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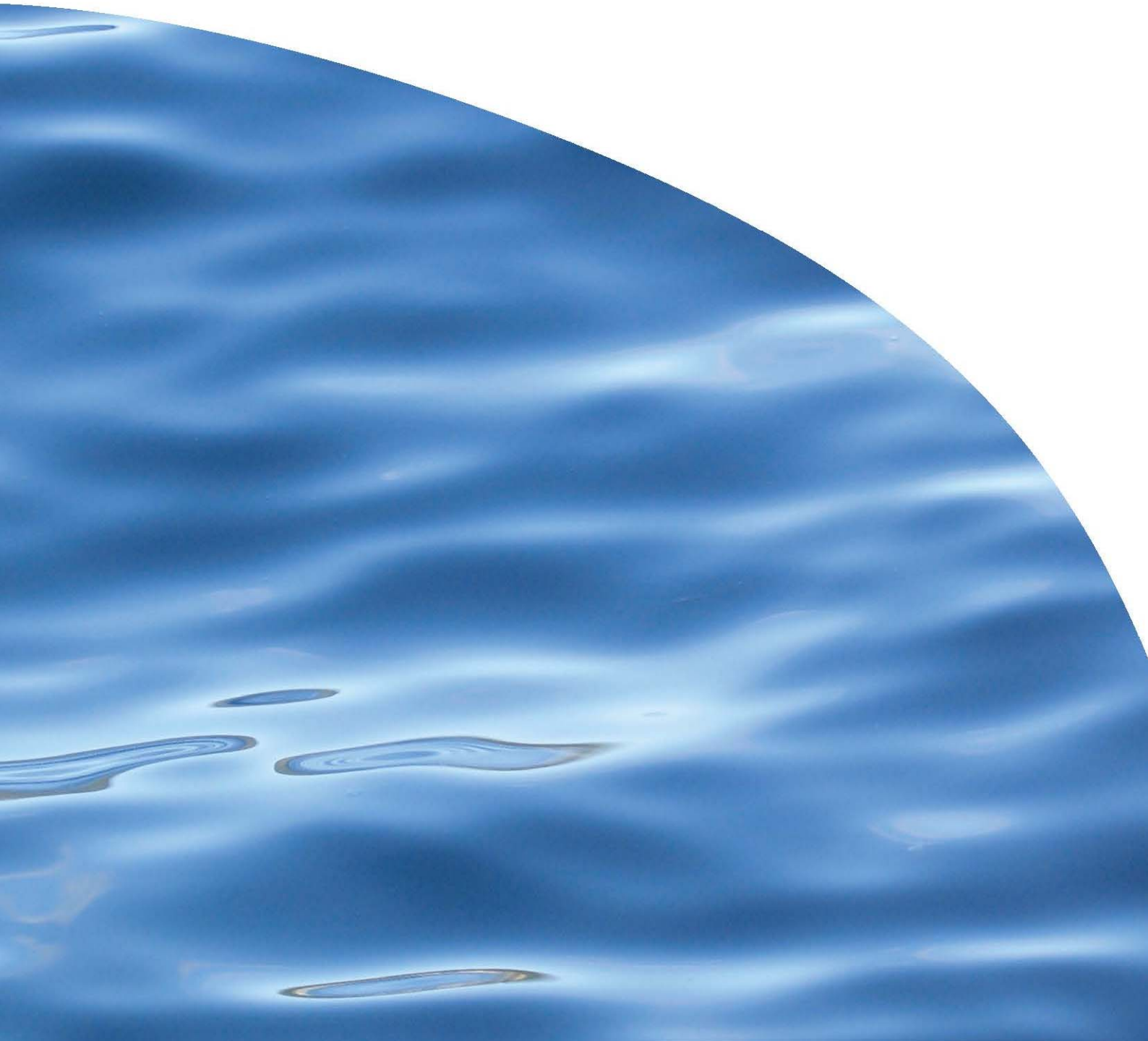
TOWARDS AN INTEGRATED MONITORING PROGRAMME FOR NELSON BAYS COASTAL MARINE AREA



TOWARDS AN INTEGRATED MONITORING PROGRAMME FOR NELSON BAYS COASTAL MARINE AREA

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Prepared for Tasman District Council and Nelson City Council

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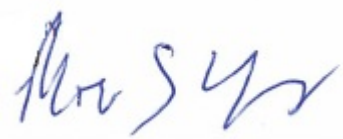

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EXECUTIVE SUMMARY

Tasman District Council (TDC) and Nelson City Council (NCC) have identified a need to better address coastal ecosystem monitoring as part of the requirements and policy objectives under the Resource Management Act 1991 (RMA) and the 2010 New Zealand Coastal Policy Statement (NZCPS). In response, the councils have requested advice from Cawthron Institute (Cawthron) in regard to developing an integrated monitoring programme to better track environmental changes and sustainably manage the Nelson Bays (Golden and Tasman Bay) coastal marine area (CMA; waters extending out to 12 nautical miles).

This report aims to provide advice and recommendations toward establishing a programme for monitoring in the Nelson Bays coastal marine area (CMA) that integrates current and future consent and State of the Environment (SoE) monitoring in the region. Objectives included defining council requirements and policy objectives for monitoring under the RMA and NZCPS obligations and identifying the key stakeholders and activities occurring in the region that potentially lead to adverse effects in the marine environment. The report also provides a stock-take of current consent-related and SoE monitoring and limitations of existing efforts, and considers the role of Māori and cultural monitoring, and aspects of integration across ecosystems and regions. The final objective was to outline next steps for developing an integrated SoE monitoring programme for the Nelson Bays CMA.

There is a diverse range of stressors derived from both land-based and maritime activities that impact the Nelson Bays CMA, and considerable uncertainty remains around the nature and extent of wider environmental changes occurring in the bays in response to the cumulative effects of these stressors. This is due in part to a lack of long-term coastal monitoring. Monitoring and assessment of impacts from resource consent-related activities occurring in the marine environment (such as aquaculture and outfall discharges) is generally robust. Estuarine environments are relatively well-monitored, but needs for wider SoE monitoring of the CMA are not being fully met. This is common in most regions around New Zealand, where SoE monitoring is so limited in scope that the background state of the environment, the importance of various activities, and the relative importance of non-point-source effects, are poorly understood.

Establishing a comprehensive, integrated coastal monitoring programme for the Nelson Bays CMA will be an iterative process where information needs, monitoring priorities and activity, and communication strategies are all considered. The proposed next steps revolve around the three main components of a monitoring programme: prioritisation, monitoring and communication. We recommend that ultimately the councils in the region work together, toward a robust, useful and efficient monitoring programme for Nelson Bays that serves multiple purposes. If communicated effectively, this programme could assist in building wider consensus around prioritising issues and managing the marine environment.

Some aspects of prioritisation and monitoring could be carried out in the short term, using existing funding sources such as Envirolink and MPI's Aquaculture Planning Fund (APF).

Prioritisation

- Identify and address gaps in baseline data
- Ensure iwi, community, and industry priorities are understood

Monitoring

- Identify and centralise existing datasets of potential value
- Identify most appropriate indicators for Nelson Bays
- Adopt or develop standards for assessing environmental health

The existing platform provided by the Nelson Biodiversity Forum and proposed Golden and Tasman bays stakeholder working group (SWG), combined with industry engagement and collaborative science initiatives such as the NIWA Rebuilding Shellfish strategy provide an ideal platform from which to progress the development of an effective monitoring programme.

In order to prioritise monitoring efforts, get stakeholder buy-in, and begin to establish baseline conditions, it is recommended that councils compile and interpret currently available data and information on the state of the bays. It is advised that this information be presented in layperson language and communicated widely in on-line and printable formats. A living 'State of the Bays' reporting system could then become the primary tool for communicating the environmental conditions and issues in the Bays. The Hauraki Gulf Forum's State of the Gulf communication strategy may provide a good model for this process.

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1. INTRODUCTION

Tasman District Council (TDC) and Nelson City Council (NCC) have identified a need to better address coastal ecosystem monitoring as part of the requirements and policy objectives under the Resource Management Act 1991 (RMA) and the 2010 New Zealand Coastal Policy Statement (NZCPS). Carrying out efficient and effective monitoring requires coordination of consent and state of the environment (SoE) monitoring. It is recognised that the aquaculture industry is currently responsible for the majority of monitoring activity in the coastal zone, and that limited SoE information is available to provide a context for consent-based monitoring. Nelson Bays is lacking a matured monitoring approach and advice is needed to assist in the development of an integrated monitoring programme to better understand and manage the region's coastal waters.

Cawthron Institute (Cawthron) was asked to provide advice and recommendations toward developing a wider coastal SoE monitoring programme for the Nelson Bays[1] coastal marine area (CMA), which falls under the jurisdiction of TDC, NCC, and Marlborough District Council (MDC). Monitoring associated with aquaculture consents is currently the primary monitoring activity in the Nelson Bays coastal marine area. For this reason a focus of this report is to identify opportunities for integrating consent-based monitoring with SoE monitoring. Requirements and policy objectives of the RMA and NZCPS, and appreciation of potential synergies are such that it is also appropriate to consider the role of Māori and cultural monitoring, integration of freshwater with coastal monitoring programmes, and integration of environmental monitoring datasets at national scales for use in Ministry for the Environment (MfE) national environmental reporting.

1.1. Report scope and objectives

This report aims to provide advice and recommendations toward establishing a framework and programme for monitoring in the Nelson Bays coastal marine area (CMA) that integrates current and future consent and SoE monitoring in the region. The report is intended to inform the Tasman District (TDC) and Nelson City Councils (NCC), as well as Marlborough District Council, since all three have jurisdictional boundaries that include a portion of Tasman Bay (Figure 1).

While estuarine environments and coastal margins are considered part of the coastal zone, monitoring activity in these areas is well-developed in comparison with subtidal areas of the outer coast. Accordingly this report deals primarily with the latter, but includes port-associated monitoring activities. Monitoring activity in intertidal and

[1] Nelson Bays includes Golden Bay, which is under the jurisdiction of TDC, and Tasman Bay, which is under the jurisdiction of TDC, NCC, and MDC (see Figure 1).

freshwater environments is considered with respect to integration of monitoring activity across ecosystem boundaries.

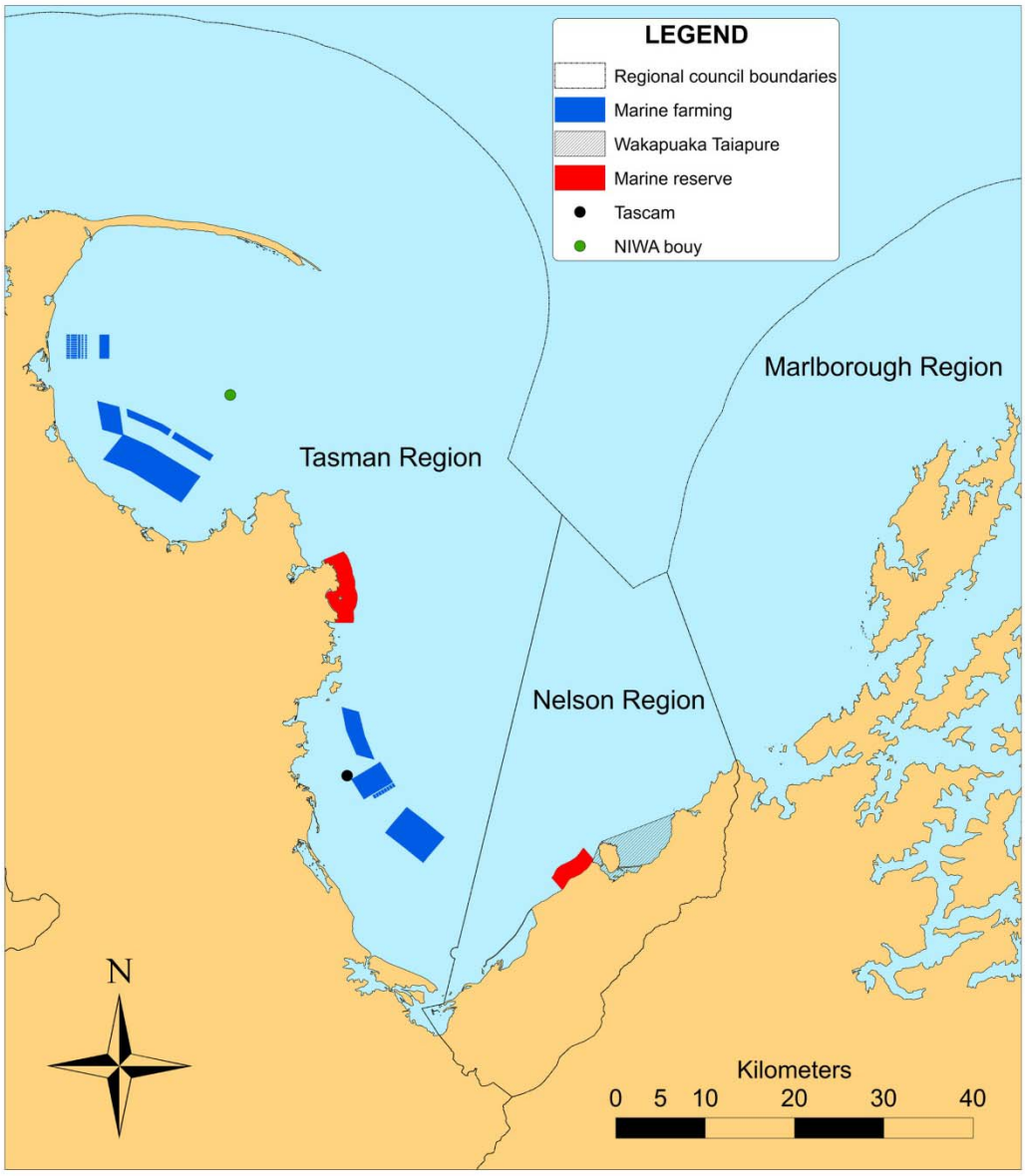


Figure 1. Tasman and Golden bays showing council boundaries extending out to 12 nautical miles (NM). Aquaculture management areas are in deep blue and marine reserves are in red.

