Aquaculture is a substantial and growing industry in New Zealand. It produces healthy and highly sought-after food products as well as health supplements. It provides well-paid jobs, supports whānau, hapū and small communities, and generates important export income. It has the potential to contribute to marine restoration. It is generally positively viewed by the New Zealand public. Managed well, the industry has a positive outlook for the future.

The government has recently announced a review of the resource management system. This provides the opportunity to rethink the future management regime for aquaculture in the context of growing pressures on coastal systems, a changing climate and new technologies.

This report surveys the development of the industry, its potential effects on the marine environment and current management settings. It reviews aquaculture management in other jurisdictions and provides recommendations for a new management approach in New Zealand. The report draws on the EDS Resource Management System Reform project, which has undertaken a first principles look at the resource management system and developed options for future reform.
Farming the Sea
MARINE AQUACULTURE WITHIN RESOURCE MANAGEMENT SYSTEM REFORM
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Executive summary

Aquaculture is a substantial and growing industry in New Zealand. It produces healthy and highly sought-after food products as well as health supplements. It provides well-paid jobs, supports whānau, hapū and small communities, and generates important export income for the country. It has the potential to positively contribute to marine restoration. It is generally favourably viewed by the New Zealand public. Managed well, the industry has a positive outlook for the future.

Eight different legislative regimes have applied to aquaculture since the late 1960s, the most recent reform being in 2011. The frequency of change indicates a legislative system which has struggled to meet the needs of the industry, Māori and the public. The government has recently announced an intention to embark on broader resource management system reform commencing later in 2019. This provides an opportunity to rethink the future management regime for aquaculture. The past 50 years or so. The 1980s and 1990s saw great expansion within the aquaculture industry. By the time the Resource Management Act (RMA) came into force in 1991, bringing with it a greater emphasis on managing environmental impacts, there were already 677 authorised marine farms in New Zealand. Five years later there were 808 permitted farms. These early applications had minimal requirements and they generally did not undergo robust environmental scrutiny. Many will come up for reconsenting over the next few years. This creates an excellent opportunity to reset the management framework for aquaculture in order to embrace a risk-based and more flexible bay- or zone-based approach which could generate improvements for both productivity and environmental health. This will likely require changes to the regulatory environment.

Under current law, aquaculture is treated pretty much the same as any other activity within the coastal marine area, with the type of activity status and matters to be considered determined by the provisions of the regional coastal plan. The 2004 reforms required marine farms to locate within aquaculture management areas, but this requirement was removed in 2011. Aquaculture settlement legislation, which provides for Māori to receive a representative 20 per cent of aquaculture space (or cash in lieu), has assisted iwi to become more involved in the industry. The New Zealand Coastal Policy Statement contains a specific aquaculture policy (Policy 8) as well as a range of policies restricting the location and operation of the industry in the coastal marine area (along with other marine users) to protect important values. There is currently no specific national aquaculture policy or guidance, and other jurisdictions typically have much greater prescription over farm siting criteria and operating standards.

This report reviews the development of regional planning for aquaculture in three main aquaculture areas – the Marlborough Sounds, Tasman and Golden Bays, and the Coromandel Peninsula. All regions sought to put in place spatial zoning for aquaculture which proved helpful in managing strong demand for aquaculture space. Central government intervened in the Marlborough District in an effort to consent space for the relocation of low flow salmon farms and in the Waikato region to consent new space for finfish farming. In the case of Marlborough this resulted in considerable community conflict (with new space yet to be created), and in the case of Coromandel the sites created were suboptimal due to high levels of catchment-sourced nitrogen entering the marine area. Tasman District’s zoning proposals were tied up in complex litigation with the wild (enhanced) scallop industry and were delayed 22 years, by which time the scallop fishery in the area had collapsed. Many other councils struggled with the challenge of creating spatial zoning for aquaculture due to issues of timing, cost, political risk and community opposition. Such issues could be addressed through a well-designed marine spatial planning process building on the learnings from the Sea Change Tai Timu Tai Pari process in the Hauraki Gulf.

Two years ago, open ocean salmon farming was thought to be 10 years away, but New Zealand King Salmon (NZ King Salmon) has recently made an application for a large salmon farm in Cook Strait off Port Gore. Because the development...
and application of technology has been so rapid, the current policy, planning and management system does not contemplate open ocean salmon farms (or many other offshore activities). There is also a paucity science to underpin an assessment of effects as little is known about the likely impact of the activity on deeper-sea ecosystems.

The monitoring system for marine farms is generally not fit for purpose. Many early consented farms have no or few monitoring requirements and other farms are required to monitor things that provide little useful management information. There has been some useful innovation in developing limits and triggers to guide monitoring programmes. The lack of sufficient state of the environment information has reduced the ability to contextualise monitoring data in a way that can inform management responses. In addition, monitoring information is often not freely accessible to the public in a meaningful manner and more transparency in the provision of information could generate greater public confidence in the industry.

Overseas comparators
There are many similarities across the six jurisdictions reviewed, and in many respects New Zealand is an outlier in the way it manages aquaculture. All jurisdictions treat the lease of the seabed separately from consent to carry out activities, and all generate a return to the public through rental fees or upfront licence charges. In several cases the leases are tendered. In the case of Norway, the consents are split in a slightly unusual way, with the aquaculture sites themselves being licensed by local authorities and the central government issuing and charging for ‘aquaculture licences’, which appears to be an effective way of ‘taxing’ the industry for use of a public resource (at around NOK10 million or $NZ1.7 million per licence). In addition, additional permits such as those to cover environmental and animal health consents are often required. In New Zealand, there is only the one consent required (coastal permit) and typically there has been no additional charge for its grant (apart from application processing costs and sometimes ongoing monitoring/compliance costs) or ongoing rental payable. More recently there has been some limited tendering of space, but this is sporadic.

In most jurisdictions, revenues go directly to the national or state government. In Norway, the money from aquaculture licences is put into an Aquaculture Fund and a large share is paid to the local councils who host aquaculture within their areas. This recognises that local communities bear most of the environmental impacts of the industry and helps to encourage councils to provide for the activity.

South Australia is the only jurisdiction surveyed that provides for a range of different types of leases, and it makes specific provision for shorter-term leases to enable research and piloting of new aquaculture methods and/or species. This seems a positive innovation and something New Zealand could look at to help strengthen research and development in the sector.

The length of time leases are granted for varied from 15 in NSW to 30 years in Tasmania and British Columbia, with Scotland at 25 years and South Australia at 20 years for production leases. In New Zealand consents can be granted for 20 to 35 years, which is not out of step with this international practice for leases. However, in several of the jurisdictions reviewed, licences were issued for much shorter periods, with Tasmania issuing them for 10 years and British Columbia having a maximum of nine years for shellfish aquaculture and six years for finfish. This enables the operation of marine farms to be regularly reviewed and licences adjusted as needed. On the other hand, Scotland and Norway issue permanent licences. However, in Norway, licences can be revoked for a range of matters including environmental considerations or a change of circumstances.

Norway grants licences for productions levels and not seabed leases as such, and the authorised production can be distributed over multiple sites, and multiple licences exercised over one site, providing considerable flexibility as to where production can be located. It potentially can be shifted between growing cycles depending on environmental conditions. In New Zealand, marine consents are fixed to a defined geographical location, and this reduces the flexibility of the industry to respond to environmental and market changes. A modified Norwegian system could be worth exploring further.

In some jurisdictions, environmental protection authorities (EPAs) play a much stronger role in managing the environmental impacts of aquaculture, particularly finfish farming which creates greater environmental risks. For example, in Scotland the EPA addresses impacts on the water column and seabed from salmon farming. The Tasmanian Government recently gave its EPA the role of granting environmental licences for finfish farms. New Zealand could consider a stronger role for the EPA in the management of aquaculture (with a requisite development of the technical skills required), particularly where there are elevated or poorly understood risks such as with indigenous finfish aquaculture and open ocean aquaculture.

In those jurisdictions where marine spatial planning has or is being undertaken, a legal linkage has been created between the plans and the consenting of marine farms. Scotland and British Columbia have both been implementing an integrated form of marine planning, which applies to a broad range of activities including aquaculture. In Scotland, consent can only be granted for aquaculture if it is in accordance with the relevant marine plan. In British Columbia, applications for aquaculture are assessed for consistency against marine plans prepared through a partnership between First Nations and the provincial government.

In Norway, spatial provision for aquaculture is undertaken at the local council level. However spatial zoning has also been deployed to determine where new aquaculture licences can be granted based on relative environmental risk (and in particular sea lice). The Tasmanian Government has undertaken a single-sector
spatial planning exercise to identify areas suitable for salmon aquaculture across the entire state coastline, and leases can only be granted in these areas. Aquaculture exclusion areas can also be identified, as can areas for future release. The NSW Government has spatially identified priority areas for oyster farming. New Zealand could learn from other countries in terms of creating a statutory linkage between marine spatial planning (where such plans are developed) and prospective aquaculture areas, building on the marine spatial plan developed for the Hauraki Gulf.

NSW is the only jurisdiction reviewed that has strong provisions to protect space and water quality for oyster farming, no doubt driven by its dependence on inshore shellfish that is particularly susceptible to catchment impacts. This is something that New Zealand could strengthen given that the bulk of our industry is located in near-shore coastal waters which are suffering ongoing degradation.

Significantly, all jurisdictions appeared to have a much more developed policy framework around aquaculture decisions than New Zealand, and in particular to guide siting decisions and management of ongoing operations. This typically included clear and measurable thresholds and triggers for action (including the provision to impose moratoria, as in British Columbia). There was also a greater amount of guidance material to describe best practice. For example, the Scottish Planning Policy sets out locational policies for aquaculture to guide the identification of areas potentially suitable for the activity and sensitive areas that are unlikely to be appropriate. Fisheries and Oceans Canada has issued Siting Guidelines to show how new finfish farms will be assessed, which are reviewed at least every five years. It has also prepared an integrated aquaculture management plan for shellfish aquaculture. The NSW Government has developed a State Environmental Planning Policy on aquaculture, and this references a strategic framework around aquaculture decisions than New Zealand, and in particular to guide siting decisions and management of ongoing operations. This typically included clear and measurable thresholds and triggers for action (including the provision to impose moratoria, as in British Columbia). There was also a greater amount of guidance material to describe best practice. For example, the Scottish Planning Policy sets out locational policies for aquaculture to guide the identification of areas potentially suitable for the activity and sensitive areas that are unlikely to be appropriate. Fisheries and Oceans Canada has issued Siting Guidelines to show how new finfish farms will be assessed, which are reviewed at least every five years. It has also prepared an integrated aquaculture management plan for shellfish aquaculture. The NSW Government has developed a State Environmental Planning Policy on aquaculture, and this references a strategic document – the Aquaculture Strategy – that can be regularly updated without the need to change the formal policy. The Strategy sets out, amongst other things, minimum performance standards for farms.

Many of the jurisdictions reviewed had active monitoring, reporting and compliance regimes. Regular on-farm inspections are carried out in Scotland, for example. In British Columbia, destocking can be required if thresholds are exceeded. Regular on-farm inspections are also carried out. In Norway, farms are required to be fallowed for two months between growing cycles. If unacceptable conditions develop on sites, they can be ordered to be fallowed.

Large salmon farming jurisdictions had much more developed risk management frameworks. For example, in Scotland farms are designated within farm management areas and each farm is required to be party to a joint ‘farm management agreement’ which sets out how risks are to be managed across the farms within the area. In contrast, New Zealand’s risk management regime appears relatively undeveloped, and will need to be considerably strengthened if the industry is to reliably grow and incorporate new species in the future without risking serious biosecurity or disease issues.

Some of the jurisdictions reviewed have developed a far more transparent system of reporting aquaculture information to the public. In Scotland, there is publicly available ‘Scottish Pollutant Release Inventory’ which regularly reports the scale of discharges from salmon farms. The South Australian Government is establishing a programme of producing regular ‘Regional Performance Reports’ for the aquaculture industry to increase the transparency of information given to the community. In New Zealand, the availability of information is patchy, and there is room for considerable improvement.

Overall, New Zealand’s regulatory framework for aquaculture appears relatively underdeveloped, and much can be learnt from the experience of other jurisdictions, particularly those with larger aquaculture industries which have encountered a range of challenges, including biosecurity, disease and public contention. New Zealand has the opportunity to get ahead of the game in these respects, before the aquaculture industry grows further, moves into the open ocean and/or expands into new species. It will be important to design a future aquaculture regime for New Zealand carefully, to ensure it manages risks in a way that supports the industry while protecting the environment and avoiding the creation of excessive bureaucracy. Such a detailed design exercise is outside the scope of this report and is something that will require further work.

Implications of resource management system reform

For close to two years, EDS has been undertaking a project focused on the reform of New Zealand’s resource management system. Phase 1 of the project focused on analysing the resource management system from first principles. It asked fundamental, future-focused questions about the overall set of laws, institutions and interventions relating to how we manage our natural and physical resources. Phase 2 of the project commenced in January 2019 and is focusing on selecting and developing a preferred model as well as charting out a transition pathway for reform. As a related project, EDS is investigating marine spatial planning, including international best practice and its applicability to the New Zealand context.

From this work, a series of themes are emerging about some of the likely elements of a future resource management regime. They include the closer incorporation of Te Ao Māori, clearer and stronger environmental bottom lines, stronger national direction and involvement in strategic planning, greater use of spatial planning both for land and the sea, a focus on restoration rather than just mitigation of effects, and the development of a stronger framework for allocation. These themes, and their implications for future aquaculture management, are explored in this report.
Any future system will need to protect Treaty settlements, including the 2004 Māori aquaculture settlement, and embrace emerging partnership models for marine management. A future system is likely to set more environmental bottom lines. This should provide greater certainty to the aquaculture industry about what performance standards are expected, and also more certainty about the quality of coastal marine areas on which the industry depends. In addition, stronger national direction is likely and could take the form of a ‘New Zealand Resource Management Strategy’. This could be accompanied by sectoral strategies such as a national ‘Aquaculture Strategy’ which could identify matters such as siting criteria and priority areas for aquaculture and off-limit areas nationwide. There will almost certainly be a stronger focus on spatial planning on land and sea. This could assist with positive planning for the location of aquaculture within the context of other users of marine space and catchments.

Due to declining environmental quality in many inshore coastal systems, a future system is likely to place more emphasis on proactive restoration, and this could support a move towards ‘restorative aquaculture’ approaches along with better management of current pressures. In addition, a future system may place more focus on supporting greater resilience and ability to adapt to changing conditions (especially as a result of climate change). This could encourage the use of a greater variety of methods and species in aquaculture as well as a more flexible regulatory regime to enable adaptation and change.

**Part B: Industry and environmental considerations**

Part B reviews a range of industry and environmental considerations which are important to designing a future regulatory framework for aquaculture. It first reviews the historical development and current state of the industry.

**Overview of aquaculture industry**

Aquaculture has been undertaken by Māori for centuries, with the modern industry in New Zealand becoming established only during the 1960s. Oyster farming was initially focused on the indigenous rock oyster species, but moved to the more vigorous Pacific oyster during the 1970s after the invasive species arrived in New Zealand waters, likely on the hull of a ship. Mussel farming was originally based on the raft method used in Spain, but after trial and error the current long-line method was adopted.

Although the first experiments with mussel farming took place in the Hauraki Gulf, the industry took greater hold in the Marlborough Sounds, where there was a wide range of sheltered growing areas and less opposition from other marine users. Salmon farming only became established during the 1980s when the law was changed to allow it. It is therefore a relative latecomer within the industry.

The first operational farms were established in Big Glory Bay in Stewart Island, but the Marlborough Sounds proved to be a more favourable place for salmon production, and was where growth was concentrated. The early salmon farm sites in the Marlborough Sounds proved unsuitable due to shallow depths and low water flow, and new sites were identified through a process of trial and error. A major algal bloom incident at Big Glory Bay in 1989 hit the industry hard and resulted in a consolidation of ownership.

Although many species have been trialled in the past, the current industry strongly relies on just three, the endemic green-lipped mussel, the inadvertently introduced Pacific oyster, and the purposefully introduced king salmon. There was significant growth in aquaculture during the 1980s and 1990s, particularly for mussel farming activities. Aquaculture is now a significant contributor to jobs, regional and national incomes, and export earnings. There is also a significant Māori presence in the aquaculture industry as a result of the Māori aquaculture settlement.

Pacific oyster farming is largely confined to northern harbours; mussel farming is concentrated in the Marlborough Sounds and to a lesser extent in waters around the Coromandel Peninsula; and salmon farming is primarily located in the Marlborough Sounds and Big Glory Bay in Stewart Island. More recently, there has been a rationalisation in the industry, leading to greater concentration and corporatisation of ownership. There are now four main growers of Pacific oysters and two main growers of salmon.

All three sectors are currently facing significant barriers to growth. For Pacific oysters the main constraint has been the herpes virus, which has increased mortalities, driven many growers out of the industry and prompted a move towards the use of hatchery spat and basket technology. For mussels, the main constraint is a shortage of spat and poor spat retention on lines. For salmon, the main constraint is availability of suitable water space and additional smolt supplies. A shortage of labour is also a considerable constraint for mussel and oyster growers.

For oysters and mussels, there is considerable potential to increase production from existing space through selective breeding, increased spat retention (for mussels) and improved growing methods and technologies. For salmon, a move to deeper, cooler sites is required if the industry is to grow significantly. There is considerable potential to develop new high value products from existing species, particularly in the ‘superfood’ nutraceutical markets. There is also potential to better utilise ‘pest’ species growing on mussel lines such as blue mussels and Undaria (Japanese kelp).

New technology is facilitating offshore finfish farming which could help reduce conflicts and enable the salmon industry to grow significantly. Farming indigenous finfish will likely raise new issues and risks that have yet to be encountered in the New Zealand aquaculture industry due to naturally occurring parasites and diseases associated with local species.
Seaweed aquaculture could have considerable potential either as a stand-alone activity or integrated into existing farms. It could deliver significant environmental benefits. Multi-trophic aquaculture is as yet largely unproven, but has some potential to increase production. It may be better undertaken at a bay- or region-wide scale.

Environmental considerations
This report reviews a range of environmental effects which can be generated by aquaculture, both positive and negative. Many of the negative effects can be mitigated by good farm siting, and this emphasises the importance of robust spatial planning and site selection prior to farm establishment.

The benthic effects of shellfish farming are relatively small in terms of severity but can take some years to reverse if farms are poorly sited. There can potentially be some positive benthic effects through the deposition of shell on the seabed and support for reef restoration projects, but these will be site-specific. In contrast, salmon farming (and potentially other finfish farming) can have serious effects on the seabed beneath and around farms. The impacts are greater in shallow, low flow sites, which is where most salmon farms were originally located and where some still operate. The benthic environmental quality standards which are being applied to new salmon farm consents in the Marlborough Sounds are an improvement, but still allow significant degradation of natural seabed systems under the farms.

The effects of marine farming on the water column can include local scale stimulation and depletion of phytoplankton, depletion of zooplankton (including fish larvae) by shellfish farms, and increased nitrogen inputs from finfish farms. Eutrophication of the seabed beneath salmon farms can also result in oxygen depletion near the seabed. Marine farming can result in the accumulation of zinc (from fish feed), copper (from antifouling) and plastics (from farm equipment) in the marine environment. Such effects can be minimised through good siting siting, robust management practices and the removal of contaminants from the farming system.

The *EDS v King Salmon* case, through setting clear environmental bottom lines, has provided much greater certainty around the interface of marine farming with landscape and natural character. Marine farms are generally incompatible with outstanding natural landscape, natural character and biodiversity values. Marine farms can impact marine mammals and seabirds, but such effects have been minimised by siting farms away from their key habitat and good management of farm equipment. There is evidence of genetic mixing in New Zealand’s endemic wild green-lipped mussel populations from mussel farming activities. The risk of genetically changing wild populations through the use of hatchery-bred spat and smolt will need careful management. Biosecurity is a major risk for the industry, and one that marine farming operations amplify. Many pathway and on-farm risks remain unregulated and are likely to increase if new species are farmed.

Catchment impacts can be damaging to marine farms, indicating a stronger need for integrated management across the land-sea boundary. The cumulative impacts of marine farming are poorly understood, hampered by the lack of baseline information and good monitoring. Better science is required to understand such risks and their broader impacts on the marine ecosystem. Climate change may have significant implications for the aquaculture industry including ocean acidification, warming seawater, more frequent outbreaks of algal blooms, greater disease risk, more biofouling and increased coastal pollution. Marine farming practices will need to change in response, and sites that have been suitable for aquaculture in the past may not be in the future.

**Part C: Recommendations**

Drawing from the above analysis, we have developed a set of six recommendations for a future regulatory regime for aquaculture in New Zealand.

1. **Spatial marine management**

   New Zealand should move to a system of marine management based on the identification of areas or ‘zones’ for which a range of environmental quality outcomes and associated standards are prescribed in the regional coastal plan, starting in places where ecological health is currently an issue. These would be designed to address cumulative effects from all activities impacting on the marine area. These should be developed through a collaborative process involving iwi, regulators, scientists, industry, community members and other stakeholders. They need to be ambitious and may require restorative measures to be undertaken. They could include a transitional pathway, so that more stringent standards are applied over time to meet the desired outcomes.

   Many of our inshore coastal areas are severely degraded from the cumulative impact of a range of human-induced stressors, and the task before us is not to mitigate future impacts but to proactively improve environmental health. This could help drive a move towards creative approaches to introducing multi-trophic and restorative aquaculture on a zone-wide scale.

   Proactive planning for potential activities within each zone, including but not limited to aquaculture, can take place within the envelope provided by the standards. Science and monitoring can then focus on the area-based scale rather than on individual marine farms. Regular (or real-time) monitoring should be undertaken on an area basis to determine whether the standards are being met. This, in turn, can feed into state of the environment monitoring and reporting at a regional scale. Such standards could relate to water quality, seabed condition and indicators of overall ecosystem health. Clear triggers should be identified as to when management action will occur in response to the standards not being met. Collaborative and integrated marine spatial planning exercises, drawing on the lessons learnt from the Sea
Change Tai Timu Tai Pari process, could be used to identify appropriate zones and environmental quality standards, amongst other things.

2. Flexible adaptive regulatory regime
We were attracted to the more flexible regulatory regime applied in Norway, where licences were attached to biomass which could be moved between different aquaculture areas depending on environmental conditions and market requirements. This could help avoid farmers being trapped into marginal or unsuitable sites which does not benefit the farmer or the environment. It could assist the industry in becoming more resilient and adaptable to changing conditions. This idea would need more detailed thought and design in order to tailor it to the New Zealand context, but we think it merits close consideration particularly given likely future changes to technology and the marine environment.

3. Stronger risk management
The biosecurity risks to the aquaculture industry in New Zealand are likely to increase in the future, and we are not convinced that the current system is up to the task of adequately managing them. The avoidance of problems in some sectors may be due more to good luck than good management. The experience of other countries is a salutary lesson, where there are serious problems with sea lice and disease that costs millions of dollars in lost production and treatment expenses each year. As the industry in New Zealand grows and diversifies into new species, we need to develop a much more robust biosecurity system which integrates matters such as information collection, regional biosecurity zones, farm separation, single-cohort production, falling and the like. There also needs to be a strong inspection and enforcement effort to make sure that the rules are complied with because one breach can risk whole sectors of the industry.

4. Allocation and de-allocation framework
A more developed allocation framework should be developed for marine space alongside the use of other public resources. This should address both allocation of space and de-allocation when environmental quality limits have been exceeded. The framework should set out a series of principles that will apply and would need to be cognisant of Treaty requirements. It could take the form of separate legislation (an Allocation Act) or a more fully developed section of the RMA. Allocation for marine farming could be of farmed biomass, rather than a defined area of seabed, to enable flexibility in location of farms over time.

A fair charge (whether it takes the form of a rental, tax or upfront licence cost) should be imposed for the private use of the marine commons. The proceeds could be used to improve marine management and monitoring, which is severely underfunded. Currently, holders of coastal permits for marine farms can sublease the space and charge a rental for it, even though they have effectively been given the use of public space for free. We were told that this is a common practice, and it seems unfair.

5. Stronger national direction and role of the Environmental Protection Authority
There is a need for stronger national direction, particularly for future aquaculture siting decisions, which are critical in achieving good environmental quality standards as well as operating requirements. The Environmental Protection Authority, as an independent and technically skilled agency, could usefully play a role in developing such direction, which, under the current regime, could take the form of a national policy statement or national environmental standard.

For open ocean aquaculture, we think a stronger national role is merited, given that there currently exists a very thin policy and planning framework to guide decision-making, and a paucity of science. We suggest that the Environmental Protection Authority may be a better decision-making authority in this area than councils, given the agency’s role in decision-making for the exclusive economic zone. There is the prospect under oceans law reform for the RMA and exclusive economic zone legislation to be combined and this would provide a more integrated platform for managing across the boundary. This is an area that needs urgent attention and focused policy development.

6. Transparency of information
Monitoring information, including monitoring undertaken on marine farms as part of consent conditions and state of the environment monitoring, should be made accessible to the general public via the web in a timely fashion. Regular reviews summarising the significance of the information for the layperson would also be very useful. This will help to engender public confidence in the industry and the regulators. Some national guidance on what is expected from councils in this regard could be useful.

7. Greater support for research and development
Although the aquaculture industry has got a long way through trial and error, future success is likely to rely on a much stronger science-based approach. This will require greater institutional and financial support from both government and industry and could also merit the creation of research and development hubs and pilot farms.

Concluding comments
This research project has identified the considerable strengths of the aquaculture industry in New Zealand but also some key weaknesses, including in the current management regime for the industry. The forthcoming resource management law reform process provides an excellent opportunity to remedy some of these weaknesses. Designing a regulatory regime that will better provide for the industry while protecting and restoring the marine environment is beyond the scope of this project but is something that merits considered attention. We believe that we can and should do better.
Chapter One: Introduction
Aquaculture is a substantial and growing industry in New Zealand. It produces healthy and highly sought after food products as well as health supplements. It provides well-paid jobs, supports whānau, hapū and small communities, and generates important export income for the country. It has the potential to contribute to marine restoration. It is generally favourably viewed by the New Zealand public. Managed well, the industry has a positive outlook for the future.

Commercial scale aquaculture had its beginnings in the late 1960s, at a time when there was limited environmental awareness. The industry became established largely through trial and error in order to identify suitable growing methods and locations. Substantial growth of the industry during the 1990s and 2000s placed considerable pressure on New Zealand’s newly established legislative regime, which was not nearly as well developed for the sea as it was for land. More recently, environmental concerns and broader issues, such as warming seas, have called into question the ongoing suitability of some marine farming sites.

Like wild fisheries, the industry is dependent on ongoing access to the marine commons. Aquaculture involves placing structures, equipment and living organisms into the marine environment. The farmed species are either indigenous or introduced. The young animals are caught in the wild or are hatchery produced. They either self-feed or require external feed to be dispensed into the water column. All these activities have impacts on the landscape and ecological values of the marine environment that need to be managed.

Eight different legislative regimes have applied to aquaculture since the late 1960s, with the most recent reform being in 2011. The frequency of change indicates a legislative system which has struggled to meet the needs of the industry, Māori and the public. The government has recently announced an intention to embark on broader resource management system reform commencing later in 2019. This provides an opportunity to rethink the future management regime for aquaculture in the context of growing pressures on coastal systems, a changing climate and the development of new technologies.

This report reflects on these issues and provides recommendations on the potential way forward. It draws on the EDS Resource Management System Reform project which is undertaking a first principles look at the system and developing options for future reform.

This report is based on a broad range of information sources. They include reviews of relevant literature; current New Zealand law applying to aquaculture; legislation and administrative arrangements for aquaculture in six other jurisdictions (Scotland, New South Wales [NSW], South Australia, Tasmania, British Columbia and Norway); and a report by marine scientist Hilke Giles titled *Environmental Management of New Zealand Aquaculture: The Science*.
In addition, a study tour of Norway was undertaken to investigate salmon farming practices and management settings; meetings were held with aquaculture managers and scientists in Hobart and Melbourne; field trips were undertaken to one mussel and two oyster farming operations in the Hauraki Gulf; and the author attended the 2018 Aquaculture New Zealand Conference in Blenheim. Also, semi-structured interviews were held with 27 key participants in aquaculture decision-making. The interviews were undertaken on a confidential basis so interviewees have not been identified in the report. However, some direct quotes have been included to help illustrate and provide some ‘colour’ to the discussion. The source of each quote has been identified by one of five broad sectors (Industry, Government – which includes central and regional, Community, Science and Consultants) to provide context. In addition, some quotes from published works have been italicised and, where this is the case, the authors are referenced.

The report is structured into three parts. Part A focuses on the management framework for aquaculture. After this introduction, Chapter 2 describes the evolution and current status of New Zealand’s aquaculture management regime. Chapter 3 reviews aquaculture management in other jurisdictions and assesses how New Zealand compares. Chapter 4 then analyses aquaculture within the context of potential future resource management law reform.

Part B of the report explores industry and environmental considerations which need to be taken into account when considering a future aquaculture management regime. Chapter 5 describes the historical context for the development of aquaculture in New Zealand before Chapter 6 describes the current industry. Chapter 7 summarises current knowledge on the potential environmental effects of aquaculture and how these can be managed.

Finally, Part C of the report sets out recommendations for the direction of a future aquaculture management regime. These are exploratory only, and we recommend that additional work be undertaken to flesh out concrete proposals for aquaculture management in the context of the forthcoming resource management law reform process.
Endnotes

1  Robertson and Comfort, 2014
2  Storer, 2018
3  Giles, 2019
PART A: AQUACULTURE MANAGEMENT FRAMEWORK

Chapter Two: Current management regime

Mahurangi Harbour
'The coastal marine area is a unique environment that requires different approaches to environmental management compared to land or freshwater environments.'

(Giles, 2019)

‘When the RMA first came in the rules around applications were very loose. You could put in a one-pager and be first in.’

(Industry)

‘The cost of applying for a consent was small and the value per hectare of the space was high. It was around $20,000 to apply for a 4-hectare site, which was worth $200,000. This caused a lot of speculation.’

(Government)

There has been a long history of change to the legislative arrangements applying to aquaculture, with no fewer than eight differing legislative regimes being promulgated over the past 50 years or so. Under current law, aquaculture is treated pretty much the same as any other activity within the coastal marine area, with the type of activity status and matters to be considered when applying for a resource consent to be determined by the provisions of the regional coastal plan. There are some specific provisions in the Resource Management Act 1991 (RMA) that apply only to aquaculture, and there is a wider range of options for councils when it comes to addressing multiple applications and the allocation of space. There is also a specific aquaculture policy in the New Zealand Coastal Policy Statement (NZCPS) (Policy 8) requiring councils to make provision for the activity in appropriate places. In practice, there is considerable variation between councils in terms of how aquaculture is provided for. More detail on the management settings and the context in which they have been applied is provided in the following sections.

2.1 Evolution

Prior to the RMA, the consenting of marine farming was provided for in dedicated legislation (see Chapter 5). The 1980s and 1990s was a period of great expansion within the aquaculture industry. By the time the RMA came into force in 1991, bringing with it a greater emphasis on managing environmental impacts, there were already 677 authorised marine farms in New Zealand. The leases and licences established under the Marine Farming Act 1968 became 'deemed coastal permits' under the new regime. As a result, there remains in the system a considerable legacy of older-style consents. Five years after the RMA was in force there were 808 permitted farms, comprising 527 mussel farms, 255 oyster farms and 26 salmon farms. Eighty-two per cent (464) of the mussel farms were in the Marlborough Sounds, and there were an additional 200 applications in the pipeline for the area. Applications only had to meet minimal requirements, and the space was effectively ‘free’ apart from modest application costs, so a ‘gold rush’ for marine farming space developed.
A spotlight on the consenting history for the Ruakaka Bay site, Queen Charlotte Sounds

The Ruakaka Bay site was consented by the first marine farming licence issued in the Marlborough Sounds in November 1975 (Marine Farm Licence 1). The licence was initially issued for a mussel farming site in Crail Bay but was subsequently transferred to Ruakaka Bay. It was then taken over by Regal Salmon and is now held by New Zealand King Salmon (NZ King Salmon). The original licence covered just over 0.4 hectares. A series of subsequent resource consents substantially increased that area to just over 11 hectares, extended the range of species that could be farmed to include salmon and snapper, and provided for the discharge of feed and establishment of cages and barges on the site.3

The original term of the licence in 1975 was 14 years. Two extensions were granted by variations to the resource consent for an additional 28 years. The Aquaculture Reform (Repeals and Transitional Provisions) Act 2004 extended it further to 2024, resulting in an effective grant of licence for 49 years.4 This illustrates a process of ‘creep’ whereby the scope of original consents can be gradually extended, both in terms of spatial extent and length of tenure, in this case from a size of 0.4 hectares to 11 hectares and from a term of 14 years to 49 years.

Although this process can provide greater commercial certainty for the marine farmer, it risks less than optimal environmental management. When granting consent for marine farming at Ruakaka site in 1975, the decision-maker was almost certainly not contemplating that the consent would last for close to 50 years or longer. The site, itself, has proved marginal for salmon farming, and it was one of the six low flow sites proposed to be retired and replaced with new higher flow sites in the Sounds, as part of the Ministry for Primary Industries (MPI) salmon relocation project (see Section 2.4). The 1980s and 90s was a period of great expansion in mussel farming in the Marlborough Sounds.

The gold rush prompted the government to place a moratorium on the further grant of consent for marine farms within Marlborough District between 1996 and 1999. When the moratorium was lifted, the council was flooded with 439 applications for coastal permits.5 A nationwide moratorium was subsequently placed on the grant of aquaculture consents in 2002, being lifted in early 2005 after new legal provisions had been put in place. These focused on requiring sectorally based spatial planning, with councils expected to identify aquaculture management areas (AMAs) for the location of all new farms. Marine farming was a prohibited activity outside these areas. The new regime was accompanied by a Māori commercial aquaculture settlement (described in Section 4.2).

