He tīahoaho rawa atu te tūtohi tuarua o te pūrongo: E tūtohi ana au me āta aroturuki ngā wahapū me ngā hōpua tuku wai kia mōhio ai tātou he aha te aha, ā, ka āhei te whakatau whaimōhio mō ngā whakahaere.

Ka titiro noa iho te kaipānui ki te pūrongo e 200 ngā whārangi, ka pātai he aha e pēnei ana te nui o te pūrongo hei tautoko i ngā tūtohi ngāwari e rua. Kua whānau mai te waikaka i te kōpū o te rangahau pēnei te rahi o te tohorā.

Kāore he raru ki a au ki te whāki he uaua tēnei pūrongo te whakaoti. Ka mutu te pānui me te kōrero ki ngā kaiwhakahere wahapū, ka kaha ake tō mātou whakaaro kāore pea he kōrero hou. Ehara i te mea kāore anō kia tuhia ngā raruraru kei mua i te aroaro mō ngā wahapū me te ngoikore o tō tātou whakahaere. Ehara. E whakaae ana tātou katoa he nui ngā pēhanga rerekē e pā atu ana ki ngā wahapū, ā, me pāhekoheko te whakahaere.

Ko te raru, kāore he mea pāhekoheko noa mō te whānuitanga o ngā mahi i roto i te hōpua, ngā tūmanako o ngā pakihi, te hunga whairēhia me ngā kainoho me ō rātou tauoranga e pā mai ana ki aua wāhi. Ko te mutunga o ngā kōrerorero maha me ngā rōpū tāngata kua whakahihikotia, kua whaimōhio hoki, e whakaata ana he uaua te ahu whakamua.

He iti te uara o te pūrongo e whakaatu atu ana ki ēnei tāngata tērā e mōhiotia ana e rātou – he pūnaha hauropi ēnei me ngā pōrearea whīwhiwhi, taupatupatu hoki nā tāua, nā te tangata. Ka mutu, tērā pea he tika taua whakatau mō tēnei pūrongo. E whakapono ana au ka whakapai ake ngā mōhiohio pai rawa mō ngā nekeneke, ā, me te whakahau me whakahaere i ngā wahapū hei wāhanga o ngā hōpua. Engari kāore e taea e au te whakapae he marohi hou ēnei, he whakaaro huna rānei ki te mahi whakakaha. He maha ngā ngā hinonga, ngā hapori me ngā whakaritenga whakahaere hei whakatere.

Ko taku tino wawata ka tautuhi tēnei pūrongo i ngā tōpana e mahi ana (kāore e mahi ana rānei) i runga i te āhuatanga hou, ā, ka akiaki i ngā tāngata kia pātai ki a rātou tonu, anō, mēnā ka ahu whakamua ina takahi tonu tātou i te ara e whāia ana e tātou ināianei. Tērā pea e tutuki pai ana tātou, engari he pōhēhē tērā ki a au nei. Engari i mua i te whakatau, me titiro i te tuatahi ki ngā āhuatanga onāianei.

Ka pātai ētahi kaipānui he aha te take kia pānui i te pūrongo mēnā kua kī te kaituhi he paku ngā tūtohi e rua. Nā te mea ka kohikohi tēnei pūrongo i ngā kōrero hira maha mō te pūtake i pēnei ai te āhua o ō tātou wahapū. Ehara i te aromatawai taiao noa iho. He aromatawai tangata, ahurea hoki. Kāore e kore, me pērā. Ko ngā wahapū he wāhi i whakaemi ai ngā tangata mai i te taenga tuatahi mai o te iwi Māori ki tēnei motu. Ko te momo tiaki i ngā wahapū he whakaata i ngā uara o ngā kainoho wahapū – ka haere te wā ka panoni aua uara, ā, e panoni tonu ana.

Neke atu i te 400 ngā wahapū me te rerekētanga o ngā āhua me te rahi i Aotearoa, ā, e mōhiotia ana he rerekē te āhua. Ka tata tikitū aua wahapū kei ngā pāka ā-motu, kei ngā pito rānei o te motu kāore e takahia ana, mēnā e tikitū ana tētahi mea i te rautau rua tekau mā tahi nei. Engari he maha noa atu ngā wahapū kua tūkinohia e ngā taumanutanga me ngā whakamārō tuaone mō ngā whakawhanaketanga kāinga, arumoni hoki me ngā huanui ikiiki.

Ko te nuinga nui rawa atu o ngā taumata e whiwhi ana ki te para i ō ngā wā o neherā. Ka tāmi te para i ngā kaimoana me te karepō, ā, ka whakakōmaru i te wai. Ka tīmata ngā taiora nō te ahuwhenua me ngā wheketere whakatikatika wai paru i ngā pūkohu ngaruru me te whakaheke i te taumata o te hāora memeha i roto i te wai. Kua uru ngā paturiha, ngā konganuku taumaha, ngā peita kore-whakaparu, ngā matū whakarite papa rākau, ngā kirihou, ngā hopiwē, ngā tāmeha me ngā rongoā ki ō tātou wahapū, ā, ka whakakotahi hei inu kōrori e noho pūmau tonu ai ana whakaaweawe nō muri noa atu i te wā i mutu ai te whakamahi.

He āwangawanga mēnā ka puta mai kotahi noa iho o ēnei pēhanga. Engari ko ngā whakaweawe tāpiripiri te raruraru nui – otirā i ngā wā he iti tō tātou mōhio ki ngā pūtake me ngā whakaweawe. He mea anō kia mōhio ka whakaputa tētahi pēhanga kotahi i tētahi panoni – hei tauira, ina he nui ake te para he maha ake ngā mānawa. Engari ina mahi tahi ana ngā tini pēhanga, kāore i te mōhiotia he aha te putanga. Ko te hua o te heke i te para me ngā taiora i te wā kotahi ka whakawhirinaki ki te taumata me te tūhononga i waenganui i aua mea e rua. Mēnā kua whakatōhenehenetia kētia te pūnaha hauropi, kāore pea e aunoa te tupana ki tētahi waikanaetanga. Ka whakamāramahia i roto i te upoko tuarua ētahi o ēnei whīwhiwi.

I te tīmatanga o tēnei kaupapa i whakatau mātou ki te kōwhiri i ētahi wahapū tauwhāiti me te tautuhi i tō rātou hītori, tō rātou āhua, ā, me pēhea hoki e whakahaeretia ana. I tuhia ēnei hei kēhi rangahau, ā, ka tāpirihia ki tēnei pūrongo hei tāpirihanga. E whakawaitia ana au ki te tūtohi kia pānuitia ērā i mua i te pānui i te tinana matua o te pūrongo nā te mea ehara i te ōrite te momo o te wahapū. Kei tēnā tōna ake āhuatanga motuhake, kei tēnā tōna, me tōna ake hītori, me tōna ake kete uaua rawa atu anō hoki. Ko ngā wahapū e rima i kōwhiria ai (me ngā pokapū tāone matua kei roto i ngā taiapa pewa) ko:

- Te pūahatanga o New River (te tāone nui o Waihōpai)
- Te Hoiere (Havelock)
- Tauranga Moana (te tāone nui o Tauranga, Maunganui, Katikati, Ōtāwhiwhi)
- Te pūahatanga o Te Awarua-o-Porirua (te tāone nui o Porirua, Whitby me Pāuatahanui)
- Te pūahatanga o Whāingaroa (Whāingaroa).

He pai ki te kōrero mō ngā nohanga matua i runga i ēnei wahapū nā te mea ka kapi i momo tāone whānui ahakoa te āhua me te rahi me te whānui o ngā mahi ahumahi, wāpu hoki. Waihoki ko ngā mahi i roto i ō rātou hōpua e kapi ana tata ki te katoa o ngā āhuatanga o ngā whakamahinga whenua matua o te ōhanga koiora o Aotearoa (ahumāra, pāmu tarutaru kararehe, ngāherehere), tae atu ki te hī ika arumoni, rēhia hoki me te ahumoana.

He ōrite te tuhi i ngā rangahau kēhi katoa. Tuatahi ka tautuhia te wāhi ōkiko o neherā. E ai ki tōna ake whakamāramatanga he mea hou ngā wahapū. Ko ngā wāhi ēnei kua tae ināianei te moana ki te tuawhenua hei urupare ki ngā taumata moana turapa whai muri i te mutunga o tērā wā hukapapa o mua. Kei te neke hoki te whenua nā reira he wāhi nekeneke ōkiko ēnei. Ka whakahaeretia tonutia taua hātepe e te panoni āhuarangi ā-tangata.

I muri iho ka whakaahuatia te hītori tāngata o ngā wahapū. Ia wā ka tīmata i te tūhuratanga e ngā tāngata nō Poroniha i tae tuatahi mai. Neke atu i te 500 o te whakanohonga kore raru i āta mōhio ngāi Māori ki ngā hātepe koiora e kitea ana ki ēnei wahapū. He whakatōhenehene mō ngā pūnaha hauropi i tō rātou taenga mai. Engari kāore he aha i te taha o te hurihanga o te uhi whenua, te manga, te taumanutanga me te whakamārō horihori i ngā taitapa i puta mai ai i te taunga mai a te Pākehā.

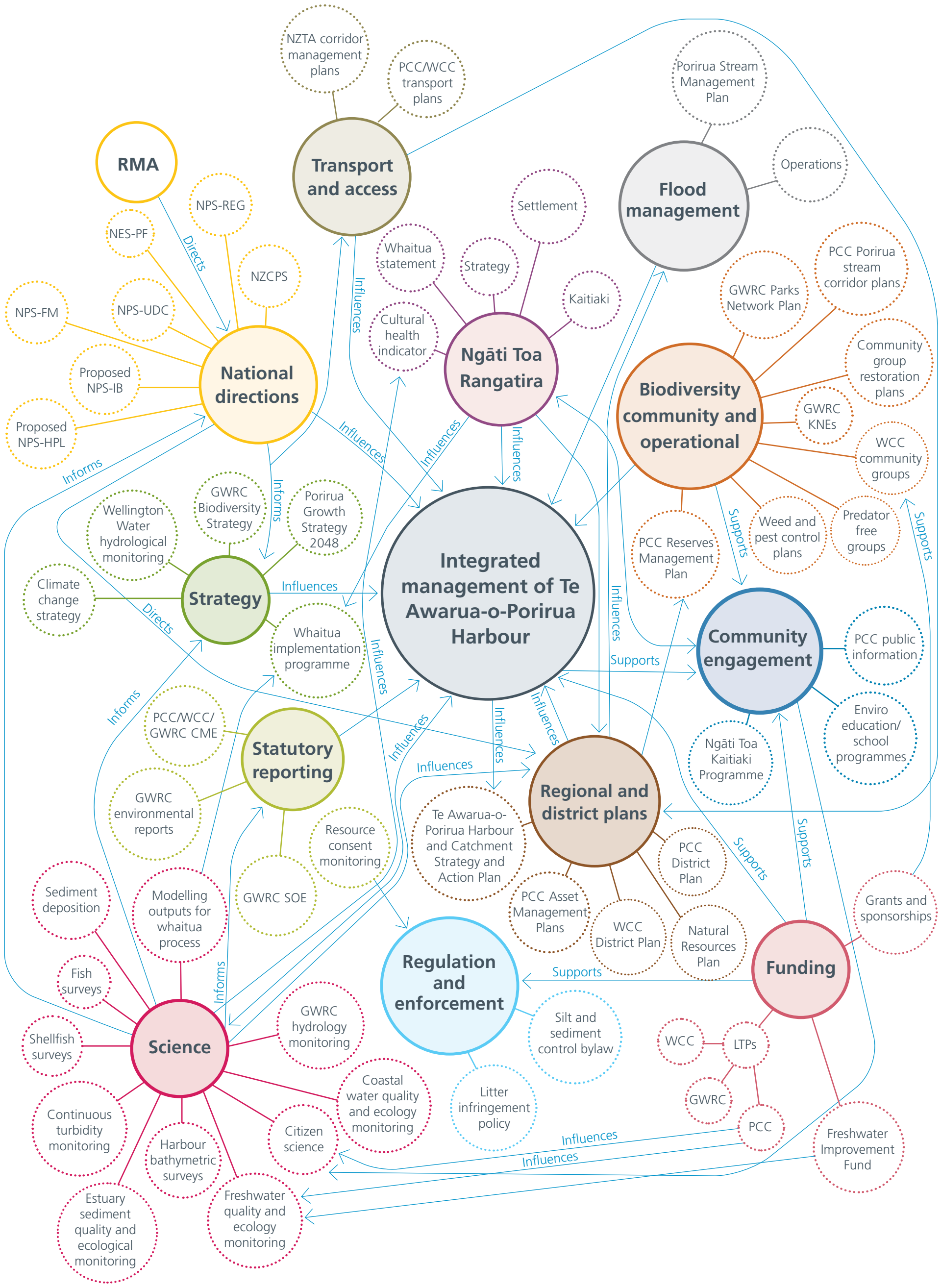
E tautuhi ana te wāhanga whai muri o ia rangahau kēhi i te āhua o nāianei me ngā whakamāramatanga e puta ana i te aroturuki mō te ia o tana hauora. He mea nō nā noa nei te aroturuki hei āta whakaarohanga mā ngā kaiwhakahaere wahapū kia mārama he aha ngā nekeneke. Ka hoki noa atu te aroturuki tūturu ki te auahatanga o ngā kaunihera ā-rohe i te mutunga o ngā tekau tau 1980. He tino rerekē hoki te hōhonutanga o te aroturukitanga. Ko Tauranga, o ngā wahapū e rima, e whiwhi ana ki te maha o ngā paetohu matawhānui – kāore he ohorere pea, nā ngā rauemi e whakaratoa ana e te tāone nui whai wāpu matua me te tuawhenua whai rawa.

Engari ina whakaaro ki te hītori, ko te toru tekau tau he meneti torutoru noa iho. Ko te iwi Māori e whai ana i te hōhonutanga o te mōhiotanga ki ēnei wāhi. Ko te mātauranga whakaemi ka noho i roto i te mātauranga Māori he hononga rangatira ki neherā, ā, he huarahi ki te whakamārama i te wā nei. Otirā, kua memeha te mātauranga nō te whakapapa e te whakakino me te ngaromanga i ū mai i te tāmitanga noho whenua a te Pākehā.

Tērā tētahi wāhanga whakamutunga e uiui ana i ngā āwangawanga ā-hapori me ngā whakaritenga onāianei e pā ana ki te whakahaere o ia wahapū. He tino rerekētanga i waenganui i ēnei whakaritenga. Me mōhio mai ina whakaputa ana i ngā āwangawanga o ngā hapori mō ō rātou wahapū, kāore i whakataua te tika, te hē rānei o ngā whakaaro i homai ki a mātou. Waihoki, kāore i kōrerotia te kaha me te ngoikore o te whakahaere o ēnei wahapū e rima. Ko te whāinga kē kia whakaatuhia te whakaahua onāianei o te āhuatanga koioraōkiko, ahurea, pāpori, ōhanga hoki o ia wāhi.

Ko te rangahau me ngā āta kōrerorero i tautoko i tēnā rangahau kēhi, i tēnā rangahau kēhi, i āwhina i a mātou kia whakatau i ētahi whakataunga mō te ara e whakahaere ana mātou i ngā wahapū. Ko te painga o ngā rangahau kēhi ki ngā kaipānui, koinei te tūmanako, ka whakarato i te mōhio ki te nui o ngā wāhanga nekeneke, ā, he aha i pērā ai te wero nui o ēnei wāhi e arohaina e te katoa, engari kāore i whiwhia e tētahi.

Ina kōrero au mō ngā wāhanga nekeneke, kāore au i te whakaaro mō te horanuku me ngā mea koiora anake. E tika ana hoki tēnei mō ngā hapori. Ka whakaatu te upoko tuatoru e pēhea ana tō tātou whakahaere i ngā wahapū, ā, ka whakamātau te upoko tuawhā ki te tautuhi i ētahi o ngā taunahua kei mua i te aroaro o te pūnaha whakahaere. Ko te āhua e whai muri mai nō te upoko tuawhā e whakaahua ana i te mea kua tautuhia e au hei powhiwhi o te ture me ngā hinonga.



Mātāpuna: ko te pūtake ko ngā kōrero tahi me Nigel Clarke, Kaitohutohu Matua Pātuitanga, Te Whanga o Porirua me Ngā Wai, te Kaunihera o Porirua, Pipiri 2020

Āhua 4.4: Ko te whakamātau a tētahi kaiwhakahaere pūahatanga ki te whakamārama i te kōwhīwhiwhi o ngā tuhinga me ngā hinonga hei whakaarotanga e pā ana ki te pūahatanga kotahi. Kāore i whakaritea ngā wāhanga, ngā hononga katoa rānei; hei tauira, ngā ture ā-motu pērā i te Ture Conservation 1987 me te Ture Soil and Conservation and Rivers Control 1941.

He whakaahua whakawehi e kore e taea te whakarāpopoto. Ka tautuhi te pūrongo i te whānuitanga o ngā raruraru – he mana whakahaere īnakinaki, he kawenga īnakinaki, he pukapuka kaupapa here e panoni tonu ana, me ngā mea māmā pērā i te whakauruhitanga me te tautuku ngoikore. Otirā, ahakoa pēhea te whakatakoto o ngā wāhanga o tēnei pangahono, ko te pātai e hoikia tonutia ana: me pēhea e tino tutuki i te whakahaere pāhekoheko e whakatū ai i ngā wahapū ki te pokapū o ngā mahi a te katoa.

Kua whāki aku kōrerorero me te iwi Māori i te mōhiotanga mārama ko te takaoraoratanga mō te pāhekoheko he raruraru tino Pākehā nei. Mēnā ka whakarite koe kia whatiwhatihia te whiwhinga, ā, ka tapahi me te kotikoti i te wahapū me tana horanuku, ka whakamate koe i te mauri, te hauora o te wāhi. Ko tētahi o ngā tino aho e kitea ana i roto i tēnei pūrongo – ko ōna pūtake kei ngā rangahau kēhi – he whakaaro nō te hapū, te whānau me ngā kaitiaki i whai wāhi ki te rangahau, kāore e taea te whakawehe i te iwi me te horanuku e noho ai rātou.

Ahakoa he rerekē te kaha me te momo o te mahi, e whakaputa atu ana anō te iwi taketake nō ngā rautau kua hipa hei kaitiaki. Kei raro e tino rangona ana te kaupapa kāore anō kia tutuki e pā ana ki te Tiriti o Waitangi. Engari he mōhiotanga hoki i roto i te hapori whānui kei roto i ngā whakaaro pērā i 'ki uta ki tai' (mai i ngā maunga ki te moana) he kōrero iti te kupu, nui te kōrero, kāore i whakatinanahia i roto i ngā pukapuka kua rahi ake ngā kupu. Ko te pātai mēnā e āhei ana tātou te wehe atu i te mahai whakauru i ngā kīanga pēnā ki ngā pukapuka tūmanako kia tae ki te mahi whakahaere pēnā e whakapono ana tātou ki aua kīanga. Āe mārika, ko taku tūtohi kia āta pāhekohekotia ngā pūahatanga i roto i ngā wāhanga whakahaere wai māori i roto i te Tauākī Kaupapa Here Ā-Motu mō te Whakahaere Wai Māori ka tino tautoko i taua āhuatanga.

Ka āwhina noa te whakaaro torowhānui mō ngā wahapū. Engari ehara tēnei i te tāpu mahana hei urunga mā tātou me te whakatā. Nā te mea kāore e kore ka whakatōhenehene te panoni āhuarangi me te whakawaikawatanga o ngā moana nunui i te maha o ngā tūhonotanga e pōhēhē ana mātou e mārama ana tātou. Koinei te kaupapa o te upoko whakamutunga.

He mahi nahenahe te tautuhi ka ahatia ō tātou hapori, ki ngā kupu pūtaiao. Ko ngā tino whakaaweawe he rerekē rawa – ā, kāore e ōrite. Ki ngā wāhi e nui noa ana te moni tōpū ā-kiko, ahumoni hoki, kāore e kore ka kitea he rauemi hei tiaki i aua rawa. Engari he utu e utua ai e ngā tipu me ngā kararehe e noho ana ki ō tātou wahapū. Ina mārō haere ngā taitapa wahapū, ka taparereti a te āheinga ki te maunu me te urutau.

He nui rawa te utu o te urutau mō te hunga tāngata hoki. He nui noa atu te pānga o te panoni āhuarangi ki ngāi Māori nā te mea he maha rawa ngā āhuatanga taiao me ngā wāhi ahurea hira ki te takutai moana e tūhonotia ai mā te whakapapa. Ā, i roto i ētahi o ngā rohe whakaraerae, ehara i te mea ko ngā mōrearea āhuarangi anake e pā mai ana ki ngā tāngata. Atu i ō tātou tāone nui tino rahi, he ngoikore te hanganga o ngā hapori, ā, he iti ngā rauemi ahumoni. Ahakoa e 20 henemita anake te pikinga o te taumata o te moana he whakaaweawe nui mō te waipuke, te para me te ngāhorohoro.

Mēnā ka waihotia, ka urutau ngā wahapū i ō rātou āhua me ō rātou āhuatanga. Ko te urutau tangata ki taua panoni he uaua ake. He āwhina mēnā e mahi ai tātou kia whaimōhio ki ngā nekeneke, ā, ka pāhekoheko i tō tātou urupare. Ka kapi tēnā kōrero, i roto i te rerenga kotahi, ngā tūtohi e rua i tautuhia e au i te tīmatanga: tuatahi, hangaia tētahi anga whakahaere kaha e tiro ana ki ngā wahapū me ngā hōpua hei tuakiri kotahi, ā, tuarua, whakatūturu i te āheinga ki te raraunga kounga nui e wātea ana hei whakatūturu he pūmahara, he pūmau hoki ā tātou whakataunga. Ko te wawata e mārama ana te whakapae a tēnei pūrongo mō ēnei marohi. Ehara i te hōkaka, i te matawhānui rānei. Engari he painga tō ngā mea e rua. Mā te paku o aua tūtohi pea e whakarewangia ai.

Simon Upton

Te Kaitiaki Taiao a Te Whare Pāremata

1

Zostera muelleri ssp. novozelandica

The challenge of managing estuaries

Estuaries receive and accumulate large amounts of whatever is emptied into the catchments that feed them – by foresters and farmers at the top of the catchment to motorists and businesses right on the foreshore, as well as everybody in between. As a result, trying to manage estuaries involves working with people who can live hundreds of kilometres apart and who do not necessarily feel themselves to be part of a catchment community, let alone connected to the estuary.

This is the management challenge posed by estuaries: how to integrate so many different human claims on catchment resources in a way that still enables them to function as a complex ecosystem.

At the time of writing we have (or have in development) national policy statements for New Zealand's coastal environment, freshwater management, urban development capacity, renewable electricity generation, electricity transmission, highly productive land and indigenous biodiversity.

There is no national policy statement – nor one envisaged – specifically for estuaries. This report does not advocate developing one. But it does ask whether estuaries risk being forgotten among all the other priorities that are being worked on.

This report is not intended to be an authoritative account of the state and challenges facing the 400-plus estuaries in Aotearoa New Zealand. Rather, a handful of estuaries were selected that could provide complementary insights into the different ways in which the present condition of estuaries reflects the history of their use and abuse.

In each case, by far the oldest human relationship with the estuaries is that of Māori who are connected to these places through whakapapa. The relationship that Māori have with estuaries and their catchments is of central importance. Yet their capacity to manage places that have been their homes for centuries remains ill-defined, and their access to resources that once sustained them, compromised.

In trying to understand the histories of the five estuaries, efforts were made to listen to all elements of the communities that live around them today. The direction this report has taken has been influenced in no small part by these discussions. The challenge of writing about estuaries is the challenge of making sense of different histories, different responsibilities and different values being placed on common resources.

Estuaries are complex ecosystems. So are the human communities that surround them and the regimes that have evolved to manage them. Whether, for all that complexity, they make a difference is another matter. Estuaries are often the backdrop for other problems – managing infrastructure, managing water quality, managing commercial or recreational space. The health and wellbeing of an estuary is rarely the sole and undivided responsibility of any one person or entity. This report tries to take the estuary's point of view in asking whether we are doing as good a job as we could be.

Source: NelsonNZ, Flickr

Figure 1.1: Waimea Estuary with surrounding rural, residential, plantation forestry and horticulture areas.

What are estuaries?

Estuaries are places where freshwater and saltwater mix with the ebb and flow of tides. Estuaries are also where the terrestrial and marine environments converge. Some are relatively simple openings to the coast, where large freshwater flows or big tidal fluctuations mean that a lot of what enters the estuary is flushed out, such as Tauranga Harbour.

At the other end of the spectrum, there are those that are partly enclosed by ephemeral land features such as sand spits or gravel banks, like Waituna Lagoon or Lake Ellesmere/Te Waihora. Others again are enclosed by harder land barriers, like the Southland Fiords or the Marlborough Sounds.

The physical shape of an estuary, particularly its depth, what forms the estuarine floor, and the influence of tides and of freshwater input, all determine which species can live there. Saltmarshes, mangroves, and intertidal and subtidal seagrass beds each need slightly different estuarine floors and levels of exposure to air and to being submerged under water.

For each distinctive plant community, there are animal and microbial species adapted to it.[1] Wading birds feed in the shallows, looking for snails and worms. Going deeper, fish like flounder and gurnard mostly live in estuaries, and others like snapper and kahawai visit to feed or use the space as a nursery.

Estuary dwellers influence the processes within the estuaries themselves. For example, burrowing organisms like worms and some shellfish, and fish and rays looking for food create pits and aerate the estuarine floor. Cockles, mussels and many other shellfish filter water to feed on nutrients, binding sediments in the process and creating habitat for other species.[2]

Estuaries are also home to a wide range of mobile organisms. For example, īnanga, the most common of the whitebait species, have a complex life cycle spanning marine environments during the larval stage and freshwater environments as adults. Their passage through estuaries is a vital transitional stage.

The health of estuaries is critical to the survival of all these species and many more, including those just passing through, such as tuna (eels).[3]

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[1] Thrush et al., 2013.
[2] Thrush et al., 2013.
[3] Todd et al., 2016.

Source: Tomas Sobek Photography

Figure 1.2: Hāpuka Estuary, part of Westland Tai Poutini National Park.

How did we get here?

For humans, estuaries have been important from the very beginning. People arrived in these islands from the sea. They needed places that provided shelter and access to the hinterland.

Polynesians in waka hourua came first. For example, *Kurahaupō* landed in Northland; *Tainui*, *Te Arawa* and *Tākitimu* landed in eastern Bay of Plenty;[4] and *Te Hoiere* waka explored the Pelorus district.[5] At the time of these first arrivals, the catchments that fed the estuaries were covered in indigenous primary forest and wetlands and teemed with birds. Erosion was controlled and slowed by the plants that clothed the land. Rivers, estuaries and near-shore seas were plentiful in kaimoana.

As Māori explored and modified this new land, estuaries continued to be key entry points for their emerging culture and offered a necessary and accessible basket of resources. Estuaries were a source of spiritual wellbeing and a natural classroom. They became part of the new universal knowledge system of Aotearoa: mātauranga Māori.[6]

These coastal inlets became the setting for contact and commerce with the people who lived there. Coastal hapū traded resources with inland dwellers, with many rōpū travelling far to trade with others.

[4] Taonui, R., 2007.

[5] Nelson City Council et al., 2014.

[6] Jackson et al., 2017.

These patterns, established over hundreds of years, continue to underpin the identity and spiritual wellbeing of Māori, and the particular values they associate with estuaries.

Unsurprisingly, the first European settlers also sought out estuaries. Estuaries were gateways to the resources of the interior, just as they had been for Māori. A world then dominated by sea transport ensured that the most suitable estuaries became port settlements. The appeal was, of course, not limited to commerce. The majority of New Zealand's main towns are situated on natural ports, or places with access by river-mouth or waterways. The coastal margin – particularly where it is protected from the elements – is also an attractive place to settle and recreate, and some estuaries became port settlements that have grown today into sprawling cities.

The upheaval caused by the arrival of European settlers also dislocated the practice of kaitiakitanga by Māori.[7] The fine-grained understanding and management of the food web and its support systems that was essential for the survival of estuaries was disrupted by settlers, who viewed estuaries not just as places to live but also as sites for waste disposal. It became taken for granted that estuaries would receive whatever waste farming, forestry, cities and port activities produced.[8]

The clearance of land through Māori settlement and agriculture was not minor.[9] But what succeeded it at the hands of European settlers was land clearance on an industrial scale that saw erosion increase up to ten-fold.[10] Estuaries were used as dumping grounds – a place to locate landfills and reclaim land (Figure 1.3).[11]

[7] Jackson et al., 2017.

[8] See Keith, 1990, p.58.

[9] PCE, 2019a.

[10] Marden, 2004.

[11] For examples see Appendix 1: New River Estuary, Appendix 3: Tauranga Harbour and Appendix 4: Te Awarua-o-Porirua Harbour.

Source: Hazeldine's Studios Limited

Figure 1.3: New River Estuary reclamation work in Invercargill, 1960.

Many estuaries still receive stormwater and wastewater overflows, as well as water carrying contaminants and sediment from land use in their catchment. Estuaries are also impacted upon by activities carried out in the estuaries themselves and at sea, including transport and fishing.

The modification of estuaries and estuarine edges has impacted on the functional integrity of those processes that have naturally dealt with marine and terrestrial inputs.[12] To the extent that material entering an estuary is not flushed entirely out to sea, the estuary will act as a waste trap. Yesterday's and today's pollution – be it sediment from a subdivision or contaminants from road run-off – will be stored up for tomorrow.

This out-of-sight, out-of-mind treatment is only viable for as long as the estuaries can absorb these pressures. As pressures accumulate over space and time, a raft of problems reveals that instead of diluting pollution, estuaries are saving it up to bite back. For most New Zealanders that will mean water that is not fit for recreation and seafood that is not fit for consumption. For the creatures that inhabit the estuaries, it can mean local extinction.[13]

[12] Kennish, 2002.

[13] Altieri and Witman, 2006; Thomsen et al., 2019.

A national inventory of estuarine health was carried out as far back as 1976. Based on surveys from 100 authorities or people interested in or responsible for estuaries, 150 estuaries were assessed, of which over two thirds were deemed polluted. Furthermore, 18 per cent had worsened since the 1960s.[14]

More recently, a 2016 assessment of the estuaries in the lower North Island found that only 4 of 48 sites surveyed were subject to only low anthropogenic pressures.[15] A 2018 study showed nutrients entering estuaries were up to five times that of pre-human levels, and a third of those estuaries were at high or very high risk of damaging effects from those nutrients.[16]

The need for integrated management

Estuaries are only one small part of the environment we need to look after. There are also rivers, wetlands,[17] landscapes, heritage and cultural sites, and areas of high indigenous biodiversity, to name a few. All of them are part of a larger whole.

While there is obvious merit in looking at the overall health of the environment and the cumulative effects of the pressures that we place on it, trying to manage things in an integrated way can make for daunting complexity. The idea of 'integrated management' lies at the heart of the Resource Management Act 1991 (RMA). Spelling that out can be a wordy business. For estuaries, this means:

> "a process that recognises the catchment as the appropriate organising unit for understanding and managing ecosystem processes in a context that includes social, economic and political considerations, and guides communities towards an agreed vision of sustainable natural resource management in their catchment".[18]

As a nation, we are still in the process of stitching together a series of national policy statements and standards that will spell out our aims for environmental management. These instruments each deal with discrete components of the environment.

Managing these different 'bits' of the environment discretely has the advantage of simplicity; the challenges are broken down into digestible chunks. But even though policies and processes seem to be in place to manage estuaries within their wider catchment, managing them for positive environmental outcomes seems to be treading water.

An inquiry into the health of New Zealand's estuaries has to confront both common management challenges and the specificities of any particular estuary and the community that lives around it. What also needs to be addressed is how to appropriately utilise the two knowledge systems (mātauranga Māori and science) that exist in Aotearoa New Zealand to manage estuaries in an integrated way.

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[14] McLay, 1976.

[15] Todd et al., 2016.

[16] Plew et al., 2018.

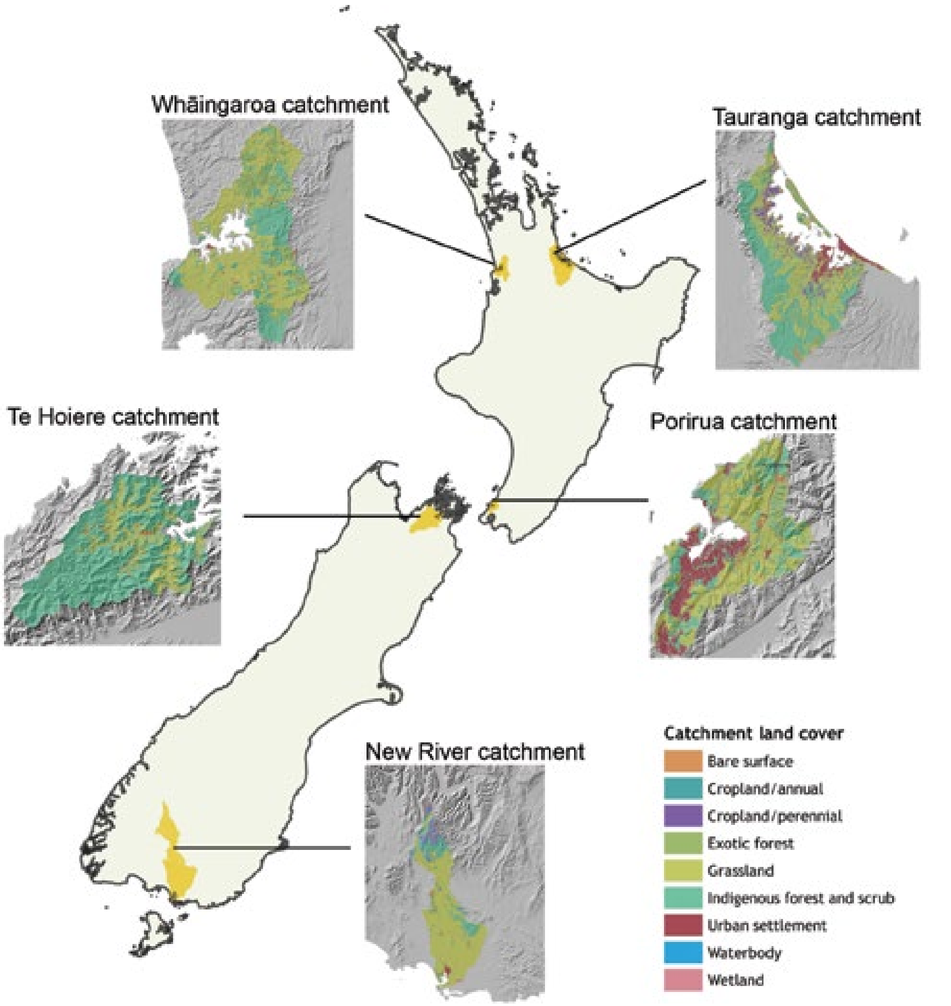
[17] Wetlands other than estuaries can include freshwater lakes and lagoons and other waterbodies that are transitional tidal zones between freshwater and seawater (Hume et al., 2016).

[18] Fenemor et al., 2011.

In this report

The report introduces what estuaries suffer from and how those pressures can mix in unpredictable ways. It describes the maze of management institutions and devices that have been developed in an attempt to deal with this complexity. There follows an analysis of some of the reasons why estuary management is not achieving the level of estuarine health many would like to see. A very short list of suggestions for improved management is suggested, followed by a final discussion of how climate change will completely reshuffle many of the cards in estuarine settings, as it will all coastal environments.

Appendices provide snapshots of the case studies that were undertaken to support this review. To understand the very different social and economic settings that weigh on estuaries, five very different estuaries were chosen as case studies: New River Estuary (also known as Kōreti, in Invercargill), Pelorus Sound/Te Hoiere, Tauranga Harbour, Te Awarua-o-Porirua Harbour and Whāingaroa in Raglan (Figure 1.4).



Source: Manaaki Whenua – Landcare Research, 2020;
New Zealand outline from Land Information New Zealand (LINZ)

Figure 1.4: The five case studies and their catchment areas in yellow.

These estuaries were chosen because they present different biophysical characteristics: the catchments are of differing size, steepness and soil types, and take from a few days to a few months for the water arriving from upstream to flush out to sea. The five estuaries are also subject to different pressures: some are dominated by the effects of agriculture or urban development while others are subject to a wide range of pressures. The case studies highlight very different approaches to estuary management and different ways of trying to incorporate a holistic approach. Finally, the level of monitoring and understanding also varies between the five estuaries (Table 1.1).

No claim is made that these estuaries are representative. Neither are any judgments made about the strengths or weaknesses of the way in which these estuaries are being managed. That was not the purpose of this exercise. The intention was to provide the reader with specific examples of how complex it is, both environmentally and politically, to manage estuaries.

Table 1.1: Some characteristics of the five case study estuaries.[19]

Pressure	Biophysical	Major sources of pressures and state	Governance
New River Estuary	• 399 kha catchment • Large, flat catchment with extensive drainage (tile) • Shallow estuary • 42% intertidal • 5 days flush time	• Landfill • Farming • Rivers modified to drain the land • TN load 3.8 times pre-human[20] • ETI D[21]	• 1 iwi, several rūnaka with strong science focus • Regional, district and city council • 50 estuaries in the region • Community starting to engage
Pelorus Sound/ Te Hoiere	• 159 kha catchment • Steep catchment • Shallow then deep estuary • 3% intertidal • 107 days flush time	• Farming • Forestry • Aquaculture • TN load 1.2 times pre-human • ETI B • 2–5 mm/year sedimentation, 10 times pre-human	• 8 iwi • Small district council • 17 estuaries in the region • Community focused on writing submissions to council
Tauranga Harbour	• 122 kha catchment • Volcanic erodible catchment • Shallow estuary • 77% intertidal • 15 days flush time	• Urban development • Forestry • Horticulture • TN load 3.9 times pre-human • ETI B	• 3 iwi with strong science focus • Regional council, 3 city councils and joint programme • 18 estuaries in the region • Community involvement
Te Awarua-o-Porirua Harbour	• 19 kha catchment • Rolling hills with poor soils • Subtidal estuary with narrow opening • 11% intertidal • 7 days flush time	• Roading • Reclamation • TN load 1.7 times pre-human • ETI D • 6–9 mm/year sedimentation	• 1 iwi with strong governance focus • Regional and 2 city councils • 21 estuaries in the region • Community involvement
Whāingaroa Harbour	• 51 kha catchment • Steep hillslopes • Large shallow estuary with narrow opening bar • 69% intertidal • 7 days flush time	• Urban development • Landscape use change • TN load 3.2 times pre-human • ETI C • −4 to +7 mm/year sedimentation	• 3 iwi • Regional and 2 city councils • 51 estuaries in the region • Community involvement

Note: Kha: kilohectare or 1,000 hectares.

[19] Hume et al., 2016; Handley et al., 2017; Plew et al., 2018, Table A-1.

[20] TN: total nitrogen

[21] ETI: estuary trophic index from A (best) to D (most at risk).

For each case study, on-the-ground interviews were carried out with estuarine managers and members of the community. A sample of the values held in each community were gathered through interviews with a range of participants and sectors, tangata whenua and governance groups who associate with each estuary.

The main changes that have occurred in these estuaries over time are described, with a focus on those that have placed the most pressure on each estuary. Aspirations for the future are also summarised. Iwi oral history was sought for each of the case study estuaries in an attempt to extend our understanding of estuarine health further back than European arrival. This oral history work was carried out using kaupapa Māori theory, and principles to guide the process were developed in collaboration with the local contractors. Where applicable, footnotes refer to oral history interviews.

A detailed summary of the findings in each estuary and the method used to gather oral history is captured in the appendices. All the case studies highlighted the need for management that comes to grips with *cumulative pressures* that arise at the level of *entire catchments*.

2

Bryopsis vestita

What do estuaries suffer from?

Many pressures

In this report, pressures are defined as disturbances resulting from human activities that change the health of estuarine environments. They can come from a range of sources – from the highest points of the catchment to the estuary itself and everywhere in-between (Table 2.1). They can also come from global activities such as climate change.

Pressures can originate from well-defined sources – namely, point sources such as industrial wastewater discharge pipes, or from diffuse or non-point sources. Diffuse pressures are often difficult to track and manage, and monitoring them is much more complex than a single point-source pressure.

Pressures are not just caused by current activities. Because not all discharges are flushed out to sea, materials like sediments can linger, forcing us to live with the consequences of historic disturbances.

Some of the most publicised pressures include nutrients and sediments that can be traced to farms, forests, towns, fishing and shipping. Estuarine nutrient levels vary around the country and can reach up to five times that of pre-human levels.[1] Nutrient accumulation in estuaries can lead to algal blooms, which directly degrade ecosystem services such as nutrient cycling, carbon storage and nursery refugia for organisms. Algal blooms can out-compete other species and accelerate the consumption of dissolved oxygen, leading to mass mortality of benthic species, as has occurred in New River Estuary.[2]

Sedimentation is around ten times that of pre-human levels in many estuaries around Aotearoa New Zealand.[3] Increases in sedimentation and turbidity can affect the use of estuaries as pathways for migratory species and as nursery grounds for marine and freshwater fish.[4] However, the effect of sediment accumulation is not always homogeneous across an estuary. Wave exposure, the extent of intertidal area and the frequency of flushing times are the main factors influencing the retention of sediments in the estuary.

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[1] Plew et al., 2018, Table A-1; also see Table 1.1.

[2] Stevens, 2018a; also see Appendix 1: New River Estuary.

[3] Handley et al., 2017, p.92.

[4] McDowall, 1976.

The influence of these factors can differ even within a single estuary. This has been observed in the two arms of Whāingaroa Harbour. The Waingaro arm has not experienced long-term sedimentation: waves driven by the prevailing southwest wind mobilise sediments and transport them to the open ocean. However, the Waitetuna arm, which is more sheltered from the southwest winds and therefore less exposed to wave action, has suffered a threefold increase in sedimentation since 1870, becoming more susceptible to land-based activities over time.[5]

There are also pressures coming from the seaward side, such as estuarine floor disturbance, species removal through fishing and the introduction of invasive species from shipping and recreational boats. For example, the Mediterranean fanworm (*Sabella spallanzanii*), which was introduced from Europe and first detected in New Zealand in 2008, is now a biosecurity risk to New Zealand.[6] It attaches to wharves, boats and the seafloor and can form dense mats that compete with other species, such as mussels and oysters, for space and food. When attached to boats, it slows them down, making them less manoeuvrable and less fuel efficient. The Mediterranean fanworm is now present in a number of New Zealand harbours and is subject to regional management plans.

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[5] Swales et al., 2005b; also see Appendix 5: Whāingaroa Harbour.

[6] See https://marinebiosecurity.niwa.co.nz/sabella-spallanzanii/ [accessed 22 June 2020].