Establishing a coordinated coastal monitoring programme, such as that being considered for Nelson Bays, requires a multi-stage approach where information needs, monitoring priorities and activity, and communication strategies are all considered. This report represents the first step towards developing and implementing coordinated monitoring in the CMA.

Key objectives of this report are to:

1. Define statutory obligations and requirements for monitoring in the coastal marine area (CMA).
2. Identify and broadly define major stakeholders and the nature and extent of the effects (both direct and indirect) of their activities on the CMA.
3. Describe current consent and SoE monitoring underway and limitations of existing efforts.
4. Outline next steps to develop an integrated SoE monitoring programme that integrates data from a number of sources including consent-related monitoring.

With regard to Objective 1, it was agreed with council representatives that this report would focus on obligations and policy objectives under the RMA and NZCPS as, to our knowledge, these requirements are currently the most extensive. It is beyond the scope of this report to assess the extent to which regional planning documents reflect the requirements of the RMA and NZCPS.

The impact of a particular activity is dependent in part on the nature of the region in which it occurs. Accordingly, as well as identifying the major stakeholders in the region (Objective 2) we consider the key stressors potentially impacting the marine environment in Nelson Bays.

Details on current consent and SoE monitoring activity (Objective 3) were sourced from existing published material and informal interviews with representatives of relevant groups.

In outlining the next steps (Objective 4), we identify information resources and tools that should be considered in the development of a coordinated regional monitoring initiative in Nelson Bays. A number of national and regional initiatives are underway that would be useful, either by informing the process of developing a framework or providing baseline information. A key example is a similar initiative by Waikato District Council to integrate consent-based and SoE monitoring. This report represents the first stage in further developing monitoring in the Nelson Bays CMA. It is intended to form a basis for seeking further support to carry out the recommended next steps (*e.g.* through the Ministry for Primary Industries (MPI) Aquaculture Planning Fund).

1.2. Definition and purpose of environmental monitoring

Environmental monitoring[2] is the collection of information to assess changes occurring over time and space in response to natural processes and / or anthropogenic activities.

Councils are responsible for managing resource consents for activities on land as well as those within the coastal marine area (CMA), which includes the seabed and overlying waters out to 12 nautical miles offshore (Figure 1). Consent holders for activities that may have adverse effects on the environment are usually required to carry out baseline monitoring and assess likely effects prior to consenting, as well as carry on monitoring for purposes of managing the activity and in some cases ensuring compliance.

Consent-related monitoring is generally (or ideally):

- designed to detect particular potential effects of a consented activity
- conducted at a local-scale (*i.e.* within the zone of influence)
- limited to the time period in which the activity is likely to have an impact on the environment
- compared to baseline information and / or control sites away from the activity
- undertaken at specified times after commencement or at specified stages of development of the activity
- reported to council as a consent condition, and subsequently the information becomes publicly available (although the information is rarely widely distributed).

Consent-related monitoring does not account for changes that may be occurring in the wider environment, where the effects from multiple human activities (whether consented or not) and natural processes may lead to cumulative environmental change. Regional councils are required to carry out some level of environmental monitoring to assess the conditions of the wider environment within their jurisdictions, including the CMA. Most often the monitoring is designed to address the state of a single domain — air, land, freshwater or marine — and is later compiled to assess and report on the overall SoE for a region.

State of the Environment-related monitoring is generally:

- carried out routinely at designated sites across the region
- ongoing
- useful for gauging the overall trajectory of environmental conditions

[2] The term ‘monitoring’ throughout this document refers to environmental monitoring.

- able to identify broad-scale spatial and temporal changes in environmental health
- generally reported on annual to 5-year intervals.

State of the Environment monitoring is the responsibility of council (under the RMA, NZCPS) but can include a range of other information that may or may not be associated with council.

Other monitoring (not consent- or SoE-related) also occurs. For example, marine reserves are monitored by, or for, the Department of Conservation. This monitoring can identify the effects of fishing on the marine environment, and also contribute to SoE information in a broader sense. Cultural and community monitoring may occur as part of initiatives unrelated to council matters. Industry also carries out monitoring for their own purposes. These other monitoring activities may also contribute relevant information to SoE monitoring.

2. MONITORING OBLIGATIONS OF COUNCILS AND CONSENT HOLDERS

Councils and consent holders have statutory obligations under the RMA to monitor the CMA. Both councils and consent holders can agree to monitoring that is beyond their statutory obligations. Councils may also have other monitoring obligations; for example, under their regional plans or as a result of agreements made with iwi[3].

2.1. Councils

2.1.1. Resource Management Act 1991

The RMA requires that a local authority monitor the state of the whole or any part of the environment of its region or district to the extent that is appropriate to enable it to effectively carry out its functions (Section 35). The results of its monitoring must be compiled and made public (at least) every five years. Also, a local authority must keep and make available to the public information that is relevant to the monitoring of resource consents and current issues relating to the environment.

2.1.2. New Zealand Coastal Policy Statement

The New Zealand Coastal Policy Statement 2010 (NZCPS) sets out the Government's objectives and policies in order to achieve the purpose of the RMA in relation to the coastal environment of New Zealand. Monitoring and reviewing of the effectiveness of the NZCPS is considered in Policy 28. To give effect to this policy, local authorities should collect district and regional monitoring data that can be incorporated into a nationally consistent monitoring and reporting programme. Also, local authorities should undertake other information gathering or monitoring that assists in providing a national perspective on coastal management trends, emerging issues and outcomes.

Other than Policy 28 there are few explicit statutory obligations and requirements for monitoring in the CMA set out in the NZCPS. However, a local authority will need to consider what monitoring is required in order to give effect to the NZCPS in its policy statements and plans, or when considering a resource consent application. For example, it will be necessary to gather SoE information in order to give effect to the policies regarding indigenous biodiversity (Policy 11), harmful aquatic organisms (Policy 12), enhancement of water quality (Policy 21) sedimentation (Policy 22), discharge of contaminants (Policy 23), and identification of coastal hazards (Policy 24). For example, Policy 21 states that where water quality has deteriorated to the extent that it has a significant adverse effect on ecosystems or use (including aquaculture and cultural activities), priority should be given to improving that water

[3] Extended kinship group, tribe, nation, people, nationality, race — often refers to a large group of people descended from a common ancestor.
Note: All te reo Māori translations in this report are from www.maoridictionary.co.nz

quality. More specifically, Policy 8 requires recognition that high water quality may be one of the relevant considerations in providing for aquaculture. Regional authorities are required to ensure that "development in the coastal zone do not make water quality unfit for aquaculture activities in areas approved for that purpose". Accordingly an understanding of water quality is necessary to determine how to manage areas of coastal water and water bodies so that water quality can be maintained at, or restored to, appropriate levels. Where this knowledge is uncertain or unknown, local authorities are directed to adopt a precautionary approach under Policy 3 of the NZCPS.

Policy 2 prescribes how local authorities take into account the principles of the Treaty of Waitangi and kaitiakitanga[4], in relation to the coastal environment. Local authorities must, as far as is practicable with tikanga Māori[5], incorporate mātauranga Māori[6] in regional policy statements and plans and when considering resource consent applications. Guidance on Policy 2[7] highlights that tangata whenua[8] may have an interest in SoE monitoring and reporting and that monitoring by Māori may be a means for tangata whenua[8] to exercise kaitiakitanga[4]. Examples given include "joint development of monitoring programmes, observations, data collection, [and] receiving monitoring reports from consent holders".

The NZCPS also recognises the need to integrate management of the coastal environment across boundaries including land-sea boundaries, local authority boundaries, and iwi[3] / hapū[9] boundaries or rohe[10] (Policy 4).

2.1.3. Environmental Reporting Bill

State of the Environment (SoE) monitoring is also carried out on a national level through the Ministry for the Environment (MfE) in collaboration with Statistics New Zealand. In August 2013, the Government introduced an Environmental Reporting Bill (ERB). This mandates the provision of comprehensive environmental information for the public in a manner that is easily understood, independent and relevant to priority environmental issues. The marine environment is one of the key domains for environmental reporting and the statistics that will be used in future to assess state of the environment in the marine domain are currently being established by MfE. National environmental reporting for all domains requires data from a number of providers, including regional councils. The quality and accessibility of data is of particular importance to achieving effective reporting at the national level.

[4] Guardianship, stewardship, trustee.
[5] Correct procedure, custom, habit, lore, method, manner, rule, way, code, meaning, plan, practice, convention.
[6] Māori knowledge — the body of knowledge originating from Māori ancestors, including the Māori world-view and perspectives, Māori creativity and cultural practices.
[7] http://www.doc.govt.nz/conservation/marine-and-coastal/coastal-management/nz-coastal-policy-statement/policy-statement-and-guidance/
[8] Local people, hosts, indigenous people of the land — people born of the whenua (land).
[9] Kinship group, clan, tribe, subtribe — section of a large kinship group.
[10] Boundary, district, region, territory, area, border (of land).

2.2. Consent holders

Under the RMA, consent applicants are required to describe how the effects of their proposed activity on the environment will be monitored, and by whom (Schedule 4). A local authority can impose conditions of consent that require consent holders to carry out specified testing, inspections, and reporting (s 108). However, under the Newbury Test[11] consent conditions must be for a resource management purpose and must fairly and reasonably relate to the development authorised by the consent to which the condition is attached. This means that a consent holder can be required to monitor the effects of their activity in the CMA. Any conditions requiring a consent holder to take on a significant part of the authority's duties (*e.g*. wider SoE monitoring), or undertake monitoring that does not fairly and reasonably relate to their consented activity are likely to be considered unlawfully imposed. However, conditions that cannot be required by the local authority, can be volunteered by a resource consent applicant[12]. If a consent is then granted with such conditions, they are enforceable. Under these circumstances, therefore, consent holders may undertake monitoring that is beyond what might be fairly and reasonably affected by their particular activity.

The RMA requires that cumulative effects be assessed as part of the resource consent process; however the requirements for assessing cumulative effects fall beyond the scope of a single consent applicant or industry and are best dealt with through a central entity such as a regional council (Dubé 2003; Duinker & Greig 2006; MPI 2013). However, there may still be an expectation that consent holders would contribute to such monitoring; for example, by providing data to a regional-scale programme or through cost-sharing.

[11] Newbury DC *vs* Secretary for the Environment [1981] AC 578, [1980] 1 All ER 731
[12] Augier *vs* Secretary of State for the Environment (1978) 38 P and CR 219 (QBD)

3. INFLUENCES ON THE COASTAL MARINE AREA

Developing effective monitoring programmes requires a good understanding of the ways various activities lead to environmental changes in the CMA. Human activities and related stressors[13] contribute to the following key threats to marine ecosystems: (1) pollution, (2) resource over-use (*e.g.* overfishing), (3) habitat modification, and (4) climate change (COS 2009; see Figure 2). Anthropogenic stressors include those that are physical (*e.g.* bottom trawling), chemical (*e.g.* contaminants), and biological (*e.g.* invasive species). Some stressors occur naturally in the marine environment, such as sedimentation associated with flood events or weather-induced shifts in water temperature or wave climate. Natural stressors can be exacerbated by anthropogenic activities, as in the case of land use changes that increase rates of sedimentation and nutrient delivery to coastal waters.

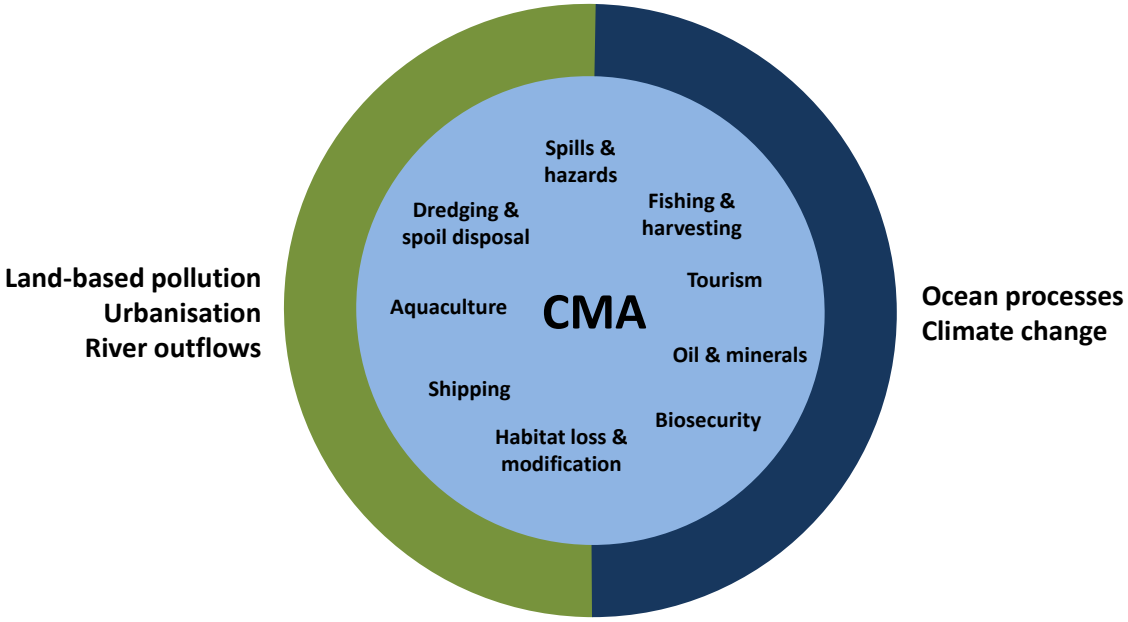


Figure 2. Sources of stressors in the coastal marine area (CMA). Stressors may act individually and may also act cumulatively with other sources and types of stressor.