The AMA provisions were relatively short-lived, being repealed in 2011 and replaced with the current regime. The 2011 amendments also gave power to the Minister of Aquaculture to directly intervene in changing aquaculture provisions in regional coastal plans. A summary of the various legislative changes that have applied to aquaculture over the past 55 years is shown in Figure 2.1.
<table>
<thead>
<tr>
<th>Date</th>
<th>Legislative provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td><strong>Rock Oyster Farming Act 1964</strong>&lt;br&gt;Enabled the lease of areas of the foreshore or seabed for rock oyster farming. Leases for up to 14 years with provisions for right of renewal. Provision for rentals to be charged. Decisions made by the Minister of Marine.</td>
</tr>
<tr>
<td>1968</td>
<td><strong>Marine Farming Act 1968</strong>&lt;br&gt;Enabled the lease of areas of the foreshore and seabed for marine farming (excluding rock oysters). Leases for up to 14 years with provision for a right of renewal. Maximum area per lease of 5 acres (around 2 hectares). Provision for rentals to be charged. Decisions made by the Minister of Marine.</td>
</tr>
<tr>
<td>1971</td>
<td><strong>Marine Farming Act 1971</strong>&lt;br&gt;Enabled the lease or licence of areas of the foreshore and seabed for marine farming (excluding salmon and trout) for up to 14 years with rights of renewal. A rental or annual fee to be paid. Provision for spatial management through the identification of areas to be set aside for marine farming and areas which would not be available for the activity. Public applications could be sought for suitable areas. Decisions made by the ‘controlling authority’, which was variously the harbour board, local authority or the Minister of Marine. All decisions required consent of the Minister. Salmon farming was subsequently authorised in 1980 by a change to the regulations.</td>
</tr>
<tr>
<td>1991</td>
<td><strong>Resource Management Act 1991</strong>&lt;br&gt;Presumption that a coastal permit is required for all marine farms. Applicable policies and rules determined by regional coastal plans (which could include spatial planning). Applications required assessment of environmental effects for the first time. Decisions made by regional councils (or Environment Court on appeal). Consent from the Minister of Fisheries also required under the Fisheries Act 1983 to ensure that there would not be ‘an undue adverse effect on fishing or the sustainability of any fisheries resource’. The Marine Farming Act regime continued to apply to existing marine farms. Salmon farming was subsequently authorised in 1980 by a change to the regulations.</td>
</tr>
<tr>
<td>1993</td>
<td><strong>Fisheries Act Amendment Act 1993</strong>&lt;br&gt;This addressed a loophole that developed when the RMA came into force whereby there was no legal ability to authorise the holding or harvesting of fish on farms. Marine farmers were now required to obtain two permits, the first a coastal permit under the RMA for coastal occupation, structures and discharges, and the second a marine farming or spat-catching permit under the Fisheries Act.</td>
</tr>
<tr>
<td>2002</td>
<td><strong>Resource Management (Aquaculture Moratorium) Amendment Act 2002</strong>&lt;br&gt;Placed a two-year moratorium on the grant of coastal permits for aquaculture to enable a new regime to be developed.</td>
</tr>
<tr>
<td>2004</td>
<td><strong>Aquaculture Reforms (Repeals and Transitional Provisions) Act 2004</strong>&lt;br&gt;Created a fundamentally different regime for aquaculture focused on the identification of AMAs where aquaculture could be established as a controlled or discretionary activity. Aquaculture was to be a prohibited activity outside AMAs. Existing marine farm areas were deemed to be AMAs. New AMAs were to be developed by councils through plan changes or by other parties through privately initiated plan changes. The Act also removed the dual consenting regime and only consent under the RMA was now required. An ‘undue adverse effect’ test relating to customary, recreational and commercial fishing was to be applied to AMAs and not to individual farm applications. &lt;br&gt;Existing leases and licences issued under the Marine Farming Act or permits issued under the Fisheries Act were now deemed to be coastal permits. They had a term totalling the balance of their current term plus 14 years, provided the total term did not exceed 20 years, and with a preferential right to apply for a new coastal permit on the same site when the current permit expired. These provisions have meant that many permits come up for reconsenting in 2024, 20 years after the Amendment Act came into force.</td>
</tr>
<tr>
<td>Date</td>
<td>Legislative provision</td>
</tr>
<tr>
<td>------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2004</td>
<td><strong>Māori Commercial Aquaculture Claims Settlement Act 2004</strong> Providing for the settlement of Māori claims to commercial aquaculture through the allocation of 20 per cent of the value of all aquaculture space consented between 21 September 1992 and 30 September 2011. Space consented between 21 September 1992 and 31 December 2004 was treated as ‘pre-commencement space’, while space consented between 1 January 2005 and 30 September 2011 was treated as ‘interim AMA space’. For pre-commencement space, the settlement obligations owed to iwi were able to be taken in the form of cash, authorisations to develop space or the transfer of established farms. For interim AMA space, the settlement obligations owed to iwi were only able to be taken in the form of authorisations to develop 20 per cent of the relevant AMA.</td>
</tr>
<tr>
<td>2011–current</td>
<td><strong>Aquaculture Reform (Repeals and Transitional Provisions) Amendment Act 2011</strong> Removed the requirement for AMAs and now applications can be made for any part of the coastal marine area subject to the provisions of the regional coastal plan. Minimum 20-year term of consent and maximum of 35 years. Fisheries New Zealand to make ‘aquaculture decision’ regarding impact on wild fisheries after resource consent granted. Provision for range of allocation methods for space. Provisions of regional coastal plans relating to aquaculture can be amended directly by regulation on recommendation of the Minister of Aquaculture. The Tasman and Waikato regional coastal plans were directly amended by the Act, including the creation of a new Coromandel Marine Farming Zone. <strong>Māori Commercial Aquaculture Claims Settlement Amendment Act 2011</strong> Amends the methods for delivering the 20 per cent obligation for aquaculture space consented after 1 October 2011. The amendment sets a framework for the Crown and iwi to enter into regional agreements, through which it is agreed what form the settlement obligations will take (cash, authorisations to develop space or a combination of both). The amendment also obliges the Minister to maintain a plan for satisfying the Crown’s settlement obligations. In practice, this has resulted in a prospective settlement with iwi for assets representative of 20 per cent of the value of all development forecasted to occur to 2035.</td>
</tr>
</tbody>
</table>

**Figure 2.1 Summary of legislative provisions applying to aquaculture 1968–2019**

![Workers cleaning growth off oyster racks in the Mahurangi harbour.](image-url)
2.2 Māori aquaculture rights

Māori rights applying to aquaculture include Treaty rights as encapsulated in the Aquaculture Treaty Settlement and customary rights to the marine and coastal area. These are described separately below.

Māori Commercial Aquaculture Claims Settlement Act 2004

The Māori Commercial Aquaculture Claims Settlement Act 2004 seeks to settle all Māori claims in respect of commercial marine aquaculture arising after 21 September 1992. Through the Settlement Act, iwi are to receive a representative 20 per cent of all space approved for aquaculture development. As approval of aquaculture space takes place under the RMA, all aquaculture settlements are regionally based on regional council boundaries.

Te Ohu Kai Moana Trustee Limited (known as Te Ohu Kaimoana) is the corporate trustee of the Māori Commercial Aquaculture Settlement Trust (known as the Takutai Trust), a trust established by the Settlement Act to receive regional aquaculture settlement assets from the Crown. In relation to the Takutai Trust, Te Ohu Kaimoana’s primary role is to allocate and transfer regional aquaculture settlement assets to iwi. There are three phases to the settlement, each with different delivery mechanisms (see adjacent spotlight). The settlement has contributed to the asset base of iwi as well as facilitated greater involvement in the aquaculture industry.

A spotlight on the Aquaculture Treaty Settlement

There are three phases of the Aquaculture Treaty Settlement, and for iwi, these can be characterised by their delivery mode – past, present and future:

Audaculture approved under the regime operating from 22 September 1992 to 31 December 2004 (just prior to the commencement of the Settlement Act), referred to as the pre-commencement phase. The Settlement Act provided for iwi to receive settlement assets equivalent to 20 per cent of the representative value of all space approved during through the pre-commencement phase through either the approval of space after 2004, purchase of marine farms or cash. There were several practical obstacles preventing settlement obligations being in the form of space and so all pre-commencement phase obligations were taken as cash.

Aquaculture approved under the regime operating from 1 January 2005 until 30 September 2011, referred to as the interim AMA phase. In this phase iwi were to receive authorisations to apply for resource consents for a representative 20 per cent of aquaculture space in any approved AMA at the same time as its approval. Iwi would need to apply for resources consents themselves, and get approval from MPI under the ‘undue adverse effects’ test, but the AMA regime meant that most of the issues were resolved during the planning process and the consenting process was therefore straightforward (akin to a non-notified controlled activity by the time an authorisation was given).

Aquaculture approved after 1 October 2011, referred to as the new space phase. In this phase, the iwi of a region are to receive settlement assets equivalent to the value of 20 per cent of the representative value of all aquaculture development in a region through entering into Regional Aquaculture Agreements with the Crown. This phase of the settlement is forecasted, with the Crown providing iwi with access to assets prior to development occurring. The amount of assets is based on forecasts of national development of demand for aquaculture by species. For the period between 2011 and 2035, MPI worked with experts and iwi to forecast the national growth in demand for salmon, green-lipped mussels and Pacific oysters. Once the forecast was agreed, a valuation model was built for each species that considered the timing of development and variations in regional costs. This model was refined and agreed between the Crown and iwi, and was used to determine the overall financial equivalent that iwi would receive in 2015 for the various regional settlements, if cash was taken. In the new space phase, iwi in a region can choose how to receive the settlement assets – as authorisations for space inside an ‘Aquaculture Settlement Area’ (if established, these areas give iwi the exclusive right to apply for consent for aquaculture activities within that space), cash or a combination of both. These provisions are supporting the greater involvement of iwi in the aquaculture industry, although some groups have accepted money in lieu of space.

These settlement arrangements will need to be respected in any changes to the aquaculture management framework.

Freshly harvested Pacific oysters
Marine and Coastal Area (Takutai Moana) Act 2011

The Marine and Coastal Area (Takutai Moana) Act 2011 also has implications for aquaculture and was a response to foreshore and seabed issues that arose within an aquaculture context. Iwi in Te Tau Ihu (top of the South Island) were concerned that marine farms were being consented within their customary kaimoana areas, but they were unable to obtain consent for their own farms. Ngāti Apa then questioned who had title to the foreshore and seabed in the Māori Land Court. The case ended up in the Court of Appeal which determined that the Māori Land Court could investigate Māori customary rights in the foreshore and seabed which had not generally been extinguished by legislation. The government subsequently overturned the Court of Appeal’s decision, with the passage of the Foreshore and Seabed Act 2004, which placed ownership of the area with the Crown (except for areas already in private ownership). This Act was subsequently replaced in 2011 by the Marine and Coastal Area (Takutai Moana) Act which stated that the foreshore and seabed was not owned by any party. The legislation provides for the exercise of customary interests in the common marine and coastal area through ‘protected customary rights’ and ‘customary marine titles’. These rights do not affect the grant of coastal permits for the continuation of existing marine farms, even if there is a change of species or method used, provided there is no increase in area or a location change. However, an application for a new marine farm in a protected customary rights area that will, or is likely to, have an adverse effect on that right requires the approval of the right holder before consent can be granted. Likewise, the views of a group which has applied for customary marine title must be sought before consent can be granted for a coastal permit within that title area. This means that a marine farmer cannot commence marine farming within the area without the consent of the title-holder. A title-holder can decline consent on any grounds and, as such, has a powerful veto right over future aquaculture activities in the area. However, there is a high evidentiary threshold required to obtain a customary title and, as a result, such restrictions will only likely apply to discrete areas of the coast. Ngāti Porou is the first iwi to secure agreement for customary title, which will extend over significant parts of the coastline around East Cape.
2.3 National policy framework

National policy that applies to aquaculture is set out in the NZCPS. This is a statutory document and all policy statements and plans prepared under the RMA are required to give effect to it. In addition, when considering an application for a coastal permit for aquaculture, the regional council must have regard to the NZCPS. Three NZCPS policies specifically refer to aquaculture – Policies 8, 12 and 21. In addition, Policy 7 addresses strategic planning for the location of activities, including aquaculture, as well as the management of cumulative effects (see spotlight below).

Policy 8 specifically focuses on aquaculture and requires regional councils to provide for the activity within their regions. Policy 12 addresses biosecurity risks and requires that, as far as practicable, regional councils control ‘the establishment and relocation of equipment and stock required for or associated with aquaculture’ to manage adverse effects on the environment caused by the release or spread of harmful aquatic organisms. Where the quality of water in the coastal environment has deteriorated so that it is restricting existing aquaculture, Policy 21 states that regional councils must give priority to improving that water quality. A number of other NZCPS policies may also be relevant to the assessment of an application for aquaculture, for example Policy 2 – taking account of the principles of the Treaty of Waitangi and kaitiakitanga, Policy 11 – protecting indigenous biodiversity, Policy 13 – preservation of natural character, Policy 15 – natural features and natural landscapes, Policy 18 – recognising the need for public open space in the coastal marine area for use and appreciation and Policy 23 – managing discharges to water in the coastal marine area.

This means that, overall, there is an obligation on councils to consider making planning provision for aquaculture within their districts, but within the constraints of the environmental bottom lines set to protect outstanding natural landscapes and features, outstanding natural character and indigenous biodiversity (see adjacent spotlight). Councils also need to address the management of cumulative effects and the setting of thresholds or limits within areas to manage them. This includes setting limits that avoid ‘significant’ adverse effects on all landscape and natural character values. There is also an obligation on councils to manage biosecurity risks caused by aquaculture and conversely to manage the impacts of other activities on aquaculture where they adversely affect water quality that the farms rely on.

A spotlight on the NZCPS and provision for aquaculture in regional coastal plans

Policy 8 of the NZCPS seeks to encourage councils to make positive provision for aquaculture within their regions in ‘appropriate places’ by explicitly requiring them to recognise the positive effects of the activity. It states:

‘Recognise the significant existing and potential contribution of aquaculture to the social, economic and cultural well-being of people and communities by:

(a) including in regional policy statements and regional coastal plans provision for aquaculture activities in appropriate places in the coastal environment, recognising that relevant considerations may include:

(i) the need for high water quality for aquaculture activities; and

(ii) the need for land-based facilities associated with marine farming;

(b) taking account of the social and economic benefits of aquaculture, including any available assessments of national and regional economic benefits; and

(c) ensuring that development in the coastal environment does not make water quality unfit for aquaculture activities in areas approved for that purpose.’

However, such social, cultural and economic contributions need to be considered alongside any environmental effects. In this respect, Policies 13 and 15 are particularly relevant. Together they provide for the preservation of natural character and the protection of natural features and landscapes from inappropriate subdivision, use and development by avoiding adverse effects. The Supreme Court in Environmental Defence Society v New Zealand King Salmon Company has recently determined that there is no insurmountable conflict between Policy 8 on the one hand and Policies 13 and 15 on the other. The Court held:

‘Policies 13(1)(a) and 15(a) provide protections against adverse effects of development in particular limited areas of the coastal region — areas of outstanding natural character, of outstanding natural features and of outstanding natural landscapes (which, as the use of the word “outstanding” indicates, will not be the norm). Policy 8 recognises the need for sufficient provision for salmon farming in areas suitable for salmon farming, but this is against the background that salmon farming cannot occur in one of the outstanding areas if it will have an adverse effect on the outstanding qualities of the area. So interpreted, the policies do not conflict.’
Such an approach would apply to other policies which use the word ‘avoid’ including Policy 11 of the NZCPS, which addresses impacts on indigenous biodiversity. In particular, adverse effects on threatened or at risk indigenous species, threatened indigenous ecosystems and vegetation types and marine protected areas must be avoided.

Policy 7 provides assistance when planning for aquaculture, encouraging regional councils to be strategic in their planning and, in particular, requiring them to identify areas of the coastal environment where particular activities such as aquaculture are provided for and also where they are inappropriate. The Policy also specifically addresses the management of cumulative effects, requiring councils ‘where practicable’ to ‘set thresholds (including zones, standards or targets), or specify acceptable limits to change, to assist in determining when activities causing adverse cumulative effects are to be avoided’. This provides support for councils to adopt proactive spatial planning for aquaculture, rather than relying on a case-by-case consenting regime, and to identify measurable limits for acceptable levels of change (an approach which is discussed in more detail in Chapter 4).

Although helpful, the national policy framework set out by the NZCPS is high level and relatively undeveloped when compared to that provided in other countries (see Chapter 3). Other jurisdictions typically have much greater prescription over farm siting criteria and operating standards. We note the suggestion by Hilke Giles that it would be useful to develop criteria for good marine farm siting, drawing on current scientific knowledge and experience in regional coastal planning to date, in order to assist with better decision-making in New Zealand in this important area. She also suggests that development of such a framework could usefully learn from the approach taken in the Sea Change Tai Timu Tai Pari process, which applied a set of criteria to identify potential aquaculture locations. These included biophysical factors, environmental factors, minimising adverse effects on sites of significance to mana whenua, natural character and landscape, and minimising exclusion of others from coastal space. Such guidance could help with identifying sites that maximise production while minimising environmental effects, and could be encapsulated in a national environmental standard or national policy statement on aquaculture under the RMA.
‘Making good decisions on farm locations is one of the most important aspects in the environmental management of aquaculture.’ (Giles, 2019)

‘The biggest weakness in the RMA is planning. The way aquaculture is permitted would be way better if planning was stronger, if the community got together to agree on what to protect and where the different activities could go and to consider the relative risks of activities and the impacts from land also. This could be woven into a balance with the aspirations and ambitions of communities and central government understanding of how New Zealand works.’ (Industry)

2.4 Regional planning

The primary planning document that applies to aquaculture is the regional coastal plan. This sets out the planning and rules-based framework within which aquaculture can be consented. Due to the somewhat complex legislative history that has applied to aquaculture (described above), and the varying ways in which the industry has developed in different regions (as described in Chapter 5), there is a wide variety of approaches to aquaculture in regional coastal plans. The picture has been complicated by central government intervention at times, which has taken planning decisions outside the control of local communities. We now review the situation in three major marine farming areas – the Marlborough Sounds, Tasman and Golden Bays, and the Coromandel Peninsula – in order to provide a sense of these variations. We then turn to the management of prospective open ocean salmon farming. Finally, we review what we have learned about spatial planning for aquaculture.

Marlborough Sounds

Mussel and salmon farming was well developed in the Sounds before the RMA came into force, and the area was the first to experience the ‘gold rush’ for space during the 1990s. The region has the greatest concentration of marine farms in the country. Largely as a result of the strong pressure for space, the regional coastal plan was one of the first to develop a spatial allocation regime for aquaculture. Shortly after the Marlborough District Council notified its first proposed regional coastal plan under the RMA in 1995 (as part of the proposed Marlborough Sounds Resource Management Plan), the government imposed a moratorium on consenting additional farms in the district.

After a lengthy process of community consultation and negotiations, a revised plan was approved by the Environment Court in 1999. This effectively divided the Sounds into two zones – Coastal Marine Zone 1, where new aquaculture was prohibited, and Coastal Marine Zone 2, where aquaculture could be permitted variously as a controlled, discretionary or non-complying activity. The designations were based on broad community agreement that aquaculture would be concentrated in the more developed Pelorus Sound (the ‘working Sound’) and would be largely excluded from Queen Charlotte Sound, which had greater importance for recreation and tourism. The plan became operative in 2003 and still provides the applicable rule framework for aquaculture in the Marlborough Sounds. Planning in the region was largely unaffected by the statutory amendments during the 2000s, which required the development of AMAs, as a spatial planning framework was already in place which effectively achieved the same end.

In 2011, NZ King Salmon challenged this long-settled spatial allocation regime. This was at least partly due to the regional coastal plan primarily focusing on the needs of the green-lipped mussel farming industry. The environmental conditions required by mussels and salmon are very different, with salmon farms requiring cooler, deeper sites with faster water flow. Salmon farming was a relative latecomer to the Sounds, and the greater complexity of finfish farming systems meant that it took longer for the industry to establish and expand. By that stage, most of the available sites have been allocated to mussel farms. Locating salmon farms on former mussel sites was often not successful, as demonstrated by the difficulties experienced with salmon farming at Ruakaka Bay (see Section 7.1).
The company lodged a privately initiated plan change application to enable eight salmon farms to be established in areas where aquaculture was prohibited under the plan. This was accompanied by resource consent applications for all sites, seeking that they be granted for 35 years (the maximum term possible). The Minister of Conservation applied newly minted call-in provisions on the basis that the package of applications involved ‘matters of national significance’. The provisions had been inserted into the RMA as part of a raft of 2011 amendments designed to ‘streamline’ planning and consenting processes. This meant the applications were not decided by the Marlborough District Council or Environment Court on appeal, but by a Board of Inquiry whose members were directly appointed by the Minister. Control over planning for salmon farming was thereby taken out of the hands of the local community and lacked politically independent scrutiny.

After hearing the applications, the Board of Inquiry granted the plan change and resource consents for four of the eight sites. EDS challenged one of the sites (at Port Gore) in the High Court, and subsequently the Supreme Court, and the plan change and consent were overturned. At the same time, a local community group ‘Save Our Sounds’ challenged all four sites but was unsuccessful. This meant that NZ King Salmon was granted three new sites through what was effectively ‘spot zoning’ – the Waitata, Ngamahau and Kopāua sites.

These sites enabled the company to expand production but did not address the problem of the existing low flow sites. Rising seawater temperatures in the inner Sounds were causing problems for fish health (king salmon being a cold water species) and the low water flows and shallow depths were resulting in poor seabed conditions under the farms. At this stage, MPI intervened in order to facilitate the relocation of six of those farms to areas in the outer Sounds where both production and environmental outcomes might be improved. In this way, the relocation could potentially provide a ‘win-win’ outcome.

The proposal proved highly controversial (see spotlight below). In part, this was because MPI proposed to use new regulatory powers under the RMA which enabled the Minister of Aquaculture to directly insert provisions into the regional coastal plan authorising new sites. Although potentially providing a shorter and more streamlined process, it effectively took planning away from the council and appeal rights away from the community. The government changed in 2017, before a final decision on the sites had been made by the former Minister, and the issue of whether new salmon farming sites will be created via regulation has yet to be resolved.
A spotlight on the NZ King Salmon farm relocation proposals in the Marlborough Sounds

By the mid-2010s, there were 11 salmon farming sites in the Marlborough Sounds. Six of the sites were ‘low flow’ and were experiencing difficulties with warming seawater. Two of the sites, in Crail Bay, have not been stocked since 2011. The other four sites (at Ruakaka Bay, Otanerau, Forsyth Bay and Waihinau Bay) had at times exceeded what are now regarded as acceptable levels of seabed enrichment, despite low stocking rates.

In response to this issue, MPI initiated a process to identify additional potential new sites for salmon farming in the Sounds and by 2015 had identified nine potential high flow sites. At that point the Ministry convened, in association with the council, the ‘Marlborough Salmon Working Group’ to consider future options for salmon farming in the Sounds, including these sites. At that stage, open ocean aquaculture was thought to be at least a decade away, so was not considered as an option. The Group identified three of the proposed sites as potentially suitable, three of the sites as unsuitable, and consensus could not be reached on the remaining three.

Following these deliberations, MPI publicly notified six of the sites, and indicated that the Minister intended to use his regulatory powers under sections 360A–C of the RMA (inserted by the 2011 amendments to the Act) to authorise new sites rather than going through a lengthy plan change and resource consenting process, which would have otherwise been required. MPI proposed that the six low flow sites be decommissioned and that the six new sites be developed in a staged process. The Ministry then established the Marlborough Sounds Salmon Farm Relocation Advisory Panel in early 2017 to consider public submissions. A total of 596 written comments were received on the proposals which had raised considerable community interest. Most of the submissions were from individuals (85 per cent) followed by business (11 per cent). Just over two thirds expressed support for the proposal (69 per cent). The Panel noted that many supporting comments were received from NZ King Salmon employees and people with contractual links to the company.

The Panel’s report describes the mood of the hearing. In the early stages, there was little tension while presentations were made by MPI staff, the Marlborough District Council and NZ King Salmon. When the community submissions started to be heard, there was a radical shift in tone:

“The mood of the hearings changed, as in many cases presenter after presenter expressed their anger at the Minister’s use of sections 360A–C of the RMA ... and the overriding of the Marlborough District Council’s planning functions ... Some of this anger and frustration was probably associated with the fact that salmon farming in the Marlborough Sounds has had a long and litigious history. Nevertheless, the members of this Panel have collectively a long history of hearing environmental cases and we are agreed that none of us has ever experienced the level of vitriol that was palpable in the hearing room as these presentations continued.”

Iwi also expressed anger and frustration at the lack of respect for iwi values and a breach of their entitlement to be fairly dealt with as Treaty partners. Iwi had been told that there was no new space available in the Marlborough Sounds for aquaculture, and that the Minister was unlikely to use his new regulation-making powers under the RMA to address the issue, so iwi agreed to a cash settlement in lieu of space. Just as iwi were finalising the settlement, the Minister announced that he was proposing to use those same powers for the benefit of NZ King Salmon. This created a ‘legacy of bitterness over the late advice of the intent by the Minister to use the ss.360 A–C powers for a commercial entity, when their use had so recently not been offered to iwi’.

The Panel recommended that three sites be proceeded with (the same sites recommended by the earlier group) at Tio Point, Horseshoe Bay and Richmond Bay South. The recommendations are still with the Minister, and at the time of writing, no decision on the way forward had been made.
In June 2016, the council notified a proposed new Marlborough Environment Plan. Prior to its notification, the council decided to remove the aquaculture chapter. In its place, a working group has been meeting, since 2017, to develop plan provisions that would specifically apply to shellfish aquaculture only (in addition to broader plan provisions, such as those protecting biodiversity and natural character, which apply across all activities). These will need to be introduced to the proposed plan by way of variation. The council is awaiting the decision of the Minister on the salmon relocation proposals before finalising new plan provisions for this activity.

Such a separation of the development and consideration of provision for different activities, and even for different types of aquaculture, is unfortunate and the antithesis of integrated management. Spatial planning that focuses on only one narrow activity risks reaching a suboptimal outcome for the Sounds overall. We were told that the council considers the Sounds ‘to be full’ in terms of aquaculture and that the focus in the future will be on better managing the impacts of existing farms rather than providing for additional ones. NZ King Salmon, perhaps seeing the writing on the wall, has started investigating open ocean options for salmon farm expansion (in addition to its current inshore farms), as discussed below.

There are some valuable lessons that can be drawn from the Marlborough District experience. Central government intervention in the NZ King Salmon relocation proposals generated significant animosity and conflict, which may make it more difficult for the future development of the industry in the region. It also overrode iwi interests and aspirations. Using processes that foment conflict and increase rifts in the community makes it less likely that people will be able to collectively come together to resolve challenging problems in the future. The Sounds is facing severe ecological pressures, which will require concerted community effort to resolve, and such approaches can only be counterproductive in this respect. Given that the council is in the process of developing the new aquaculture chapter for its proposed plan, it would make sense to fold the salmon farming matter back into council planning processes, in order that planning in the Sounds can start to be ‘knitted’ back together in a strategic fashion.

‘The community by and large don’t want more mussel farming in the Sounds. We don’t mind a few mussel farms but they have to be balanced with the environment. We don’t believe that mussels are doing that much damage. But when there are ecological effects we want them fixed.’ (Community)
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995 (March)</td>
<td>Proposed Marlborough Sounds Resource Management Plan notified (including the regional coastal plan)</td>
</tr>
<tr>
<td>1999</td>
<td>Environment Court approves revised plan. Zoning approach for aquaculture confirmed</td>
</tr>
<tr>
<td>2003 (July)</td>
<td>Plan becomes operative in part</td>
</tr>
<tr>
<td>2011</td>
<td>NZ King Salmon lodges privately initiated plan change and resource consent applications for eight salmon farms in contravention of the plan’s aquaculture zoning regime</td>
</tr>
<tr>
<td></td>
<td>Application called-in by the Minister of Conservation and referred to a ministerially appointed Board of Inquiry</td>
</tr>
<tr>
<td>2012</td>
<td>Board of Inquiry hearings held</td>
</tr>
<tr>
<td>2013 (February)</td>
<td>Board of Inquiry decision approving four sites</td>
</tr>
<tr>
<td>2013</td>
<td>Appeal to the High Court lodged. High Court releases decision confirming the Board of Inquiry’s decision. Leave granted to appeal to the Supreme Court</td>
</tr>
<tr>
<td>2014 (April)</td>
<td>Supreme Court releases decision, overturning one site and confirming the remaining three</td>
</tr>
<tr>
<td>2015</td>
<td>MPI identifies an additional nine potential relocation salmon farming sites in the Sounds</td>
</tr>
<tr>
<td>2016</td>
<td>(June) Proposed Marlborough Environment Plan publicly notified; aquaculture chapter not included</td>
</tr>
<tr>
<td></td>
<td>(July) MPI (in association with the council) convenes the Marlborough Sounds Salmon Working Group to consider future options for salmon farming in the Sounds. The Group identifies three of the sites identified by MPI as potentially suitable as relocation sites, three as unsuitable and is unable to agree on the remaining three</td>
</tr>
<tr>
<td>2017</td>
<td>(January) MPI publicly notifies six sites indicating the Minister’s intention to use his regulatory powers to directly insert provisions for the relocation sites into the council’s regional coastal plan</td>
</tr>
<tr>
<td></td>
<td>(January) Minister establishes Marlborough Salmon Farm Relocation Advisory Panel to considers public submissions</td>
</tr>
<tr>
<td></td>
<td>(April and May) Panel holds hearings</td>
</tr>
<tr>
<td></td>
<td>(April) Council establishes Aquaculture Working Group to consider shellfish aquaculture provisions for the proposed plan</td>
</tr>
<tr>
<td></td>
<td>(July) Panel delivers report and recommendations to the Minister</td>
</tr>
<tr>
<td>2018 (Jan)</td>
<td>Panel’s decision publicly released by the Minister which supports three relocation sites</td>
</tr>
<tr>
<td>2019 (July)</td>
<td>Decision yet to be made on salmon relocation sites in the Sounds</td>
</tr>
<tr>
<td></td>
<td>Aquaculture chapter for proposed Marlborough Environment Plan yet to be notified</td>
</tr>
</tbody>
</table>

Figure 2.2: Summary of key events in planning for aquaculture in the Marlborough Sounds
Tasman and Golden Bays

Unlike the situation in the Marlborough Sounds, there was much more limited marine farming in Tasman District prior to the RMA coming into force in 1991, although the area was a focus for mussel and scallop spat catching. In 1980, four licences (covering 4 hectares) were granted under the Marine Farming Act for mussel farms in Wainui Bay. The licensing was controversial due to the farms’ close proximity to the coast. The farmed area has since been expanded to cover 15 hectares, with the farms currently used for mussel spat catching. Just prior to the RMA, an additional group of marine farm licences was granted off an area called Waikato in Golden Bay, followed by seasonal scallop spat catching licences in Golden and Tasman Bays to provide for the scallop enhancement programme.

The 1990s saw a ‘gold rush’ for space in Tasman District, particularly in Golden Bay (see Figure 2.3). Prior to the notification of the district’s first regional coastal plan in 1996 (as part of the Tasman Resource Management Plan), consents were issued over large areas for seasonal and rotational mussel spat catching in Tasman Bay (1362 hectares) and Golden Bay (1636 hectares) as part of what is called the ‘Ring Road Consortium’ consents.

‘As we transferred the terrestrial based spatial planning model to the CMA [coastal marine area] to identify spaces for aquaculture, we did all the investigations around what the potential was for expanding the industry and the constraints in terms of other uses. We didn’t want to push aquaculture out, but we didn’t want it too close. The optimal depth for marine farms was 10 metres. We involved a wide range of interests and came up with a model where we decided to allocate space for the purpose. We put it 3 kilometres offshore so you cannot see the farms from the land.’ (Government)
Tasman District was the first council to develop an AMA regime, which was included in its initial regional coastal plan notified in 1996. After carefully analysing options, the council defined a series of spatial areas (AMAs), which would be available for allocation to marine farming, with aquaculture prohibited elsewhere in the district. The model was subsequently taken up by central government in the 2002 Amendment Act. The Tasman AMAs covered around 3000 hectares of marine space, which is roughly equivalent to the entire area allocated to marine farming in the Marlborough Sounds. The notified plan provisions helped the council to manage the flood of applications, as those seeking farms outside the AMAs became prohibited activities, and therefore could not be pursued.

The main submitters on the aquaculture plan provisions were the Friends of Golden Bay, whose members were worried about the untested nature of aquaculture and its ability to pollute the seafloor with detritus, and the Challenger Scallop Enhancement Company, which was seeking to preserve its ability to operate a wild but enhanced scallop fishery in the area. The plan provisions were appealed to the Environment Court and were considered during a series of three hearings between 1999 and 2004. The Court ultimately approved three AMAs for mussel farming accompanied by a rules framework which provided for controlled and discretionary activities in discrete subzones. An adaptive management framework provided for staged development of the areas. In addition, an Ecological Advisory Group was established to provide independent specialist advice to the council. By this stage (in 2004), the AMA requirements in the 2004 Amendment Act had come into force. The Tasman AMAs were declared ‘interim AMAs’ in November 2005, on recommendation of the Minister of Conservation, in order to bring them under the new regime.

Before the provisions could become operational, the Minister of Fisheries was required to make a decision on any undue adverse effects on fishing activity and fisheries resources. This decision took almost two years before it was issued in December 2008. The decision, as it related to the enhanced scallop fishery, was then challenged by way of appeal and judicial review all the way to the Court of Appeal. This was a very lengthy process, which resulted in a final court determination only in April 2013.26

**Figure 2.3 Spat catching and marine farming sites and applications in Golden Bay as at October 1999** (Source: Tasman District Council)
The end result of the proceedings was that the matter was remitted back to the Minister of Fisheries for redetermination. A few farms within the AMAs (part of the Ring Road consortium) escaped this litigation due to their earlier timing, and they became operative in 2009.