Table 2.1: Some of the pressures estuaries may face with associated effects, sources and state.[7]

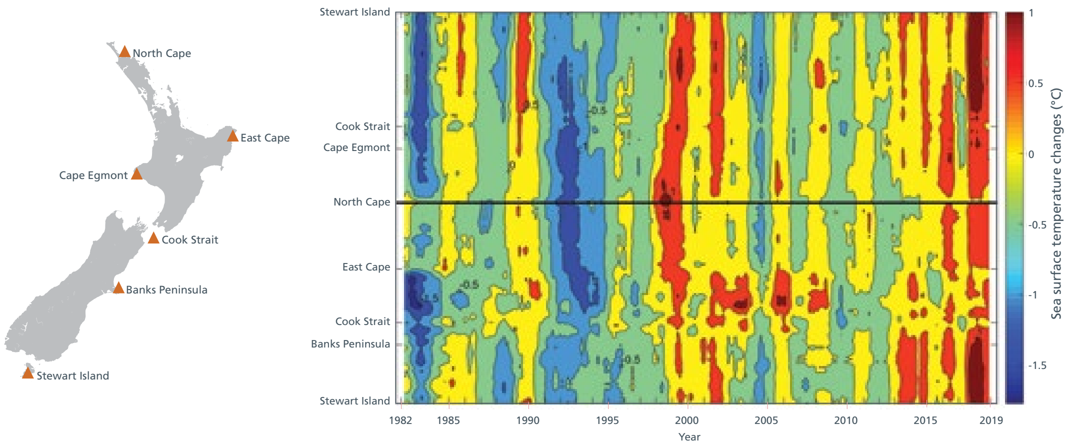
Pressure	Some effects	Source	State in estuaries
Sediment	• Smothers shellfish and seagrass habitats • Reduces light incidence • Favours community structures resilient to sedimentation • Retains pollutants	• Urban, farms, forests, fishing, dredging	• Up to 10 times pre-human levels • At least 50% of surveyed estuaries across New Zealand have sediment values above thresholds limits
Nutrient enrichment	• Triggers blooms of toxic and non-toxic algae • Changes nitrogen cycling • Reduces dissolved oxygen • Displaces species	• Wastewater treatment plants, farms, shipping	• Variable trends by area • 35% of estuaries have high or very high eutrophication sensitivity to nutrient pressure
Chemicals and waste pollution	• Potential to bioaccumulate in the trophic chain • Can lead to loss of productive habitats and alter or impair community structure and function	• Industries, farms, aquaculture, shipping, wastewater treatment plants and stormwater outlets	• Heavy metals monitored but organic chemicals mostly unmonitored • Lead levels above limits in sites from Auckland and Wellington harbours; zinc levels above limits in Auckland and Northland sites; copper levels above limits in Northland sites • Plastics monitored through citizen science at some sites; microplastics not monitored
Pathogens	• Toxicity to humans	• Wastewater treatment plants, stormwater outlets, farms, ships	• Regular monitoring for enterococci and faecal coliforms but not for viruses, protozoa and helminths • Increasing trends of enterococci (2.3%) between 2008 and 2017

[7] Biophysical data gathered from MacDiarmid et al., 2012; Swales et al., 2012; Hume et al., 2016; Plew et al., 2018; Cummings et al., 2019; IPCC, 2019a; Sutton and Bowen, 2019; Berthelsen et al., 2019; MfE and Stats NZ, 2019b; Pinkerton et al., 2019; and https://data.mfe.govt.nz [accessed 18 June 2020].

Fish and shellfish removal	• Reduces populations • Destroys habitats	• Commercial, recreational and customary fishing	• Commercial fishing monitored at regional scale • 2019 fish stock assessment identified the decline of red snapper and tarakihi, both of which use estuaries as nursery grounds
Estuarine floor and margin disturbance	• Loss of habitat and species • Changes community composition • Changes tidal flows, wave reach and sedimentation processes • Increases barriers to migratory fish	• Urban reclamation, hardening edges, inland earth works, fishing	• Loss of benthic habitats large for some urban estuaries, subtidal beds and sub-estuaries with large catchments
Invasive species	• Predate and displace native species • Change estuarine floor hydrodynamics and nutrient cycling processes	• Shipping, recreational vessels, aquaculture	• Some monitoring • 45 coastal and marine habitats are threatened by invasive species; 193 invasive species are well established
Climate change	• Loss of habitat • Warms waters and increases acidity • Increases sediment and nutrient loading into estuaries from more intense rainfall events	• Industries, urban, livestock farming, shipping	• Mostly unmonitored • Sea surface temperatures have warmed over one degree Celsius at the coast between East Cape and Cook Strait between 2000 and 2015
Emerging issues	• Physiological stress, and community structure shifts • Unknown effects	• Industries, farms, shipping, wastewater treatment plants and stormwater outlets	• Mostly unmonitored

As habitats with both terrestrial and marine influences, estuaries are particularly vulnerable to many of the effects of climate change and ocean acidification.[8] Estuarine ecosystems throughout New Zealand are exposed to increases in both air and sea temperatures (Figure 2.1). Estuaries are also exposed to increased acidity and changes in water chemistry, and to changes in river flow and nutrient input.

Floods and droughts come with their own stresses. For example, droughts caused by La Niña in Pelorus Sound/Te Hoiere between 1999 and 2002 reduced river inflow into estuaries, resulting in a decline of particulate nitrogen, particulate carbon, plankton abundance and food quality. This reduced mussel yield by 25 per cent.[9]



Source: Philip Sutton, NIWA

Figure 2.1: Timeseries of annually smoothed temperature changes near New Zealand coasts. A) Reference monitoring stations. B) The *y*-axis represents the locations monitored running north from Stewart Island along the east coast to North Cape, then south down the west coast. The *x*-axis represents years from 1982 to 2019.[10]

Cumulative effects

Cumulative effects have been described as "stressors that overlap in space and/or time (e.g. environmental, economic, social)."[11] Most estuaries around New Zealand and the world are subjected to the cumulative effects of multiple pressures. Yet, in a survey of international studies investigating pressures on estuaries, the vast majority (93 per cent) were found to have considered single pressures only.[12]

Understanding how multiple pressures interact in a complex and dynamic system like an estuary is challenging, and scientific understanding of the cumulative effects of pressures on estuaries is still developing. Yet it is critical to helping us manage estuarine health.

[10] Phillip Sutton, Deep South National Science Challenge project, pers. comm., April 2020.
[11] Davies et al., 2018, p.23.
[12] O'Brien et al., 2019.

When multiple pressures have been investigated, it has often been assumed that the impact of individual pressures can be treated separately from one another.[13] However, the interactions between pressures can yield quite unexpected results. Sometimes, the impact of a specific pressure was found to be many times more severe when coupled with another pressure – but at other times, combined pressures acted to diminish the overall effects.[14]

As a result, looking at pressures in isolation rather than as a whole might lead to a profound misunderstanding of the processes at play and their likely outcomes, and in turn, misguided management proposals. For example, if two pressures cancel each other out, reducing only one might lead to a worsening of the health of the estuary.

Expect the unexpected

It is not only the interaction between pressures that can be unexpected. Pressures can lead to irreversible changes in the health of the estuary that tip the ecosystem into a new state. Put in somewhat technical language, Aotearoa New Zealand is vulnerable to "rapid changes or tipping points which can be difficult to predict because of variations in pressure responses, recovery times, interactions (e.g. synergistic, antagonistic), and surprise".[15]

Take for example seagrass, an important part of healthy estuaries.[16] Taken in isolation, an increase in nutrients could stimulate seagrass growth. Coupled with higher sediment loads, however, seagrass can be smothered, favouring benthic phytoplankton and macroalgae expansion (Figure 2.2).[17] This is slowly happening in New River Estuary.[18]

These are complex processes with self-amplifying or self-dampening feedback loops. The presence of macroalgae, which lowers light penetration to the estuarine floor, can stop the recovery of seagrass communities even if the increase in nutrients and sediments – which triggered the problem – is reversed. Simply reducing or removing pressures might be insufficient to reverse the damage done:[19] the estuary could simply end up tipping to another stable, albeit potentially less desirable, state. Active restoration might be required to return to a healthier estuary.

[13] Clark et al., 2016; Berthelsen et al., 2017; Andersen et al., 2019; O'Brien et al., 2019.

[14] Teichert et al., 2016; Ellis et al., 2017.

[15] Davies et al., 2018.

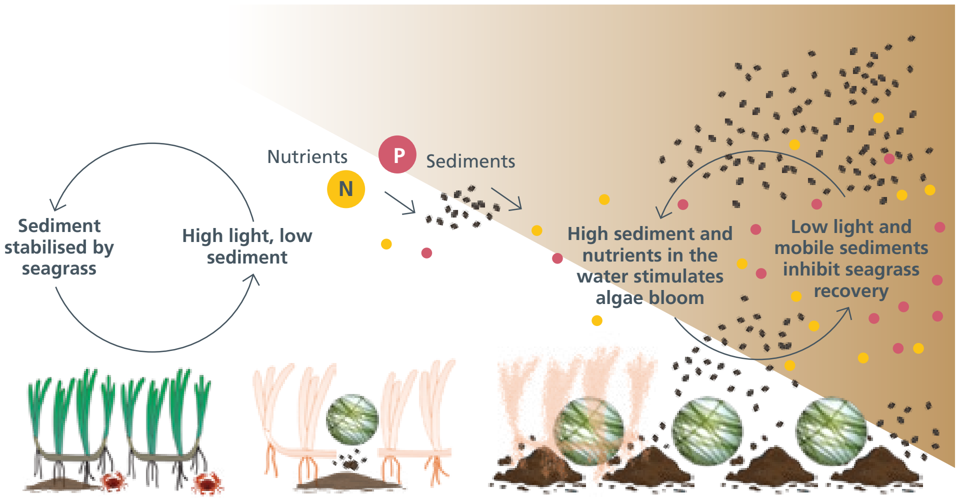
[16] Matheson et al., 2009.

[17] Lee et al., 2007.

[18] See Appendix 1: New River Estuary and chapter four.

[19] Nyström et al., 2012; Duarte et al., 2015; Foley et al., 2019.

One active restoration option suggested in this seagrass example is the re-establishment of large predatory fish to remove the nuisance algae.[20] But restoration is likely to be an expensive and risky business,[21] of which New Zealand has limited experience. For one, how would large predatory fish be re-established in a highly modified estuary? The establishment of marine protected areas in and around estuaries might help achieve this aim, for example.



- Dense seagrass bed
- Stabilised sediment
- Presence of grazing and bioturbating species

- Patchy seagrass bed
- Destabilised sediment
- Drift algae enters meadow

- Drift algae and sediments cover estuarine floor
- Seagrass suffocated
- Reduced grazing organisms

- Anoxic sediment
- Toxic sulfides
- Sediment mobility
- Low survival and diversity of species (including algae)

Source: Adapted from Moksnes et al., 2018

Figure 2.2: Feedback loops in seagrass meadows. Seagrass stabilises sediments in soft-bottomed estuaries and provides vital habitat for estuary ecosystems. Excess sediment blocks light to the seagrass and estuarine floor, and nutrients encourage algae growth. Increased algae, in turn, lowers light levels and prevents seagrass recovery.

[20] Elliott et al., 2007.

[21] Nyström et al., 2012; Verdonschot et al., 2013.

Some illustrations

Effects of nutrients in Pelorus Sound/Te Hoiere

An example of an unexpected outcome is the way improved land-based practices have led to a drop in the productivity of shellfish growth in the aquaculture industry in Pelorus Sound/Te Hoiere. Land use has been intimately linked to shellfish productivity through the analysis of shellfish deposition in estuary core sediment samples (Figure 2.3).[22]

Source: Dr Sean Handley, NIWA

Figure 2.3: Sediment core being retrieved (left) and section of core in preparation for removal and washing to extract shell fragments (right).[23] This project was funded by the Marine Farming Association, Marlborough District Council and the Ministry for Primary Industries.

Pelorus Sound/Te Hoiere was low in inputs of sediment and associated nutrients prior to European arrival, relying mostly on marine inputs for half the year.[24] Green-lipped mussel beds first appeared in Pelorus Sound/Te Hoiere in the late 1860s following land use change and an increase in nutrients.[25] The intensification of farming from the late 1940s to 1980s associated with government subsidies for fertilisers coincides with a spike in the productivity of filter feeders in Kenepuru Sound, suggesting a widespread increase in productivity had occurred.[26]

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[22] Handley, 2015; Handley et al., 2017.

[23] Handley et al., 2017.

[24] Zeldis et al., 2008.

[25] However, mussel shells were poorly preserved in the core samples taken and could have been present in low quantities prior to the 1860s (Handley et al., 2017).

[26] Handley et al., 2017, p.9.

When farming on steeper land began to be abandoned in favour of pine plantations in the 1980s, the productivity of the sound started to decline. The input of shells to sediments today is about half of what it was in the 1970s,[27] and there is little or no growth of farmed mussels for six months of the year. Recent failure of mussel spat in the Marlborough Sounds, Golden Bay and Tasman Bay areas may also be linked to this reduction in productivity. Anecdotally, the removal of the exotic seagrass *Spartina* in Pelorus Sound/Te Hoiere in the 1990s coincided with an increase in productivity in mussel farms for a few years, presumably due to sediment and nutrient release.

Future mitigation measures to reduce nutrient discharge from the catchment into the estuary could further reduce the availability of nutrients and hence the productivity of Pelorus Sound/Te Hoiere, affecting the aquaculture industry. However, as nutrients bind to fine sediment, reducing sediment discharge from the catchment could result in an increase in dissolved nutrients reaching the estuary. Depending on the level of reduction of both sediments and nutrient discharges, there might actually be more nutrients available, and the productivity of the sound could increase as a result of these cumulative effects.[28]

This example demonstrates the influence cumulative pressures can have on a natural system over time, and the importance of a values-based approach in the management of the estuary, where an 'optimum' level of inputs relates to qualities that iwi and the wider community value.

Sediments and mangroves

Mangrove expansion is another example of unexpected tipping points. Mangroves are an important part of healthy estuaries – they stabilise sediments, sequester carbon, are habitats for birds and underwater species, and act as buffer zones to storm surges and sea level rise.[29] However, the cumulative combination of sediment loading from land development and nutrient-enriched run-off favours mangrove colonisation in raised tidal flat areas previously occupied by seagrass and saltmarsh meadows.[30]

[27] About a 50% reduction between the periods of 1850–1970 and 1970–2016, in all three areas sampled (Handley et al., 2017).

[28] Handley et al., 2017, p.108.

[29] Kelleway et al., 2017.

[30] Horstman et al., 2018.

In many places (e.g. Tauranga Harbour), mangrove expansion has caused contention in the community. A minority of people claim that mangrove habitats benefit the harbour, and they actively participate in community efforts to protect them. Conversely, most of the community argue that mangroves have taken over space previously used for recreational purposes and mahinga kai, and should therefore be removed.

A Mangrove Management Operational Policy was adopted by the Bay of Plenty Regional Council in 2014 to prevent the ongoing expansion of mangroves. An agreement was made to remove mangrove seedlings from 600 hectares belonging to 13 sub-estuaries and open tidal flats of Tauranga Harbour.[31]

Further rules under the 2019 Regional Coastal Environment Plan have been implemented (DD 20 and DD 22) to strengthen specific controls on mangrove removal as permitted or controlled activities, and to protect adult mangroves at high-value sites such as Pataua Island Scientific Reserve in Ōhiwa Harbour.[32]

[31] See Appendix 3: Tauranga Harbour.

[32] BOPRC, 2019c.

Caulerpa geminata

3

How are estuaries managed?

The management of estuaries is not about managing the body of water itself but rather managing the activities that affect it. That means considering *all* the activities that cumulatively impact on estuaries – regardless of where they are located – in an integrated way and with climate change in mind.

Activities that require consideration for estuarine management span many domains. As a result, the management of estuaries relies on a range of different national and local policies, as well as a range of players.

This chapter outlines existing national frameworks, the many interest groups and stakeholders involved, and some of the management approaches that are being practised. The following chapter examines issues such as the potential for overlap between agencies and the difficulties encountered in securing cooperation between the many players.

Source: Matua Estuary Care Group

Figure 3.1: Estuaries span many domains and are a place to pass knowledge to future generations.

Te ao Māori

Significant areas were traditionally managed by Māori through an understanding of whakapapa. The guardians of certain environmental domains (ngā atua) were understood as being people's ancestors, parents or tuākana.[1]

This connection required management of one's own whānau and communal activity and responsibility to use resources within those domains in a reciprocal way (kaitiakitanga).[2] For estuaries, Tangaroa (atua of the sea) would be one of the main atua but not the only one. Reliance on whakapapa means acknowledging the interdependencies between all ecosystems, including terrestrial, freshwater and marine.[3]

Out of this whakapapa a knowledge system – mātauranga Māori – developed. Mātauranga Māori is a multifaceted knowledge system that encompasses everything from the physical, such as mahinga kai, through to principles, such as tikanga, kaitiakitanga and wairuatanga.[4]

As Māori settled in Aotearoa New Zealand and mātauranga evolved with their new environment, management was established, usually within hapū or whānau groupings who had mana, rangatiratanga or kaitiakitanga of an area. If a rōpū had mana whenua over an area, it was their responsibility to ensure that the mauri of those areas or resources was sustained for future generations.[5]

Regulatory framework

Crown–Māori relations

The Crown has a duty to uphold Treaty principles. It has placed certain obligations on local government, including those set out in section 8 of the RMA, which requires that all decision makers "shall take into account the principles of the Treaty of Waitangi". Guidance documents are available to help implement Treaty principles and appropriate involvement of Māori in environmental management.[6]

Treaty of Waitangi settlements have also created a pathway for some hapū and iwi to reassert their connection to their rohe and reinforce their kaitiakitanga and rangatiratanga in respect of estuaries. The Marine and Coastal Area (Takutai Moana) Act 2011 has established a separate process to recognise some of the rights whānau, hapū and iwi have to parts of the marine and coastal area.

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1 Jackson et al., 2017.

2 Durie, 1998; Jackson et al., 2017.

3 Durie, 1998.

4 Taura et al., 2017, p.151.

5 Jackson et al., 2017.

6 For example, DOC's *NZCPS 2010 Guidance note – Policy 2: The Treaty of Waitangi, tangata whenua and Māori heritage*; see https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/coastal-management/guidance/policy-2.pdf [accessed 15 June 2020].

Many hapū and iwi seek a return to an approach to environmental management that encompasses all areas and activities from the mountains to the sea (ki uta ki tai). This is not a new concept but, rather, reflects whakapapa. The principle of ki uta ki tai is being used in some government policies such as the National Policy Statement for Freshwater Management (NPS-FM, see below). Trying to fit te ao Māori concepts into national regulatory frameworks is not without its difficulties.

The Resource Management Act 1991

The RMA requires a joined-up approach to managing the environment. The meaning of 'effect' in the RMA includes "any cumulative effect which arises over time or in combination with other effects".[7] The RMA incorporates the precautionary principle into decision-making by requiring consideration of "the risk of acting or not acting if there is uncertain or insufficient information about the subject matter of the provisions".[8] It also includes provisions that would allow the general public to take court action in cases where a local authority has failed to properly address an environmental issue in its planning instruments.[9]

The New Zealand Coastal Policy Statement 2010

The idea of managing estuaries as an environmental unit is a surprisingly recent phenomenon in New Zealand. It made its first appearance in the initial New Zealand Coastal Policy Statement (NZCPS) of 1994, which was subsequently updated in 2010. Objective 1 of the NZCPS is "to safeguard the integrity, form, functioning and resilience of the coastal environment and sustain its ecosystems, including marine and intertidal areas, estuaries, dunes and land".[10] The NZCPS is the prime policy directly applicable to the management of estuaries.

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[7] RMA 1991 s 3.

[8] RMA 1991 s 32(2)(c).

[9] RMA 1991 s 310 (Declarations).

[10] DOC, 2010, p.9.

Source: Jean-Claude Stahl, Te Papa

Figure 3.2: Haast River mouth, where freshwater meets the coast.

The NZCPS recognises the principles of the Treaty and imposes a range of requirements on local authorities to work with tangata whenua as kaitiaki of the coastal environment, including how they should be involved in decision making. It also stipulates that, in consultation with tangata whenua, sites of special value should be identified, assessed, protected and managed.[11]

Although the NZCPS can only include policies in relation to the coastal environment,[12] the 2018 implementation guidance report by the Department of Conservation (DOC) noted: "Policy 4: Integration and Policy 7: Strategic planning require that planning documents and decision-makers consider current and potential effects, including cumulative effects, across the land/water interface, irrespective of jurisdictional boundaries and responsibilities."[13]

Beyond the need to consider integrated management and cumulative effects, in 2010 the NZCPS introduced the need to consider economic values such as those derived from aquaculture, infrastructure and mineral extraction. This revision also removed specific references to mangroves under the natural character policies and the hazard policies – councils can now either protect or clear mangroves based on local considerations.

In 2020, all 11 regional councils and six unitary authorities had either a regional coastal plan or a plan with a coastal chapter that covered estuaries. Five of those 17 bodies had a second-generation plan: Auckland, Bay of Plenty, Gisborne, Hawke's Bay and Manawatū-Whanganui.

[11] DOC, 2010, Policy 2(g), p.12.
[12] RMA 1991 s 56 and 58.
[13] DOC, 2018, p.3.

The National Policy Statement for Freshwater Management

The NPS-FM was prepared in 2006 and approved in 2011. Since then it has been updated every three years, with a fourth iteration released in 2020. Key advances in management are described below.

Te Mana o te Wai

The NPS-FM 2014, updated in 2017 (NPS-FM 2017) recognised Te Mana o te Wai – "the integrated and holistic well-being of a freshwater body" – as a matter of national significance. Te Mana o te Wai protects the mauri of the water and recognises the connection between the land, water and human health.[14] However, the NPS-FM 2017 only required regional councils "to consider and recognise" Te Mana o te Wai,[15] whereas the NPS-FM 2020 states that every council must "give effect to" Te Mana o te Wai when managing freshwater.[16]

Kāhui Wai Māori – the Māori Freshwater Forum established to support MfE's Essential Freshwater programme – made recommendations to ensure Te Mana o te Wai was implemented appropriately.[17] The NPS-FM 2020 has taken up relevant recommendations.[18] In particular, it has identified principles relating to the roles of tangata whenua and other New Zealanders in the management of freshwater.[19] The NPS-FM 2020 also provides a hierarchy of obligations for Te Mana o te Wai, which prioritises first the health and wellbeing of waterbodies and freshwater ecosystems, second the health needs of people (such as drinking water) and third, the ability of people and communities to provide for their social, economic and cultural wellbeing, now and in the future.[20] It also requires councils to enable tangata whenua to engage and identify Māori freshwater values to the extent they wish to.[21] Mahinga kai is now a compulsory value and wai tapu and tauranga waka are also values that must be considered.

Integrated management

The NPS-FM 2017 directed councils to manage whole catchments in an integrated way through Objective C1: "To improve integrated management of fresh water and the use and development of land in whole catchments, including the interactions between fresh water, land, associated ecosystems and the coastal environment."[22] However, the following Policy C1 was relatively weak, as regional councils were only required to "recognise" – rather than actually provide for – "the interactions, ki uta ki tai (from the mountains to the sea) between fresh water, land, associated ecosystems and the coastal environment".[23]

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[14] New Zealand Government, 2017, p.7.

[15] New Zealand Government, 2017, Policy AA1, p.11.

[16] New Zealand Government, 2020, 3.2(2), p.11.

[17] Controller and Auditor-General, 2019a; Kāhui Wai Māori, 2019.

[18] Kāhui Wai Māori made broader recommendations related to the overall management of Freshwater not just for the NPS-FM: Kāhui Wai Māori, 2019.

[19] New Zealand Government, 2020, 1.3(3), p.4.

[20] New Zealand Government, 2020, 1.3(5), p.6.

[21] New Zealand Government, 2020, 3.4(1), p.11.

[22] New Zealand Government, 2017, Objective C1, p.17.

[23] New Zealand Government, 2017, Policy C1, p.17.

The NPS-FM 2020 requires regional councils to adopt an integrated management approach, ki uta ki tai.[24]

The NPS-FM 2017 required all regional councils and unitary authorities to establish freshwater values and attributes. Programmes to implement regional freshwater plans (that give effect to the NPS-FM) are currently under development around the country and have been reviewed elsewhere.[25] The NPS-FM 2020 continues this approach.

Despite directing councils to manage whole catchments in an integrated way, estuarine pressures such as sediments are not covered. The only types of estuaries included in the NPS-FM attributes are lakes and lagoons that are intermittently open to the sea.[26]

In spite of this patchy guidance, some councils have attempted to manage estuaries as part of an integrated catchment management process that mirrors NPS-FM requirements. For example, two regional councils within our case studies – Greater Wellington Regional Council and Environment Southland – have proposed to plan for and manage estuaries using the sort of framework established by the NPS-FM.[27] Attributes have been proposed for Te Awarua-o-Porirua Harbour, while they are still to be determined for New River Estuary (see Box 4.2 on page 73).

[24] New Zealand Government, 2020, 3.2(2)(e), p.12 and 3.5(1), p.13.

[25] See MfE, 2017b; Controller and Auditor-General, 2019a.

[26] New Zealand Government, 2020, Appendix 2A, pp.40–61.

[27] See chapter four, Appendix 1: New River Estuary and Appendix 4: Te Awarua-o-Porirua Harbour.

Other legislation

The subject-based approach to national policy statements and resource-specific legislation makes integration difficult (Box 3.1).

Box 3.1: Examples of some other requirements bearing on estuarine integrated management

The **National Environmental Standards for Plantation Forestry** permit some activities that are part of plantation forestry in large parts of rural New Zealand. There is an ability to impose more stringent rules in a range of circumstances, but some local authorities have indicated that setting more stringent rules could be difficult in practice. For example, estuarine sedimentation is one of the main pressures on Pelorus Sound/Te Hoiere, and the contribution of plantation forestry is a key preoccupation of the Marlborough District Council.[28]

The **Fisheries Act 1996** regulates fishing to ensure the sustainability of the resource. The Act prevents local authorities from making rules under the RMA to control the taking, allocation or enhancement of fisheries resources for the purpose of managing any of the fishing or fisheries resources that it covers. However, in 2019, the Court of Appeal clarified that regional councils can impose controls on fishing activities under the RMA if they are aimed at protecting biodiversity and do not replicate the types of controls provided for under the Fisheries Act (for example, setting catch limits under the RMA would likely be unlawful).[29]

Local statutes relate specifically to certain bodies of water. These statutes provide for specific governance and planning arrangements. Examples that bear on estuaries include the Hauraki Gulf Marine Park Act 2000 and Fiordland (Te Moana o Atawhenua) Marine Management Act 2005.

[28] Urlich, 2015; Handley et al., 2017; also see Appendix 2: Pelorus Sound/Te Hoiere.

[29] Court of Appeal of New Zealand, 2019; Urlich, 2020.

Key players

Kaitiaki, iwi and hapū

Māori have never relinquished their responsibility as kaitiaki of estuaries and regard themselves as having an obligation to protect these important ecosystems.[30] Kaitiaki are reclaiming their mātauranga and drawing upon their own worldview, as well as partnering with science institutes to explore ways in which estuaries should be managed.

Treaty of Waitangi settlements allow hapū and iwi to have a stronger decision-making voice in specific settings. For example, Te Awa Tupua (Whanganui River Claims Settlement) Act 2017 recognises the river as its own legal entity and provides mana whenua with a co-governance opportunity. This extends to the mouth of the Whanganui River on the Tasman Sea, as well as all lakes and wetlands connected continuously or intermittently.

Another example is Te Rohe o Te Wairoa Reserves Board–Matangirau, which was established under the Iwi and Hapū of Te Rohe o Te Wairoa Deed of Settlement to manage five reserves (including the estuarine Ngamotu Lagoon). Three iwi members and three Wairoa District Council members make up the board.[31]

Under the RMA, environmental management plans prepared by iwi and hapū for their rohe state their interests, concerns and preferred management approaches. For example, in Southland, Te Ao Marama Incorporated was created to coordinate iwi input in local and regional planning and consents, as well as to promote the role of iwi as kaitiaki. It works closely with Environment Southland and territorial authorities in the region.[32]

There is also capacity under the Fisheries Acts 1996 for iwi and hapū to reserve some coastal waters from specified forms of fishing, temporarily or permanently, providing for customary food gathering and traditional fishing practices, and to help maintain local stocks. These customary management tools include temporary closures or restrictions, mātaitai reserves, taiāpure and fisheries bylaws.[33]

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[30] Durie, 1998.

[31] See https://www.govt.nz/treaty-settlement-documents/te-wairoa-iwi-and-hapu/ [accessed 16 June 2020].

[32] Runanga Papatipu o Murihiku, 2008; Kainamu-Murchie et al., 2018.

[33] See https://www.mpi.govt.nz/law-and-policy/maori-customary-fishing/managing-customary-fisheries/ [accessed 15 June 2020].

Government agencies

DOC supports the Minister of Conservation in fulfilling her coastal management responsibilities relating to the NZCPS and regional coastal plan approval. The NZCPS was first approved in 1994 and independently reviewed in 2003, and the second NZCPS was released in 2010 and reviewed in 2016/17.[34]

DOC has developed guidance documents to accompany the NZCPS,[35] and has strong technical and operational capabilities. It supports on-the-ground work relating to estuaries all around the country, and manages many estuarine reserves.[36]

DOC also has authority to investigate and establish marine reserves under the Marine Reserves Act 1971. Marine reserves can protect estuaries and vegetation but only to mean high water springs.[37] The reserves are technically designed for scientific purposes, but they also help meet marine biodiversity targets specified in the New Zealand Biodiversity Strategy 2000–2020.[38] The Biodiversity Strategy was being updated at the time of writing.

The Ministry for the Environment (MfE) is responsible for water quality at the national level and has advised the Minister on preparation of the multiple iterations of the NPS-FM. It reviewed the effectiveness of the NPS-FM in 2017, as did the Controller and Auditor-General in 2019.[39] MfE also contributes to developing the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, including sedimentation in estuaries.[40]

MfE and Stats NZ regularly report on the state of New Zealand's environment. *Environment Aotearoa 2019, Our marine environment 2019* and *Our freshwater 2020* include estuaries.[41] Information directly relevant to estuaries includes coastal and estuarine water quality and the heavy metal load in sediment drawing on data from coastal and estuarine sites in 12 of the 16 regions of New Zealand.[42]

Fishing in and around estuaries is primarily managed by Fisheries New Zealand, a business unit of the Ministry for Primary Industries (MPI). Freshwater fishing can also be regulated under the Conservation Act 1987 with DOC. Maritime New Zealand deals with issues of pollution from vessels, and Biosecurity New Zealand (also a business unit of MPI) deals with biofouling on vessels and monitoring for new pests.

New Zealand Food Safety (another business unit within MPI), district health boards and regional authorities all have a role to play in managing the potential risks to human health of collecting shellfish. National microbiological water quality monitoring is undertaken by councils, following direction and guidelines developed by the Ministry of Health and MfE through the NPS-FM.

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34 DOC, 2017a, 2017b.

35 See https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/ [accessed 17 June 2020].

36 See https://www.doc.govt.nz/estuaries [accessed 17 June 2020] and Appendix 4: Te Awarua-o-Porirua Harbour.

37 See Figure 4.3.

38 DOC, 2000, Objective 3.6, p.67.

39 DOC, 2017b; MfE, 2017b; Controller and Auditor-General, 2019a; also see chapter four.

40 MfE and Stats NZ, 2020, p.32.

41 MfE and Stats NZ, 2019a, 2019b, 2020; PCE, 2019b.

42 MfE and Stats NZ, 2019b; also see https://www.stats.govt.nz/indicators/coastal-and-estuarine-water-quality [accessed 13 May 2020].

Regional councils

Under the RMA, regional councils are required to prepare regional plans and regional coastal plans, which must specify objectives, policies and rules to guide decision making at the consenting level. The contents of regional plans must give effect to national policy statements (including the NZCPS) and national planning standards.[43] The provisions of plans must be reviewed at least every ten years (although that need not necessarily result in changes).

Following the promulgation of the NZCPS, many councils started monitoring estuaries in a more consistent manner (Box 3.2). Coastal scientists and planners from New Zealand's regional councils and unitary authorities meet regularly as part of the regional sector's coastal special interest group. They have developed a research strategy to guide coastal and marine resource management.[44]

Box 3.2: National Estuarine Monitoring Protocol

Estuaries across New Zealand are exposed to different pressures that may vary in intensity. The National Estuarine Monitoring Protocol is a non-statutory standard guide developed in 2002 by Cawthron Institute for MfE to help councils describe the state of an estuary and establish a benchmark for comparison with future surveys. The protocol developed environmental performance indicators to help describe the health of the intertidal estuarine floor while considering the difference between types of estuaries (see Table 3.1).

The protocol is meant to be evolving, allowing for the development of further indicators. For example, the use of species and abundance of invertebrate communities has led to the development of biotic indices, such as the RI-AMBI, TBI and Mud BHM (see Table 3.1). There are also modelling tools such as the national estuarine trophic index (ETI), which assesses susceptibility of an estuary to eutrophication and estimates its trophic state.[45] However, the 2002 document itself has not been revised.

[43] RMA 1991 s 67(3) and s 75(3).

[44] Berkett et al., 2015.

[45] Robertson et al., 2016a.

Table 3.1: Some indicators developed for estuaries.[46]

Indicator type	Indicator	Issues associated with estuarine condition
Physical and chemical	Particle grain size (% grain size)	Sedimentation
	Total organic carbon (TOC) (%)	Organic enrichment
	Total nitrogen (TN)	Nutrient enrichment
	Total phosphorus (TP)	Nutrient enrichment
	Trace metals (Cd, Cr, Cu, Ni, Pb, Zn)	Contamination
	Redox potential discontinuity (RPD)	Organic enrichment
Biotic	Epifauna diversity/richness (taxa per sample)	Integrative measure of overall health
	Epifauna abundance	
	(individuals per sample)	Integrative measure of overall health
	Infauna diversity indices	Infauna community
	Benthic microalgae: sediment chlorophyll-a	Nutrient enrichment
	Benthic microalgae: phaeophytin	Nutrient enrichment
	Macroalgal cover (% cover)	Nutrient enrichment
	Richness-integrated AZTI marine biotic index (RI-AMBI)*	Macrofaunal community response to sediment and organic enrichment
	Trait-based index (TBI)*	Response to sedimentation and metal contamination
	Metals benthic health model (Metals BHM)*	Macrofaunal community response to metals
	Mud benthic health model (Mud BHM)*	Macrofaunal community response to mud

* Indicator developed after the National Estuarine Monitoring Protocol was published.

Territorial authorities

Under the RMA, territorial authorities (city and district councils) have responsibilities to avoid, remedy or mitigate the adverse effects of land-based activities carried out above the line of mean high water springs, although it is regional authorities that have the responsibility for discharges. District plans must give effect to any applicable national policy statements, national planning standards, regional policy statements and national environmental standards.

The RMA also requires the preservation of the natural character of the coastal environment from inappropriate use and development (s 6(a)). Local authorities also need to monitor the environment, the efficiency and effectiveness of policies and the exercise of resource consents (s 35).

[46] Adapted from Robertson et al., 2002; Rodil et al., 2013; Robertson et al., 2015; and Berthelsen et al., 2019.

In addition to RMA planning documents, city and district councils also produce annual plans and long-term community plans under the Local Government Act 2002. Preparing long-term community plans includes public consultation and decision making on issues such as estuarine management. These plans specify the community's vision, goals and planned expenditure for promoting economic, social, cultural and environmental wellbeing in their area.

Community involvement

There are a host of individuals and groups who are passionate and active in caring for their local estuaries. Community groups have become involved in restoration projects,[47] citizen science, monitoring estuarine health and legal action.[48] For example, where there has been poor estuary quality, inter-agency conflicts and a lack of remedial action, groups have undertaken their own independent monitoring and initiated legal proceedings, pushing for progress.[49]

Some illustrations

Three different examples of management action are discussed in further detail here: a community-based approach, an approach using the NPS-FM framework and a local statute.

A community-based approach

The Whāingaroa Catchment Management Project, established in 1996, was the first formal attempt in New Zealand to establish community-based, integrated environmental management on a catchment scale. Inspired by a Canadian integrated catchment management initiative, this endeavour resulted in the Whāingaroa Environment Catchment Plan in 2002, which is led by the Whāingaroa Environment Centre.[50] The plan is non-regulatory. Many local programmes have eventuated, including large-scale riparian planting on private land.

The approach has proved only partially successful in the New Zealand setting.[51] According to Environment Waikato, sedimentation levels in Whāingaroa Harbour increased and then became consistent between 2001 when monitoring started and 2010.[52] Anecdotal evidence points to an improvement in snapper numbers and the extent of seagrass beds in the estuary.[53] The centre was conducting an evaluation of its effectiveness at the time of writing.

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[47] See https://www.doc.govt.nz/nature/habitats/estuaries/restoring-estuaries-map/ [accessed 17 June 2020].

[48] Peters, 2016.

[49] PCE, 2005.

[50] Environment Waikato, 2002.

[51] van Roon and Knight, 2001.

[52] Environment Waikato, 2008, 2010.

[53] See Appendix 5: Whāingaroa Harbour.

Source: Dr Sophie Mormede, PCE

Figure 3.3: Snapper visit estuaries to feed or use as a nursery. Their numbers appear to be increasing in Whāingaroa Harbour.

Using the NPS-FM framework

To implement the NPS-FM, Greater Wellington Regional Council embarked on a whaitua process. This process produces catchment-based management plans where estuarine attributes and associated targets or limits are developed to represent community values, as expressed through five whaitua committees established in the region. For Porirua, estuaries were specifically identified as the final receiving environment for the freshwater management plans.

Te Awarua-o-Porirua Whaitua Committee was established in December 2014.[54] The whaitua process produced *Te Awarua-o-Porirua Whaitua Implementation Programme* in 2019 and the associated *Ngāti Toa Rangatira Statement* with its own recommendations.[55]

Te Awarua-o-Porirua Whaitua Implementation Programme contains 75 recommendations. It advocates the establishment of attributes and targets for the estuary, including reducing the sedimentation rate to the estuary, reducing the levels of enterococci in the estuary and maintaining the health of macroalgae. It also recommends the development of a monitoring plan for the estuary.[56]

Some recommendations are to be included in the Greater Wellington Regional Council's proposed natural resources plan through a plan change or variation process;[57] others will be non-statutory. How the regional council will achieve the non-statutory recommendations was under consideration at the time of writing, but it is likely to be affected by the NPS-FM 2020, which needs to be given effect as soon as reasonably practicable. The effectiveness of the Whaitua Implementation Programme is unlikely to be known for some time.

[54] See Appendix 4: Te Awarua-o-Porirua Harbour.

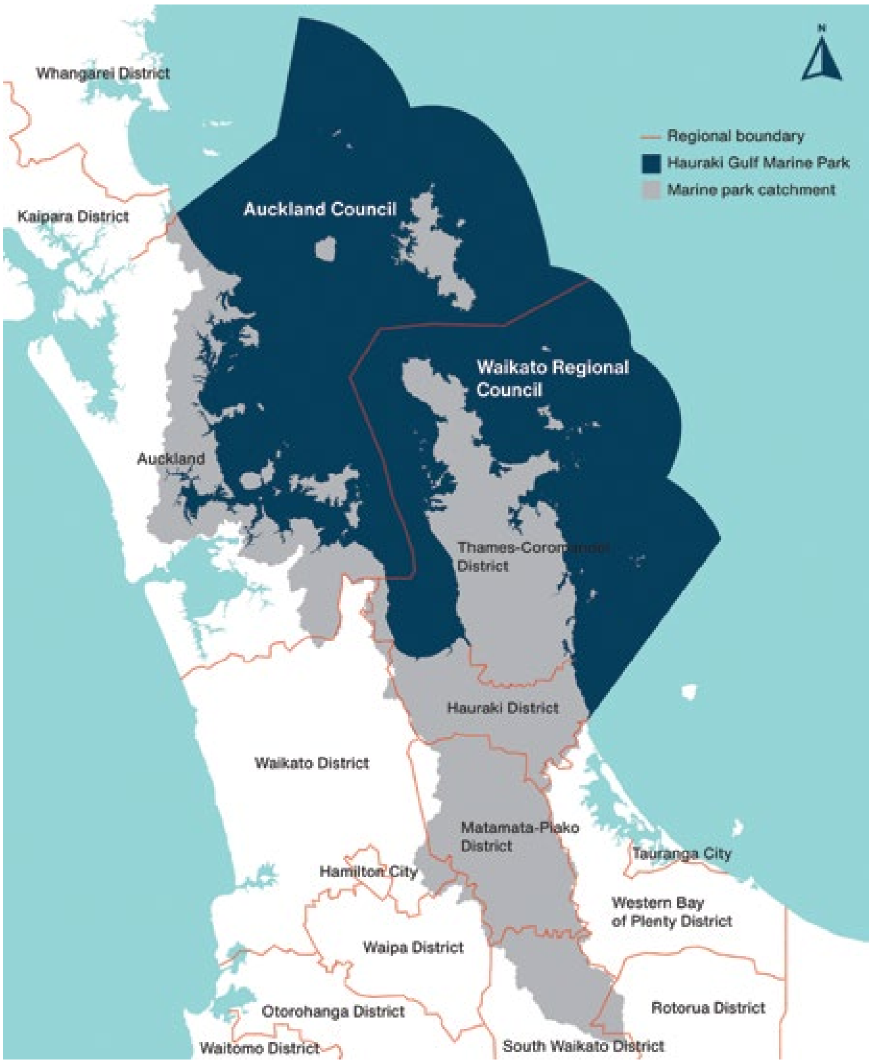
[55] Ngāti Toa Rangatira, 2019; Te Awarua-o-Porirua Whaitua Committee, 2019.

[56] Te Awarua-o-Porirua Whaitua Committee, 2019.

[57] Matthew Hickman, GWRC, pers. comm., 15 June 2020.

Using a local statute

A number of statutes relate specifically to certain bodies of water. One such example is the Hauraki Gulf Marine Park established by the Hauraki Gulf Marine Park Act 2000. The coastal boundary and drainage catchment of the park are depicted in Figure 3.4 as well as the regional authorities and territorial authorities covering this catchment. The Hauraki Gulf suffers the impacts of a very wide range of activities that range from port, commercial and residential activities in Auckland city to dairy farming in the Hauraki Plains and leachate from old mine workings in the Coromandel Peninsula.



Source: Hauraki Gulf Forum

Figure 3.4: Map of the Hauraki Gulf Marine Park (dark blue), its catchment area (dark grey), and regional council and territorial authority areas (outlined in red).

The Hauraki Gulf Marine Park Act also established the Hauraki Gulf Forum in 2000 to enable representatives of relevant central and local government authorities and mana whenua in the area to meet, discuss and potentially coordinate planning and management functions and monitor environmental quality.

The Hauraki Gulf Forum's *State of our Gulf 2011* report indicated that current management approaches were insufficient to reverse continuing degradation.[58] As a result, an independent multi-stakeholder marine spatial planning exercise was undertaken between 2013 and 2016.