Key stressors in the coastal environment include smothering of seabed habitats and reduced water clarity associated with sediment loading, increased nutrient concentrations and subsequent increases in primary production with potential for adverse eutrophication effects, and influx of a range of contaminants including metals, industrial and agricultural chemicals that can impact coastal recreational resources.

[13] Stressors are defined here as factors or processes that lead to negative impacts on ecosystem components, including lethal and sub-lethal effects on organisms, their populations and the communities and habitats they form.

Effective management of natural resources requires an understanding of the nature and extent of stressors leading to change in the system of interest. Stressors driving change may be natural or anthropogenic, they may or may not be under council control, and their impact may be measurable on a scale of 10s or 100s of metres (such as outfall discharges), or occur on larger spatial scales (such as diffuse pollution via river plumes) and over longer time periods (such as climate change-related stressors).

Some impacts are relatively easily definable, as in the case of point-source discharges from sewage outfalls or industrial processing plants. The local impacts of many of these kinds of activities in a region can be identified and measured through consent-related monitoring, and the cumulative effects of these activities on the wider environment can be addressed through SoE monitoring. Non-point sources of impacts are more complex and difficult to monitor, such as diffuse sources of pollution generated on land that ultimately make their way to the marine receiving environment. However, in the absence of wider SoE-related monitoring, the ability to prioritise and manage consented activities within the context of wider cumulative environmental change is near impossible.

Stressors derived from land-based activities may be related to council-controlled activities, and are generally regional in scale. These are activities that can impact the marine environment via runoff from land. Examples include diffuse and cumulative inputs of sediments and nutrients from agriculture and forestry, and single-source point discharges.

Marine activities may or may not be under council control. Those that are tend to be spatially limited, *e.g.* outfalls, channel dredging, aquaculture and some tourist activities. Marine activities (and associated stressors) not under full council control include fishing, shipping, invasive species incursion, and potential risks associated with oil and mineral exploitation beyond the CMA. Some stressors remain from historical decision-making and activity, such as land-use changes and modification of coastal margins.

Multiple stressors can interact in complex, synergistic ways and cumulatively degrade marine ecosystems. Eutrophication provides an example of the interaction of multiple stressors. The process of eutrophication is driven by nutrient loading from multiple sources (*e.g*. agriculture, wastewater outfalls, finfish farms) and can be exacerbated by other stressors such as overfishing and the loss of habitats that play an important role in nutrient retention such as seagrass meadows and wetlands.

3.1. Key activities and stressors in Nelson Bays

A range of anthropogenic activities and associated stressors impact on the coastal marine area of Nelson Bays. Key commercial activities in the region include fisheries, shellfish aquaculture, shipping and tourism. Land-based industries, such as pastoral farming, horticulture, and forestry also contribute to stressors in the downstream coastal waters of Tasman and Golden bays.

The highest-profile environmental issues in the bays are probably the collapse of the scallop fishery and the compromised dredge fisheries for oysters and mussels. The factors leading to these issues are still debated and are the focus of research proposed through the NIWA Rebuilding Shellfish Fisheries programme (Michael *et al.* 2012). Factors contributing to variable or poor growth in cultured shellfish are also not well understood.

Sedimentation is considered a particularly important issue and debate has occurred over the relative roles of land-use changes in terms of sediment loads and the effects of dredging and trawling on the seabed, which in turn may lead to increased tidal and / or wave-induced re-suspension of sediments. Sediments entering the bays are also known to be high in metals such as chromium and nickel (Gillespie *et al*. 2011a) due to naturally high levels in the mineral belt in the upper catchment. These metals can be toxic if sufficiently concentrated and in a form able to be assimilated by organisms (Svobodová 1993).

As a receiving environment, ways in which the Nelson Bays are actually or potentially impacted by human activity on land include: runoff of nutrients, sediments, contaminants from horticultural and pastoral farming, forestry, and other urban or rural land development activities. Many of these are diffuse stressors, but some, such as wastewater outfalls from sewage treatment plants or industry, are site-specific. In the case of Tasman Bay, land-derived nutrients are a potential stressor, but effects are likely localised to some estuaries, and less important in the wider CMA. This is due to hydrodynamic mixing processes and the much larger contribution of ocean sources to nutrients in the bays (Gillespie *et al.* 2011c).

Closures of popular bathing beaches occasionally occur due to elevated levels of faecal indicator bacteria following rainfall and the input of diffuse sources of pollution (*i.e.* associated with runoff as opposed to sewage outfalls). Mussel growers are also impacted by faecal contamination when closures of commercial harvest are incurred within growing areas (Cornelisen *et al.* 2011). Cockle beds in Golden Bay and green-lipped mussel farms in both Golden and Tasman bays are frequently closed following rainfall events due to the regulations imposed through shellfish sanitation programmes. These regulations are based on limited knowledge of contaminant sources and pathogen associated risks in the Nelson Bays. While faecal contamination is not a stressor on shellfish growth *per se*, it has clear economic

consequences for the industry. It also conflicts with the requirement under the NZCPS that regional authorities ensure that the water quality needs of the aquaculture industry are met. Reduced water and shellfish quality also reduces accessibility and use of customary and recreational harvest areas.

Commercial fishing using dredging, seining, and trawling has been widespread in Nelson Bays, with measurable impacts on community structure and sediment characteristics (Handley *et al.* 2014). The environmental effects of shellfish aquaculture in both Tasman and Golden Bays is typical of those observed in other mussel harvest areas, and is primarily limited to mild organic enrichment of the seabed, and changes in benthic community structure that are largely attributed to the drop-off of shells.

Shipping is a growing industry for Nelson. As with most ports, contamination exists at Port Nelson. Stressors associated with shipping include introduction of invasive species and the requirement for dredging and spoil disposal. Shipping also carries a risk of catastrophic stressors, such as an oil spill or other accidental discharge into the marine environment. The within- port/marina impacts include maintenance dredging, vessel traffic, and contamination. Contaminant impacts may result from historical and current use of metals in antifouling products, or hydrocarbon discharges.

Less-understood stressors in the region may be associated with recreation and tourism activities such as fishing charters, kayaking, transportation and sightseeing. Associated impacts can result from increases in boat traffic, noise and disturbance of wildlife. Extraction of marine resources and habitat disturbance also occur via recreational fishing and cultural harvest undertaken either from vessels or land. Recreational uses with likely minimal impacts include yachting and a wide range of activities such as swimming, kayaking / waka ama[14] paddling, and surfing / windsurfing / kiteboarding.

Beyond the regional scale, there are also stressors associated with climate change. The effects of global climate change are expected to include increases in ocean temperatures and acidity, sea level rise, and the frequency and severity of storm events. These longer-term environmental changes are important to consider due to the close proximity of townships to the coast, regional fisheries and the growing shellfish aquaculture industry. Ocean acidification is considered to represent a particular risk to shellfish-based industries.

[14] Outrigger canoe.

4. CURRENT MONITORING IN NELSON BAYS

4.1. Consent-related and State of the Environment monitoring

In developing SoE monitoring that integrates other data sources, it is important to identify existing monitoring activity. Monitoring activities recently or currently undertaken, or planned, in Nelson Bays are listed in Table 1. In addition to the information provided in the table we summarise key estuarine monitoring programmes below and provide more discussion on the monitoring of aquaculture as this is a major monitoring activity underway in Nelson Bays. We also identify some existing cultural monitoring, although this is currently limited to project-specific activity in estuarine environments.

Although not covered in this report, a large amount of freshwater monitoring, which is ultimately relevant to health of the CMA, is carried out by Council and by consent holders. For example, stream water monitoring is carried out for consented activities associated with forestry operations, discharges from various wastewater treatment plants and dairy effluents. As is the case with other regional councils, NCC and TDC recognise an opportunity to strengthen SoE monitoring in the CMA through better coordination with land-use / river water quality monitoring.

Not all data from programmes listed in Table 1 is publically available and the table is not comprehensive; only outer coastal and port-associated monitoring activity is included. It also does not reflect work undertaken as part of research or commercial projects which may produce datasets complementary to monitoring data or programmes. For instance, Cawthron and NIWA carry out studies and surveys for their own research projects, or on behalf of industry. The information presented here indicates that there are monitoring programmes presently undertaken, but that they are largely focused around specific activities that are either directly within the CMA, such as aquaculture, or have the clear potential for adverse effects on the CMA, such as outfalls and port activities. As indicated in Section 3, there are a number of activities beyond these, including land-based activities that contribute to environmental change in the CMA.

Table 1. Monitoring activity in Nelson Bays coastal marine area (CMA).

Tasman District Council			
Programme	**Data collected**	**Frequency and duration**	**Documented in**
Bathing water quality monitoring	Enterococci density (approx. 17 beaches in Tasman and Golden Bays, plus approx. seven rivers)	Multiple occasions over summer every second year, subset tested annually	http://www.tasman.govt.nz/environment/water/swimming-water-quality/
TASCAM[15] benthic	Benthic SoE surveys: • Seabed physical, chemical and biological properties	5-yearly	*e.g.* Gillespie and Johnston (2012)
Golden Bay and Tasman Bay AMA:[16]mussel farming	Seabed and water column surveys: • Physical, chemical and biological properties	Approx. every 1–2 years, dependent on stage of farm development	*e.g.* Forrest *et al.* (2012)
Golden Bay and Tasman Bay AMA: spat catching	Benthic surveys: • Spat / juvenile shellfish on seabed, predator density, shellfish health assessments	After spat-catching season (usually annually)	*e.g.* Forrest and Taylor (2011)
Nelson City Council			
Programme	**Data collected**	**Frequency and duration**	**Documented in**
Port Nelson / NCC long-term monitoring programme	Benthic surveys: • Sediment physical, chemical and biological properties (grain size distribution, % organic, seven metals plus Hg) • Sediment semi-volatile organic compounds, organotins • Macro-infauna	1-, 2- and 5-yearly (2010-2019) (Baseline in 1996, previous monitoring programme 2004–2007)	Long term database Cawthron reports, *e.g.* (Sneddon 2013c) multi-year analysis of the data planned in 2014 (after fifth survey)

[15] TASCAM is a hi-tech coastal monitoring buoy used to remotely collect physical and biological data on the water quality of Tasman Bay, New Zealand.
[16] Aquaculture Management Areas

Nelson City Council *(continued)*			
Programme	**Data collected**	**Frequency and duration**	**Documented in**
Effects of Bell Island sewerage discharge[17]	Mussel deployment surveys: • Faecal indicator bacteria (seawater samples and mussel tissue) • Phytoplankton species and abundance • water column profiles of salinity, temperature, light, turbidity, chlorophyll-*a* and dissolved oxygen	6-monthly	*e.g.* Gillespie and Forrest (2013)
	Outfall mixing zone surveys: • Seawater nutrients, faecal indicator bacteria and phytoplankton • Shellfish faecal indicator bacteria	5-yearly	*e.g.* Gillespie *et al.* (2011a)
	Benthic surveys: • Sediment physical, chemical and biological properties (organic content, grain size distribution, nutrients metals, epifauna / infauna)	5-yearly	*e.g.* Gillespie *et al.* (2012)
Outer boulder bank Nelson fisheries outfall seabed effects.	Benthic surveys: • Sediment grain size, organic content, mercury concentration • Epifaunal communities, substrate characterisation	5 yearly (2005–2040)	*e.g.* Sneddon and Clark (2011)
Nelson Harbour and entrance channel (dredge areas)	Sediment surveys: • trace metals (Cu, Pb, Zn) • PAHs • Organotins (Mbt, Dbt, Tbt, Tpht)	Annually (during maintenance dredging)	*e.g.* Sneddon (2013b)
Dredge spoil disposal	Water column surveys: • Bathymetry of spoil disposal site	Annually (post spoil disposal)	Sneddon (2012a)
	• Turbidity and/or clarity • TSS	Annually (during spoil disposal) for 3–10 years[18]	

[17] Effluent quality sampled monthly for *E.coli*, faecal coliforms, total phosphorous, total nitrogen, suspended solids and BOD, programme also includes substantial estuarine component

[18] If no effect found in the first three years, again at 11 years. If no effect found in year 11, further monitoring unnecessary.