During the lengthy litigation process, the scallop enhancement fishery finally collapsed (largely due to the impact of its intensive dredging activity on the seabed where the scallops lived), meaning that when the Minister reconsidered the matter, he could only conclude that there would be no undue adverse effect from aquaculture on the fishery. However, it still took almost four years for the Minister to remake his decision, which was released in February 2017. The AMAs were finally confirmed by Gazette notice in January 2018, 22 years after the plan had first been notified and during a time when the law relating to aquaculture had been changed several times.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>Tasman Resource Management Plan (including the regional coastal plan) notified</td>
</tr>
<tr>
<td>1998</td>
<td>Council makes decisions on submissions to the plan</td>
</tr>
<tr>
<td></td>
<td>Appeals to the Environment Court lodged</td>
</tr>
<tr>
<td>1999–2004</td>
<td>Environment Court inquiry into plan. Decision creates AMAs and rules framework</td>
</tr>
<tr>
<td>2005</td>
<td>Interim AMAs created by Order in Council</td>
</tr>
<tr>
<td>2006 (January)</td>
<td>Council applies to the Ministry of Fisheries for an aquaculture decisions on the interim AMAs</td>
</tr>
<tr>
<td>2008 (December)</td>
<td>Minister of Fisheries releases final undue adverse effects decisions on interim AMAs</td>
</tr>
<tr>
<td></td>
<td>Decision appealed and judicially reviewed to the High Court</td>
</tr>
<tr>
<td>2009</td>
<td>Ring Road Consortium applications in AMA 2 and 3 approved</td>
</tr>
<tr>
<td>2011 (December)</td>
<td>High Court refers decision back to the Minister of Fisheries for reconsideration</td>
</tr>
<tr>
<td></td>
<td>Resource Management Amendment Act (No 2) 2011 amends the Tasman Regional Coastal Plan to make the AMAs operative</td>
</tr>
</tbody>
</table>

Tasman District’s AMA provisions had the misfortune to become tangled up with a litigious wild fisheries sector, which delayed matters many years. We were told that, with the AMAs now operational, there is more than enough space to meet current and future anticipated demand in the district.

**Coromandel Peninsula**

Waikato Regional Council also went down the route of establishing AMAs early on, following on from Tasman District’s lead. When the RMA came into force in 1991, there were around 67 hectares of small mussel farms scattered around the Coromandel coastline and 70 hectares of intertidal oyster farms. By 1994, a further 220 hectares of mussel farms were permitted in Wilson Bay. In October 1999, the council notified a Marine Farming Variation to its proposed regional coastal plan, which created a marine farming zone in Wilson Bay alongside the existing area of mussel farms. Council decisions on the variation were released in July the following year.

The Wilson Bay Marine Farming Zone is located in the Firth of Thames, about 1.75 kilometres offshore from Kereta, in depths ranging from 10 to 25 metres. The area is well flushed, with strong tidal currents. The zone is split into two subzones (Area A and Area B) separated by a 1 kilometre gap. The total farmable space of 1210 hectares is around half the entire farming zone, which covers 2473 hectares. Shellfish farming using long-lines within the Wilson Bay Marine Farming Zone was classified as a controlled activity. Spat catching, shellfish research and intertidal oyster farming were discretionary activities as were existing farms. All other aquaculture activities were prohibited. The plan provided for staged development with only 260 hectares of farms in each area able to be developed initially (or 50 per cent of the total allocated space). Finfish farming was prohibited in all marine farm sites in the region.
The council released its decision on the Wilson Bay zone in 2000 and a year later granted the first resource consents for mussel farms in the area. Consent applications for Area B were caught by the aquaculture moratorium announced in November 2001. When the moratorium was lifted at the end of 2004, Area B had to be declared an AMA before the consents could be processed. Council requested interim AMA status from the Minister of Conservation in August 2005, but due to an outstanding appeal on the Marine Farming Variation, this was not granted until February 2008.

Council commenced work on developing a plan change that would allow fish farming in parts of Wilson Bay Area B in 2007. This involved 18 months of meetings with a stakeholder reference group and six technical reports to investigate the potential ecological effects. A draft plan change was prepared for council to consider in early 2009. In March 2008, the council asked the Chief Executive of the Ministry of Fisheries to make a determination on whether the Area B AMA would create undue adverse effects on fishing. The decision took around 18 months and was favourable, so that the Area B interim AMA became fully operational in 2009. However, the decision was restricted to the impacts of shellfish aquaculture on fishing, which meant that a second undue adverse effects consideration would be required for finfish if the council were to progress with its intended plan change.

The Ministry of Fisheries then suggested that legislation should be used to directly achieve the plan change rather than using the existing RMA planning processes. The council’s work had focused on enabling existing farms to convert to finfish in order to avoid the need to create new AMAs. This approach was reflected in the Amendment Bill which was circulated in draft form in mid-2010 and was eventually introduced into the House in November 2010.

Matters quickly progressed, and the Ministry suggested to the council that the Bill be amended by a Supplementary Order Paper to create a new fish farm zone as well. The council was supportive of this approach and suggested some candidate areas. Due to the fast progression of the Bill, the Minister set up a three-person Aquaculture Ministerial Advisory Panel, which took public submissions and held hearings into just one prospective site, a proposed Coromandel Marine Farming Zone. There was an extensive consultation process with one-on-one meetings with key groups, public drop-in sessions and public media. The hearings were held in February 2011. The timeframe for the process was particularly short, and the hearing commenced on the last day of the submission period. In addition, contrary to good practice, the public submission period ran over the Christmas/January holiday period. The Panel did not take long to consider the matter, reporting back to the Minister by late February.

The end result was that the 2011 Amendment Act directly changed the Waikato regional coastal plan to create a 300-hectare Coromandel Marine Farming Zone, located about 13 kilometres off the Coromandel coastline, in depths of around 30 to 40 metres. In addition, a new Area C was carved out of Area B in Wilson Bay to also provide for fed aquaculture. Total nitrogen caps were placed on each zone. In total it was expected that, based on the nitrogen caps, both areas combined could accommodate up to 12,000 tonnes of farmed finfish. This is a substantial quantity when compared to the current 12,000 tonnes of marine-farmed salmon currently produced each year in New Zealand. The large scale was based on advice that 8000–10,000 tonnes was the minimum required to allow the establishment of a new fish farming industry. However, providing for such a large farming operation might be seen as a bold move, given that the effects of farming non-salmon species at scale in New Zealand are not well understood. The precise detail of the farming operation, and any precautionary and adaptive measures, will need to be assessed at the resource consenting stage.

On reflection, the creation of large finfish farming zones in the inner and outer Firth of Thames seems somewhat surprising. The environmental impact of finfish farms that is of most concern (apart from biosecurity) is eutrophication of the seabed and the resulting oxygen depletion of seawater. The Firth of Thames (including the inner and outer areas) is the most nitrogen-stressed large coastal water body in the country, with oxygen depletion already occurring seasonally, and evidence that the health of the system is gradually worsening over time (see spotlight below). There are many other healthier coastal areas in New Zealand where finfish farming might be located, and some of these in the Hauraki Gulf were identified during the Sea Change Tai Timu Tai Pari process. As discussed in Chapter 7, good initial siting of marine farms is a critical decision when addressing environmental impacts of the activity. Many earlier sites for finfish farms in the Sounds were poorly located and we can hopefully learn from those mistakes. Narrow focus and rushed decision-making can lead to suboptimal siting outcomes which we need to avoid. This is where marine spatial planning can contribute, through applying a measured and strategic approach to identifying optimal locations for marine farms within a region in order to achieve both on-farm productivity and good environmental outcomes.
Although there was considerable political and commercial pressure to create the finfish farm zones, once they were in place there was little interest in taking them up. Due to the Global Financial Crisis, interest in embarking on a new and untried finfish farming enterprise had waned. This is not surprising given that a 2011 estimate put the cost of commercialising a new fish species at around $80–100 million, with it taking 7–10 years to realise a return on the capital expended. The council finally called for tenders for the Coromandel zone in early 2017, and in September 2018 granted Pare Hauraki iwi an authorisation, which enables them to apply for a resource consent to operate a finfish farm on the site. Council decided not to release the finfish farming space in Wilson Bay Area C due to concerns about high nitrogen loadings in the inner Gulf.

Spotlight on the impacts of excessive nitrogen flows into the Firth of Thames

Regular monitoring of seawater off Coromandel township has been undertaken every three months since 1998 and a time-series of data built up. The monitoring effort has collected information on seawater chemistry and plankton composition at a location only about 2 kilometres from the Coromandel Marine Farm Zone. Analysis of the data shows a disturbing trend of lower oxygen in deeper waters and depressed pH levels in both upper and lower waters during late summer and early autumn, when the water layers stratify. During this period, oxygen levels were often reducing to between 60 and 70 per cent saturation (compared to 100 per cent in well-aerated seawater), and in extreme events to less than 40 per cent. In addition, the pH levels of the seawater were dropping below 7.9, well below its spring level of between 8.05 and 8.1 (which is the normal oceanic level). The changes are significant and are thought due to the high levels of nitrogen draining into the Firth of Thames from intensive dairying undertaken in the Hauraki Plains. The nitrogen encourages excessive phytoplankton growth, and when the tiny plants decay their respiration reduces oxygen and adds CO₂ to the seawater, thereby reducing pH.

Although the levels of nitrogen entering the Firth of Thames via rivers do not appear to have increased over the past 20 years or so, seawater conditions have worsened, indicating that the ability of the Firth to process nitrogen (‘denitrification’, whereby dissolved nitrogen is converted to nitrogen gas and released to the atmosphere) may have decreased due to overenrichment of the system. Modelling has indicated that removal of nitrogen from the water column may have reduced by close to 60 per cent over the 12-year period to 2013. This is consistent with monitoring data which show that dissolved nitrogen in the water column has increased by 5 per cent per annum since 1998 and phytoplankton cell numbers by 7 per cent.

The impacts of climate change, and consequent further seawater acidification, is likely to make the situation worse. Farming fish in the area will serve to add more nitrogen into an already nitrogen-stressed system. There may also be questions about the health of the fish themselves if plumes of the seasonally oxygen-depleted water reach their nets from the underlying low oxygen layers. Although it may be possible to successfully farm fish in this area (and the impacts will be assessed during the resource consenting process), it seems very likely that there are better locations for this activity.
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>1994</td>
<td>Proposed regional coastal plan notified</td>
</tr>
<tr>
<td>1997</td>
<td>Council notifies decisions on regional coastal plan</td>
</tr>
<tr>
<td>1999</td>
<td>Marine Farming Variation notified to proposed regional coastal plan. Creates marine farming zone in Wilson Bay which is restricted to shellfish</td>
</tr>
<tr>
<td>2000</td>
<td>Council’s decision on the variation released</td>
</tr>
<tr>
<td>2001</td>
<td>First resource consents for mussel farming granted in Area A</td>
</tr>
<tr>
<td>2005</td>
<td>Regional coastal plan operative in part (not including the marine farm variation)</td>
</tr>
<tr>
<td>2007</td>
<td>Council starts work on plan change to enable existing marine farms to farm finfish Marine Farming Variation becomes operative</td>
</tr>
<tr>
<td>2008 (February)</td>
<td>Wilson Bay Area B declared an interim AMA (for shellfish)</td>
</tr>
<tr>
<td>2008 (March)</td>
<td>Council seeks a determination from the Chief Executive of Ministry of Fisheries on undue adverse effects</td>
</tr>
<tr>
<td>2009</td>
<td>Minister’s decision favourable for shellfish (but does not address finfish) and interim AMA becomes operative Council processes consents for Area B (shellfish only) Council halts work on finfish plan change</td>
</tr>
<tr>
<td>2010 (mid)</td>
<td>Draft Amendment Bill circulated that (amongst other things) would legislate to implement the council’s proposed finfish plan change directly into the plan (which applies only to existing space)</td>
</tr>
<tr>
<td>2010 (November)</td>
<td>Aquaculture Legislation Amendment Bill (No 3) Bill introduced into the House MPI proposes to amend Bill to provide for new finfish space in the region</td>
</tr>
<tr>
<td>2010 (December)</td>
<td>Aquaculture Ministerial Advisory Panel established to consult on new Coromandel marine farming zone Public consultation starts on 17 December</td>
</tr>
<tr>
<td>2011 (February)</td>
<td>Those who wish to be heard asked to notify the Ministry by 4 February Submission period ends on 9 February Advisory Panel hearings start on 9 February Advisory Panel releases report on 25 February</td>
</tr>
<tr>
<td>2011 (September)</td>
<td>Resource Management Amendment Act (No 2) 2011 passed (being split from the earlier Bill)</td>
</tr>
<tr>
<td>2011 (October)</td>
<td>Changes to Waikato regional coastal plan creating finfish farming zones becomes operative</td>
</tr>
<tr>
<td>2012</td>
<td>Council work on tendering space ceases due to lack of interest</td>
</tr>
<tr>
<td>2017 (January)</td>
<td>Council calls for tenders for Coromandel Marine Farming Zone</td>
</tr>
<tr>
<td>2018 (September)</td>
<td>Authorisation granted to Pare Hauraki iwi with resource consent to be applied for within two years</td>
</tr>
</tbody>
</table>

Figure 2.5 Summary of key events in planning for aquaculture in the Coromandel region

Workers are stacking freshly bagged mussels which have been harvested off the Coromandel Coast.
Open ocean farming

Offshore finfish aquaculture is being promoted internationally as having significant benefits, when compared to coastal marine farming, including less competition for space, greater scale advantages, fewer environmental impacts, better growing conditions and lower disease transfer risk.34

Although it was only two years ago that open ocean salmon farming was thought to be at least a decade away, NZ King Salmon has now lodged applications for resource consent to investigate up to 13 sites around the east coast of the South Island for salmon farming, followed by an application to establish a large open ocean salmon farm off the northern tip of Port Gore in Cook Strait (see spotlight). This indicates the rapidity with which new technology is being developed and deployed. The investigation sites are large, extending up to 3500 hectares. We have been advised by the applicant that some of these applications are now in flux and may be reconfigured35 and farming in the more exposed sites will likely require novel technology which may still take some years to become technologically and financially feasible.36

Because the development of this kind of aquaculture has been so rapid, the current policy, planning and management system does not contemplate open ocean farms (or many other offshore activities). There is also a paucity of science to underpin an assessment of effects as little is known about the likely impact of the activity on deeper-sea ecosystems. Consequently, there are questions as to whether the current regime is adequate to ensure good outcomes. Dedicated research accompanied by piloting a small open ocean farm might help fill some important knowledge gaps.

A spotlight on potential benthic impacts of open ocean aquaculture

Open ocean aquaculture no longer belongs to the future and is now a real possibility. In July 2019, NZ King Salmon applied for a salmon farming resource consent for a site covering 1792 hectares located 6 to 12 kilometres north of Cape Lambert (which is the northern tip of Port Gore in the Marlborough Sounds) in depths of 60 to 100 metres. We were told that the company unexpectedly found that this area of Cook Strait is in such a wave shadow that it can be farmed with existing, proven technology.37

The company seeks consent to discharge an initial 20,000 tonnes of feed per year into up to 20 pens of around 200 metres in circumference. Each pen is expected to produce around 500 tonnes of fish, thereby producing a total of around 10,000 tonnes for the entire farm (a sizeable amount given that New Zealand’s total annual salmon production is currently just over 14,000 tonnes a year). Beyond the first stage, the company is seeking the ability to increase feed discharges up to potentially 40,000 tonnes of feed.

The application indicates that there are horse mussels throughout the proposed site and although they are considered sensitive species (and are an important benthic habitat-forming species38), the ‘actual effects on them from salmon farms are unknown’. For this reason, an adaptive management approach is proposed.39

In terms of potential benthic effects, marine scientist Hilke Giles observes:

‘While locating aquaculture offshore will enhance the dispersal of organic enrichment and thus reduce the intensity of organic deposition under farms, the response of offshore benthic communities and subsequently the assimilative capacity of benthic offshore ecosystems for organic enrichment is largely unknown. These ecosystems will have some capacity to consume (by benthic fauna) and decompose (by benthic microbes) organic matter but it is important to consider that organic matter released from fish farms is enriched in proteins and lipids and thus of higher quality and more easily broken down than organic material naturally occurring in these areas. In comparison to benthic fauna communities in coastal sediments that are diverse and typically tolerant to organic pollution and reduced oxygen, benthic fauna communities in offshore sediments are adapted to low food conditions and oxidised sediments and therefore are most likely less tolerant to organic enrichment.’40

Extensive offshore areas around New Zealand have already been impacted by fisheries bottom trawling and in some cases dredging. In such areas, the benthic communities will have adapted to disturbance, and the effects of salmon farming on them may be reduced as a result. Other areas have suffered minimal historical disturbance and therefore may be more sensitive to finfish farming. Development of farms in these areas will require greater care and precaution.

A future aquaculture management framework needs to be able anticipate such future developments and start putting in place the knowledge and policy base so they can be well managed. Joint industry-government piloting could be one option to help achieve this.
Spatial planning for aquaculture

The 2011 aquaculture legislative amendments removed the requirement to locate marine farms within AMAs due to the approach not working as intended – no new aquaculture space had been created under the new provisions. It is important to note that the creation of new space is not necessarily the prime measure of success. There were already very large areas being set aside for aquaculture in the Firth of Thames and Tasman and Golden Bays prior to the 2005 AMA regime coming into force. These provided for foreseeable future mussel farming demand in what were key mussel growing areas in the country. The Marlborough Sounds already had a zoning scheme in place and was pretty much fully allocated. In addition, as indicated above, a shortage of space is not the prime issue currently facing the mussel and oyster farming industries (although it is a key issue for the salmon farming industry). And as is discussed in Chapter 6, there is considerable opportunity to use existing shellfish space more efficiently.

On the face of it, the creation of AMAs as a planning tool to manage aquaculture appears to be a sound idea. Our regional review has touched on the three regions where the pressure to create new space has been the greatest, and where the bulk of the industry is located. They all, in some sense, were ahead of the game before the government decided to legislate for AMAs nationwide in 2004. By 1999, Marlborough District Council had a zoning regime in place, which allocated space for aquaculture in one part of the Sounds and prohibited it from the balance (although it lacked clarity on some issues such as mid-bay farms). By this stage aquaculture was well developed in the Sounds, if not overdeveloped, so the challenge for the council was to ‘hold the line’ rather than create new space. The spatial zoning regime did not meet the needs of the salmon industry and the more recent ad hoc ‘spot zoning’ for salmon farming in the Sounds has been the result.

Tasman District was the first council to create large areas of new aquaculture space through the development of AMAs. This was in response to a ‘gold rush’ for space that occurred in the 1990s, particularly in Golden Bay. The areas were based on a strategic assessment of farming needs and environmental values. They are accompanied by an adaptive management approach, as well as ongoing independently verified monitoring. The AMAs resulted in a significant increase in marine farming space for aquaculture in the region and headed off unsuitable gold rush applications. They were confirmed by the Environment Court in 2004. The 14-year delay after this point was not due to RMA planning processes or the council, but to slow decision-making on behalf of the Minister of Fisheries followed by lengthy legal proceedings. The AMAs become entangled in a complex legislative thicket generated by unworkable provisions that had been applied to aquaculture during the various reform processes. The new space is now available to marine farmers and appears likely to accommodate demand for the foreseeable future. So, if one overlooks the inordinate delays, which were outside the remit of the RMA, it could be said that the AMAs have proved to be a successful strategy in that district for managing aquaculture.

Waikato Regional Council was also quick to adopt an AMA approach to create significant new space whilst prohibiting new aquaculture outside of these areas. Wilson Bay Area A (the larger) came into effect relatively quickly and by 2006 the council was processing consents for the area. Area B became tied up in the aquaculture reform process but council was issuing consents by 2009. The new areas had baseline monitoring undertaken to assist the management of environmental impacts. In addition, a novel ‘limits of acceptable change’ monitoring regime was developed. This leads us to the conclusion that the AMA process has also worked well in the Waikato region and must surely be preferable to a hodgepodge of individual consent applications scattered along the coastline.

The council’s wish to free up its rules to allow finfish farming within its AMAs was expedited by a ministerially appointed panel process and legislation to change the plan. Meanwhile, interest in the space had dissipated and it may have been better to let regional planning take its normal course. This may have allowed a more considered approach to the seawater oxygen depletion and acidification issues described above. A more collaborative, strategic approach would likely have identified more suitable space elsewhere in the region, as occurred with the Sea Change Tai Timu Tai Pari process undertaken between 2013 and 2016.

The 2004 amendments attempted to apply the AMA approach to all regions irrespective of the level of demand or size of the industry, and this may have been one of its key failings. Undertaking the science and analysis to undertake robust spatial planning for aquaculture is expensive and may not be merited in regions where the industry is small and/or council resources thin. There were other reasons why the approach may not have taken root in other regions. The timing was unfortunate. By 2004 most councils had operative regional coastal plans and were not in a plan review phase. Undertaking a dedicated plan change for aquaculture on its own is an expensive exercise, and arguably the benefits are private (obtained by the marine farmers who access the space).

The RMA does not have a well-developed allocation or coastal occupation charging regime and this also makes for a difficult community conversation when public space is being allocated for private use. When the AMA policy was introduced, the government did not provide any financial support to councils for the extra costs of the planning process. It was envisaged that some of the costs could be later recouped from tendering space, but the proceeds of such a process were uncertain. Somewhat belatedly, government established the
Coastal ecosystems are among the most complex ecosystems on Earth. They contain numerous organisms and materials that interact through physical, chemical, and biological processes. Many of these processes are not well understood, posing considerable difficulties in determining the state of the environment and predicting change in response to natural or anthropogenic factors, such as marine farming. This complexity creates challenges for making good decisions on operational aquaculture matters, including identifying suitable marine farm locations and predicting ecological effects.' (Giles, 2019)

The current system promotes huge spending on collecting virtually useless information and then throwing it away when we are desperate for better understanding of these coastal ecosystems.' (Science)

2.5 Monitoring
As the aquaculture industry in New Zealand matures, more emphasis will need to be placed on monitoring rather than on planning and consenting for new locations. Monitoring of aquaculture, and the environment on which it impacts, is highly variable around the country and between species and farms. In general, marine farms that were consented prior to the RMA coming into force have few or no monitoring requirements. More recent farms typically have monitoring obligations attached to the consent. Newer salmon farms are the most rigorously monitored due to their greater potential adverse effects than shellfish farming.

Where shellfish farms are monitored, questions were raised with us about the usefulness of the information obtained. Some interviewees expressed concern that money was being wasted. They said they did not object to paying for monitoring per se but would like to see the money well spent on providing useful information. They considered that they were being required to monitor factors which were already well known, such as the impact of mussel farming on the seabed.
‘There is a need to move away from the “site specific-only” approach taken as a result of consent conditions and to think more broadly about environmental effects.’ (Giles, 2019)42

‘We think if monitoring shows problems we will be pinged first. If it falls on us we should fix it and if it falls on someone else they should fix it.’ (Industry)

‘Our ability to address cumulative effects in environmental management has progressed very little since the introduction of the RMA … To the author’s knowledge, no practical implementation support is available to resource managers in New Zealand for addressing cumulative effects in key processes, such as resource consenting or policy formation.’ (Giles, 2019)46

There also appears to be some inequity in monitoring requirements across sectors. Some interviewees questioned why marine farms were required to pay for monitoring, whereas other activities in the catchment such as dairy farming and forestry which also impacted the marine environment did not have similar requirements placed on them. This seems particularly iniquitous when catchment activities can impose substantial additional costs on marine farmers from runoff, such as harvesting closures after heavy rain, which are not accounted for.

One reason why monitoring does not necessarily represent value for money is that it is often undertaken in absence of expected outcomes and/or predetermined trigger levels that generate a response. This means that the gathering of information is not linked to management action. There have been several efforts to address this gap. A ‘limits of acceptable change’ framework was developed for the Wilson Bay Marine Farming Zone, which included trigger points, and shows some promise (see spotlight below). A similar approach is applied to the AMAs in Tasman and Golden Bays. The benthic environmental quality standards for salmon farming in the Marlborough Sounds establishes a trigger based on a gradient of benthic enrichment stages, with a predefined level of enrichment triggering a destocking of the farm.43 A similar approach to water quality is currently under development.

Another reason why monitoring has underdelivered is because the data often need to be considered within a broader context in order to provide meaningful information. But state of the environment monitoring in the marine environment is generally weak and typically poorly linked with consent monitoring. Novel approaches, such as using satellite imagery to track change across broader marine areas and over longer time periods, may help with this challenge.44

Even when state of the environment data are available, monitoring may not provide a clear picture of the ecological effect of a farm or of group of farms. This is because ‘many ecological impacts observed in the coastal marine area have multiple causes, of which aquaculture may be one possible contributor’.45 It is also often virtually impossible to demonstrate cause and effect, and that the reduced environmental quality is a result of just one activity.
A spotlight on the application of trigger points in the Wilson Bay Marine Farm Zone

The ‘limits of acceptable change’ framework which was applied to the Wilson Bay Marine Farming Zone was developed by NIWA in the early 2000s. Scientists drew inspiration from similar approaches applied to tourist usage of US national parks and the disposal of dredge spoil on the Great Barrier Reef. The limits themselves were agreed by a collaborative group of marine farmers, council representatives and scientists from NIWA and Cawthron after considering scientific advice.47

Scientists had identified phytoplankton levels as a key driver of fish productivity in the Firth of Thames and Hauraki Gulf, and the limits focused on controlling depletion by mussel farming.48 Two water column trigger points were identified:49

• **Marine Farming Zone trigger point**: The farm to control site deviations indicates depletion of 25 per cent or more compared to the non-stocked periods (September 2001 to August 2002) over any subsequent September to August period, or synoptic survey results for the Wilson Bay Marine Farming Zone show average chlorophyll \(a\) depletion > 25 per cent over an area twice that of the Zone, relative to unaffected waters outside that area.

• **Firth of Thames wide trigger point**: Spatially and temporary averaged chlorophyll \(a\) depletion resulting from marine farming activities, and relative to un-impacted waters, should not exceed 20 per cent over 10 per cent of the area of the Firth of Thames.

When Area A was first developed during the early 2000s, a monitoring programme was initiated which involved taking fortnightly water column samples from a site near the centre of the farms and also at two control sites, one to the north and one to the south of the farming area. The northern and southern sample sites were positioned sufficiently distant from the farms to be unaffected by mussel farming activity in Area A. The chlorophyll \(a\) data from these two control sites were used to predict what the levels would have been in Area A in the absence of the mussel farms. This prediction was then compared with the actual levels measured mid-farm, to identify what the impact of mussel farming had been. This method takes into account other natural or human-induced variation in levels which may have occurred. In this way, the chlorophyll \(a\) depletion resulting from the marine farming activities could be measured against the first trigger point. When Area B was developed in the late 2000s the same monitoring approach was applied. After seven years, when the monitoring data showed chlorophyll \(a\) depletion well within acceptable limits, the monitoring frequency was reduced to monthly.50

This monitoring activity, funded by the industry, has now built up a very useful time series of data which can potentially be used to help understand broader environmental patterns and changes in the Firth of Thames. Unfortunately, the monitoring reports and underlying data have not been made publicly available.

Measuring change against the second Firth-wide trigger has been more challenging. Three different approaches have been used to throw light on any potential impacts of mussel farming on broader phytoplankton levels (and associated productivity) in the Firth of Thames. The first utilised simulation modelling and this indicated that phytoplankton depletion did not extend over an area substantially greater than the size of the farm itself.51 The second deployed a mass-balance approach where carbon and nitrogen flows into and out of the system were calculated. This indicated that mussel biomass harvest (in 2005) removed just 0.2 per cent of the Firth’s carbon primary production. This figure was predicted to rise to only 1.6 per cent when the Wilson Bay Marine Farm was fully developed, as well as an additional zone on the western side of the Firth of Thames which was twice as large, and was at that time under consideration by the Auckland Regional Council.52 The third approach used satellite imagery to measure levels of chlorophyll \(a\) in the Firth over a 15-year period between 2002-2017. This identified a long-term median depletion of only a 1.6 per cent reduction of chlorophyll \(a\) over an area about one and a half times the size of the farms and about 6 per cent in the centre of the farms.53 Overall, these three methods indicated a chlorophyll \(a\) depletion effect far less than the pre-defined trigger.
Hilke Giles provides some helpful suggestions on how we might improve our understanding of the effects of aquaculture and thereby better manage them. She distinguishes between near-field effects which occur close to a marine farm, such as enrichment of sediments beneath the farm, and far-field effects, which may occur at a distance, such as effects on phytoplankton production. Far-field effects are more diffuse and harder to measure, and are therefore less well understood than those in the immediate proximity of the farms. Giles suggests that regulators and industry need to shift from a focus on undertaking environmental monitoring as a stand-alone compliance-focused activity towards developing ‘a regional environmental monitoring programme or framework that combines different monitoring and information gathering programmes’. The development of system-wide modelling, which has been undertaken for marine farming areas such as Pelorus Sound and the Firth of Thames, will be helpful in this respect.

The research undertaken for this project found that, although much monitoring and state of the environment information is available online, coverage is patchy (with availability differing across councils), and the information is not organised or curated in an accessible manner. A notable gap is the lack of public access to the monitoring data from the Wilson Bay Marine Farming Zone. Aquaculture New Zealand has established a voluntary ‘A+ Programme’ which provides a sustainable management framework for marine farmers. However, no information on farm performance is yet publicly available, although there is an intention to provide such information in the future (see Section 2.7). This would be helpful, particularly if the information was linked to a broader public information system.

Greater information availability to the public would provide more transparency and potentially improve the public perception of the industry and confidence in it. Marlborough District Council is a leader in this respect, having constructed the user-friendly ‘Smart Map’ system which attaches all the relevant consent and monitoring documents to a spatial mapping tool which identifies the location of all farms. Such a system could potentially be expanded to cover the entire country, with an ability for marine farmers to also upload relevant information that they are willing to share. The Land, Air and Water Aotearoa website provides a useful example of how agencies can collaborate to provide environmental information in a form that is accessible to the community. New Zealand could also learn from other countries where the transparent provision of information on the environmental impacts of aquaculture is being given greater prominence, as described in Chapter 3.

A spotlight on more effective monitoring of marine farms

‘For monitoring to fulfil an effective role in the environmental management of activities, it is important that it is linked to clearly specified actions that are taken in response to monitoring results. If monitoring reveals adverse effects that require intervention, clear pre-defined actions should be triggered. These could include changes in operational practices, targeted investigations or other mitigation measures. Similarly, if monitoring reveals that effects are low and well understood, there should be actions to provide for a reduction in monitoring effort. Unfortunately, this is often not easily provided for in conditions of consents. This can lead to ongoing monitoring efforts that do not add knowledge or other value but are of significant cost to the consent holder. Developing better processes for addressing such instance of “monitoring for the sake of it” could assist both the aquaculture industry and regulators in obtaining a clearer focus on environmentally important aspects of aquaculture activity management and better allocate resources to high priority matters.’

(Giles, 2019)
2.6 Reconsenting

As already indicated, many of the early consents that were granted under the Marine Farming Act, and that became coastal permits under the RMA, are coming up for reconsenting in 2024, with around 60 per cent of the current 1900 aquaculture coastal permits expiring within six years. When many of the early farms were consented, the information available to decision-makers was minimal, and there was little assessment of environmental effects. It is very likely that if some sites had to undergo the level of scrutiny typically given to resource consent applications today, they may not meet the current standard of environmental management (see spotlight below).

A spotlight on early consenting of marine farms in Marlborough Sounds

The early consenting of marine farming in the Marlborough Sounds was fairly perfunctory, with little consideration given to environmental concerns, which were not at the forefront of public consciousness during the 1970s. The ease of gaining marine space, at little cost, led to a flood of applications. This means that some farms are not in locations that are today optimal for production and/or environmental quality. Many of the older farms are coming up for reconsenting during the next few years, and this provides an opportunity to redress any issues. The quotes below seek to tell this story from the perspective of some of our interviewees.

‘The history of shellfish farming in the Marlborough Sounds is that it was very ad hoc. It wasn’t planned. The original planning criteria in the old maritime planning days was very much “you can’t go beyond 200 metres”. It was navigation driven. There was also a realisation that it was inappropriate to have sites adjacent to scenic reserves and residential clusters.’ (Government)

‘When I applied for consent I never fronted council, just sent the documents in and an envelope came back.’ (Industry)

‘Under the Harbours Act and Marine Farming Act there was nothing around benthic impacts. There was an A4 paper printed with blocks to fill out. You had to indicate who would do the farming and show they were adequately funded. You filled it in and paid $80. It was done on navigation and the like. There was a gold rush under that regime. I would be a millionaire if I had applied for all the sites.’ (Industry)

‘There is a guy that has a lot of farms in the Marlborough Sounds who is not a marine farmer. He scans the maps and finds places, gets resource consent and then leases them out straight away.’ (Community)

‘When we had the gold rush there were two teams of councillors hearing applications all day every day. The original consents were a one-page pro rata deal. If there was something significant under the farm it was declined.’ (Government)

‘For all the early consents, no-one dived underneath so we don’t know what they were parked over. You can get smothering from the shell, faeces and pseudofaeces.’ (Science)

Some marine farmers told us that a lot of their effort and money goes into protecting existing space and as a result they are not investing in research and development. They are having to make numerous applications for...
replacement consents which can be opposed through the Environment Court. In addition, they are frustrated that marine farms go through extensive scrutiny in consenting but that other activities that are having a detrimental effect on the Sounds are lightly regulated (see spotlight below). On the other hand, others told us that reconsenting had been a relatively straightforward process.

**A spotlight on marine farmers’ concerns about the cost of consenting**

Many interviewees associated with the marine farming industry expressed concern about the high costs of consenting and the lack of an even playing field with other sectors. For example, there are no environmental consenting requirements for fishers trawling or dredging the seabed despite the impacts being much greater than those posed by marine farms. Some of these sentiments are expressed in the quotes below. They indicate a need for a more holistic approach to marine management, where significant environmental threats across all sectors are identified and managed, rather than the ad hoc sectoral approach currently being applied.

‘The hoops we have to go through defy common sense. It’s getting harder and harder and costs escalate. If other resource users had to apply under the RMA, such as forestry, fishing, land development and grapes, if they had to do what we do they wouldn’t exist. We feel picked on.’ (Industry)

‘The cost of consenting can be high and seems disproportionate to other risks to the environment. If you are not careful it is easy to spend the value of the farm on the consenting process if it goes to the Environment Court, of around $100,000 per hectare. That is without doing any bespoke research. If you are required to undertake science it will cost more than the farm’s worth.’ (Consultant)

‘It’s an expensive way to regulate and asymmetrical as a lot of effort has been spent on aquaculture over the years when it is not necessarily the main problem facing the system ... The problem with the RMA is that we don’t triage, we don’t identify what the problems are and then try to fix them.’ (Consultant)

Concern about the cost and uncertainty of reconsenting has driven a central government initiative to develop a proposed National Environmental Standard for Marine Aquaculture. This, amongst other things, would replace regional council rules in regional coastal plans with national rules. These would require most replacement consents for existing farms to be processed as non-notified, restricted discretionary activities (unless they were in an area that a regional coastal plan specified as unsuitable for aquaculture). This would require an assessment of prescribed matters by the council and consent could be declined. Members of the public retain a role in planning decisions (such as identifying areas that are unsuitable and suitable for aquaculture in regional coastal plans) but would be excluded from the site-specific reconsenting process in order to reduce time and cost and to avoid any subsequent appeals.