Interest groups such as the Environmental Defence Society encouraged this approach with the hope of bringing together in one plan arrangements for land-based management, fisheries management, marine conservation and RMA marine management that had until then been treated separately.[59]

The result was Sea Change – Tai Timu Tai Pari, New Zealand's first marine spatial plan.[60] It included over 180 specific recommendations. In 2019 a new ministerial advisory committee was established to help central government decide how to progress relevant recommendations within the context of a marine spatial plan.[61] While the advisory committee works on, the forum has issued a fresh *State of our Gulf 2020*. The report paints a grim picture of continued pollution from land-based run-off, declining fish stocks, functionally extinct crayfish and an increasing number of seabird species classed as threatened.[62]

As these three initiatives operating at very different spatial scales illustrate, there is no lack of imagination in coming up with different ways of tackling the complex management issues that estuaries throw up. How effective they are is another matter. The next chapter focuses on *why* our management of estuaries is either not working or taking so long to bear fruit.

[58] Hauraki Gulf Forum, 2011, p.13.

[59] Peart, 2008.

[60] Sea Change Stakeholder Working Group, 2017.

[61] New Zealand Government, 2019.

[62] Hauraki Gulf Forum, 2020a.

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Champia novae-zelandiae

Hurdles to good estuary management

There is agreement on many of the issues faced in trying to manage estuaries.

These include fragmented science, management and governance; diverse social values; conflicting and competing interests; and capacity.[1] In some cases, monitoring has documented a sustained decline in the health of an estuary, yet management has been insufficient to reverse the trend.

For example, the state of four estuaries in Southland has been monitored consistently since 2001. This includes New River Estuary, for which monitoring dates back to 1991.[2] Results to 2015 show a progressive worsening of state for most indicators for all four estuaries.[3]

If this direction continues, a future similar to that of estuaries in the French region of Brittany[4] could await New River Estuary: large areas overtaken by deadly nuisance algae, risks to human and animal health and loss of tourism revenue (Figure 4.1). Such areas are already a problem in New River Estuary, albeit with a different species of nuisance algae (Figure 4.2).[5]

Source: Denis Brothier, Flickr

Figure 4.1: A blanket of sea lettuce in Kervel in Brittany, France. This mat decomposes into a dangerous layer killing all animals below and emitting deadly gas.

February 2007 January 2012

Source: Robertson Environmental Limited and Environment Southland[6]

Figure 4.2: The appearance of nuisance algae in the Waihōpai arm of New River Estuary between 2007 and 2012.

[6] Robertson et al., 2017b.

Some of the many hurdles to estuarine management that have recurred in our case study interviews and in other discussions are discussed below. Some of the attempts to overcome these hurdles are also described.

Te ao Māori and management

The case studies revealed various levels of involvement by Māori in the management of estuaries, but none were entirely satisfactory to local iwi and hapū. The Auditor-General's 2019 review of the freshwater management system recommended strengthening relationships with iwi and hapū.[7]

There have been attempts to incorporate Māori concepts into current legislation and management frameworks such as the NPS-FM.[8] However, this has been fraught with difficulties. A holistic way of thinking has been compartmentalised into the various laws that govern estuaries, making it difficult to manage them according to interconnected Māori values.[9] For example, despite the NPS-FM 2020 recognising ki uta ki tai and estuaries being included in the definition of a 'receiving environment',[10] estuaries are still excluded from the more detailed provisions such as the tables of attributes.

Additionally, the various legislative tools that do include Māori concepts for governing estuaries prioritise them differently. For example, section 4 of the Conservation Act 1987 states that the Act must be interpreted and administered in a way that shall "give effect to" Treaty of Waitangi principles. In contrast, the RMA only requires that the principles be taken into account. Various Treaty settlements include requirements for councils to engage appropriately, and the Marine and Coastal Area (Takutai Moana) Act 2011 also sometimes requires further engagement.

Māori concepts have often been misinterpreted, simplified or omitted from both statute and the common law. Professor Sir Mason Durie had this to say about the RMA:

> "Although the RMA recognises a number of Māori cultural beliefs, the omission of reference to mauri, a key Māori concept which links resources with both the environment and with people, caused some concern, especially as it had been included in the original bill. Moreover, its replacement with the phrase 'intrinsic values of ecosystems' fails to convey the same sense of interconnectedness or an appreciation of the environment as a network of living entities."[11]

Te Mana o te Wai and ki uta ki tai are well understood by kaitiaki and are used to focus on-the-ground estuarine work. For example, Te Mana o te Wai is one of the core values of Te Wai Māori Trust, which distributes Te Wai Māori funds. Some projects that have been funded include catchment-based restoration projects and life cycle and population research of tuna.[12]

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[7] Controller and Auditor-General, 2019a.

[8] New Zealand Government, 2020.

[9] Turvey, 2009. Māori values also encompass economic, health and wellbeing as well as environmental components.

[10] New Zealand Government, 2020, 3.5(1), p.13.

[11] Durie, 1998, p.30.

[12] See https://waimaori.maori.nz/ [accessed 16 June 2020].

However, regulating authorities do not always apply these concepts in practice. The NPS-FM 2020 states that: "Every regional council must give effect to Te Mana o te Wai." They also "must engage with communities and tangata whenua to identify long-term visions, environmental outcomes, and other elements of the NOF".[13] It will be important to monitor and review whether the changes to the NPS-FM 2020 and related guidance documents will make a difference.

Variable boundaries

Estuary ecosystems are complex – the same could be said about any ecosystem. This, in itself, is not an issue. But to cater to this complexity, our laws often divide the natural world into domains and divisions that do not always make sense. The problem arises where the ecosystem, its inputs and outputs span different biophysical and legislative domains.

Legal boundaries

Estuaries sit firmly within the RMA, which hands to regional councils the governance of activities on land, the coast and the sea out to 12 nautical miles from the coastline. However, the treatment of the land–sea boundary varies between different national and regional policy statements.

The DOC-led NZCPS covers the coastal environment (with each region left to define it based on local circumstances), and includes the intertidal zone, interrelated coastal marine and terrestrial systems, and areas under the influence of coastal processes.[14] What it does not include is most freshwater – the main input to estuaries. National direction on freshwater is instead set out in the NPS-FM, which is administered by MfE.

The NPS-FM 2020 provides direction for regions on the management of freshwater systems, including rivers, lakes, freshwater wetlands, and even lakes and lagoons that are intermittently open to the sea. While it directs regions to set the criteria for nitrogen and phosphorus attributes with consequences for nutrient sensitive receiving environments (including estuaries), the scope of attribute-setting does not extend to other parameters, such as sediments for estuaries.[15] Figure 4.3 illustrates how different management instruments treat the land–sea boundary.

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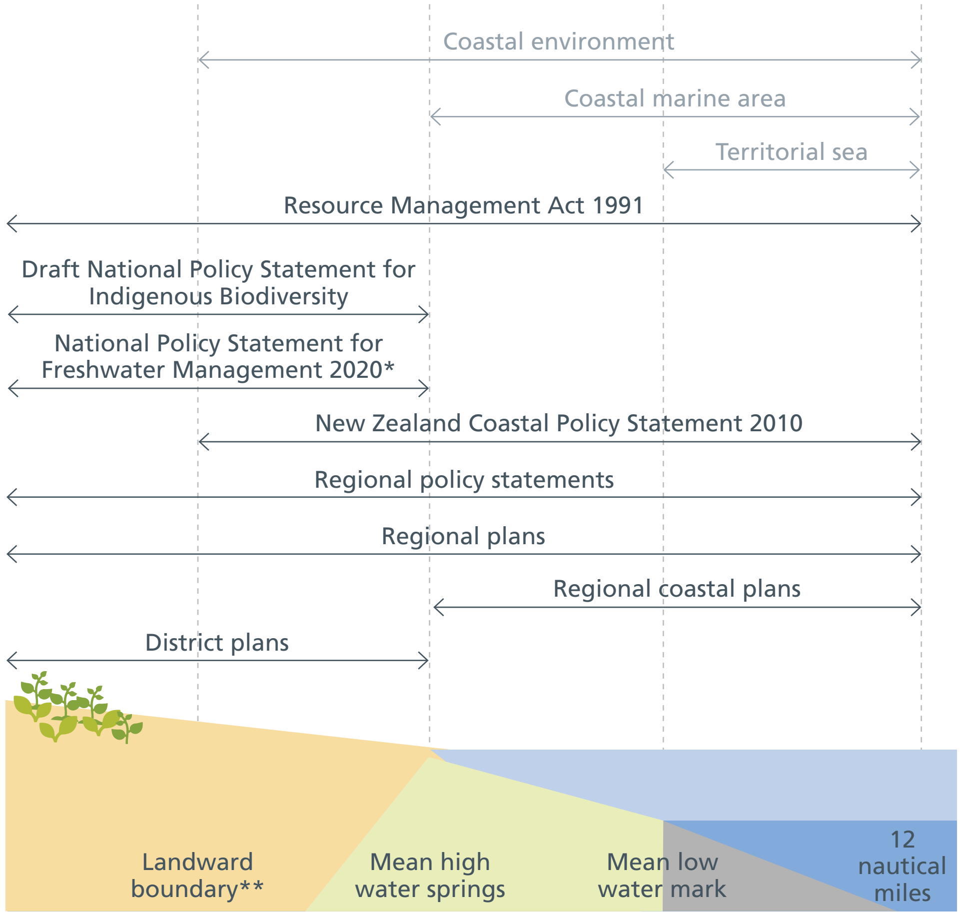
[13] New Zealand Government, 2020, 3.4(1), p.11.

[14] DOC, 2010.

[15] New Zealand Government, 2020, 3.11(8), p.17.



* The application is variable as regional councils can decide whether to manage lakes and lagoons that are intermittently open to the sea and coastal wetlands as coastal or freshwater.
** The landward boundary of the coastal environment varies according to local geography.

Source: PCE

Figure 4.3: Areas where different RMA instruments apply in the coastal space.

While developing the NPS-FM in 2012, officials from MfE and DOC discussed adding estuaries to the NPS-FM, but this did not eventuate.[16] Estuarine attributes were not added to the NPS-FM in 2014 although the need for integrated management including the coastal environment was introduced.[17]

A 2017 statutory review of the effect of the NZCPS on RMA decision making identified the inability of the NZCPS to manage the effects of land use on coastal wetlands and estuaries as an issue. However, the NPS-FM and NZCPS were not deemed to be inconsistent with one another, and there was no suggestion that the two instruments could not adequately work together.[18]

[16] Cornelisen et al., 2017.
[17] New Zealand Government, 2017, Objective C1, Policies C1 and C2.
[18] DOC, 2017a, p.42.

While the NPS-FM 2020 now includes estuaries in its definition of 'receiving environments', it still fails to include specific guidance and benchmarks for managing estuaries.[19]

Some regions have made the connection between the coastal and freshwater environments and implemented their own joined-up policies. Some attributes and action plans have been developed (such as those for Te Awarua-o-Porirua and New River Estuary), and these provide a starting point for developing values and attributes suitable for estuaries for inclusion in the NPS-FM.[20]

Yet, at a national level, the division between freshwater and downstream estuaries remains. MfE's latest freshwater programme, the at-risk catchments project, seems to be about understanding the implementation of integrated catchment management by working through the process in a small number of exemplar catchments. Its scope specifically stops at the saltwater boundary: it only includes rivers, lakes and inland wetlands. It does note, however, that estuarine health is a potential co-benefit of this project.[21]

The inability of estuarine managers to impose management on the upstream environment was identified as one of the biggest challenges facing estuarine environments.

Legal boundaries and climate change

Climate change raises its own legal intricacies. The effect of climate change on estuaries and the modification and movement of estuaries with climate change will not respect legal boundaries.

Many estuaries affected by sea level rise will naturally move further inland if the landform allows. However, this will trigger complex legal consequences depending on the ownership of the land at risk, as well as potentially impacting on public access to the new location.

Estuaries commonly straddle the line of mean high water springs (MHWS). Under the existing law, land that is:

- above MHWS will be either publicly or privately owned
- below MHWS will be either privately owned or owned by nobody, because it is part of the 'common marine and coastal area' (the Crown does not own land inside the common marine and coastal area).

For the parts of estuaries that remain located above MHWS, the law of accretion and erosion will apply. This could result in changes to the ownership of land that becomes part of the estuary itself, and to the ownership of adjoining land. The law in this area is complex. Public access to an estuary via adjoining land may or may not be lost if the land becomes covered in water. This will depend on the legal mechanism used to create the public access. For example, esplanade strips and marginal strips created from 10 April 1990 move as the waterbody involved moves.

[19] New Zealand Government, 2020, 3.5, p.13.

[20] New Zealand Government, 2017, Appendix 2: Attribute tables.

[21] See https://www.mfe.govt.nz/fresh-water/fresh-water-and-government/freshwater-work-programme/catchment-level-action [accessed 16 June 2020] and MfE (2017a).

For the parts of estuaries that become located below MHWS, the impact on access will differ depending on who used to own the affected land. If it was publicly owned, it will be added to the 'common marine and coastal area' and the public will be able to access it (subject to certain constraints). However, if it was privately owned, it will remain privately owned, and the right of public access may well be lost.

Finally, for all parts of an estuary both above and below MHWS, natural movement of the estuary margin could be impeded if private landowners are allowed to use structures such as sea walls to prevent the inundation of land.

A tangle of legislation and entities

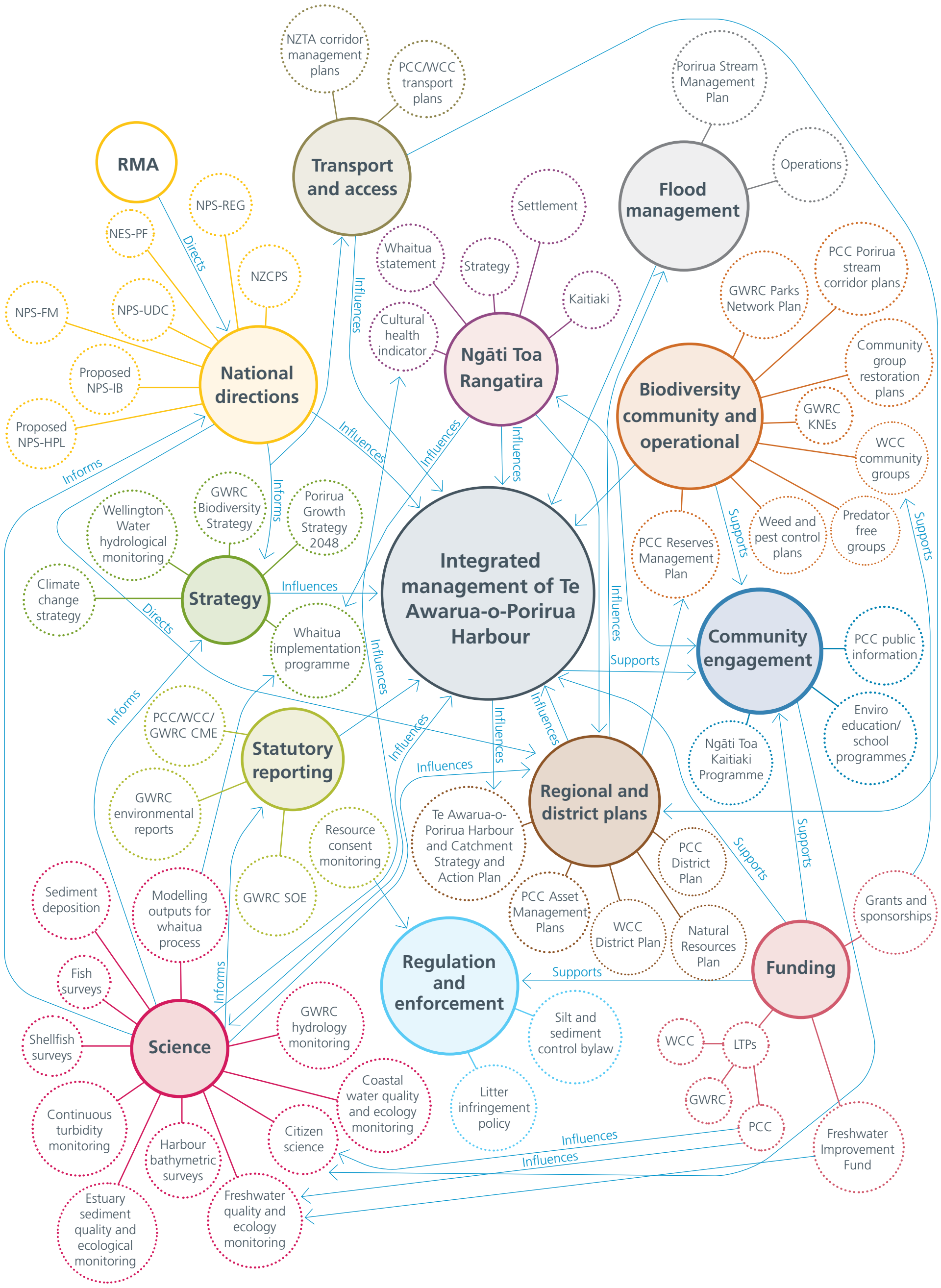
The result of the regulatory framework and organisations involved is a plethora of plans. In an understatement, a 2017 review of the NPS-FM by MfE found that "councils face practical challenges in accomplishing integrated management".[22]

The complexity of integrating plans

Even when there is an appetite to improve the state of estuaries, the legislative framework under which estuaries management falls is complex and sometimes conflicted. Take for example Te Awarua-o-Porirua Harbour and Catchment Strategy and Action Plan.[23] Figure 4.4 shows why achieving integrated catchment management poses such a challenge. To succeed, there must be alignment between the different agencies that are involved (Greater Wellington Regional Council, Porirua City Council, Wellington City Council, Ngāti Toa Rangatira, Wellington Water Limited, New Zealand Transport Agency, KiwiRail), various statutes (RMA, Local Government Act 2002, Land Transport Act 1998), and numerous organisational strategies, policies, procedures and operational plans. This is virtually impossible given the constraints on staff working within all these organisations.

[22] MfE, 2017b, p.29.

[23] PCC, 2015.



Source: based on discussions with Nigel Clarke, Senior Advisor Partnerships, Porirua Harbour and Catchments, Porirua City Council, June 2020

Figure 4.4: One estuary manager's attempt to explain the maze of documents and entities that need to be considered in respect to a single estuary. Not all pieces or links are specified, for example, national legislation such as the Conservation Act 1987 and the Soil Conservation and Rivers Control Act 1941.

Ever-changing goalposts

The figure above is mind-bogglingly complex. But as if that was not enough, it is constantly subject to change.

The NPS-FM, for example, was approved in 2011, updated and replaced in 2014, amended in 2017 and replaced again in 2020. Territorial authorities and regional councils create plans that might be obsolete by the time they are implemented. In a similar way, investment made by various industries might be insufficient when a new plan change occurs.

The long-term plans developed by territorial authorities and regional councils provide a further illustration of constant change. Such plans are subject to the tide of elections and local community concerns. The coastal section of Marlborough District Council's state of the environment reports provides a gauge of the regional concerns of the day. Bathing water quality and fisheries management were central to the 2002 report, aquaculture and ship wake in 2008, and aquaculture and land use leading to sedimentation in 2015.[24]

The stop–start procedural machinations of the various management tools we deploy seem poorly suited to the changing, dynamic environments that estuaries epitomise.

Lack of commitment

The complexity of policies and entities involved throws into sharp focus the inherent difficulty estuaries pose: since no single entity is responsible, individual agencies with their own mandates can always busy themselves with matters for which they have full responsibility, and leave reaching closure on larger, more complex issues to another day. Below are some examples illustrating some of the issues.

Planning and accountability

Work implementation by regional councils and territorial authorities is achieved through long-term plans.

The 2018–2028 long-term plans from regional, district and city councils relevant to the five case studies – usually hundreds of pages each – had few, if any, mentions of estuaries, sediments or nutrients. The single notable exception was Porirua City Council's long-term plan, which includes a key performance indicator target to reduce sediment in the harbour, and budget allocated to monitoring it.

A similar attempt to provide some level of accountability and transparency has been made by Greater Wellington Regional Council. One of the Chief Executive's key performance indicators is to maintain or improve water quality by reducing sedimentation levels in streams, including those emptying into Te Awarua-o-Porirua.[25] Having the same performance indicators at both regional and territorial level is one way of ensuring a common approach and focus.

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[24] See https://www.marlborough.govt.nz/environment/state-of-the-environment-reporting [accessed 16 June 2020].
[25] GWRC, 2019a.

Implementation

Even when plans are developed by regional councils or territorial authorities, or by other means such as through forums or whaitua processes, their implementation is not a given.

For example, it is often difficult to galvanise political processes and overcome stakeholder conflicts within a single catchment. This is obvious in the number of appeals freshwater plans have been going through around the country. At the time of writing, both Greater Wellington Regional Council and Environment Southland regional freshwater plans were going through the court system.

In 2018 Porirua City Council acknowledged that: "While 150 years of damage takes generations to restore, we won't be making a dent in our goals if the shareholding councils don't take significant action, matched with a strong financial investment – very soon."[26]

In other instances, there has been a lot of work carried out to create management plans and recommendations but with little ensuing action. The Hauraki Gulf Marine Park Act is one such example (Box 4.1).

Box 4.1: Lack of results in the Hauraki Gulf Marine Park

As discussed earlier, work by the Hauraki Gulf Forum has been going on for 20 years, and in 2016 New Zealand's first marine spatial plan, Sea Change – Tai Timu Tai Pari, was concluded.[27]

Sea Change – Tai Timu Tai Pari

Sea Change was welcomed by those involved, but its implementation requires cohesive long-term work by many parties, including representatives of the Department of Conservation, Fisheries New Zealand and Te Puni Kōkiri, elected representatives of Auckland Council, Waikato Regional Council, Thames-Coromandel, Hauraki, Waikato and Matamata-Piako district councils, and tangata whenua of Hauraki Gulf/Tīkapa Moana/Te Moananui-ā-Toi and its islands.

The Environmental Defence Society expressed concern as to "whether an integrated plan can be effectively implemented through the existing fragmented institutional structures that apply to the gulf."[28]

Despite commitment to an integrated catchment management approach by all involved, the implementation of recommendations has generally been lacking. A 2018 note by the Controller and Auditor-General stated that "there is a risk that if there is no further consideration of the recommendations in the marine spatial plan, the money and effort spent on the project will largely be wasted."[29]

[26] PCC, 2018, p.2.
[27] Sea Change Stakeholder Working Group, 2017.
[28] Peart, 2017, p.8.
[29] Controller and Auditor-General, 2018, p.5.

A review by the Environmental Defence Society in 2019 noted that "the key challenge of the Hauraki Gulf project has been shifting the project from the plan development phase to implementation".[30]

In the meantime, the Firth of Thames, a feeder estuary with a long flushing time of 32.7 days, continues to receive significant sediment and nutrient loads from rivers.[31] *The State of our Gulf 2020* report notes that "the pace of change is outstripping the ability of current management frameworks to respond effectively."[32]

Hauraki Gulf Forum

The Hauraki Gulf Forum, concerned at the lack of overall progress outlined in its *State of our Gulf 2020* report, made two major shifts to encourage greater progress. The first was to adopt a co-governance leadership model to give greater effect to partnership under Te Tiriti o Waitangi. This requires that one of the forum's two co-chairs be from and selected by its tangata whenua members. The second was to adopt an updated set of ambitious goals for Hauraki Gulf/Tīkapa Moana/Te Moananui-ā-Toi. The forum has called for:

- at least 30 per cent marine protection
- 1,000 square kilometres of shellfish-bed and reef restoration
- riparian planting of the marine park's catchment
- an end to marine dumping in or near the marine park.

Achievement of those goals will require significantly more and better integrated management than has been demonstrated in the 20 years since the marine park was established. Even if implemented, the outcomes of these initiatives will not be known for some time.

The *State of our Gulf 2020* report also concludes that after 20 years and six reports since the marine park was established, "it is time to also consider whether … there are better options for delivering integrated management and improved outcomes for the Gulf."[33]

[30] Peart, 2019, p.1572.
[31] Plew et al., 2018.
[32] Hauraki Gulf Forum, 2020b, p.163.
[33] Hauraki Gulf Forum, 2020b, p.11.

Delay in securing a mandate for action

Even when a problem appears to be obvious to at least one section of the community, securing a mandate for action can be protracted and costly. The challenge can be illustrated by two very different experiences – Auckland and Maketū.

The tale of Auckland's response to its wastewater and stormwater problems is one of delay in getting very costly capital works accepted as a necessary burden to be carried by ratepayers.

Repeated closure of beaches around Auckland starting in the summer of 2015 led to the development of real-time data collection, forecasting and a predictive, interactive web-based platform informing people of the risk of swimming at 84 beaches in the Auckland region.[34]

Many decades of underinvestment in wastewater and stormwater infrastructure in the region was finally showing up in estuaries and surrounding coastal beaches. Many of these beaches are in Waitematā and Manukau harbours, two of the largest and most urbanised estuaries in New Zealand.

The Auckland Plan 2050, adopted in 2018, budgeted about $35.7 billion for water infrastructure between 2018 and 2048.[35] These are costly course corrections requiring ongoing management that could have been averted if the case for action had been successfully made to ratepayers much earlier.

On the other hand, communities can sometimes find it hard to convince the powers that be that action needs to be taken. The Ōngātoro/Maketū Estuary provides a case in point. It goes back to just before the creation of the office of the Parliamentary Commissioner for the Environment (PCE). In those days (the early 1980s) there was a Commission for the Environment headed by Commissioner Ken Piddington.

The then Minister for the Environment, Dr Ian Shearer, asked the Commissioner to investigate long-standing tangata whenua and community complaints. The Commissioner undertook a survey of social issues.[36]

The Kaituna River had been diverted in 1957 via Te Tumu Cut to alleviate flooding and improve drainage of farmland. The result of this diversion included salinisation, declining fish and shellfish stocks, degraded water quality, reduced amenity values and impeded access for the local coastal community. Fishers moved elsewhere, visitor numbers declined and customary rights were undermined.[37]

Detailed investigations followed through the 1980s. A 3,000-signature petition calling for the return of the Kaituna River to Ōngātoro/Maketū Estuary was presented to Parliament in 1984 by Sir Peter Tapsell, eventually leading to a Cabinet directive in 1988 for DOC to redivert the river as part of a wider estuary restoration project.

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[34] See https://safeswim.org.nz/ [accessed 16 June 2020].

[35] Auckland Council, 2019, p.43.

[36] Tortell, 1984.

[37] Tortell, 1984.

DOC eventually commissioned four culverts in 1996. These only brought back a small proportion of the water diverted (four per cent), which proved insufficient to improve the ecological and cultural health of the estuary, which continued to decline.

In September 2009 – after a long period of community and stakeholder engagement – the non-statutory *Kaituna River and Ōngātoro/Maketū Estuary Strategy* was published by Environment Bay of Plenty, Western Bay of Plenty District Council, Tauranga City Council and Rotorua District Council.

This led to the establishment of the Kaituna River Re-diversion and Ōngātoro/Maketū Estuary Enhancement Project in 2012, funded by regional ratepayers without assistance from central government.[38] The rediversion was finally finished in February 2020, restoring 20 per cent of the flow from Kaituna River to the estuary and creating over 20 hectares of new saltmarsh habitat.[39]

For the local community, healing from the Kaituna Cut has been a long time coming. It took four decades to obtain action despite being initiated right from the top by the Minister for the Environment.

Whether delay is a result of the lack of community buy-in or bureaucratic inertia in the face of significant costs, it is clear that delay is costly – both financially and environmentally. We should not need to spend decades securing a mandate for action.

Lack of central government technical support

The lack of support from central government was highlighted in our case studies by both agencies and stakeholders. The Controller and Auditor-General noted in his 2019 report on managing freshwater quality that: "Council staff suggested that central government should bring regional council experts together to prepare a 'toolbox' that provides different ways of implementing community decisions about freshwater quality."[40]

The task of implementing cumulative effects management of estuaries is a case in point. Neither the NZCPS itself nor the many guidance documents[41] on how to implement it set out a clear methodology for managing cumulative effects. This lack of technical information was recognised in the 2017 operational review of the NZCPS.[42] Further guidance documents were developed since, including on sedimentation and discharge of contaminants.

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[38] Everitt and De Monchy, 2013.

[39] See https://www.boprc.govt.nz/our-projects/kaituna-river-rediversion-and-maketu-estuary-enhancement/ [accessed 11 June 2020].

[40] Controller and Auditor-General, 2019b, p.44.

[41] See https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/ [accessed 18 June 2020].

[42] DOC, 2017a, p.10.

The need for a wider knowledge base

Multiple pressures interact with one another and create feedback loops in the estuarine ecosystem, so it can be hard to know which sources of pressures need to be tackled, in which order, or even their relative significance. Managers turn to scientists to help underpin decisions. They should also leverage the significant knowledge base that mātauranga Māori represents.

Mātauranga Māori

Through a Māori lens that looks at connectivity as well as the discrete elements of the estuarine environment, the world will look different. Mātauranga Māori is a powerful tool for management because it synthesises observations about people, the environment and their interactions, without compartmentalisation.[43]

Monitoring of wild shellfish (like cockles or pipi) for human consumption highlights the problem of treating holistic issues by measuring single variables. Shellfish can become contaminated by bacteria, viruses, parasites and marine biotoxins, and chemical hazards like heavy metals, chemical control agents and environmental contaminants.[44] However, indicators and monitoring conducted by regional councils and MPI do not cover all known contaminants.[45] For example, a recent study in Tauranga Harbour found that *E. coli*, faecal coliform and enterococci cannot be used as indicators for viral contaminants like norovirus and adenovirus.[46] Testing for viral contamination is not often conducted because of the cost.

Mātauranga Māori estuarine monitoring programmes have been developed around New Zealand to monitor for Māori values and cultural health. For example, in Nelson, indicators were categorised under various atua who represent the main estuarine ecosystems (Tangaroa, Tāwhiri-mātea, Tāne-mahuta and Tūmatauenga, for example) and the overall mauri of the area.[47] A web-based estuarine cultural health index tool created for Tauranga Harbour is now available nationally to help whānau, hapū and iwi to develop their own indicators.[48]

Kāhui Wai Māori also recommended the creation of a new compulsory Māori value in the NPS-FM to provide for Māori measures of freshwater system health.[49] This recommendation has been implemented in the NPS-FM 2020. However, it devolved mātauranga Māori development to councils rather than providing for a national framework as was recommended.[50]

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[43] Jackson et al., 2017.

[44] Contamination may not necessarily be an actual public health risk. Bioaccumulation and contaminant release varies across different species (Scholes et al., 2009). Cooking and storing time can also affect susceptibility of risk (New Zealand Food Safety Authority, 2010).

[45] MPI monitors marine biotoxins only (see https://www.mpi.govt.nz/food-safety/food-monitoring-and-surveillance/monitoring-programmes-under-the-animal-products-act/seafood-monitoring-programmes/ [accessed 16 June 2020]). Regional councils monitor faecal coliform and enterococci contamination of water, but only sporadically test for viruses, trace metal and emerging organic contaminants (see Oliver and Conwell, 2019). Furthermore, flesh testing is not a part of any regular estuarine monitoring programme in any of the five case study estuaries.

[46] Scholes et al., 2009.

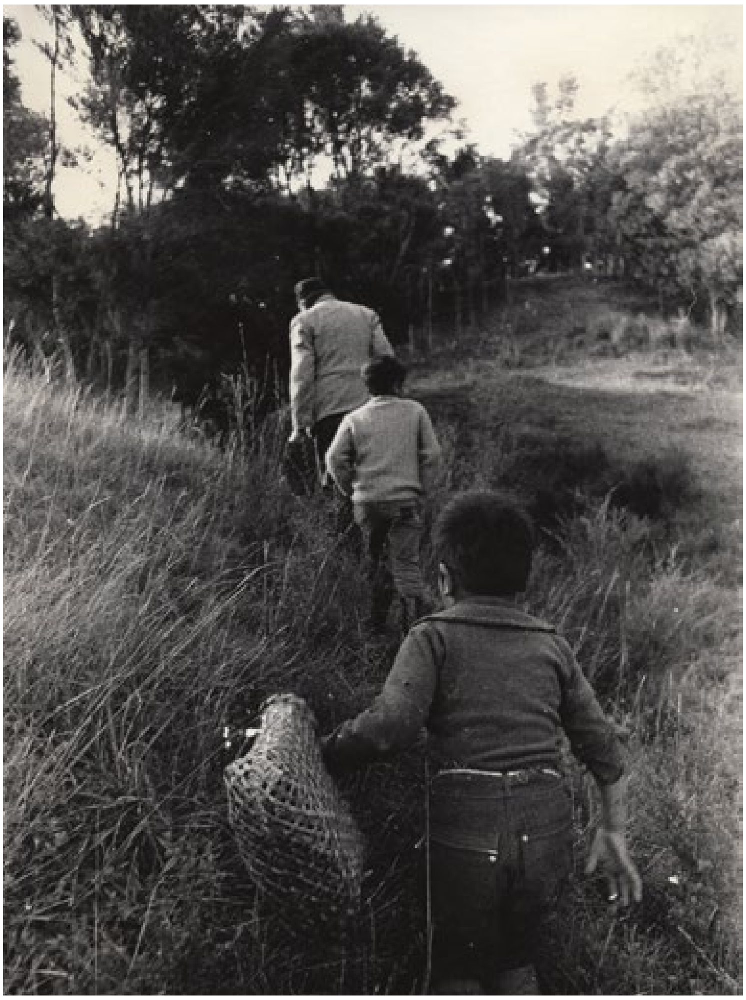
[47] Walker, 2009.

[48] See www.maatai.co.nz [accessed 16 June 2020] and Appendix 3: Tauranga Harbour.

[49] Kāhui Wai Māori, 2019.

[50] New Zealand Government, 2020, 2.2 Policy 2, p.9.

Cultural monitoring has proved to be, in some situations, the most effective tool to examine environmental impacts. For example, customary harvesting was the only useful method to detect the spatial extent of lamprey reddening syndrome in kanakana adults swimming upstream to Southland rivers.[51]



Source: Helen Buttfield, School Journal, 1968; Archives New Zealand, Flickr

Figure 4.5: Māori follow maramataka, the lunar calendar, when harvesting different kai throughout the year, which ensures sustainable harvests.

[51] Kitson, 2012.

Indicators and limits

The way in which the state of estuaries is determined in New Zealand is still very uneven. A national review of estuarine monitoring noted that *what* is monitored, *when* it is monitored and *how* it is monitored are all subject to significant variability.[52]

If a monitoring programme is not properly designed, it will be unlikely to achieve its aims, whether they are to ensure compliance or to chart hoped-for improvements in the health of the relevant estuary. Monitoring has too often been driven by what is easy to collect rather than what might be required, in the estuary and also the catchment.[53] Further, if developed without hapū, iwi and community involvement, the parameters and sites included in a monitoring programme may fall short of capturing the state of components of the ecosystem valued by the community.

An estuarine monitoring site for a national monitoring programme, for example, requires a central position to get a picture of average conditions for the estuary. While useful for national-level comparisons, it might say little about local issues. Conversely, a site established to monitor a local consented discharge might be critical for detecting changes in locally important pressures but would not give a representative picture of the state of the estuary. However, both programmes can feed into the goals of the other if they are designed to do so.

Recognising the need for a more holistic and nationally consistent set of indictors, methods and data sharing for estuaries, the Managing Upstream: Estuaries State and Values project was launched by MfE in 2017. To start with, an inventory of monitoring information was carried out. Data that mostly resided with territorial authorities and regional councils were centralised. Then a list of potential health indicators was derived from the values communities place on their estuaries.[54]

The indicators link the values of ecosystem health, human health for recreation, and mahinga kai, and in doing so inform decisions on management.[55] However, the project was put on hold before these were fully developed. In the absence of indicators and corresponding limits, councils opting to include estuaries in their NPS-FM plans are faced with a long and difficult process to establish indicators and limits independently (Box 4.2). While innovative solutions will no doubt arise throughout the country, it will make any collation of national datasets difficult in the future.

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[52] PCE, 2019b.

[53] PCE, 2019b.

[54] Cornelisen et al., 2017; Zaiko et al., 2018; Berthelsen et al., 2018.

[55] Zaiko et al., 2018.

Box 4.2: Limit setting for Southland's estuaries

Recognising ki uta ki tai and the connection between freshwater and its estuaries, Environment Southland decided to build on the limit-setting process of the NPS-FM and develop freshwater objectives and associated attributes, targets and limits for its estuaries as part of the People Water and Land Programme.[56] However, the next step – determining the quantity of contaminants currently in estuaries, and what level of reductions would be required to achieve the desired outcome – is a much more challenging task.

A key step in generating scientific knowledge to inform the objective- and limit-setting process was to compare different estuaries and their pressures. To enable that to happen, Environment Southland first needed to understand the ecological state of each estuary and the pressures reaching them. Information was also needed on how those pressures had changed over time for each estuary, and how the ecological state of the estuary had changed in response.[57]

A number of different approaches were taken following multi-stakeholder workshops held in 2014. One was to propose an ecological condition gradient. The concept was simple: if Environment Southland was to map the ecological condition of the region's estuaries over time on one axis and contaminant concentrations on the other, there might be a relationship between the two variables that could be used to develop a management framework.

This also required the identification of suitable indicators to express the ecological condition gradient that could potentially be used as attributes[58] to set freshwater objectives following the NPS-FM-prescribed process. Despite having only coarse estimates of the quantities of nitrogen, phosphorus and sediment reaching estuaries, the preliminary results indicated a link between nitrogen pressure and eutrophic conditions in these estuaries.[59]

As part of its NPS-FM limit-setting process, Environment Southland is now developing more accurate estimates of the quantities of nitrogen reaching estuaries and predicting the size of the reduction required to achieve different points along the condition gradient. These results will then be presented to the community and used to inform discussions on the level of ambition for estuarine condition.

Attributes and limits are not yet set for Southland's estuaries. The concept also relies on a single cause-and-effect process when much more complex processes might be at play (see chapter two).

[56] See Appendix 1: New River Estuary; Nicol and Robertson, 2018.

[57] To achieve this, Environment Southland leveraged approximately two decades of monitoring data collected from representative estuaries across the region.

[58] As defined by the NPS-FM 2017 (New Zealand Government, 2017).

[59] Robertson et al., 2017b.

Since many of the pressures on estuaries arrive via rivers and streams, monitoring rivers for estuarine pressures could enhance our understanding of the burden on estuaries and facilitate comparisons between estuaries, providing a more coherent picture of ecosystem health.[60] However, monitoring of rivers has largely evolved to support freshwater management and may not be appropriate to capture the pressures most relevant to estuaries, such as sediment accumulation. Work is currently being undertaken to link river indicators and estuarine health.[61]

Source: rjcox, Flickr

Figure 4.6: Whitebaiting on the West Coast. Understanding pressures on rivers and streams could provide a better picture of overall ecosystem health.

Tools to understand pressures

Simply increasing the amount of estuarine monitoring undertaken – even with appropriate indicators – is not enough. It must also lead to the management of the sources of the pressures. Translating an issue in the estuary to a management response can be challenging for a number of reasons – but particularly so where a pressure can result from a wide range of sources and activities.

Recognising the problem, a Southland farmer, an automation engineer and an environmental scientist have built a continuous water monitoring system. If successful, it could be installed at farm or sub-catchment scales to shed light on the effectiveness of management regimes on diffuse discharges.[62]

[60] Clapcott et al., 2018.
[61] Berthelsen et al., 2020a.
[62] See www.derrick.org.nz [accessed 16 June 2020].

Many such initiatives are taking place around Aotearoa New Zealand, often with limited funding and little strategic oversight. But the pervasiveness of many of these pressures is nationwide. A lack of central government guidance and ad hoc approaches have resulted in the use of tools that are not fit for purpose or not designed to characterise the environmental effects of land use.

Developing and enforcing limits on the activities responsible for pressures inevitably places existing practices in question. Tools to help communicate problems and evaluate trade-offs between management options are critical to decision making and ultimately to improvements in ecosystem health.

Models can help support decision making, particularly when diverging views are at play in complex situations, as is often the case with estuaries. They can also help capture the uncertainty of our knowledge of the system and its variability that managers face. As a proof of concept, the PCE commissioned the development of a generic estuarine model. This exercise was used to illustrate how pressures might combine in an estuarine system, and how such models might be used to inform collaborative management processes.

Although at the early stages of development, this model has some potential to support collaborative processes.[63] As the model stands, the pressures included are suspended sediment, mud content, nitrogen, heavy metals and climate change. Marine pressures such as fishing were excluded due to a lack of knowledge to inform the model but could be added later. The state of the estuary is currently defined in terms of water clarity, shellfish stocks, biodiversity and juvenile fish, as well as other biological characteristics. The uncertainty surrounding the variability and our understanding of each step of the model was captured, providing an output that takes into consideration the overall uncertainty of the predictions. This tool is available and could be easily adapted to add place-based values such as mahinga kai. It could also be developed further to include other pressures or processes of importance.

Even with catchment-scale models that can identify elements of the social, cultural or physical landscape that need to be the focus of management actions, ensuring onsite changes are achieving their desired outcomes can be difficult to discern due to background variation, long lag times or any number of other changes in the catchment.

[63] Bulmer et al., 2019; the report, tool and its review are available on our website https://www.pce.parliament.nz/publications/managing-our-estuaries.

Weak control and enforcement

The control of activities at the source of pressures often relies on the existence of conditions in resource consents. Conditions designed to manage effects of a consented activity in isolation are not always sufficiently well-defined to allow enforcement action or an understanding of the effects on estuaries. Even when they are, enforcement and prosecution is often either avoided or is unsuccessful for a raft of reasons, including cost, political meddling and uncertainty about the outcome.[64]

Following the enactment of the Resource Management Amendment Act 2020, the Environmental Protection Authority has powers to assist a council, or step in where a council is not taking action at all or there is evidence it is acting but not doing a good job. This is, however, limited to isolated 'incidents' and does not enable intervention to address a general failure to manage effects on estuaries or any other part of the environment.

Truly effective compliance, monitoring and enforcement requires interventions such as adequate resourcing of councils with guidance and skills, with a view to proactive monitoring of consent conditions (rather than just in response to complaints), as well as monitoring permitted activities (those not requiring consents).[65]

A summary of compliance, monitoring and enforcement in the five case study estuaries highlights the variability around the country (Table 4.1). For example, Southland had the second lowest number of resource consents but the highest number of convictions. By contrast, Wellington region had the highest number of resource consents but not one conviction; it also has the lowest number of compliance officers per capita.

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[64] MfE, 2016; Controller and Auditor-General, 2019a.
[65] Brown, 2018.

Table 4.1: Summary of an independent analysis of 2017/18 compliance, monitoring and enforcement in the five case study regions.[66]

	Waikato	Bay of Plenty	Wellington	Marlborough	Southland
Number of TAs	**11**	**6**	**8**	**1**	**3**
CME FTEs	**46.5**	**31**	**15.5**	**9.4**	**13.1**
Per 1,000	0.10	0.10	0.03	0.20	0.13
Complaints	**1,543**	**2,834**	**1,308**	**557**	**742**
Responded	100%	100%	83%	100%	90%
Attended	20%	DNA	42%	48%	51%
Breaches	24%	DNA	17%	34%	17%
Compliance					
Number of RCs	4,500	5,500	63,751	20,802	5,376
% with monitoring	33%	35%	2%	13%	59%
% compliant	77%	69%	94%	83%	100%
Formal action	387	137	93	62	137
Convictions	22	8	0	2	66
Permitted activity monitoring programmes	**Dairy, forestry**	**Forestry**	**No programmes**	**Dairy, forestry, wineries**	**Agriculture excluding dairy**

Note: CME = compliance, management and enforcement; DNA = did not answer; FTE = full time equivalent (staff); RC = resource consent; TA = territorial authority.