Nelson City Council *(continued)*			
Programme	**Data collected**	**Frequency and duration**	**Documented in**
Dredge spoil disposal *(continued)*	• Sediment (contaminants, grain size, organic content) • Macroinvertebrate quality • *Austrofucus glans*, mercury, PCBs OCPs • Neogastropoda for imposex	5-yearly (beginning 2012)	
Department of Conservation: Marine reserve monitoring			
Programme	**Data collected**	**Frequency and duration**	**Documented in**
Hororangi Marine Reserve and adjacent areas (reef)	Macrofauna	Annually (fish and lobster), 3- to 4-yearly (other invertebrates). Ongoing from 2006 dependent on funding priorities.	*e.g.* Davison *et al.* (2013)
Hororangi Marine Reserve and adjacent areas (soft sediment)	Sediment properties (grain size, organic content), infauna, macrobiota	Baseline (2006) May be repeated after 10 years	Keeley et al (2006)
Tonga Island Marine Reserve and adjacent areas (reef)	Macrofauna	Variable, up to annually, 1993–present. Annually (fish and lobster) 3- to 4-yearly (other invertebrates) Ongoing depending on funding.	Davidson and Richards (2013)
Tonga Island Marine Reserve and adjacent areas (soft sediment)	Habitat maps, benthic flora/fauna, sediment characteristics (physical and biological)	Baseline data pre-2003	Thrush *et al.* (2003)

Other monitoring efforts and data sources			
Programme	**Data collected**	**Frequency and duration**	**Documented in**
TASCAM buoy[19]	Weather ,water temperature, salinity, turbidity and chlorophyll-*a*, current speed & direction	Continuous (available hourly)	http://www.cawthron.org.nz/tascam/
NIWA Golden Bay Marine Monitoring Buoy[19]	Maximum wave height, water temperature	Hourly	http://www.tasman.govt.nz/environment/coastal-marine/metbuoy-2155/
Nelson Port Beacon	Sea level, wave height and frequency	Continuous	http://www.portnelson.co.nz/shipping-information/harbour-conditions/)
"Biosecurity Port Surveys" (National Marine High Risk Site Surveillance), Port Nelson[20]	Invasive species detection, species lists	Variable, twice annually since summer 2007/8. Future schedule uncertain	*e.g.* Inglis *et al.* (2008).
Survey of scallops and oysters for MPI	Dredge surveys	Usually annually, 1994–2012	*e.g.* Williams and Bian (2012)
Reef check (planned community initiative)	Fish, invertebrate, and substrate surveys along fixed transects in and around marine reserves	Multiple surveys during summer–ongoing	International website: http://www.reefcheck.org/

[19] Minor financial contribution made by TDC

[20] Also Nelson Haven, Mapua and nearby Waimea estuary, Golden Bay Baseline published in 2009 Stuart M, Jones E, Piola R, McClary 2009. Golden Bay Non-Indigenous Species Port Survey: Baseline Surveys of New Ports and Marinas.

In addition to the monitoring described in Table 1, the Marlborough Shellfish Quality Programme (MSQP) programme measures phytoplankton composition and biomass, and shellfish toxicity weekly, associated with shellfish growing areas in the top of the south. The data is held by industry, but MPI purchases these data from industry for issuing of public warnings.

Scallop larval and spat monitoring programmes are also undertaken for industry purposes. Other ongoing industry-associated data collection may also take place. For example, the health and productivity of aquaculture stock may be informative of water column productivity, and data such as water temperature that may be collected as part of industrial operations, could complement the data collected by dedicated observation platforms such as TASCAM. In addition, numerous 'one-off' studies have been undertaken for industry, research, community or council-related purposes. While these are not undertaken for the purpose of monitoring, they also provide valuable baseline and SoE information (see Section 5.1 for examples).

Estuaries are often a key focus for monitoring throughout New Zealand for a number of reasons. These range from their proximity to the coast and ease of sampling, to their high ecosystem values and to their sensitivity to land-based stressors. Key estuarine monitoring projects in Nelson Bays include:

- Estuarine monitoring for the purpose of SoE reporting is undertaken at Waimea Inlet, Moutere Inlet, Motueka Delta, Motupipi Estuary, and Ruataniwha Estuary. Baseline surveys have also been implemented for Delaware Inlet and Nelson Haven estuaries and is planned for Whangamoa Estuary. Broad-scale habitat mapping and fine-scale sediment monitoring are undertaken. This is usually on a 5-yearly basis, although annual monitoring may take place when there is cause for concern regarding ecosystem health. Coastal (intertidal or terrestrial) mapping, and sandy and rocky shore monitoring also takes place at 5- to 10-year intervals, and estuary State of the Environment reports are released ~5-yearly[21].
- Post-remediation contaminant monitoring occurs at the Fruitgrowers Chemical Company (FCC) site, Mapua. This has been occurring at least annually 2005–2011[22], and includes mollusc and sediment contaminant sampling, and macroalgal cover.
- Nelson Pine Industries (NPI) are required to monitor the estuarine biological community, epifauna, infauna, and flora (three sites within Waimea Estuary), and ammonia and formaldehyde in sediments (three sites in Waimea Inlet adjacent to NPI, Rough Island, Nelson Haven) (*e.g.* Dunmore 2012).

[21] http://www.tasman.govt.nz/environment/coastal-marine/coastal-marine-biodiversity/estuarine-information/ http://nelson.govt.nz/environment/environmental-monitoring/state-of-the-environment-reports-3/
[22] http://www.tasman.govt.nz/environment/land/contaminated-land/the-former-fruit-growers-chemical-company-site-at-mapua

- Talleys: Port Motueka. As part of the resource consent conditions to discharge contaminants into the Moutere Inlet, the company monitors discharges and benthic habitats and communities (Sneddon 2013a).

In summary, monitoring and assessment of impacts from resource consent-related activities occurring in the marine environment (such as aquaculture and wastewater outfall discharges) is generally robust. Estuarine environments are relatively well-monitored, but requirements for wider SoE monitoring of the CMA as outlined in Section 2 are not being fully met. This is common in most regions around New Zealand, where SoE monitoring is so limited in scope that the background state of the environment, the importance of various activities, and the relative importance of non-point-source effects, is poorly understood. As a result, appropriate baselines for assessing wider impacts of individual activities, as well as cumulative effects from multiple stressors, are unable to be established. Greater emphasis and effort goes into wastewater consent monitoring, despite that fact that point-source discharges may not be the most important cause of coastal degradation. While substantial effort goes in to freshwater and estuarine monitoring in Nelson Bays, councils recognise that SoE monitoring in the coastal marine environment is minimal.

4.2. Aquaculture

Mussel farming in Nelson Bays has intensive monitoring requirements around farms, and aquaculture currently represents the most significant monitoring activity in the Bays. Concern exists within the aquaculture industry that monitoring requirements are not as fit for purpose as they could be, and that other stressors are not sufficiently monitored or understood. Accordingly aquaculture is considered to be potentially over-monitoring, while many other stressors are under-monitored.

Mussel farm monitoring requires that farm-based measurements are compared with controls approximately 1 km from the farms. The SoE information available, which has use in placing the consent-related measures into context, is supplied by the TASCAM buoy (Cawthron) and Golden Bay wave buoy (NIWA), and the associated benthic monitoring. Other data is not necessarily publicly available. Council provision of SoE data in the CMA (beyond estuaries) is limited to a minor annual contribution to the two buoys and benthic monitoring undertaken at the TASCAM station.

Standardisation across monitoring of farm effects occurs to a large extent because the same science providers tend to be involved in planning the monitoring work. It has been suggested that monitoring required as part of the recently-approved consent for mussel farming in MDC-administered waters (eastern Tasman Bay) will be designed to be consistent with existing Nelson Bays farms as much as possible and that some consideration also be given to standardising monitoring approaches

large-scale mussel farms throughout New Zealand (pers. comm. P. Gillespie, Cawthron).

4.3. Cultural monitoring

Assessments using cultural health indicators are undertaken under some recent freshwater and estuarine[23] projects (*e.g.* McColgan & Walker 2009; Tiakina Te Taiao 2013). Māori cultural intertidal monitoring approaches have also been tested in some Nelson / Tasman coastal regions (*e.g.* Delaware Inlet (Walker 2009); cultural health monitoring of Mairiri [Moutere] Estuary associated with the 'Muddy Buddy' event, [Tiakina Te Taiao 2013]). To our knowledge no cultural monitoring currently occurs in outer coastal waters. Several contributors to this report expressed a belief that, in general, provision by councils for the kaitiaki[24] relationship of Māori with the marine environment lacks strength. The NZCPS recognises that monitoring is one way in which Māori can exercise this relationship.

4.4. Data availability

Data sharing for the benefit of all stakeholders should be fostered to realise a more effective integrated monitoring programme. The TASCAM and NIWA buoy data is available online, and summary data is available in a range of reports available in hard copy from council, or in some cases, online. For example, aquaculture monitoring reports are publically available on request once the council has received them. Raw data is generally not available in these reports. Access to most data would be via contact with the consent holder, and would be at their discretion. Fishing is an important activity that contributes to environmental change in Nelson Bays but lies outside council control; however, catch data associated with commercial and customary fisheries is available in the region and is held by MPI.

The New Zealand Catalogue of Marine Environmental Monitoring Programmes[25] holds metadata of monitoring activity, but only the estuarine monitoring program information is included for Nelson Bays. The portal for data relevant to the Nelson Bays shellfish fisheries as part of the NIWA-run Rebuilding Shellfish Fisheries programme is planned in the near future (pers. comm. Keith Michaels, NIWA). Once fully functional, this will hold a catalogue of metadata, with raw data available where possible. Initially it is most likely that example data will be available, but the intention is to host any regional data that is publicly available.

[23] A taiāpure (a stretch of coast, reef or fishing ground set aside as a reserve for inland kinship groups to gather shellfish or to fish) was put into effect in Delaware Bay in 2002. Although, to our knowledge, no management criteria have as yet been proposed. If some monitoring were to be considered for the taiāpure área, it could be usefully coordinated with nearby estuary and Horoirangi Marine Reserve monitoring.
[24] Trustee, minder, guard, custodian, guardian, keeper.
[25] http://geodata.govt.nz/geonetwork_memp/srv/en/main.home

5. OPPORTUNITIES FOR INTEGRATION

A positive aspect of the current monitoring situation is that extensive data are currently being collected in numerous programmes and targeted projects (Table 2). In most cases these data will have value beyond the specific aim of fulfilling consent conditions, or describing local environmental characteristics. Accordingly, they have potential to contribute toward SoE monitoring and reporting. In developing future monitoring programmes in the CMA, there is an opportunity to better integrate consent-related and SoE monitoring. This in turn will lead to a number of benefits including: more efficient and cost-effective monitoring by consent holders and councils, and also a more robust information base for establishing baselines, contextualising impacts associated with various activities, and tracking cumulative environmental change.

The remainder of this report focuses on the initial development stages of an overarching, integrated monitoring programme for the Nelson Bays. Once a basic framework for integration is established, there are additional challenges to the implementation of a larger-scale integration aimed at improving SoE monitoring efforts and efficiencies in the CMA. These include:

1. working across the three Top of the South regional authorities
2. resourcing of finances
3. accessibility and transferability of data and information across monitoring programmes (*e.g.* standardisation of survey design, data collection, and management approach) to achieve comparability with other programmes.

Integration of management objectives and monitoring programmes across the three Top of the South regional authorities is the ideal for effective and efficient monitoring activity in the Nelson Bays coastal area. The management objectives and associated monitoring should be shared, both because this is necessary for effective management and comparable monitoring design, and because the NZCPS requires provision for integration across local authority boundaries (Policy 4). Common goals and agreed objectives of monitoring within an integrated programme for Nelson Bays will require a governance structure that transcends any one council. The Tasman Bay Working Group within the Biodiversity Forum could serve this overarching role, and ensure that monitoring is consistent with respect to programme objectives, and components such as standards, sampling design, and data formats and availability. Wide stakeholder engagement, including industry and iwi, within the governance structure will assist in improving data sharing and participation.

Coastal SoE monitoring across New Zealand is limited by lack of resources, and it may be that robust monitoring of the CMA cannot be instituted without greater financial commitment from central government. Regional authorities will need to

consider the options for funding ongoing monitoring efforts. While consideration of this in any depth is beyond the scope of this report, the role of communication will be important to inform rate payers about the value they are receiving from the monitoring programme. Possible components of long-term monitoring include sector contributions (*e.g.* levies from land-based and marine industries impacting on the CMA) toward region-wide field sampling programmes (*e.g.* expansion of the existing sanitation / seafood safety programmes).

5.1. Forms of integration

Integration of monitoring is the coordination of monitoring efforts and sharing of data and information across programmes. To maximise benefits of integration, there needs to be a two-way flow of data, so that, for example, consent-related monitoring both informs, and is informed by, SoE information. The schematic of information flow in a coordinated monitoring framework depicted in Figure 3 identifies consent-associated, industrial, community, and Māori cultural information integrated with state of the environment information (so that each specialised monitoring outcome could then inform each of the others). Other groupings or sub-components of specialised monitoring activity could undoubtedly be identified in different regions or settings. A further component of integration can occur across multiple consent holders. Integration requires standardised sampling methodologies and consistent data formats and exchange protocols to ensure comparability and pooling of data across different monitoring activities. An exception to this may, however, be cultural health indicators, where it may not be appropriate to integrate all aspects of information collection and storage with other types of data and information.

Key opportunities to benefit from integration across monitoring efforts include the following:

- **Across multiple consents:** Integrating across consents involving similar activities and stressors has the potential to provide more comprehensive datasets for assessing effects and also can make monitoring more efficient and cost-effective. An example is a consortium approach to monitoring multiple shellfish farm consents, where reference sites are shared and not all farms are monitored.

- **Consent-related with SoE:** Consent data can feed into larger SoE datasets, which is particularly important when assessing cumulative effects. Bay-scale data can be made available to consent holders to provide context for consent-related effects reporting. Broad-scale information can also function as a useful industry tool, and could be informative for planning and risk management. For example, more rigorous data on climatic trends and the ability to predict productivity could assist in planning stocking levels and harvesting schedules in aquaculture. An example of this form of integration already occurs in the Waimea Inlet. The Bell

Island outfall and bio-solids disposal monitoring at 5- to 6-year intervals occurs alongside the Waimea Inlet SoE monitoring. The same time intervals and comparable methodologies are used.

- **Industry and community with SoE:** As described in Section 4, a range of monitoring data types is generated by industry, various community groups and the Department of Conservation for purposes other than consent- or SoE-related monitoring. Nonetheless these datasets are potentially very useful for providing a broader picture about the state of the environment.

In the addition to the above, Māori cultural indicators and Western science methods are increasingly being used in parallel. When used in combination, they have an increased potential to strengthen SoE monitoring efforts (see Section 5.1.1 for further discussion).

The benefits of integration can occur on many scales, from alignment of small local programmes, to integration across councils, ecosystems, and even alignment with international programmes (as also represented in Figure 3). Data from other environments, particularly estuarine and freshwater, are important for linking stressors from activities outside the CMA, and information on larger-scale stressors (national, global) will improve the understanding of the state of the local environment (see Section 5.1.2). Each of these aspects of integration can be considered during design and refinement of monitoring programmes, including the selection of indicators, and sampling design.