The proposals only address site-by-site consenting and do not provide support for councils to adopt a bay-wide reconsenting approach, which could reduce costs (by processing a single bay-wide application and imposing common consent conditions, including bay-wide monitoring linked to state of the environment monitoring), enhance productivity through enabling the reconfiguration of farm locations within the bay, and also reduce environmental effects. Although not easy to achieve within the current system, where ownership structures and expiry dates differ within bays, the lack of any tangible incentives to pursue this option is likely a missed opportunity.

The fact that many consents are coming up for replacement in 2024 should, in our view, be seen as an opportunity to undertake a reset of the management framework for marine farms. This could involve a move to a risk-based and more flexible bay- or zoned-based management system, as proposed in Chapter 4 below. We would argue that such approaches would better support the industry in the context of a fast-changing future environment than the existing site-by-site consenting approach.

Many of the early aquaculture consents, such as for these mussel farms in Pelorus Sound, will be coming up for replacement over the next few years.
2.7 Biosecurity

Although New Zealand has largely ‘got away’ with a less than rigorous biosecurity approach, this may not be the case in the future if the industry grows and expands into new species in the context of warming oceans. We can learn from other countries where pest and disease issues have become major issues for the industry, with severe financial implications. New Zealand has the opportunity to ‘get ahead of the game’ by instituting a robust biosecurity management regime prior to new species being farmed to help avoid the problems experienced elsewhere.

Part of the challenge in addressing biosecurity issues is the broad perception amongst marine farmers that little can be done to manage the risk. A 2016 study based on an online survey and on-site interviews found that ‘most respondents believe that nothing can be done to stop waterborne transmission, and therefore many marine farmers believe that on-farm biosecurity measures are futile’. However, this is not the view of the industry body, Aquaculture New Zealand, which has incorporated a range of biosecurity matters into its industry A+ Programme (see spotlight).

A spotlight on Aquaculture New Zealand’s A+ Programme

Aquaculture New Zealand operates a voluntary industry A+ Programme which establishes a set of sustainable management standards for farm operation. The standards cover a range of topics including ecology, water quality, waste, resources, food safety and animal health, iwi participation, community and compliance. By joining the programme, growers commit to implementing the best practices set out in the standards and making all their staff aware of them. Each member is responsible for filling out an environmental checklist on an annual basis and participating in an independent verification when requested to do so.

For biosecurity matters, the checklist covers a wide range of matters through the following questions:

- Do you wash and/or visually inspect seed (<5mm) prior to transferring between regions and/or require that it has been washed/inspected when receiving it? (mussels) Do you wash and/or visually inspect stock (spat/seed/oysters) prior to transferring between regions and/or require that it has been washed/inspected when receiving it? (oysters)
- Do you carry a copy of the MPI ‘New Zealand’s Marine Pest Identification Guide’ on your vessels?
- Have on-water staff been trained in biosecurity awareness and/or management?
- Do you keep records of collection and transfer of spat/seed? (mussels and oysters) Do you maintain stock transfer records for your farms? (salmon)
- Do you maintain harvesting records for your farms?
- Do you minimise transfer of equipment between regions?
- Have you identified any notifiable pests or diseases or unusual mortality on your farms?
- If you have found pests, diseases or unusual mortality please detail the actions taken, including whether reported to MPI and any follow up outcomes
- Are any of your farms covered by a Biosecurity Management Plan?

The first independent verifications are scheduled for mid-2019. Once completed, Aquaculture New Zealand plans to issue an A+ Sustainability Report which will summarise progress on the main key performance indicators for each objective and the findings and recommendations of the verification assessments. The report will also highlight positive initiatives taken by the industry during the period and make recommendations on areas for improvement which the industry can focus on during the forthcoming year. The report should be public by the end of October 2019.

The A+ Programme has been well received by the industry with member companies (who are listed on the A+ website) including at least 95 per cent of the industry by production.
In terms of non-aquaculture-related sources of biosecurity risk, there is now greater stringency at the border, with new standards for ballast water and biofouling in place. This should help reduce the arrival of new organisms into the country. There has also been greater effort put into ensuring that vessels moving between regions have clean hulls. Some resource consent conditions for marine farms contain biosecurity measures, including controlling movement of spat and cleanliness of equipment, although enforcement is generally weak. In addition, controls have been put on the movement of stock and equipment when pest outbreaks occur. Considerable work has been undertaken to identify options to address biosecurity risks, in the context of aquaculture, including pathway management, area-based management and the development of on-farm biosecurity management plans.64

Good advance planning is important, including the development of regional pathway management plans and identification of triggers for action if outbreaks occur, as a fast response can be critical to a positive outcome. Pathway management plans are currently being developed for the top of the North Island, top of the South Island and Fiordland.65 Risk can also be managed through the creation of ‘fire breaks’ for stock movement between farming regions, separation of farms based on dispersion patterns, and farming single age groups followed by a fallowing stage. Such measures do not necessarily mesh well with current farm locations, and farming systems and may require a significant change to how the industry is currently configured. The measures could be supported by regional marine spatial planning and the development of management zones which incorporate biosecurity considerations, as discussed in Chapter 4.

Good information is essential for effective biosecurity measures, but a recent MPI investigation found serious deficiencies in the data available, including ‘the complete lack of information on stocking densities or biomass held on farms’. It found that ‘the extent of inconsistencies among supposedly overlapping datasets was enormous’ and that ‘there was also huge variation in formats of datasets’. In addition, ‘inconsistencies and errors in field names, including the names of farms or companies, were widespread’.66 MPI is currently working on the development of a more robust register system for marine farms so that farms can quickly be located, and stock movements tracked, in the event of an outbreak.

The proposed National Environmental Standard on Marine Aquaculture would require an applicant seeking consent (for both new and existing farms) to lodge an on-farm ‘biosecurity management plan’ as part of the application. The council would then assess whether the plan met criteria set out in a guidance document.67 This approach focuses on farm-by-farm biosecurity management, whereas it may be more effective to also manage on the basis of AMAs or bays. Such plans could be supported by the identification of several biodiversity ‘containment’ regions across New Zealand. Stock and equipment could be freely moved within the zone, but consent would be required to move outside of it. This would assist with containing outbreaks of pests or diseases within the region. The growing use of hatcheries could assist with such a regime, reducing the need to transport live spat across the country. However, it would necessitate a greater number of hatcheries than currently exist, and they would need to be geographically well spread.
KEY MESSAGES

- There has been a long history of regulatory changes to aquaculture, with the current regime under the RMA treating aquaculture in a very similar way to other activities that require resource consent.

- By the time the RMA came into force there were already 677 authorised marine farms in existence. As a result, there remains a large legacy of older-style consents.

- The Māori Commercial Aquaculture Claims Settlement Act 2004 provides a framework for the settlement of all Māori claims in respect of commercial marine aquaculture, enabling iwi to receive assets equivalent to 20 per cent of the value of all space approved for aquaculture development after 21 September 1992. This is assisting some iwi to become more involved in the aquaculture industry.

- The NZCPS provides a supportive policy framework for the management of aquaculture under the RMA, but is high level and lacks specificity.

- Councils in areas where there has been strong demand for aquaculture space, such as Marlborough District, Tasman District and the Waikato region, were early adopters of spatial planning for aquaculture (AMAs). The approach has enabled a more managed expansion of the industry.

- The adoption of a narrow focus, and rushed decision-making processes, are still leading to farm siting decisions that may not be optimal.

- There are several likely reasons why AMAs were not more broadly embraced by councils, including timing, cost and political risk. Folding such planning into regular regional coastal plan review processes may have had more success.

- Direct intervention by central government to create new aquaculture space can prove counterproductive when it increases levels of conflict in the local community.

- Open ocean salmon farms are now on our doorstep but the scientific understanding and planning framework to manage them well are lacking.

- Monitoring of aquaculture has generally been weak for older consents and more robust for newer consents, but the lack of sufficient state of the environment information has reduced the ability to contextualise monitoring data in a way that can inform management responses.

- Monitoring information is often not freely accessible to the public in a meaningful manner and more transparency in the provision of information could generate greater public confidence in the industry.

- The large number of farms that will come up for reconsenting by 2025 creates an excellent opportunity to reset the management framework for aquaculture in order to embrace a risk-based and more flexible bay- or zone-based approach. This may require a change to the regulatory environment.
Endnotes

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4 Marlborough District Council, 2007
5 Banta and Gibbs, 2009
6 Māori Commercial Aquaculture Claims Settlement Act 2004, s 3
7 Ngāti Apa v Attorney-General [2003] 3 NZLR 643
8 Marine and Coastal Area Act 2011, s 55(3)
9 Marine and Coastal Area Act 2011, s 55(2)
10 Marine and Coastal Area Act 2011, s 62
11 Marine and Coastal Area Act 2011, s 68(1)
12 Marine and Coastal Area Act 2011, s 66(2)
13 Ngā Rohe Moana o Ngā Hapū o Ngāti Porou Bill (No 2)
14 Resource Management Act 2001, s 104(1)
15 Environmental Defence Society v New Zealand King Salmon Company (2014) 17 ELRNZ 442
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20 Marlborough Salmon Farm Relocation Advisory Panel, 2017, 8
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43 Benthic Standards Working Group, 2014
44 See Pinkerton et al, 2018
45 Giles, 2019, 32
46 Giles, 2019, 32
47 Zeldis, Felsing and Wilson, 2005, 1-2
48 Zeldis, Felsing and Wilson, 2005, 2
49 Turner and Felsing, 2005, 17-20
50 John Zeldis, pers comm
51 Broekhuizen et al, 2004
52 Zeldis, 2005, ii
53 Zeldis and Swaney, 2018, 2257
54 Giles, 2019, 32–36
55 Rebecca Clarkson, 2019, pers comm
56 https://www.lawa.org.nz
57 Giles, 2019, 49
58 Southorn, 2017, 3; Nixon, 2017, 2
59 See McDermid et al, 2012, where trawling and dredging were identified as major threats to the marine environment
60 Sim-Smith, France and Lees, 2016, 2
61 http://www.aplus.org.nz
62 Rebecca Clarkson, pers comm
63 Rebecca Clarkson, pers comm
64 See Georgiades, Fraser and Jones, 2016
66 Morrisey et al, 2010, 1-2
67 Lojkine, 2018
Management in other jurisdictions

Stavanger coast, Norway
There is much we can learn from the experience of others, particularly as the aquaculture industry is more developed in many other jurisdictions than in New Zealand. This chapter describes the aquaculture management regime in six overseas jurisdictions: Scotland, Tasmania, British Columbia, Norway, South Australia and NSW. It draws heavily on an international review undertaken for the project by Kate Storer, which drew on available web-based sources. The resources available to the project did not enable an independent assessment of the effectiveness of these regimes.

3.1 Scotland

Scotland is a major producer of Atlantic salmon with 162,817 tonnes being produced in 2016 (more than 10 times New Zealand’s total annual salmon production). Atlantic salmon is native to Scotland but Scottish strains of Atlantic salmon tend to mature early, reducing the value of the fish as they reach market size, so hybrid Norwegian strains are now used instead. The industry has set ambitious growth targets, which are supported by the Scottish Government, and would have finfish production roughly doubling to 300,000–400,000 tonnes by 2030.

Notwithstanding the industry’s growth objectives, there is significant concern that the growth of the sector is not being adequately managed. Key issues have included sea lice (with the risk of transfer to wild populations), disease (with around 12 significant diseases present) and escapees (with an average 146,000 farmed salmon entering the sea every year). In early 2018, the Scottish Parliament commissioned an independent review into the environmental impacts of salmon farming.

The focus of the aquaculture industry in Scotland is salmon farming (comprising 95 per cent of the industry), so our description of the consenting regime focuses on this sector. A salmon farm requires multiple consents. A Seabed Licence must be obtained from the Crown Estate (Crown Estate Act 1961), which provides for exclusive use of the marine area for 25 years. Occupation charges are imposed based on the finfish gutted weight (currently GBP 27.50 per tonne for salmon) payable to the Scottish Government. In addition, a Marine Licence is required from Marine Scotland (Marine Scotland Act 2010), which addresses navigational safety.

Planning permission must be obtained from the local authority (Town and Country Planning [Scotland] Act 1997). Consenting is undertaken within the framework of ‘Development Plans’ prepared by local authorities, which must be consistent with the Scottish Planning Policy. This policy sets out locational policies for aquaculture to guide the identification of areas potentially suitable for new development as well as sensitive areas, which are unlikely to be appropriate. Local authority Development Plans are also now required to be consistent with the marine spatial planning framework for Scotland currently being established (through the development of a National Marine Plan and Regional Marine Plans). Larger finfish farms are required to submit an environmental impact assessment, which is publicly notified (something which is not required for shellfish or seaweed farms). Consent decision-making must be in accord with marine plans. Consents are permanent.

A Controlled Activity Regulations Licence is also required to be obtained from the Scottish Environment Protection Agency (Water Environment [Controlled Activities] [Scotland] Regulations 2011). This is concerned with impacts on the water column and seabed, including from the discharge of feed, waste and medicines from finfish operations. Consents set site-specific limits on the quantity of fish that may be held on-site and the type and amount of chemicals that can be used. Decisions are informed by the use of modelling software. Compliance with conditions of the licence is monitored by the agency, and the operator is required to commission regular studies on the effect of the farm on the seabed. The operator is also required to regularly provide data detailing the scale of discharges from the farm, and this forms part of the publicly available Scottish Pollutant Release Inventory, available on the agency’s website.

An Authorisation to Operate an Aquaculture Production Business from the Marine Scotland Fish Health Inspectorate is required and other requirements under the Aquaculture and Fisheries (Scotland) Act 2007 need to be met. These regulate animal health matters and the spread of disease. The authorisation is granted to the operator rather than the site. The inspectorate monitors on-farm operations through regular inspections (one- to three-yearly depending on the risk profile). Inspections assess the risk of escapees, sea lice...
management and the spread of disease. Aquaculture operators must keep records on a number of matters, including the number of parasites counted weekly and measures taken to avoid the escape of fish. They are also required to be part of a Farm Management Agreement for the farm management area in which the farm is located or alternatively must prepare and maintain a Farm Management Statement. These documents address fish health management, parasite management, movement of fish and harvesting and fallowing. Farms within a farm management area are required to coordinate management measures such as keeping fish of a single year class, synchronised fallowing, timing control measures for key time periods, and cooperating in the investigation of risks and implementation of biological and non-biological controls.

3.2 Tasmania

Aquaculture in Tasmania is focused on farming Atlantic salmon, with around 60,000 tonnes (more than three times New Zealand’s total annual production) farmed annually, generating a gross revenue of A$726 million. In 2009, the industry (supported by government) set a target to double gross revenue to A$1 billion by 2030, and this target may be exceeded based on current growth rates.

Marine farms in Tasmania are required to obtain three main consents. Unless a special permit is granted, a lease is required from the Department of Primary Industries, Parks, Water and the Environment under the Marine Farming Planning Act 1995, which is granted for 30 years. Leases are only granted for areas which have been identified as marine farming areas under the Act, thereby linking in with sectorally based spatial planning. Within 12 months of approval by the Minister, the Department must prepare a draft ‘Marine Farming Development Plan’, which designates aquaculture exclusion areas, areas for future release, and areas that are subject to a competitive tender process for space. An environmental impact statement must be prepared alongside the draft plan. The draft plan is submitted to the Marine Planning Review Panel after which it is open for public submission. The plan is approved by the Minister on recommendation from the Panel. The plans are intended to enable an integrated approach to the management of marine farming by requiring areas suitable for aquaculture to be identified upfront, following a process which can consider potential environmental effects as well as the integration of the development plan with terrestrial planning issues.

A Marine Farming Licence is also required from the Department of Primary Industries, Parks, Water and the Environment under the Living Marine Resource Management Act 1995, which addresses impacts on fisheries and the aquatic environment. Licences are granted for up to 10 years. Conditions attached to licences address the environmental management of the farm, and may include conditions to address visual impacts, biological effects, record keeping and reporting and chemical usage.

Finally, an Environmental Licence must be obtained from the Tasmanian Environmental Protection Authority (EPA) under the Environmental Management and Pollution Control Act 1994 (Tasmania’s primary environmental legislation) for new finfish farms. Under the Finfish Farming Environmental Regulation Act 2017, the responsibility for managing fish farming has been transferred from the Department to the Tasmanian EPA. The EPA publicly notifies applications, undertakes an environmental impact assessment, and determines whether or not to grant the licence and what conditions to attach to it. There is a right of appeal to the Appeal Tribunal.
3.3 British Columbia

British Columbia is a major producer of farmed shellfish and finfish, and it has a large salmon farming industry. The marine environment in which farmers operate is particularly sensitive, not least because wild salmon populations are a critical part of the ecosystem and a major wild harvest fishery, being an important resource for coastal communities (including First Nations peoples).

As such, aquaculture activities have a high profile in British Columbia, and significant government resource is expended on growing and managing the industry. Atlantic salmon is the primary farmed species, producing 90,500 tonnes in 2015. In addition, king salmon (the same species as farmed in New Zealand), oysters, mussels, geoduck and other clams, scallops, sablefish, sturgeon, Arctic char and seaweed are also grown commercially. There are 120 finfish sites and 450 shellfish aquaculture sites (covering approximately 3800 hectares). The sector has a goal of increasing aquaculture production by 13,000 tonnes (14 per cent) per year.

Prior to 2010, most aspects of aquaculture were managed by the British Columbia Provincial Government. After the legal authority of the provincial administration to manage finfish farming was successfully challenged in the British Columbia Supreme Court in 2009, most aspects of aquaculture are now managed by the federal government. The legal challenge was prompted by concern that the environmental effects of finfish farming were not being properly regulated at the provincial level.

Marine farmers in British Columbia require several permissions in order to farm. They are all integrated into one application lodged with the provincial government and the agencies then liaise with each other to review the application and reach a decision.

Land Act tenure must be obtained from the British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development for the use of the seabed under the British Columbia Land Act 1996. Commonly a ‘licence of occupation’ is granted for a term up to 30 years. A lease can also be granted for a similar term, which provides a registrable interest in land. Applications are either managed on a first in, first served basis or under a competitive process where applications are assessed against a wide range of criteria. In some cases, areas suitable for aquaculture are identified in regional planning processes, which are used to inform decision-making. Since 31 July 2015, new salmon aquaculture operations have been on hold, and applications for them will not be processed. Rents are charged, and for finfish aquaculture they are set at 7.5 per cent of the finfish landed value (set at Can$9,898 per hectare per year or a minimum of Can$600) and a lease costs 8 per cent of the finfish landed value per year. The costs for shellfish aquaculture are less, being 4 per cent of landed value (set at Can$6,483 per hectare or a minimum of Can$600), with a lease costing 5 per cent. Farms also require an Exemption to Navigable Waters from Transport Canada under the Navigable Waters Protection Act 1985.

An Aquaculture Licence is required from Fisheries and Oceans Canada under the Fisheries Act 1985. The Pacific Aquaculture Regulations 2010 and the Aquaculture Activity Regulations 2010, promulgated under that Act, provide for the regulation of the aquaculture industry. Licences are granted for specific sites (so a new licence is required for each new site) and are issued for a maximum of nine years for shellfish aquaculture and six years for finfish. Fisheries and Oceans Canada (on behalf of the Minister) has broad power to consider all relevant matters in relation to the application, including the effects of the proposal on the environment. It has issued ‘siting guidelines’ indicating how new finfish farms will be assessed. These are reviewed at least every five years. From time to time, Fisheries and Oceans may impose a moratorium on applications for marine finfish aquaculture of certain species or in certain locations. At present, there is a moratorium on all finfish aquaculture in tidal waters north of Aristazabal Island, on all salmon aquaculture in the Discovery Islands, and on all new salmon aquaculture operations throughout British Columbia due to concerns about impacts on wild stocks.

To guide the regulation of shellfish aquaculture in British Columbia, Fisheries and Oceans Canada has prepared the Pacific Region Shellfish: Integrated Management of Aquaculture Plan (April 2017 – version 2.1). The plan is a high level document, which sets out the broad framework for the management of shellfish aquaculture. A general set of conditions is applied to all shellfish licences, and other conditions may be applied as appropriate. Licence holders are required to undertake inspections of their facility when it is first installed, and at least once a year thereafter, including before shellfish are introduced to the facility or when structures or equipment are altered. There are also monitoring and reporting requirements.

As part of the application for licence/tenure, applicants need to address whether the proposal is consistent with the relevant local government bylaws for land use planning and zoning and any coastal plan. If it is not, an application for rezoning may be required in addition to the licence/tenure application. The application also needs to address whether the application is consistent with any Marine Plan prepared under the Marine Plan Partnership for the North Pacific Coast, which is a joint programme between the British Columbia Provincial Government and First Nations. Under the programme, subregional coastal and marine plans have been developed for areas of the North Pacific Coast. Amongst other things, the plans identify marine protected areas and special management areas for activities such as shellfish aquaculture, tourism, renewable energy and cultural uses. Identified zones are accompanied by a ‘Recommended Uses and Activities Table’ that
identifies marine uses and activities that are considered Acceptable, Conditionally Acceptable, or Not Acceptable for a particular zone.

Both finfish and shellfish aquaculture applicants are required to pay both an administrative fee for processing the application and also an ‘access-to-resource’ fee for the exclusive use of, and access to, the respective water column and surface area. These are paid annually. In 2018, the fees were Can$5.30 per hectare for shellfish and Can$2.65 per tonne for finfish.

Once consented, marine farms operate under the Aquaculture Activity Regulation 2010. Stringent monitoring obligations are imposed on finfish farms, including regular benthic monitoring prior to stocking and at peak production. If allowable thresholds are exceeded then the farm must be destocked until further monitoring demonstrates that it has recovered. Finfish aquaculture operators are required to maintain Health Management Plans (salmonid facilities) or Carcass Management Plans (non-salmonid facilities), which need to comply with requirements in respect of biosecurity, medication, disease outbreak and other matters. Operators are also required regularly to report to Fisheries and Oceans Canada on the health of their stocks and treatments used. Fisheries officers monitor compliance with licence conditions, including reviewing monitoring data, conducting surveys to search for escaped fish, observing harvests and fish transfers, and inspecting facilities. They aim to inspect each finfish facility at least once during a production cycle.

The movement of farmed fish and shellfish is regulated under section 56 of the Fisheries (General) Regulations. Operators are required to obtain a licence for the transfer of fish or shellfish from the Introductions and Transfers Committee, which reviews applications to assess risks for possible disease or effects on native species and ecosystems. When issuing a licence, the committee may prescribe conditions to minimise risks associated with transfer activities, such as egg disinfection or quarantine of stock.
3.4 Norway

Norway is a major finfish farming nation. In 2014, it produced 1,198,900 tonnes of Atlantic salmon, 74,300 tonnes of rainbow trout, 3800 tonnes of farmed cod, 1500 tonnes of farmed halibut and 800 tonnes of other finfish, including turbot, wolffish and char. Atlantic salmon is native to Norway, and farmed fish have been selectively bred from those caught from Norwegian rivers several generations ago. Norway is the largest producer of farmed Atlantic salmon in the world, contributing 60 per cent of global production in 2013. The Norwegian Government has a target of achieving a fivefold increase in value from finfish farming between 2014 and 2050.

Marine farmers are required to obtain multiple authorisations. Similar to the case in British Columbia, one application for all approvals is lodged at the relevant regional office of the Directorate of Fisheries, which then forwards the relevant parts to other agencies for assessment.

First and foremost, an Aquaculture Licence is required from the Ministry of Trade and Fisheries (delegated to the Directorate of Fisheries) under the Aquaculture Act 2005. Community licences directed towards research and education are free, limited in time and directed towards a specific purpose. Commercial licences are granted in perpetuity and require payment of a sizeable fee (NOK10 million – NZ$1.7 million in 2013). This grants a right to farm a particular biomass in the marine area. Fees for licences are now paid into the Aquaculture Fund, established in 2016. Seventy per cent of this funding is transferred to municipalities, 10 per cent to county municipalities, and 20 per cent goes to the state. Data is released regularly which shows how much money is transferred to each municipality from the Fund.

Licence holders are required to comply with conditions regulating the operation of their facilities. Licences for salmon and trout are limited in number, can be distributed regionally, and can be linked to regional or industry policy requirements. Other licences (including for other finfish and shellfish) are generally considered on a case-by-case basis. Licences are fixed to a region but can be moved from site to site within a region (on applying for consent to undertake the transfer).

Commercial licences for salmon and trout are awarded in ‘allocation rounds’. The Ministry determines how many licences should be made available and advertises them on the basis of specific criteria. Historically, if there were more applicants than licences, applicants would need to compete to obtain one. Licences were awarded to those applicants that the Ministry considered best met the allocation criteria. This process was found to be often too resource intensive, requiring difficult judgements to be made about the relative quality of the applicants. The Aquaculture Act now provides for an alternative process whereby applicants must pass basic qualification criteria, after which licences are allocated based on the drawing of lots or a bidding process where the highest bid wins.

A spotlight on the Norwegian ‘traffic light’ system for managing farm growth

Because sea lice is such a major problem in Norway (see Chapter 7), in 2017 the government implemented a new ‘traffic light’ system. The system divides the coast into 13 different areas, with a different colour code based on the number of sea lice reported. Aquaculture licences will be granted to authorise expansion in green areas (with a 6 per cent growth opportunity every two years); in yellow areas allowances are frozen; and in red areas production cannot increase and may be required to reduce by 6 per cent. Farmers in red areas who can demonstrate their farms have no sea lice, which is only likely to be achieved through new technology such as closed-system farming, may be allowed to expand.

One licence can cover up to four sites. A licence normally authorises 780 tonnes of production (900 tonnes in the north of the country). A maximum of six licences can authorise operations on any one site. This enables biomass to be moved between sites depending on the conditions. No more than 15 per cent of the total biomass awarded under marine licences can be held by one owner unless authorised by the Ministry. The Ministry will not grant authorisation for ownership of more than 25 per cent of the total biomass, thereby seeking to avoid market domination. The Aquaculture Act establishes a statutory right to transfer and mortgage aquaculture licences. The Ministry can amend or temporarily or permanently revoke marine licences, if it considers this necessary due to environmental considerations, a change of circumstances material to the grant of the licence, or a serious contravention of conditions or regulations. A licence can also be revoked if it is not exercised within two years.

Operators must document the environmental condition of the site at the time of establishment, operation and decommissioning facilities. If unacceptable conditions are identified the Department can order the site to be fallowed until conditions improve. Farms are required to be fallowed for at least two months between growing cycles. The Ministry can establish a ban on aquaculture in certain areas, order the relocation of operations or place other conditions on operations if necessary to protect ecosystems. Monitoring is required to cover the condition of the seabed, water quality, oxygen saturation and temperature.
A Planning Authorisation is also required from the municipal government under the Planning and Building Act. This serves to authorise a site for aquaculture production and it also has a biomass limit attached. Often the authorised site is quite large so that several aquaculture licences can be used within the site. Consent is only required if the aquaculture licence is in contravention of council land use plans. Such plans may include a coastal zone plan, which can identify aquaculture zones (which are approved for aquaculture) as well as those areas not approved. If an aquaculture zone has been identified, an aquaculture licence can only be granted for use within the zone.18

Salmon farms also require a Discharge Authorisation from the Water Resources and Energy Directorate under Act No 6 (1981), relating to protection against pollution and waste. This is to authorise the discharge of waste into the sea. They also need a Navigation Permit from the National Coastal Administration under Act No 51 (1984), relating to harbours and fairways. A Food Safety Authorisation from the Food Safety Authority under Act No 124 (2003), relating to food production and safety is also required. The Authority assesses the risk of disease spread amongst other things. It can establish geographical zones for managing the spread of disease including preventing the transportation of organisms between zones. Such a zoning system has been implemented for the control of sea lice, as described above.
3.5 South Australia

Aquaculture is one of the largest primary production sectors in South Australia, with a total annual value of A$227.8 million. Key species are southern bluefin tuna, Pacific oysters, blue mussels, yellowtail kingfish and greenlip abalone. Similar to Tasmania, South Australia has recently reviewed its aquaculture regulatory framework, which resulted in the development of the Aquaculture Regulations 2016 under the auspices of the Aquaculture Act 2001. The regime is managed by the Department of Primary Industries and Regions.

Marine farms in South Australia require both a lease to provide access to state waterspace and a licence to authorise the activity. The Aquaculture Act provides the framework for aquaculture zoning, where areas are identified as aquaculture zones. The South Australian Government has identified 12 zoned areas around the state. Although aquaculture can be permitted outside these areas (so long as not in ‘aquaculture exclusion areas’), those seeking consent within the areas will undergo a more streamlined consenting process on the basis that relevant investigations have already occurred and the government will welcome and support the applications. Most of the zones are designated as ‘public call areas’, where tenure is allocated through a competitive process. All tenders are assessed by the Aquaculture Tenure Allocation Board, which determines which applicants are most likely to produce the maximum benefits to the community from the use of the state’s aquatic resources. All leases are also referred to the Minister of Transport to address any navigational issues.

There are four types of aquaculture leases:

- **Pilot leases** may be only granted within aquaculture zones and are to provide for trial aquaculture development, which are short-term in nature. Leases have a maximum term of 12 months but may be renewed for up to a maximum of five years. If the lease-holder demonstrates productive use, it is possible to convert the pilot lease to a production lease. They are not transferable.

- **Production leases** are generally only granted for areas within existing aquaculture zones. These are for established long-term operations. They can be issued for a maximum of 20 years and are renewable. They are transferable with consent of the Minister.

- **Research leases** can be granted inside or outside aquaculture zones, and their purpose is to support research, which will increase, enhance or diversify aquaculture production. They have a maximum term of five years and are renewable but not beyond the term of the research project.

- **Emergency leases** can be granted inside or outside aquaculture zones and provide for the protection of the environment or preservation of stock on an emergency basis. The lease has a maximum term of six months but is renewable.

Applicants for licences must first lodge an expression of interest with the Department. There are six types of licences granted – for intertidal molluscs, subtidal molluscs, abalone, finfish, tuna and miscellaneous (for holding empty structures or temporary holding of stock). Most licences go through a public consultation process and all licence applications are reviewed by the South Australian EPA to address any environmental issues before consent is granted. Licencees are required to develop individual aquaculture strategies, which are approved by the Minister for Agriculture, Food and Fisheries. This specifies how day-to-day operations are to be managed. It includes matters such as maintenance of equipment, actions to avoid disease, response plan to deal with escapes, actions to deal with dead stock, and inspections and monitoring of the areas. Fallowing of 12 months is generally required between the stocking of sea cages. Farmers are required to provide an annual environmental monitoring report which details information on water discharge and quality, species farmed, feed inputs, disease incidents and chemical use. Annual fees are charged for marine licences and leases. These include a range of charges depending on the species farmed but include A$16,624 for a tuna licence (and A$12,191.30 per lease) and A$7,691 for a fish licence (and A$3,790.60 per lease).

The Department publishes regular ‘Regional Performance Reports’ for major aquaculture development areas every two years. These summarise the results of environmental monitoring, compliance processes, biosecurity management and development and production performance, amongst other things. They are designed to provide greater transparency to the community.

Norway has a highly automated salmon industry. Here a robot stacks boxes of packed fresh salmon.
3.6 New South Wales

Aquaculture in NSW is focused on oysters (primarily Sydney rock oysters but also Pacific and flat oysters), with around 21,798 hectares of leases comprising 2238 sites scattered along the NSW coast. These produce around 4000 tonnes of oysters and some $44 million in revenues annually (around double New Zealand’s entire annual oyster production). The government aims to almost double production to 7500 tonnes. Traditionally oysters were farmed on racks in the intertidal zone, but tray baskets and mesh cylinders are now increasingly used.

Marine farmers are required to obtain three main consents, which are all integrated into one application to streamline processing. An Aquaculture Lease over water space is required from the Department of Primary Industries under the Fisheries Management Act 1994. The maximum term is 15 years with a first right of renewal for a further 15 years and subsequent preferential rights of renewal if the area remains available for aquaculture. Renewal applications are generally granted. Rental fees are payable to the NSW Government and are set by regulation at a minimum of A$159 per year or A$59 per hectare. The lessee does not have exclusive rights to the area, which may be subject to public fishing rights.

A Development Consent is required from the territorial authority under the Environment Planning and Assessment Act 1979. This is undertaken within the State Environmental Planning Policy No. 62 – Sustainable Aquaculture. Large oyster farms (of more than 10 hectares), fed aquaculture, and the use of non-native species are generally identified as ‘designated’ developments because of their higher risks. They require an environmental impact statement and public submission process. When considering applications for oyster farms, consent authorities are required to take into account the New South Wales Oyster Industry Sustainable Aquaculture Strategy (Aquaculture Strategy), of which the latest version is dated 2016. This identifies ‘Priority Oyster Aquaculture Areas’, and development consent is not required for oyster farms within these areas.

The State Environmental Planning Policy No. 62 – Sustainable Aquaculture includes measures to protect aquaculture from the impacts of other activities. Where land development is proposed, it requires consent authorities to consider whether it may have an adverse effect on an oyster aquaculture development or a Priority Oyster Aquaculture Area (even if undeveloped). If it suspects there will be such an effect, the consent authority must notify the application to the Department of Primary Industries and consider any comments received. Consent can be refused on the basis of such impacts. The Aquaculture Strategy also sets out water quality and flow objectives for oyster aquaculture areas, with the aim of maintaining and improving water quality, tidal range and flow. The objectives include matters such as faecal coliforms, pH, salinity, suspended solids, iron and aluminium. When statutory environmental management plans are prepared, consideration must be given to the potential impact of the activity or plan on Priority Oyster Aquaculture Areas, and they must include specific actions that will contribute to the protection or improvement of water quality for oyster aquaculture. This is to help address concern that catchment or foreshore development could reduce the suitability of an oyster aquaculture area for its intended purpose.

Marine farmers also require an Aquaculture Permit from the Department of Primary Industries under the Fisheries Management Act 1994, which remains in force until cancelled but is not transferable. The focus of the permit is on the management of the impacts of aquaculture on fish populations, aquatic habitats, commercial and recreational fishing and other marine farming. Applications must include information relating to the nature of the proposal; the physical and hydrological features of the site and surrounding area; assessment of predicted impacts on threatened species, populations, ecological communities or critical habitat listed under the Fisheries Management Act 1994; and proposals for mitigating adverse effects. Proposals which are likely to have significant adverse effects will not be approved unless compensatory measures are proposed.