The difficulty of managing cumulative effects

A 2017 review by DOC of the effect of the NZCPS on RMA decision-making noted that "Managing cumulative effects can be particularly challenging (and expensive) at the resource consent stage in the absence of a robust, wider strategic planning framework." "Challenges remain and not all councils are prioritising strategic planning (due to a lack of technical information, high costs, silo approaches, etc.)."[67]

[66] Brown, 2018.

[67] DOC, 2017a, p.31 and p.5, respectively.

Consent-based management

Imposing conditions that focus only on the specific activity in question can result in 'death by a thousand cuts' to the environment. Beyond single resource consents and best practice, activities need to be understood and managed with a view to cumulative effects: will the marginal effects cause an unacceptable increase in the cumulative adverse effects already caused by all the other permitted or consented activities in the area?[68] And beyond managing new consents, should what is already permitted to occur with or without a consent be revised in the context of cumulative effects management?

Cases of resource consents rejected on the basis of cumulative effects exist. For example, the Environment Court's decision on an appeal against Auckland Council's decision not to extend the Rural Urban Boundary into the Okura Catchment explained:

> "We have expressed a degree of uncertainty as to the cumulative effects of sediment, heavy metal and other undefined stressors might impact on the complex ecological setting of the Estuary. We have taken note of the significance of the Estuary due to its Marine Reserve status and its recognition in the SEA [significant ecological area] provisions of the Unitary Plan. We have recognised the need to adopt a precautionary approach in our assessment of these effects."[69]

To conclude: Is integrated management possible?

This chapter has canvassed many of the hurdles that confront estuary managers – and some of the attempts that have been made to clear them away. Awareness of their number and complexity makes it very tempting to call for an approach that puts the estuary as a living entity right at the centre of everyone's attention. Why can we not integrate all our efforts?

An evaluation of whether the RMA has delivered desired environmental outcomes for New Zealand noted that airshed management had achieved the management of cumulative effects. Interestingly, it concluded that where human wellbeing is at risk, attention is timelier than for ecological concerns alone.[70] This is true of many environmental challenges. Harm to oneself often seems to have stronger motivational power than harm to the general environment.

Some of the stresses on estuaries do carry specific risks for health and wellbeing, such as food poisoning or becoming sick through recreational exposure to polluted water. However, such health risks can be avoided by people not consuming kaimoana or using the estuary for recreation. While there is a huge loss of amenity, there is less involuntary exposure to risk. Those who live in an airshed cannot avoid breathing polluted air, so the case for airshed-wide action can become very intense.

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[68] For example, Milne, 2008.

[69] *Okura Holdings Limited and Others v Auckland Council* [2018] NZEnvC 87, 2018, p.234.

[70] Brown et al., 2016.

The NPS-FM is attempting integrated management, ki uta ki tai, across entire catchments. Another integrating tool, the NZCPS, makes the same sort of attempt, but has no mandate to manage many of the activities in a catchment that affect the health of the estuary. And as we have seen, powers and responsibilities are split between many entities spread over local and central government.

It is easier to talk about integrated management than to do it. This situation is by no means unique to New Zealand. South Africa's National Environmental Management: Integrated Coastal Management Act 2008 is hailed as a leader in estuarine management. However, a review of its effectiveness found key challenges to implementation included:

> "[a] lack of political support, inadequate institutional capacity, lack of human and financial resources, uncertainty regarding ICM [integrated catchment management] functions across different spheres of government, conflicting policy frameworks, lack of clarity regarding the application of ICM provisions on private and communal land, limited civil-society involvement in decision-making, and persistence of state-centric approaches."[71]

There is a familiarity about this list when applied to the New Zealand context. Many attempts have been made locally to overcome these hurdles. Many reviews have been written on the subject, and the latest round of resource management reform will no doubt add to them. It would be very easy to simply repeat many of the recommendations that have already been made. Instead, I have concentrated on trying to identify a very short list of initiatives that might make a difference.

[71] Sowman and Malan, 2018, p.121.

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A shortlist of initiatives that could make a difference

Stating that estuaries are very special and complex environments may be true, but it is scarcely helpful. Similarly, drawing attention to the potential for conflict between multiple stakeholders, statutes, policies and plans is to state the obvious.

I have been struck by the widespread level of broad agreement that exists regarding the issues and the need to do something about them. This is a conversation that has been had many times over. Repeating the usual list of recommendations would be of limited use. For that reason, I have decided to nominate two potential points of leverage that should be prioritised:

- the mandatory inclusion of estuaries as part of freshwater management units within the National Policy Statement for Freshwater Management
- robust monitoring that supports decision making.

I also investigated the idea of nominating estuarine champions.

Clearly, whatever action is taken will also need to address the multiple pressures that climate change will continue to exert on estuaries. For example, climate change will force the migration of estuaries, and managers will have either to harden estuarine margins or allow them to move.

Treatment of estuaries within the framework of the National Policy Statement for Freshwater Management

As noted earlier in this report, estuaries are covered by a range of different national and local policies. The activities imposing pressures on estuaries are covered by even more national and local policies. There is no national policy statement or environmental standard dedicated to estuaries and their inputs, and estuaries tend to be glossed over in the planning instruments that apply to them.

The National Policy Statement for Freshwater Management

Clear requirements are needed to ensure decisive action is taken to manage estuaries. These could be added to the New Zealand Coastal Policy Statement, but I consider that it would be preferable to locate them in the National Policy Statement for Freshwater Management 2020 (NPS-FM 2020). This is because the latter already includes a comprehensive framework including values and attributes – which will also be required to manage estuaries effectively. While estuaries are complex places, implementing estuary management within the NPS-FM 2020 would be relatively straightforward and make sense, given that they require a similar management approach to freshwater.

While the NPS-FM 2020 represents some improvement over its predecessor, it does not represent a decisive step forward for estuaries. Estuaries are now expressly included as part of the 'receiving environment'.[1] But they are only required to be dealt with under the policies on integrated management, which require a relatively high-level response.[2] Regional councils have discretion as to whether or not they are treated as part of a freshwater management unit (FMU).

Firstly, to ensure that estuaries are consistently managed properly, the NPS-FM 2020 would need to require the inclusion of all estuaries in one or more FMUs so that the National Objectives Framework (which includes setting attributes, monitoring, etc)[3] applies to them. Under Policy 3.8 of the NPS-FM 2020, there is a requirement that every waterbody in the region must be located within at least one FMU. But the definition of a 'waterbody' excludes estuaries. Policy 3.8 should be explicitly extended to cover estuaries.

Secondly, the definition of an FMU in clause 1.4 of the NPS-FM 2020 should be amended to make it clear that the term 'related catchment' includes estuaries.

These two changes to the NPS-FM 2020 would entrain a far more robust process for the management of estuaries.

[1] New Zealand Government, 2020, 2.2 Policy 3, p.9.

[2] New Zealand Government, 2020, 1.4(1), p.7.

[3] New Zealand Government, 2020, 3.7, p.14.

Recommendation 1: Mandatory inclusion of estuaries as part of freshwater management units (additions underscored)

• Subpart 2 National Objectives Framework 3.8(2) – p.15:

Every water body and every estuary in the region must be located within at least one FMU.

• Clause 1.4 Interpretation (1) – p.6:

FMU, or freshwater management unit, means all or any part of a water body or water bodies, and their related catchments (including any estuary), that a regional council determines under clause 3.8 is an appropriate unit for freshwater management and accounting purposes

These are not radical changes to the NPS-FM 2020 because a river without an estuary is already managed all the way to the sea. An estuary is simply a river with a slower flow at its mouth that allows for mixing with saltwater from the marine environment.

Although the marine and freshwater environments overlap, the NPS-FM 2020 uses the term 'mahinga kai' to refer only to freshwater species. Values are given in FMUs that are used to provide mahinga kai. Estuaries are traditional food baskets and the inclusion of estuaries as FMUs would require the extension of mahinga kai to include marine species such as tuatua, pipi or cockles.

Recommendation 2: Addition of marine species to mahinga kai in the NPS-FM 2020 (addition underscored)

- Appendix 1A 4 Mahinga kai – p.37:

Mahinga kai generally refers to freshwater and marine species that have traditionally been used as food, tools or other resources.

Developing values and attributes for estuaries

National values and attributes for estuaries should be developed as a matter of priority and then promptly included in the NPS-FM 2020. This is not a new recommendation by any means. My predecessor called for it in 2015.[4]

If estuaries are included in FMUs, the national objectives framework process would apply to estuaries.[5] This would require the development of values, environmental outcomes, attributes and target attribute states that cover estuaries. It would also require monitoring and intervention if deterioration is detected.

Estuarine carrying capacities, indicators, values and attributes are likely to differ from those applied to rivers. The scale at which those attributes apply needs to be considered as well: having a single attribute for an entire estuary or a sub-catchment is clearly inadequate, as shown in the case studies.[6]

These values and attributes must also be defined for all the main types of estuaries, not just one, in order to be widely applicable. This work had commenced under the Ministry for the Environment's Managing Upstream: Estuaries State and Values project and should be continued in some form.

The attributes developed will provide a useful starting point to design the more bespoke measures that will be required for many estuaries. An advantage of including estuaries in the definition of FMUs – and subsequently in the national objectives framework process – is that the process requires community engagement, including with tangata whenua, and councils have the capacity to further refine attributes over time through consultation. Tools to help regions develop such attributes were among the many outputs of the Managing Upstream: Estuaries State and Values project that were not funded to completion.

Recommendation 3: Addition of attributes for estuaries to the NPS-FM 2020

Meaningful attributes for estuaries need to be developed and added to Appendix 2A (attributes requiring limits on resource use) of the NPS-FM 2020.

The mandatory inclusion of estuaries as part of FMUs within the NPS-FM 2020 need not be delayed until national attributes have been developed. In the interim, the other changes as detailed above can and should be made to prevent further degradation. Attributes for freshwater have been added to the NPS-FM over time, and this process could be replicated for estuaries. In the meantime, regional councils would need to develop their own attributes for estuaries.

[4] PCE, 2015.

[5] New Zealand Government, 2020, 3.7, p.14.

[6] See Appendix 4: Te Awarua-o-Porirua Harbour and Appendix 5: Whāingaroa Harbour – both estuaries have two arms with very different health status.

Robust monitoring that supports decision making

Monitoring is a critical part of the cumulative effects management framework needed to achieve improved estuarine health. There must be identification and continued understanding of pressures, their sources and estuarine health itself. Integration of these monitoring programmes within estuarine management is critical. This is echoed in one of the recommendations from *Our marine environment 2019:* "Understand sources of pollutants and how they move in land, freshwater, and marine environments by developing more consistent monitoring methods."[7]

I have already conducted an in-depth analysis of monitoring requirements as part of my review of the national environmental reporting system. I specifically recommended that "a standardised and consistent approach to collecting, managing and analysing data should be developed, made publicly available and made mandatory."[8] Clearly this recommendation applies here.

Standardised – In the section above I have discussed the need to include estuaries in the definition of FMUs and to develop values and attributes for estuaries. These steps will ensure standardised and consistent monitoring of the state of estuaries. This also applies to the many pressures that affect them and the impacts that are currently under-represented in reporting indicators.[9]

Consistent – Headway has been made in developing a national database for estuarine health monitoring.[10] This work should continue, reinforcing the need to restart the Managing Upstream: Estuaries State and Values project, or a similar programme. Furthermore, a similar project designed to collate and disseminate the information collected on pressures and their sources would be beneficial to locals on the ground, as well as territorial authorities, regional councils and New Zealand as a country. These should be integrated with freshwater information.

Available – Just as for other environmental settings, estuarine monitoring and management programmes need to be made publicly available and reported in a clear and transparent manner. Transparency allows for easy auditing and comparison of the performance of estuary management across the country.

Regular – I envisage that reporting would be regular and consistent, so that updates can also provide a useful 'alert' system. All indicators (and any trends) need to be reported against meaningful benchmarks in a timely fashion. This should act as a trigger and lead to actions being taken to ensure that any relevant attributes are not exceeded. Examples of report cards include that developed for Te Awarua-o-Porirua Harbour,[11] or those developed in Queensland for estuarine health.[12] Reporting estuarine health, river health and the state of pressures concurrently would support integrated catchment management.

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[7] MfE and Stats NZ, 2019b, p.60.

[8] PCE, 2019b, p.86.

[9] PCE, 2019b, p.49.

[10] Berthelsen et al., 2020b.

[11] Baker et al., 2018.

[12] See https://healthyriverstoreef.org.au/report-card-results/ [accessed 16 June 2020].

Mandatory – Voluntary monitoring initiatives have led to patchy and inconsistent information, thwarting attempts to build a coherent and comprehensive understanding. Estuarine monitoring using meaningful and standardised indicators and methods needs to be mandatory. The Managing Upstream: Estuaries State and Values project should provide a vehicle for developing the indicators and setting the standards. The NPS-FM requires long-term, fit-for-purpose, adaptive monitoring of FMUs.[13] The inclusion of estuaries as part of FMUs will provide regulatory certainty and drive the collection of consistent and standardised data.

Consistent and authoritative time series coupled with improved spatial coverage are essential if we are to detect trends. Only then will we be able to judge confidently whether we are making progress – and get a handle on whether costly interventions are having an effect.

It is important to apply those same principles to the pressures that estuaries face. Merely monitoring the health of estuaries is only the first step to their management. Monitoring pressures and understanding where they come from and how they combine to produce the effects observed is paramount to the effective management of estuaries. It is this sort of information that enables communities to have an informed discussion about trade-offs between different management regimes and on uncertainty.

Mātauranga Māori – There is also a need to keep on supporting the development of mātauranga Māori monitoring of estuaries and their catchments across the country. The NPS-FM 2020 requires regional councils to involve tangata whenua in developing and implementing mātauranga Māori monitoring to the extent they wish to be involved.[14] The mandatory inclusion of estuaries in FMUs would extend this monitoring requirement from streams, rivers and lakes to include all estuaries. This monitoring is likely to go beyond a purely ecosystem health perspective.

Independently assessed – Finally, all levels of government responsible for making and implementing policies in the estuarine environment need to be prepared to have the effectiveness of their policies independently assessed. This can be politically sensitive, but the fact that it is not currently required for national state of the environment reporting does not mean it should not be undertaken. Taxpayers and ratepayers should expect those who spend their money administering environmental programmes to evaluate whether they are achieving their objectives.

Recommendation 4: Robust monitoring that supports decision making

Monitoring needs to be standardised, consistent, available, regular, mandatory, include mātauranga Māori and be independently assessed.

This applies to the monitoring of FMUs within the NPS-FM 2020, and to pressures that cumulatively impact on estuaries. This monitoring should be integrated to support decision making.

[13] New Zealand Government, 2020, 3.18(3), p.21 and 3.19(4), p.22.

[14] New Zealand Government, 2020, 3.4(1)(d), p.13.

Estuarine champions

One possible way to break impasses or overcome inertia in particular situations might be to appoint independent estuarine champions. Those estuaries under the greatest cumulative pressures could benefit from someone who can be the voice of the estuary and persist until progress is made.

Estuarine champions would be charged with ensuring that the many responsible agencies do what they say they will do, and that any plans to improve the health of an estuary are credible and resourced. And where they are not, put a spotlight on that. Estuarine champions would have no decision-making power but would be an independent auditor for a specific estuary that they would know intimately.

An advocate of the type I have described could do little without expert support that can provide strong backing in dealing with what are often powerful vested interests. This implies the need for an estuarine champion to be able to call on national-level specialist knowledge. This sort of expertise could be assembled within the Ministry for the Environment.

However, consultation on this idea raised seemingly intractable problems about who would appoint such people, how their independence could be secured, whether a single person could carry out such a role and, even if they were to do so, how they could respond to the need for so many estuarine issues to be framed bi-culturally.

Alongside these challenges, the resourcing of champions would probably be relatively easy, notwithstanding the fact that public funding for environmental defenders has been largely eliminated.

In the end, I was unable to find a practical way to frame a useful recommendation. I am happy to share the results of my enquiries with anyone wishing to carry such an idea further.

In conclusion

These two points of leverage require immediate attention: the mandatory inclusion of estuaries as part of FMUs under the NPS-FM 2020, and robust monitoring that supports decision making. If tackled in a sustained, unswerving way, they would, I believe, make a difference.

It would be nice if we could leave it there. But the looming pressures of climate change and ocean acidification are likely to completely re-deal the cards. Unless adaptation to these pressures is a core element of integrated catchment management, the initiatives proposed may be of little effect. The following and final chapter turns to this challenge.

6

Codium fragile ssp. novae-zelandiae

Looking forward

Some effects of climate change

Estuaries are particularly vulnerable to many of the effects of climate change and ocean acidification,[1] a vulnerability compounded by all the other pressures they are cumulatively subjected to, and the way we interact with them.

To discuss the consequences for estuaries of climate change and ocean acidification completely could easily fill an entire report. The more modest aim of this chapter is to highlight the breadth of pressures from climate change and ocean acidification that estuaries are facing, and point to some of the additional challenges that estuarine managers will need to confront in the coming decades.

Rising temperatures

The earth's atmosphere at the surface has heated up by about one degree Celsius on average since the industrial revolution.[2] In Aotearoa New Zealand, the annual average land surface temperature has similarly increased by around one degree Celsius since reliable records began in 1909.[3] Oceans are also warming. Since 1970 they have taken up more than 90 per cent of the excess heat in the climate system.[4]

Trends in sea surface temperature in New Zealand's waters over the past few decades vary regionally (Figure 6.1), though temperatures in the coastal environment have increased throughout the country.[5] The intertidal habitat of many estuarine species can expose them to increasing sea temperatures, with the additional stress of exposure to higher air temperatures and desiccation during low tides.

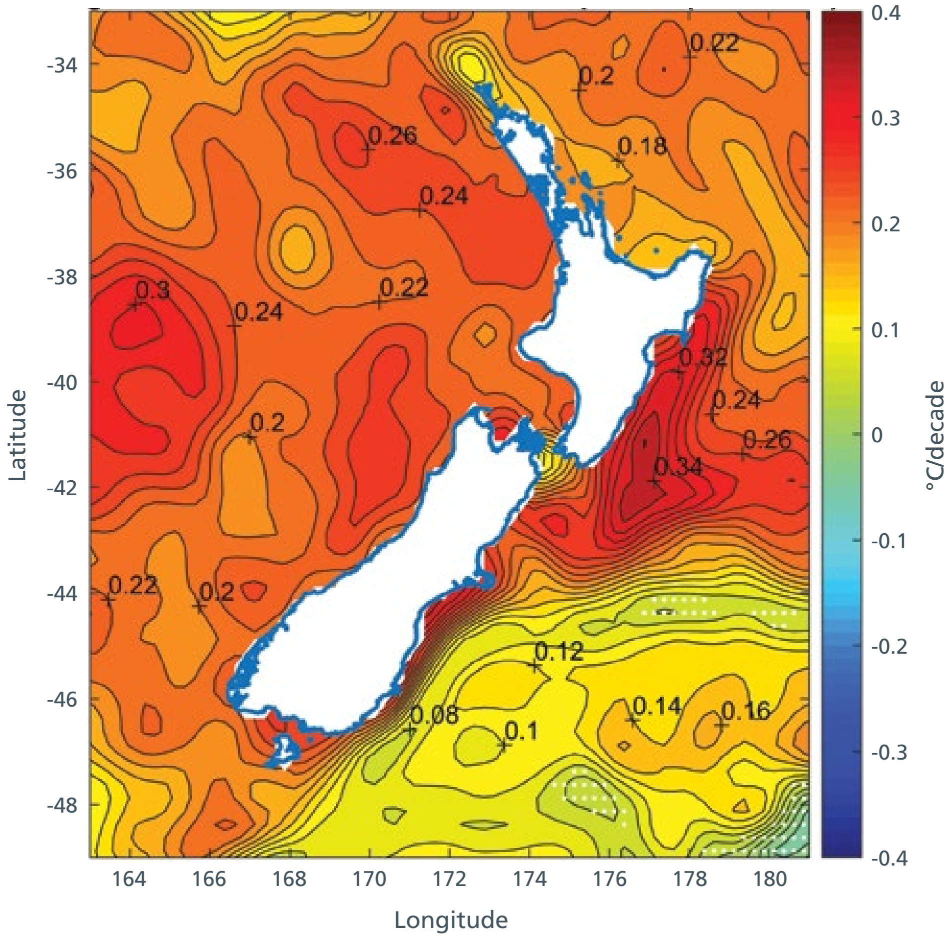
[1] Robertson et al., 2016b.

[2] IPCC, 2013, p.6.

[3] MfE and Stats NZ, 2017.

[4] IPCC, 2019c, p.9.

[5] Sutton and Bowen, 2019.



Source: Sutton and Bowen, 2019

Figure 6.1: Trend in sea surface temperatures around New Zealand 1981 to 2018. Contour intervals are 0.02 °C/decade.

One factor important to understanding the impact of rising temperatures is the natural temperature range of a species and whether projected changes will push a species outside of that natural range. For example, Lyttelton Harbour is near to, but not quite, the northern extent of the range for the coastal intertidal bull kelp species *Durvillaea poha*. A marine heatwave in the summer of 2017/18 saw sea surface temperatures in Lyttelton Harbour reach 23 degrees Celsius.

High water temperatures in the harbour, in combination with low wave heights and air temperatures over 30 degrees Celsius during the low tide, led to the complete loss of *D. poha* from the harbour, but less dramatic losses from coastal sites north or south of the harbour. Following this die-back event, the site was colonised by the invasive kelp *Undaria*, which is likely limiting the re-establishment of *D. poha*.[6]

[6] Thomsen et al., 2019.

Rising water temperatures are also altering the properties of water in a wide range of environmental settings. Two properties crucial to estuarine life are the water's ability to hold oxygen and its ability to mix.

Water contains dissolved oxygen, which fish 'breathe' through their gills and on which most underwater life forms depend. The concentration of dissolved oxygen in water depends on temperature and salinity: as the seas and estuaries warm, evaporation increases, which concentrates and increases the salinity. In combination, these factors lower the amount of oxygen that the water can hold, directly threatening the survival of living things.[7] Although not an issue yet in New Zealand,[8] small increases in already warm water in the tropics have resulted in oxygen concentrations that are dangerously low for most marine life.[9]

Furthermore, where the physical and chemical properties of water are different, water can form layers that do not mix, a phenomenon known as stratification. In Southland's Fiords, for example, where the water is deep and sheltered, stratification causes the less dense freshwater to form a layer that effectively 'floats' above the denser seawater.[10]

Similarly, when marine heatwaves occur, surface waters warm faster than deep water, intensifying stratification and reducing the mixing of nutrients, oxygen or plankton in the water column. Understanding the impact of these changing physical and chemical conditions on estuarine ecosystems is particularly challenging because they are naturally variable ecosystems and these changes will interact with other existing pressures.[11]

Rain, drought and wind

As air temperatures rise, the capacity of the air to hold moisture also increases. This effect, coupled with projected changes to the vertical movement of air within storm cells, is likely to increase the intensity of extreme rainfall events, which can affect the entire country.[12] High-intensity rainfall events and associated catchment and shoreline soil erosion are responsible for much of the sedimentation pressure on estuaries.[13] The increased intensity of rainfall events due to climate change will also place additional pressures on the capacity of stormwater and wastewater systems. In shallower estuaries, large freshwater inflows from such rainfall events can also lower water temperatures and reduce salinity.[14]

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7 Losses of between 0.5% and 3.3% oxygen in the ocean surface to 1,000 m between 1970 and 2010 have been recorded, mostly in tropical zones (IPCC, 2019b).

8 Anoxic sediments have been reported in New Zealand estuaries, but these are not static – they vary between seasons.

9 IPCC, 2019b, s 5.3.1.

10 Stanton and Pickard, 1981.

11 MacDiarmid et al., 2012; Moe et al., 2013.

12 Pfahl et al., 2017.

13 Green, 2006.

14 Tait and Pearce, 2019.

The frequency and intensity of droughts is forecast to increase in New Zealand, particularly on the east coasts of both the North and South Islands.[15] In the North Island, river flows are projected to decline late in the century,[16] which may increase the salinity of estuaries and reduce the input of nutrients, organic matter and other micro-organisms.[17] The impacts will be exacerbated if there is an increasing demand for water abstraction upstream.

Maximum windspeeds are also projected to strengthen, particularly so in the southern half of the North Island and all of the South Island.[18] High winds can resuspend sediments in shallow estuaries. While this can have the beneficial impact of moving sediments that would otherwise build up and smother sediment-dwelling organisms,[19] the lowered light level reaching the estuarine floor will generally be negative for the growth of benthic algae and seagrasses.

A greater frequency of high windspeeds will reduce the accessibility of the estuary for cultural, recreational and commercial activities. Strong winds and consequent storm surges in harbours and ports will increase the dangers associated with navigating channels and limit the ability of vessels to dock safely.[20] In the warmer regions of the country where mangrove ecosystems border the estuaries, mangroves can dissipate tidal energy in some scenarios and protect communities and infrastructure from storm surges and coastal erosion.[21]

Rising sea levels

Increasing temperatures are melting ice sheets and glaciers, shifting large quantities of freshwater into the oceans. At the same time, the volume of the oceans is increasing through thermal expansion – warmer water takes up more space than colder water. Together, these drivers have raised the global mean sea level by 0.16 metres since the early 1900s.[22] This process is projected to accelerate, and some thermal expansion will continue for centuries, even if global greenhouse gas emissions are rapidly reduced.

Although the increase in sea level to date may seem small, projected rises will change the shape of estuaries and the space available for estuarine dwellers.[23] Estuaries' ability to flush,[24] the extent of saltwater intrusion into freshwater, and the chemical processes that accompany the intrusion will also alter the habitats that estuaries can offer.[25] Finally, when coupled with storm surges, high tides and rainfall events, the extent of flooding will increase and with it the risk of erosion.[26]

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[15] MfE, 2018.
[16] Collins et al., 2018.
[17] Palmer and Montagna, 2015.
[18] Note, there is lower confidence in wind projections than other changes (MfE, 2018).
[19] Norkko et al., 2002; Hewitt et al., 2003; Green, 2006.
[20] UNCTAD, 2018.
[21] Montgomery et al., 2018.
[22] IPCC, 2019c, p.10.
[23] Tait and Pearce, 2019.
[24] Kettles and Bell, 2016.
[25] McBride et al., 2016.
[26] Stephens et al., 2020.

For many species it will be important to adapt our land use to enable the critical habitats on which they depend to shift. For example, īnanga, the most common of the whitebait species, have a complex life cycle spanning marine environments during the larval stage and freshwater environments as adults. The upper limit of an estuary, where saltwater and freshwater meet, provides the critical juncture where freshwater-adapted adults spawn into damp, riparian habitats, and newly hatched larvae can make their way to the ocean.[27] As sea levels rise, the extent of saltwater and appropriate spawning conditions will shift upstream. For the Waihou River in the Waikato, sea level rise of just one metre is projected to move the point at which salt and freshwater meet a full five kilometres upstream.[28] To ensure this species is able to adapt, suitable spawning sites will be required along the entire reach so that breeding can continue under suitable environmental conditions.

Acidification

The oceans have absorbed not only heat but also up to 30 per cent of the carbon dioxide released to the atmosphere since the 1980s.[29] This is shifting the balance between the different forms of carbon in the water and increasing its acidity.[30] Measurements from the subantarctic surface waters off Otago indicate that the pH there dropped from 8.10 to 8.04 between 1998 and 2017, equivalent to a 7.1 per cent increase in acidity.[31] Predicting the impact of increased ocean acidity on estuarine ecosystems is particularly challenging because pH varies with the tides as marine and freshwater influences shift, as well as with biological activity.[32]

Marine plants such as seagrasses,[33] seaweeds and algae cycle carbon in the water column. By day, they take carbon dioxide from the water to photosynthesise, which decreases the water's acidity. Then overnight they respire, releasing carbon dioxide back into the water column and increasing acidity. In coastal Otago's kelp forests, the pH can naturally fluctuate by as much as 0.9 pH units over the course of a midsummer's day.[34] These natural variations are well in excess of projected increases in ocean acidity by 2100.[35]

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[27] See https://www.doc.govt.nz/nature/native-animals/freshwater-fish/whitebait-migratory-galaxiids/inanga/ [accessed 24 April 2020]; MfE and Stats NZ, 2020.

[28] McBride et al., 2016.

[29] IPCC, 2019c, p.9.

[30] Seawater contains several different forms of carbon, including dissolved carbon dioxide (CO_2), carbonic acid (H_2CO_3), carbonate ions ($CaCO_3^{2}$–) and bicarbonate ions (HCO_3–). When extra carbon dioxide is absorbed, the balance between these forms of carbon is disturbed and shifts to a new equilibrium, resulting in more hydrogen ions (i.e. higher acidity) and fewer carbonate ions.

[31] MfE and Stats NZ, 2019b. Wallace et al., 2014; Law et al., 2018b.

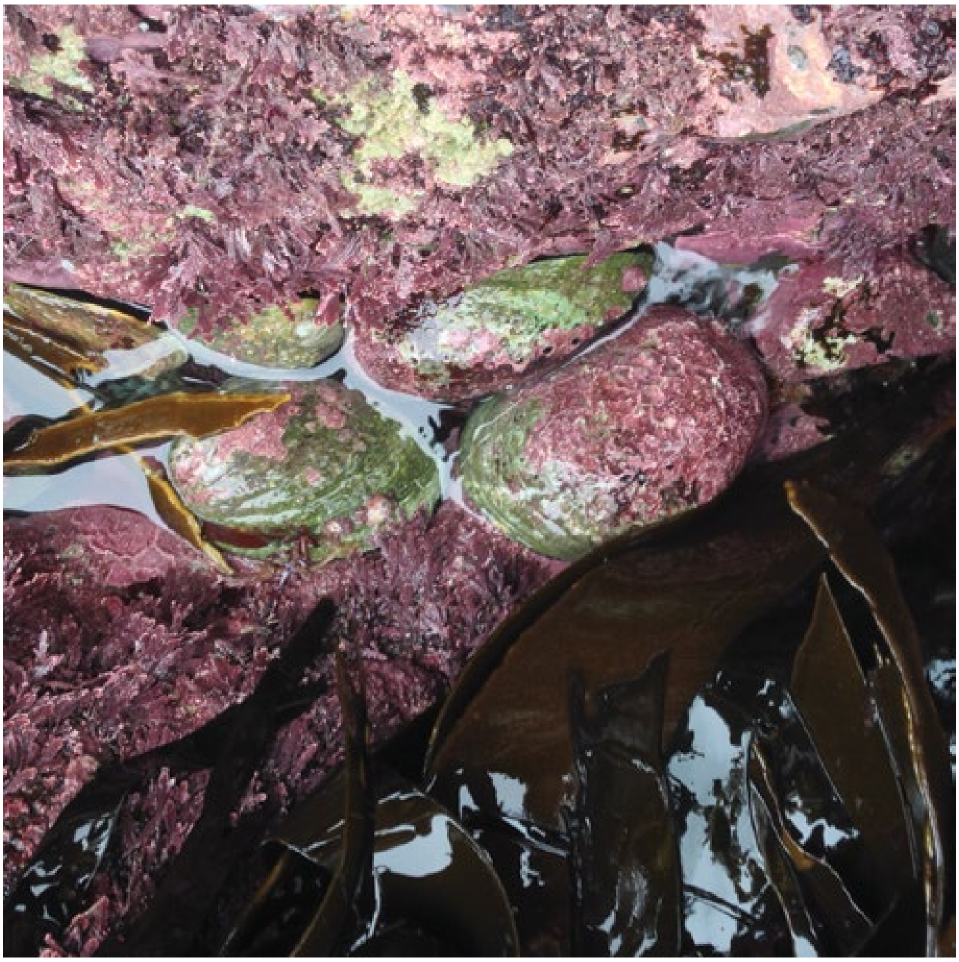
[32] Wallace et al., 2014; Law et al., 2018b.

[33] UNEP, 2020.

[34] Cornwall et al., 2013; Law et al., 2018a.

[35] Law et al., 2018b.

The implications of increased acidity on organisms is variable. For some groups of marine plants and algae, such as seagrasses, seaweeds and phytoplankton, higher concentration of dissolved carbon dioxide may increase their productivity and growth. For others, most notably organisms that have hard shells or skeletal-like structures built from calcium carbonate, like shellfish, kina, corals or crustose algae, the reduced availability of carbonate ions may negatively affect calcification, particularly in early developmental stages when shells and exoskeletons are forming and vulnerable to deformation.[36] Experimental studies have also demonstrated that elevated carbon dioxide concentrations lower the swimming performance of juvenile snapper.[37]



Source: adonis_wei, iNaturalist

Figure 6.2: Both pāua and the coralline algae living on it are potentially vulnerable to increases in ocean acidity.

[36] Law et al., 2018a.

[37] McMahon et al., 2020.

Indirectly, acidity also affects the solubility and form of chemical contaminants, which can alter their transport and fate. Like abnormal rises in temperature or salinity, these changes can affect the toxicity of chemical contaminants. This is particularly relevant to metals trapped in sediments, as some are released into the water when acidity rises and become available to bottom-dwelling species. As a result, changes to water chemistry from ocean acidification have the potential to exacerbate some of the impacts of land-based pressures, such as the use of pesticides and metal run-off from roads and building roofs.[38]

What does this mean for estuarine management?

The magnitude of the impact of climate change and ocean acidification will depend on how the world responds. Estuarine managers have no control over these phenomena – this sits largely in the geopolitical space. All that can be done is to map out trajectories of change and plan the response to these new pressures in a way that integrates them with the management of existing pressures. Management responses will depend on the past, current and future intended uses of the estuary.

Take the example of sea level rise. The way coastal land is managed as seas rise will be a significant factor in determining whether species and ecosystems are able to adapt quickly enough to survive and move with their environment. Existing sea walls protect roadsides and private property around estuaries, and stopbanks line the rivers feeding into them. Already, more than two thirds of Te Awarua-o-Porirua has hard-edged structures like rock walls, flood banks and causeways.[39]

While these hard walls and structures protect people, livelihoods and culturally important sites, as seas rise, the physical space between our cities and the open water shrinks. This effectively squeezes the potential habitat availability for intertidal and coastal ecosystems and the services they provide to society. The loss of intertidal flats will result in the loss of cockles, seagrass beds, migratory waders and other species that depend on these dynamic systems, and there is a risk the carbon stored in them could be released.[40] The decisions communities make to address these threats could lessen or exacerbate the impacts of climate change.

In the short term, it might make sense for communities to decide to make small upgrades to their flood protection schemes. But doing so may create a perception of safety and lead to ongoing investments and development, which then require further protection. This is the road of path dependency.[41] Equally, a community might make a decision to implement RMA controls that require new structures to be movable, thereby buying time for the community to adjust to an eventual retreat and preventing further financial lock-in.

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[38] Moe et al., 2013.
[39] See Appendix 4: Te Awarua-o-Porirua Harbour.
[40] Bulmer and Townsend, 2018.
[41] Parsons et al., 2019.

For some places, like major cities, the cost of retreat might be large enough to justify ongoing protection efforts.[42] However, this will come at a cost to ecosystems and our way of life; hard walls around Auckland and elsewhere could result in the loss of beaches, salt marshes and mangrove ecosystems.

The impacts on the social, economic and cultural values of Aotearoa New Zealand's communities will not be even. Māori in particular are likely to be disproportionately affected by climate change. A significant number of Māori communities live in low-lying coastal areas. The natural features and significant cultural sites where Māori connect through whakapapa, as well as mahinga kai sites, are expected to be adversely affected.[43] The most vulnerable regions and people are not just exposed to climate hazards. They are more likely to have substandard infrastructure. These communities often have limited financial resources and find themselves disadvantaged and under-represented in local, regional and central government decision making.[44]

Whatever decisions are made, there is a real risk that we get caught up negotiating consent conditions and litigating liability while losing sight of the wider context. At sites where retreat is all but inevitable, we could lose both property and ecosystem values if we do not retreat early enough to give coastal species the space and time they need to move with rising tide lines and colonise new sites (Figure 6.3).

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[42] OECD, 2019.
[43] King et al., 2012; Iorns, 2019.
[44] King et al., 2010.

2009

2020

Source: Google Earth Pro

Figure 6.3: Following the retreat from the Christchurch red zone, wetlands are establishing in the place of suburbs. Satellite images of Waygreen Avenue, New Brighton, in 2009 (top) and 2020 (bottom) show the recovery of wetland nine years after the 2011 Christchurch earthquake.

In conclusion

Climate change and ocean acidification add further pressures to estuarine environments – pressures that cannot be ignored when developing systems to integrate the management of cumulative effects on estuaries. While the likely trajectory of these pressures can be plotted, the bigger challenge is communicating what it means to the communities who live adjacent to estuaries and empowering them to take decisions with a very long time horizon.

It has proved hard enough to win acceptance for the fact that activities at one end of a catchment can impose unacceptable costs on communities far from the source of the problem. But at least pressures like nitrogen pollution or sedimentation are within the control of the wider community. Estuarine change caused by the impact of emissions on sea level, temperature and ocean acidity will be determined by the action or inaction of a global community that shows no sign of acting on the scale required.

Faced with this unpalatable prospect, people who live near estuaries have no option but to adapt. The only question is whether they do so proactively with at least a measure of control over how to manage the process, or reactively, in which case the costs of disruption are likely to be much higher. Whether we can summon the social and political resources to adapt proactively is the critical question. The longer it is left in the too-hard basket, the lower our chances of making a durable transition.

7 Appendices

Appendix 1: New River Estuary

Figure 7.1.1: New River Estuary.

Physical form

Eight hundred years ago New River Estuary's catchment was largely forested. Podocarp and broadleaf forests dominated the lowlands, with species such as mataī, tōtara, kahikatea and rimu. Beech forests occupied the colder slopes and highlands, while tussocks prevailed above the snow line and in cooler mountain valleys.[1] Wetlands, including peat bogs and swamp forests of kahikatea extended across the plains.[2]

Mean annual temperature in Invercargill and the New River Estuary ranges between 14 degrees Celsius during summer and five degrees Celsius in winter. The inland regions of the catchment see both higher temperatures in summer and cooler temperatures in winter by comparison with the estuary. Mean annual rainfall across the catchment ranges from about 900 millimetres on the Waimea Plains to 1,500 millimetres in the mountains and 1,150 millimetres at Invercargill and the estuary.[3]

Ōreti River, the largest contributor of freshwater to New River Estuary, originates in the Thomson and Eyre Mountains 170 kilometres north of the estuary, and passes through the northern Waimea Plains and cuts through the Southland Syncline north of the Hokonui Hills before crossing the Southland Plains to join the estuary from the northwest.[4]

Both the Waimea and the Southland Plains have been formed over millennia by rivers depositing inorganic sediments and gravels from the mountains over the shallow rock that underlies this region.[5] At the bottom of the catchment, the estuary is formed around the confluence of the Ōreti and Waihōpai rivers. From there, waters from the 400,000 hectares of the catchment are flushed into Foveaux Strait.[6]

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[1] Walker et al., 2006; Grant, 2008; Ledgard, 2013.

[2] Ausseil et al., 2008; Robertson et al., 2018.

[3] Macara, 2013.

[4] Turnbull and Allibone, 2003.

[5] Turnbull and Allibone, 2003.

[6] Manaaki Whenua – Landcare Research, 2020.

Source: Kerry Du Pont, Flickr

Figure 7.1.2: New River Estuary boardwalk, Invercargill.

History

The Murihiku coastline was visited and occupied by Waitaha, Ngāti Māmoe and later Ngāi Tahu. Their whakapapa became intertwined through conflict, alliances and marriages to become a stable and united hapū: Ngāi Tahu Whānui.[7]

The climate of the south was harsh, and Murihiku tangata whenua moved with the seasons and food supplies. Nohoanga were situated inland, on offshore islands such as Rakiura and Tītī Islands, and along the coast, in addition to kāinga or kāika. Traditional trails allowed passage through the landscape. Traversing the length of the Murihiku region, the Ōreti River formed one such trail, joining the coast to the mountain headwaters and lakes that were important pounamu gathering sites.[8]

During settlement, Māori cleared lowland and swamp forests using burn-offs, promoting harakeke and scrub communities such as bracken and mānuka.[9]

[7] Ngāi Tahu Claims Settlement Act 1998.

[8] Ngāi Tahu Claims Settlement Act 1998, Schedule 50: Statutory acknowledgement for Ōreti River.

[9] McWethy et al., 2010; Ledgard, 2013, p.27.

The New River Estuary itself (also referred to as Kōreti or Wai-o-Pae)[10] was an important site and source of mahinga kai. Two main settlements, Ōue and Ōmāui were situated nearby: Ōue on the sand peninsula to the north of the estuary mouth, and Ōmāui to the south. In their statutory acknowledgement, Ngāi Tahu recounted that:

> "Māui is said to have sojourned at Ōmaui (at the mouth of the New River Estuary) for a year, during which time he claimed the South Island for himself. It is said that in order to keep his waka from drifting away he reached into the sea and pulled up a stone to be used as an anchor, which he named Te Puka o Te Waka o Māui (Rakiura or Stewart Island)."[11]

The settlements at Ōue and Ōmāui enjoyed warmer microclimates than the mainland side, so much so that oranges were grown at Ōue.[12] Although too cold to grow kūmara, tī kōuka were once abundant on the sandy peninsula and provided an important carbohydrate source.[13] Shellfish were also a dietary staple.[14] Ōue was renowned for the cockle bed on the eastern shores of the estuary.[15] Pipi and kūtai were also common, and a short walkway, Te Ara Pakipaki, joined the settlement to the toheroa beds at Ōreti Beach.[16]

The estuary was a rich source of fish. It was known for its pātiki, tuna, īnanga and kanae.[17] Areas with harder bottoms, where the sediment did not settle, were nursery areas for pātiki.[18] The entrance to the estuary was also easier to navigate in waka than the harbour at Bluff because of the tide rip there, making it a gateway to the southern islands and Te Ara-a-Kiwa – Foveaux Strait.[19]

European sealers and whalers began to arrive in the late 1700s.[20] With them came Western crops such as potatoes that were adopted by Māori. The Europeans also brought disease. Outbreaks of influenza between 1817 and 1820 and measles in the 1830s decimated Māori communities. An oral history describes numerous large burial mounds near Ōue after these epidemics, now sunk into the landscape.[21]

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[10] Spelling variants include Waihopai and Waihopae (Jane Kitson, pers. comm., June 2020).

[11] Ngāi Tahu Claims Settlement Act 1998, Schedule 104: Statutory acknowledgement for the Rakiura/Te Ara a Kiwa (Rakiura/Foveaux Straight Coastal Marine Area).

[12] Oral history participant 14.

[13] New River Estuary Technical Advisory Committee, 1977, p.58; oral history New River group interview.

[14] Oral history New River group interview; New River Estuary Technical Advisory Committee, 1977, p.79.

[15] Oral history New River group interview; oral history participant 14; Tuhawaiki's 1843 map (reproduced in Barton, 1980).

[16] Oral history New River group interview; oral history participant 14.