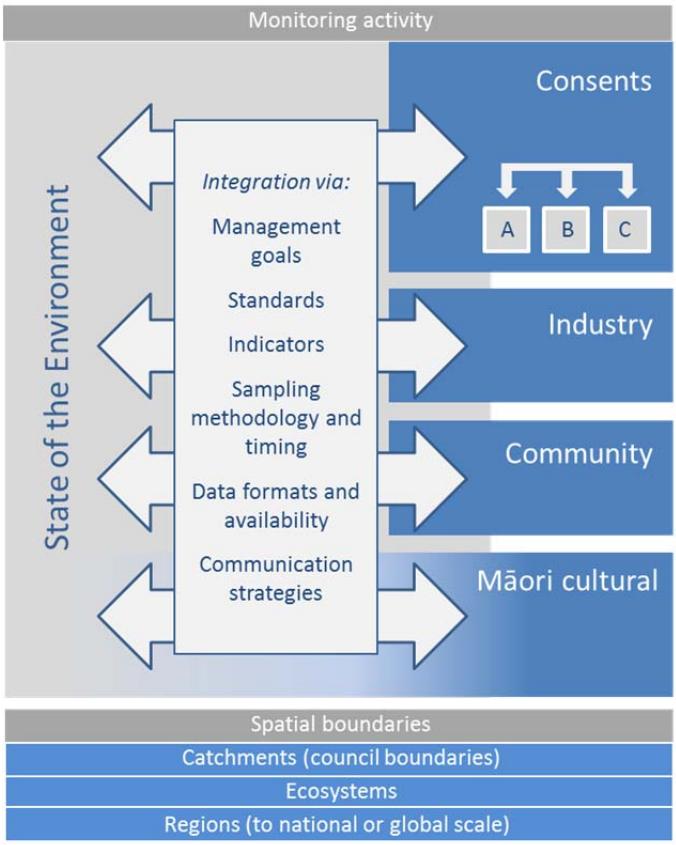


Figure 3. Monitoring activity and mechanisms for integration between information types (top) and spatial boundaries across which information can be integrated (bottom). An ideal monitoring framework will maximise the potential for each type of information to contribute to State of the Environment (SoE) monitoring, and for SoE information to inform specific monitoring. To recognise the unique role of Māori cultural monitoring, this is not depicted as distinct from SoE monitoring.

5.1.1. Māori cultural and Western science

There is broad recognition among Māori[26], scientists and council communities of a need to build better relationships between Western scientific approaches to ecosystem management and Māori communities, values, and knowledge. Development and integration of cultural monitoring is one aspect of the recognition of, and provision for, Māori values and interests in resource management (*e.g.* Walker 2009).

In discussing an integrated coastal monitoring with a range of interested parties (see acknowledgements), key benefits of cultural monitoring were generally considered to

[26] In collecting information for this component of the report we held a series of informal conversations, with the intention of bringing together a range of ideas around cultural monitoring in Tasman and Golden Bays. We were not able to speak with representatives of all iwi. We have attempted to represent a range of ideas regarding monitoring in the information presented here, but we do not wish to imply that the information in this report represents the beliefs of any particular contributor.

be two-fold. Firstly, the holistic approach is considered to provide meaningful information about the ecosystem as a whole, rather than the reductive measures employed in much mainstream scientific monitoring. Secondly, the focus on mahinga kai[27] is important because of the central role of kaimoana[28] in Māori culture.

The other strong message, raised by Māori interviewees for this report, was the inaccessibility of monitoring information. There was a strong wish to have accessible and engaging information regarding both the state of the environment, and the effects of particular activities. Aside from the desire to understand the state of health of the Nelson Bays, it was generally considered that more effective outreach would result in better engagement of local communities, support for evidence-based decision-making, and increased social licence for sustainable resource use. Current availability of monitoring information is considered to be limited both by the ability to easily access reports, and the use of esoteric language and data-presentation in the reports. This highlights the importance of communication in realising the benefits of integration.

A 'Mountains to Sea' perspective that integrates across ecosystems was also considered a central strength of a Māori approach to monitoring. This was an important component of local Maori collaboration in the Motueka Integrated Catchment Management programme (2001–2011). The experience and documentation from this project provide a valuable example of the complementary methodologies, and the cultural and ecological benefits of a combined scientific / cultural[29] approach (Harmsworth *et al.* 2011).

In developing integrated monitoring for Nelson Bays, the utility of cultural knowledge and cultural health indicators in SoE monitoring was widely considered to be high. The incorporation of local and historical knowledge, and the use of qualitative 'big-picture' measures were considered to be key factors in the complementarity of cultural and mainstream scientific monitoring. Similarly, the focus on kaimoana[28]was considered to be widely relevant as these species can be considered indicators of wider ecosystem health, and therefore inform SoE assessments.

The utility of cultural monitoring indicators in a commercial setting (*i.e.*, related to aquaculture operations) was generally not considered high, however some contributors were very positive about the potential to integrate such indicators with mainstream scientific consent-based monitoring programmes.

A key challenge for increasing cultural health monitoring is funding, although it tends to be considerably less expensive than mainstream scientific monitoring

[27] Garden, cultivation, food-gathering places.
[28] Seafood, shellfish.
[29] We note that this was a science-driven project and does not provide the only approach to inclusion of a cultural perspective to monitoring. Iwi-driven projects will be considered by some to be more relevant.

methodologies. The differing expectations regarding traditional Māori knowledge versus other kinds of expertise are acknowledged in the guidance material for Policy 2 of the NZCPS, where it states that: “Tangata whenua exercise of kaitiakitanga may require payment for Māori involvement and expertise”.

5.1.2. Integrating across natural and jurisdictional boundaries

Tasman Bay is a relatively discrete coastal water body that falls under the jurisdiction of three regional authorities. Monitoring programmes carried out or overseen by different authorities need to be integrated if the health of the CMA is to be monitored in a manner that encompasses the natural boundaries of the system. The design of any environmental monitoring programme should take into consideration connectivity and spatial linkages within and among ecosystems and processes occurring over varying time scales.

Throughout most of New Zealand, SoE monitoring in estuarine and freshwater environments is currently more intensive than on the outer coast, which is the ultimate receiving environment. The information collected in these upstream environments is directly relevant to coastal water health, and would be critical in addressing cumulative effects in the CMA (see Section 3). Hence there is a need to better integrate among monitoring programmes that focus on different environments that are part of the larger natural system. Opportunities for integration of CMA monitoring with estuarine and freshwater monitoring activity may include temporal alignment with these programmes, consideration of the location of sampling sites on the outer coast, alignment of data formats and management, and the incorporation of all these environments when communicating regional environmental health information to the public.

A scientific panel assessing the National Objectives Framework for Freshwater for use in estuaries found high potential value in using an integrated approach to setting objectives for estuaries, and a similar assessment for applicability to the outer coast would be informative. In addition, the estuarine environmental assessment and monitoring protocol (Robertson *et al.* 2002) is an example of development of a methodology which has experienced wide national uptake, and which may provide lessons for integration of coastal monitoring across New Zealand. The council-led LAWA initiative (www.lawa.org.nz) began as a means of communicating river health information, but is beginning to present information on the environmental conditions of land, freshwater and coastal waters in a more holistic manner. LAWA may develop to become a useful data storage or communication tool for coastal data.

In addition to regional considerations, there is also opportunity to integrate monitoring efforts with programmes from other regions and at the national level. For instance, monitoring protocols and standards are being developed for the aquaculture industry in both the Marlborough Sounds and Waikato CMA. By following the same protocols

and standards, data from the Nelson Bays region can contribute toward national datasets that provide a more comprehensive picture of the ecological effects of aquaculture in New Zealand.

To facilitate data sharing and integration at a National level, MPI has initiated a Marine Environmental Monitoring Programme (MEMP) aimed at cataloguing monitoring efforts in the CMA and wider Exclusive Economic Zone. The first document from the MEMP programme is currently under review, and will be an important information source for councils in developing monitoring programmes. The MEMP also aims to develop on online portal for metadata on monitoring programmes and existing datasets, and to foster better sharing and integration of monitoring data across the country. In addition to the MEMP, datasets and information more specific to the Nelson Bays region have been compiled as part of the joint Massey University and Cawthron project ‘Valuing Marine Ecosystem Services’.

6. DEVELOPING AN INTEGRATED MONITORING PROGRAMME

The ultimate outcome for councils and the region would be robust and informative monitoring and reporting of the effects of consented activities, nested within an overarching SoE monitoring programme. Data and information integrated from multiple sources would track environmental changes across the CMA and over the long term. The first step in achieving this is to establish a framework that assists councils in aligning consent monitoring requirements with SoE monitoring. Such a framework has been developed for Waikato Regional Council (see Forrest & Cornelisen 2014) and is likely transferable for use by other regional councils.

Frameworks for developing monitoring programmes typically centre around three basic components: 1) prioritisation, 2) monitoring, and 3) communication (Figure 4). In this section, we introduce each component and outline the various elements and information that contributes to each of them. We then outline next steps for addressing each component. Existing information that will assist in undertaking the next steps are included in Appendix 1.

While some components of a monitoring programme for Nelson Bays can be identified on the basis of the current understanding of bay-wide activity, values, and stressors, other components will require a substantial development process. Integration can occur on a range of scales and levels and development of an integrated monitoring programme will be an iterative process. A general management goal of coastal water quality maintenance functions as an example of how management objectives might drive design of a monitoring programme (see Box 1).

Figure 4. The three key components of a monitoring framework. Integration across information types and spatial boundaries (as depicted in Figure 3) can occur at every stage of development of a monitoring framework.

BOX 1: MONITORING LINKED TO AN EXAMPLE MANAGEMENT GOAL

Maintenance of water quality at or above levels relevant to a range of iwi and stakeholder requirements or values is a goal recognised and prioritised by regional councils and highlighted in the NZCPS (see Policy 8). This goal can be framed as a management objective such as: *Management of discharges to the marine environment to protect ecosystem, amenity, aquaculture, and tangata whenua requirements or values in the CMA*[30]. Assessment of marine water quality is consistent with both TDC and NCC´s resource management plans, although both state a particular focus on the near-shore environment.

Key to effective monitoring of water quality will be background data and information (*i.e.* **baseline conditions**), and an understanding of sources of marine water quality degradation (*i.e.* **stressors**). The requirements for each component of the goal (ecosystem, amenity, aquaculture, and tangata whenua **values**) would need to be defined through research and consultation and in some cases developed in partnership with iwi.

Monitoring objectives linked to this management goal could therefore be defined as:

- Describe background levels and variation in water quality characteristics key to ecosystem, amenity, aquaculture, and tangata whenua requirements or values.
- Identify the nature and extent of sources of degradation to these requirements or values.

To begin addressing these monitoring objectives it would be necessary to identify limitations in establishing appropriate baseline conditions, the current state of water quality, and the main anthropogenic sources of changes to water quality. The extent to which existing information is adequate should be assessed with respect to the range of values (we assume that the values have been well-understood before the goal is formulated). It is likely that further information will be required. For example, it is likely that tangata whenua values are not well catered-for by current monitoring approaches.

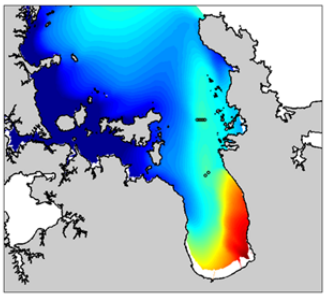
Indicators: Ways of measuring water quality may differ depending on which component of the management goal is being assessed. Indicators are useful in gauging change associated with water column characteristics and ideally provide a context for wider marine ecosystem health. Indicators to consider include TRIX (a trophic level index), which is formulated from concentrations of chlorophyll-*a*, oxygen, mineral nitrogen, and total phosphorus (Vollenweider *et al.* 1998). This indicator is now being used in water column monitoring of shellfish farm expansion in Tasman and Golden bays (Forrest & Knight in prep.). It has been found to provide a more stable measure of overall water column conditions than single parameters, which vary considerably and are difficult to link to any one process. Further discussion on the use of various indicators for coastal monitoring can be found in (Keeley *et al.* in prep.).

Standards: Water quality standards (*e.g.* values, levels or bands not to be exceeded) that reflect the values of each component are required to assess whether management goals are achieved. In some cases, standards may be established for indicators as described above, or for specific parameters that address a particular component. For example, levels of faecal contamination (measured as bacteria concentrations in water and shellfish) may not affect ecosystem functioning, but are relevant to amenity, aquaculture, and tangata whenua values.

Standards for each component of the goal would need to be defined separately, and then integrated where possible (the standard defined for the most rigorous of the component requirements may be adopted as the minimum water quality permissible for a given area).

[30] Based on WDC policy 7.2 in the proposed regional policy statement, www.waikatoregion.govt.nz

The following are useful tools that can assist in developing and carrying out monitoring that addresses water quality.

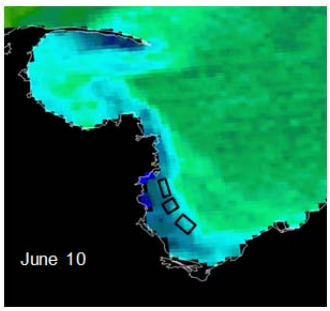


Modelling and associated ground-truthing*:* Modelling has an important role to play in understanding, predicting and managing cumulative effects and New Zealand has access to extensive modelling capability. Data on individual stressors can be integrated with other impacts across multiple scales, from point-source discharges to broad-scale changes in ocean temperature, and the model can be interrogated for information on measured or predicted changes of interest.