The Fisheries Management (Aquaculture) Regulation 2012 sets out the conditions that will attach to permits, including standard conditions, specific conditions that attach to certain types of marine farms, and special conditions that relate to specific permits. Permit holders must provide certain information such as annual production returns and also must pay an annual contribution to the cost of administration and research. Permits may be cancelled in the event of mismanagement or breaches of the Act. Oyster farmers are required to pay a bond (cash deposit or bank guarantee) to the value of A$1000 per hectare or an annual contribution of A$40 per hectare to ‘ensure that the industry shares responsibility for problems arising from lease management and maintenance issues’.

The Aquaculture Strategy establishes minimum standards of performance for the oyster industry, covering aspects such as biosecurity, noise, stocking rates and sanitary/tidy practices. If operators do not comply, they will be issued with a notice to comply. Failure to comply with such a notice is taken as a contravention of a condition of the aquaculture permit. The Strategy includes triggers for review of the extent to which an operator is meeting its objectives, including where annual production drops below a certain limit and where leases are abandoned or harvests closed as a result of water quality issues or downgrading of harvest area classifications (which relate to the sanitary status of the area for food safety purposes). The Department of Primary Industries carries out regular (usually every three years) inspections of permit areas. Permit holders are required to submit an annual condition report detailing the condition of lease areas and how well they meet permit and lease conditions.
3.7 Summary of overseas experience

There are quite a few similarities across the jurisdictions reviewed, and in many respects New Zealand is an outlier in the way it manages aquaculture. All jurisdictions treat the lease of the seabed separate from consent to carry out activities, and all generate a return to the public through rental fees or upfront licence charges. In several cases the leases are tendered. In the case of Norway, the consents are split in a slightly unusual way, with the aquaculture sites themselves being licensed by local authorities and the central government issuing and charging for ‘aquaculture licences’, which appears to be an effective way of ‘taxing’ the industry for use of a public resource (at around NOK10 million or $NZ1.7 million per licence). In addition, additional permits such as those to cover environmental and animal health consents are often required. In New Zealand, there is only the one consent required (coastal permit) and typically there has been no additional charge for its grant (apart from application processing costs and sometimes ongoing monitoring/compliance costs) or ongoing rental payable. More recently there has been some limited tendering of space but this is sporadic.

In most jurisdictions, revenues go directly to the national or state government. In Norway, the money from aquaculture licences is put into an Aquaculture Fund, and a large share is paid to the local councils who host aquaculture within their areas. This recognises that local communities bear much of the cost of the environmental effects of the industry and helps to encourage councils to provide for the activity.

South Australia is the only jurisdiction surveyed that provided for a range of different types of leases, and it makes specific provision for shorter-term leases to enable research and piloting of new aquaculture methods and/or species. This seems a positive innovation and something New Zealand could look at to strengthen research and development in the sector.

The length of time leases are granted for varied from 15 (NSW) to 30 years (Tasmania and British Columbia), with Scotland at 25 years and South Australia at 20 years for production leases. In New Zealand consents can be granted for 20 to 35 years, which is not out of step with this international practice for leases. However, in several of the jurisdictions reviewed, licences were issued for much shorter periods, with Tasmania issuing them for 10 years and British Columbia having a maximum of nine years for shellfish aquaculture and six years for finfish. This enables the operation of marine farms to be regularly reviewed and licences adjusted as needed. On the other hand, Scotland and Norway issue permanent licences. However, in Norway, licences can be revoked for a range of matters, including environmental considerations or a change of circumstances.

Norway grants licences for productions levels and not seabed leases as such. The authorised production can be distributed over multiple sites and multiple licences exercised over one site, providing considerable flexibility as to where production can be located. It potentially can be shifted between growing cycles depending on environmental conditions. In New Zealand, marine consents are fixed to a defined geographical location, and this reduces the flexibility of the industry to respond to environmental and market changes. A modified Norwegian system could be worth exploring further.

In some jurisdictions, EPAs play a much a stronger role in managing the environmental impacts of aquaculture, particularly finfish farming, which creates greater environmental risks. For example, in Scotland the EPA addresses impacts on the water column and seabed from salmon farming. The Tasmanian Government recently gave its EPA the role of granting environmental licences for finfish farms. New Zealand could consider a stronger role for the EPA in the management of aquaculture (with a requisite development of the technical skills required), particularly where there are elevated or poorly understood risks such as with indigenous finfish aquaculture and open ocean aquaculture.

In those jurisdictions where marine spatial planning has or is being undertaken, a legal linkage has been created between the plans and the consenting of marine farms. Scotland and British Columbia have both been implementing an integrated form of marine planning, which applies to a broad range of activities including aquaculture. In Scotland, consent can only be granted for aquaculture if it is in accordance with the relevant marine plan. In British Columbia, applications for aquaculture are assessed for consistency against marine plans prepared through a partnership between First Nations and the provincial government.

In Norway, spatial provision for aquaculture is undertaken at the local council level. However, spatial zoning has also been deployed to determine where new aquaculture licences can be granted based on relative environmental risk (and in particular sea lice). The Tasmanian Government has undertaken a single-sector spatial planning exercise to identify areas suitable for salmon aquaculture across the entire state coastline, and leases can only be granted in these areas. Aquaculture exclusion areas can also be identified, as can areas for future release. The NSW Government has spatially identified priority areas for oyster farming. The most recent legal regime applying to aquaculture in New Zealand has moved away from spatial zoning at a council level without prohibiting it, and there is as yet no formal marine spatial planning framework. New Zealand could learn from other countries in terms of creating a statutory linkage between marine spatial planning (where such plans are developed) and prospective aquaculture areas, building on the marine spatial plan developed for the Hauraki Gulf.
NSW is the only jurisdiction reviewed that has strong provisions to protect space and water quality for oyster farming, no doubt driven by its dependence on inshore shellfish that is particularly susceptible to catchment impacts. This is something that New Zealand could learn from given that the bulk of our industry is located in near-shore coastal waters which are suffering ongoing degradation.

Policy 8 of the NZCPS does require regional councils to ensure that ‘development in the coastal environment does not make water quality unfit for aquaculture activities in areas approved for that purpose’, but this has not been rigorously applied or enforced. It is also at a much higher descriptive level than the specific water quality standards prescribed in NSW for aquaculture areas.

All jurisdictions appeared to have a much more developed policy framework around aquaculture decisions than New Zealand, and in particular to guide siting decisions and management of ongoing operations. This typically included clear and measureable thresholds and triggers for action (including the provision to impose moratoria, as in British Columbia). There was also a greater amount of guidance material to describe best practice. For example, the Scottish Planning Policy sets out locational policies for aquaculture to guide the identification of areas potentially suitable for the activity and sensitive areas, which are unlikely to be appropriate. Fisheries and Oceans Canada has issued ‘siting guidelines’ to show how new finfish farms will be assessed, which are reviewed at least every five years. It has also prepared an integrated aquaculture management plan for shellfish aquaculture. The NSW Government has developed a State Environmental Planning Policy on aquaculture and this references a strategic document – the Aquaculture Strategy – that can be regularly updated without the need to change the formal policy. The Strategy sets out, amongst other things, minimum performance standards for farms.

New Zealand lacks a developed national policy framework for aquaculture, with only brief reference to the sector in the NZCPS. This means that regional councils, all with varying levels of capability in the marine domain and aquaculture specifically, are left to work things out for themselves. As discussed above in Chapter 2, Hilke Giles has made some excellent suggestions on how more detailed national guidance on a range of matters could make a positive difference. These include siting, the assessment of effects, the development of suitable monitoring frameworks, the setting of trigger levels and levels of acceptable effects, and the management of cumulative effects. Although the benthic management guidance for salmon farming addresses some of these matters, it only applies to one species (salmon) in one location (Marlborough Sounds). In the case of open ocean aquaculture, which councils have no experience of managing, such national guidance could be particularly useful.
Many of the jurisdictions reviewed had active monitoring, reporting and compliance regimes. Regular on-farm inspections are carried out in Scotland. In British Columbia, destocking can be required if thresholds are exceeded. Regular on-farm inspections are carried out at least once during each production cycle. Regular on-farm inspections are carried out in NSW. In Norway, farms are required to be fallowed for two months between growing cycles. If unacceptable conditions develop on sites, they can be ordered to be fallowed.

Large salmon farming jurisdictions had much more developed risk management frameworks. For example, in Scotland farms are designated within farm management areas and each farm is required to be party to a joint ‘farm management agreement’ which sets out how risks are to be managed across the farms within the area. In contrast, New Zealand’s risk management regime appears relatively undeveloped, and will need to be considerably strengthened if the industry is to reliably grow and incorporate new species in the future without being threatened by serious biosecurity or disease issues.

Some of the jurisdictions reviewed have developed a far more transparent system of reporting aquaculture information to the public. In Scotland, there is publicly available ‘Scottish Pollutant Release Inventory’ which regularly reports the scale of discharges from salmon farms. The South Australian Government is establishing a programme of producing regular ‘Regional Performance Reports’ for the aquaculture industry to increase the transparency of information given to the community. In New Zealand, the availability of information is patchy, and there is room for considerable improvement.

Overall, New Zealand’s regulatory framework for aquaculture appears relatively underdeveloped and much can be learnt from the experience of other jurisdictions, particularly those with larger aquaculture industries which have encountered a range of challenges, including biosecurity, disease and social carrying capacity. New Zealand has the opportunity to get ahead of the game in these respects, before the aquaculture industry grows further, moves into the open ocean and/or expands into new species. It will be important to design a future aquaculture regime for New Zealand carefully, to ensure it manages risks in a way that supports the industry while protecting the environment and avoiding the creation of excessive bureaucracy. Such a detailed design exercise is outside the scope of this report and is something that will require further work.
KEY MESSAGES

- All the jurisdictions surveyed separated consent to occupy marine space from consent to undertake marine farming operations. In New Zealand, the two matters are conflated into one consent.

- Other jurisdictions are more effective at deriving a public return from the use of marine space through rentals or large upfront licensing fees. Historically, the occupation of marine space by private parties has been largely at no cost in New Zealand.

- South Australia provides an interesting model of tailored short-term leases to provide for research and development, which we could learn from.

- Norway has an interesting model where licences for production levels are granted and can be exercised jointly at one site or split over multiple sites. This creates considerable flexibility as to where production is undertaken over time. New Zealand could consider a more flexible consenting regime along these lines.

- In some jurisdictions, EPAs play a much stronger role in managing environmental impacts, particularly of finfish farming. New Zealand could consider a stronger role for the EPA, particularly in managing the effects of open ocean salmon farming, which is a matter that councils have no experience in.

- Most jurisdictions have some form of spatial planning for aquaculture, and where integrated marine spatial planning is undertaken direct linkages between planning and consenting are drawn. New Zealand has recently resiled from the mandatory AMA approach and this may be a retrograde step.

- NSW has strong provisions to protect inshore aquaculture from catchment impacts, including water quality standards, and New Zealand could consider a similar approach.

- All jurisdictions had a much more developed national/state policy framework for aquaculture decisions than New Zealand, including guidance for siting decisions and minimum performance standards for plans. New Zealand could consider strengthening this area.

- All jurisdictions had active monitoring, reporting and compliance regimes and some have placed a recent focus on providing transparent information to the public. New Zealand could improve in this regard.

- Overall, New Zealand’s regulatory framework for aquaculture appears underdeveloped within the international context. If the industry is to significantly grow here, it will be important to get ahead of the game by putting a place a more nuanced and sophisticated regime. Designing such a regime will require further work and greater agency alignment.
Endnotes

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17 Standing Senate Committee on Fisheries and Oceans, 2016
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Chapter Four

Implications of resource management system reform
4.1 Overview
For close to two years, EDS has been undertaking a project focused on resource management system reform. The project is being undertaken in the context of worsening environmental indicators and growing problems around urban management. Thus far, this work has resulted in the production of three working papers and a synthesis report as part of Phase 1 and a working paper as part of Phase 2. Phase 1 of the project focused on analysing New Zealand’s resource management system from first principles. It asked fundamental, future-focused questions about the overall set of laws, institutions and interventions relating to how we manage our natural and physical resources. The synthesis report defined the system, broke it down into chunks for analysis, and presented three potential models for future reform.

Phase 2 of the project commenced in January 2019 and is focusing on selecting and developing a preferred model as well as charting out a transition pathway for reform. It will involve the publication of two working papers and a final report over the course of 2019, as well as extensive engagement. The work has been undertaken within the context of the government indicating an intention to begin its own rethink of the resource management system during 2019. As well as informing constructive debate around future options, EDS’s work will help inform the government’s own reform process. The project has significant implications for aquaculture because any reform process is likely to involve changes to the RMA, the prime piece of legislation that aquaculture is managed under.

As a related project, EDS is investigating marine spatial planning, including international best practice and its applicability to the New Zealand context. It is analysing how marine spatial planning might be institutionalised within the current (and any future) legal framework in New Zealand. This work will feed into the Resource Management System Reform project just described. It produced a report in 2018 (at the end of Phase 1) titled Turning the Tide: Integrated Marine Planning in New Zealand. This included an in-depth ‘lessons learnt’ review of the Sea Change Tai Timu Tai Pari project, which developed a marine spatial plan for the Hauraki Gulf. It also reviewed international experience in developing and implementing marine spatial plans. A second phase is focusing on the ‘nuts and bolts’ of how a regulatory framework could provide for marine spatial planning in New Zealand. This includes a review of relevant overseas statutes, a legal analysis of New Zealand marine law, a series of in-depth interviews and the development of a range of potential options. A final report, titled Healthy Seas: Implementing Marine Spatial Planning in New Zealand, is in the process of being finalised.

From all of this work, a series of themes are emerging about some of the likely elements of a future resource management regime. They include the closer incorporation of Te Ao Māori, clearer and stronger environmental bottom lines, stronger national direction and involvement in strategic planning, greater use of spatial planning both for land and the sea, a focus on restoration rather than just mitigation of effects, and the development of a stronger framework for allocation. These themes, and their implications for future aquaculture management are explored in the sections below.

4.2 Incorporation of Te Ao Māori
EDS’s Resource Management System Reform project has sought to grapple with the appropriate incorporation of a Māori worldview and Māori interests into a reformed resource management system, including Treaty interests. A future system will need to reflect multiple worldviews, including Te Ao Māori, and explore synergies between Te Ao Māori and a Western ecocentric approach. Any future system will also need to embrace the principles of the Treaty of Waitangi, including active protection, good faith, remediation of past grievances and informed decision-making. In particular, it means that the 2004 Māori aquaculture settlement, and other Treaty settlements, need to be respected in any future regulatory system for aquaculture.

The Māori concept of kaitiakitanga relates to the management of resources – including use and protection – and could be drawn on in a future system and our approach to managing aquaculture. This concept draws on a tightly-knit relationship between duties and obligations on one hand and the use of natural resources on the other. Kaitiakitanga could be more strongly reflected in the purpose and principles of new resource management legislation, thereby more closely weaving mātauranga Māori and Te Ao Māori into decision-making. In addition, such legislation could provide for greater involvement of iwi in planning processes, such as through the establishment of partnership governance bodies to oversee marine spatial planning (building on the Sea Change Tai Timu Tai Pari model). The resolution of Māori Treaty claims over harbours, and customary claims over the foreshore and seabed, is also likely to result in new models of marine management which will impact aquaculture, although these will be location-specific.

4.3 Environmental bottom lines
The Resource Management Law Reform project identified the need to impose firm environmental bottom lines as one of the seven core functions that a future resource system in New Zealand needs to perform. Bottom lines are not about balance or mitigation but are outcomes-based ‘lines in the sand’ that the law defends strictly and vigorously against erosion from cumulative human actions. They are not just about preventing harm and can also be about enhancement,
to bring the environment back to an acceptable state. Bottom lines can be prescribed in statute, in national policy statements (such as the NZCPS) and in environmental standards/rules. Where general bottom lines are set out in statute they need to be fleshed out into specific and measurable limits (to the extent possible) in planning instruments that ‘bite’. For example, it would be possible to provide clear national bottom lines for aquaculture in an ‘Aquaculture National Policy Statement’ or ‘Aquaculture National Environmental Standard’. These could include siting and operational expectations and requirements. Within this framework, more detailed provisions could be included in regional coastal plans to address the regional context.

Interestingly, the first real clear bottom line established under the RMA was applied to aquaculture, where the Supreme Court found that the requirement to ‘avoid’ adverse effects on outstanding natural landscapes meant that consent could not be granted to locate a salmon farm within such a landscape at Port Gore. Prior to that, the courts had applied a ‘balanced judgement’ approach to considering the impacts of proposals on landscape values, which enabled these to be counter-balanced with other considerations such as the economic benefits of the proposed activity. The case caused some consternation amongst the industry and practitioners because it overturned more than 20 years of jurisprudence. However, as time has moved on, this approach to bottom lines has gained more acceptance and people have adjusted their affairs accordingly. This has been evidenced by NZ King Salmon investing in a potential move to open ocean sites rather than continuing to seek sites within outstanding natural coastal landscapes.

This mirrors overseas experience: when hard standards are put in place, and are strictly enforced, energy moves away from contesting the standards and towards innovating in order to meet them. It is important, in this respect, that there is trust in the durability and predictability of the system, and in the standards themselves being immovable and strongly enforced. Otherwise energy is spent on political lobbying, undertaking multiple legal challenges, and seeking to subvert the system rather than on changing behaviour in order to comply.

The future is likely to see a need for more environmental bottom lines in response to declining environmental quality. These will provide greater certainty for the aquaculture industry about what is expected in terms of siting and its own environmental impacts, but they should also provide greater certainty about the environmental quality of coastal marine areas on which the industry depends. This will also require greater innovation and adaptability within the industry to find new ways of operating to ensure standards are met. The ways of doing things in the past may not be suitable in the future. A management regime should seek to support and potentially encourage such innovation.

The EPA could have a stronger role in the setting and enforcement of national level environmental bottom lines, particularly in relation to matters such as water quality, seabed enrichment and biosecurity.

### 4.4 Stronger national direction

Stronger bottom lines are likely to be accompanied by stronger national direction. One of the proposals in the Resource Management Law Reform project is the greater use of strategic tools, including the development of a ‘New Zealand Resource Management Strategy’ that would set out a strategic framework at a national level that seeks synergies across local and regional jurisdictions, sectors and domains, and proactively deals with conflicts and trade-offs arising at a national level. It could also have a spatial element. It would be need to be much more than a wish-list of competing aspirations and would have strong and direct legal influence over other statutory frameworks, such as the RMA. More specific and flexible strategies, such as an ‘Aquaculture Strategy’, could be developed within the context of the broader national strategy.

Such a high level strategic document, accompanied by a sectoral strategy, could help provide a more reliable strategic direction for aquaculture in New Zealand as well as serve to communicate the government’s intent for the industry. If the strategy included a spatial component, this could help identify priority areas for aquaculture around the country, as well as ‘no-go’ off-limits areas (such as Fiordland). In the context of open ocean aquaculture, it could identify areas where such development would be actively supported.
4.5 Spatial planning

Spatial plans identify what goes where, and to the extent that they have a strategic element, they are about what goes where over time. Spatial planning is concerned about both the terrestrial and marine contexts. It is a useful way to integrate and align various regimes that have spatial implications. In the marine context, marine spatial planning has been increasingly applied in countries around the world and is now commonplace in overseas jurisdictions. Some plans are into their second iteration. They typically identify important ecological areas and areas suitable for new development. They may include hard zoning and/or policies to guide management of activities. The marine spatial plan prepared for the Hauraki Gulf through the Sea Change Tai Timu Tai Pari process was an integrated strategic and spatial plan that explicitly addressed aquaculture (see adjacent spotlight).

A spotlight on the Sea Change Tai Timu Tai Pari spatial planning process

New Zealand’s first marine spatial plan was completed in December 2016. It was a result of the three-year Sea Change Tai Timu Tai Pari project that focused on addressing the growing spatial resource conflicts and ecological degradation in the Hauraki Gulf. The project was innovative in a number of respects, including through establishing a co-governance structure; tasking a group of mana whenua and stakeholder representatives (including aquaculture) with producing the plan on a collaborative basis; addressing both catchment and marine issues in an integrated manner; and integrating mātauranga Māori and science. It was possibly the most ambitious marine planning exercise to be undertaken in New Zealand.

The spatial element of the plan identified suitable and unsuitable areas for aquaculture (including 13 new aquaculture areas), prospective locations for marine protected areas, areas for phasing out seabed damaging fishing methods, and focus areas for catchment management. The strategic element of the plan identified the strategic drivers of environmental decline in the Gulf and strategies and actions to address them. This included a ‘Gulf Sediment Initiative’, ‘Biodiversity and Habitat Restoration Initiative’ and ‘Ahu Moana Initiative’ (joint iwi-community management areas), amongst others.7

Sea Change provided a rich learning environment from which a number of lessons can be drawn to help design future marine spatial planning projects. Sea Change was reviewed in 2018 by EDS, and the results are set out in our publication Turning the Tide.8 A summary of the findings of the review can be found in the Appendix.

Marine spatial planning provides an evidence-based and proactive approach to identifying suitable areas for aquaculture. It enables aquaculture to be considered alongside other existing and potential activities and uses of marine space. This helps to reduce the community ‘push-back’ that can occur during single sector planning exercises, as experienced by some councils when they embarked on identifying AMAs. It also enables an integrated approach to be applied, including considering catchment impacts alongside marine management. Strategic drivers of environmental decline in the marine area can be identified and appropriately addressed, rather than the ad hoc sectoral approach currently applied (where sectors such as aquaculture, forestry and fishing are treated differently). The expansion of marine spatial planning should be a positive development for the
aquaculture industry and aquaculture management more generally. It seems unlikely that there will be ‘wall-to-wall’ marine spatial plans around New Zealand’s coasts, but such exercises will probably be focused on areas where there are significant management pressures and challenges such as, for example, the Marlborough Sounds.

Marine spatial planning would also help to support the approach described in Chapter 2, where the allocation of space for activities would be based on marine spatial areas or ‘zones’ where environmental quality objectives are defined and acceptable ecological effects or limits within each zone prescribed. Monitoring would then be focus on each zone, and the extent to which environmental quality meets prescribed objectives and limits, rather than on aquaculture sites within them. This would likely result in reduced on-farm monitoring costs while increasing the usefulness of the monitoring information generated. It may require a pro-rata charging regime to share the costs of monitoring amongst users of the area and the council. Marine spatial planning could also be used to plan multi-trophic and restorative aquaculture on a bay- or region-wide basis.

4.6 Proactive restoration

One of the roles of a future resource management system, identified in the Resource Management System Reform project, is to pursue ‘good’ outcomes, not just prevent or manage ‘bad’ ones. This could take a number of forms in relation to the marine environment. Duties could be imposed on public authorities (both central and local) to take positive action, such as setting objectives to improve the quality of the marine environment and taking proactive action to meet them. This could include, for example, investing in the rebuilding of wetland systems to reduce sediment flow into the marine area, identifying marine protected areas where natural restoration can occur, and supporting reef and seabed restoration efforts.

In addition, the resource management system can look for synergies between public and private sector efforts, such as identifying aquaculture zones where marine farming could provide positive benefits to the marine environment. This could include, for example, seaweed aquaculture zones where seaweed is utilised to extract excess nutrients and carbon from the water column as well as provide market products. Shellfish aquaculture zones could be located where shellfish can contribute to reinstating shell substrate on the seabed. Marine farmers could be permitted to deposit waste shell in suitable areas on the seabed as well as encouraged to provide live mussels for reef restoration projects (as is currently happening in the Hauraki Gulf and Marlborough Sounds). Innovative funding mechanisms could be developed such as charging a levy on catchment activities causing degradation of marine areas and using the funds generated to support restoration efforts. This would act both as a disincentive for ‘bad’ activities and an incentive for ‘good’ ones. Another way in which a reformed resource management system could seek positive outcomes is through offering viable alternatives to activities which are no longer desirable due to their harmful environmental effects. This was the approach taken with the salmon relocation initiative undertaken by MPI, as described in Chapter 2.

A spotlight on ‘restorative aquaculture’

The concept of ‘restorative aquaculture’ is gaining traction overseas. The idea is that marine farming can make a positive contribution to the environment as well as producing economically profitable products. For example, by carefully farming shellfish and seaweed together, the enterprise can help restore ecosystems and mitigate the impacts of ocean acidification. This concept takes the idea behind multi-trophic aquaculture (which we discuss in Chapter 6) further, so that rather than growing several species together to mitigate negative impacts on the environment, they are grown to also create positive impacts. In this way, the overall health of the marine environment is improved through the marine farming operation.10

The literature on this topic includes some cases from North America, but the application of the idea is still in its infancy. For example, a finfish farmer operating in Long Island Sound in the United States is growing brown kelp on his backbone lines over the top of cages and has socks growing seaweed below. The seaweed ‘groves’ have become nurseries and sanctuaries for marine species. In Maine, another marine farmer set up America’s first integrated seaweed and oyster farm in 2009. In Alaska, five marine farms are growing kelp along with oysters and other shellfish.11

The Resource Management Law Reform project also suggested that there may be a valid role for government to promote particular sectors or activities which are seen as having a public interest. These could be subsidised or incentivised by smoothing the regulatory pathway. For example, if there was found to be a public interest in the development of open ocean salmon farming, government could step in, undertake the research to determine the effects, identify open ocean salmon farming zones, and then tender the areas to interested parties. This would have the impact of at least partially de-risking the activity for the private sector while also providing greater surety to the public that farms would be located in appropriate places. However, this approach could also have downsides and would need to be carefully considered. It is contrary to
the current free market ethos of the RMA and brings with it considerable risks. Government could be accused of favouring some industries over others and subsidising the profits of private businesses at the taxpayers’ expense. There is also the risk of industry capture with such an approach.

Environmental improvements could also be achieved by requiring applicants for resource consents not only to avoid, remedy and mitigate the adverse effects of the activity but to also provide environmental improvements by offsetting any impacts using the principle of net gain. In the context of aquaculture, this could include not just requiring finfish and shellfish farms to minimise any adverse effects on the seabed, but requiring them to improve seabed health. This could help, for example, to incentivise the use of new technologies such as waste capture systems which hold and extract waste before it reaches the seabed, as well as investment in restoration initiatives. Such an approach would need to be carefully managed to ensure that offsetting is used to exchange like for like and is not used to enable degradation of the marine environment (see spotlight below).

A spotlight on offsetting aquaculture impacts

In Clearwater Mussels Limited v Marlborough District Council (2018), where consent was sought for two mussel farms in the Outer Marlborough Sounds, the Environment Court found that the farms would degrade the natural character of the area, including the habitat of king shag. In order to provide some compensatory benefits to at least partially offset these negative effects, the applicant had proposed a ‘Pest and Predator Programme’ targeting habitats of indigenous species. The Court held that the programme would not be effective in addressing the effects of the applications. Specifically, it would not avoid or mitigate the risks that disturbance from human activity associated with the marine farms could have on local king shag colonies, nor would it materially compensate for, or offset, the loss of natural character values that would result from the farms. Consent was declined.12

Aquaculture can help to restore the marine environment such as through assisting with the re-establishment of wild mussel beds.
4.7 Resilience and adaptation

The Resource Management Law Reform project has posited that alternative ‘umbrella’ principles to sustainability in a future system could include resilience and risk management. These concepts recognise that the future is likely to be characterised by an unstable environment and rapid change. In Chapter 7 we describe the likely impacts of climate change on the aquaculture industry, and this indicates that future management will need to be more adaptive than in the past and seek to build in resilience both within the industry and the marine environment on which it is dependent.

Resilience in marine ecosystems has been characterised in varying ways. Levin and Lubchenco identify the essential elements as being ‘diversity and heterogeneity, redundancy and degeneracy, modularity, and the tightness of feedback loops’.14 Diversity and heterogeneity relate to the adaptive capacity of the system – the ability to alter its composition in the face of change while retaining its populations of species and remaining functional. It means that systems are more robust in the face of impacts. Degeneracy refers to having multiple elements that perform the same or similar function, so if one is lost others can continue to perform the same role. Modularity refers to containing harm by minimising the transmission between groups as well as protecting ecosystem ‘modules’ from impacts, such as through connected but separately defined marine protected areas.

This suggests that use of a diverse range of species for marine farming may promote greater resilience in the marine environment and within the industry. The regulatory regime may need to be more flexible in enabling the trialling of new species and the change and/or addition of species to current farms. A more flexible consenting regime, such as the one applied in Norway where farmed biomass can be moved between approved aquaculture zones within broader regions, may enable more effective adaptation to future climatic changes.

‘Ecosystems that have relatively high diversity tend to be more resilient to external pressures, largely because of high variability in population densities and their ability to maintain aggregate properties, such as nutrient cycling or trophic functioning.’

(Australia State of the Environment Report 2016)13

‘… loss of biodiversity increases the ecosystem’s susceptibility to abrupt change and is also likely to result in loss of ecosystem services.’

(Levin and Lubchenco, 2008)15

Black-backed gulls feeding at Area B, Wilsons Bay Marine Farming Zone.
4.8 More developed allocation regime

The Resource Management System Reform project found that the current statutory regime for allocation of the use of public resources, including their assimilative capacity, was underdeveloped. Currently resources are largely granted to those that apply first, with the permitting process (based on acceptability of environmental effects) effectively doubling as an allocative process (who gets rights). This has mainly been the case for aquaculture, with a few exceptions. More recently, a competitive attribute-weighted tendering process for coastal space has been provided for in the RMA and has been used for aquaculture, with the allocation of the Coromandel Fish Farm Zone by the Waikato Regional Council being a case in point. However, the Act itself provides no guidance as to what such allocative principles should be.

Where there is a need to de-allocate resources, in the event they have been overallocated, the matter becomes more complex. This is because people tend to be more averse to losing existing rights rather than making equivalent gains. The need to de-allocate occurs when, collectively, people hold rights that allow bottom lines to be exceeded. In the context of aquaculture, this situation might arise where the cumulative impacts of historic use in an area exceed acceptable limits, a situation some argue has occurred in parts of Marlborough Sounds. The RMA is not well equipped to deal with this issue, and a future regime could provide clearer principles, including considerations of fairness, to guide de-allocation processes across all sectors contributing to the problem.

The Resource Management System Reform project has posited that there may be some merit in developing a separate Allocation Act which would address allocation of a wide range of public resources including minerals, fisheries, freshwater and marine space. This option was incorporated into Models 2 and 3, which are described in Chapter 15 of the Synthesis Report. The new Act could include a set of high level allocative principles that would apply to all regimes and also more specific allocative principles for different domains including the marine area. The principles and processes established would need to be sensitive to and incorporate Māori interests, determined by tikanga, when controlling resources. It would mean that the decision to grant resource consent would be separated from the decision to allocate rights to use scarce public resources (in the same way that already occurs for mineral extraction). This is norm in the overseas jurisdictions reviewed in Chapter 3 above. An alternative approach would be to have a more developed legal framework for allocation as part of a revamped RMA in order to recognise that allocation and environmental impacts are not always separate issues.
KEY MESSAGES

■ The government has indicated the intention to pursue broader resource management law reform later in 2019. EDS’s Resource Management System Reform project will help inform this process.

■ Any future system will need to protect Treaty settlements, including the aquaculture settlement, and embrace emerging partnership models for marine management.

■ A future system is likely to set more environmental bottom lines. This should provide greater certainty to the aquaculture industry about what performance standards are expected and also more certainty about the quality of coastal marine areas on which the industry depends.

■ Stronger national direction is likely and could take the form of a ‘New Zealand Resource Management Strategy’. This could be accompanied by sectoral strategies such as a national ‘Aquaculture Strategy’ which could identify matters such as siting criteria and priority areas for aquaculture and off-limit areas nationwide.

■ There will almost certainly be a stronger focus on spatial planning on land and sea. This could assist with positive planning for the location of aquaculture within the context of other users of marine space and catchments.

■ Due to declining environmental quality in many inshore coastal systems, a future system is likely to place more emphasis on proactive restoration, and this could support a move towards ‘restorative aquaculture’ approaches along with better management of current pressures.

■ A future system may place more focus on supporting greater resilience and ability to adapt to changing conditions (especially as a result of climate change). This could encourage the use of a greater variety of methods and species in aquaculture as well as a more flexible regulatory regime to enable adaptation and change.