[17] Oral history New River group interview; New River Estuary Technical Advisory Committee, 1977, p.77.

[18] Oral history New River group interview.

[19] Oral history participant 14.

[20] Hall-Jones, 2006, p.60.

[21] Oral history participant 14; supported by written accounts and archaeological evidence (Jane Kitson, pers. comm., June 2020).

Although small pockets of land were purchased by whalers and early settlers, the region's major land sale made on behalf of the Crown was the Murihiku Deed of Purchase in 1853. In this transaction, seven million acres (about 2.8 million hectares) of land was acquired by the Crown, and 4,875 acres (about 1,970 hectares) was intended to be set aside for seven Ngāi Tahu reserves, though this did not eventuate.[22] Three years later in 1856, the Governor, Colonel Thomas Gore Browne, announced the establishment of the town of Invercargill on the eastern banks of the Waihōpai arm of the estuary.

Pressures and state

Vegetation clearance and land use intensification

Flax milling and forestry industries were prominent in the late nineteenth and early twentieth centuries,[23] clearing indigenous vegetation and making way for exotic pastures. To make land on the Southland Plains suitable for pasture growth, rivers were straightened, and tile drains were dug to drain the land. As early as 1861, the Southland Region was home to over 9,000 cattle and 70,000 sheep.[24] The first exports included cattle and sheepskins but were comprised largely of wool. Meat and dairy produce supplied domestic markets until refrigerated exports began in the 1880s.[25]

The limits of soil fertility were soon reached and deficiencies in trace elements revealed through health problems in stock. The remedy came through the addition of fertilisers, including superphosphates, to boost trace elements, nutrients, and lime to neutralise the acid soils. The introduction of aerial topdressing in the 1940s made it easier to apply fertilisers, which attracted government subsidies from the 1940s to 1980s.[26] Sheep dominated the pastoral industry in Southland with the flock peaking in 1985 at over nine million sheep, compared to 30,000 dairy cows. Thereafter, a decline in sheep numbers accompanied a steady rise in dairy herds on the plains and intensification of land use. By 2017, Southland supported just under four million sheep and 680,000 dairy cows.[27]

Intensification in the hill country removed some of the deep-rooted vegetation that slowed the flow of water on the slopes. This activity has resulted in higher erosion susceptibility of soil and increased sediment – and often phosphorus loads – entering the waterways.[28] The loss of vegetation around waterways and the straightening of streams contributes further sediment through bank erosion.[29]

[22] Ngāi Tahu Claims Settlement Act 1998; Te Rūnanga o Ngāi Tahu, 2017; also see https://forms.justice.govt.nz/search/Documents/WT/wt_DOC_68476209/Wai27.pdf [accessed 22 June 2020].

[23] Olssen, 2006, pp.76–77.

[24] Cutt, 2006, p.152.

[25] Cutt, 2006, pp.152–153.

[26] Cutt, 2006, p.157; Nightingale, 2008.

[27] Roberts, 2008; Ledgard, 2013; Moran et al., 2017.

[28] McDowell et al., 2004; Basher, 2013. Ellis et al., 2018.

[29] Ellis et al., 2018.

Practices such as winter fodder crop grazing also increase sediment and nutrient loads. These practices, most common in Southland, Otago and Canterbury, see stock moved off the best pastures during winter when there is no growth and onto crops such as brassicas, beets and root crops. These crops are often partitioned into strips, so the herds can only graze a small portion of the paddock at a time.[30] The density of cows over small spaces leads to deposition of high volumes of urine and dung – and with it, nitrogen[31] and pathogenic microbes. This, combined with high winter rainfall, leads to increased nitrogen loss. Soil structure is also damaged through compaction from trampling, leaving the site devoid of vegetation and vulnerable to erosion and, consequently, sediment and phosphorus loss.[32] In the year ending June 2018, winter forage brassicas were grown on 43,658 hectares in Southland.[33]

Land reclamation and landfill

Reclamation of smaller areas of the Waihōpai arm of the estuary began in the late 1800s. Significant alteration began following the passage of the New River Harbour Reclamation Act 1902. This Act gave the Borough of Invercargill permission to reclaim approximately 1,091 acres (approximately 440 hectares), "the greater part of which is covered by the tidal waters of the New River".[34]

The western flats of the Waihōpai arm – the site of the current day airport – were embanked and drained. The eastern bank was reclaimed using a variety of methods, including:

- infilling with material dredged from the estuary
- the establishment of an exotic grass, *Spartina*, to capture sediments
- the construction of a system of gates that held tidal waters to encourage sediment deposition
- taking advantage of dumped rubble, clean fill and municipal and industrial waste as fill.[35]

Over time, further Acts and agreements approved the reclamation of more of the estuary.[36] In total, approximately 1,650 hectares were reclaimed from both sides of the Waihōpai arm, altering flushing and water movement in the estuary.[37]

[30] Belliss et al., 2019.

[31] Most nitrogen comes from urine.

[32] Pearson et al., 2016. The Action for healthy waterways decisions on the national direction for freshwater announced in May 2020 will place restrictions on winter grazing practices from winter 2021. Consent will be required "where the activity occurs over 50 ha or 10 per cent of the property, whichever is the greater, and where it occurs on slopes 10 degrees or steeper". MfE, 2020a, p.6.

[33] MfE, 2019, Appendix 17, p.326.

[34] New River Harbour Reclamation Act 1902 (Local).

[35] New River Estuary Technical Advisory Committee, 1977, pp.41–42; e3 Scientific, 2019, p.10.

[36] New River Estuary Technical Advisory Committee, 1977, pp.42–43, 104.

[37] New River Estuary Technical Advisory Committee, 1977, p.99. See 'Estuaries in the Oreti': https://www.es.govt.nz/environment/water/estuaries/estuaries-in-the-oreti [accessed 29 November 2019].

The New River landfill, part of this land reclamation, received municipal and industrial waste from the 1930s. Through the 1960s and 1970s the site was poorly contained and monitored, and it spread floatable waste throughout the estuary with each tide. A causeway was built around the site during the 1970s following public concern; this contained the waste and allowed the landfill to continue operating.[38] The landfill was then closed in 2004. In 2007, the Invercargill City Council was awarded a Green Ribbon Award for restoring the site to a green recreational space.[39] Yet, as the closed landfill is unlined due to its age, the potential for leachate contamination entering the estuary is a concern for the community.[40]

Flood protection schemes and sea level rise

The city of Invercargill is built on the edge of the New River Estuary, partly on land reclaimed from the estuary itself. As a low-lying city at the bottom of a large catchment, Invercargill is vulnerable to flooding and sea level rise. Following large floods in 1984, protection works, including dams, stopbank channels and tide gates, were constructed on the waterways that run through the city limits.[41]

At present, eight stormwater pump stations are in place, most of them along the Waihōpai River, supporting the gravity-fed network in low-lying areas, particularly under highwater conditions such as during high tides or flooding in the receiving waterways. Faced with climate change, the city council has begun to consider the risks facing the city, including the historical landfill, from sea level rise and storm surge events.[42]

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[38] e3 Scientific, 2019, pp.10–12.

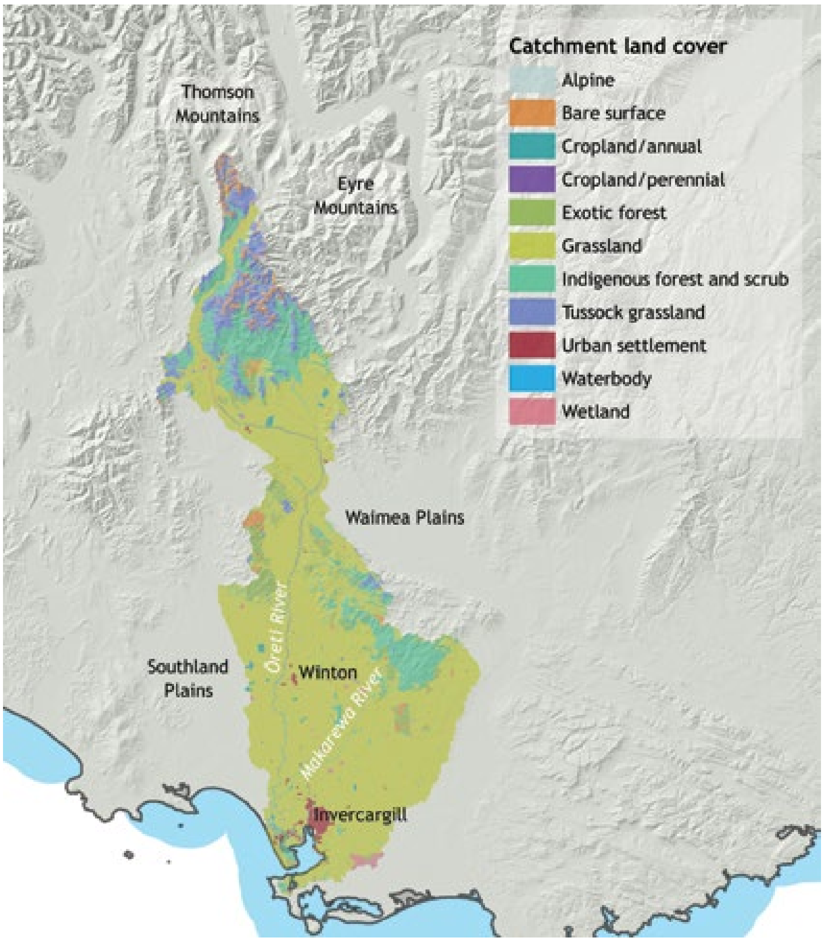
[39] ICC, 2017b.

[40] Smith, 2019.

[41] ICC, 2017c.

[42] ICC, 2017c; ICC, pers. comm., June 2020.

State and monitoring



Source: Manaaki Whenua – Landcare Research[43]

Figure 7.1.3: Map of New River catchment with its land uses.

The estuary today is 4,557 hectares. It is shallow, soft bottomed and highly influenced by tidal action. Approximately 65 per cent of the estuary area, including seagrass, rushes, sand and mud flats, are exposed at low tide.[44] It is the ultimate receiving environment for stormwater and treated wastewater from Invercargill city and surrounding towns; discharge from industrial facilities, including meat and dairy plants; leachate from the closed landfill; and rivers draining an intensive agricultural catchment.[45]

The catchment comprises 66 per cent high-producing grassland (which includes dairy, dairy support, beef and some sheep), six per cent low-producing grassland (including sheep) and five per cent forestry.[46]

[43] Manaaki Whenua – Landcare Research, 2018, 2020.
[44] Robertson et al., 2017b, p.23.
[45] Robertson et al., 2017b, p.29.
[46] Manaaki Whenua – Landcare Research, 2020.

The estuary is estimated to receive approximately eight times more nitrogen than it would have prior to land development.[47] Land use in the catchment contributes to 80.6 per cent of the total nitrogen, 68.2 per cent of the phosphorus and 99.9 per cent of suspended sediments reaching New River Estuary.[48]

Today, there are 36 water-take permits for irrigation from the Ōreti freshwater management unit, and a further 360 for stock water and dairy shed washdown, altogether servicing a maximum consented 187,355 dairy cows.[49]

Estuarine ecology

Although sand was historically quite mobile,[50] the widespread clearance of vegetation on the dune systems between Ōreti Beach and the estuary resulted in significant movements of sand, filling in many of the dune lakes.[51] Decades of development throughout the catchment and reclamation of the estuary have altered the estuary's functioning. There have been changes in the estuary substrate, with a shift from sands to sticky, smelly muds. These changes have coincided with the reduced abundance and size of tuaki and pātiki.[52] The decline of kelp has forced whānau to move further away to find healthy kelp beds to make pōhā tītī.[53]

Environment Southland began monitoring estuarine ecology under the national estuary monitoring programme from 2001. Broad-scale habitat monitoring, which maps out seagrass, salt marsh, macroalgae and areas of soft mud, is scheduled at five-year intervals – and is conducted annually when eutrophic symptoms appear. Fine-scale monitoring examines the sediment in greater detail, taking sediment core samples to look at grain size and contaminants in the sediments. Fine-scale monitoring is also scheduled at five-year intervals but is, again, conducted annually when issues arise.

Between 2001 and 2016, monitoring has shown a decline in seagrass cover of 40 per cent, a 52 per cent increase in muddiness, an eight-fold increase in the area of dense, opportunistic macroalgae, and a 15-fold increase in the area of gross eutrophic zones. These measures indicate that the estuary is in a high state of impairment.[54]

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[47] Plew et al., 2018, Table A-1.

[48] Robertson et al., 2017b, p.29.

[49] Environment Southland, pers. comm., June 2020.

[50] Sand shifted between Ōreti Beach and Ōmāui on 15- to 30-year cycles. Oral history New River group interview.

[51] New River Estuary Technical Advisory Committee, 1977, p.58.

[52] Oral history New River group interview.

[53] Ngāi Tahu, 2015.

[54] Robertson et al., 2017b, p.44.

Human health

As well as ecological changes, data from the few recreational monitoring sites within the wider estuary indicate that it is often not safe for recreation. Concentration of *E. coli* over the past three summers at the New River water ski club on the Ōreti Arm has led to a 'caution advised' classification, describing the risk of infection as moderate, while the Ōmāui beach site is classified as 'unsuitable for swimming'.[55] Shellfish bacteria are monitored at two sites: Whaler's Bay and Mokomoko Inlet. Kaimoana collected from these sites is not considered safe for human consumption.[56]

A 2014 study on metal and organic contaminants in estuary sediments showed that only nickel in sediment exceeded the 'low' interim sediment quality guidelines set by the Australian and New Zealand Environment and Conservation Council (ANZECC) in the upper arms of the estuary.[57] Further upstream, sediment from urban rivers had elevated levels of arsenic, lead, nickel, copper, mercury, DDT and zinc, and agricultural rivers and streams had elevated levels of cadmium. These same contaminants measured in kaimoana were not at levels that warranted health caution, although concentrations of metals were higher in tissue collected nearer stormwater discharges.[58]

Water quality monitoring

Invercargill City Council (ICC) manages drinking water, stormwater and wastewater within the city and communities surrounding the estuary. A structured water quality monitoring programme started in 1991, conducting monthly tests of water quality at nine sites, at both high and low tide. The dataset is used as a basis for ICC's discharge consent applications and monitoring.[59]

ICC owns and manages the stormwater and wastewater systems within the city limits. The Clifton wastewater treatment plant receives waste from the 46,000 residents as well as trade waste.[60] Treated wastewater is discharged into New River Estuary, contributing an estimated four per cent of the total nitrogen and 11 per cent of the total phosphorus load entering the estuary.[61]

The efficacy of the city's stormwater management system was questioned during both the 2011 and 2017 consent renewal process, when submissions largely focused on cross-contamination with the city's sewerage systems. Resource consent terms were tightened to include shorter-term and more stringent measures to ensure that contaminant levels in the discharge improve.[62]

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[55] LAWA, 2020a.

[56] Environment Southland, 2020.

[57] ANZECC sediment guidelines (2000) have interim low guideline values (ISQG-low) and interim upper guideline values (ISQG-high). ISQG-low values indicate the concentrations below which there is a low risk for possible toxicity. High guideline values (ISQG-high) indicate concentrations at which toxicity-related adverse effects are expected to be observed. ISQG values are only indicators and should be used with other lines of evidence (ANZECC and ARMCANZ, 2000).

[58] Cavanagh and Ward, 2014.

[59] Robertson et al., 2017a; ICC, pers. comm., December 2019.

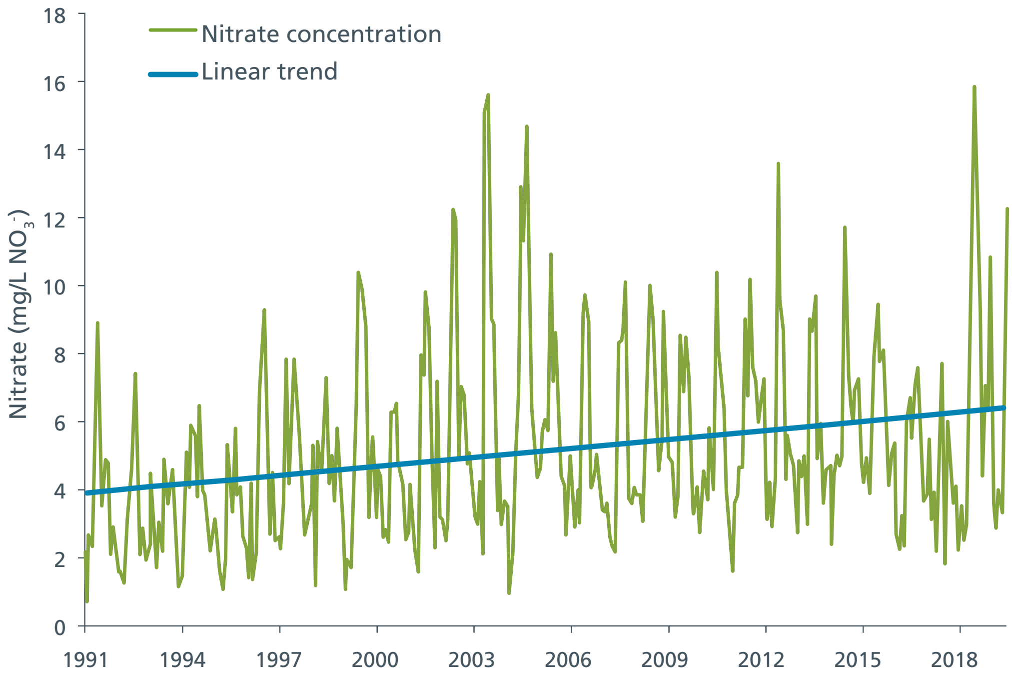
[60] ICC, 2017a.

[61] Robertson et al., 2017b, p.29.

[62] See https://www.es.govt.nz/environment/consents/notified-consents/2016/invercargill-city-council [accessed 18 June 2020]; ICC., pers. comm, June 2020.

The closed landfill site is managed by ICC. A recent desktop review commissioned by Environment Southland assessed the potential contaminants from the site and pieced together sets of existing data from across the reclaimed area, including historical industrial sites. Its summary stated that "the land use history of the New River Estuary in Invercargill has left a legacy of contamination; the extent and risk of which is unknown."[63]

ICC owns and manages the sole municipal drinking water intake for the city, which is sourced from the Ōreti River at Branxholme. The declining quality of the river's water, particularly the increasing nitrate concentration, is a concern for the council (Figure 7.1.4). While nitrates are well within current drinking water standards of 50 milligrams per litre, levels as low as 3.9 milligrams per litre have been linked to an increased risk of cancer, and the drinking standards could change.[64]



Source: ICC

Figure 7.1.4: Nitrate concentrations in the Ōreti River, at the intake for Branxholme water treatment plant.

[63] e3 Scientific, 2019, p.56.

[64] Ministry of Health, 2008, p.8; Schullehner et al., 2018.

Community concerns

Murihiku iwi

Our interviews highlighted that the past and ongoing discharge of waste, particularly untreated sewage, directly into waterways and the estuary is deeply offensive to iwi. They associated the loss of connection to place with the degradation of the estuary and its ecosystems. Gathering and sharing kai is an important practice for the iwi, ensuring connectivity and social cohesion among whānau. It is an important part of understanding one's identity and a means of knowledge transfer between generations, of mātauranga Māori. The loss of once-abundant resources and contamination of those remaining has been keenly felt by the community. Knowledge is now being transferred from a distance, rather than through practice and interaction with the whenua.[65]

Recreational use of the estuary by iwi members continues through waka ama. To reduce the risk to their paddlers, local groups take their waka to the local swimming pool or travel to other estuaries to practise tipping drills. They aspire to be able to do this safely in their own awa.[66]

Interviewees felt that although the condition and outlook for the estuary is bleak, it was too important to be written off, and needed improvement as a taonga for future generations. There was great concern expressed for the future of the estuary, and recognition that the issues seen today are likely to be exacerbated by future climate change. This sentiment is reflected in the kaupapa of Te Tangi a Tauira: The Cry of the People, Runanga Papatipu o Murihiku's natural resource and environmental iwi management plan: "we belong to the environment and are only borrowing the resources from our generations that are yet to come."[67]

In September 2019, Te Rūnanga o Awarua applied to place a mātaitai reserve along the coastline from Mokomoko Inlet (at the southern end of New River Estuary) around the coastline to Cable Bay, on the grounds that the site contains several traditional fishing grounds of customary significance. They stated that:

> "For decades now, Ngāi Tahu have been excluded from actively managing this important food-gathering area and have witnessed the depletion of stocks to the detriment of our mana and rangatiratanga. This application is intended to provide an umbrella mechanism to begin to rectify this situation."[68]

A first consultation concluded in March 2020, and a second consultation was planned at the time of writing.

[65] Murihiku iwi, pers. comm., 23 September 2019.
[66] Murihiku iwi, pers. comm., 23 September 2019.
[67] Runanga Papatipu o Murihiku, 2008, p.24.
[68] Whaanga, 2019, p.5.

Urban communities

Despite the evident pollution levels relating to swimming, and health risks posed by the poor water quality, the estuary is a popular place to recreate. The Ōreti arm hosts the local Sea Scouts, a power boat club, two rowing clubs and a water ski and runabout club, and it has four waka rōpū regularly paddling.[69] The estuarine area also provides facilities on land, including Te Araroa Trail along the eastern side of the estuary.

Fishing and food gathering are important parts of the community's link to the estuary.[70] Changes have been observed in recent years in both the availability of seafood and in their habitat. Floundering has long been a popular pastime – though it was noted that some fishers have moved from once favoured sites because of the sticky, smelly anoxic mud and algae that clogs the drag nets. Fishing for mullet, foraging for cockles and whitebaiting on the rivers also occurs. However, some residents noted that the prospect of contaminated kaimoana kept them away.[71]

Source: Kevin Daniel Chase, iNaturalist

Figure 7.1.5: New River Estuary forms part of the Awarua-Waituna wetland Ramsar site, reflecting its international significance. The estuary is an important place for shorebirds and is popular for watching birds like the royal spoonbills pictured.

[69] ICC, 2013; waka rōpū, pers. comm., 23 September 2019.
[70] Ward, 2015; urban community, pers. comm., 23 September 2019.
[71] Cavanagh and Ward, 2014; urban community, pers. comm., 23 September 2019.

The New River Estuary Forum grew out of concern for the continuing degradation of the estuary.[72] While the forum ultimately hopes to prompt action to improve conditions in the estuary, its principal current focus is on raising community and local authority awareness of the issues, and strengthening connections with the estuary. Members of the group interviewed felt there was a lot of work ahead to make the estuary a safe place to be, and that the transformation needed is likely to be expensive and take time. They noted that greater community support and buy-in for restoration projects was needed, and that agency support was critical to restoring the estuary.

Farming

While livestock and agricultural practices used in the catchment have changed over time, farming is deeply entrenched. The farming community takes great pride in the work of their ancestors who developed land with soils that were acidic, anaerobic and poorly drained or perennially saturated, turning them into the fertile pastures that sustain the region's economy today.

The community remembers the impacts of the removal of agricultural subsidies in the 1980s, which saw hardship and depression peak in rural communities.[73] While interviews revealed that the majority of farmers want to improve farming practices and take care of the land and waters that sustain them, memories of the 1980s make people wary of the social impact of rapid water reforms. They stressed the need for evidence-based tools and the means to make the required changes.

The New Zealand Landcare Trust has four community-led catchment groups currently active in the catchment, covering a significant proportion of the developed land area.[74] The trust takes a facilitation and support role in both rural and urban catchment groups. Its aim is to assist communities to work towards more sustainable land and water management.[75] Through such voluntary approaches, the farming community sees the potential for wider uptake of good management practices and coordination of actions across Southland.[76]

The farming community noted that good practices will only go so far and that some big challenges remain unresolved. These include the legacy of straightened rivers speeding up flow and erosion, and the loss of meanders and flood plains, which would have allowed the capture and uptake of sediment and nutrients. Winter grazing was referred to as the region's Achilles heel in the high-intensity systems of the lower country.[77] In the high country where low-intensity farming systems predominate, the observed increase in storminess and erodibility of soils was identified as a concern.[78]

[72] Savory, 2019.

[73] Wallace, 2014.

[74] NZ Landcare Trust, 2020.

[75] New Zealand Landcare Trust, pers. comm., June 2020.

[76] Farming community, pers. comm., 24 September 2019.

[77] However, there is optimism for environmental outcomes alongside the animal welfare outcomes sought by the Winter Grazing Action Group established by MPI (O'Conner, 2020); farming community, pers. comm., 2020.

[78] Farming community, pers. comm., 24 September 2019.

Management

Te Ao Marama Inc

Te Runanga o Ngai Tahu Act 1996 recognises the rights of tangata whenua and their role in exercising mana whenua and mana moana over the Murihiku region. Subsequently, Te Ao Marama Incorporated was established to fulfil the consultation requirements under the Resource Management Act 1991. This group is made up of representatives from the four Ngāi Tahu rūnanga from the Murihiku/Southland region: Ōraka-Aparima Rūnaka, Hokonui Rūnanga, Waihōpai Rūnaka and Awarua Rūnanga. It works closely with Environment Southland and territorial authorities to coordinate iwi input in planning and consents, and to promote the role of iwi as kaitiaki. To assist in this process, the group released a natural resource and environmental iwi management plan in 2008 – Te Tangi a Tauira: The Cry of the People.[79]

Te Ao Marama has provided a unique point of engagement with iwi for regional and territorial authorities throughout the planning and consenting processes. All Southland councils have signed a Charter of Understanding with Te Ao Marama that agrees to "the sustainable management of the region's environment and for the social, cultural, economic, and environmental needs of communities, for now and into the future."[80]

While the Treaty establishes this as a partnership for making resource management decisions, and the relationship with the regional council is considered positive, there is concern that the voice of Te Ao Marama is being lost among those of other stakeholders. In evidence given recently in the Environment Court appeals hearing for the Proposed Southland Water and Land Plan, it was stated that: "For all the goodwill of the Charter of Understanding, the local government RMA processes have let Papatipu Rūnanga down through insufficient weighting being given to this common goal and partnership."[81]

Invercargill City Council

Through steady upgrading of the city's water infrastructure, a stable population size and closure of some significant industries, ICC considers that the quality of discharges from their network is improving overall. However, ageing stormwater and sewerage networks are an issue for ICC. Ongoing challenges include the limited control the city has over discharges into drains by site occupants and residents, and the poor state of the network on private properties. ICC has engaged in public awareness campaigns in addition to contaminant tracing work in an effort to lower the stormwater contaminant load.

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[79] Runanga Papatipu o Murihiku, 2008.

[80] Environment Southland et al., 2016, p.4.

[81] See https://www.es.govt.nz/repository/libraries/id:26gi9ayo517q9stt81sd/hierarchy/about-us/plans-and-strategies/regional-plans/proposed-southland-water-and-land-plan/documents/background-documents/evidence/Nga%20Runanga%20-%20Evidence%20in%20chief%20-%20Michael%20Skerrett [accessed 18 June 2020].

Environment Southland

Environment Southland notified its Proposed Southland Water and Land Plan in June 2016, laying the foundation for the limit-setting process as required by the National Policy Statement for Freshwater Management (NPS-FM).[82] To set limits, the proposed plan divides the region into five freshwater management units, with New River Estuary and its catchment making up the majority of the Ōreti freshwater management unit.[83] The proposed plan recognises the link between the New Zealand Coastal Policy Statement and the NPS-FM, and has defined its freshwater management units as inclusive of estuaries.[84]

To guide consenting for land use and associated activities, the proposed plan introduced a novel approach to zoning land based on the physiographic features of the landscape. These zones were developed to describe how water, and the contaminants it carries, moves through the landscape both above and below ground to a receiving waterbody.[85] Based on this understanding of contaminant pathways, the plan proposed rules specifying permitted and prohibited land use activities within particular physiographic zones, including restrictions on further intensification within a number of particularly leaky zones. The circumstances specifying how these zones would be applied is one of many issues being appealed in the Environment Court at the time of writing.

Environment Southland, in partnership with Te Ao Marama Inc, has established the People, Water and Land Programme – Te Mana o te Tangata, te Wai, te Whenua. The programme sets up three workstreams: enabling action on the ground; understanding community values and objectives for freshwater; and establishing a community-based group to provide advice to Environment Southland and Te Ao Marama Inc on how to achieve these objectives. The latter workstream established the Regional Forum in 2019, which is composed of 15 members of the community with a range of backgrounds and expertise. By 2022 the forum will provide advice on an agreed programme to update the Proposed Southland Water and Land Plan, which will implement the NPS-FM.[86]

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[82] New Zealand Government, 2017.

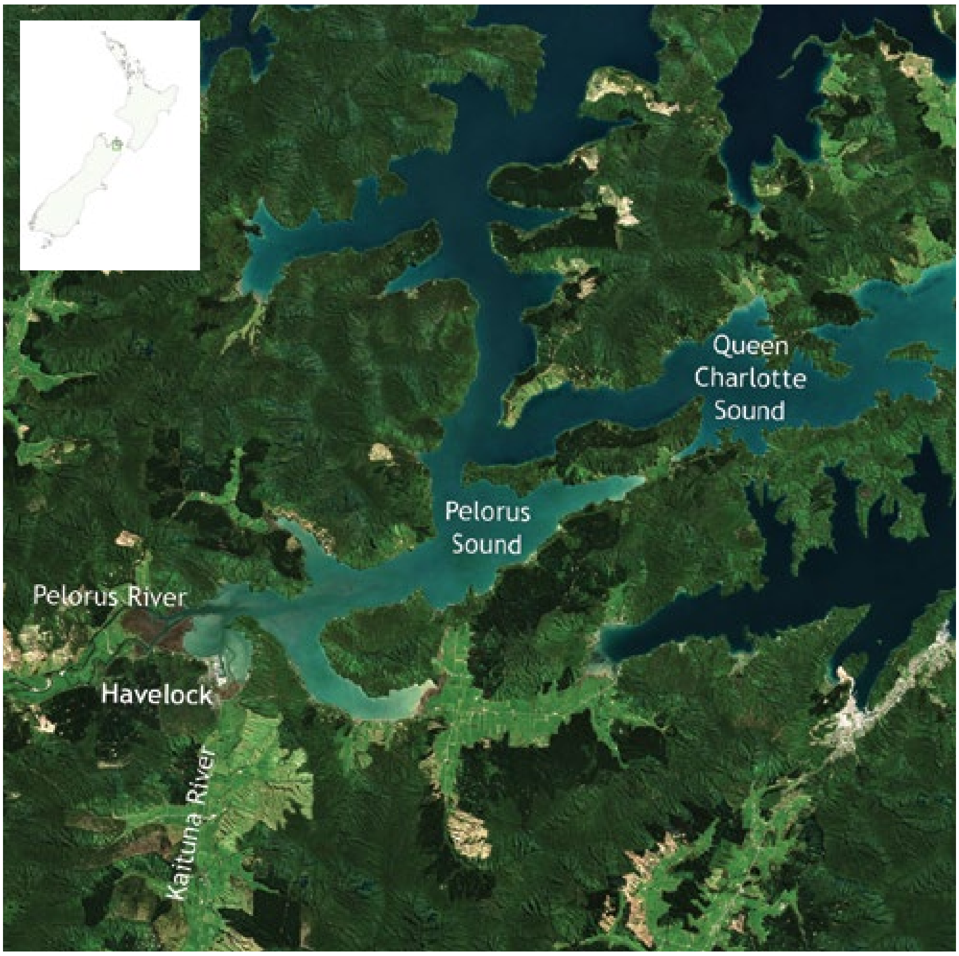
[83] The interim environment court decision on the *Proposed Southland Water and Land Plan* splits the Waituna from the Ōreti freshwater management unit, making six freshwater management units. https://www.es.govt.nz/about-us/plans-and-strategies/regional-plans/proposed-southland-water-and-land-plan#:~:text=The%20proposed%20Southland%20Water%20and,and%20stock%20access%20to%20waterways. [accessed 14 July 2020].

[84] Environment Southland, 2018.

[85] Hughes et al., 2016.

[86] Nicol and Robertson, 2018.

Appendix 2: Pelorus Sound/Te Hoiere



Source: Modified Copernicus Sentinel data, sourced from the LINZ Data Service and licensed by Sinergise Ltd, for reuse under CC BY 4.0

Figure 7.2.1: Pelorus Sound/Te Hoiere.

Physical form

Pelorus Sound/Te Hoiere, situated at the top of the South Island, has a catchment of 1,149 square kilometres.[1] Prior to human settlement, the steep hills of Pelorus Sound/Te Hoiere were dominated by bracken, as well as beech and podocarp forests. Extensive wetlands, marshlands and mudflats covered the frequently flooded, relatively flat valley floor.

Rainfall in the upper catchment is up to 3,200 millimetres per annum, while Havelock is much dryer, with only 1,600 mm annual rainfall.[2] The soils in the catchment are generally nutrient-deficient and the topsoil is shallow and easily erodible.

[1] Robertson, 2019b, p.4.

[2] Mean annual rainfall interpolated from 1961 to 2015; see https://www.marlborough.govt.nz/environment/climate/rainfall [accessed 2 June 2020].

Pelorus Sound/Te Hoiere presents a reverse picture of the catchment: an inner, shallow, sediment-based estuary leading to a 56-kilometre-long, relatively deep (about 40 metres) drowned-river type of estuary. It comprises several arms and numerous bays.

The sound operates as a double-ended sediment and nutrient trap, delivered from both the river (mostly in winter) and Cook Strait (mostly in summer), allowing a year-long supply of nutrients to the sound.[3]

This acts as a conveyor system: freshwater goes out on the top and seawater comes in from the bottom, providing connectivity between the inner and outer sound. As a result, sediments remain in the Pelorus channel for approximately 107 days, much longer than the other case studies (at one to five days).[4]

Around ten times the pre-human level of sediment enters Pelorus Sound/Te Hoiere each year.[5] In 1-in-50-year rainfall events, the entire valley floor is drowned, as happened in 2012 (Figure 7.2.2).

The benthic substrate of the shallow part of the estuary has been dominated by mud-rich sediments for at least 3,400 years, and the ecosystem has co-evolved with this fluctuation of sediment inputs from periodic storms.

Source: Marlborough District Council

Figure 7.2.2: The Pelorus Valley after a 1-in-50-year rainfall event in 2012.

History

In Ngāti Kuia history, the taniwha Kaikaiawaro created the navigable part of Te Hoiere awa by digging it out with its nose, making two deep rua as it went. Kaikaiawaro was trying to find a way to Whakatū (Nelson) for Matua Hautere, a descendant of Kupe. The Pelorus district, river and sound was named after the waka of Matua Hautere, *Te Hoiere*.

The banks of the Pelorus River and surrounding areas have been occupied for generations and have deep historical and spiritual significance to the many iwi who settled there.

The area was significant for mahinga kai, and Māori actively modified the environment in Te Hoiere and the many bays they settled in throughout the Marlborough Sounds.[6] Papakāinga and pā were found along the Pelorus and Kaituna rivers. Temporary occupation sites were used throughout the area, following natural resource availability, avoiding seasonal floods and as places to retreat to in times of conflict. Resources were plentiful and included tuna, pātiki, tāmure, herring, īnanga and kūtai, as well as harakeke, kererū and ducks.

Place names provide a vivid picture of Māori connection to this whenua. In Te Hoiere, Kaikūmera means to eat the kūmara, Kaituna to eat eels (though some locals now call it Kaitūtae in reference to the sewage outlet into the river), Paranui indicates a lot of mud, used to dye harakeke, and Te Matau is the fish hook – the shape of the land at the south of the Pelorus River that has now been straightened somewhat by the road. There is Motuweka (the practice of laming the weka to catch others), Pareuku (the clay cliff) and Taituku (the receding tide, where the high-tide flow used to reach near Canvastown).[7]

One of the first European settlers to arrive in Pelorus Sound/Te Hoiere was a sealer named John Guard who established processing stations on the shores of the estuary from 1827.[8] From the 1840s, settlers felled the forest and commenced pastoral farming, as well as fishing.

In August 1863, the Marlborough Provincial Council offered bonuses for the discovery of gold and coal in the financially struggling province. The rush in 1864 contributed to the development of Havelock and Canvastown.[9] Dredging of the Wakamarina River was conducted in the 1890s, while gold mining and prospecting were carried out in the upper Pelorus Sound/Te Hoiere catchment.[10]

Plantation forestry in the Pelorus Sound/Te Hoiere catchment started in the 1940s. Pastures on steeper land were abandoned in favour of pine planting with the help of government grants.

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[6] Handley et al., 2017.

[7] Mark Moses, pers. comm., 25 February 2020.

[8] Wakefield, 1845, Chapter III.

[9] Stephens, 2009.

[10] Handley et al., 2017.

Aquaculture in Pelorus Sound/Te Hoiere is documented as far back as the late 1800s. A history of aquaculture in Pelorus Sound/Te Hoiere recalled that: "In the Pelorus Sound, a Ngāti Kuia family recorded that green mussels 'were shifted around by us to wherever we were living' to provide an ongoing food source."[11] But it was in the 1970s that large-scale mussel farming began, with finfish farming following in the 1980s.

Pressures and state

Sedimentation

Prior to European settlement, sedimentation was in the order of 0.2 to 1.2 millimetres per year, mostly from slips in one or two large flood events. The sound likely had clearer waters with better visibility than at present.[12]

By 1897, the cutting of native timber had dramatically changed the landscape of the lower Pelorus Valley.[13] The native forest that was left on the hilltops was ravaged by pigs, rats, deer, stoats and possums. The acclimatisation society released deer in the Nelson and Pelorus Sound/Te Hoiere area from the 1860s to the 1960s. The society recorded how this introduced deer population grew and their distribution spread, but did not monitor the damage they did to the environment.[14]

Gold mining, then forestry, farming and roading increased sedimentation to 1.8 to 4.6 millimetres per year.[15] Pelorus Sound/Te Hoiere is now one of the muddiest estuaries in New Zealand.[16] Sedimentation has increased again in the last ten years.[17] The source is still a subject of dispute.[18]

Spartina, an introduced weedy seagrass, was originally planted in the Havelock Estuary in 1952 to convert what was considered useless mud flats into productive land. The theory was that mud and silt builds up in the grass causing the level of the mud flats to rise, but it is an invasive species and has had devastating effects on estuarine ecosystems. *Spartina* was subsequently eradicated by the Department of Conservation (DOC) and Marlborough District Council (MDC) from this area in 2005.[19]

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[11] Dawbar, 2004, p.2.

[12] Handley et al., 2017.

[13] Stephens, 2015.

[14] Clarke, 1971.

[15] Handley et al., 2017, p.8.

[16] Urlich, 2018a, p.5.

[17] Handley, 2016, p.31.

[18] For example, Handley et al. (2017, Figure 4-2) claim forestry-based sediments dominate in Pelorus Sound/Te Hoiere, while elsewhere, Eyles and Fahey (2006) claim that forestry and pasture have the same sediment loss overall.

[19] Davidson et al., 2011, p.89; Robertson, 2019a.

Nutrient use

To enable farming, the productivity of this nutrient-deficient land was initially secured by regularly burning scrub. This was followed by the government-subsidised application of fertilisers in the 1950s to 1980s using topdressing. Less productive land was eventually converted to forestry, also with the help of government subsidies from the 1960s to the 1980s.[20]

Point source discharges

A limited number of industrial discharges into Havelock Estuary have occurred since the 1840s. Current resource consents include the Sanford mussel processing plant discharge, the sewage oxidation ponds that discharge into the Kaituna River, and the stormwater from Havelock township and its marina.

A landfill was created on the banks of the Kaituna River in the 1940s. It was closed and capped in the 1990s, but the site is still used as a refuse transfer station. Research concluded that the leachate is unlikely to have caused significant adverse effects on the health of the estuary due to dilution rather than low leaching.[21]

A wastewater treatment plant was installed in the mid-1980s, but the effluent has high levels of enterococci and faecal coliforms.[22] Monitoring has showed a mild increase in nutrients in the water at 10 metres downstream of the discharge point but not at 50 metres downstream of the discharge point.[23] The site is susceptible to liquefaction and climate change, and becomes flooded during high rainfall events coinciding with high tide. Due to the wastewater treatment plant's poor performance, MDC is in the planning stage for a new plant at a new site and the addition of a wetland as an additional buffer.[24]

Fishing and aquaculture

A great variety of fish have been recorded in the Marlborough Sounds, and early settlers advocated for the establishment of fishing stations. Power trawling and dredging started in the 1950s, with the addition of recreational scuba diving and cheap speed boats from the 1960s. The combined result was a reduction in most shellfish and fish populations from the early 1970s, reduction in seaweed beds, and major habitat changes.[25]

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[20] Handley et al., 2017.

[21] Davidson and Brown, 2000.

[22] van Eeden, 2018.

[23] Davidson and Brown, 2000.

[24] See https://www.marlborough.govt.nz/services/utilities/sewerage/havelock-oxidation-ponds-upgrading-proposals [accessed 2 June 2020].

[25] Handley et al., 2017; FNZ, 2018.

Shellfish, including mussels, are an important component of the Māori diet. They became an important part of the local Pelorus Sound/Te Hoiere economy after a fishery operated from 1859 until the early 1900s, when it was closed due to overfishing. Commercial dredging for mussels started in 1962, depleting this resource by 1969 and removing the 'crust' of mussels to expose the underlying muddy bottom.[26] Mussel beds in the inner Pelorus Sound/Te Hoiere have not recovered, which might be partly due to the effect of trawling and dredging, known to have detrimental effects on the marine ecosystems.[27]

Scallop fishing reached peak production in the 1970s. Enhancement trials and rotational management were attempted, but eventually scallop fishing in the Marlborough Sounds closed in 2016. The pāua quota for the area comprising Golden Bay, Tasman Bay and Marlborough (quota management area PAU 7) was reduced in 2002 and has remained stable since that time, but the stock is very likely overfished.[28] A resource consent was sought for pāua reseeding experiments in Pelorus Sound/Te Hoiere, but was not granted.[29]

The aquaculture industry is thought to have changed Pelorus Sound/Te Hoiere. For example, mussel farms are potentially associated with an increase in water clarity between the 1970s and 2014 but with a less clear trend in recent years.[30] Prior to the 1970s boom in aquaculture, seasonal algal blooms and low water visibility were common. There are, however, still limited data on the area's carrying capacity or environmental impact assessments for aquaculture farms.

Aquaculture can also have unexpected effects. For example, 2019 saw the first bloom of *Alexandrium fraterculus*, a non-toxic alga that was only found in Hauraki Gulf before then. It was suggested that the alga might have been introduced with mussel spat from the Hauraki area.

[26] Handley, 2015.
[27] Urlich, 2017.
[28] FNZ, 2018, p.1079.
[29] Michael Bradley, Te Rūnanga a Rangitāne o Kaituna Inc, pers. comm., 18 September 2019.
[30] Handley et al., 2017, p.23; Stenton-Dozey and Broekhuizen, 2019.

Source: Dr Sean Handley, NIWA

Figure 7.2.3: Pelorus Sound/Te Hoiere aquaculture, with farming and forestry in the background.

Climate change

The effects of climate change are already apparent in the Marlborough Sounds. The first recorded toxic algal bloom (*Alexandrium pacificum*) hit Queen Charlotte Sound in 2011 and Pelorus Sound/Te Hoiere in May 2018. The biotoxin alert for Nydia Bay – where the bloom originated – has been a reoccurring event since 2018.