Further, models can provide a tool for improved management of coastal activities, as impacts can be predicted or mitigated on the basis of proposed scenarios of development, protection, exploitation, or other changes. There are a range of modelling approaches with varying benefits and limitations, and the purposes of a model must be clearly defined to ensure that the model is fit for purpose. Relevant existing modelling approaches include the use of:

- 'box' models that inform high-level assessments (*e.g.* Jiang & Gibbs 2005),
- sophisticated hydrodynamic and transport models for assessing water quality in response to changes in contaminant inputs (see image, Knight & Beamsley 2013),
- modular systems that link physical, ecological, and social components (*e.g.* ATLANTIS model proposed for the region through the NIWA Shellfish Strategy Group).

Permanent observation platforms: Long time-series are required to establish ranges of baseline conditions and separate anthropogenic effects from natural variation. TASCAM (see image) has been collecting meteorological information, sea temperature, salinity, turbidity, chlorophyll-*a* and current speed and direction data in Tasman Bay for three years. The NIWA buoy in Golden Bay collects meteorological information, wave height and sea temperature data, however additional sensors could be added to provide comparable information with the Tasman Bay facility. Other industry-associated buoys are also deployed which could contribute informative data.



Satellite imagery: Freely available satellite imagery ground-truthed with time-series data from observation platforms can be used to extend monitoring of water quality across Nelson Bays. This can be a cost-effective 'desktop' approach to understanding spatial and temporal variability in water quality conditions. Analysis of satellite imagery allows the examination of patterns in near-surface turbidity, water temperature (see image) and levels of chlorophyll-*a* under varying physical conditions. This approach is useful for strengthening data provision in poorly sampled areas (Knight & Jiang 2014).

6.1. Prioritisation

Resources are limited for environmental monitoring, so prioritisation must occur in several areas (and across all components) to ensure the best outcome for money and effort. Inadequate objectives are a common problem in monitoring (ANZECC and ARMCANZ 2000). The most effective monitoring will be targeted to the highest priority issues in regional marine ecosystem management. Monitoring should therefore be designed to reflect the priority management objectives and activity of a region, and accordingly should target the most important issues or 'pressures' on the CMA.

A key role of prioritisation is in identifying what data and information gaps to fill so that adequate baselines are established. Lack of information regarding the status and variability of ecosystems can hamper effective management because the nature and degree of impact of particular stressors is not understood. This makes it difficult to develop appropriate consent conditions, and increases public (and specialist) concern regarding use of natural resources (see case study in Appendix 4).

Three priority data issues include:

- **Baseline data** that reflects background (un-impacted) conditions and/or the current state of the environment may need to be collected or collated to fill knowledge gaps, minimise uncertainty, and refine management objectives.
- **Long-term data collection** to understand variability in background conditions over time, and to separate the effect of stressors from background variation.
- Some **uncertainty** will always remain. This may be because the whole area of interest is already impacted such that the pristine state of the environment is unknown, because resourcing has restricted measurement of baseline conditions, or because of the inherent complexity of interactions within ecosystems. Uncertainty must be acknowledged and incorporated into management to ensure sustainability.

Pressure on the environment / stressors

Some stressors are better understood than others (see Section 3). This may cause the more well-studied impacts to be prioritised above those for which less information is available. The impacts of consented activities in the marine environment are generally quite well understood while the impacts of other activities, such as land-use changes, may not be so well defined. Future stressors and related management efforts, both planned (such as for changes in aquaculture pressures) and unplanned (such as in response to oil spills or other event-related impacts) should be considered in management objectives, and accordingly reflected in monitoring activity, for example, in the selection of reference sites.

Ability to manage

It may be more relevant to set out active management objectives and prioritise monitoring relating to those sources of environmental stress which are under council control. However, documentation of the effects of larger-scale stressors on the regional environment is necessary for the assessment of cumulative effects, or to inform decision-making on a larger (national / international) scale.

Public values and concerns

Management objectives, and the monitoring priorities associated with them, should be determined in a systematic and transparent way, and include robust engagement with iwi and the wider community (ensuring genuine representation of local stakeholders) regarding their aspirations for the environment.

Some habitats may be given higher priority for management and monitoring than others because of, for example, associated cultural importance, recreational opportunity, or rarity, or because the public perceive a real or imagined risk to that habitat.

A community is more likely to engage in setting management objectives, than with the process of developing the associated monitoring. Interviewees for this report expressed much greater interest in management objectives than in the monitoring activity itself. Several interviewees stated that monitoring data was of limited interest if the objectives or standards being targeted offered insufficient protection to the environment. A range of individuals, including iwi and aquaculture industry people, discussed the need for goal-focussed monitoring and the importance of ensuring that the data collected is relevant to the question being addressed.

6.1.1. Next steps

Identify and address gaps in baseline data

It is necessary to understand the limitations of our current knowledge about the regional coastal environment both as part of defining management objectives, but also for the design of specific components of a monitoring programme. The nature of information gaps identified will dictate the action required to address them.

Key questions to address are:

- Which knowledge gaps identified in existing programmes are not being addressed?
- Which components of coastal health are not captured by these programmes?

In addition to Table 1, the most up to date and complete summary of existing environmental information is under development through the Rebuilding Shellfish Fisheries programme (contact Keith Michael, NIWA), and the Integrated Valuation of

Marine and Coastal Ecosystem Services programme (contact Dana Clark, Cawthron). Additional information is provided in Appendix 1.

Ensure iwi, community, and industry priorities are understood

Robust consultation should take place to ensure that concerns of the public are understood. It is likely that some community concerns can be at least partially addressed by better communication of information already held by council, scientists, or industry. Other concerns are likely to require a change of process (such as development of partnership relationships with iwi), and / or gathering of new information.

Although past consultation undertaken by councils serves to inform some questions of outer coast management and monitoring (*e.g.* management of aquaculture management areas, Motueka River plume behaviour and effects), public attention and council planning documents tend to focus more on near-shore environments. Accordingly, it is likely that an outer coast-specific and ongoing consultation process would be appropriate.

Define management objectives relevant to monitoring for the Nelson Bays Coastal Marine Areas

Management objectives are outlined in council resource management plans, some broadly, and some in greater detail (see examples in Appendix 3). Regional management objectives should be assessed to identify where they require development of additional guidance with regard to developing monitoring goals. The Nelson Biodiversity Forum has recently proposed the formation of a Tasman / Golden Bay stakeholder working group for championing a unified approach to managing the Nelson Bays CMA. This would provide the ideal platform from which to develop common management goals that are shared collectively by the three councils and key stakeholders in the region (*e.g.* fishing and aquaculture companies, recreational fishers, iwi).

Define monitoring goals to address management objectives

Management objectives already reflected in resource management plans or those defined at a national level could be assigned monitoring goals relatively quickly. An example is given in Box 1.

6.2. Monitoring

Four key aspects of designing monitoring activity are the identification of indicators for measuring environmental change, establishment of standards for enacting management actions in response to change, the sampling design, and data management (see Figure 4).

Indicators

It is important to first identify appropriate environmental indicators that reflect changes in priority activities and stressors. Some indicators will be relevant to both consent-related monitoring and council-led SoE monitoring, while others may be relevant only to SoE monitoring. Some will serve multiple purposes (*i.e.* reflect both ecosystem and aquaculture values), while some may be specific to a particular value (such as some cultural indicators).

Standards

Standards provide a benchmark for evaluation of a given aspect of environmental quality, and may be qualitative or quantitative. Indicators may be single measurements, composites, or statistical representations of multiple measurements. They may be based on values of the stakeholders in a region, or even industry data where that can reflect the state of the ecosystem. Monitoring programmes must be able to identify changes in the factors of interest with sufficient certainty to justify action being taken if measures fall below the set standards. A tiered response is often adopted which stipulates different actions depending on the severity / temporal nature of the breech; *e.g.*

1. Repeat monitoring to determine longevity of indicator deterioration
2. More detailed spatial monitoring to address cause and effect relationships
3. Reduction or cessation activity(s) leading to degradation.

Sampling design

The certainty with which a monitoring programme can represent conditions across space and time will need to be balanced against the costs of higher data resolution (*i.e.* increased monitoring), and the costs of uncertainty (*e.g.* increased environmental risk, public concern, or lengthy resource consent processes). These requirements will inform the sampling design of the component in question. Design of the sampling programme will accordingly take into account factors such as:

- The level of replication (spatial and temporal) required to achieve the level of certainty required for decision-making.
- Site selection, which requires consideration of:
    - representativeness (how do findings from one site represent other sites in the region?)
    - degree and nature of impact (does the site represent pristine or impacted conditions, or something in between?)
    - future change (will the site be impacted by different factors over time?)

Data management

Design of the monitoring data management system should consider data storage and access requirements of council, consent holders, industry, iwi, and other likely users of the data. Central to this component would be the identification of information coordination needs between TDC, NCC, and MDC. This integration would ideally also occur on a national scale, requiring standardisation of systems. Emerging systems for managing and sharing data include the NIWA data portal being developed as part of the Rebuilding Shellfish Fisheries programme and the collaborative initiative, Land and Water Aotearoa (see Appendices 1 and 2).

6.2.1. Next steps

Identify existing datasets of potential value

This would include assessment of both the existence and availability of data. Where uncertainty has been identified in developing management or monitoring goals a programme to fill those knowledge gaps is required. Similarly where insufficient information exists to understand impacts of key stressors, new data collection may be required, or data held privately may be requested.

Establishment of ongoing data-sharing relationships may be appropriate. For example, substantial data on benthic infaunal communities has been collected for a range of scientific, industry, or council purposes, and is held in Cawthron's CADDIS database. If made available, these data could be used to create a generalised species distribution which would be informative both for assessing long-term change, and as a baseline dataset from which to assess recovery from catastrophic events (*e.g.* oil spills).

Action could also be taken to ensure that existing data is as useful as possible. For example, to ensure existing SoE monitoring datasets (*e.g.* TASCAM benthic monitoring) are maintained, and to make provision for collating historical data from existing monitoring activity (including consent-related monitoring).

Identify most appropriate indicators for Nelson Bays

This is likely to be a combination of singular and multi-parameter health indices, and include physical, chemical, and biological components. A range of approaches are available, and would need to be assessed with respect to their relevance to the environment and management goals of Nelson Bays (see Box 1).

Adopt or develop standards for assessing environmental health

In some cases national or international standards / guidelines will be directly applicable to Nelson Bays, for others, further research may be required to determine their relevance regionally. Available standards should be collated and assessed for their utility in Nelson Bays. As an example, this process is being undertaken for Waikato Regional Council as part of an Aquaculture Planning Fund project and is described in Keeley *et al.* (in prep).

Develop an approach (or system) for collating, sharing and managing data

Data from consent monitoring and long-term state of the environment monitoring programmes are most beneficial if they are able to be integrated so that each can inform the other, and so that they can be used collectively to document and understand wider cumulative environmental change. Consistency of data formats and coordination between regulatory monitoring programmes (*e.g.* compilation of monitoring data from multiple aquaculture ventures) and alignment with long-running programmes would strengthen the ability to assess the state of the wider environment over time and space.

The approach most suited to ongoing development of an integrated monitoring framework would be for councils to assume the role of central organiser of SoE monitoring and reporting. Several interviewees referred to a general move towards a more collaborative approach amongst marine stakeholders; however the need for a cultural change in data-sharing may be necessary. This may need to be led by council (perhaps through buy-in by the proposed Golden and Tasman Bay stakeholder working group), whereby provision of informative data by council to industry in time leads to a greater willingness to make privately collected data available for SoE monitoring and reporting. Potential synergies for data use should be discussed with consent holders and other stakeholders, and any ways in which data formats or monitoring schedules can be adjusted to increase data integration should be assessed.

6.3. Communication

Results and outcomes from monitoring must be communicated to fulfil the purpose for which it was collected, and in many cases the data and information must be accessible to the general public. In the case of consent-based monitoring, reporting generally involves submission of a report to council and, on some occasions, to a specified committee of experts for review. State of the environment information could similarly fulfil the immediate council requirements by remaining in council hands or in inaccessible formats (long documents, 'data-heavy', specialist language, *etc*). However, beyond these formal (reporting) requirements, communication to a broader audience (outreach) clearly offers advantages to all parties with an interest in informed decision-making.

Accessible and engaging communication of both consent-related and SoE monitoring has the potential to:

- engage the public in informed discussion about environmental health
- improve understanding of the effects associated with different activities
- increase social licence for sustainable resource use (*i.e.* understand risk)

- lower costs to councils and applicants by avoiding lengthy environment court applications.

For example, the aquaculture industry could receive greater social license to operate by communicating the information on the impacts of their operations to the wider public.

The review summary produced as part of the Rebuilding Shellfish Fisheries programme (Michael *et al.* 2012) identified frustration regarding not only the state of the health of the bays, but with the "…lack of understanding around standards, monitoring, and compliance programmes run by councils". This indicates a need to better communicate not only monitoring-associated environmental information, but detail of the monitoring activity itself. The benefits of communication of monitoring information were recently highlighted in a parliamentary press release where the Minister for the Environment uploaded local monitoring reports to promote the benefits of marine reserves (see Appendix 5).

6.3.1. Next steps

Develop a communication strategy for monitoring information

Developing a communication strategy will require consideration of availability of monitoring information and the manner in which it is communicated. It is likely that summary information such as periodic state of the environment reporting will be an effective component, but other methods of engagement will also be relevant. For example, communication pathways specific to iwi may be appropriate. The ideal communication strategy may not be entirely council-operated, but, dependent on the particular purpose, initiatives from industry or the scientific community may be appropriate.