■ A more developed allocation system for public resources may emerge, which could provide greater specificity as to how rights to occupy marine space are allocated and include new charging systems.
Endnotes

1 Severinsen and Peart, 2018a; Severinsen, Peart and Cox, 2018; Severinsen and Peart 2018b; Severinsen and Peart, 2018c
2 Peart, 2018a
3 Severinsen and Peart, 2019, 5–6
4 Environmental Defence Society v New Zealand King Salmon Company (2014) 17 ELRNZ 442
5 Severinsen and Peart, 2018b, 60
6 Severinsen and Peart, 2018c, 223
7 Sea Change Tai Timu Tai Pari, 2017
8 Peart, 2018
9 See Severinsen and Peart, 2018c at 104–108 for more in-depth discussion of this concept
10 Sourced from Schiffman, 2016
11 Sourced from Schiffman, 2016
12 Clearwater Mussels Limited v Marlborough District Council [2018] NZEnvC 88 at [101]–[102]
13 Levin and Lubchenco, 2008, 30
14 Levin and Lubchenco, 2008, 30
16 Severinsen and Peart, 2018c, 232
17 See Stewart, 2015
Historical context
Aquaculture has been undertaken in New Zealand for centuries. The Waitangi Tribunal’s report on an aquaculture claim by Ngāti Kahungunu and Ngāti Whātua (Wai 53) outlines multiple examples of Māori actively engaging in the relocation and enhancement of wild kaimoana stocks. They include seeding and relocating pāua to local beds and removing kina to allow for better growth.\(^1\)

5.1 Oyster farming

The origins of the modern aquaculture industry stem back to the late 1920s and followed the demise of wild shellfish stocks through overharvesting. The first trials of artificially cultivating oysters were carried out in 1927, drawing on Australian experience and focusing on the indigenous rock oyster (*Saccostrea commercialis*). The oysters were placed into trays made out of galvanised wire attached to wooden frames and then attached to wooden piles driven into the mud in the intertidal zone. Initial trials were undertaken in the Mahurangi Harbour, at Kawau Island and in the Bay of Islands. The oysters themselves were sourced from those attached to mangroves.\(^2\) There were some teething problems as the oysters clustered and become covered in oyster larvae. The wire frames eventually corroded and collapsed. In addition, where there was slow water current, mud collected around the frames and smothered the oysters.\(^3\)

Efforts to farm rock oysters continued but did not make significant progress until the mid-to-late 1960s when the then Marine Department hired Les Curtin, an oyster farmer from Sydney, to set up some trial farms. Curtin experimented with different spat collection methods and locating trays at various levels in the tide to gauge growth rates. He set up an operation in the Pukapuka arm of the Mahurangi Harbour soon after his arrival in the country (Lease No 2 which still exists today) and then extended his operations to Bon Accord Harbour at Kawau Island, Orongo Bay near Russell in the Bay of Islands, the Coromandel Harbour and the Pahi arm of the Kaipara Harbour. By the end of the 1960s he had some success and was supplying most of the industry with spat. By this stage, legislation was in place to enable the lease of areas for private oyster farms through the Rock Oyster Farming Act 1964.\(^4\)

Fibrolite sticks were used for catching spat until the early 1980s, when the use of asbestos was banned in New Zealand, and an alternative substrate was needed. Woodfibre-reinforced board was trialled as an alternative, but after immersion in the sea water the wood fibres swelled and became soft. So the focus turned to using treated solid wood. There was some experimentation with large 1.8-metre-square wooden frames, but these proved very difficult to reuse. Another method trialled was driving the sticks vertically into the mud, to avoid the need to construct racks to put them on. Eventually, the method of placing bundles of wooden sticks 25 millimetres square and 1.8 metres long on racks was adopted, with the sticks gradually being shortened to 1.2 metres by 1990.\(^5\)

As the farming of indigenous rock oysters got underway, the Pacific oyster (*Crassostrea gigas*) appeared in New Zealand, first caught on spat sticks in the Mahurangi Harbour in 1970. It was thought to have arrived on the hull of a Japanese vessel.\(^6\) The Pacific oyster was faster growing and outcompeted the native oyster in the lower intertidal zone. It therefore made economic sense for farmers to move to the new species, which had largely taken over the industry by the mid-1970s. Oyster farming proved labour intensive and profits were marginal for many years. By 1977, New Zealand oyster exports comprised 441 tonnes with a value of around $500,000.\(^7\)
5.2 Mussel farming

Experiments with the farming of green-lipped mussels (*Perna canaliculus*) commenced in the mid-1960s once the wild dredge fishery had collapsed. They were inspired by reports of the blue mussel farming industry in Spain, where the mussels were suspended on ropes in the water column attached to rafts. Stuart McFarlane, who had been involved in dredging the Hauraki Gulf mussel beds, started experimenting with mussel cultivation in 1965 by suspending bundles of manuka below a pontoon at Homestead Bay, Ponui Island. The mussel spat settled on the brushwood, and although many of the bundles washed away, he tied those remaining to an iron frame and suspended them in 20 metres of water. When McFarlane pulled the bundles up after 18 months he found sufficient mussels of a commercial size to fill nine sacks. It was a good start, but there had been problems. Technically McFarlane had no authorisation to moor his pontoon, and boaties, objecting to its presence in the anchorage, dragged it ashore.

McFarlane kept experimenting, using a bigger pontoon and different substrates to catch spat. His ropes ended up collecting a lot of mud and he concluded that a more exposed location was required. This prompted the transfer of operations to Man O’ War Bay on the eastern side of Waiheke Island. Here he moored his small rafts, arranged in groups of six, each with over a hundred 12-metre long ropes. Similar experimentation was undertaken in the Marlborough Sounds in the late 1960s after the Marine Farming Act 1968 was passed into law. Eventually the rafts were replaced by buoyed lines which were cheaper and more flexible, and spat was obtained by collecting spat-encrusted seaweed off Ninety Mile Beach.

The first application for a licence under the new Marine Farming Act was lodged by Associated Fishermen Limited, in 1969, for five sites in Kenepuru Sound. This was quickly followed by a competitor, Nelson Fisheries Limited, applying for licences. The new legislation was found to be unworkable, and it was amended in 1971. This was to enable (in addition to the grant of a lease over the seabed) the grant of a licence, which created more limited rights. Both could be granted for up to 14 years with a right of renewal. The amended Act consolidated provisions for all marine farming and repealed the Rock Oyster Farming Act.

The Marine Farming Act 1971 made provision for sectorally focused marine spatial planning. The Minister was empowered to identify areas not available for marine farming. He could also set aside areas considered suitable and invite applications for the space. An application fee of up to $50 was set and an annual fee was also charged once the lease or licence was granted. Applications were publicly notified and objections could be lodged. The Act required objections to be upheld if the proposal would ‘interfere unduly’ with existing rights of navigation, commercial fishing, or recreational or scientific use of the foreshore and associated sea area.

In 1974, the Ministry of Agriculture and Fisheries produced a map showing suitable and unsuitable areas for mussel farming in the Marlborough Sounds.

By May 1975, seven mussel farm applications had been lodged, each for around 3 hectares. The Fishing Industry Board had identified 22 suitable marine farm sites in the inner Pelorus and Kenepuru Sounds. The first mussel farm licence in the Sounds was granted in October 1975 (Licence No 1 in Crail Bay, which was subsequently moved to Ruakaka Bay and later became a salmon farm) although experimental rafts were authorised prior to this through mooring permits issued by the harbour board. By 1977 the first big mussel crops were being harvested. The first mussel licences in the Hauraki Gulf were granted later, in 1984, as there had been strong opposition to the expansion of the industry in the already heavily utilised marine space.

In the early days of the industry, and prior to the RMA, development was largely based on small mussel farms (of 1–3 hectares in size) located in a coastal ribbon formation close to the shore (see Figure 5.1).
5.3 Salmon farming

Chinook salmon (now commonly referred to as king salmon) was introduced to New Zealand from Sacramento, California, in 1901. Hatcheries were set up and the small fish were released back into rivers for game fishing. It was not until 1980 that regulations under the Marine Farming Act were changed to legalise ocean ranching, sea-pen rearing and pond rearing of salmon. Salmon ranching, where small, tagged fish were released into rivers and the adults captured on their return from the sea, was trialled for some years but did not prove commercially viable. Sea-cage rearing showed more promise, although there were also some initial setbacks. The first sea-cage, which was imported from Norway, was set up in Golden Bay but did not last long before strong winds broke it up.

The first fully operational salmon farming operation was subsequently established in the more protected waters of Big Glory Bay, Stewart Island, in 1982 by a joint venture between BP Nutrition Limited and Blue Circle Cement Limited. The site was selected due to its high water quality and was ringed by a national park. However, it was shallow, with an average depth of only 16 metres, and the seawater in the bay was very slow to flush. By 1989, there were seven salmon farms in the bay. That year an algal bloom hit, decimating salmon stocks. The extent of the loss caused a rationalisation of the industry, with some operators going out of business.

In 1995, restrictions were placed on nitrogen discharges from the salmon farms to reduce the risk of future blooms, as well as adverse seabed impacts.

Due to the impacts of the algal bloom, slow growth rates and high operating costs, more interest was focused on the Marlborough Sounds. A salmon farm was established at Mills Bay in 1984, but this proved unsuitable, and after a couple of years it was moved to Ruakaka Bay (the site of an earlier mussel farm), which although further out into the Sounds, still had poor water flow. The same year a small farm was established in Hallam Cove, but this also proved unsuitable, and the farm was moved to a site at Waihinau. A year later, in 1985, a farm was established at Crail Bay but this too proved poorly located, and the farm was closed in the late 1980s. There were several short-lived farms in Port Underwood in the late 1980s. Other low flow sites were developed during the late 1980s and early 1990s at Otanerau Bay, Forsyth Bay and Port Ligar, the latter soon discontinued. The first high flow site was established at Te Pangu Bay in the Tory Channel in 1990, followed by Clay Point in 2007.
This illustrates the learning process that took place, through trial and error, to find out where the best sites for salmon were. Most of the early sites were located in areas originally consented for mussel farms, with the consents being amended to include finfish species. They had therefore not been identified with the needs of salmon farming in mind. The sites that were eventually located in the colder water of the Tory Channel showed improved smolt survival, and they avoided the high seawater temperatures from January to April that occurred in Pelorus Sound. Current salmon farming sites in the Marlborough Sounds are shown in Figure 5.1.

Salmon is a cold water species, and because the water in the Sounds is warmer than that around Stewart Island, the nets needed to be sunk to around 10 metres as opposed to the 3-metre depth of the Stewart Island farms. Despite this, salmon farming in the Sounds proved to be significantly cheaper due to the closer proximity to services. A salmon farm was also established at Lucas Bay in Akaroa Harbour in late 1985. A rationalisation of the industry during the 1990s prompted greater investment in selective breeding and methods to enable year-round harvests. Food conversion rates were improved through importing extruded feed from Canada, Australia and Chile, and this reduced feed costs as well as environmental impacts.

**KEY MESSAGES**

- Aquaculture has been undertaken in New Zealand by Māori for centuries, with the modern industry becoming established during the 1960s.
- Oyster farming was initially focused on the indigenous rock oyster species, but moved to the more vigorous Pacific oyster during the 1970s after the invasive species arrived in New Zealand waters, likely on the hull of a ship.
- Mussel farming was originally based on the raft method used in Spain, but after trial and error the current long-line method was adopted.
- Although the first experiments with mussel farming took place in the Hauraki Gulf, the industry took greater hold in the Marlborough Sounds where there was a wide range of sheltered growing areas and less opposition from other marine users.
- Salmon farming only became established during the 1980s, when the law was changed to allow it. It is therefore a relative latecomer within the industry.
- The first operational salmon farms were established in Big Glory Bay, Stewart Island, but the Marlborough Sounds proved to be a more favourable place for the industry, and was where growth was concentrated.
- The early salmon farm sites in the Marlborough Sounds proved unsuitable due to shallow depths and low water flow, and more favourable sites were identified through a process of trial and error.
- A major algal bloom incident at Big Glory Bay in 1989 hit the salmon farming industry hard and resulted in consolidation of ownership.
Endnotes

1 Waitangi Tribunal, 2002, 30
2 Report of the Secretary, Marine Department, *Appendix to the Journals of the House of Representatives, 1927–1928, H-15,15–16*
3 Report of the Secretary, Marine Department, *Appendix to the Journals of the House of Representatives, 1928–1929, H-15,13; Report of the Secretary, Marine Department, Appendix to the Journals of the House of Representatives, 1930–1931, H-15, 23*
4 Johnson, 2004, 447–448; Jim Dollimore, pers comm
5 Jim Dollimore, pers comm
6 Johnson, 2004, 448–449
7 Johnson, 2004, 450
8 Greenway, 1969, 315; Dawber, 2004, 24
9 Johnson, 2004, 435
10 Johnson, 2004, 435
11 Dawber, 2004, 56–57
12 Dawber, 2004
13 Dawber, 2004
14 Haworth, 2010
15 James, Hartstein and Giles, 2018a
16 Haworth, 2010
17 Forrest et al, 2007, 69
18 Haworth, 2010
Kopāua salmon farm, Pelorus Sound
Successfully farming wild stock, in an ever-changing marine environment, is a complex business and requires considerable skill. Many marine farmers have focused on just one species, in order to concentrate on farming it well.

**A spotlight on regional aquaculture activity**

In the Marlborough Sounds, as at 2015, there were 565 mussel farms, 14 oyster farms (with three main farms) and nine salmon farms (of which three were in development at that time). They covered a total of 3192 hectares and employed an estimated 254 people on the farms and 605 in processing. They produced around $276.4 million in export sales revenue and contributed $150.7m to GDP.¹

In the Thames-Coromandel District, as at 2017, there were 100 mussel farms (owned by 35 entities) and 15 oyster farms (owned by three entities). They covered a total of 1550 hectares, so around half the area occupied by farms in the Marlborough Sounds. The industry employed an estimated 143 people on farms and 244 in processing within the district (with other processing taking place in Auckland). It produced around $73 million in export sales revenue.²

Māori have a strong interest in the aquaculture industry, both through iwi ownership of Moana New Zealand (the largest oyster farmer in New Zealand) and direct iwi investment in, and operation of, marine farms around the country. The 2004 Māori aquaculture settlement has helped increase iwi involvement in the industry (see Section 4.2).

**A spotlight on Te Atiawa involvement in aquaculture**

Te Atiawa is one of several iwi with mana whenua and mana moana (traditional authority and influence) over the top of the South Island. Te Atiawa commenced marine farming in the early 1990s and has interests in six mussel farms. Although not involved in salmon farming directly, Te Atiawa owns a half share in a marine farming licence for a salmon farm at Clay Point in Queen Charlotte Sound. It also owns shares in NZ King Salmon and is seeking further interests in the industry. *Te Atiawa is interested in investing further in aquaculture in order to become a significant player in the finfish farming industry.*³

Although there have been experiments with farming other marine species over the years, three species dominate the New Zealand industry: Pacific oyster, green-lipped mussel and king salmon. Green-lipped mussels are unique to New Zealand and so are distinctive in international markets. They grow quickly, can be grown in a range of conditions, and to date have lacked any debilitating diseases. Pacific oysters are also fast growing and robust. Juvenile salmon are easier to farm than other finfish species because of the large size of their eggs, although the king salmon farmed in New Zealand is much harder to grow than Atlantic salmon. King salmon is distinctive in international markets as most salmon producers in other countries farm Atlantic salmon. All three products have high market demand.
6.1 Pacific oysters

There are currently around 200 operational oyster farms, which occupy 750 hectares of sheltered intertidal marine area in northern New Zealand. Over 1000 hectares have been consented for oyster production but not all is currently utilised. Farming is focused in the Parengarenga, Whangaroa, Mahurangi and Kaipara Harbours as well as the Bay of Islands, Coromandel Peninsula and Ohiwa Harbour. Around 38 per cent of production is located in the Northland region, 37 per cent in the Auckland region and 24 per cent around the Coromandel Peninsula.4

In 2018, around 1992 tonnes of oysters were harvested, generating $26 million in exports and $11 million in domestic sales. The harvesting volume has not increased significantly over the past 20 years but revenues have more than doubled due to higher prices being obtained. Over two-thirds of exported oysters are sold as frozen half shell (68 per cent) with just under a third as live chilled (30 per cent). Australia is the largest market, followed by Hong Kong.5

Prior to an outbreak of the OsHV-1 virus in 2010, around 80 per cent of farmed oysters were sourced from wild spat, much being caught in the Kaipara Harbour. Since the outbreak, the Cawthron Institute has focused on breeding resistant strains of hatchery spat, which are on-grown in a land-based nursery operated by a subsidiary of Moana New Zealand before being supplied to farms. Around 50 per cent of the industry is now supplied in this way.6 The use of hatchery spat also provides an opportunity to increase production levels and value through selective breeding.

Spawning in wild populations generally occurs over the summer months between January and March. The wild spat is caught on bundles of sticks set out on racks. These are then collected and transported to other areas where they are unbundled and laid out across wooden racks constructed in the lower intertidal area to allow the oysters to grow. Oysters grow to market size in around 12–18 months. On harvest, a proportion of the growth on the sticks is unusable and is discarded (at times up to 20 per cent). This means there is considerable opportunity for increased efficiencies if such losses could be reduced.

In some cases, oysters are stripped off the sticks and on-grown in plastic mesh baskets and trays which are attached to wire or ropes strung between posts in the intertidal area.7 The benefit of using baskets is that the oysters grow into a rounder shape and the baskets can be moved up and down in the water column to manage growth rates and to keep the oysters clean. They also provide greater portability, enabling oysters to be moved to cleaner waters if water quality issues occur. Floating baskets are also being trialled at some farms, and these can potentially be used in the shallower areas of permitted farm areas, which were designed for farming the native rock oyster and were previously unsuitable for Pacific oysters, which can tolerate deeper water.8

The Cawthron Institute produces hatchery spat tailored to the needs of individual farmers, with each ‘run’ producing desirable genetic characteristics on request. On-growing in the land-based nursery is expensive as micro-algae needs to be produced to feed the small oysters. Hatchery-produced juveniles are generally on-grown directly in baskets or bags. This can cause some difficulties as the small oysters require fine mesh to contain them, and small openings in the plastic can easily become clogged with silt and marine growth when suspended in the water column. Methods of growing the tiny hatchery spat directly in the sea are being trialled to help overcome these issues, such as placing them in aerated upwellers with forced water flow to enhance growth rates. Oysters generally need to be harvested before they spawn, when they lose much of their condition. Some hatchery spat is bred as triploids (with an extra set of chromosomes) which produces oysters that do not spawn. They can therefore be harvested all year round. Triploids naturally occur in wild stocks,9 and so (we were told) meet the requirements for being classed as ‘organic’. The meat weight of triploid oysters can increase by as much as 70 per cent when compared to wild oysters.10

The increasing use of basket technology provides an opportunity to grow more uniformly shaped oysters, which could facilitate the greater use of automated processing technology. Because of their widely varying shapes, oysters are...
all opened by hand, which is labour intensive and therefore costly. It is also potentially problematic when there are labour shortages (as there currently are).

Stock is often moved from place to place during the growing period, including to clean water areas prior to harvesting to reduce the risk of contamination. Different sites (and locations within sites) have varying growth rates, and by utilising a portfolio of locations farmers can achieve year-round production. This is important to maintain a continual supply of product to markets, to sustain income streams into the business, and to provide year-round employment for staff. Owning farms in a range of localities also enables oyster farmers to better manage risk in the event that one area gets hit by disease, an algal bloom or a poisoning event.

There has recently been a significant rationalisation of the industry, particularly after the oyster herpes virus outbreak in 2010. Seafood giant Sanford exited the oyster farming industry in the wake of the virus, selling all of its farms to Moana New Zealand. Iwi-owned Moana New Zealand is currently the largest New Zealand farmed oyster producer followed by Biomarine, Pakihi Oysters, and Sea Products. There is potential to increase production from existing space through selective breeding and improved growing methods.

6.2 Green-lipped mussels

Mussel farming is concentrated in the Marlborough Sounds, where 60 per cent of the industry is located, with the waters off the Coromandel Peninsula being the next largest-producing area (with 26 per cent of the industry). Other farming operations are dotted around the country in places such as Banks Peninsula and Stewart Island, and there has been a move to more exposed sites in places such as Tasman Bay, Golden Bay and coastal Ōpōtiki. In 2018, production was 86,176 tonnes, generating $272.5 million in exports and an estimated $40 million in domestic revenue. The main overseas markets are the United States and China. Most mussels are exported frozen in a half shell (70 per cent), with 12 per cent of exports in the form of mussel oil, which is used to ease arthritic pain in humans and animals. Ownership of mussel farms is less concentrated than in the oyster and salmon industries, with multiple entities still involved in the sector. Some consolidation has occurred in the Marlborough Sounds, where around 90 per cent of mussel farms are now operated by five or six companies, although the resource consents for the farms are held by a greater number of entities.

In the Marlborough Sounds, there are some 565 mussel farms occupying 3192 hectares of water space. There are a greater number of individual consents (around 890) as some farms have multiple consents. The farms are generally arranged in a ribbon development along the shoreline. More recently, there has been a proposal that farms should move off the shallow cobble areas and other biogenic habitats, which may have higher biodiversity values, by shifting the inside lines to the outside of the farms. All mussel farms use the long-line technique. This involves suspending a single long continuous rope in the water column, which is held up by a double-stranded backbone line that is anchored into the seabed at each end and held up with buoys. A single backbone arrangement is used in more exposed sites.

Spat is seeded onto the ropes in long stockings knitted out of a cotton/synthetic twine, which breaks down in the seawater after several weeks. There is generally poor spat retention, with up to 95 per cent being lost within the first few months of seeding. The loss level is similar for wild-caught and hatchery-produced spat. Improving spat retention levels, even by a small percentage, could significantly increase the productivity of the industry. Mussels are often stripped off ropes and reseeded during production, to achieve the optimal spacing for growth. There is a wide variation in production time to harvest, ranging from around 10 months to three years, depending on the location of the farm. The industry is highly mechanised with largely automated harvesting, seeding and processing systems.

Most mussel farming operations in New Zealand rely, to some extent, on spat sourced from seaweed washed up onto Te Oneroa-a-Tōhē (Ninety Mile Beach), which provides around 75 per cent of the total national wild spat catch. This source has a variable and quota-limited supply. Spat catching is also undertaken in the Marlborough Sounds, Golden Bay and Tasman Bay, as well as a range of other smaller areas. Shortage of spat is currently the main constraint on production in the industry, meaning that currently available space cannot be farmed. Research is underway, via a Primary Growth Partnership between SPATnz (a wholly owned subsidiary of Sanford) and MPI, to develop hatchery-produced mussel spat. This would potentially increase certainty of supply as well as enable selective breeding, which would increase production rates. Once the project is completed in 2019, Sanford will have a five-year exclusivity period over the intellectual property, which will expire in 2024. Sanford is currently the only entity farming with hatchery-bred spat.

Similar to the situation with oyster farming, successfully farming mussels to generate year-round production is a challenging logistics exercise. Like oysters, mussels need to be harvested before they spawn in order to maintain their condition. The use of spat from different areas, which have different characteristics, helps to spread production over the year. Ninety Mile Beach spat leads to harvestable mussels from summer through to early winter, whereas wild spat from Golden Bay tends to be harvestable earlier during spring and summer. Different locations have different growing characteristics, some areas producing faster growth in mussels and others slower. The Marlborough Sounds provides a
wide range of growing conditions, in a contained area, making it ideal for mussel production.

Some sites grow spat well due to the availability of clear sheltered water whereas others, such as the Firth of Thames, grow larger mussels well due to the presence of a good food supply but do not support spat retention. In general, larger mussels can withstand rougher conditions. This is one reason why it will not likely be realistic to move all mussel farms to the open ocean; inshore sheltered coastal farms will be needed at least as nursery areas. Similar to the oyster industry, a portfolio of sites helps to mitigate risks, so if one area is out of production (eg due to an algal bloom, bacteria contamination or bad weather), another area can be harvested. Fortunately, there have been no disease outbreaks in green-lipped mussels to date.

Mussel farming has been moving further from land to more exposed sites. A mussel farm off Ōpōtiki is succeeding to grow mussels with lines suspended around 5 metres underwater. There are also two farms in the Marlborough region, off D’Urville Island and Clifford Bay, which have several lines in place. We were told that the cost of equipment and production for open ocean mussel farms is about double that of inshore farms, so a larger scale is needed to provide an adequate financial return.

There is considerable market potential for new product lines based on the components of current aquaculture products such as mussels, which are a ‘superfood’ with high nutrient levels. For example, Aroma has developed a fast-growing enterprise focused on extracting nutraceuticals from mussels, primarily for the treatment for arthritis, including in cats and dogs. The requirements for this industry are different. The mussels do not need to be of the same size as those grown for consumption and can have a more flexible harvesting regime.

There has also been growing interest in utilising the by-products from existing operations. There has been some promising work undertaken on utilising the blue mussels that grow on the top and bottom of green-lipped mussel lines. Up until now, these have typically been stripped off and discarded into the sea during harvesting. The company CFARMX is exploring the utilisation of protein from the mussels as a component of fish feed. There is also potential to use blue mussels to produce nutraceuticals and nutritional supplements.

Another example is Undaria (Japanese kelp), an invasive pest species that arrived in New Zealand during the 1980s, probably in the ballast water of a ship. The seaweed grows prolifically on mussel lines and other marine structures. In 2004 restrictions on harvesting Undaria were partially lifted, and in 2010 the seaweed was permitted to be farmed in heavily infested areas. The seaweed is now being harvested off mussel lines in some areas. Waikaitu, for example, expected to harvest 100 tonnes of Undaria during the 2018 season, which is mainly used as organic fertiliser.
6.3 King salmon

King salmon is currently farmed in three marine locations. The bulk of production (63 per cent) is from the Marlborough Sounds, followed by Stewart Island (22 per cent), with only small production in Akaroa Harbour (15 per cent). Other salmon farms are located in freshwater hydro-canals (and are not further discussed in this report). Total production in 2018 (including freshwater) was 14,339 tonnes, generating $103.1 million in exports and around $148.5 million in domestic revenues. Salmon is mainly sold chilled, gilled and gutted (71 per cent) or as frozen fillets (13 per cent). The main export market is the United States, followed by Australia and Japan. Salmon farming is a much more capital-intensive form of aquaculture than oyster or mussel farming.

There has been significant rationalisation within the industry in recent years. Sanford is now the only salmon farmer in Stewart Island, where the company operates two farms across seven sites (producing just over 3000 tonnes a year) and a processing plant in Bluff. Due to the shallow depths and low rate of seawater flushing in Big Glory Bay, the sites are rotationally fallowed (left vacant to enable the seabed to recover). Sanford recently obtained consent to increase salmon production in the Bay (see Section 7.1).

NZ King Salmon is the only salmon farmer in the Marlborough Sounds and the company produces around 8000 tonnes a year. It currently has 11 permitted sites, but five of these are older sites which have proved marginal for salmon production due to their shallow depths, low water flow and warming seawater. For these marginal sites, the company is looking to use air-induced upwelling to lift the cooler water up into the farms. NZ King Salmon is currently seeking additional sites both within the Sounds and in exposed sites around the South Island coast, as described in Chapter 2.

These are vertically integrated companies which operate their own hatcheries, processing and marketing. NZ King Salmon has hatcheries at Tentburn, Waiau and Takaka, and Sanford operates hatcheries at Waitaki and Kaitangata. The use of multiple hatcheries enables some risk mitigation in the event of a disease outbreak in a hatchery. As indicated earlier, industry rationalisation has enabled greater investment in selective breeding. For example, NZ King Salmon has selectively bred a genetically distinct fish which is initially grown in freshwater and is out-grown in seawater, and is marketed as a premium product under the brand ‘Ōra King’.

New Zealand is a tiny salmon producer in international terms, with Norway producing 1,198,900 tonnes, Scotland 162,817 tonnes and Tasmania 50,000 tonnes of Atlantic salmon. However, New Zealand is the largest producer of the harder-to-farm king salmon. In Norway, the farms are much larger than here, producing on average around 5000 tonnes per farm, from six large round clustered cages. This means that just three farms in Norway have the same output as the entire New Zealand industry. A key issue for the industry internationally, as salmon farming grows in size, is how to sustainably source feed for the massive quantities of fish produced, and much effort is focused on solving this challenge. New Zealand currently sources feed from overseas, so faces similar issues as part of the international feed supply chain.
Salmon farming involves the suspension of weighted nets in the seawater where the smolt (juvenile salmon) are placed until they grow to harvestable size. Smolt are transferred at different times of the year to enable year-round harvesting. In the Marlborough Sounds, smolt may initially be placed in one farm before being moved at a larger size to another location. Farms primarily consist of a series of square nets attached by walkways, technology developed in New Zealand. The cages are typically surrounded by high nets to keep out predators such as fur seals and seabirds. There is usually a barge or floating structure permanently attached to the farm to hold the feed and other equipment. Feed consists of pellets which are air blown into the nets at regular intervals through a pipe via an automatic feeding system. Waste fines, uneaten pellets and faeces fall through the net and may dissolve in the water column or deposit on the seabed under normal conditions, there is around a 10 per cent mortality of the farmed fish before harvest, with the dead fish being regularly removed from the farm. Under normal conditions, there is usually a barge or floating structure permanently attached to the farm to hold the feed and other equipment. Feed consists of pellets which are air blown into the nets at regular intervals through a pipe via an automatic feeding system. Waste fines, uneaten pellets and faeces fall through the net and may dissolve in the water column or deposit on the seabed. Some prototypes are being designed as partially or fully contained to both avoid sea lice and enable waste material to be collected and removed before it discharges to the seabed. Closed-farm technology called ‘the egg’ enables 90 per cent of the solid structure to be submerged and is able to house 1000 tonnes of salmon. Underwater feeding systems are also being developed to avoid the need for a barge to be permanently attached to the farm (as the underwater pipes can potentially run along the seabed to the farm from a land base). Pellets are pumped in seawater rather than the current system undersea. Pellets are pumped in seawater rather than the current system. Underwater pipes can potentially run along the seabed to the farm from a land base. Pellets are pumped in seawater rather than the current system of being blown by air. This renders the pellets more digestible for the fish through soaking, and also removes the problem of small particles of food being blown into the cages, thereby potentially reducing feed costs and the release of food waste into the water column. Another novel design is converting and repurposing an oil rig for sea farming.

Technology development is rapid and it is expected that some of the more advanced Norwegian underwater cage technology will shortly be available. New Zealand can benefit from these technological advances, which could enable open ocean salmon farming as well as reduce environmental impacts of the activity. We could also investigate similar incentive schemes to help speed up New Zealand-based technological developments.

Fish are harvested with automated vacuum pumps that suck the fish from the pens and down a chute located on a barge, where they are automatically stunned and killed. An automatic knife then bleeds the fish and they are graded by hand. Feed comprises between 50 and 70 per cent of the costs of operating the farm. NZ King Salmon recently reported achieving a 1.81 conversion rate (ie 1.81 kilograms of feed producing 1 kilogram of salmon). Currently, the main components of its feed are avian meal (26 per cent), wheat (19 per cent), fish meal (18 per cent), vegetable meal (16 per cent) and fish oil (9 per cent). Most feed is imported from Tasmania and is supplied by the Norwegian company Skretting. Skretting has recently established a land-based experimental salmon farming site at Okiwi Bay in the Sounds in order to design and test feed that is specific to king salmon, given that Atlantic salmon is the species mainly grown overseas. The Cawthron Institute has also recently built a large land-based finfish research centre in Nelson, which is the location of a king salmon feed efficiency project. These developments should facilitate further progress in selective breeding, feed components and feed conversion rates.

New technology has the potential to further transform the sector, particularly through enabling aquaculture to move into the open ocean. The largest salmon-producing regions in the world (Norway, Scotland and Tasmania) are all looking to move salmon farming offshore to enable expansion and to address problems of eutrophication, lice, pests, disease and community opposition. Radical new technology is being developed to enable this shift. Norway is the leader in this area, with strong government support for investment in innovation to develop commercially viable offshore farms (see spotlight below). This new technology has been described as a game changer for the industry.
lice, were that to become a problem in New Zealand. However, as discussed in Chapter 2, this is a novel development and the impacts of increased nutrient discharges into deeper sea ecosystems would need to be carefully researched prior to farming taking place. In addition, seal predation may become a greater issue, with it potentially being harder to protect submerged farms from attack.

6.4 Other species
A few other species have been commercially farmed from time to time but are still small scale. For example, pāua pearls are being grown in the Tory Channel. Moana New Zealand is successfully growing around 80–90 tonnes of pāua on a land-based site adjacent to the NIWA Bream Bay Aquaculture Centre and is looking to lift its production in the future. Pāua (Haliotis iris) has been farmed commercially at small scale since 2002 and methods have evolved over time. Trays are used but initially had to be frequently cleaned of waste food and faeces, with a resultant staffing cost. Varying feeding routines were trialled, but the pāua failed to reach the same size as those in the wild, where they are bathed in swirls of oxygenated water on rocky reefs. Eventually a new system was adopted whereby water was regularly poured over the trays, clearing them of debris and providing conditions more similar to those in the sea. This enabled pāua to grow to full size. Pāua is still not an easy species to farm. The animals take at least four years to reach harvestable size and feed needs to be provided throughout this long growing period. One of the advantages of farming pāua is that small animals can be harvested as ‘cocktail pāua’ to meet market demand, whereas there are minimum size limits which prevent this in the wild fishery.

Flat oysters (Ostrea chilensis) were successfully farmed in the Marlborough Sounds and Stewart Island for some years, but all the farms were removed in 2017 when the parasite Bonamia ostreae was discovered in Stewart Island (after being discovered in the Sounds two years earlier) in order to protect the wild dredge fishery.

There has been much experimentation over the years with farming other species, including scallops, snapper, crayfish, prawns and kina. The New Zealand geoduck (Panopea zelandica) has been identified as potentially suitable for aquaculture, although not a great deal is known about the wild population. The species is also called ‘elephant clam’ because of the large meaty syphon that extends out of the shell. It is considered a delicacy in China. Farming the species will likely be dependent on the production of hatchery spat as there is no known source of wild spat supply. The Cawthron Institute is currently undertaking a programme of research into the species aimed at enabling its successful commercial culture.

There has long been interest in farming the indigenous yellow-tailed kingfish (Seriola lalandi lalandi), with NIWA having successfully grown the fish through its entire lifecycle in the Bream Bay hatchery. Breeding work on hāpuku (Polyprion oxygeneios) is also advanced, although not as progressed as kingfish. These species have yet to be commercialised, but Pare Hauraki Kaimoana have successfully tendered for the rights to apply for a resource consent in the Coromandel Marine Farming Zone with the intention of farming kingfish, as discussed in Chapter 2. Butterfish may also have promise. It has high quality, firm white flesh, which is attractive to the market. Being largely vegetarian, the cost of feed is relatively low and does not require any wild fish components.

Farming indigenous species of finfish will likely raise new issues and risks that have not been encountered in salmon farming, as there are naturally occurring parasites and diseases associated with local species (see Section 7.7). In addition, there will likely be different challenges regarding the development of suitable feed and obtaining good feed conversion rates.

Seaweed culture appears to have considerable potential as a polyculture, being located on the fringes of current farms or as a dedicated farming operation. However, its commercial viability has yet to be proven. Seaweed aquaculture is more benign to the marine environment than other forms of marine farming, as it makes its own food through photosynthesis and in doing so extracts carbon and nitrogen from seawater. Seaweed groves could be grown above or outside shellfish or finfish farms. There is also potential for large offshore seaweed farms, which would require minimal husbandry until harvest.
Seaweed aquaculture could provide considerable benefits, both in helping to ameliorate the impacts of climate change and providing valuable products and food. Seaweed beds are very efficient at capturing CO₂, with wild seaweed beds capable of storing up to 10 times the amount of carbon stored by a similar area of forest. As well as extracting CO₂ from seawater, seaweed can ameliorate the impacts of ocean acidification by increasing localised pH levels and oxygen. Seaweed aquaculture could therefore be seen as a form of ‘blue carbon farming’.

An article by Duarte et al (2017) provides a useful overview of the potential benefits of seaweed farming. As well as sequestering CO₂, the farming of seaweed could help with climate change mitigation in other ways. Seaweed can be used as an input to biofuel production, and would be a more sustainable source than crops which require arable land, freshwater and fertilisers. For example, scientists have calculated that using less than 1 per cent of Norway’s exclusive economic zone for seaweed aquaculture could supply up to 60 per cent of the country’s transportation fuel needs.

The nutrient-rich residues after biofuel production, or composted seaweed, can be used as fertiliser, thereby reducing the need for emissions-producing synthetic fertiliser production. If fermented seaweed is added to the feed of ruminant animals (such as cows and sheep), there are indications that it could significantly reduce methane emissions. When grown for human consumption, seaweed could help replace other sources of food with greater carbon footprints.