Increasing water temperatures have also affected finfish farming. Following high salmon mortalities on a few farms from warm waters in the Marlborough Sounds in 2017 and 2018, New Zealand King Salmon is looking to expand into the open ocean with an application to farm seven kilometres north of Cape Lambert in the Cook Strait. There is a proposal to relocate farms from areas of low flow, some within Pelorus Sound/Te Hoiere, to areas of higher flow.[31]

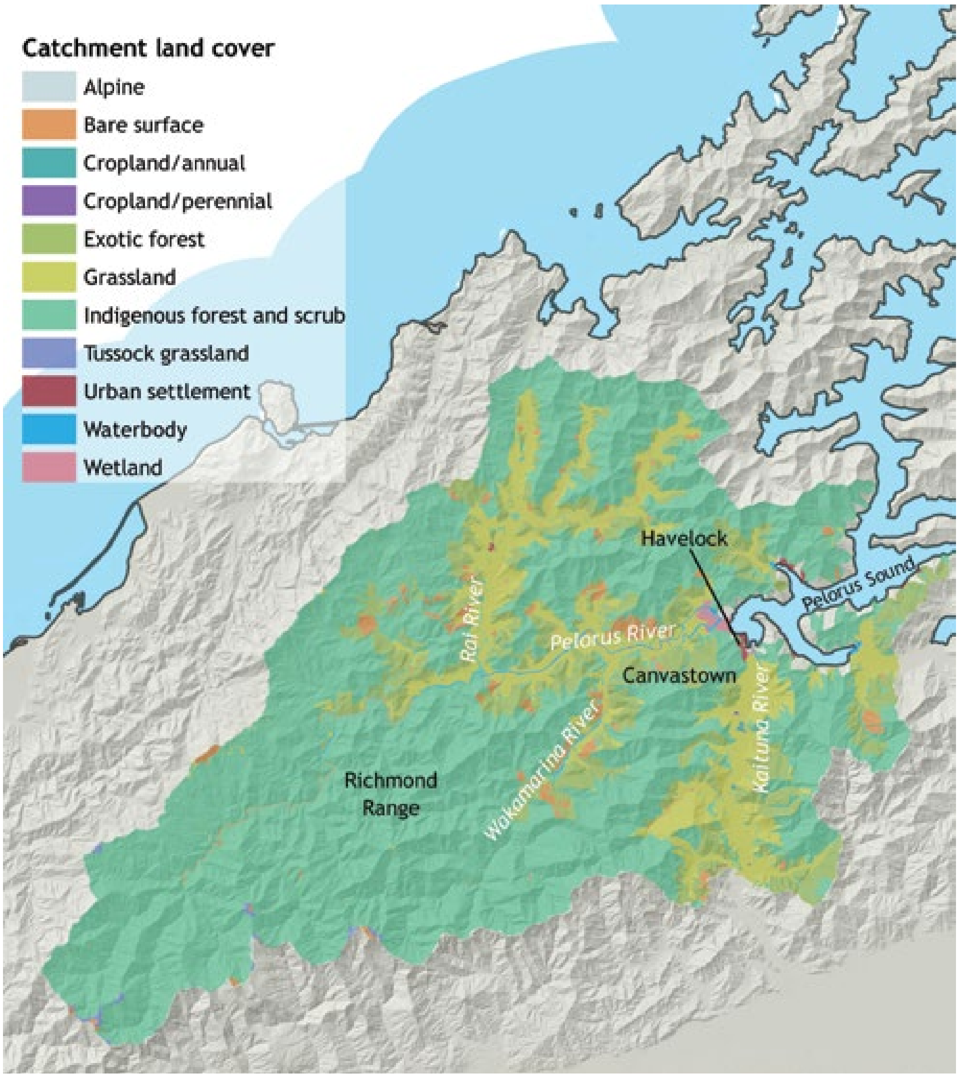
Other reported impacts of climate change and land-based effects include a reduction in wild-caught mussel spat in Pelorus Sound/Te Hoiere, loss of kelp, increased storms, and saltwater intrusion in the Havelock town freshwater supply.

[31] Salmon Farm Relocation Advisory Panel, 2017.

State and monitoring

Current pressures, state and response of estuaries in Marlborough, with Havelock as a case study, are detailed in MDC's *State of the Environment Report 2015*. It summarised that for Havelock Estuary, "the increase in mud is a sign that the estuary is under stress from farming, forestry and sediment washed down in storms".[32]

In 2018, land use in the Pelorus Sound/Te Hoiere catchment comprised 73 per cent regenerating forest, 13 per cent exotic forest and 12 per cent high- and low-producing pasture (see Figure 7.2.4). Exotic forest coverage has increased by nine per cent since 1996, pasture has decreased by six per cent and regenerating forest has decreased three per cent.



Source: Manaaki Whenua – Landcare Research[33]

Figure 7.2.4: Map of the Pelorus Sound/Te Hoiere catchment with land use.

[32] Hamill et al., 2015.

[33] Manaaki Whenua – Landcare Research, 2018, 2020.

The estuary at Pelorus Sound/Te Hoiere contains the largest wetland complex in the Marlborough Sounds. It is nationally important due to the presence of two threatened species – the banded rail and the black-fronted tern – and a wide variety of wetland birds, including oystercatchers, black swans, ducks, herons, four species of shag (pied, little, little black and black), pūkeko and Caspian terns.[34] Pelorus Sound/Te Hoiere also comprises 21 ecologically significant marine sites, including the Havelock Estuary itself.[35]

Estuaries in the Marlborough Sounds have been monitored since 2001. The Havelock Estuary environment is highly modified and degraded,[36] and anoxic sediments have been recorded in recent monitoring. The overall health of the Havelock Estuary as described by the Estuary Trophic Index rating is moderate, with high soft mud content and decreasing seagrass beds.[37] A relatively small (16 hectare, 2.9 per cent) part of the intertidal estuary was adversely impacted by gross eutrophic zones and areas with low sediment oxygenation. Fishers, both commercial and recreational, have noticed a major reduction in fish and shellfish availability in the estuary and rivers (see community concerns section below).

Seven river locations in the Pelorus Sound/Te Hoiere catchment have been monitored monthly since 1996. Trends over that time show an overall improvement in turbidity, varied trends in nitrogen loading between locations, and a general decline in the macroinvertebrate community overall. Furthermore, there is a general decrease in biodiversity towards the seaward end of the rivers.[38] In December 2018, for the first time in the history of Pelorus Sound/Te Hoiere, the Kaituna River was the subject of a health warning. It remains unsafe for swimming today.

Fish & Game New Zealand has management responsibilities for salmon and trout fishing in Marlborough rivers. Fish have been released and monitored in the Pelorus catchment since 1987. Over 1,000 fish were released in the Pelorus catchment in 2017, as well as 5,700 ova. The salmon fishery is in decline in the Rai and Opouri rivers.

Currently, consents with monitoring are notified at two factory wastewater discharge sites, two port stormwater sites and one treated municipal wastewater site. Dairy and forestry activities also have consents. Not all resource consents investigated here had an appropriate cultural impact assessment included.

Although cultural health indicators are not currently used by MDC, the Proposed Marlborough Environment Plan includes the development of these in collaboration with iwi.[39] Cumulative effects on the estuary and the environment in general are not currently explicitly considered.

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[34] Davidson and Brown, 2000.

[35] Davidson et al., 2011.

[36] Robertson, 2019b, p.25.

[37] Hume, 2018; Robertson, 2019a, 2019b.

[38] LAWA, 2020c.

[39] Method 3.M.5 of the Proposed Marlborough Environment Plan; see https://www.marlborough.govt.nz/your-council/resource-management-policy-and-plans/proposed-marlborough-environment-plan [accessed 18 June 2020].

Community concerns

The recent history of Pelorus Sound/Te Hoiere is that of a financially struggling province with successive economic, population and social booms and busts, often driven by government subsidies. The current trend is for depopulation, with the workforce being imported into the area, and primary industry operations consolidating into fewer companies. The community currently consists of retirees and a few farming families. Of the two schools in the area, one has closed and the other is in danger of closing.

The region continues to be defined by migration in and out of the area. As the local community changes, so do their values and views, to the frustration of long-term players in the area. Using the coastal section of MDC's state of the environment reports as a gauge for regional concerns of the day, there is a similar picture of continued change. Bathing water quality and fisheries management were central to the 2002 report, aquaculture and ship wake in 2008, and aquaculture and land use leading to sedimentation in 2015.[40]

Ngāti Kuia

To Ngāti Kuia, the state of the Pelorus Sound/Te Hoiere environment is clear, and action is required now.[41] They want a philosophical and moral compass to guide decision making, and the use of cultural health indicators and mauri models[42] to implement monitoring and to feed into decisions. Ngāti Kuia want a community-based approach to kaitiakitanga, with iwi being empowered to take a leadership role with the community. As such, Ngāti Kuia have actively supported the Marlborough Sounds Integrated Management Trust and Marlborough Marine Futures focus on community-based, collaborative management based on successful models such as Fiordland Marine Guardians and Te Korowai o Te Tai ō Marokura in Kaikōura. They are founding members and partners in the Kotahitanga mō te Taiao process,[43] but have reservations about how it will be implemented.[44]

[40] See https://www.marlborough.govt.nz/environment/state-of-the-environment-reporting [accessed 18 June 2020].

[41] Ngāti Kuia, pers. comm., 7 October 2019.

[42] For example, see Morgan, 2006.

[43] Kotahitanga mō te Taiao, 2019.

[44] Ngāti Kuia, pers. comm, 7 October 2019.

Whānau in the area have been affected by significant alienation from their land by Pākehā, and enduring social segregation. Specific issues related to the management of Pelorus Sound/Te Hoiere include:

- the protection of wāhi tīpuna and the management of Māori land
- recognition of Ngāti Kuia as the first people
- siltation and reclamation of the estuarine area
- water quality and quantity
- pollution and waste treatment
- loss of access to and use of traditional resources
- protection of the ecology
- management of developments in the area.[45]

Te Rūnanga a Rangitāne o Kaituna Inc

For Te Rūnanga a Rangitāne o Kaituna Inc,[46] the need to act now is also paramount. The rūnanga expressed frustration at a tendency to keep on documenting the destruction of the environment.

In the 1970s, Te Rūnanga a Rangitāne o Kaituna Inc embarked on commercial eel fishing in the Kaituna River and set net fishing for snapper, flounder, rig, butterfish, moki, blue cod, elephant fish, scallops, pāua and mussels in Pelorus Sound/Te Hoiere. This activity was stopped by the introduction of the fisheries Quota Management System: as it was a part-time activity, the rūnanga was not allocated quota for those species. Te Rūnanga a Rangitāne o Kaituna Inc went into commercial scallop and oyster fishing, which ceased in the mid-1990s due to low stock levels. It carried out floundering between 2012 and 2016 but again had to cease due to low fish numbers.

Te Rūnanga a Rangitāne o Kaituna Inc has been actively seeking ways to improve the mauri of the area, including being involved in a yellow-belly flounder enhancement programme. But difficulties in securing a consent have prevented any releases to date.

Te Rūnanga a Rangitāne o Kaituna Inc is heavily involved in challenging decisions in court (e.g. against the Seabed and Foreshore Act 2004 (2004 No 93), and the allocation of oyster and scallop quotas). The rūnanga places importance on this litigation as a formal way of having their views heard. Fishing formerly provided employment for the people of the area, and it is the aspiration of Te Rūnanga a Rangitāne o Kaituna Inc to restore those opportunities.

[45] Oral history participants 5, 7 and 8; Brown, 2017.

[46] Michael Bradly, Te Rūnanga a Rangitāne o Kaituna Inc, pers. comm., 7 October 2019.

Farming

Many farms flank Te Hoiere/Pelorus and Kaituna rivers, and some have the estuary as a neighbour. Farms have consolidated over time: there are now half as many farms as 20 years ago, covering the same area of land. The connection of this community to the estuary is varied, with some recreating in the rivers while others fish in the estuary.

Farmers interviewed felt a strong responsibility as caretakers of their land, knowing it intimately, and they expressed a desire to work with MDC and other stakeholders to achieve the best possible environmental outcomes. They felt there was not enough support from councils for individual ideas for innovation and action on farms (e.g. plant guides, council staff to help with consents and planning). They felt under pressure from other parts of the community to improve their environmental performance.[47]

Forestry

The connection of this sector to the estuary is mostly through barging and consents. Workers in forestry are not necessarily local to the Havelock area, which limits their recreational association with the estuary. Aspirations of the local forestry group included better operations enforced through stricter regulations and appropriate enforcement. Members of the forestry sector expressed frustration at being blamed for sedimentation issues. They are supportive of collaborative processes, as they consider that improving the state of the environment must engage all industry sectors and communities.[48]

Aquaculture

Aquaculture is the second biggest industry in Marlborough after wine. There are currently over 500 marine farm sites within the Marlborough Sounds, and they produce approximately 80 per cent of all commercially grown seafood in New Zealand.[49]

Similar to the farming sectors in the area, aquaculture activities have consolidated in recent years, so the industry is represented by a smaller number of larger players compared to previous decades.[50] Unlike other primary industries, operators do not own the area where their activity takes place, and as such they have to maintain their social licence to keep operating.

Members of this group interviewed felt that community-based processes had failed to reach consensus and provide certainty for the industry, and greater leadership was required. Aquaculture operators said they were keen to keep innovating but were dissuaded by Resource Management Act costs.[51]

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[47] Farming community, pers. comm., 17 September 2019.
[48] Marlborough Forest Industry Association, pers. comm., 18 September 2019.
[49] See https://www.marlborough.govt.nz/environment/coastal/marine-farming [accessed 18 June 2020].
[50] Baines et al., 2000.
[51] Marine Farming Association, pers. comm., 17 September 2019.

Urban communities

Locals[52] are concerned by the increase in mud and loss of bird life over the last few decades, and that they cannot catch fish as they used to. They feel that profit has driven unsustainable practices such as forestry on unsuitable land, too much aquaculture and overfishing. Some long-term residents believe that the biggest impact on the environment is the explosion in the number of possums, goats and deer. Scree field size has increased in the sounds, and the bush composition is changing.

They also expressed a desire for action rather than delay while further research is conducted. Friends of Pelorus Estuary focused on submissions to resource consents and other consultation processes more than environmental restoration projects on the ground. They expressed a degree of burnout in the community around environmental issues.

Source: Dr Sophie Mormede, PCE

Figure 7.2.5: Pelorus Sound/Te Hoiere Estuary, Havelock and the Kaituna Valley.

[52] Urban community, pers. comm., 18 September 2019.

Management

Council

MDC is a unitary authority, affording it the ability to integrate the management of land, water and coastal resources under the Marlborough Sounds Resource Management Plan and Proposed Marlborough Environment Plan. The plan was publicly notified in June 2016, and decisions on the plan were notified in February 2020 (though the aquaculture chapter of this unified plan was still due to go through public consultation at the time of writing). MDC is a small, agile council: staff adjust to different roles, and there is a high degree of interaction across functions.

On the other hand, there are extensive natural resources to manage, leading to capacity challenges for MDC. Communication channels exist with various stakeholder groups, but these groups feel that the low number of staff at MDC makes it challenging to ensure meaningful engagement. MDC is relatively well-staffed in terms of compliance, management and enforcement, at 0.2 full-time equivalent roles per 1,000 rate payers (Table 4.1).

Kotahitanga mō te Taiao Alliance

Kotahitanga mō te Taiao Alliance is a collaboration between all the councils in the top of the South Island, most iwi in Te Tau Ihu and DOC.[53] There are six iwi who claim an interest in the Pelorus Sound/Te Hoiere area – Ngāti Kuia, Rangitāne, Ngāti Toa, Ngāti Koata, Te Āti Awa and Ngāti Tama. All but Ngāti Toa have signed a memorandum of understanding with Kotahitanga mō te Taiao Alliance.

The alliance – 'collective action for our nature' – was established in 2017. The focus of the alliance is to co-develop landscape-scale conservation initiatives that have environmental, social, economic and cultural benefits. There is strong engagement in this process, and a strategy for how to implement the alliance's vision was released in 2019.

The Pelorus Sound/Te Hoiere catchment is the second catchment to receive a share in central government funding as part of the Ministry for the Environment's at-risk catchments project.[54]

Farming

MDC has run initiatives with farmers, including developing stream crossings, fencing, farm plans and on-farm effluent storage. Annual surveys show an improvement in compliance and a 95 per cent reduction in the number of stream crossings in the area since 2002.[55] As a result, *E. coli* levels in rivers are in the best 25 to 50 per cent nationally.[56] MDC is now turning its attention to managing other environmental issues not related to dairy farming.

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[53] Kotahitanga mō te Taiao, 2019.
[54] MfE, 2020b, p.12.
[55] Neal, 2017.
[56] LAWA, 2020c.

Forestry

Managing plantation forestry in the Marlborough Sounds by way of consenting processes has occurred for over 40 years. Complaints about the environmental effects of forestry are not new either. For example, a complaint was made to the Nature Conservation Council and the Minister for the Environment in 1974 on the effects of forestry on the Marlborough Sounds, in particular, mud washing off the hillsides into the sounds.[57]

Most slopes in Pelorus Sound/Te Hoiere are not currently deemed sufficiently steep to make forestry a restricted discretionary activity under the National Environmental Standards for Plantation Forestry. Following reclassification in 2015, the area in Marlborough categorised as having very high erosion susceptibility dropped from 91,000 to 3,000 hectares in Marlborough. Of this, only 146 hectares are currently in plantation forests or 0.2 per cent of plantation forestry in Marlborough.[58]

In 2018, the MDC Sounds Advisory Group suggested the development of a Marlborough Sounds sustainable land transition fund to support the retirement of land from forestry in the most erosion-prone areas, but this did not eventuate.[59]

MDC has been trying to improve the environmental performance of existing operations and constrain further planting.[60] Methods to trace the source of estuarine sediments back to land use are also being developed.[61]

Fishing and aquaculture

Danish sein fishing is prohibited in and around the entire Marlborough Sounds, and bottom trawling is prohibited in many parts of Pelorus Sound/Te Hoiere to protect habitats of significance.[62] To improve the connectivity between different agencies, a monthly forum of MDC, DOC and the Ministry for Primary Industries is run to discuss the coastal and marine environment, marine protected areas, and aquaculture.

A mussel restoration project in Pelorus Sound/Te Hoiere received a grant from the Ministry for Primary Industries' Sustainable Farming Fund in 2018. The project is supported by the National Institute of Water and Atmospheric Research (NIWA), The Nature Conservancy, the University of Auckland and industry.[63]

57 Nature Conservation Council, 1974.

58 Basher et al., 2015, Tables 3 and 4; Te Uru Rākau – Forestry New Zealand, 2018.

59 Urlich, 2018b.

60 Urlich, 2015.

61 Handley et al., 2017.

62 Davidson et al., 2011.

63 See https://www.marinefarming.co.nz/public/projects/pelorus-mussel-restoration-project/ [accessed 2 June 2020].

Source: Dr Sean Handley, NIWA

Figure 7.2.6: Green-lipped mussels in Pelorus Sound/Te Hoiere.

Development

MDC is limiting further growth of Havelock township with no new housing until issues with the wastewater treatment plant are resolved. A new wastewater treatment plant is scheduled for the 2021/22 budget and will be developed on a new site. Freshwater for domestic and industrial uses is also currently a limiting factor, with regular saltwater ingress issues.[64]

Proposed Marine Guardians

A Marine Guardians model has been proposed for the Marlborough Sounds by the Marlborough Girls College 2018 marine team, in collaboration with MDC. The proposal is inspired by the Fiordland (Te Moana o Atawhenua) Marine Management Act 2005 and the Kaikōura (Te Tai ō Marokura) Marine Management Act 2014. The proposal also suggests that the sounds be considered as a legal person, following the model of Te Awa Tupua (Whanganui River Claims Settlement) Act 2017.

Marine Guardians would have the statutory authority to commence a marine protected areas process, and would include iwi, members of the community, and local and central government, as well as a supporting advisory group.[65]

[64] MDC, pers. comm., 17 September 2019.

[65] Urlich et al., 2019.

Appendix 3: Tauranga Harbour

Source: Modified Copernicus Sentinel data, sourced from the LINZ Data Service
and licensed by Sinergise Ltd, for reuse under CC BY 4.0

Figure 7.3.1: Tauranga Harbour.

Physical form

Over 1,000 years ago, Tauranga Harbour, also known locally as Te Awanui, was a natural lagoon. Its catchment was covered in dense native forests, wetlands and sand dunes.

Tauranga Harbour is bounded by Matakana Island on the seaward side, and the barriers of Bowentown Heads to the north and the Mount Maunganui tombolo to the south. On land, the estuary is bordered by urban areas: Tauranga city, Mount Maunganui and the smaller settlements of Bowentown, Tanners Point, Katikati and Papamoa. An extensive catchment (1,300 square kilometres) feeds the estuary, bounded by the Kaimai Range, ending at Papamoa in the south. Catchment soils are volcanic with allophanic clay and lack bedrock.[1] This ensures good drainage but makes the soils vulnerable to drought and erosion.

[1] Stewart et al., 2018.

The Tauranga Harbour catchment has warm summers, mild winters and rainfalls ranging from 1,000 to 2,000 millimetres per year. Most of the precipitation occurs in intense rain events during autumn and winter. Seventy-three freshwater bodies collectively provide the harbour with around three and a half million cubic metres of freshwater per tidal cycle.[2] This extensive flow flushes deposited and suspended sediment away from the estuary and into the sea within 0.8 to 1.5 days. As a result, clear waters dominate the harbour. The deposition of sediment and contaminants around the harbour is also strongly influenced by tidal waves and wind. The influence of different sediment-dispersal actions makes it difficult to establish the sources and causes of cumulative sedimentation.

Source: Ethan Russel, BOPRC

Figure 7.3.2: Tanners Point, Tauranga Harbour.

History

Tauranga Harbour was a place of spectacular natural beauty when the first waka, *Tākitimu* of Ngāti Ranginui, captained by Tamatea-arikinui, arrived in 1290. This area is now recognised as the tribal area of descendants of the waka *Mātaatua*, among others.

Along the coast, kaimoana included pipi, tītiko, pāpaka, aua, tāmure and kahawai, and Māori of Tauranga Harbour followed strict protocols to maintain kaitiakitanga of the moana. Most important were rituals centred on preserving and upholding links to the spiritual guardians. These involved acknowledging the whakapapa of natural resources and conducting appropriate rites, such as rāhui, that recognised ngā atua and their domain.

[2] Hume et al., 2016.

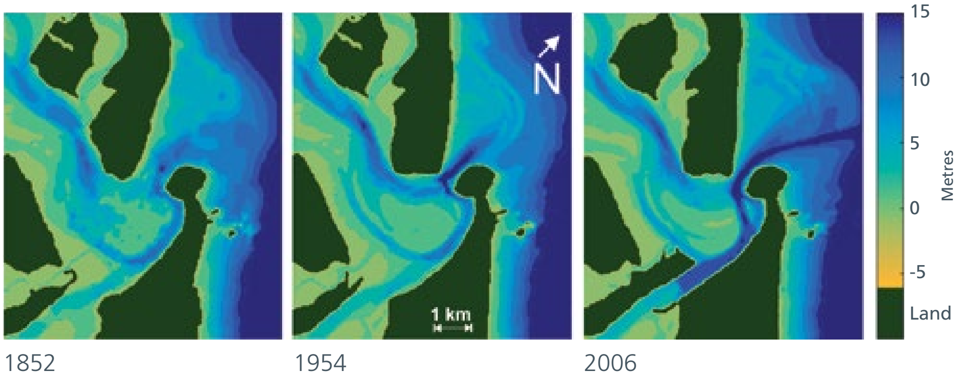
During settlement, Māori burned forests to grow bracken and create paths to hunt moa.[3] Disturbance of native vegetation was evident when Christian missionaries arrived in the 1870s. Areas of once-dense tree canopies were now covered in scrublands of mānuka, five finger, bracken, karamū, tutu and tree ferns.[4]

In January 1864, Brigadier General G. J. Carey and his British forces arrived at the harbour. European settlers cleared most of the forests in the Whakamārama, Kaimai and Oropi areas, and logged and mined the area southwest of Te Puke. However, agricultural expansion was hindered by the cobalt deficiency of the volcanic soils. The increase in logging made settlers dependent on maritime transport to export and import goods between Tauranga, Auckland and even Australia. This triggered the construction of the first port in 1873.

Pressures and state

Land reclamation and development

Construction of the Port of Tauranga, wharves, causeways, bridges and roads required land reclamation and channel dredging through the late nineteenth and early twentieth centuries.



Source: Ariana Moffatt and Karin Bryan

Figure 7.3.3: Tauranga Harbour bathymetric charts showing channel depths prior to construction and reclamation of Sulphur Point (1852), through to 2006.

In 1981, dramatic events surrounding the construction and almost immediate collapse of the Ruahihi Power Station had a major impact on the ecology of Tauranga Harbour. The collapse created a tsunami of freshwater that flooded surrounding farms and brought sediment into the estuary.[5] Freshwater organisms commonly found in the Wairoa River almost completely disappeared for several years, and the physical characteristics of the river were altered dramatically, becoming wider and shallower.[6] In the estuary, tuangi and seagrass beds were buried or destroyed, and with them, once-abundant fish species disappeared.

[3] Ewers et al., 2006.

[4] McQueen, 1961.

[5] Tauranga City Council, 2013.

[6] Waitangi Tribunal, 2010.

After multiple dredging events in the harbour over the years, the Environment Court granted consents for dredging to deepen and widen the entrance channel to the harbour in 2013. Work began in 2015, and further deepening and widening has since been consented. Tangata whenua have publicly opposed further port development and have sought reviews in the High Court against the Environment Court's decision.[7]

Wastewater and stormwater

With urban growth came the need for a wastewater system. The first septic tank was located at the Railway Wharf in 1913, which collected sewage from the strip of Tauranga city that extends into the harbour. The untreated waste was then discharged into the harbour to the dismay of residents gathering kaimoana. After several complaints about the smell, the Government proposed changing the discharge point to Sulphur Point a few hundred metres away towards the harbour entrance. However, the new location was considered to be just as bad as the harbour, as the Waikareao Estuary did not have enough outflow to push the effluent to open waters. Despite petitions signed by Māori from five settlements in 1928, the effluent disposal consent was granted – it was argued that while pipi beds were likely to be contaminated, they were distanced from Māori gathering grounds.[8]

Tauranga city now has two wastewater treatment plants – the Chapel Street plant that services sewage from Tauranga city, and Te Maunga plant, which receives discharges from Mount Maunganui and Papamoa. Once treated, wastewater from both plants is pumped out to sea, 950 metres offshore at Omanu. The outfall pipe will need to be replaced by 2028.

There are six wastewater treatment plants operating in the wider harbour catchment operated by various local government agencies, including ocean outfalls (Katikati, Waihī Beach, Maketū and Te Puke), land treatment via irrigation (Waihī Beach and Waiari Stream). Compliance ratings for the treatment plants have been high, with 93.7 per cent compliance for Western Bay of Plenty District Council and 100 per cent compliance for Tauranga City Council treatment plants.[9] Tauranga City Council manages the wastewater overflow mitigation and response, and monitors stormwater discharge and sediment in the harbour under a resource consent. This mixture of operators and different technologies creates a complex situation for management of wastewater.

Agriculture and horticulture intensification

The clearance of native vegetation and expansion of pastureland for agriculture and horticulture began to intensify in the 1930s. By then, technological advances enabled the limitations of volcanic soils to be addressed, especially through the application of fertilisers. Land use intensification brought with it the use of fertilisers, pesticides, hormones and growth enhancement additives. These activities contributed an increased sediment and nutrient load to the harbour.

[7] Hearing Commissioners, 2010.
[8] Waitangi Tribunal, 2010.
[9] Newlands, 2019.

The boom in the sector between the 1950s and 1970s influenced the construction of transport routes to bring produce to market. It also resulted in an increase in phosphorus and cadmium levels in soils, linked to fertiliser use. Since the 1980s, kiwifruit productivity has doubled due to the implementation of practices such as the replacement of former shelter trees with kiwifruit vines; enhanced pollination; creation of new kiwifruit cultivars; use of agrichemicals to increase flower numbers and uniformity of timing between male and female flowering; improved infrastructure for frost protection; and improvements in packing and cool storage techniques after harvest.[10]

Most of the pastureland converted to orchards over this period was on gentle slopes but sometimes included recontouring rolling land to reduce slopes. Steeper land in the catchment remains in pasture and continues to contribute sediment to the harbour.

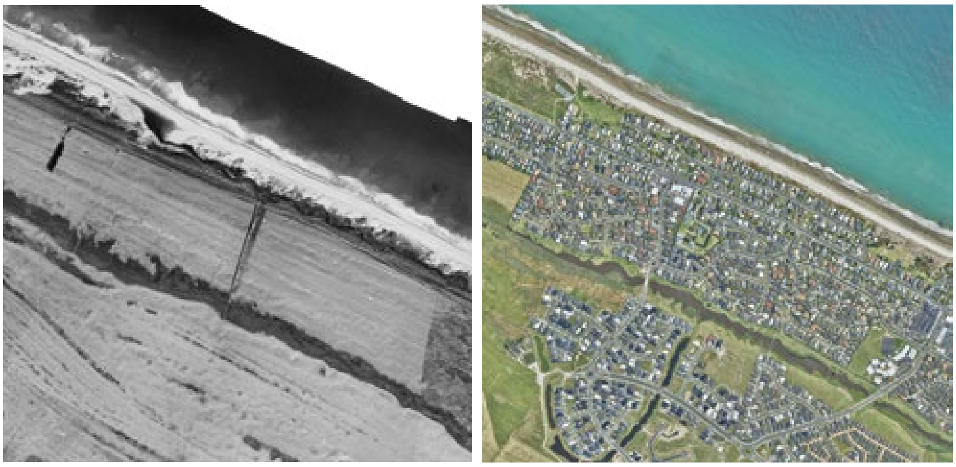
Rural and urban development

The Tauranga Harbour Board began monitoring the estuary in the 1970s, coinciding with the passage of the Marine Pollution Act 1987. By then, accumulation of rural and urban pressures since the 1950s was already evident. The quality and flow of freshwater was impaired, and shellfish beds had disappeared. Bathing and gathering kaimoana in some areas were curtailed. Increased erosion around the foreshore of Maungatapu, Matapihi, Te Puna and the islands of Motuhoa, Matakana and Rangiwaea threatened many cultural landmarks.

The development of lifestyle blocks has been a growing trend in the catchment, particularly around Papamoa (Figure 7.3.4). Almost 16 per cent of the land is used as lifestyle blocks or mixed-use land, while 8.6 per cent of the catchment comprises urban cover. The rapid expansion of lifestyle blocks has caused issues with sewerage and water, as both services need to be pumped and the systems lack capacity to service residents during peak capacity.[11]

[10] Ruth Underwood, Fruition Horticulture, pers. comm., October 2019.

[11] See https://www.tauranga.govt.nz/council/water-services/wastewater/treatment [accessed 5 December 2019].



Source: Bay of Plenty Regional Council

Figure 7.3.4: Urban intensification in Papamoa between 1939 and 2017.

Port of Tauranga

Throughout its more than 100-year history, dredging and reclamation related to operation of the port have led to changes in the harbour. After the implementation of the Resource Management Act 1991, two of three port sites – the Sulphur Point container terminal and an inland log storage area – obtained resource consents for the discharge of stormwater. A portion of the effluent from Sulphur Point passes through a settlement pond prior to discharge, and all of the stormwater from the inland log storage area is treated by flocculant-assisted settlement ponds.[12]

The management of pollution from the third port site – Mount Maunganui wharves – has been different. It operated without a resource consent to discharge stormwater for 28 years. However, it had in place a stormwater management programme that included recovering bark, dirt and debris from the catchment prior to rainfall via vacuum sweeper trucks and loaders. Some pipelines also have gross pollutant traps to prevent bark from logging operations entering the harbour. After a lengthy process that started in 2012, a consent was finally sought in early 2017 and granted in June 2019.[13]

The *Rena* oil spill

Ships entering and leaving the Port of Tauranga also have impacts on the coast. The *Rena* oil spill of 2011, considered the worst maritime environmental disaster in New Zealand's history, occurred on Astrolabe Reef, about 21 kilometres beyond the harbour mouth. In addition to the 1,733 tonnes of heavy fuel oils and 200 tonnes of marine diesel oil that were lost to the sea, eight of the 1,368 containers contained hazardous substances.

[12] Port of Tauranga, pers. comm., 2 December 2019.
[13] BOPRC, 2019d.

Although 1,300 tonnes of heavy fuel oil was recovered from the *Rena*, the beaches were covered in black thick hydrocarbons, known to accumulate in the tissues of marine organisms if ingested. Around 20,000 seabirds were affected by the spill. It will take years to assess the full extent of the disaster and the effects that sunken containers holding raw pesticide material such as highly toxic tributyltin (ship antifouling paint) and granulated copper could have on the ecosystem.[14]

After completion of the $700 million recovery project in 2015, which involved 8,000 volunteers, populations of birds such as little penguins and the nationally critical New Zealand dotterel have increased, and accumulation of hydrocarbons in shellfish are now below risk limits.

An unforeseen consequence of the *Rena* shipwreck was the development of a temporary fishery closure area during salvage operations. This closure resulted in increased biodiversity such as sponges, anemones, kelp forests and fish at the site, and it created a site for recreational divers.[15] Now that it is open to fishing, kaimoana stocks (especially crayfish) have fallen again.[16]

The Motiti Rohe Moana Trust sought permanent protection for this area. A legal case mounted in the Environment Court in 2019 and sustained in the High Court confirmed the power of local councils – in this case, Bay of Plenty Regional Council (BOPRC) – to regulate fishing to protect native species.[17] Early in 2020 a petition was launched calling on the Government to change the law to ensure that powers relating to fishing remain the prerogative of central government.[18]

Climate change

An increase in heavy rain events and sea level rise is predicted to occur as a result of climate change. Erosion of shorelines and cliffs has been observed in many parts of the harbour, affecting public and private structures. A recent study on sea level rise in the harbour estimated that by 2030, 640 properties could be affected by erosion triggered by heavy rains. By 2130, an estimated 1.6 metres of sea level rise could affect the city.[19] Maungatapu, Matapihi and Matua are among the harbourside areas of the city most prone to erosion. An increase in the sediment load to the harbour of almost 43 per cent by 2051 is also predicted.

Sea level rise will ultimately impact on community wellbeing and will likely affect the maintenance and sustainability of stormwater and wastewater networks.[20] Tauranga City Council and BOPRC have been collaborating on an audit programme to identify potential stormwater contamination risks from industrial sites and potential sites requiring discharge consents in order to improve stormwater discharge quality.[21]

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[14] Murdoch, 2013.

[15] Moorby, 2016.

[16] Phil Ross, Waikato University, pers. comm., 19 June 2020.

[17] Anderson et al., 2019.

[18] See https://www.national.org.nz/petition_launched_to_prevent_fishing_ban [accessed 19 June 2020].

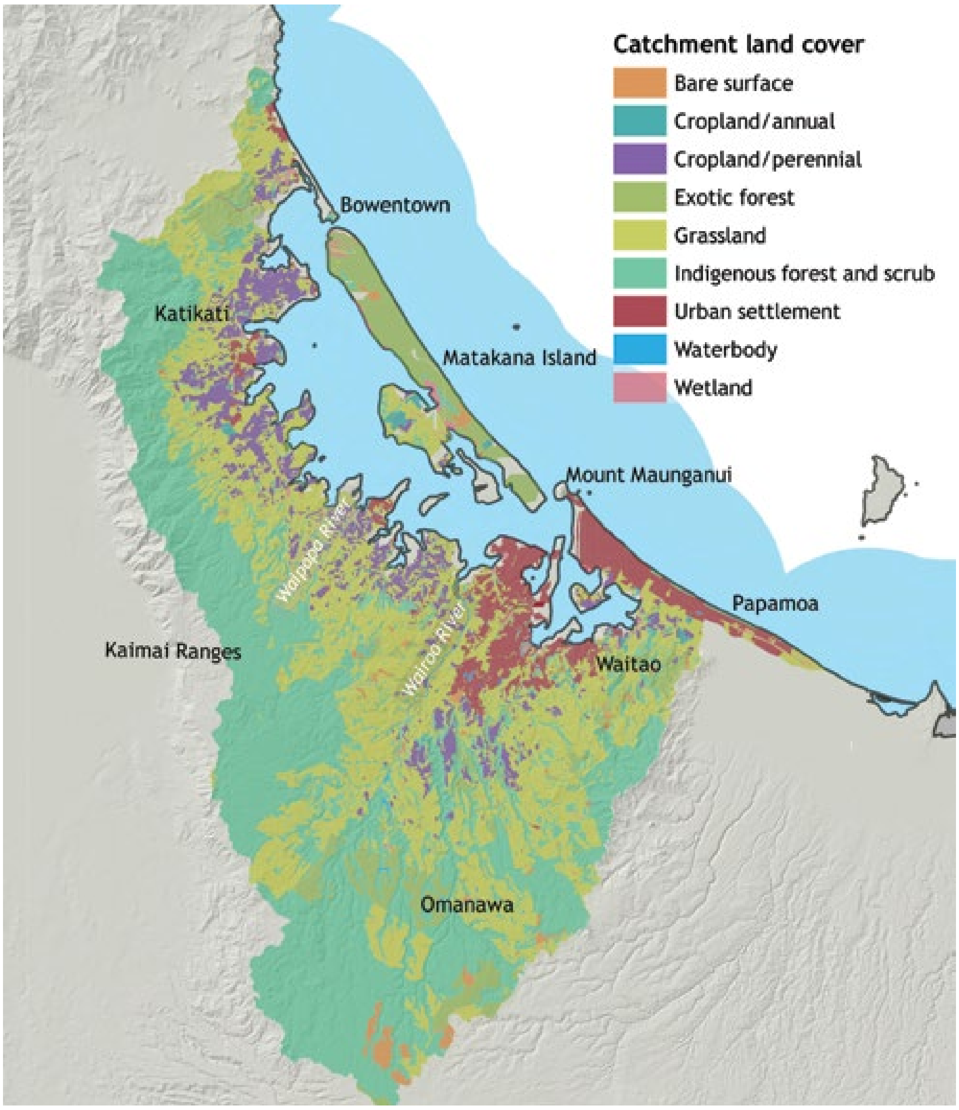
[19] Hume et al., 2010.

[20] BOPRC, 2015.

[21] Tauranga Moana Advisory Group, 2019.

In 2019, BOPRC declared a climate emergency. The Climate Change Action Plan has now been approved and BOPRC is working with the community to transition to low-carbon activities and adapt to the coming changes.[22]

State and monitoring



Source: Manaaki Whenua – Landcare Research[23]

Figure 7.3.5: Map of Tauranga Harbour catchment with its land uses.

Today, Tauranga Harbour is a shallow, mostly intertidal (77 per cent) drowned valley, with beds of seagrass, tidal flats, mangroves, saltmarshes, rush land and salt meadows. These areas have significant national and international ecological value. They are important zones for spawning, a nursery for īnanga and snapper, and have recreational values for flatfish, snapper and trevally fishing. The sand flats hold extensive beds of cockles and macroinvertebrates – important indicators of the health of the estuary.

[22] BOPRC, 2019b.

[23] Manaaki Whenua – Landcare Research, 2018, 2020.

Mangroves and marshes provide habitat for resident birds such as white-fronted terns, fernbirds and oystercatchers. Between October and April, the harbour provides important habitat for threatened migratory birds such as godwits, Australasian bittern and banded rails.[24] The harbour is also valued for its recreational and historical sites, as well as the urupā at Motuopae Island in Waikareao Estuary.

Land use in the catchment is mixed between urban, horticultural and agricultural uses. Native vegetation dominates the catchment (42 per cent of land cover), with a smaller component of exotic forests (12 per cent). Agricultural landcover (34 per cent grassland and seven per cent crops) supports a mixture of cropping, sheep, beef, deer and dairy farming, mainly on the lowlands. Rich volcanic soils with good drainage support horticulture (around four per cent kiwifruit and two per cent other crops). Urban settlement land cover has increased significantly over the past two decades, from four per cent in 1996 to 5.6 per cent in 2018 – a 40 per cent increase.[25]

Tauranga City Council and Western Bay of Plenty District Council are the territorial authorities responsible for the management of roading, the three waters system, land development and the effects land use may have on the associated resources in the catchment. They also have a general duty to conduct environmental monitoring, cultural management and landscape plans.

BOPRC, in conjunction with local councils, monitors groundwater and stream water levels and quality, and models water balance.[26] Monitoring has found that during rain events, zinc, and to a lesser degree copper, are the main pollutants exceeding ANZECC water quality guidelines trigger values around Tauranga city.[27] Concentrations of zinc were exceeded at 14 sites, and concentrations of copper were exceeded at 16 sites.

BOPRC began collecting water quality data in the estuary in 1989, and more extensive and comprehensive information has been collected for benthic ecosystems from the Tauranga Harbour since 2013 as part of its regular state of the environment monitoring programme.[28] This monitoring includes weekly testing for shellfish contamination during summer as part of the bathing water quality monitoring, monthly water quality sampling and bi-monthly monitoring for biosecurity risks such as the invasive seaweed *Undaria*. Sediment contamination and sedimentation rates are surveyed annually at 69 sites, with sediment-dwelling animals surveyed annually at seven sites, and polycyclic aromatic hydrocarbons every three years.[29]

[24] Chudleigh, 1990.

[25] Manaaki Whenua – Landcare Research, 2020.

[26] See https://www.tauranga.govt.nz/living/natural-hazards/understanding-our-hazards-studies-maps-and-data/flooding/flooding-from-rising-groundwater [accessed 5 November 2019]; BOPRC, 2016a.

[27] Tauranga City Council, 2019. Trigger value refers to concentrations of chemicals that, if exceeded, could pose a potential risk to organisms (at a sublethal or lethal level) and would require councils to start a management response.

[28] BOPRC, pers. comm., December 2019.

[29] Park, 2014; Dare, 2019.

The sedimentation rate in the harbour has also been measured strategically in sites where impacts were likely to occur since 2013 and has been variable across the catchment. Fifty-nine per cent of the 65 monitored sites[30] showed an increase in sediment accumulation compared to background levels,[31] with pastoral areas recognised as the source of 63 per cent of the sediments.[32] Sedimentation monitoring records are still short for the harbour, but trends indicate that sediment accumulation prevails in sheltered areas, while low levels of sedimentation were recorded at outer estuaries and main channels.