Make existing data and information accessible in easy-to-understand formats

Following on from developing a communication strategy, the councils should investigate where opportunities lie to better share and make data more accessible to stakeholders and the wider public, particularly when the information assists in informing the public on environmental issues in the Nelson Bays. A good example of providing data in an accessible format is the real-time information on river flows available on the TDC website. Other opportunities include establishing public access to remote sensing imagery of the region, improving communication of time-series data such as TASCAM, and linking in with other data being collected in the bays (*e.g.* Port Nelson beacon, aquaculture harvest areas in Golden Bay).

7. CONCLUDING REMARKS AND RECOMMENDATIONS

This report provides a compilation of background information and next steps required to develop and implement a co-ordinated monitoring programme in the Nelson Bays CMA; a programme that better utilises existing data from consent-related monitoring programmes and integrates this information with existing and future SoE monitoring in Golden and Tasman bays.

There is already a significant amount of environmental data and information collected in Nelson Bays region, and any new efforts (including consent-related and SoE monitoring) should take into consideration the need to better align and integrate datasets where benefits can be realised. To facilitate this in future, we recommend that the councils in the region work together on completing the steps outlined in Section 6 to work toward a robust and efficient monitoring programme for Nelson Bays. This would serve multiple purposes, and if communicated effectively, can assist in building wider consensus around prioritising issues and managing the marine environment.

The timing is ideal to implement a region-wide monitoring programme for the Nelson Bays that serves to inform the public about the environmental state of the bays. The existing platform provided by the Nelson Biodiversity Forum and proposed Golden and Tasman bays stakeholder working group (SWG), combined with Industry engagement and collaborative science initiatives such as the NIWA rebuilding shellfish strategy provide an ideal platform from which to progress some of the next steps in achieving an effective monitoring programme.

In order to prioritise monitoring efforts, get stakeholder buy-in, and begin to establish baseline conditions, it is recommended that the Councils work together (perhaps through the SWG) to compile and interpret currently available data and information into a ‘State of the Bays’ reporting system. It is advised that the report is produced in layperson language and communicated widely in on-line and printable formats. A living ‘State of the Bays’ report could then become the primary communication tool for reporting on the conditions and issues in the bays. The Hauraki Gulf Forum’s State of the Gulf communication strategy may provide a good model for this process.

The following next steps within the prioritisation and monitoring components could be begun or progressed in the short term, using existing funding sources such as Envirolink and MPI’s Aquaculture Planning Fund (APF).

Prioritisation

- Identify and address gaps in baseline data
- Ensure iwi, community, and industry priorities are understood.

Monitoring

- Identify existing datasets of potential value
- Identify most appropriate indicators for Nelson Bays
- Adopt or develop standards for assessing environmental health.

The APF supports council-led projects that facilitate sustainable development of aquaculture within the coastal marine area, which in turn requires maintenance of high water quality conditions for growing aquaculture resources. Projects funded to date include the development of models in the Hauraki Gulf and Marlborough Sounds for forecasting and assessing aquaculture farm effects within the context of wider cumulative effects including river inputs. These models also assist in the design of monitoring programmes.

Additional APF projects in the Waikato CMA include the development of frameworks for integrating consent-related and SoE monitoring and standards for assessing benthic and water column effects associated with aquaculture and in the wider environment as a result of cumulative effects. Conducting similar work to this latter project for the Nelson Bays region, perhaps based around the management goal outlined in Box 1, would contribute toward addressing the next steps listed above. In addition, the same fund could be used to further develop useful tools for regional monitoring in the CMA (see Box 1). Due to its aquaculture focus, only some aspects of developing a comprehensive, integrated monitoring programme would be relevant to an APF application, and it may be appropriate to consider additional sources of funding such as Envirolink to address components such as cultural monitoring and wider communication strategies.

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10. APPENDICES

Appendix 1. Developing a Nelson Bays monitoring programme: information sources

Information to aid prioritisation

A good deal of knowledge and activity which can inform the prioritisation of monitoring already exists for the coastal waters of Nelson Bays and is listed below. In addition, the existing 'Decision matrix (DM) for prioritising estuaries for state of environment monitoring' is a good example of methods used in prioritising efforts (see e.g. Gillespie 2008). The DM is meant to provide a tool for councils to engage with stakeholders. It can be re-evaluated over time to identify any changes in community/iwi values concerns, etc.

Existing data and information to assist in formulating baselines

Some studies on less-impacted areas of Nelson Bay exist. For example,

- Marine reserve monitoring includes both rocky reef (*e.g.* Davidson & Richards 2013) and soft sediment habitats (*e.g.* Keeley *et al.* 2006). While still impacted by a range of larger-scale anthropogenic stressors, these studies, in the context of international literature on marine reserve effectiveness, are the best available information on the ecosystem functioning of unfished systems.
- Large-scale processes such as nutrient dynamics have been relatively well studied; key publications include Zeldis (2008), Mackenzie (2004) and Gillespie *et al.* (2011).
- Work in estuaries: Estuary monitoring reports and state of the environment reports are available online at:
  - http://www.tasman.govt.nz/environment/coastal-marine/coastal-marine-biodiversity/estuarine-information/
  - http://nelson.govt.nz/environment/environmental-monitoring/state-of-the-environment-reports-3/

Existing data and information describing environmental pressures / stressors

Nelson Bays are relatively well-studied compared to many other coastal regions in New Zealand. Key bodies of information include:

- Stressors impacting shellfish health: Rebuilding Shellfish Fisheries programme (see Project summaries, below)
- Impacts of land-derived material on the coastal zone: Outcomes of the Motueka Integrated Catchment Management project such as Cornelisen et al. (2011) and Gillespie et al. (2011b; 2011c)
- Benthic impacts: summarised by Handley (2006)
- Consented activities: Aquaculture and other consent based-monitoring reports.

Collating or defining specific management objectives

Guidance on this process exists in resources such as:

- Marine Futures research project (see Appendix 2)
- An integrated monitoring framework for the Great Barrier Reef World Heritage Area (Hedge et al.)
- National Water Quality Management Strategy, No. 7, Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC & ARMCANZ 2000). Currently being revised, see Appendix 2.
- Monitoring information available at www.qualityplanning.org.nz.
- WDC monitoring framework development (Forrest & Cornelisen 2014).
- MPI, Decisionmaker´s Dashboard and Risk Screening Tool. http://www.fish.govt.nz/en-nz/Commercial/Aquaculture/Marine-based+Aquaculture/Aquaculture+Ecological+Guidance.htm (under development)

Designing a monitoring programme

Information on selection of **standards, indicators, and tools** that should be considered includes:

- MPI project “Development of a National Marine Environment Monitoring Programme”, (see Appendix 2)
- A new MPI-led programme to develop environmental reporting statistics for marine biodiversity and oceanic monitoring (under development)
- The Marine Futures project will address the identification of indicators and thresholds (in the context of broader marine management issues)
- National Water Quality Management Strategy, No. 7, Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC and ARMCANZ 2000). Currently being revised, see Appendix 2.

Council experience which is informative includes:

- Marlborough District Council is currently working with MPI, Cawthron, NIWA and the aquaculture industry to develop standards and wider coastal monitoring for the Sounds (Contact Steve Ulrich at MDC).
- The Waikato Regional Council has embarked on a region wide initiative to develop modelling and monitoring tools and to improve integration of consent-related and SoE monitoring. A three-report series funded by the Aquaculture Planning Fund and describing this process is due out in June 2014. (Contact Hilke Giles at WRC).

Data sources that will inform the development of monitoring programmes and methodologies include:

- Marine consent-based monitoring activity
- TASCAM / NIWA buoys

- Estuary work
- Marine reserve monitoring
- Industry-related work, MSQP *etc*.
- Valuing Ecosystem Services MBIE Research programme (see Appendix 2)
- Rebuilding Shellfish Fisheries programme (see Appendix 2)

Data management issues for an integrated monitoring framework have been considered by:

- MEMP: The issues and options regarding data integration or exchange on a national scale are being addressed in the MPI project 'Development of a National Marine Environment Monitoring Programme', and the associated report will be informative regarding this aspect of a monitoring framework.
- The website Land and Water Aotearoa (www.lawa.co.nz) is being further developed and seeks to deliver a comprehensive summary of freshwater quality in New Zealand. This council-centred information-sharing initiative is being extended to the marine environment and is likely become a standard for information exchange / data storage.

Appendix 2. Summaries of existing programmes[31]

Rebuilding Shellfish Fisheries programme

Rebuilding Shellfish Fisheries in Tasman and Golden Bays is a programme to assess potential approaches to help restore the sustainable production of shellfish fisheries. In NIWA-coordinated workshops and report/s, the concerns of iwi and stakeholders have been recorded and the state of knowledge regarding drivers of shellfish production has been reviewed.

The shared vision of workshop participants was “To maintain healthy, productive, and sustainable fisheries for commercial, recreational, and customary use in Tasman and Golden Bays.”

The stressors potentially impacting shellfish health are fundamental to the overall health of the Tasman Bay and Golden Bay ecosystems, accordingly information relevant to shellfish health will generally also be relevant to broader state of the environment health. Accordingly, although focussed on a specific component of the coastal ecosystem, the Rebuilding Shellfish Fisheries programme is an important source of baseline information on the state of Tasman and Golden Bays, and has also identified many of the knowledge gaps managers currently face.

A data portal where information relevant to the health of shellfish fisheries will be made available in the near future. Metadata will be catalogued, with raw data available where possible. Initially it is most likely that example data will be available, but the intention is to host any regional data that is publicly available.

The review document produced for the 2012 workshop is currently in draft stage and being expanded to include further detail on the effects of fishing from the wider (non-local) literature. It is expected to be finalised and made available by mid 2014.

Integrated Valuation of Marine and Coastal Ecosystem Services

This project uses the Nelson Bays as a pilot for research placing economic and social-cultural valuations on ecological processes. It aims to develop a more holistic approach toward ecosystem services values and processes. Existing ecological knowledge of the Bays environment is being brought together and assessed in terms of the ecosystem services provided. The various ecosystem services layers have thus far been described, spatially mapped and discussed in a series of narratives currently in draft stage, When complete, these narratives will provide a valuable backdrop for development of an integrated SoE monitoring initiative. The second stage of the project (if funded) will also test the utility of the ecosystem services concept in resolving a selected resource management problem in the

[31] Much of this material taken from Forrest B, Cornelisen C 2014. Framework for environmental monitoring in the Waikato coastal marine area. Prepared for Waikato Regional Council. Cawthron Report No. 2415: 33 p. plus appendices.

Bays. The first stage of this Massey University-run MBIE-funded research project is due for completion in late 2014 but may be extended for a further two years.

Waikato Regional Council

Waikato Regional Council, with assistance from the MPI-administered Aquaculture Planning Fund, is currently developing a guidance document for the aquaculture industry and other stakeholders in its region which aims to provide clear information on environmental monitoring requirements for aquaculture consents, as well as a methodology for integrating consent and SoE monitoring. The products will include a review of monitoring approaches in other New Zealand regions and overseas. While developed specifically for the Waikato region, the guidance document, which is due to be released in 2014, will contain useful information and principles of relevance to other regions.

New Zealand Marine Farm Monitoring Workshop

A recent Marine Farm Monitoring Workshop (12 December 2013) was undertaken at the request of MDC. The aim was to provide advice and recommendations on current and marine farm monitoring practices in the Marlborough Sounds, and other marine farming areas. Although the focus was on salmon farming, the outcomes of this process are likely to be relevant to Tasman and Golden bays aquaculture. Many of the concerns reflected here regarding the degree and relevance of aquaculture-associated monitoring in relation to other stressors and limited SoE information were repeated in the workshop. The outcomes of this workshop will be made available to all councils in an Envirolink report.

Sea Change — Tai Timu Tai Pari: Hauraki Gulf Marine Spatial Plan

This project is being led by a partnership between mana whenua, Auckland Council, Waikato Regional Council, territorial authorities, the Department of Conservation, Ministry for Primary Industries and Hauraki Gulf Forum. In recognition of the need for a better coordinated approach to managing the Hauraki Gulf, this partnership will develop the Sea Change — Tai Timu Tai Pari plan by 2015. While not legally binding in itself, it will provide a strong framework to guide the management of the Hauraki Gulf, and help shape future agreements and statutory plans. Outcomes include a number of datasets that will support state of the environment assessments of the Waikato region's east coast.

For more information and project updates see: http://www.seachange.org.nz

Estuarine data GIS layers (Department of Conservation)

The Department of Conservation is working with Landcare Research to further develop national GIS layers of estuarine information. As part of this work national and regional datasets are collated into a national GIS dataset, *e.g.* catchment and margin intactness, inanga spawning sites, threatened species presence / absence, marine mammals, significant habitats (seagrass, saltmarsh, intertidal mudflats). The aim is to produce a comprehensive range of information that is available to various agencies, including regional councils. The dataset can be used to assess estuaries for specific values or pressures, *e.g.* as habitat for threatened species, the presence of intact catchments, continuity with coastal sequences or

extent of seagrass. It will aid with decisions about management effort at regional and national scales. This project will also help identify gaps in our knowledge. It is likely to take at least two years (estimated completion date around June 2016) to compile all data and set up the GIS layers. Information on this project will be made available on the Department of Conservation website.

Revision of Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)

Australian and New Zealand Environment Ministers have given approval to undertake a revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (known in New Zealand as the "ANZECC 2000 guidelines"). These guidelines are a key resource for managing water quality and protecting aquatic ecosystems in Australia and New Zealand.

The ANZECC 2000 guidelines provide methods for setting appropriate limits on pollutant concentrations to protect different types of water bodies and sediments. They recommend developing criteria that are locally appropriate for specific ecosystem types, but where this is not possible, the guidelines provide default 'trigger values'. Exceedance of these values is intended to trigger further investigations or management responses. In New Zealand there are many situations in which these trigger values are used.