The University of Waikato is currently leading a $13 million project designed to investigate the production of species such as kelp, red algae and sea lettuce for use as feed supplements, cosmetics and human foods. In particular, the project will investigate the use of seaweed to reduce methane emissions from stock and to help fight pathogens affecting agriculture and horticulture, including the Psa bacteria in kiwifruit.

Multi-trophic aquaculture, where different species are farmed together, has long been discussed but has yet to happen at any scale in New Zealand or elsewhere in the world. In theory, shellfish could be farmed in the vicinity of finfish farms in order to benefit from increased phytoplankton production resulting from elevated inflows of nitrogen from the caged fish. As well as growing a valuable product, shellfish extract phytoplankton from the water column, thereby potentially helping to ameliorate the risk of algal blooms. Seaweed extracts nitrogen from the water column, something that is produced by both finfish and shellfish farms. The mussel and seaweed lines could also act as a wave buffer for the fish cages. Experiments with this approach have been undertaken in places such as Canada, Spain and Scotland.

This relationship was investigated by marine scientist John Zeldis in a nitrogen mass-balance study exploring the carrying capacity of the Firth of Thames for finfish farming. Zeldis estimated that harvesting 10 tonnes of mussels would remove the same amount of nitrogen added by the farming of one tonne of fish. A different study, which looked into the possibility that finfish farming in the Pelorus Sound could benefit mussel farms, found that any benefit was likely to be small, resulting in only a few per cent increase in food, and then only over the summer months. This indicates that mussel farming has a greater potential to ameliorate the impacts of finfish farming, than finfish farming has to increase mussel production.

Seaweed farming is occurring in some parts of Scotland as part of an integrated multi-trophic approach to aquaculture – a practice that derives from traditional Chinese marine farming. A joint trial project, to investigate the viability of the concept, is currently underway in Loch Fyne on the west coast of Scotland. It is supported by a partnership between the Loch Fyne Oyster Company, the Scottish Salmon Company and the Scottish Association for Marine Sciences. The trial involves cultivating seaweed and shellfish close to a salmon farm. It is hoped that they will utilise the nutrients that the salmon farm releases into the water column. This, in theory, will lead to higher seaweed and shellfish production whilst at the same time reducing any excess nitrogen in the water column. Such an approach (if it works) could both increase productivity and reduce environmental impacts. The trial is still in its early stages. We could learn from such projects and look to develop similar trials near salmon farms in New Zealand.

Because of the complex way in which water moves, it may be impossible to fully ameliorate the impacts of aquaculture on a site-by-site basis. Another way of approaching the concept is to move to a bay- or region-wide scale. Some farmed species are nitrogen producers and others are nitrogen extractors. A marine spatial planning framework could potentially identify where best to put particular species groups based on hydrodynamic modelling and predicted broad
movements of nutrients. On an even broader scale, other positive effects such as habitat restoration through shell drop (in appropriate areas), nutrient uptake and protection from dredging and trawling could be factored into a bay- or region-wide marine restoration strategy. This would be consistent with the ‘zone-based’ management and monitoring system proposed by Hilke Giles and (and further discussed in Chapter 2). It would represent a move away from an effects-based, mitigation mindset, which has become entrenched under the RMA, to proactively seeking positive outcomes, which could be further supported in a reformed resource management system (see Chapter 4).

6.5 Spat supply and retention

As already indicated, most of the industry is at least partially reliant on spat which has attached to seaweed and other debris and is washed up onto Ninety Mile Beach. More than 100 tonnes of this material is collected each year and is transported in refrigerated trucks to mussel farms around the country. The spat is collected by hand in scoop nets and also through the use of a tractor with a large net attached to the front. Harvesting was brought under the quota management system in 2004, and quantities are restricted by a total allowable commercial catch. Spat supply at Ninety Mile Beach has been highly variable over the years, and the reason for this is unknown. In 2000, Gymnodinium catenatum (which causes paralytic shellfish poisoning) developed along the west coast of the North Island, and this prevented the collection of spat for a time to avoid its spread to mussel-growing areas.

Despite the economic importance of this product, which is critical to the $350 million mussel industry, the location of the source mussel beds is still unknown and they remain unprotected. Genetic and geo-chemical marker analysis has been used to throw some light on this issue, and this indicates that there may be several source populations. Marine scientist Andrew Jeffs reported to the 2018 Aquaculture New Zealand Conference that New Zealand may have reached ‘peak wild spat’. The spat-encrusted debris arriving on the beach is reliant on wind flow, with westerlies, which are predicted to become more prevalent off the coast under climate change, not being helpful in this respect.

On top of a restricted and uneven supply, there is a very high proportionate loss of both wild-caught and hatchery-produced mussel during the growing process. One scientist has estimated that less than five per cent of mussel spat that is seeded onto farms survives to harvestable mussels. As well as reducing production, this has significant financial implications, as spat costs the industry around $6–8 million a year. This comprises some 20 per cent of total operational costs. A 5 per cent increase in retention would halve the requirement for spat, saving several million dollars in costs each year. It would also help alleviate the current shortage of spat, which is hindering the operation of farms at their full productive capacity.

The biology of the spat (and the green-lipped mussel itself) is still poorly understood. Small mussels are quite mobile and can choose to move sites if conditions are not favourable, but what triggers them to stay or leave a line (or other sites) is not known. Possibilities include the movement of lines, strength of water currents or salinity of the seawater. There have been some investigations into this issue, but greater investment in scientific research is required to identify any remedial actions.

One potential solution, at least in the case of hatchery-produced spat, is to raise the mussels to a larger size before they are seeded onto ropes. However, on-growing mussels in land-based facilities can be an expensive business given the need to provide food and constant water flow. Solving the spat supply and retention issue would enable the industry to derive considerably more value out of existing space and consequently to operate more profitably. The oyster industry is facing similar challenges with wild spat being inconsistent, of variable quality and with potential biosecurity implications.
KEY MESSAGES

■ Although many species have been trialled over the years, the industry strongly relies on just three species: the endemic green-lipped mussel, the inadvertently introduced Pacific oyster, and the purposefully introduced king salmon.

■ There was significant growth in aquaculture during the 1980s and 1990s, particularly for mussel farming activities. Aquaculture is now a significant contributor to jobs, regional and national incomes, and export earnings.

■ There is a significant Māori presence in the aquaculture industry supported by the 2004 Māori aquaculture settlement. Iwi-owned Moana New Zealand is now the largest farmed oyster producer in New Zealand.

■ Pacific oyster farming is largely confined to northern harbours; mussel farming is concentrated in the Marlborough Sounds and to a lesser extent in waters around the Coromandel Peninsula; and salmon farming is primarily located in the Marlborough Sounds and Big Glory Bay in Stewart Island.

■ More recently, there has been a rationalisation in the industry, leading to greater concentration and corporatisation of ownership. There are now four main growers of Pacific oysters and two main growers of salmon.

■ All three sectors are currently facing significant barriers to growth. For Pacific oysters the main constraint has been the herpes virus, which has increased mortalities, driven many growers out of the industry and prompted a move towards the use of hatchery spat and basket technology. For mussels, the main constraint is a shortage of spat and poor spat retention on lines. For salmon, the main constraint is availability of suitable water space and additional smolt supplies. A shortage of labour is also a considerable constraint for mussel and oyster growers, potentially on a par with spat.

■ For oysters and mussels, there is considerable potential to increase production from existing space through selective breeding, increased spat retention (for mussels) and improved growing methods and technologies. For salmon, a move to deeper, cooler sites is required if the industry is to grow significantly.

■ There is considerable potential to develop new high value products from existing species, particularly in the ‘superfood’ nutraceutical markets.

■ There is also potential to better utilise ‘pest’ species growing on mussel lines such as blue mussels and Undaria.

■ New technology is facilitating open ocean finfish farming which could help reduce conflicts and enable the salmon industry to grow significantly.

■ Farming indigenous finfish will likely raise new issues and risks that have yet to be encountered in the New Zealand aquaculture industry due to naturally occurring parasites and diseases associated with local species.

■ Seaweed aquaculture could have considerable potential either as a stand-alone activity or integrated into existing farms. It could deliver significant environmental benefits.

■ Multi-trophic aquaculture is as yet largely unproven, but has some potential to increase production. It may be better undertaken at a bay- or region-wide scale.
Endnotes

1. Clough and Corong, 2015
2. Pambudi and Clough, 2017
3. Te Atiawa Manahwhenua ki Te Tau Ihu Trust, 2011, para 4.1
4. Aquaculture New Zealand, 2018
5. Aquaculture New Zealand, 2018
6. Allison and Destremau, 2015
8. This is because the leases were drawn up at a time when the indigenous oyster was being farmed, which grows higher up the intertidal area than the Pacific oyster
9. Individual oysters with four sets of chromosomes naturally occur, and when these breed with diploids (with two sets of chromosomes) they produce triploids. However, as triploids are unable to reproduce they do not persist past one generation
10. Allison and Destremau, 2015
11. Aquaculture New Zealand, 2018
12. Rebecca Clarkson, pers comm
13. Clough and Corong, 2015
15. New Zealand Institute of Economic Research, 2018
17. Smith, Moore and James, 2016
18. Smith, Moore and James, 2016, 7
19. Camara and Symonds, 2014
20. See http://aromanz.nz/about-aroma/
21. Eder, 2018
22. Wright, 2012
23. Taunton, 2018
24. Aquaculture New Zealand, 2018
25. Grant Rosewarne, pers comm
26. Haworth, 2010
27. New Zealand King Salmon, 2018
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32. Davies, 2016
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36. Seafood New Zealand, 2017
37. Gribben and Heasman, 2015
38. Ensor, 2009
39. NIWA News, 2018
41. Soto, 2009
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43. Broekhuizen, Hadfield and Plew, 2015, 117
44. https://www.zerowastescotland.org.uk/content/integrated-multi-trophic-aquaculture
45. Giles, 2019, 61
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47. Beston, 2000
48. Dunphy, Silva and Gardner, 2015, 24
49. Jeffs, 2018
50. Andrew Jeffs pers comm
Environmental considerations

Mussel farm, Kairara Bay, Great Barrier Island
Farming the sea has a range of potential environmental effects which it is important to understand when considering a management regime for the sector. The scientific knowledge about many of these has been ably summarised by Keeley et al in their 2009 publication Sustainable Aquaculture in New Zealand: Review of the Ecological Effects of Farming Shellfish and Other Non-fish Species and by Forrest et al in their 2007 publication Review of the Ecological Effects of Marine Finfish Aquaculture: Final Report. In addition, in 2013 MPI commissioned a Literature Review of Ecological Effects of Aquaculture, which updated material in the earlier reports. Although now somewhat dated, these documents are the most recent compilations of science on the topic. The description below, which covers some of the more significant effects (but not all impacts), draws heavily on these reviews.

7.1 Seabed
Effects on the seabed from farming oysters and mussels are primarily due to shell and related material dropping off the lines or racks and deposits of faeces and pseudofaeces excreted from the animals. Biofouling cleared from farms can also contribute to organic matter dropping to the seabed. When filtering seawater to extract food, mussels also inadvertently filter out other inedible particles such as sediment. In order to expel these particles, the animal binds them in mucus and ejects them out of its body and into the water column. These ‘pellets’ (pseudofaeces) then often sink to the seabed. The effects of all these deposits are well studied and usually comprise a mild enrichment of seabed sediments (around a 7.5 per cent increase in organic matter) and a build-up of sediment and shell beneath the farms. This in turn can result in changes to the relative abundance of species living beneath the farms (favouring some smaller species), and potentially an increase in the number of predators such as starfish, which feed off the dropped mussels.

Such effects have been assessed by scientists as being low to moderate in severity, and they generally do not result in major disruption to the communities living under the farms. They are largely confined to the footprint of the farm and ‘are usually difficult to detect within 20 to 50 metres away’. Although the effects are generally mild, they can take years to reverse depending on the site (see spotlight on East Bay below). Oyster racks can increase sediment build-up on the seabed by interrupting current flows. Shell and other debris falling from the racks can also impact the seabed. Such impacts can be reduced by the use of basket technology, which requires less artificial structure in the marine area and reduces shell drop.

At Port Underwood, a reduced abundance of species with special ecological value has been recorded under mussel farms.
A spotlight on rehabilitation of mussel farm seabed impacts at East Bay

The removal of a mussel farm from East Bay (in the outer Queen Charlotte Sound) in 2002 provided an excellent opportunity to monitor the benthic effects of the farm and the speed and nature of natural rehabilitation processes. Monitoring was undertaken over an 11-year period (2002–2013) after a farm that had operated on the site for 14 years was removed. The site was located at depths of 17 to 30 metres.

In terms of the effect of the farm on the seabed, divers found considerable mussel shell debris under the growing areas, and this had negatively affected a number of species including giant lampshell, scallop and horse mussel, which were present in fewer numbers. These filter feeders were likely affected by increased sediment, in the form of pseudofaeces, and may also have been smothered by shell drop-off. In general, the effects were greater on filter feeders than deposit feeders or predators such as starfish and kina, which increased in numbers under the farm. This was likely due to their ability to feed on the dropped mussels.

The study found that the recovery of the seabed surface took substantial time, with the deep mud requiring between five and 11 years and the coarse, soft sediment taking up to 11 years. Once the farm was removed, the number of predators declined quickly, most probably due to the lack of supply of mussels as food. However, it took 11 years or more for the populations of filter feeders such as horse mussel and giant lampshell to recover, with some other species such as scallops making a quicker comeback.

The site was approved for mussel farming at a time when there was little environmental scrutiny and it would not likely receive approval today. This indicates the importance of good siting for mussel farms and ensuring that they are located over substrates that can assimilate low to moderate enrichment.

In some cases, shellfish farms can have positive effects on the seabed, particularly where it has been impacted by other activities such as trawling, dredging and catchment-derived sediment. This is through increasing the amount of complex structure on the seabed through shell drop and the creation of three-dimensional habitat. Increased macro-fauna biodiversity has been observed under some mussel farms. Such beneficial effects will depend on the characteristics of the site, and are generally greater where there is sufficient water movement to disperse the faeces and pseudofaeces, so they do not accumulate under the farm.

The farms themselves can also provide habitat for a diverse range of non-farmed species. For example, a study of biofouling organisms on two mussel farms identified 71 different taxa present on the mussel ropes, mainly suspension feeders. ‘After 6 months, biofouling organisms on average comprised 54% of the total rope biomass.’ Much of this is lost, however, when the lines are stripped for reseeding or harvesting. Support from marine farmers for reef restoration projects, through providing live mussels at no or reduced cost, can also help seabed restoration efforts in areas where seabed conditions are suitable for mussels. For example, the Revive Our Gulf project, which is working to restore mussel beds in the Hauraki Gulf, has been supported by Coromandel mussel farmers. A $500,000 project has recently been initiated in the Marlborough Sounds aimed at re-establishing wild mussel beds. The project is being led by the Mussel Farming Association and is co-funded by MPI’s Sustainable Farming Fund and the industry.

Salmon farms, and likely any future finfish farms utilising other species, have a much more significant effect on the seabed than shellfish farms. This is due to the introduction of feed into the system. The deposition of faeces from the fish (and small amounts of uneaten feed) onto the seabed leads to organic enrichment, which can significantly change its chemistry and ecology. The effects can extend, in a decreasing gradient, tens to hundreds of metres from the farm in a depositional ‘footprint’. These effects can be reduced by locating farms in appropriate sites which are deep and well-flushed. Well-flushed sites help to reduce the impact in the vicinity of the farm, but result in milder impacts spread over a larger area of the seabed. This raises the question of whether it is better to create a small footprint with intense impacts (thereby containing them) or a larger footprint with reduced impacts (thereby spreading lesser impacts more widely). For example, the deposition footprint from the recently established high flow Waiatapa salmon farm in the Marlborough Sounds extends at least 800 metres from the farm, covering an area of around 38 hectares.

Good farm management can also help to reduce impacts from source. For example, the majority of modern farms use automated feeding systems, which shut off when underwater cameras detect uneaten food. This significantly reduces feed costs and the amount of waste reaching the seabed. In addition, lower feed conversion ratios can reduce the amount of feed that is required to be dispensed into the water column in the first place.
‘More than 20 years of research and investigation both within New Zealand and overseas has consistently shown that finfish farm discharges can change well-aerated and species-rich soft sediments in the vicinity of the farm cages into anoxic (oxygen-depleted) zones that can be azoic (devoid of life) in extreme cases, or dominated by only a few tolerant sediment-dwelling species.’

(Forrest et al, 2007)⁹

Excessive enrichment manifests as black-coloured sediment; a sulphide smell; cream or white coloured patches of bacteria mat on the seafloor; a lack of living organisms within the sediment; and, in extreme cases, gas bubbles emerging from the seafloor. All these markers have been observed under low flow salmon farms in New Zealand at some stage. Bacteria breaks down decaying plant and animal material, and the presence of bacteria mats is an indicator of a low oxygen environment. In weak flushing sites such as Forsyth Bay, Otanerau Bay and Ruakaka Bay in the Marlborough Sounds, pronounced effects have been observed.⁹ By 2013, the seabed ecology at the Otanerau Bay site ‘had all but collapsed’, and there was ‘persistent anoxia’. Ruakaka Bay was identified as a site ‘close to the edge’.¹⁰ The site at Waihinau Bay, which had been farmed since 1989, had ‘little, if any, resilience left in the benthic environment to assimilate large quantities of organic matter’.¹¹

The Waihinau Bay site is still being farmed on a rotation falling system, with the most recent stocking in 2018. There is no requirement attached to the resource consent to monitor the condition of the seabed (despite its marginal suitability for salmon farming). To its credit, NZ King Salmon is undertaking monitoring on a voluntary basis, and the results are made publicly available. The 2018 monitoring exercise, which was undertaken around six months after the latest restocking, found that the sediments at the site were highly enriched with bacteria mat present and high numbers of enrichment-tolerant species. Some localised areas had regressed to ‘post-peak’ conditions, meaning that enrichment was so great that total biomass of nutrient tolerant species was declining. The monitoring report recommends that feed input into the site be ‘closely monitored to prevent further deterioration’.¹²

It was a similar situation at the Otanerau Bay site, which is still being farmed. This site also showed very high enrichment, with some areas at post-peak condition. Luckily, these impacts are largely confined to the farm sites. Conditions were more positive at the Ruakaka Bay farm where enrichment is moderate to high.¹³
A spotlight on seabed enrichment at Forsyth Bay

A salmon farm was established at Forsyth Bay in 1994 in around 30 metres of water. Before it was fallowed in 2001, an investigation found little sign of any marine life under the farm – the seabed was covered with extensive bacterial mats and gas rising to the surface from the sediment. The site was so poorly suited for salmon farming that an international expert advised the Marlborough District Council that it should consider ‘revoking the consent for the site’. Monitoring of the site after it was fallowed showed that the condition of the seabed started to improve within a year of the farmed fish being removed. The bacterial mats disappeared, and there was an increase in the abundance of animals within the sediment. After 4 to 5 years ‘recovery’ had ostensibly been achieved although ‘significant differences were still evident in some environmental indicators’. The overall health of the sediments was much slower to recover than the surface communities (and slower than anticipated by scientists), with some areas of sediment still organically enriched after eight years. In addition, only about 50 per cent of the benthic species groups dominant prior to the farm enrichment, had re-established. At that stage (in 2009), the farm was restocked and it has been managed under a rotational stocking and fallowing regime since that time. An investigation into the impact of restocking in 2009, found a rapid deterioration in seabed health within only three months, with the seabed changing from a ‘near-natural state’ to having ‘severely impoverished macrofauna’. Virtually all the species that had re-established after fallowing disappeared within that short time.

The farm was most recently destocked in early 2016. In a 2018 monitoring report scientists concluded that, due to persistent enrichment of the deeper sediments, the seabed may never fully recover without remedial work. Very high levels of zinc were also measured within the sediment (the highest recorded at any monitored farm site in New Zealand), with average levels across the site three times the high level recommended by the Australian and New Zealand Environment and Conservation Council. Such a high heavy metal load will also likely be contributing to adverse ecological effects.

This case study highlights the importance of avoiding such high levels of enrichment in the future and the danger of assuming that sites can naturally recover after heavy enrichment over long periods of time. Restocking of an already compromised site can also result in rapid deterioration. In this case, scientists had expected the site to fully recover naturally, but this has not happened. This illustrates the limitations of our current knowledge of marine ecosystems and the need to apply precautionary approaches.

Nutrient caps and fallowing of farm sites are being used in Big Glory Bay, Stewart Island, to manage benthic effects (see spotlight below). Farms there are also located in shallow depths, and in reduced flushing conditions. A modelling study estimated the residence time for seawater to be around four weeks in low wind conditions.

The benthic conditions of consent on the older salmon farms were particularly lax, with some only requiring the avoidance of a ‘dead zone’ beneath the farm. Some, such as the farm in Waihinau Bay, had no monitoring requirements. More recently, best practice standards for the benthic impacts of salmon farms in the Marlborough Sounds have been developed. This regional approach should be commended, as it is a significant improvement on the previous approach. However, the new standards still allow serious degradation of the seabed (see spotlight below), albeit at a level where recovery is thought still to be possible.

Research within New Zealand has sought to identify methods to expedite seabed recovery once it has become highly enriched. For example, a team of scientists at Cawthron have investigated the efficacy of three methods: heavy raking of the seabed (harrowing), pumping oxygenated surface water into the sediments (irrigation), and removing the affected sediment from the site. Only the third option proved to have any beneficial effects on seabed condition. Its application at a commercial scale would require a better understanding of the effects of sediment dispersal during the removal process as well as finding somewhere to safely dispose of the sediments.

As described in Chapter 3, technology is currently being developed overseas to capture waste within farm nets, so it can be extracted from the marine system before it reaches the seabed. Given the significant detrimental effects that fish farm waste can cause when deposited on the seabed, this technology should be expedited as soon as possible to become an integral component of standard operating practice at low flow sites in New Zealand.
Salmon farming in the Marlborough Sounds and Big Glory Bay, Stewart Island, have adopted different approaches to managing benthic impacts. In the Marlborough Sounds, benthic environmental quality standards are now in place to manage salmon farms there. Their purpose is to ‘provide consistent and clear requirements for the independently conducted, annual benthic monitoring and management of existing farms’. They provide for three monitoring levels depending on the risk created by the site and set out where sampling should be undertaken. A series of zones is used to provide an indication of the spatial extent of impacts. Zone 1 is the area of the cages, Zone 2 is typically an area 50 metres around the cages, and Zone 3 extends to 150 metres away. Enrichment levels are measured across a gradient which increases in tenths from 1 (natural) to 7 (anoxic) (see Figure 7.1). The enrichment levels are calculated using a weighted averaging approach, with the organisms present within the sediment having the greatest influence on the score (0.7) compared to organic loading (0.1) and sediment chemistry (0.2).

An environmental quality standard is set at an enrichment level of 5 ‘high enrichment’; that is, farms can continue operating at this level but not if it is exceeded. The environmental characteristics of the sediment in low flow sites, at this permitted level, are described as including very high numbers of opportunistic species, very low species richness, major sediment chemistry changes, the presence of bacterial mat, and out-gassing occurring on the disturbance of the sediment. At high flow sites the characteristics are less pronounced in some areas although there are greater numbers of opportunistic species present (see Figure 7.2).

The enrichment level of 5 is the point where there is the greatest biomass of life under the farm, comprising a few enrichment-tolerant opportunistic species. This means that the system, although highly degraded, has the greatest ability to assimilate waste produced by the farm. When the enrichment level moves towards 6, sebed communities start reducing in size, waste metabolism declines abruptly, and waste products start accumulating under the farm with consequent impact on fish health. Level 5 therefore comprises a ‘sweet spot’ for the farming operation where the waste assimilation ‘service’ provided by the highly modified seabed community is maximised. However, it also comprises a highly degraded natural system.

If enrichment levels greater than 5 are measured anywhere on the site, a management response is required to reduce them beneath that level within 24 months. If after that time, any part of the farm exceeds 5.6, the farm must be destocked. If the farm is to be restocked at any stage there must be a stocking plan that enables the site to meet the standard in the future. All consent renewals for salmon farms in the Sounds after the standard was produced have had it attached to their consent (including the Clay Point and Te Pangu sites).

A different system used to operate at Big Glory Bay in Stewart Island, which focused on inputs rather than effects. A total cap of 332.064 tonnes of nitrogen was placed on inputs into the marine system via feed each year. The cap applied over all seven sites consented for salmon farming, which are operated by Sanford. To keep within the cap, the farming operation ran a monthly budget for the amount of nitrogen in the feed that was dispensed into the water column. Each site had an individual nitrogen cap, but with the ability to deploy the total authorised nitrogen input across all or any of the sites ‘provided that significant adverse effects on the seabed are avoided and other effects can be remedied or mitigated’. A significant adverse effect was defined as occurring if ‘no marine life exists under salmon cages’; that is, when it has become a dead zone. The seabed impacts are managed via a fallowing plan, with each site able to be farmed for two years and fallowed for five years in a seven-year cycle, designed to allow the sites to recover and to avoid cumulative long-term effects.

In 2019, Sanford was granted a variation to the conditions attached to the consents, which almost doubled the overall nitrogen limit applied to the existing salmon farms in the
bay to 659 tonnes (thereby allowing more intensive stocking levels). Conditions provide for a progressive increase in levels to reach the maximum no earlier than 2021. Other conditions applying to benthic effects focus on similar matters to the benthic environmental quality standards developed for the Marlborough Sounds, and include maintaining diversity and abundance of marine taxa at levels which allow for sufficient seabed recovery through a farm rotation cycle, with a fallowing period of not less than five years. The proposed conditions specify no more than 20 per cent of core samples to have no taxa present; no visually obvious, spontaneous out-gassing of hydrogen sulphide or methane; and bacteria mat coverage no greater than 50 per cent of the sampled area.26

Figure 7.1 Enrichment gradient for benthic impacts of salmon farming
(Source: Benthic Standards Working Group, 2014)
<table>
<thead>
<tr>
<th>ES</th>
<th>General description</th>
<th>Environmental characteristics: LF – low flow sites</th>
<th>HF – high flow sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td><strong>Pristine end of spectrum.</strong> Clean unenriched sediments. Natural state, but uncommon in many modified environments.</td>
<td>LF: Environmental variables comparable to an unpolluted/un-enriched pristine reference station. HF: As for LF, but infauna richness and abundances naturally higher (~2 × LF) and % organic matter (OM) slightly lower.</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td><strong>Minor enrichment.</strong> Low-level enrichment. Can occur naturally or from other diffuse anthropogenic sources. 'Enhanced zone.'</td>
<td>LF &amp; HF: Richness usually greater than for reference conditions. Zone of 'enhancement' – minor increases in abundance possible. Mainly a compositional change. Sediment chemistry unaffected or with only very minor effects.</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td><strong>Moderate enrichment.</strong> Clearly enriched and impacted. Significant community change evident.</td>
<td>LF &amp; HF: Notable abundance increase; richness and diversity usually lower than reference station. Opportunistic species (i.e. Capitellid worms) begin to dominate.</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td><strong>High enrichment.</strong> Transitional stage between moderate effects and peak macrofauna abundance. Major community change.</td>
<td>LF: Diversity further reduced; abundances usually quite high, but clearly sub-peak. Opportunistic species dominate, but other taxa may still persist. Major sediment chemistry changes (approaching hypoxia). HF: As above, but abundance can be very high while richness and diversity are not necessarily reduced.</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td><strong>Very high enrichment.</strong> State of peak macrofauna abundance.</td>
<td>LF: Very high numbers of one or two opportunistic species (i.e. Capitellid worms, nematodes). Richness very low. Major sediment chemistry changes (hypoxia, moderate oxygen stress). Bacterial mat usually evident. Out-gassing occurs on disturbance of sediments. HF: Abundances of opportunistic species can be extreme (10 × LF ES 5.0 densities). Diversity usually significantly reduced, but moderate richness can be maintained. Sediment organic content usually slightly elevated. Bacterial mat formation and out-gassing possible.</td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td><strong>Excessive enrichment.</strong> Transitional stage between peak abundance and azoic (devoid of any organisms).</td>
<td>LF: Richness and diversity very low. Abundances of opportunistic species severely reduced from peak, but not azoic. Total abundance low but can be comparable to reference stations. % OM can be very high (3–6 × reference). HF: Opportunistic species strongly dominate, with taxa richness and diversity substantially reduced. Total infauna abundance less than at stations further away from the farm. Elevated % OM and sulfide levels. Formation of bacterial mats and out-gassing likely.</td>
<td></td>
</tr>
<tr>
<td>7.0</td>
<td><strong>Severe enrichment.</strong> Anoxic and azoic; sediments no longer capable of supporting macrofauna with organics accumulating.</td>
<td>LF: None, or only trace numbers of infauna remain; some samples with no taxa. Spontaneous out-gassing; bacterial mats usually present but can be suppressed. % OM can be very high (3–6 × reference). HF: Not previously observed — but assumed similar to LF sites.</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 7.2 General descriptions and primary environmental characteristics for the seven enrichment stages* (Source: Benthic Standards Working Group, 2014)
Another effect on the seabed arises from the deposition of zinc and copper from fish feed, and also from anti-fouling where copper-based products are used. The metals do not break down so can accumulate in marine sediments. These metals are naturally present in seawater, in very small concentrations, and they are essential elements for marine life. However, excess concentrations can be harmful, impacting on the ability of marine organisms to grow and reproduce. The extent of the effects will depend on how much of the metal is in a form that can be taken up by marine life (bioavailable). In sediments under highly organically enriched farms, much of the metal is bound up in an insoluble form, so it does not enter the water column where it can be ingested by organisms. However, a high zinc residue would likely be a problem, in the event that the site is fallowed and the metal starts to be released.

Zinc has been found at levels exceeding guidelines for ‘probable ecological effects’ under New Zealand salmon farms and copper at lesser concentrations that at times exceed guidelines for ‘possible ecological effects’. A rotational fallowing system will only slow down accumulation and the only real solution is to retire the sites from farming or remove these compounds from the farming system. This has been achieved in respect of copper-based anti-fouling, which is no longer used on nets. The amount of zinc additive to feed has also been significantly reduced. As already indicated, there has been some research into the option of removing the top layer of sediment from under farms and disposing of it on land, but this would only likely be an option for small sites and would need to be undertaken with care to avoid other environmental impacts. The use of treated timber for oyster posts and racks can also result in toxins leaching into seawater, with the basket system reducing this risk through reducing the need for rack infrastructure.

7.2 Water column

There are a number of ways in which oyster and mussel farms can affect the water column. Farm structures can affect waves, currents and flushing times, although the effects are usually small outside sheltered bays. In sheltered places, where farms form a ribbon around the perimeter of a bay, the effects on shallow subtidal and intertidal reef communities could be significant. Species that rely on water movement for their survival, such as seaweeds and filter feeders, can be particularly impacted. However, to date, there has been little research into this issue.

Farmed shellfish release small amounts of dissolved nitrogen into the water column, which can encourage plankton growth, but they also filter plankton out of seawater. In addition, the animals trap nitrogen in their flesh (and to a lesser extent in their shells) as they grow, and this is removed from the water column on harvest. Shellfish farms can also remove sediment from the water column and drop it onto the seabed as pseudofaeces, although there is no evidence that marine farming actually improves the clarity of seawater. This may be because the pseudofaeces eventually break down and the released sediment is remobilised into the water column.

Mussels, in particular, can potentially affect the quantity and composition of phytoplankton, small zooplankton and fish larvae through their feeding activity. Surveys in Port Underwood, Horseshoe Bay (Pelorus Sound) and Kenepuru Sound have identified localised phytoplankton depletion within mussel farms of up to 50 per cent, and areas close to farms could suffer up to a 20 per cent reduction in available planktonic food, but this research has been criticised for not being methodologically sound. A desktop study calculated the level of reduction in fish eggs at less than 10 per cent in Admiralty Bay, where mussel culture occupies 10 per cent of the water area. Monitoring at the Wilson Bay farms in the Firth of Thames has shown minimal phytoplankton depletion when measured over a 15-year period (see spotlight below). Such water column effects can be reduced through good siting (well-flushed locations) and spacing of farms (to reduce the concentration of mussels in any one area). Potential cumulative impacts are discussed in Section 7.9 below.

A spotlight on phytoplankton impacts of mussel farms in Wilson Bay, Firth of Thames

Determining the impact of mussel aquaculture on phytoplankton levels can be a difficult task. This is illustrated by the wide range of results produced by different assessment methods applied to the Wilson Bay Area A mussel farms. Modelling work undertaken in the early 2000s predicted that chlorophyll a levels within the farms could be reduced by up to 30 per cent, although the reductions were thought likely to be less in practice. Actual monitoring within the farming zone, after 816 lines had been installed, found up to a 19.5 per cent depletion at the centre of the farm. Then, a more recent analysis of satellite imagery over a 15-year period (2002–2017) found a long-term medium of only a 1.6 per cent reduction of chlorophyll a over an area about one and a half times the size of the farm and 6 per cent at the farm centre. The imagery also indicated a small impact on water temperature (warming in winter and cooling in summer likely due to weak physical disturbance to the water flow caused by the farm structures) and no impact on turbidity (cloudiness of the water), indicating that the mussel farms were not improving water clarity through their filtering activity.
Salmon farms can potentially affect the water column through the obstruction of water flow and direct nutrient enrichment, as well as oxygen depletion stemming from the decomposition of waste materials deposited on the seabed (as described above). Dissolved nutrients (mainly ammonia) are directly excreted by the fish into seawater. Such increased nutrients support phytoplankton growth (as seawater is normally nitrogen limited), potentially including algal blooms and changes in phytoplankton species composition. To date, no link between finfish farming in New Zealand and harmful algal blooms has been established. Such effects are likely greater in shallow poorly flushed sites. They tend to be more pronounced some distance from the farms themselves, as there is a time lag between the release of the nutrients (which move away from the farms in the water currents) and their take-up by phytoplankton as they reproduce. This makes them particularly hard to measure as it is difficult to distinguish between the effects of a farm and other inputs into the system. For example, depressed dissolved oxygen levels have been measured in the Tory Channel during several months of the year, as part of routine monitoring of salmon farms there, but it is unclear whether this is a result of salmon farming activity, catchment inputs, and/or other factors.

Recently consented salmon farms typically have a range of water quality standards imposed as conditions. For example, the Ngamahau Bay salmon farm which was established in 2015, is monitored monthly against standards for chlorophyll a, dissolved oxygen and total nitrogen levels. A water quality environmental standard for salmon farming in the Marlborough Sounds is currently under development.