While sediments in the harbour have buried some shellfish beds and smothered about 34 per cent of the intertidal seagrass meadows, other species such as mangroves have thrived in sheltered areas with enriched land-based sediments. Mangrove expansion has more than doubled over the last 50 years.[33]

Increases in nutrient levels, suspended sediments and numbers of Canada geese and black swans have been linked to the decline of seagrass beds in Tauranga Harbour. Seagrass in northern Tauranga Harbour declined by 34 per cent between 1959 and 1996, and by a further 6.5 per cent between 1996 and 2011. However, seagrass extent in southern Tauranga Harbour increased by 3.8 per cent between 1996 and 2011, which was attributed to improved water quality in this area.[34]

Ecological assessments of harbour sediments have further linked the presence of chemicals, fine sediment (mud) and nutrients to changes in the structure of macroinvertebrate communities. While levels of heavy metals in harbour sediments are relatively low (well below guideline limit values) and have remained stable since 2008, the metals have synergistic interactions with sedimentation loading, likely affecting biological community structure in the estuary.[35]

Water quality at swimming beaches in the catchment is mostly positive – since 2014 most monitored beaches have been graded as having very good (29 per cent), good (36 per cent) or fair water quality (29 per cent). Only one site was graded as poor.[36]

BOPRC conducts regular surveys in un-reticulated communities to assess stormwater discharges, seepages and groundwater close to onsite wastewater treatment systems (i.e. septic tanks).[37] Monitoring has shown that sources of bacteria in certain areas are related to seepage from septic tanks, with an additional agricultural component in drains adjacent to fields with stock. Nutrients from submarine groundwater discharges are entering the harbour over prolonged periods, with inputs of nitrogen and phosphorus five and eight times higher respectively than inputs from surface waters.[38]

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[30] Monitoring sites were selected as sensitive areas of the harbour where sediment impacts are likely to occur. Locations monitored are not proportional to the whole of Tauranga Harbour.

[31] BOPRC, 2019c; BOPRC, pers. comm., 29 May 2020.

[32] Hume et al., 2010.

[33] Horstman et al., 2018.

[34] Park, 2016.

[35] Ellis et al., 2017.

[36] Lawton and Conroy, 2019.

[37] Scholes, 2018.

[38] Stewart et al., 2018.

A four-year research programme that started in 2015 – Oranga Taiao Oranga Tāngata – was developed as part of a government investment priority that aimed for New Zealand's estuaries and lakes to be "sustained or restored through enhanced knowledge and actions that improve the quality and resilience of these ecosystems."[39] The programme, coordinated by Manaaki Te Awanui Trust, universities and research institutes, uses science and mātauranga Māori to develop modelling tools and processes to assist iwi and hapū to identify preferred options for enhancing and restoring coastal ecosystems.

The project has produced surveys on cumulative impacts to biodiversity, modelling of coastal ecosystem services, a framework for an estuarine cultural health index (ECHI) and a mitigation matrix to determine best options for managing the harbour.[40] The ECHI, named Maatai, is now available to 11 iwi and hapū affiliates of Te Pūmautanga o Te Arawa Trust,[41] allowing them to become more involved in monitoring and identifying changes in the wellbeing of ecosystems within their areas. It is to be released nationally in 2020. ECHI surveys prioritise sites of cultural significance documented in iwi management plans, and their results contribute to collective knowledge that can be used to identify emerging concerns and improvements.

Community concerns

Ngāti Ranginui, Ngāi Te Rangi and Ngāti Pūkenga

In interviews conducted for this study, Tauranga Māori affirmed that their authority and capacity to act as kaitiaki in the management of cultural resources is a vitally important practical expression of their rangatiratanga over ancestral taonga. However, over the decades, tangata whenua of Te Awanui (Tauranga Harbour) have been excluded from decisions that have shaped their ancestral land and seascapes and use of coastal resources. Māori have felt unable to act as kaitiaki and unable to guard or protect their taonga from the impact of development.[42]

Changes in the harbour are limiting the ability of successive generations of Ngāi Te Rangi to maintain their cultural practices. For example, access to resources such as fish and other kaimoana has dramatically decreased. The iwi considers that further urban development and growth is unacceptable. It has witnessed degradation of the mauri of the harbour ecosystem and kaimoana resources, with treatment of wastewater and sedimentation key concerns for the iwi.[43]

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[39] See https://www.mtm.ac.nz/oranga-taiao-oranga-tangata [accessed 25 February 2020].

[40] Taiapa et al., 2014.

[41] See https://tpota.org.nz/ [accessed December 2019].

[42] Waitangi Tribunal, 2010.

[43] Waitangi Tribunal, 2010.

Port of Tauranga

The Port of Tauranga is the largest, fastest-growing and most productive port in New Zealand. It articulates its approach as "grounded in the principle of kaitiakitanga or guardianship – of our environment, our people, our community and our future."[44] The port company is pursuing improvements to air pollution, and is reviewing stormwater discharges to identify potential treatment options and improvements.[45]

Farming

Pastoral agriculture is the second most significant land use in the Tauranga catchment after indigenous and exotic forests (53 per cent).[46] Farmers are feeling pressure from the community and other sectors to reduce water pollution and sedimentation.

Since the mid-1900s the number of cows in the catchment has decreased from approximately 25,000 to 9,000, resulting in most of the land being converted to lifestyle blocks and horticulture.[47] While retention dams have been built in gullies to control sedimentation on the remaining agricultural land, their effectiveness is not always guaranteed. Heavy rain events, in particular, wash these nitrogen-rich agricultural soils into the estuary.

Dairy farms have a four-year environmental plan, largely driven by Fonterra. The plans are usually based on broad approaches that do not always capture the individual nature of a farm or address the different activities and systems employed on the land. Those assumptions may lead to inadequate management actions. Farmers aspire for councils to work with them and allocate more resources to suitable advice and monitoring for sedimentation and nutrient mitigation plans. They want water that is suitable for swimming and fishing.[48]

Tauranga catchment is home to a quarter of New Zealand's kiwifruit plantations. The horticulture sector feels it is addressing its environmental impacts on the catchment through monitoring and improving practices. Examples include application of nutrients during the plant-growing phase to reduce leachate, and maintenance of grass swards and in situ mulching of pruning to reduce sediment run-off. Environmental research priorities for the horticulture sector originally focused on reducing pesticide residuals through integrated pest management programmes (e.g. KiwiGreen). Between 2010 and 2016 the focus was on pest and disease control (e.g. *Pseudomonas syringae* pv *actinidiae* (Psa). The current focus is on the use and fate of fertilisers.[49]

[44] See http://www.port-tauranga.co.nz/download/fYkdff2bdadkN/ [accessed November 2019].

[45] Port of Tauranga, pers. comm., April 2020.

[46] Manaaki Whenua – Landcare Research, 2020.

[47] David Jensen, Puketiro Farm, pers. comm., 5 February 2020.

[48] David Jensen, Puketiro Farm, pers. comm., 5 February 2020.

[49] Fruition Horticulture, pers. comm., 4 October 2019.

Forestry

Rayonier Matariki Forests owns and manages 70 forests across the country, including a number in the Tauranga Harbour catchment. It aspires to look after its land but would like to have clearer rules about how to limit its impact. Rayonier feels the sector has been blamed for the increase of sedimentation in the harbour, especially since the removal of mangroves, yet there are inconsistent messages from scientists about the source of sediment.[50] It also feels that evidence for links between forestry activity and responses in estuary health (e.g. fish stocks in the estuary and source rivers) is lacking.[51]

The National Environmental Standards for Plantation Forestry are being implemented by the industry, but present challenges. For example, Rayonier feels that the standards are inconsistent with other regulatory documents such as the New Zealand Coastal Policy Statement and the National Policy Statement for Freshwater Management. It is concerned that regional councils may elect to impose rules that are more stringent than the national policies. This causes issues for operators working across several regions.

Regional forestry operators are specifically critical of urban engineers undertaking roles as advisors and consultants on forestry management post-harvest. This is closely linked to concern within the industry (and Rayonier) that conditions set in *TP223 – Forestry operations in the Auckland region* are not suitable for the management of forestry harvesting activities in the region due to the differences in mitigation practices between urban and forestry activities.

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[50] Some NIWA studies suggest sedimentation emerges from forestry activities while others (e.g. Manaaki Whenua – Landcare Research) suggest that compound specific isotope (CSI) techniques for tracing land use-related contribution of sediment are not conclusive.

[51] Rayonier Matariki, pers. comm., 5 September 2019.

Urban communities

Tauranga Harbour has 11 estuary care groups working to maintain ecological and recreational values across the harbour. Over the last 30 years, the groups have observed changes in the estuaries, from the colonisation of mangroves and the decline of fish species such as parore – both triggered by sediment accumulation – to the increased number of swans and Canada geese, and their influence on seagrass bed deterioration. Care groups link these effects to the poor management of habitats across the harbour's margins.[52]

While goals vary across community groups, the maintenance of open waterways to ensure access to the estuary is a shared goal. Care groups have strong financial and technical support from BOPRC and the Tauranga Moana programme. Ongoing programmes include:

- fixing fish passages to allow the migration of freshwater species such as whitebait
- installing farm fences
- rehabilitating harbour margin vegetation
- maintaining high-tide roosting sites for wading birds
- eradicating pest species
- removing rubbish
- running educational programmes with primary schools, Waikato University and Toi Ohomai Institute of Technology.

However, these activities occur in isolated pockets, and most of the coastal margins are unattended.[53]

Mangrove management is one of the main contentions in the community. In general, the community agrees that mangroves are natural habitats that are now part of the harbour. A minority of people claim that mangroves bring benefits to the harbour (e.g. they act as habitat for some estuarine species, protect the harbour from erosion and act as a buffer for sea level rise), and actively participate in community efforts to protect them. Others argue that while mangroves play an important ecological role, they have negatively impacted their estuaries by displacing other habitats, such as salt marshes, and blocked access to areas previously used for recreational purposes and mahinga kai.[54]

Mangrove expansion was managed by care groups and Tauranga City Council between 2005 and 2007. Shortly after that, BOPRC established rules to allow for mangrove control through resource consent granting. In 2014 a Mangrove Management Operational Policy was adopted to prevent the ongoing expansion of mangroves. An agreement was made to remove mangrove seedlings from 600 hectares per annum belonging to 13 sub-estuaries and open tidal flats of Tauranga Harbour (Figure 7.3.6).

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[52] Omokoroa Environmental Managers, pers. comm., 5 June 2020.

[53] Uretara Estuary Managers, pers. comm., 8 June 2020.

[54] Matua Estuary Care Group, pers. comm., 10 June 2020; Omokoroa Environmental Managers, pers. comm., 5 June 2020.

Source: Bay of Plenty ArcGIS map[55]

Figure 7.3.6: Thirteen sub-estuaries and open tidal flats where mangrove seedlings can be removed by estuary care groups under resource consent.

Recreational fishers

While snapper and trevally are currently caught in good numbers by recreational fishers, an increasing abundance of starfish has been noted, linked to blooms of sea lettuce in intertidal areas.[56] Likewise, fishers expressed concerns at the increased numbers of bronze whaler sharks within the harbour, and the potential dangers they pose to the environment and public.

Fishers are also concerned about run-off and pollution from drains entering the estuary from causeways and roads. Recreational fishers would like to see the implementation of greenbelts in orchards and farmland, improved filtration systems to reduce sediment loads, and the use of nutrient absorbers. They support restrictions on further building around the shores of the estuary.[57]

[55] Data source: http://gis.boplass.govt.nz/arcgis/rest/services/imagery [accessed February 2020].
[56] Mount Maunganui Fishing Club and commercial fisher, pers. comm., 2 October 2019.
[57] Mount Maunganui Fishing Club, pers. comm., 9 October 2019.

Management

BOPRC manages the harbour catchment under the Bay of Plenty Regional Policy Statement, and the Bay of Plenty Regional Coastal Environment Plan.[58] The second generation of the plan became operative in December 2019 and is aimed at sustainable management of coastal marine areas and surrounding land. This version includes new rules to regulate activities in the coastal marine area (e.g. discharge of sewage from boats and activities in high-value heritage areas)[59] and a new integrated management section that encourages a catchment approach that assesses cumulative effects. The new plan is to be used in conjunction with Ngā Whakaaetanga-ā-Ture ki Te Taiao ā Toi (Statutory Acknowledgements in the Bay of Plenty).[60]

Over a 10-year period starting in 2013, BOPRC will invest more than $63 million in the Tauranga Moana Programme, which aims to look after the health of the harbour, the land and its people.[61] The programme coordinates work on infrastructure and planning for the catchment, parks, recreation and maritime areas.[62] It involves collaboration between the regional council, Tauranga City Council, Western Bay of Plenty District Council, tangata whenua, DOC, researchers, industry and the wider community.

While the Tauranga Moana Programme has been running for seven years, it has not influenced local and national regulatory documents such as regional plans or national policy statements. There is an expectation that work done with the programme will be considered once legislation to implement the Tauranga Moana Iwi Collective Deed of Settlement is passed into law, and a resulting co-governance entity is created.[63] This would include representatives from Ngāti Ranginui, Ngāti Te Rangi and Ngāti Pūkenga.

Tauranga Harbour catchment is one of the water management areas selected for implementation of new policies under the National Policy Statement for Freshwater Management. BOPRC, together with tangata whenua and the Freshwater Futures community group, is to set and apply water quality and quantity limits. It is not expected that the plan will be implemented for the Tauranga Harbour area until 2025.[64] Although the plan change is focused on improving the quality of freshwater sources, the estuary will benefit from the changes.

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[58] BOPRC, 2014.

[59] BOPRC, 2019a.

[60] See https://www.boprc.govt.nz/your-council/working-with-iwi/statutory-acknowledgements/ [accessed 12 December 2019].

[61] BOPRC, 2016b; BOPRC et al., 2019.

[62] The Tauranga Moana programme excludes operational or transport infrastructure plans from BOPRC.

[63] BOPRC et al., 2019.

[64] MfE, 2017c.

Sustainable economic growth and environmental improvements have also been pillars of the SmartGrowth Future Development Strategy, a project launched by BOPRC, Tauranga City Council and Western Bay of Plenty District Council in 2004. While the strategy identified the importance of creating ecological corridors to protect sites of high ecological value between the Kaimai Range and coastal areas,[65] its 2013 version (currently under review) does not include specific information on how to implement or achieve such goals.[66]

BOPRC, together with DOC and Waikato Regional Council, currently supports the Kaimai Mamaku Catchment Forum. The group looks for options to plan and manage the Kaimai and Mamaku ranges and their catchments – as a collective – to protect and enhance the ecological and recreational values of its 240,000-hectare area. One of its objectives includes identification of potential areas for the creation of greenbelts and ecological corridors to connect forest and estuaries in the catchment.[67]

[65] van Meeuwen-Dijkgraaf et al., 2010.

[66] Part 8 of the SmartGrowth 2013 Implementation Plan mentions general goals without specific action plans: "Greater ecological protection is required, especially through key ecological corridors and linkages along rivers and streams." (SmartGrowth, 2013, p.54).

[67] Conroy and Donald, 2017.

Appendix 4: Te Awarua-o-Porirua Harbour

Figure 7.4.1: Te Awarua-o-Porirua Harbour.

Physical form

Te Awarua-o-Porirua Harbour is, along with Wellington Harbour, one of two significant natural estuaries in the southern part of the North Island. Te Awarua-o-Porirua Harbour has undergone significant changes over recent millennia. Around 9,500 years ago, the Onepoto arm was a swamp that then dried and supported a forest. The Pāuatahanui arm was a gravel outwash plain that evolved about 8,000 years ago from a freshwater swamp to the current drowned river estuary system. At that time, what is now Taupō Swamp was probably a fresh brackish lagoon.[1] Podocarp-hardwood forests dominated the catchment, which is approximately 193 square kilometres.[2]

[1] Blaschke et al., 2010.

[2] Swales et al., 2005a; Manaaki Whenua – Landcare Research, 2020.

The two arms of the estuary, Pāuatahanui and Onepoto, cover a surface of about 7.4 square kilometres at spring tide, of which an unusually high percentage (65 per cent) is underwater at low tide.[3] The estuary supports several habitats, including salt marshes, rocky platforms, gravel banks, sandy beaches and sandflats.

Porirua Stream and Pāuatahanui Stream (as distinct from the Pāuatahanui arm) are the largest of six main streams that drain into the estuary. Average rainfall in the catchment is 1,200 millimetres in its wettest months (May to October), and water remains in the harbour for seven days.[4] Water movement is mostly influenced by the tides, but currents in the middle of the estuary are also heavily influenced by wind because of its shallow depth.[5] In the coastal zone of the estuary, sand is moved in and out of the estuary by tides, prevailing northwest winds and long-period wave action.[6]

Source: Aidan Wojtas, Wikimedia Commons

Figure 7.4.2: Te Awarua-o-Porirua Harbour.

[3] Stevens and Robertson, 2008; Hume et al., 2016.

History

According to oral history, Kupe was the first to explore the Porirua area, while Tara and Tautoki visited but did not settle.[7] Between 1300 and 1500, Ngāti Ira settled in the area and became a large group in the 1820s when Ngāti Toa Rangatira migrated from the Waikato region and occupied the area with various settlements on the estuary.[8]

When Ngāti Toa settled, the area still had plentiful resources. Most estuarine and coastal shellfish species were harvested, and fish species were diverse and abundant. In the 1890s, their main food source came from the estuary and consisted of pipi, mussels, oysters, pūpū, pātiki, ngōiro, tāmure and tuna.[9] This food source was particularly important during the depression of the 1930s.[10] Cultivation sites were also established on the flat and low east-facing slopes at Pāuatahanui.[11]

The estuary was not only used for its resources but also as a playground for tamariki, and in later years when Mormonism became dominant within Ngāti Toa, the estuary was used for baptismal rituals during the 1940s and 1950s.[12]

Naming of areas was used to connect to the area and as an educational tool. Knowledge was passed down orally, so ways of transferring it accurately through naming was important. For example, Te Whata-kai-a-Tamairangi (the food store of Tamairangi) is a sandy bank in the estuary named after a high-ranking woman from Ngāti Ira.[13] Another sandbank – Ngā Karu o Topeora – was named after a niece of Te Rauparaha, leader of Ngāti Toa Rangatira.[14] These two places were valuable mahinga kai sites where stingray, shark, mullet and pipi were harvested. The pipi at Ngā Karu o Topeora were said to be as big as a person's eyes, hence the reference to karu.

Europeans began to arrive in the area in the early 1820s through whaling, sealing and trading, but significant settlement did not occur until the 1840s.[15] Development over the ensuing century and a half is, among other things, a story of the deterioration and near elimination of the estuary as a food source for tangata whenua.

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7 Taonui, 2005, 2007.

8 Bauchop, 1997; Ngati Toa Rangatira et al., 2012, p.12. For example, Taupō pā, Motukaraka, Te Onepoto and Te Kahikatoa were all settlements of Ngāti Toa.

9 Ngati Toa Rangatira et al., 2012, p.43.

10 Ngāti Toa Rangatira, 2019.

11 Healy, 1980, p.11.

12 Oral history participant 13.

13 See http://nzetc.victoria.ac.nz/tm/scholarly/tei-SmiHist-t1-body1-d16-d16.html [accessed 24 June 2020].

14 Oral history participant 9. There are differences within the iwi as to the name of this area. For example, it has also been referenced as Ngā Whatu o Topeora; see http://www.gw.govt.nz/assets/Ngati-Toa-Te-Awarua-o-Porirua-Values-and-Attributes-Report-April-2017.pdf [accessed 19 June 2020].

15 Healy, 1980.

Pasture conversion and roading construction started in the nineteenth and early twentieth centuries. Construction of the North Island Main Trunk railway began along Onepoto in the 1880s and the road bridge in the 1930s.[16] By this time, about 500 people lived in Porirua.[17] Ngāti Toa observed a marked difference in the amount of food available in the estuary compared to earlier times. However, they were still able to manaaki their guests in the 1940s when the 28th Māori Battalion came to Wellington.[18]

A housing crisis in the Wellington region in the 1930s kick-started a state building programme, and Porirua was chosen for the development. The first hospital to be built in Porirua dates to the 1880s. By the 1940s, up to 2,000 patients could be cared for in hospital facilities.[19] About 5,000 people then populated Porirua.[20] During the 1950s, housing and roading developments expanded rapidly.[21] Ngāti Toa still harvested from the estuary, but they experienced upset stomachs and sometimes caught typhoid.[22]

The 1960s saw a push for industrial and commercial expansion that saw development nearly surround the estuary and the population quadruple to 20,000.[23] In the 1970s, 770,000 cubic metres of soil were excavated and moved to reclaim land at the head of Onepoto for the development of Porirua city (see Figure 7.4.3).[24] Further drainage and channelling were constructed to reduce flooding in the business areas of the city. Mana Marina was constructed in the early 1980s, removing a further six hectares of tidal flats and dunes.[25]

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[16] Healy, 1980, pp.11–32.

[17] Scrimgeour, 1995, p.3.

[18] See https://28maoribattalion.org.nz/video/m%C4%81ori-battalion-returns-part-1 [accessed 19 June 2020].

[19] Scrimgeour, 1995, pp.2–7; PCC, 2015.

[20] Keith, 1990, p.53.

[21] Scrimgeour, 1995, pp.2–7.

[22] Oral history participant 10.

[23] Keith, 1990; PCC, 2015.

[24] Scrimgeour, 1995.

[25] Blaschke et al., 2010.

Source: Derrick Coetzee, Flickr

Figure 7.4.3: Land reclaimed in the 1970s using spoil from the Todd Motors site is now the site of multiple buildings in Porirua city.

The population of Porirua city continued to grow between the 1970s and 2018, increasing from about 20,000 people to 60,000. The total population within the catchment includes areas within the Wellington city boundary, which have also seen steady growth from around 28,000 to 38,000 residents between 1991 and 2018. The total population within the catchment in 2018 was about 95,000.[26]

Pressures and state

Since human arrival, Te Awarua-o-Porirua Harbour and its catchment have undergone significant land use changes, first to pasture, then urbanisation. The cumulative impacts of changes to land cover, rail and road construction, and an increasingly built-up environment have all contributed to the degradation of the estuary.

Pasture conversion and roading construction during the nineteenth and early twentieth centuries saw 50 per cent of the freshwater and saltwater marshes in the Pāuatahanui arm and nearly the full extent in the Onepoto arm disappear.[27] Some were filled while others were drained.[28] Dried-out areas, including those found within the Pāuatahanui Wildlife Management Reserve, were colonised by new species like rushes and grasses, which reduced the feeding areas available for wader birds. Established in 1981, the wildlife reserve protects tidal flats, indigenous salt marsh vegetation and tidal creeks, and provides a natural ecosystem for migratory birds and other species. The reserve is one of the few remaining areas where the shoreline has not been hardened by roading.[29]

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[26] See http://nzdotstat.stats.govt.nz/wbos/Index.aspx [accessed 11 February 2020]. These figures do not include temporary residents from tourism. The 2011 Census was cancelled because of the Christchurch earthquake. Population is rounded to the nearest hundred. Wellington suburbs included were Tawa, Linden, Greenacres, Grenada North, Churton Park (north and south), Takapu-Horokiwi, Johnsonville (not south), Grenada Village, Paparangi and Woodridge.

[27] Blaschke et al., 2010.

[28] Healy, 1980; Blaschke et al., 2010.

[29] Owen, 1984; White, 2005.

Source: Keith Calder, Flickr

Figure 7.4.4: Pāuatahanui Wildlife Management Reserve covers 50 hectares and contains the foremost salt marsh in the lower North Island.[30]

Substances historically used in agriculture have also left their mark on the estuary. Though no longer used today, chemicals such as DDT, tributyltin, PAHs (polycyclic aromatic hydrocarbons) and lindane have entered waterways and contaminated deposited sediments and estuarine water. In addition, the estuary has been subject to nutrients and faecal contamination from livestock on agricultural land. Pollutants from urban areas and roads have also left their mark. Substances such as copper from vehicles on roads and zinc from roofs are evident in sediments.[31]

Successive road and rail construction, as well as reclamation, has affected the hydrology of both arms of the estuary, resulting in coastal erosion in some places and increased sedimentation in others. For example, bridges at Paremata carrying State Highway 1 and the railway have constrained the tidal flow, reduced ebb-flow variation and probably changed the velocity of flushing. Land reclamation for the railway also resulted in erosion and coastal retreat for the adjacent Ngāti Toa Domain, as wave energy modified by the reclamation prevented sand from accumulating.[32] Settling of additional sediments in Te Awarua-o-Porirua Harbour has smothered some seagrass and shellfish beds.[33]

[30] See www.doc.govt.nz/globalassets/documents/parks-and-recreation/places-to-visit/wellington/pauatahanui-brochure.pdf [accessed 19 June 2020].

[31] Blaschke et al., 2010.

[32] Stirling, 1983.

[33] Healy, 1980; Stevens and Robertson, 2014.

Reclamation, upstream re-channelling, modification of the riparian margin to build hard walls and stream straightening have destroyed some of the vegetation needed for īnanga to spawn.[34] Construction and reclamation have also destroyed or degraded habitat for wader birds, shellfish and plant species.[35] Pipi beds, breeding grounds and some of the pātaka of Ngāti Toa were destroyed when city and coastal roads were built.[36]

With urban development in Porirua city came increasing stormwater and wastewater pressures. Historically, untreated waste was discharged directly into streams discharging to the estuary, including waste from the hospital into Porirua Stream in the 1940s.[37] Residents also vividly recall seeing streams that were coloured from discharges making their way into the estuary.[38]

Today, wastewater and stormwater are separated through different pipe networks, however, illegal cross-connections of wastewater to the stormwater network continue to be found, leading to some untreated sewage being discharged straight into the estuary or the coast. During heavy rainfall the wastewater system overloads and is designed to overflow into the estuary, which happens on average six times a year.[39] Stormwater and wastewater are most likely the main contributors of heavy metals, bacteria and excess nutrients to the estuary.[40] In addition, urban run-off, particularly from roading, contributes to nutrients, pathogens, heavy metals and other contaminants discharged to the estuary.[41]

Marine pressures bearing on the estuary also include invasive pests. The invasive sea squirt *Styela clava*[42] and the invasive seaweed *Undaria* have both made their way into the estuary. *Undaria* is spread mainly by fouling on boat hulls. Both species can displace native species and are considered nuisance fouling organisms.[43]

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[34] Taylor and Kelly, 2001.

[35] Owen, 1984; PCC, 2015.

[36] Ngāti Toa Rangatira, 2019.

[37] Ngāti Toa Rangatira, 2019.

[38] Oral history participant 11.

[39] Wellington Water Limited, pers. comm., 27 May 2020.

[40] GWRC, 2012.

[41] Oliver and Milne, 2012.

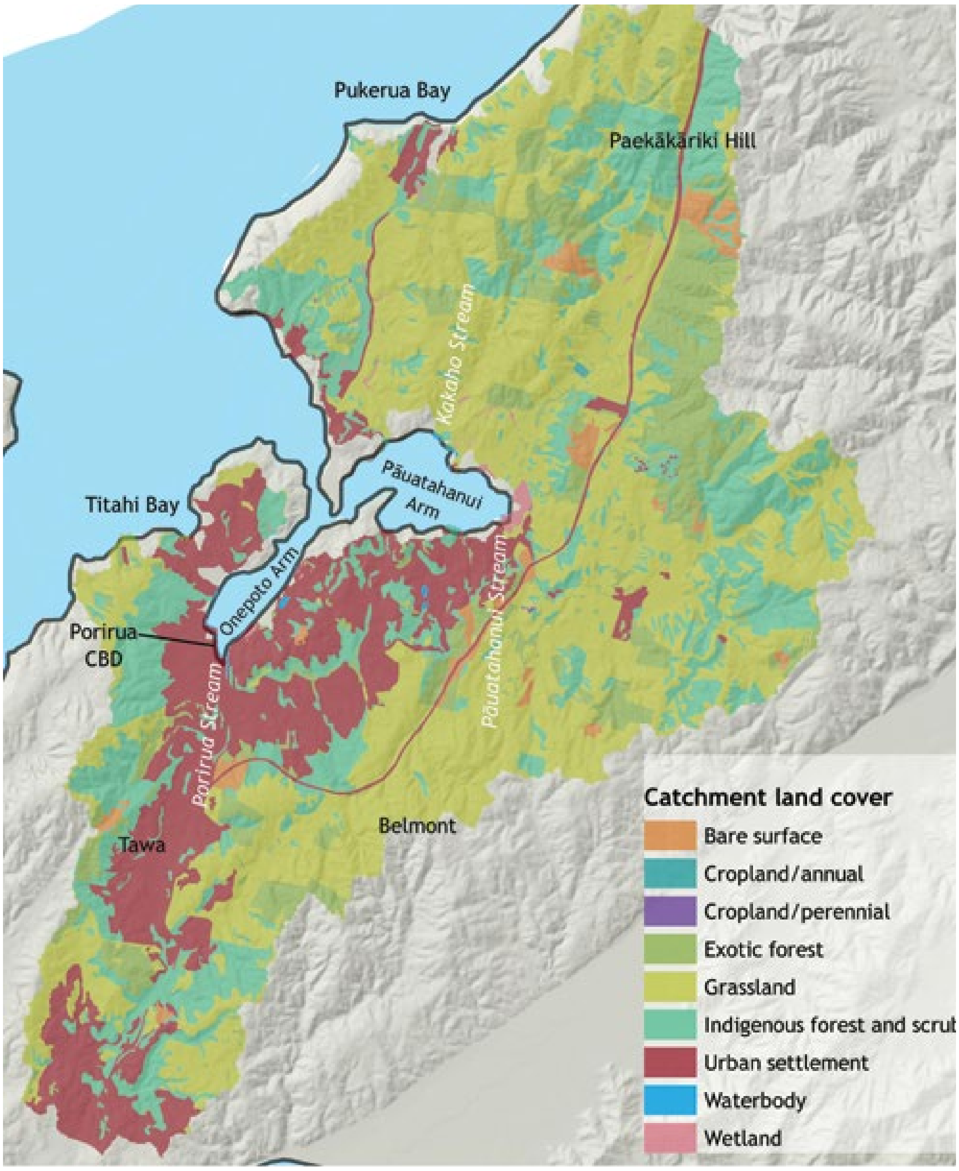
[42] See https://www.biosecurity.govt.nz/protection-and-response/finding-and-reporting-pests-and-diseases/pest-and-disease-search/ [accessed 19 June 2020].

[43] Stevens and Robertson, 2008.

The impacts of climate change on the estuary may include sea level rise, drought, landslides, erosion and flooding, especially from storm surges corresponding with high tides (storm tides).[44] There has been a decline in the area of salt marsh around both arms due to the extensive seawall and road network. Salt marshes around the estuary will therefore be especially vulnerable to climate change as there is no possibility for them to move inland. This is important because salt marshes are a large contributor of detritus that is then available to benthic deposit feeders in the estuary.[45] As the sea level rises, sea rush communities are likely to decline, resulting in detrimental effects on the communities that feed on them.[46] There will also be effects on residential areas. For example, Grays Road (on the margin of Pāuatahanui arm) is known to flood for several hours in storms and high tide conditions.[47]

[44] Tait et al., 2002.
[45] Healy, 1980.
[46] FOCUS, 2020. PCC is planning for a sea level rise between 0.6 and 1.4 m by 2120.
[47] Gibb and Cox, 2009.

State and monitoring



Source: Manaaki Whenua – Landcare Research[48]

Figure 7.4.5: Map of Te Awarua-o-Porirua Harbour catchment with land use.

[48]Manaaki Whenua – Landcare Research, 2018, 2020.

In 2018 the catchment of Te Awarua-o-Porirua Harbour comprised 43 per cent grassland, 24 per cent native vegetation, 18 per cent urban settlements, 13 per cent exotic forest, and 2.3 per cent other (Figure 7.4.5). The main changes since 1996 were an increase in urban settlement from 15.2 per cent to 18.2 per cent and a decrease in grassland, down from 47.6 per cent. The estuary's 200-metre terrestrial margin in 2012 was dominated by grassland (36 per cent), residential development (31 per cent), artificial structures (ten per cent) and commercial development (four per cent). Artificial shoreline structures (e.g. rock walls, flood banks, causeways) are a dominant feature around two thirds of the estuary.[49]

Research and monitoring in parts of Te Awarua-o-Porirua Harbour and its catchment have been ongoing since the 1970s. There is a plethora of reports on specific aspects of this system, from river water quality to bird populations. In the last couple of decades, some of the monitoring has been standardised and centralised to contribute to Greater Wellington Regional Council's (GWRC) state of the environment reporting and to fulfil actions under Te Awarua-o-Porirua Harbour and Catchment Strategy and Action Plan.[50]

Notwithstanding its history, Te Awarua-o-Porirua Harbour is still home to millions of cockles.[51] It is an important nursery for fish and is the southernmost significant nursery for rig.[52] The most commonly found fish are yellow-eyed mullet, rig, spotty and mottled triplefins.[53] The lower reaches of the streams entering the estuary are spawning and rearing grounds for whitebait and other native fish species and a migratory path for tuna.[54]

Taupō Swamp is a significant wetland with high biodiversity value, providing habitat for four threatened indigenous migratory fish (longfin eel, giant kōkopu, īnanga and redfin bully).[55] More than 35 wetland bird species inhabit the Pāuatahanui arm, and more than half are at risk and declining.[56] These include banded rail, spotless crake and fernbird.[57]

GWRC has been monitoring three streams (Horokiri, Pāuatahanui and Porirua) for freshwater quality since 1987.[58] Trends over time show variable and worsening water quality and ecological health due to sedimentation, nutrients and stormwater contaminants. Heavy metal concentrations have been recorded near or above early warning guidelines since 2012. GWRC has also been quantifying sedimentation rates from three streams to derive measures of annual sediment loads to the estuary.[59]

[49] Stevens and Robertson, 2013.

[50] Oliver and Milne, 2016.

[51] Te Awarua-o-Porirua Harbour's estimated cockle count was 410 million (Lyon and Michael, 2015; Michael and Wells, 2017), which compares favourably with surveys conducted in selected northern North Island intertidal sites where estimates ranged from 23 million to 742 million (Berkenbusch and Neubauer, 2016).

[52] Kaipara, Whāingaroa, Waitematā, Tamaki, Manukau and Tauranga are also significant nursing estuaries for rig (Francis et al., 2012).

[53] Lyon and Francis, 2013.

[54] Jones and Hadfield, 1985.

[55] GWRC, 2019b.

[56] PCC, 2015; Robertson et al., 2017c.

[57] See http://www.gw.govt.nz/threatened-bird-species-put-in-appearance-at-pauatahanui/ [accessed 18 June 2020].

[58] Blaschke et al., 2010.

[59] Morar and Alberto, 2019.

The overall condition of the estuary has been described as "good to moderate".[60] For example, surveys of cockle, mudflat top shell and mud whelk in 2015 and 2017 showed a significant increase in abundance in the Onepoto arm.[61] However, long-trend monitoring does show that over time there has been an overall decline in harbour health and the streams that feed into it. Furthermore, while the condition of the intertidal areas is good to moderate in most places, there are hotspots of major contamination in subtidal sediments.[62]

Large-scale habitat mapping of the intertidal zone was carried out in 2008 and 2013 and is due to be conducted again in 2020. Data captured prior to 2008 had varying methodologies and sampling focus, so are not reported here.

The intertidal area of the estuary is predominantly sandy (70 per cent), however, soft mud cover increased from one per cent to eight per cent between 2008 and 2013, changing the estuary's condition under this indicator from good to fair. Seagrass cover remains relatively stable, having declined by nine per cent over the same period after a decline of about 40 per cent from 1960 to 1980. After large-scale losses, salt marsh cover is moderate and now stable. Macroalgal cover is moderate. Macroalgae is an indicator of excess and sustained nutrient inputs. It has been assessed annually, but no grossly eutrophic areas have been found.[63]

Large-scale mapping of the subtidal zone was carried out in 2014.[64] Overall, the subtidal area was dominated by soft mud and poor water clarity, highlighting sedimentation as the main pressure on the subtidal estuary. There were, however, no eutrophication symptoms.[65]

Sedimentation rates in the estuary have been monitored annually at four sites since 2008, which increased to 18 sites by 2012. Sediment rates at those sites vary between −5 and +11 millimetres per year, highlighting the different resuspension processes at play in different parts of the estuary, and their different vulnerabilities to catchment inputs.[66] Where sedimentation rates on sandflats are high, algal growth has been observed.[67] One site in particular at Kakaho had an increase of 18 millimetres of mud content between 2016 and 2017, mostly coming from catchment inputs after heavy rainfall events.[68]

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[60] Stevens and Robertson, 2013.

[61] Lyon, 2018.

[62] Sorenson and Milne, 2009; Oliver and Conwell, 2014.

[63] Matheson and Wadhwa, 2012.

[64] Stevens and Robertson, 2014.

[65] Stevens and Robertson, 2008, 2013, 2014.

[66] Stevens, 2018b.

[67] GWRC, 2012.

[68] Stevens, 2018b.

Although sediment deposition trends for the Onepoto arm show a decrease between 2012 and 2017 due to site-specific sediment erosion, there has been an increase in subtidal areas covered by soft mud. Between 2012 and 2017 intertidal sediment deposition has increased by 0.6 millimetres per year in the Pāuatahanui arm and three millimetres per year in the Onepoto arm. However, subtidally (where greatest sedimentation is predicted) there has been an increase of 11.3 millimetres per year, and at certain sites like Kakaho, Horokiri and Duck Creek, increases as high as 20–27 millimetres per year have been recorded. This sedimentation rate carries a very high risk rating.[69]

Fish and shellfish have been periodically tested for faecal coliforms, trace metal and other contaminants and have sometimes been found to exceed guidelines for edibility. In the most recent tests in 2006, PAHs and other emerging organic contaminants were not tested. Generally, metal concentrations in 2006 were higher than concentrations found in earlier studies.[70] Furthermore, metal accumulation, particularly mercury, may affect future generations of rig sharks as maternal concentrations may be passed to their pups.[71]

In common with similar sites around New Zealand, water samples near popular shellfish gathering grounds are tested weekly during summer for the presence of faecal coliform contamination. If the shellfish are not safe to eat, public health warnings are issued and signs are posted on affected beaches. The first permanent signs signalling shellfish contamination were put up in 1998 in five locations in the estuary. One has also been erected at Porirua Stream mouth. The local Medical Officer of Health understands that temporary warning signs are also erected when a known sewage overflow is reported and remain in place for a period of four weeks.[72]

Water quality for swimming is monitored weekly at four sites during the summer months within Te Awarua-o-Porirua Harbour, and one site fortnightly in winter. Based on the last three years' data, only one site has a low risk of bacterial contamination when swimming: the Paremata bridge site. All other sites had a medium or high risk of bacterial contamination.[73] As in many urban estuaries, it is not recommended to swim, undertake water-based activities or collect shellfish after heavy rain events.

The Porirua Harbour and Catchment Community Trust was established in 2011 with representation from Porirua City Council (PCC), Wellington City Council (WCC), GWRC, Ngāti Toa Rangatira and community members. Between 2013 and 2017 it published an annual state of the harbour scorecard summarising the results of the most recent monitoring.[74]

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[69] Stevens, 2018b.

[70] Milne, 2006.

[71] Cook-Auckram, 2019.

[72] Jill McKenzie, Regional Public Health, pers. comm., 14 February and 23 June 2020.

[73] See https://www.gw.govt.nz/annual-monitoring-reports/2019/recreation-water-quality/enterococci.html [accessed 18 June 2020].

[74] Baker et al., 2018; see also http://www.poriruaharbourtrust.org.nz/annual-state-of-the-harbour-scorecard/ [accessed 19 June 2020].

A trial survey to develop cultural health indicators was carried out in 2016 by Ngāti Toa Rangatira, Department of Conservation (DOC) and GWRC.

Community concerns

Ngāti Toa Rangatira

The main concern Ngāti Toa expressed is that they are unable to connect to the estuary in the ways they used to, losing a part of their identity in the process. They feel that, for example, instead of harvesting mussels for kai, they now only collect them to check their health;[75] instead of swimming in the estuary, they pursue waka ama because of health concerns;[76] and instead of mahinga kai, Ngāti Toa hold regular clean-up days in Onepoto.[77]

Ngāti Toa feel that a failure to consult and involve them in decision making has resulted in the destruction of their pātaka and pollution of the estuary and has contributed to the mismanagement of the water infrastructure, resulting in the degradation of the mauri of the estuary. They feel that historical management tools like rāhui are not enforced nor well understood.[78]

Ngāti Toa want a healthy estuary so that their people can be healthy. To achieve this, Ngāti Toa continue to strive for a stronger voice at the decision-making table. As a partner under Te Tiriti o Waitangi and through their settlement, Ngāti Toa have gone some way to achieving this, but consider there is still room for improvement. Reclaiming rangatiratanga through collaborative groups and partnerships with councils and central government organisations is a positive step. Getting the community to connect to the estuary is also an important goal for Ngāti Toa.

A formal declaration by Ngāti Toa about its expectations for the estuary states:

> "When our people are physically and spiritually well and culturally thriving, we will know that the mauri of Te Awarua-o-Porirua has been restored. Ngāti Toa will hold to account all those who make decisions that affect the kaitiaki relationship that Ngāti Toa have with Te Awarua-o-Porirua. It is a responsibility that the people of Ngāti Toa accept, and we will work with our partner organisations to ensure that we are progressing towards success."[79]

Urban communities

Many users visit both arms of the estuary for swimming, boating, waka ama, water-skiing, walking their dogs and cycling. Some still collect shellfish even though it is recommended not to collect shellfish in the estuary due to the potential health risks. Multiple local groups are working towards restoring and monitoring the estuary and connecting with it.

[75] Oral history participant 11.

[76] Oral history participant 10.

[77] Oral history participant 12.

[78] Sharli Jo Solomon, Ngāti Toa Rangatira, pers. comm., 18 June 2020.

[79] Ngāti Toa Rangatira, 2019.

There is also an extensive environmental education network that includes organisations such as Mountains to Sea Wellington, PCC, Papa Taiao Earthcare, Guardians of Pāuatahanui Inlet, DOC, Te Aho Tū Roa, Porirua Harbour Trust, GWRC, Enviroschools and Wellington Water. One of the main goals of the network is to mobilise schools to support their students to actively restore and protect their local waterways through activities such as plantings, predator control, fish passage enhancement, water quality monitoring, art, and advocacy with local councils.[80]

The Porirua Harbour and Catchment Community Trust has been working to limit and preferably stop the degradation of freshwater inflows, to manage sedimentation and climate change, to restore estuarine ecosystem health, and to enhance community understanding of the estuary ecosystem and its catchment.

The trust was concerned with Transmission Gully motorway development and proposed environmental controls during the Board of Inquiry process[81] and subsequent re-evaluation of allowed exposed ground.[82] The trust is concerned that this change may have contributed to more silt deposition in the estuary. Other concerns the trust has include:

- inadequate management of changes in land use
- inadequate knowledge of rural land management by rural lifestyle residents
- contaminants from vehicles
- climate change
- rubbish
- inadequate community awareness
- lack of connection between the multiple authorities, including road and rail agencies
- ageing infrastructure
- limited financial resources.[83]

Farming

The farming population today is small compared with that of the early 1900s. Nevertheless, farmers in the Pāuatahanui arm of the catchment felt they had a strong community. They emphasised their deep connection with the land, which extends to the estuary. The farmers interviewed felt that they rely heavily on the condition of the land and water, and for some farmers there is a strong desire to ensure a smaller ecological footprint. They noted that they had taken steps to reduce the amount of sediment and contaminants entering the estuary from their land through stock exclusion, riparian planting and retirement of steep land.

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[80] Rebecca McCormack, Education Coordinator, Porirua Harbour and Catchment Community Trust, pers. comm., 3 June 2020.