The ANZECC guidelines are an important source document used by regional councils, consultants and other resource management practitioners to guide water and sediment management decision-making. The guidelines have no statutory status, except where they are adopted in regional plans. However, the guidelines are widely used to develop water and sediment quality objectives and to make decisions on contaminant concentrations for resource consents.

For more information and links see:
http://www.mfe.govt.nz/publications/water/anzecc-water-quality-guide-02/revision-water-quality.html

This project has experienced a number of delays and complications, and there is uncertainty if it will be completed as originally designed.

Review of the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (Ministry for the Environment)

The Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (2003) assist councils/agencies to better inform their communities of the risks related to swimming at their bathing beaches. They help control the public health risk from microbiological contamination in recreational waters and provide a framework for monitoring and reporting on the general health of beaches.

The guidelines incorporate a risk-based approach to monitoring water quality promoted by the World Health Organization. The guidelines are the result of consultation with regional councils, territorial local authorities and public health agencies. A review of these guidelines is planned but at the time of completion of this report there has been no progress beyond an initial scoping out the work areas required for the review.

For more information on these guidelines see:
https://www.mfe.govt.nz/publications/water/microbiological-quality-jun03/

Environmental reporting framework (Ministry for the Environment)

Consistent with international best practice, the Ministry for the Environment is broadening the scope of its current environmental reporting to include more than just the biophysical condition of natural resources. By expanding the scope, two objectives will be addressed. The first is to improve the understanding of the links and dependencies inherent in the economic, environmental, social and cultural systems, so that the Ministry can move with confidence to improve the system overall. The second is to enable the Ministry to provide a report that is coherent and consistent and that informs the public about the condition of the environment, the multiple pressures that put long term use of the environment at risk, and the economic, environmental, social and cultural significance of the current trends and condition.

To achieve these two objectives, the Ministry is developing an environmental reporting framework that will take into account measures of economic, cultural and social pressures as well as impacts of biophysical change. Early framework development stages have been undertaken using a collaborative approach including regional council representation on a working group.

A very important part of reforming reporting is to ensure independence of reporting. The Minister for the Environment has announced plans to introduce legislation to make environmental reporting mandatory and to ensure its independence by legislating a co-production by the Ministry for Environment and Statistics New Zealand, with sign-off by the respective agency executives.

Updates of this project will be made available at:
http://www.mfe.govt.nz/environmental-reporting/about-environmental-reporting/reporting-programme/monitoring-and-reporting-enviroment.html

Marine Environmental Monitoring in New Zealand (MEMP; Ministry for Primary Industries)

Long-term datasets that track persistent change in the environment are a critical component of any modern ecosystem-based approach to natural resource management and sustainable growth. NIWA has built the New Zealand Catalogue of Marine and Environmental Monitoring Programmes, which holds information about data owners and their contact details, variables monitored, where they are collected and how often. The content of these datasets will

provide context for policy development around management actions, spatial and temporal planning, and a basis for looking ahead at different scenarios.

For more information and links see:
http://www.niwa.co.nz/coasts-and-oceans/projects/marine-environmental-monitoring-in-new-zealand

Ecological guidance for aquaculture (Ministry for Primary Industries)

MPI has developed the Aquaculture Ecological Guidance Package to provide current and science-based information and advice on the ecological effects of marine-based aquaculture to assist local authorities, the aquaculture industry, and other stakeholders with their planning for and management of aquaculture. These resources are a collaborative working partnership with science providers, councils, the Department of Conservation, the aquaculture industry, and others with an interest in the coastal environment. The package includes a comprehensive Literature Review of Ecological Effects of Aquaculture, a summary overview, a Decision-makers' Dashboard (in development) and an Aquaculture Risk Screening Tool for identifying and prioritising the ecological risks of new aquaculture proposals (in development).

For more information on MPI aquaculture ecological guidance see:
http://www.fish.govt.nz/en-nz/Commercial/Aquaculture/Marine-based+Aquaculture/Aquaculture+Ecological+Guidance.htm

Biosecurity projects (Ministry of Primary Industries)

MPI have a range of current projects on marine biosecurity and fund a national marine high-risk site surveillance programme for target pests. This programme includes Waitemata and Tauranga Harbours, and MPI assisted WRC with a recent response to an incursion of the fanworm *Sabella spallanzanii* (designated an unwanted organism under the Biosecurity Act). A recent project of particular relevance is the national pathways projects, for which MPI commissioned reviews of practical measures for reducing the spread of potentially harmful marine organisms via human transport pathways within New Zealand (NIWA), and policy options for promoting the implementation of risk reduction measures (Cawthron). During two workshops held in Wellington in 2013, representatives of the aquaculture, commercial fishing, marine transport, mining and exploration, research and education, and sport and recreation pathways were invited to identify and discuss risk reduction options and potential barriers to their implementation. The aim was to engage industry, government, tangata whenua, councils, and other stakeholders in the development of a recommended package of measures and policies for reducing the domestic spread of marine pests within New Zealand. NIWA and Cawthron have recently produced reports on risks and management options, which are now being considered by MPI.

For more information on MPI marine biosecurity see:
http://www.biosecurity.govt.nz/biosec/camp-acts/marine-biosec-programme

Marine Futures: Environmental futures in New Zealand's marine ecosystems: a dynamic approach towards managing for resilience

This NIWA-led project addresses the questions:

- What are the predicted environmental limits and thresholds of New Zealand's marine ecosystems for sustainable economic growth from the marine sector?
- What modelling (or other) approach will best enhance the fit between growing New Zealand's natural marine resource economy while maintaining sustainability and environmental standards in the marine ecosystem?

Outcomes from this project will be relevant to selection of standards and tools, but more broadly it investigates collaborative decision-making frameworks. The latter aspect will likely be relevant to the prioritisation component in developing an integrated monitoring programme. The research programme in its current form comes to an end in September 2014, and it has been mapped to the Sustainable Seas National Science Challenge.

Appendix 3. Examples of relevant issues or requirements from existing council documentation.

Many of the requirements for establishing an integrated monitoring framework have already been outlined in council plans and other documents. For example:

Tasman District Council 10-year plan

"We aim to achieve a robust and cost effective approach to environmental monitoring and resource investigations which will provide a good understanding of the District's resources, an ability to assess environmental trends and manage risks to the environment."

Tasman Regional Policy Statement (TRPS) Section 4.1

"The matters that have been identified by Council and iwi as being of resource management significance in the District can be summarised as:

(i) the development of an ongoing relationship between tangata whenua iwi and Council concerning matters of resource management significance;
(ii) providing for and giving effect to the interests of tangata whenua iwi concerning the sustainable management of resources, including lands, waters, the coast, wahi tapu and other taonga."

TRPS Policy 9.1

"Council will promote the development of an adequate information base for sustainable coastal management decision-making...

Methods of implementation:

(i) The Council will assess investigation and monitoring priorities for coastal marine resources and processes, and:
    a. undertake research and monitoring within established priorities; and
    b. advocate or contribute to efforts by other agencies with interests in coastal management.
(ii) The Council will require applicants and holders of coastal permits to provide an adequate amount of information concerning the likely effects of their proposal or activity on coastal resources and processes.
(iii) The Council will consult with the fishing industry, Ministry of Agriculture and Fisheries and other agencies, or other interested parties, in establishing programmes and priorities for research and monitoring, and in ensuring all parties are kept up to date in the collection and availability of such data.

Anticipated environmental results:

(i) Improved confidence that coastal management policies are based on sound environmental information and that adverse effects of coastal activities or uses can be identified and appropriately managed."

The Nelson Biodiversity Strategy (2010)

The marine environment action plans include:

- Improve community knowledge of coastal and marine environments and developing understanding and commitment to their protection.
- Collate, order and analyse information about Nelson marine biodiversity to enable effective long-term management; develop a memorandum of understanding with marine industries (including aquaculture and fisheries) on data sharing to release information on benthic habitats currently withheld as commercially sensitive.
- Review existing coverage and undertake surveys of benthic marine habitats in Tasman Bay, mapping both biodiversity hot spots and risk zones.
- Reduce land-based pollution of the sea by: obtaining information about land use activities across Tasman Bay catchments to identify where sediment is coming from and estimate sediment accumulation rates as a basis for a review of land use management practices.

The strategy also recognises the need for integration across regional authorities; “All of the marine actions are joint initiatives to be pursued with Tasman and Marlborough communities and their councils.”

Nelson Resource Management Plan efficiency and effectiveness review 2012 / 2013

In recommendations for further work:

- Compile further coastal monitoring work to determine potential impacts on shell fisheries and marine ecology in Tasman Bay including coastal habitat mapping and consent monitoring data
- Explore opportunities to work with Tasman and Marlborough District Councils and Te Tau Ihu iwi

Appendix 4. Salmon farm expansion case study[32]

Box 1. Salmon farm expansion case study

Approximately 70% of New Zealand's farmed salmon (King salmon, *Oncorhynchus tschawytscha*) is produced at five farms in the Marlborough Sounds by the New Zealand King Salmon Company Limited (NZ King Salmon). In 2011, NZ King Salmon applied to the Environmental Protection Authority (EPA) to change the Marlborough Sounds Resource Management Plan to enable development of nine new salmon farms in the region. During the EPA Board of Inquiry (BOI) process, scientists provided technical evidence on environmental issues. The debate that arose serves as a lesson on the importance of an appropriate level of regional environmental knowledge, and accessible datasets of sufficient duration, to provide greater certainty regarding the effects of any particular consented activity, in the context of other natural and human activities that affect the environment.

Two issues that came under intense scrutiny during the EPA process related to salmon farming impacts on the seabed and on water quality (especially the potential for nutrient enrichment and harmful algal blooms). Considerable monitoring of the seabed beneath and near individual farms has been previously commissioned by NZ King Salmon. However, in assessing the relationship between Industry expansion and impacts, there was a poor understanding of broad-scale seabed effects beyond the immediate depositional 'footprint' of individual farms. In relation to water quality the situation was particularly complex, as modelling had indicated that the response to nutrient enrichment from the farms would occur beyond their immediate environs (*e.g.* across scales of kilometres or greater). Thus, the influence of NZ King Salmon farms needed to be considered in light of the cumulative effects of other nutrient sources (*e.g.* other discharges, land-run off) and nutrient sinks (*e.g.* mussel farms). Furthermore, it was recognised that adverse effects such as harmful algal blooms are often regional phenomena driven by natural environmental processes, and may occur in the absence of anthropogenic nutrient enrichment. A key gap was a lack of SOE monitoring data (and inaccessibility to datasets from research) for the Marlborough Sounds which could be used to establish baseline conditions and validate models. There were also insufficient data to determine the trophic status of the Marlborough Sounds, and the system's ecological carrying capacity; *i.e.* the level of culture that can be supported without leading to significant changes to ecological processes, species, population or communities in the growing environment (Gibbs 2007). This situation meant that the level of uncertainty with regard to the effects of the proposal was greater than would have been the case if more extensive data had been available. According to Eccles (2013), this is reflected in the final decision of the BOI:

> *"The uncertainty about the capacity of the Marlborough Sounds marine environment to assimilate the modelled nitrogen discharges from the farms sought was a troubling factor for the Board, which bemoaned the lack of available research and monitoring data…The need to monitor and understand the capacity of the receiving environment should be heeded in other areas of the country where aquaculture expansion or intensification is sought."*

The BOI eventually granted consent for four new farms, but declined consent for five other sites. Due to the paucity of baseline data, the BOI imposed conditions that require NZ King Salmon to monitor the local seabed environment and conduct regional-scale water quality monitoring for up to a year before they can proceed with stocking the new farms with fish. In the case of the water quality monitoring, NZ King Salmon is undertaking studies that will inevitably detect the cumulative effects of activities in addition to the salmon farms. In most instances those other activities are not contributing to the cost of cumulative effects monitoring in the Marlborough Sounds. The NZ King Salmon situation clearly highlights the need for coordinated regional scale monitoring programmes to establish baseline conditions in New Zealand's coastal marine areas.

[32] Forrest B, Cornelisen C 2014. Framework for environmental monitoring in the Waikato coastal marine area. Prepared for Waikato Regional Council. Cawthron Report No. 2415: 33 p. plus appendices.

Appendix 5. Press release: New research confirms benefits of marine reserves.

Nick Smith; 8 January, 2014[33]

Significant increases in the abundance and size of marine species in Tasman Bay marine reserves confirm their conservation benefits, Conservation Minister Dr Nick Smith said today while publicly releasing a new research report at the Horoirangi Marine Reserve north of Nelson.

"It is so encouraging to see the irrefutable evidence of the success of these marine reserves especially given my extensive involvement in both these reserves being established. These results reinvigorate my ambition to create a record number of new marine reserves this year," Dr Smith says.

"This new research shows that 20 years after the Tonga Island Marine Reserve was created, there are more than seven times as many crayfish and 40 times as many blue cod over 30 centimetres. In the Horoirangi Marine Reserve, which was created in 2006, crayfish are 3.5 times more abundant, and a third of blue cod are over 30 centimetres compared to just 1.7 per cent outside the reserve.

"These changes are impressive and show how marine ecosystems improve without the pressure of fishing. It increases our knowledge of the marine environment, enables people to enjoy recreational activities in areas with more abundant marine life, and can provide fishing benefits in adjacent areas.

"We will be doing more marine research in the future with the expansion of DOC's partnership with Air New Zealand. The airline is providing $7.4 million in funding for conservation, of which $1 million was dedicated to expanding DOC's research to cover entire marine reserve ecosystems.

"The marine environment is the new frontier for conservation. Historically, the focus has been on land but we now know that 80 per cent of the species that are unique to New Zealand are in our seas. New Zealand has some of the most spectacular and unique coastlines and oceans in the world and we need to do more to protect them."

[33] http://beehive.govt.nz/release/new-research-confirms-benefits-marine-reserves