[81] The trust's predecessor organisation, the Pāuatahanui Inlet Community Trust, proposed these controls during the process.

[82] Ground exposure was subject to re-evaluation by GWRC without any requirement for public notice (Board of Inquiry resource consent condition E1 and E2, and PCC E21). One significant change approved by GWRC allowed for nearly 97 hectares of ground to be exposed at one time as opposed to the 23 hectares approved by the Board of Inquiry (Cross, 2016).

[83] Baker et al., 2018; Porirua Harbour and Catchment Community Trust, pers. comm., 13 June 2020.

There is concern from the farming community that it is being blamed for the pressures on the estuary, and that there is a need for their voice to be heard. The farmers interviewed felt that connecting people from the wider community back to the land would be a good start to changing the conversation, as well as educating the community on the direct and potential impacts from farms on the estuary. One farmer interviewed also felt that, rather than disincentivising owners, managers should focus on enabling positive changes.[84]

Management

Many agencies are involved in the management of Te Awarua-o-Porirua Harbour, including GWRC, PCC, WCC, Ngāti Toa Rangatira, Wellington Water Limited, DOC, the New Zealand Transport Agency, Forest & Bird and KiwiRail. In 2006, PCC partnered with Te Rūnanga o Toa Rangatira, WCC and GWRC to develop Te Awarua-o-Porirua Harbour and Catchment Strategy and Action Plan. This strategy was last updated in 2015 and is reported on annually.[85] A major review of the strategy was carried out in 2019.[86]

In response to the National Policy Statement for Freshwater Management 2014, GWRC set up a catchment-based process with iwi, the community and the three councils to develop objectives, attributes and limits. This process was carried out by Te Awarua-o-Porirua Whaitua Committee from 2014 to 2019 and resulted in *Te Awarua-o-Porirua Whaitua Implementation Programme* and the *Ngāti Toa Rangatira Statement*. Both documents contain recommendations to GWRC, PCC, WCC and Wellington Water Limited and include a range of regulatory and non-regulatory recommendations. Implementation must be carried out in partnership with Ngāti Toa and the wider community.[87] Some recommendations, which include limits for the estuary as well as for freshwater, are currently being considered by GWRC and in a review of Te Awarua-o-Porirua Harbour and Catchment Strategy and Action Plan.

PCC is currently reviewing its district plan to give greater protection to streams and the estuary. It is also working with Regional Public Health, Te Rūnanga o Toa Rangatira and GWRC to improve the public health warning system for the estuary. As mana whenua, Ngāti Toa have a right to participate in certain decision making pursuant to various legislation.[88]

DOC is responsible for Pāuatahanui Wildlife Management Reserve (along with Forest & Bird), Horokiri Wildlife Management Reserve, Duck Creek Scenic Reserve and the refuge area. Of these, only the Pāuatahanui Wildlife Reserve is actively managed under a system that allocates and prioritises resource determined at the national level.[89]

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[84] Diane Strugnell, pers. comm., 3 June 2020.

[85] PCC, 2015; PCC, 2018.

[86] Nigel Clarke, Porirua City Council, pers. comm., 12 June 2020.

[87] Te Awarua-o-Porirua Whaitua Committee, 2019; Ngāti Toa Rangatira, 2019.

[88] For example, under the RMA, Ngāti Toa will have a right to submit on certain applications for resource consent that affect Pāuatahanui Wildlife Reserve because that area is covered by the statutory acknowledgement under the Ngāti Toa Rangatira Claims Settlement Act 2014.

[89] DOC, pers. comm., 11 June 2020.

Appendix 5: Whāingaroa Harbour

Source: Modified Copernicus Sentinel data, sourced from the LINZ Data Service and licensed by Sinergise Ltd, for reuse under CC BY 4.0

Figure 7.5.1: Whāingaroa Harbour.

Physical form

About 10,000 years ago, Whāingaroa Harbour was a post-glacial, flooded river valley system. Over time, several fluctuations in sea level, and natural sediment erosion and accumulation processes have resulted in large-scale changes in the land and seascape. Natural infilling 8,000–6,500 years ago transformed 70 per cent (24 square kilometres) of the estuary into tidal estuarine flats.[1]

[1] Swales et al., 2005b.

The Whāingaroa catchment covers about 510 square kilometres and has six main sub-catchments. Its terrain is mostly steep and unstable. Prior to human settlement, the catchment was covered in native podocarp forest dominated by rimu, rātā, beech and tree ferns. The 33 square kilometre estuary is an enclosed narrow harbour about 12 kilometres long and two kilometres wide. Paritata Peninsula separates the two arms – Waingaro-Ohautira and Waitetuna.[2] In the Waingaro arm, sediments are resuspended through tidal currents and wave action, moved out of the harbour and deposited on the coast. In areas where exposure to wave action is reduced – for example, in Waitetuna and Okete Bay – long-term sediment accumulation is occurring.[3]

This estuary is hydrologically dynamic: tides range from two to four metres, waves influence the two arms differently, and bed elevations are constantly changing. Flushing of the upper estuary is between 35 and 45 days.[4] Average annual rainfall (measured between 1984 and 2004) is 1,354 millimetres, but freshwater inflow is relatively small compared to the volume of water at the spring and neap tides.[5]

Source: Hannah Jones

Figure 7.5.2: The entrance to Whāingaroa Harbour from Te Kopua.

[2] Swales et al., 2005b; Fisher, 2014.

[3] Swales et al., 2005b.

[4] There is a gradient in residence times from the mouth to the upper estuary with longer residence times in the upper part of the estuary (Greer et al., 2016).

[5] Seven days after spring tide, neap tides occur. These are moderate tides where high tides are lower and low tides are higher than average (Swales et al., 2005b).

History

The *Tainui* waka landed south of Whāingaroa in Kawhia around 1300. Descendants of the waka eventually migrated north and settled in Whāingaroa and neighbouring west coast harbours. Tainui are the iwi whose ancestral lands surround Whāingaroa moana, and include Ngāti Tamainupō, Ngāti Māhanga, Ngāti Hourua and Ngāti Tahinga.[6]

Pātaka kai was plentiful, and with diverse and plentiful resources to choose from, iwi who lived there needed little in the way of cultivation. As a result, there was minimal forest clearance in the area.[7] Resource collection and use was conducted according to tikanga. Practical methods, such as using the maramataka to determine when to harvest, were used to allow for kaitiakitanga. An oral history participant explained: "We were always very aware of the seasonal impacts of the breeding and feeding habit of the kaimoana."[8]

Karakia and acknowledgement of ngā atua were also always present. As one person expressed it to the investigation: "It's a common customary practice to always throw your first catch back to Tangaroa, even when my mokos aren't too sure if they'll catch another one, they'll hesitantly still throw the first one back."[9] Skills needed to harvest or collect resources were shared across the whānau – from the manufacture of materials like spears, fishhooks and sinkers, to knowing how to read signs in the environment and observing fish stock patterns.

Up until the 1970s, resources available included mullet, butterfish, shark, whitebait, kahawai, tuna and kōura. When stocks needed to be replenished, rāhui, mātaitai reserves and whakatapu were imposed to ensure stocks returned to sustainable levels. Preservation was another way to ensure catch was sustainable, as the resource was taken when plentiful and saved for later months, rather than fishing year-round. For example, threading pipi and drying them was common practice in Whāingaroa.

The first European settlers arrived in the mid-1800s. Clearance of forests for pasture for dry-stock farming for sheep and beef started in the 1850s in the south of the harbour, especially on the flat and more gently sloping areas. The harbour catchment remained mostly forested up until the 1890s.[10] The township of Raglan was established in the 1860s, and by the 1870s about 435 people lived in the town. The population has now grown to about 4,300 permanent residents, which can swell fourfold with holidaymakers over the summer. There is significant urban development underway with a development of up to 1,500 new sections recently consented.

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6 Jones and Biggs, 2004.
7 Haggerty and Campbell, 2008.
8 Oral history participant 2.
9 Oral history participant 1.
10 Vennell and Williams, 1976; Swales et al., 2005b.

Pressures and state

Native forest was converted to pasture during the nineteenth and twentieth centuries. Plantation forestry began in the mid-1980s on steep land, leaving native forest blocks in only Pirongia and Te Hutewai state forests and in the sub-catchments of the Waingaro and Ohautira rivers.[11] A trend to more dairy farm conversions was seen in the early 2000s. These changes in land use over time contributed to the current load of sediment reaching the estuary, an order of magnitude greater than in pre-development times.[12] The total nitrogen load to the estuary from all combined activities, including intensified pastoral farming and urbanisation, is estimated at over three times that of pre-human times (Table 1.1).

Source: Waikato Regional Council

Figure 7.5.3: Scientists and community members measuring mud accumulation in Whāingaroa Harbour.

Urban settlement has heavily modified the southern extent of the estuary, through the construction of wharves, bridges, residential areas and industrial buildings.[13] The main pressures on the estuary from urban development are the discharge of wastewater and the potential for further sedimentation during or after development.

[11] Environment Waikato, 2002.

[12] Swales et al., 2005b. Estuarine flats are also eroding by wave energy increasing the amount of suspended sediment in the estuary.

[13] Ryer et al., 2016.

There is an ongoing development on the Rangitahi Peninsula that will provide 550 new sections on 117 hectares. The development includes water-sensitive urban design, as well as wetland and native tree areas to reduce its environmental impact on the estuary. However, in 2018 sediments from the development reached the estuary following a strong rain event that compromised the sediment retention points. An impact assessment was conducted and a case against the contractor is currently before the court.[14]

There are two further large residential developments planned for the area.

Urban settlements

Prior to the 1970s the wastewater system was inadequate, with overflows and illegal discharges into the harbour. Most dwellings, including hotels and shops, had septic tanks with field tile soakage or direct discharge into the harbour. However, during the holiday season the systems overflowed frequently, and raw sewage even seeped out into the township or discharged from broken pipes straight onto the beach about five metres above the high water level. Finally, in the 1970s a central sewerage system was built, allowing the discharge of 757,000 litres of treated domestic waste into a channel at the entrance of the harbour. The oxidation ponds for the new system were built on wāhi tapu, and iwi feared that the treated wastewater was too close to their marine and freshwater mahinga kai sites.[15]

Three months after construction (and because only one oxidation pond had been built before the commissioning of the plant), overflows were observed, followed by a broken harbour outfall in 1977.[16] Since then there have been breaches to resource consent conditions in regard to suspended solid concentrations, faecal coliform and enterococci, and discharges outside of consented hours.[17] This is due to damage by storms, station faults and overflows, as well as delayed upgrades.[18]

Fishing

There is a small commercial fishery for flatfish in Whāingaroa, with two active commercial fishers. The status of the flatfish population in Whāingaroa Harbour is unknown. Important taonga species such as shellfish, snapper, flounder, gurnard, trevally and mullet are fished recreationally in the catchment.

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[14] See https://www.stuff.co.nz/business/117165737/contractor-for-rangitahi-developments-faces-prosecution-for-sediment-spill [accessed 18 June 2020]. This matter is still to be heard by Hamilton District Court.

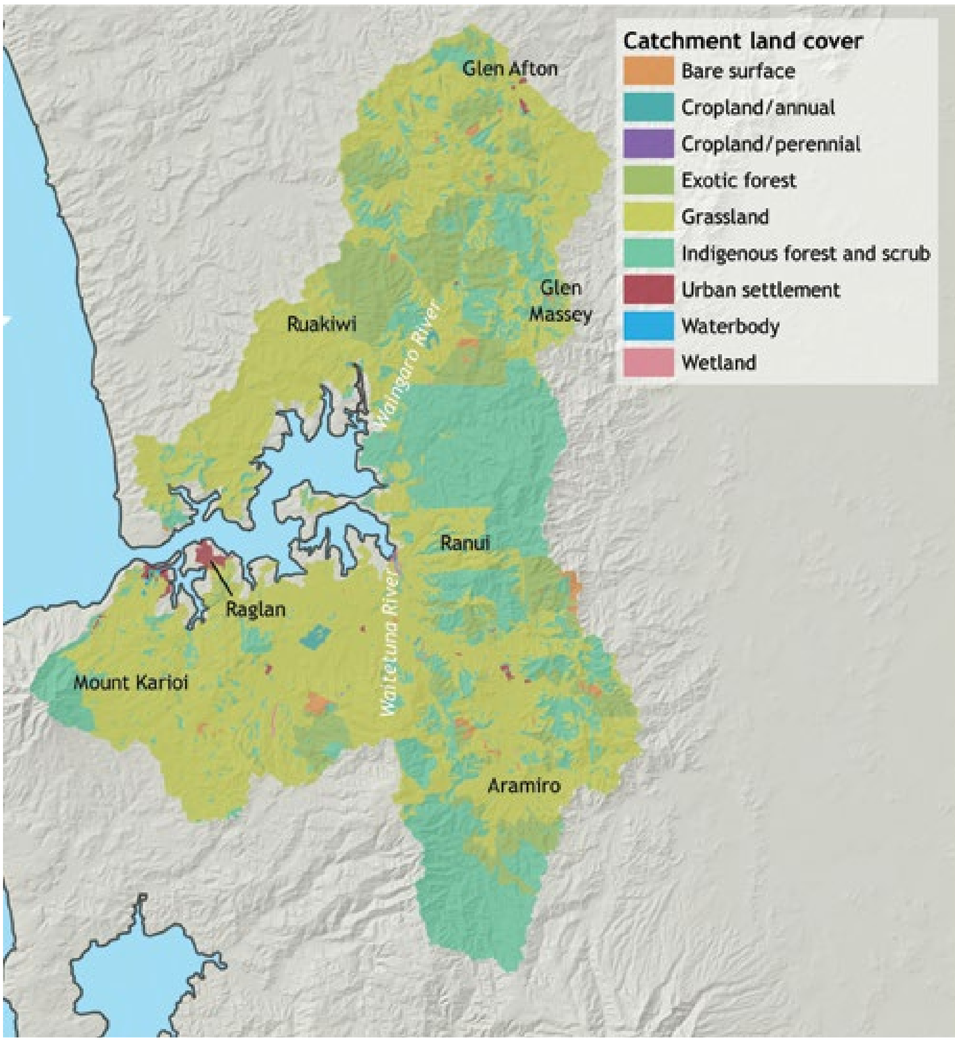
[15] Fisher, 2014.

[16] Waikato Valley Authority, 1979, p.3.

[17] Between 2007 and 2010 there was significant non-compliance with resource consent conditions at the water treatment plant in relation to suspended solids and enterococci levels. The treatment plan was upgraded over time to achieve better compliance. From 2011, a partial level of compliance was achieved, and from 2012 a high level of compliance was achieved apart from in 2015 and 2017. See https://www.waikatodistrict.govt.nz/services-facilities/water/wastewater/our-network/raglan-wastewater-treatment-plant/1 [accessed 18 June 2020].

[18] Waikato District Council, 2008; Fisher, 2014.

State and monitoring



Source: Manaaki Whenua – Landcare Research[19]

Figure 7.5.4: Map of the Whāingaroa Harbour catchment with land use.

Land use in the Whāingaroa catchment comprises about 56 per cent grassland, 29 per cent indigenous vegetation, 13 per cent exotic forest, and a very small percentage of urban and cropland (0.43 per cent and 0.22 per cent, respectively), with the rest made up of bare surfaces and waterbodies or wetlands. Since 1996, land cover has seen an increase in exotic forests (up from six per cent) with a corresponding reduction in grassland.[20]

[19]Manaaki Whenua – Landcare Research, 2018, 2020.
[20]Manaaki Whenua – Landcare Research, 2020.

Whāingaroa Harbour is an important habitat for resident, rare, threatened and international migratory bird species. Critically endangered Māui dolphin have been recorded in the harbour, although it is not known how much this species uses this area.[21] Whāingaroa Harbour was assessed as having very high natural character under the New Zealand Coastal Policy Statement 2010 classification. Kawhia and Aotea harbours to the south were assessed as outstanding.[22]

Freshwater quality monitoring started in 1993 in the main rivers feeding the estuary.[23] Three sites are monitored for water quality parameters, and two other sites for macroinvertebrates. All parameters monitored are in the worst 50 per cent quality of rivers monitored in New Zealand, with some in the worst 25 per cent. Most of those parameters present unknown or worsening trends over time.[24]

The first survey of Whāingaroa Estuary to determine the mechanism of sediment transport and deposition was undertaken in 1979.[25] In 2001 the Waikato Regional Council initiated a regional estuary monitoring programme for the Firth of Thames and Whāingaroa.[26] Five sites in each estuary were monitored two to four times a year between 2001 and 2015 for sediment properties and sediment-dwelling animals, and annually since then.[27] Sedimentation monitoring was added in 2003, at the same sites and frequency as other data collection.

Overall, Whāingaroa Harbour is relatively healthy in terms of sedimentation. Its overall state has not changed since monitoring began, but there are site-specific differences and trends that are probably related to localised pressures. Sedimentation rates are highly variable, with areas of both erosion and accretion ranging between four millimetres (erosion) and seven millimetres (accretion) per year, reflecting the difference in flushing of the two arms of the estuary.[28]

[21] See https://www.waikatoregion.govt.nz/environment/natural-resources/coast/coastal-monitoring/regional-estuary-monitoring-programme/estuaries/ [accessed 18 June 2020].

[22] Ryer et al., 2016.

[23] Environment Waikato, 2004b.

[24] LAWA, 2020c.

[25] Sherwood and Nelson, 1979.

[26] Environment Waikato, 2008.

[27] Some sites were not monitored in Whāingaroa Harbour in 2009 (Environment Waikato, 2010).

[28] Environment Waikato, 2019.

Source: Johnragla, Wikimedia Commons

Figure 7.5.5: Landscape showing the Waitetuna arm of Whāingaroa Harbour in the distance.

Surveys of the estuarine vegetation were undertaken in 2004 and 2011/12. These estimated the extent of mangrove, seagrass, sea meadow and saltmarsh communities.[29] While seagrass beds were healthy and exotic *Spartina* grass was close to being eliminated in 2012, a saltwater weed variety of *Paspalum* grass (*Paspalum vaginatum*) was prevalent. The health of estuarine vegetation improved between 2004 and 2012, which was partly attributed to riparian planting efforts in the catchments. Damage by feral goats and illegal dumping in the estuary were highlighted as some of the ongoing threats.[30]

The Raglan wastewater treatment plant has been mostly compliant with its resource consent conditions for operation since 2011.[31] An upgrade to the wastewater treatment plant is being developed in consultation with iwi, communities and stakeholders. This includes options for discharge to land. The current resource consent expired in February 2020, and a temporary resource consent of 36 months is being sought.

[29] Environment Waikato, 2004a, 2012.

[30] Environment Waikato, 2012.

[31] See https://wdcsitefinity.blob.core.windows.net/sitefinity-storage/docs/default-source/services-and-facilities/water/wastewater/raglan-wastewater-treatment-plant/wrc-raglan-audit-2018-2019.pdf?sfvrsn=6df887c9_2 [accessed 29 May 2020].

Fisheries in New Zealand are managed at the quota management area level, which involves splitting the entirety of the marine environment into management areas for each species or species group. As such, catch limits apply to those large areas rather than to specific estuaries. There have been no fishery surveys carried out specifically in Whāingaroa, and commercial data collected are not at the estuary-level for this area. However, recreational fishers note that their ability to catch snapper in the harbour has increased more than ten-fold in the past two decades.[32]

Responsibility for the safe human consumption of shellfish is shared between the Ministry for Primary Industries, regional and district councils and district health boards.[33] This arrangement has the potential to lead to gaps in monitoring nationwide.

Only sporadic testing of shellfish flesh from Whāingaroa Harbour has occurred over time. Monitoring of shellfish flesh for edibility is not part of Waikato Regional Council's monitoring programme, and the Waikato District Health Board has taken no samples since 1994.

Limited bacterial testing was carried out in 1977 in conjunction with the construction of the wastewater treatment plant. Faecal coliform measures met the council's requirements.[34] In 1983, shellfish samples taken adjacent to the oxidation ponds were found to be unsuitable for eating.[35] In 1994, bacteriological quality of shellfish was sampled at four sites over 10 weeks to ensure food safety. One quarter of the samples were found to be contaminated after periods of rainfall.

In 2017, estuarine water quality monitoring was reinstated, with indicators including faecal coliforms, temperature, salinity, pH, dissolved oxygen, nutrients and suspended sediment.[36] Water quality for contact recreation at Ngarunui Beach is further monitored every summer.[37]

Community concerns

Tainui Āwhiro

Tainui Āwhiro feel that their ability to act as kaitiaki of the area has been eroded.[38] Up until the 1970s, available kaimoana included mullet, butterfish, shark, whitebait, kahawai, tuna and kōura. Between the 1970s and 1994 they estimate that 70 per cent of their kaimoana was lost. Health concerns remain a long-running issue caused by the potential contamination of shellfish from pollution in the harbour. One key concern is the proximity of wastewater discharges to marine and freshwater mahinga kai sites contaminating this food source.

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[32] Recreational fishers, pers. comm., 3 September 2019.

[33] Also see chapter four.

[34] Rennes, 1979.

[35] Fisher, 2014.

[36] See https://www.waikatoregion.govt.nz/environment/natural-resources/coast/coastal-water-quality/estuarine-water-quality/ [accessed 18 June 2020].

[37] LAWA, 2020b.

[38] Fisher, 2014.

Recognition of the authority of hapū and iwi in Whāingaroa is another major concern. As an iwi partner, Tainui Āwhiro feel that their concerns are not taken into consideration by local government authorities managing the estuary. Engagement between iwi and councils is uneven, and iwi feel that relationships constantly need to be rebuilt given the high turnover of staff within government agencies. They also feel that they are being treated as stakeholders, not as Treaty partners.[39]

Iwi believe that a lack of consultation and decision-making power has resulted in the devastation of wāhi tapu and degradation of fishing grounds. For example, oxidation ponds for the wastewater treatment plant were built on wāhi tapu, close to the marae. Iwi voiced their opposition to the discharge of treated wastewater near fishing grounds, yet an extensive process to construct, fix and upgrade the system was undertaken without considering the impacts this would have on mana whenua.[40]

Other issues raised by iwi include horse riding on beaches, which affects shellfish beds and water quality, and ways to mitigate coastal erosion.[41] Claims under the Treaty of Waitangi, the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992, and the Marine and Coastal Area (Takutai Moana) Act 2011 are ongoing.

Whāingaroa Harbour Care

Whāingaroa Harbour Care was created in 1995 to reduce the impacts from agriculture and sediment run-off on the harbour. It is a community- and farmer-initiated community group focused on increasing the use of environmentally responsible practices. With goals to restore stream margins, harbour edges, and improve water quality and the overall ecology of the estuary, Whāingaroa Harbour Care has worked with landowners to plant around two million trees to date.

Whāingaroa Harbour Care employs three permanent staff and two to three contractors in the planting season. In 2020 they expect to plant about 130,000 trees. Through this initiative, more than 150 kilometres of harbour edge and 750 kilometres of stream edge have been fenced and planted, with about 135 kilometres of priority streams remaining to be fenced and planted. To date, 860 hectares of farmland have also been retired from farming,[42] and improvements have been made to increase the size of the riparian margin, excluding stock from streams, rivers, wetlands and harbour edges.

While the group has focused on stopping sediment run-off, it is aware that this will also reduce nutrients and bacteria.

Whāingaroa Harbour Care is concerned about the future of the estuary due to the intensification of farming practices, large-scale subdivisions adjacent to the harbour and inadequate forestry practices. All these activities have the potential to reverse the benefits of riparian planting and add sediment and contaminants to the harbour.

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[39] Angeline Greensill, pers. comm., 9 April 2020.

[40] Fisher, 2014.

[41] Rolande Paekau, pers. comm., 9 April 2020.

[42] Whāingaroa Harbour Care, pers. comm., 3 June 2020.

Whāingaroa Harbour Care has spent 25 years restoring the harbour to improve water quality, estuarine habitats, biodiversity and fishing. It believes that both regional and district council rules and consent conditions are failing to protect these achievements. Whāingaroa Harbour Care wants council consent conditions and rules to allow only sustainable development and land use practices that do not impact negatively on the receiving environment, Whāingaroa Harbour.[43]

Whāingaroa Environment Centre

The Whāingaroa Environment Centre is an information, resource and action hub supporting environmental education, community resilience and sustainability.[44] It was started in 1997 by a group of locals concerned with erosion and other environmental problems in and around Whāingaroa Harbour.

The centre has been involved in the development of the Raglan Naturally community action plan.[45] The plan intends to inform Waikato District Council's Local Area Blueprint,[46] and expresses the community's desire to be involved in council planning processes, for example, the current wastewater discharge resource consent application to Waikato Regional Council.[47]

The Whāingaroa Environment Centre is due to review the Whāingaroa Environment Catchment Plan in 2020.[48] It aims to identify actions to incorporate into the Raglan Naturally process and/or Waikato Regional Council's harbour and catchment management plan, which is currently under development.[49]

There is still frustration on the part of some individuals and community organisations in Raglan, who see a large amount of work being done by the community to protect the environment while resource consents continue to be issued that negatively impact on the health of the estuary.[50]

Members of the centre expressed a need for further relationship development between community groups and both the regional and district councils, noting their shared interests and goals for the harbour. Members are concerned the regional council is under-resourced for adequate estuarine management and that already scarce resources must be prioritised across the entire Waikato region. The Whāingaroa Environment Centre itself faces an ongoing struggle to secure sufficient funds to continue its operations.[51]

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[43] Whāingaroa Harbour Care, pers. comm., 3 June 2020.

[44] See http://whaingaroa.org.nz [accessed May 2020].

[45] Parson et al., 2020.

[46] See https://www.waikatodistrict.govt.nz/your-council/plans-policies-and-bylaws/plans/blueprints/local-area-blueprints/raglan-local-area-blueprint [accessed 18 June 2020].

[47] See https://wdcsitefinity.blob.core.windows.net/sitefinity-storage/docs/default-source/services-and-facilities/water/wastewater/raglan-wastewater-discharge-consent/supporting-documents/short-term-resource-consent-application--raglan-wastewater-discharge.pdf?sfvrsn=8b787c9_2 [accessed 18 June 2020].

[48] Whāingaroa Environment Centre, pers. comm., 5 June 2020.

[49] See https://www.waikatoregion.govt.nz/council/policy-and-plans/hazard-and-catchment-management/hcmp/raglan-whaingaroa-hcmp/ [accessed 29 June 2020].

[50] Whāingaroa Environment Centre, pers. comm., 10 June 2020.

[51] Whāingaroa Environment Centre, pers. comm., 10 June 2020.

Farming

Most farmers in the Whāingaroa catchment see themselves as caretakers of the land and share concerns about the need to reduce their impacts on the environment. One young farmer says they have been striving to use science to better manage their farm for environmental benefits and to reduce climate impacts – and as a side benefit, they can save money. He feels that peer education plays an important role in changing things for the better.

Collaboration and engagement with the wider community to work towards resolving environmental issues, and following farm environmental management plans in coordination with catchment management plans were seen as potential tools to improve the quality of the environment.[52]

Recreational and commercial fishers

Fishers interviewed were appreciative of the work done to improve the status of the estuary, as access to fish requires a healthy environment.[53]

The recreational fishers interviewed felt that there is no risk of overfishing by recreational fishers, but they were developing a fisheries harbour management plan. They suggested potential management measures, including an oceans policy, and felt that more comprehensive estimation of the size of fish populations would be beneficial to manage pressures on the stocks. They felt that decreasing sediment loads by leaving willows on the margins of the estuary and managing housing development run-off would be good ways to ensure the health of the harbour. They noted that relationships with the regional council need to be strengthened.

Management

Current management of Whāingaroa is spread across several organisations, including regional and district councils as well as iwi and community groups.

Whāingaroa Catchment Management Project

The Whāingaroa Catchment Management Project, established in 1996, was the first formal attempt in New Zealand to establish community-based, integrated environmental management on a catchment scale. It was facilitated by Waikato Regional Council and Manaaki Whenua – Landcare Research.[54] It resulted in the Whāingaroa Environment Catchment Plan in 2002, which was completely led by the community (although mana whenua did not engage with the process) and was adopted by the Whāingaroa Environment Centre. While the plan is non-regulatory, the regional council has implemented many aspects of it.[55]

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[52] Farming community, pers. comm., 3 September 2019.

[53] Recreational and commercial fishers, pers. comm., 3 September 2019.

[54] van Roon and Knight, 2001.

[55] Whāingaroa Environment Centre Committee, pers. comm., 10 June 2020.

Waikato Regional Council

Waikato Regional Council has a Regional Coastal Plan, made operative in 2005. This plan is under review with the aim of integrating it with the Waikato Regional Plan to create a single Waikato resource management plan under the banner of Healthy Environments – He Taiao Mauriora.[56]

Waikato Regional Council catchment liaison officers are the conduit between landowners and the council. Waikato Regional Council used to have eight catchment committees and four drainage advisory subcommittees across the region, but these were discontinued in 2019 and replaced with a new freshwater action committee and a climate action committee, among others.[57] The successful transfer of institutional knowledge and longer-term continuity of personnel are important for building strong regional council science programmes and maintaining relationships with community and iwi.[58]

The council is beginning community consultation on a two-year project to develop a Raglan/Whāingaroa harbour and catchment management plan.[59]

Waikato District Council

Waikato District Council is responsible for the Raglan wastewater scheme, including the treatment plant and pump stations on the harbour. The district council expressed the view that the councils and the Department of Conservation (DOC) were disconnected, and there was a need to improve relationships with the community. For example, there is little collaboration when district or regional plans are being developed, and in some instances the only communication is through the standard submission process.

Waikato District Council felt that its management of environmental issues was hampered by lack of expertise (e.g. too few Resource Management Act planners), but saw high value in working collaboratively with iwi, hapū and the community. The council felt that there had been several infrastructure improvements that had contributed to better environmental outcomes, such as the new reticulated wastewater pipe installed in 2015.

Mana whenua

Mana whenua continue to work with regional and district councils to identify solutions to improve the health of the estuary, by supporting land-based wastewater discharge solutions, riparian and dune planting to mitigate sand erosion, and enforcing bans on horse riding on beaches in areas of cultural significance. They also work with community and stakeholder groups to ensure cultural perspectives are included in decision-making processes.[60]

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[56] See https://www.waikatoregion.govt.nz/council/policy-and-plans/healthy-environments/ [accessed 16 June 2020].

[57] Henry, 2017; also see https://www.stuff.co.nz/waikato-times/news/117461897/waikato-regional-council-overhauls-its-committee-structure [accessed 23 June 2020].

[58] Michael Townsend, pers. comm., 2 June 2020.

[59] See https://www.waikatoregion.govt.nz/council/policy-and-plans/hazard-and-catchment-management/hcmp/raglan-whaingaroa-hcmp/ [accessed 29 June 2020].

[60] For example, iwi members have been involved in developing the Whāingaroa Raglan Naturally draft plan April 2019 (Parson et al., 2020).

Whāingaroa hapū have a current Waitangi Tribunal claim, Te Rohe Pōtae, which was lodged in 2008 in an attempt to assert their mana motuhake over the area.[61] Customary fisheries forums have been established to give effect to the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992 and to assist whānau and hapū to implement legislative tools to protect their marine environment. Ngā Hapū o Te Uru (the forum for west coast hapū o Tainui waka) has kaitiaki input and participates in the management of customary fisheries areas in Whāingaroa. The hapū also has an application under the Marine and Coastal Area (Takutai Moana) Act 2011 to be recognised as having customary interests and rights within the Whāingaroa marine environment.[62]

Department of Conservation

DOC has management responsibility over several marginal strips in the estuary. Marginal strips are often of low priority for DOC unless there is a specific, identified, high conservation resource or asset, such as a whitebait spawning site or an archaeological site. Thus, the only management often undertaken is weed and pest control.

Developments have the potential to damage marginal strips. DOC has limited ability or resources to enforce encroachments on those strips, and its usual practice is to contact the offending party and point out boundary issues or activities that need to cease – if it is aware of them.

The Opotoru River marginal strip is one protected area managed by DOC that adjoins a current development. The area has important archaeological sites, making DOC an affected party for the purposes of the resource consent process. Although not fully supportive of the development, DOC worked with the developers of Rangitahi development when planning the progress of particular easements, land exchange, revegetation of the streams and the future maintenance of the strip.

[61] See https://waitangitribunal.govt.nz/inquiries/district-inquiries/te-rohe-potae/ [accessed 9 June 2020].

[62] See https://www.tearawhiti.govt.nz/te-kahui-takutai-moana-marine-and-coastal-area/applications-made-under-the-marine-and-coastal-area-act/waikato-region/ [accessed 10 June 2020].

Appendix 6: Methodology

Oral history mahi

The method used to conduct the oral history work for each case study was based on kaupapa Māori theory and a pre-existing engagement model.[1] Kaupapa Māori theory developed in response to early anthropologists and ethnographers who frequently misinterpreted as myths and legends knowledge that had been transmitted over generations.

As early as the 1800s early European ethnographers were beginning to record Māori histories and other forms of oral transmissions.[2] These European commentators, who stood outside of the Māori world, generally disregarded and undervalued oral histories and other forms of transmission. However, some of their recordings still hold value, as they are the only records available from that time.[3]

Kaupapa Māori theory is underpinned by te reo and tikanga.[4] Pihama expands on the development of kaupapa Māori theory stating:[5]

> "A fundamental premise on which Kaupapa Māori theory is argued is that in order to understand, explain and respond to issues for Māori, there must be a theoretical foundation that has been built from Papatūānuku, not from the building blocks of imported theories."

Kaupapa Māori theory is not new but has been developed and used across many epistemologies – in particular, in environmental research – to ensure that enquiries are conducted appropriately and within a te ao Māori worldview.[6]

In the present investigation, kaupapa Māori theory provided the most appropriate framework within which the Parliamentary Commissioner for the Environment (PCE) investigators could work with Māori, who have valuable knowledge of the changes that have occurred over time in their area. Knowledge of these changes from the time of Māori arrival to today are remembered through mōteatea, waiata, pepeha and whakataukī, to name a few.[7]

Many whānau, hapū and iwi have recorded their knowledge to ensure that the knowledge was not lost.[8] Furthermore, through the Treaty settlement process, historical accounts have been recorded as evidence of whānau, hapū and iwi occupation of certain areas and their relationships with taonga.

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[1] The engagement model was kindly provided by Manaaki Te Awanui for a previous project and was further worked on by this group of contractors. The model is underpinned by kawa, tikanga and kaupapa.

[2] Wehi et al., 2018.

[3] Lee, 2009.

[4] Pihama, 2010.

[5] Pihama, 2010, p.10.

[6] Jackson et al., 2017.

[7] King et al., 2007.

[8] See Jackson et al. (2017) for marine oral history recording examples.

The method that was followed is described below.

Method

1. To ensure that the process was based on kaupapa Māori theory, contractors were selected who were connected to the estuary through whakapapa and had knowledge of the ecological system of the estuary and wider catchment. An advantage of this was that relationships with those being interviewed were already established. Reports were written based on the contractors' whakapapa, but all those who have mana whenua/moana were acknowledged.
2. Two workshops were run with all contractors and the PCE estuaries team to whakawhanaungatanga, to build the process based on kaupapa Māori theory, and to ensure that the interviews were run consistently.
   - Pou matua were developed to ensure contractors conducted interviews and research appropriately. Those principles were: manaakitanga, kaitiakitanga, tino rangatiratanga, whanaungatanga, mana whenua, mana moana, mana taiao, tau utuutu, āta, mōhiotanga and kotahitanga (see Table 7.6.1).
   - Important aspects were discussed, including appropriate methods of data collection; engagement; privacy of interviewees; data storage, access and use; analysis; report write up; and wānanga. An assessment was made to ensure these aspects were underpinned by the pou matua (see Table 7.6.1).

   Developing and clarifying the process was also discussed.
3. An approval form and information sheet was provided to every interviewee to seek permission to use the information in the course of the investigation.
4. Contractors conducted their research and interviews and during the process found that there was some information already available from previous oral histories work. Where this could reduce the burden on those being interviewed, this information was used instead.
5. Analysis by the contractors of the information was conducted.
6. Individual case study reports were finalised and provided to PCE. These were not intended to be published but would be available to the relevant whānau, hapū or iwi.
7. A synthesis report was commissioned but was unable to be delivered. Drawing on the pou matua, the process was adapted so that reference could be made to some of the information in the case studies while also ensuring the anonymity of participants who contributed to the report.
8. Treaty settlement documentation and written literature approved by the contractors would be included in the written final report for the investigation.
9. Where PCE needed to reference participants, permission was sought and quotes or information was referenced to an exclusive code (i.e. oral history participant 1, 2, etc or oral history group interview) to protect the participants' anonymity, as provided for in the permission form.

Table 7.6.1: Pou matua developed as underlying principles for this process.

Pou matua	Definition and example of where it was used in the process
Manaakitanga	Enhance the mana of all, first and foremost. • Provided interviewees with information about the project, seeking permission.
Kaitiakitanga	Acknowledge the kaitiaki of the area. • Hired contractors who whakapapa and have knowledge.
Tino rangatiratanga	The right to self-determination at the local level. Knowing that information given has to go back to the whānau. • Finished case study reports given back to the contractor and stored appropriately.
Whanaungatanga	Acknowledge whakapapa and connections, people and sources of information. • Sought permission to use information from the right people, including written sources.
Mana whenua **Mana moana** **Mana taiao**	Alternative views, approaches and ways of managing are welcomed and appropriate. Authority to take responsibility of the information (duty to care for own areas) from all who have mana. • Contractors encouraged to build the process in their own way. No pre-determined requirements.
Tau utuutu	Reciprocity, identify each other's needs and work towards meeting them. Kōrero of contemporary generations. • Identified early through discussion that this information would be very beneficial for mana whenua.
Āta	Tread lightly. • Considered pou matua and changes when process did not go as planned.
Mōhiotanga	Preparation and professionalism. • Held two workshops, determined process before work commenced. • Maintained transparency throughout the process.
Kotahitanga	Working as a team, everyone on the same page. • Held two workshops. • Obtained agreement from all contractors in regard to referencing interviewees. • Maintained consistent communication throughout process.

Xiphophora gladiata

8 Glossary of Māori terms

These terms are described as they are at maoridictionary.co.nz, and as they are used in this report. Other sources are noted in footnotes.

āta – gently, slowly, carefully

atua – ancestor with continuing influence, god, guardian of an environmental domain

aua – yellow-eye mullet, *Aldrichetta forsteri*

awa – river

hapū – subtribe

harakeke – New Zealand flax, *Phormium tenax*

īnanga – whitebait, *Galaxias maculatus*

iwi – tribe

kaimoana – seafood

kāinga/kāika[1] – home

kaitiaki – minder, guard, custodian, guardian, caregiver, keeper, steward, trustee

kaitiakitanga – guardianship, stewardship, trusteeship,

kanae – grey mullet, *Mugil cephalus*

kanakana – lamprey, *Geotria australis*

karamū – *Coprosma lucida, Coprosma macrocarpa and Coprosma robusta*

karu – eye

kaupapa – purpose, topic, policy, agenda

kawa – protocol, custom

ki uta ki tai – from the mountains to the sea

kōkopu – freshwater fish commonly found in whitebait

kōrero – speak, talk; discussion

[1] Southern Ngāi Tahu dialect.

kotahitanga – unity, togetherness

kūtai – mussel of several species

mahi – work

mahinga kai – garden, food-gathering place(s); to gather or harvest food

mana – prestige, authority, control

mana moana – authority over seas and lakes

mana motuhake – independence, autonomy, self-government, self-determination

mana taiao – authority over nature/the environment

mana whenua – those who have territorial rights, authority over an area

manaaki – to support, take care of, give hospitality to

manaakitanga – hospitality

maramataka – Māori lunar calendar, monthly planting and fishing almanac

mātaitai (reserve) – these reserves recognise and provide for traditional fishing through local management. They allow customary and recreational fishing but do not allow commercial fishing[2]

mātauranga – knowledge, wisdom, education, a system of knowledge

mātauranga Māori – the body of knowledge originating from Māori ancestors

mauri – life force, vital essence, life principle

mōhiotanga – knowledge, awareness, preparation

mōteatea – traditional chant, lament, sung poetry

ngōiro – southern conger, *Conger verreauxi*

nohoanga – encampment

pā – fortified village

pāpaka – paddle crab, *Ovalipes catharus*

papakāinga – original home, home base, village

pātaka – storehouse raised on posts, food storage area

pātiki – flounder

pepeha – tribal saying or proverb

pōhā tītī – bag made from kelp and tōtara bark to hold preserved birds

pou matua – guiding principles

pūpū – winkle, common cat's eye, *Turbo smaragdus*

rāhui – temporary ritual prohibition or ban on an area

rangatiratanga – authority, right to exercise authority

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[2] See https://www.mpi.govt.nz/law-and-policy/maori-customary-fishing/managing-customary-fisheries/ [accessed 24 July 2020].

rohe – territory, district, region

rōpū – group

rua – hole

rūnanga/rūnaka[3] – tribal council

taiao – nature, environment

taiāpure – a stretch of coast, reef or fishing ground set aside as a reserve for inland kinship groups to fish or gather shellfish

tāmure – snapper

tangata whenua – local people

taniwha – water spirit, monster, guardian

taonga – treasure

tau utuutu – reciprocity

tauranga waka – appropriate places to launch and land waka and water craft[4]

te ao Māori – the Māori world

Te Mana o te Wai – a concept that refers to the fundamental importance of water and recognises that protecting the health of freshwater protects the health and wellbeing of the wider environment. It protects the mauri of the wai. Te Mana o te Wai is about restoring and preserving the balance between the water, the wider environment, and the community[5]

tī kōuka – cabbage tree, *Cordyline australis*

tikanga – correct procedure, ethics, customs, protocols

tino rangatiratanga – self-determination

tīpuna – ancestors

tītiko – mud-flat snail, mudsnail, *Amphibola crenata*

toheroa – a large edible bivalve mollusc, *Paphies ventricosa*,

tuākana – elder brothers (of a male), elder sisters (of a female), cousins (of the same gender from a more senior branch of the family)

tuangi/tuaki[6] – New Zealand cockle, *Austrovenus stutchburyi*

tuna – common name for short and longfin eel

tūtae – dung, excrement

urupā – burial ground, cemetery

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[3] Southern Ngāi Tahu dialect.

[4] New Zealand Government, 2020, p.39.

[5] New Zealand Government, 2020, 1.3(1), p.5.

[6] Southern Ngāi Tahu dialect.

wāhi tīpuna – a place important to Māori for its ancestral significance and associated cultural and traditional values[7]

waiata – song; to sing

wairuatanga – spirituality

wai tapu – the places where rituals and ceremonies are performed, or where there is special significance to tangata whenua[8]

waka – canoe, large sea-faring vessel

waka ama – outrigger canoeing

waka hourua – double-hulled canoe

wānanga – workshop, meeting; to discuss

whaitua – space, territory, domain

whakapapa – genealogy, lineage, descent

whakataukī – proverb

whakawhanaungatanga – process of establishing relationships, relating well to others

whānau – family

whanaungatanga – relationship, kinship, sense of connection

whatu – eye

whenua – land

[7] As defined in the Heritage New Zealand Pouhere Taonga Act 2014.

[8] New Zealand Government, 2020, p.38.

Splachnidium rugosum

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