### 7.3 Landscape and natural character

Landscape values are a combination of biophysical elements (at a landscape scale) and the human experiences and values attributed to them. Landscape attributes include natural science factors, aesthetic values, cultural and spiritual values for tangata whenua, and wild and scenic values, amongst others.

Natural character is a different concept and includes the natural elements of the environment and the human experience of them including natural processes and patterns; natural landforms; the natural movement of water and sediment; natural darkness; and experiential attributes including the sound and smell of the sea.

Marine farms affect these values because they involve placing infrastructure and living stock in the marine environment, as well as ongoing farming activities including seeding, feeding and harvesting. Shellfish farms usually have elements that are visible above the surface of the sea. Mussel farms have rows of buoys holding up the mussel lines, which are visible as horizontal structures on the water plane. Although not permanent fixtures, barges working the farms may be perceived as impacting on amenity values when stationary. In addition, navigational lighting marking the farms is typically visible from 2 nautical miles away at night-time, detracting from the ability to experience darkness and natural elements of the night sky such as stars. In the case of oyster farms, rows of wooden racks and posts are typically visible in the intertidal zone during low tide. Finfish farms are usually visible as large vertical structures on the surface of the water. They can be particularly noticeable as farms normally use high nets to keep predators out. There is also typically a barge or floating platform permanently attached to the farm to supply feed to the cages. Marine farming can be perceived as ‘industrialising’ a natural marine environment. The introduction of farmed stock on lines and racks, or in baskets and cages, can reduce the natural character of the marine area through the unnatural configuration of the livestock (which is very different to their natural form, such as mussels or oysters growing on rocks), as can the biophysical impacts on the water column and seabed.

In terms of location, several key variables affect the ability of the marine environment to visually absorb marine farming activities. These are the visual scale of the affected coastal environment, the degree of visual interest in the view, and the elevation and distance from which the farm is likely to be viewed. In terms of biophysical effects, their significance will depend on the values of the site and other effects on the area such as trawling, dredging and sedimentation. Where an area has outstanding natural character, or is an outstanding natural landscape, Policies 13 and 15 of the NZCPS require any adverse effects to be avoided. In areas where such values are not ‘outstanding’, the policies require ‘significant’ adverse effects to be avoided. This requirement was confirmed by the Supreme Court in *EDS v King Salmon*, which related to an application by NZ King Salmon to locate a salmon farm at Port Gore in an outstanding natural landscape. The application was declined on landscape grounds because the impacts of the farm could not be avoided.

Landscape and natural character matters in relation to marine farms were more recently considered by the Environment Court in *Clearwater Mussels Limited v Marlborough District Council*, which considered applications for continued consent (existing consents having expired) for two mussel farms which were also located in Port Gore. The Court held that the presence of marine farming structures would inherently degrade the natural character of the area. This would occur as a result of effects on biotic and abiotic aspects of natural character (in particular the nationally endangered king shag) and from how people would perceive the presence of the uniform grid of lines and buoys. The Court did not consider that reducing the size of the farms or reducing the number of lines for each farm would effectively or sufficiently mitigate or avoid these significant effects (the farms...
jointly covered 6 hectares). Similar findings were reached in relation to effects on the outstanding natural landscape and features of the area. The Court held that even one farm would significantly degrade landscape values. The decision was subsequently upheld by the High Court.

At Beatrix Bay, which is a much more intensively farmed location within the Marlborough Sounds, the Environment Court in *R J Davidson Family Trust v Marlborough District Council* held that the adverse visual effects of the proposed marine farms on natural character might be minor by themselves, but their cumulative effect, on top of the accumulated effects of other mussel farms in the area, would be significant. The Court’s decision was upheld in the Court of Appeal (although the appeal focused on other matters).

In practice, this means that consent will not be granted for marine farms which have adverse effects on the landscape and natural character values of outstanding areas. Often this means that farms simply cannot locate in such areas because it is usually difficult to avoid impacts completely. Farms will also be unable to locate in other areas if they will result in ‘significant’ adverse effects on these values.

Landscape and natural character issues have often featured in marine farm consenting because the places sought by marine farmers, which have clean water and high flows, are often in the more remote areas with high landscape and natural character values. For example, an analysis of marine farm consent applications in Marlborough District during the late 1990s and early 2000s found that, of 62 refused applications, 87 per cent cited significant adverse effects on natural character, landscape and amenity values as one of the reasons for the decline. Ecological issues were also regularly mentioned and were one of the reasons for decline in 35 per cent of the applications. Cultural reasons were identified in 15 per cent of refused applications. A move to offshore aquaculture could enable such conflicts to be substantially reduced in future farms, although it may raise other concerns such as conflicts with marine mammals and fishing rights.

### 7.4 Marine mammals and seabirds

Aquaculture can impact marine mammals and seabirds through human disturbance, entanglement in gear, exclusion from habitat, impacts on food sources, and introduction of plastic (see below). This has been an issue for some species in the Marlborough Sounds, with concern that proposed mid-bay aquaculture in Admiralty Bay would exclude dusky dolphins from herding fish and that proposed farms in the outer Sounds could impact foraging areas and food sources for the nationally endangered king shag. There have been concerns raised that these effects could be cumulative, with each farm contributing (along with other human-induced stressors) to the progressive loss of habitat. As a result, the effective management of such effects may require spatial management (as discussed in Chapter 8), rather than relying on site-by-site consenting. Marine farms can also provide positive benefits to seabirds, including providing roost sites close to foraging areas and attracting small fish, which provide enhanced feeding opportunities for the birds.

The issue of habitat exclusion affecting the king shag arose in the 2012 Board of Inquiry process for the NZ King Salmon private plan change and resource consent applications. The Board imposed conditions on the approved salmon farms in king shag habitat requiring the preparation and implementation of a ‘King Shag Management Plan’, including three-yearly population monitoring of the birds. The conditions state that ‘in the event that a statistically significant decline in King Shag numbers has occurred since the previous survey, the consent holder shall investigate whether the operation of the marine farm is causing or contributing to the decline’. The conditions require the management plan to include a response mechanism including destocking or reductions in feed if the farm is found to be contributing to the decline. This has resulted in more frequent and comprehensive monitoring of the birds. Research into the species is also voluntarily part-funded by the Marine Farming Association. However, the requirement in the condition to establish a cause and effect relationship with the marine farm, in the event that there is a decline in the bird population, may be very difficult where cumulative effects are in play.

Entanglement of marine mammals in marine farms is a relatively rare event, given the extent of marine farming in New Zealand, with only 10 reported marine mammal incidents since 1987. The most recent incident was two dead dolphins found in salmon nets in the Marlborough Sounds in November 2018. Offshore mussel farms (and particularly spat farms due to their lighter gear) will likely pose increased risks for migrating whales – especially humpbacks, which are increasing in number, have no echolocation and so rely on sound and vision, and are known to be inquisitive. Their large flukes and flippers, and propensity to roll, makes them a particular entanglement risk.

Such impacts can be minimised to some extent through careful siting (away from migratory routes and frequented habitat) and good management of farms.

### 7.5 Genetic mixing

As described in Chapter 6, in the mussel farming industry spat from Ninety Mile Beach has been trucked to marine farming areas in the Coromandel Peninsula, Marlborough Sounds and Stewart Island for over 30 years. Selectively bred hatchery spat will also likely be used around the country once it becomes more widely available. A key question is what the impact of this use and movement of...
We have clear evidence of interbreeding and successful recruitment and subsequent development of mussels of mixed northern/southern ancestry. (Gardner, 2008)

In the wild, species genetically adapt to their local environment through natural selection. A high level of genetic variation has been found in New Zealand green-lipped mussels, and ‘there is a profound genetic difference between northern and southern stocks’. Recent research has not only confirmed the strong genetic differentiation between North Island and South Island stocks but also genetic differences between juvenile mussels collected from six sites along the west coast of the North Island.

Investigations into the genetic make-up of the Stewart Island stock indicate that there has already been genetic mixing from northern populations, almost certainly through the use of the Ninety Mile Beach spat. The effects of this are not clear, and in particular whether it will reduce or increase the viability of wild populations, with further research being required to better understand the risks.

These findings indicate that if hatchery-produced, selectively-bred mussel spat starts to be used more widely in the industry, this may affect the genetic make-up of wild stocks. Similar issues may arise with the use of hatchery spat for the Pacific oyster, but this species is not endemic to New Zealand and was inadvertently introduced only relatively recently (during the 1970s). It is not thought by scientists that genetic mixing should be a problem with kingfish, due to the wide mixing of genetic material across the Tasman in the wild population. There could be concern if other indigenous species are farmed, with each species having its own genetic characteristics, which will need to be carefully scrutinised. There are ways of mitigating risks of genetic mixing in hatchery-produced spat, such as with the production of triploids, which are not able to reproduce. As already noted, some oyster spat is currently produced as triploids.

7.6 Plastics

Marine farming uses a large quantity of plastic in the marine environment, and so there is the potential for this to enter the food chain. This includes the use of ropes, ties, buoys, baskets, nets, bags and stockings. In particular, stockings breakdown in the water column after seeding mussels onto ropes, and those used for the Ninety Mile Beach spat currently have around a 15 per cent polyester content (the balance being more benign cotton). Rope ties can flick off into the water when being removed from the lines during harvesting. During rough weather, gear can come adrift. It is not uncommon to see mussel buoys and lines littered on the shoreline in the vicinity of marine farming areas. These impacts can be reduced through the application of good operational practices and undertaking regular maintenance to reduce gear loss into the sea. We were told of the involvement of the industry in coastal clean-up initiatives to remove litter from beaches, which is a positive development. Resolving the issue in the longer term is likely to require reducing or removing non-biodegradable plastic from the farming system.

A spotlight on marine farm plastic waste regulation in South Australia

In South Australia, marine farmers have a legal requirement to ‘recover waste or equipment that has been blown, washed or swept off the licence areas as soon as practicable but in any event within seven days’.57

7.7 Biosecurity

Aquaculture is very susceptible to biosecurity risks, being hard hit when new organisms are introduced into the country via overseas vessels and mobile equipment. Marine farms are particularly vulnerable to biosecurity breaches, with new marine organisms potentially outcompeting the farmed species for space and food and smothering gear and animals. This can reduce production levels and increase operating costs. At the extreme level, a breach can wipe out whole farms when it involves a debilitating disease, such as has occurred with Pacific and flat oysters.

On the other hand, marine farms have the potential to increase biosecurity risks through placing a large amount of structure in the water column which ‘provide ideal habitats that allow such organisms to proliferate at high densities’. In this way, the farms can act as a reservoir for further spread of pest species. The colonies on marine farms release spores and larvae into the water column, which enables their further spread. Also, when shellfish are harvested, marine growth (including any invasive species) can be cleared off
Chapter Seven: Environmental considerations

King salmon was introduced into New Zealand without associated parasites or disease, and so the industry has been free of such challenges to date. However, there will likely be enhanced biosecurity risks if indigenous finfish species are farmed. For example, kingfish has a range of known pathogens and parasites, with the most problematic likely to be flatworms and skin flukes. Farms can become breeding grounds for disease due to the high concentration of fish, which can then be transferred to wild populations. They may necessitate the use of therapeutants for treatment, which can result in chemicals entering the marine environment, something not currently required in the salmon farming industry. The cost of managing parasites is seen as a major barrier to the expansion of kingfish farming in Australia (and potentially in New Zealand), with an estimated 20 per cent of production costs likely required for control through the use of chemicals and other treatments.

Perhaps of more concern, the regular movement of gear and live marine material around the country provides a pathway for quick dispersion. As described in Chapter 6, it is common practice for marine farmers to move live spat large distances to grow-out areas, and also to move partly or fully grown stock between farms (see Figure 7.3). A case in point is the transport of live spat from Ninety Mile Beach by truck to the Hauraki Gulf, the top of the South Island (Marlborough Sounds and Tasman/Golden Bays) and Stewart Island. Commercial and recreational vessels also spread organisms around the country once they are introduced into New Zealand waters.

Figure 7.3 Mussel spat movement around New Zealand (Adapted from Keeley et al, 2009, 47)

Marine farms provide substrate in the water column for the establishment of invasive species.
Sea lice – more particularly extensive delousing treatment and increased resistance to treatment – remains one of the most significant challenges for the aquaculture industry in Norway.’

(Standing Senate Commission on Fisheries and Oceans, 2016)67

A spotlight on sea lice risks in Norwegian salmon aquaculture

Sea lice are a major environmental risk facing the salmon farming industry in Norway (fortunately sea lice is not an issue for salmon farming in New Zealand, but parasite issues may arise if indigenous finfish species are farmed). An environmental risk assessment of the industry, undertaken by Norway’s Institute of Marine Science in 2014, found that a large number of sea cage sites created a risk of increasing sea lice infestations in wild populations, including 27 (out of 109 sites) posing a moderate to high risk of causing deaths in wild salmon smolt and 67 creating a moderate to high risk of deaths to wild sea trout. Also, viral disease outbreaks in the farms, including those impacting the pancreas, heart and skeletal muscles of salmon, were indicative of many viruses being released into the wild.68

As well as impacting wild populations, sea lice are causing high death rates amongst the farmed salmon themselves, reaching 19 per cent during 2017, and meaning that 53 million salmon died in the nets that year. Sea lice can damage fish through eating mucus, skin and blood, and this can lead to other bacterial and fungi infections.62 One estimate put the cost of sea lice to the Norwegian salmon farming industry as US$436 million in 2011.53

In response to these risks, the Norwegian authorities have put in place strict controls over sea lice infestations. Each farm must count sea lice numbers on sampled fish at least twice a month. If the count exceeds a maximum limit, then the operator must undertake a delousing treatment within 14 days. Traditionally this has involved either delivering treatment orally or externally via bathing the fish in a solution through the use of well boats. More recently, sea lice have become resistant to the chemicals used, creating a significant management challenge. There is growing interest in the use of cleaner fish such as wrasse, to reduce sea lice, but the numbers required will necessitate the farming of that fish as well.64 Vaccines are also used to treat a range of diseases affecting salmon, although there are several diseases for which no vaccines are currently available.65

Since regulations were promulgated in 2009, the Norwegian Food Safety Authority has had strong powers to intervene when sea lice infestations occur, and it can order the slaughter of all fish at a farm where sea lice prevalence is not maintained below a prescribed level. The Authority can also implement a zone management system where longer fallowing periods are required and where the introduction of new smolt can be banned in the event of resistance developing to sea lice treatments. In 2014, stricter rules were introduced to manage the risk of sea lice, including enforcing reduced limits for the level of sea lice infestation on farms. All these measures have resulted in a significant increase in costs for the farming operations.56

This case study highlights the need to be vigilant and to put in place measures to avoid such problems ahead of them occurring, particularly if the finfish farming industry in New Zealand is to expand in size and include the farming of indigenous finfish species.

The biosecurity risks created by the aquaculture industry are substantial. Both Keeley et al and Forrest et al identified this as the biggest ecological risk arising from the marine farming, outranking all other effects.66 Effective management will likely require a region- or area-based management approach as biosecurity cannot be effectively addressed just on a farm-by-farm basis. For example, studies on the dispersal of a skin fluke affecting kingfish indicate that the separation of farms by distances greater than 8 kilometres may be required to create effective management units.63 We described the current management approach to biosecurity in Section 2.7.

7.8 Catchment impacts

Because marine farms are dependent on unpolluted seawater for their operations, they are highly susceptible to catchment impacts. Shellfish harvesting is regularly delayed due to potential bacterial pollution from land runoff, including sewage and stock effluent washing into the sea after heavy rainfall. The contamination issue was so serious in the Bay of Islands that it closed down New Zealand’s major oyster growing area for eight years (see spotlight below).
A spotlight on the closure of oyster farms in Waikare Inlet

Oyster farming has been undertaken in Waikare Inlet, situated within the Bay of Islands, since 1971. The area proved highly productive, and by the early 2000s it provided around 30 per cent of New Zealand’s total commercial harvest of Pacific oysters. In 2001, 20 oyster farms in Waikare Inlet were shut down after three norovirus poisoning incidents occurred in Auckland, linked to the consumption of oysters sourced from the inlet. This was the third outbreak of the disease linked back to the area, with previous outbreaks in 1994 and 1999. This virus can only be caught through exposure to human faeces or vomit, so most likely originated from sewage contamination of the oysters. The source of the sewage was never definitively identified, but it most likely originated from the failing Kawakawa sewerage system, failing septic tanks and/or discharges from boats.

After the closure was instituted, the owners abandoned the farms, perhaps hoping that their derelict state would strengthen claims for compensation from the Far North District Council, as the owner and operator of the Kawakawa sewage treatment facility. The oyster-laden frames gradually collapsed, ‘depositing an estimated 6400 tonnes of waste oyster shell and 300 tonnes of waste timber over 30ha of inter-tidal mud’. Court proceedings to claim losses from the council failed, and the farmers ultimately received no compensation for their lost production. In 2009, eight years after the closure, the ban on farming in the area was lifted due to improved water quality resulting from an upgraded sewage treatment plant, upgraded septic tanks and better control over boat discharges. Both the Ministry for the Environment and MPI provided funds to support the clean-up of the area to enable farming to recommence. Since that incident, the Northland Regional Council has put in place a system requiring oyster farmers to lodge bonds of $9000 for each hectare of developed farm to cover the cost of cleaning up the farm if it is abandoned.

The incident highlights the vulnerability of marine farmers to other activities impacting the marine area over which they have no control, but which can critically impact their profitability and the ongoing viability of their businesses. It indicates that better protection of farms from such impacts may be warranted, such as provided for oyster farms in NSW (see Chapter 3).

Sediment is another issue which can affect the industry, particularly when farming filter feeders which ingest sediment particles from the water column. We were told that sediment flows appear to become worse in Pelrous Sound when forest harvesting is occurring in the catchment. A recent review of sediment deposition in the Sound indicates that sedimentation rates in Beatrix Bay and Kenepuru Sound have increased 4 to 10 times since European settlement of the area. The largest identified sectoral contributor to the increase is forestry, although further investigation is being undertaken to identify the sources of sediment from river inflows.

The National Environmental Standard for Plantation Forestry 2017 is not helpful in reducing sediment flows. It categorises only one area within the entire Marlborough Sounds region as a red zone, which means that production forestry planting and harvesting is potentially permitted everywhere else in catchments draining into the Sounds. The council can put in place more stringent rules, and has done so by maintaining its existing (and arguably insufficiently rigorous) controls, but this is only permitted in certain prescribed circumstances, as set out on section 6 of the Standard. This highlights the need for a more connected-up approach nationally. Sediment-producing activities such as forestry should be managed to achieve prescribed marine quality objectives which are designed to protect marine farming, as well as the health of the marine ecosystem overall, as described in Chapter 4.

### 7.9 Cumulative effects

A key issue for coastal managers is understanding the cumulative effect of marine farms in association with other stressors on the marine environment, and whether they are within acceptable levels. This will become an increasingly important issue in the future, as oceanic responses to climate change may have widespread effects on ecosystems and food webs, reducing their resilience and ability to cope with other anthropogenic pressures.

Marine farming is only one of a number of activities and processes which impact the marine environment, with catchment activities, bottom-contact fishing and weather patterns being three notable others. As a result, it is difficult to identify the precise contributors to any change in the health of a marine area. However, to put the potential cumulative impacts of aquaculture into perspective, a recent assessment of anthropogenic threats to New Zealand marine habitats overall ranked aquaculture 26th behind pressures such as ocean acidification, seawater warming, bottom trawling and dredging, sediment and pollution.

In the Firth of Thames, Tasman Bay, Golden Bay and other more recently consented places, baseline monitoring was undertaken prior to the establishment of large AMAs, and so the effects of the farms can be tracked, at least to some extent. As indicated in Section 2.5, monitoring of the Wilson Bay Marine Farming Zone in the
Firth of Thames has indicated that the cumulative effects of the mussel farms on phytoplankton levels has been very small. Unfortunately, for many farms in the Marlborough Sounds, there are no similar baseline data due to the early establishment of the industry in this area. For example, no water quality data is available from prior to farm establishment. In addition, changes in catchments activities may have affected the marine area over time, such as the application of fertilisers on land increasing nitrogen flows into the sea, making the isolation of the cumulative effects of marine farms even more difficult.

The Environment Court commented on this lack of baseline information, in the context of considering marine farming effects on the king shag in the Marlborough Sounds, in the Clearwater case. The Court expressed concern that ‘... the present inability to even identify an environmental baseline against which the effects of anthropogenic activities associated with marine farming can be reliably understood is of particular concern. In essence, it means there is no informed basis for properly targeted decision-making including potential RMA intervention.’ Despite this lack of information, the Court held that the marine farms would contribute to human activity within the king shag habitat that poses a poorly understood, but potentially significant, cumulative threat to the species.

Due to the heavy concentration of mussel farming in parts of the Marlborough Sounds, and the poor flushing of the inner Sounds, concerns about cumulative impacts have been expressed, including in the Marlborough District’s State of the Environment Report which stated ‘... in La Nina years, depletion of zoo-plankton [in Pelorus Sound] may be an issue.’ Such concerns came to the fore when mussel yields dropped by about a quarter between 1999 and 2002. This was a time of great expansion in marine farming, so there was concern that the carrying capacity of the Sound for mussel production had been exceeded. To the industry’s relief, production recovered when the weather pattern changed. Further analysis indicated that the drop in production coincided with a La Niña period which brought south-southeast winds and drought. This in turn resulted in a decrease in the abundance and food quality of plankton in the Sounds. Mussel farm production was therefore responding to the natural ebb and flow of productivity within the Sounds. There was a similar drop in production during the 2012/13 season, which was also very dry.

In order to obtain a better understanding of the cumulative effects of mussel and finfish farms on water quality in the Sounds, Marlborough District Council contracted NIWA to undertake biophysical modelling of both Queen Charlotte and Pelorus Sounds. For the Pelorus, various scenarios were modelled including an existing ‘baseline’ (which included existing mussel and fish farms as at 2012) against a scenario where all the mussel farms were removed, thereby measuring the cumulative impact of the mussel farms. The results for impacts during winter and summer differed, due to the different drivers of phytoplankton growth. In winter, growth is constrained by low light levels and short days whereas in summer it is limited by a scarcity of nutrients.

The comparison of scenarios indicated that, during winter, without the presence of mussel farms there would be higher concentrations of phytoplankton and zooplankton (which are at the base of the marine food web). The difference was greatest in Kenepuru Sound, and for zooplankton, where modelled concentrations in the absence of mussels farms were substantially more than double. A similar, but smaller change, was also shown for the Beatrix, Crail and Clova Bays area. Such a difference was not evident during summer months (when phytoplankton is nutrient limited) because the ammonium released by the mussels provides more available nutrient to phytoplankton, enabling them to grow more quickly, and thereby offset losses from mussel grazing.

Mussel farms likely have a greater impact on zooplankton abundance than that of phytoplankton. This is because zooplankton are slower growing so take longer to rebound from depletion. In addition, mussels likely harvest the same food as some zooplankton species. This means that the food supply for those zooplankton may be reduced. On the other hand, larger zooplankton are more mobile, and therefore have a greater ability to avoid being captured by the mussels. The impact of reduced zooplankton concentrations on higher levels of the food chain is not well understood. It would depend on the extent to which the marine organisms which feed on zooplankton (such as shellfish, small crustaceans, fish larvae and small fish) are constrained by food supplies (that the crop mussels also exploit) as opposed to other factors such as availability of suitable habitat, water quality and predation.

On the face of it, the modelling results raise at least an ‘amber flag’. They indicate that there is a risk of significant zooplankton depletion in low flow bays with heavy mussel farm concentrations, and this may merit further investigation. However, there are reasons to be more optimistic. The way the model has been configured reflects the worst-case scenario, and therefore likely over-estimates zooplankton depletion, so actual effects are likely to be substantially less. Unfortunately, no robust zooplankton data are currently available from the Sounds which could be used to calibrate the modelled outputs with real world information or test the validity of the suggestion that zooplankton depletion is being over-estimated by the present Pelorus Sound model.

There remains concern by some parties about the impact of mussel farming in low flow areas such as Kenepuru Sound and Beatrix, Crail and Clova Bays (see quote from Stewart below) and this, coupled with a lack of definitive modelled outputs, could merit the Council undertaking further work to provide more clarity on the issue.
‘There is little doubt in my mind that aquaculture, as practised in the Marlborough Sounds, results in measurable changes to marine communities in the Sounds and perhaps to the ecosystem as a whole. There are strong indications that the low flush areas of Clova Bay, Crail Bay and Beatrix Bay are being farmed beyond what might be considered an acceptable ecological carrying capacity.’

(Stewart, 2015)
The potential cumulative effects of finfish farming are different to those arising from mussel farming, as instead of taking food out of the water (in the form of plankton), finfish farming introduces additional feed into the marine system and therefore nutrients. There is evidence from overseas, that the cumulative impacts of finfish farming can have a significant impact on ecosystem health, and so it is something we need to take seriously when planning future growth of that industry (see spotlight on MacQuarie Harbour in Tasmania).

A spotlight on the cumulative effects of mussel farming in Beatrix Bay, Pelorus Sound

The effects of mussel farming on Beatrix Bay was considered in depth by Environment Court Judge Jon Jackson in R J Davidson Family Trust v Marlborough District Council. The decision describes the Bay, and the impact of marine farming on it, based on expert evidence presented to the Court. Beatrix Bay is one of the largest bays in Pelorus Sound. Its circular shape spans some 22 kilometres of coastline and contains around 2,000 hectares of protected waterspace. It is largely 30 to 36 metres deep, with a seabed composed of soft sediment, and is fringed by a narrow cobble reef along the shore. There are 37 marine farms located around the edge of the bay, spanning a third of the shoreline, with 85 per cent of the total water surface area unaffected by farms. Many of the earlier farms in the bay were located close to the shore over rocky substrates. Later, farms were extended seawards. The farms in Beatrix Bay are part of a larger complex of around 100 farms within a broader sheltered inlet, which includes Crail Bay.

The marine environment in Beatrix Bay has been impacted by dredging and trawling, sediment runoff from land clearance and contaminants from residential and farming use of the land. Little is known about the state of the bay prior to these activities occurring, although some early publications indicate that intertidal mussel beds and subtidal scallop and horse mussel beds were present. Sporadic dredging and trawling still occurs in the bay and these activities have likely changed the surface of the seabed sediment to a predominance of fine particles.

The Court heard evidence that between 250 and 400 tonnes of shell, mussels and sediment is released under each hectare of farm annually. Cumulatively this means that 76,000 to 121,600 tonnes of material may be released into the Beatrix Bay marine environment each year. The seabed beneath the farms is likely a ‘patchy mix of clumps of mussels and shells, and larger areas of mud and mussel shells’ compared to the soft mud and reef outside the farms. The Court found on the balance of probabilities that, cumulatively, the mussel farms had substantially changed 11 per cent of the soft seafloor of the bay with impacts extending no wider than 30 metres from farm boundaries.

Evidence was not available to identify the bay-wide significance of these changes. However, the Court found that the habitat of flatfish and other benthic species had been reduced by the farms. This, in turn, has likely affected king shags, which feed on flatfish. The Court found that the shags infrequently foraged within mussel farms and the reduced presence of flatfish on the changed seafloor under the farms was a likely contributor.

None of the evidence presented to the Court threw light on what the carrying capacity of the area might be. There was also no assessment of the cumulative effects of marine farming in addition to the on-going trawling and dredging of the bay. However, the Court concluded that the proposal to create a new mussel farm of just under 9 hectares was unlikely to add to any adverse cumulative effects to the water column in the context of larger natural variations.

Despite the lack of precise evidence, the Court rejected an argument that cumulative effects can be disregarded if there is insufficient evidence that any tipping point has been reached. The Court held that the concept of a tipping point is not found in the RMA and that in reality it is often impossible to say where tipping points are in relation to habitats. Rather, the RMA requires protection of significant habitats.
It should be acknowledged that shellfish farming can have also have positive cumulative impacts, such as removing excessive nitrogen generated from land-sourced runoff or finfish farms. Salmon farms potentially increase phytoplankton growth through discharging nitrogen into seawater, and mussel farms extract phytoplankton from the water column. In this way, mussel farming could potentially mitigate some of the impacts of finfish farming on a bay-wide scale, whereas salmon farming could increase mussel production in a nutrient-limited system. This is one of the reasons for the growing interest in multi-trophic aquaculture, as described in Chapter 6.

A spotlight on the cumulative impacts of salmon farming in Macquarie Harbour, Tasmania

In Tasmania, pressure for space (and increasing water temperatures in the southeast) resulted in the expansion of aquaculture into new areas, including Macquarie Harbour, an enclosed harbour comprising 276 square kilometres. It is a remote area, with around one-third of the waterspace located within a World Heritage Area. The harbour has a small and shallow entrance, which impedes flushing, and consists of a long, deep central basin reaching depths of 30 to 50 metres. The water within the harbour is heavily stratified. The surface water, which extends to depths of 10 metres, is dominated by river flows which are rapidly discharged through the harbour entrance. This keeps the water well oxygenated. The deeper water stays within the harbour for much longer and, due to its isolation from the atmosphere, it is naturally depleted of oxygen.

Salmon and trout aquaculture was first established in the harbour during the late 1980s. Production remained within 2000 tonnes until 2005 and then started to steadily increase. By 2009, monitoring in the harbour identified a decline in dissolved oxygen levels in its deeper waters. By 2011, salmon production had reached 9000 tonnes. A year later, despite the evidence of oxygen depletion, approval was granted to expand farming within an allowable cap of 21,500 tonnes. In 2015, production was approaching the cap, having reached 20,000 tonnes. By 2013, there was serious concern about the health of the harbour, with a marked drop in dissolved oxygen present near the seafloor and in the mid-regions of the water column. This was associated with a broad scale loss of benthic marine life across the deeper regions of the harbour. This posed a particular threat to the Maugean skate population, which is a rare species found only in the Macquarie and Bathurst Harbours.

It was only in 2017, that the Tasmanian EPA ordered the destocking of some farms, after the identification of ‘dead zones’ beneath them as well as on-farm fish deaths resulting from low oxygen levels. The overall salmon biomass cap for the harbour was reduced to 14,000 tonnes. In May 2018, there was an outbreak of pilchard orthomyxovirus within the farms, a devastating virus transferred from the wild populations. It killed 1.35 million salmon, an event critics attributed to overstocking.

In response to the new biomass restrictions, farmers have been trialling new waste capture and recovery systems in order to capture solid fish waste from the cage before it deposits on the sea floor. A system developed by Tassal involves the use of a tarpaulin at the bottom of the net. An approval granted to Tassal to trial the system means that it may maintain biomass in the harbour at a higher level (an additional 4,000 tonnes) than would otherwise have been permitted.

This case study highlights the risks of permitting finfish farming within low oxygen, poorly flushing marine systems and the importance of considering cumulative impacts and adopting a precautionary approach. Unexpected things can go wrong. It also emphasises the benefits that might be achieved if suitable waste capture technologies can be developed.
7.10 Climate change
New Zealand’s marine waters are changing as a result of human-induced greenhouse gas emissions, and the changes will amplify over time.\textsuperscript{103} This will have significant implications for the aquaculture industry. There will be impacts on shell formation, food supply, pests, diseases and coastal runoff. Productivity could reduce. Locations that were historically suitable for aquaculture may longer be so in the future. There will also be greater risks to manage. In some areas, increased food supply and/or warming waters may increase growth rates. For example, oysters and mussels tend to grow faster in warmer conditions but may not put on as much meat condition, and kingfish grow faster in warmer water.\textsuperscript{105}

Shellfish are one of the forms of marine life that are most susceptible to ocean acidification. It affects their survival, calcification, growth and development. They are especially vulnerable during their larval stages when the shells are developing, with green-lipped mussel larvae being particularly affected due to the chemical composition of their shell. Coastal waters, which is where most of New Zealand’s aquaculture is currently located, are more susceptible to acidification due to catchment impacts. For example, sampling in the Firth of Thames, which is the location of a large mussel farming area at Wilson Bay, has shown that pH levels are less than 7.7 during some events (while the Firth of Thames is not oceanic, it is noteworthy that the typical oceanic level is 8.1).\textsuperscript{106} These depressed levels are the result of high nutrient inputs from the intensively farmed catchment\textsuperscript{107} and mean that the water body is particularly vulnerable to additional decreases in pH levels due to greenhouse gas emissions. A government-funded collaborative research project is currently developing tools for the management of coastal acidification, including looking at ways to mitigate the impacts of low pH near mussel farms. Two practical remediation techniques being trialled are returning shell waste to the sea and aeration of water.\textsuperscript{108}

Warmer seawaters will likely reduce food supply in subtropical northern areas and possibly increase it in southern sub-Antarctic waters.\textsuperscript{109} There will be an increase in the likelihood of heat stress for farmed animals, which affects their metabolism and makes them more susceptible to disease. Heat stress is already evident in places such as the Marlborough Sounds and Firth of Thames. Salmon is particularly susceptible as it is a cold water species. For example, during the 2018 summer, when seawater in New Zealand was the hottest on record, NZ King Salmon reported that deaths of farmed salmon in the Sounds doubled.\textsuperscript{110} Although Sanford’s more southern Stewart Island farms were less affected, the company still reported up to 4 degrees of seawater warming and a more than 4 per cent reduction in harvest volumes. In addition, mussels spawned early, shortening the harvest window.\textsuperscript{111} Mussels in the Firth of Thames were also affected, when temperatures reached 25 degrees, with up to 20 per cent of the farmed mussels dropping off the lines, presumed a result of heat stress.\textsuperscript{112}

Although natural evolution will help species to cope to some extent, it can be expected that marine farmers will seek to selectively breed stock that is more heat resilient (which may raise the poorly understood risks of genetic mixing in wild populations, as discussed above) and endeavour to move some of their operations to deeper, cooler waters. NZ King Salmon’s relocation and open ocean proposals (see Chapter 2) is a recent case in point.

Warmer seawater may also result in more frequent outbreaks of algal blooms, as warm water helps promote phytoplankton growth. Algal blooms are a natural phenomenon, but can become problematic when they are harmful to fish or humans. Algal blooms can be particularly damaging for finfish farming. The algae contain toxins and they can also attach to gills, suffocating the fish. There has been a history of devastating outbreaks in New Zealand. In January 1989, an algal bloom hit Big Glory Bay and killed around 600 tonnes of salmon, with loses estimated at $17 million.\textsuperscript{113} The Akaroa salmon farm was hit with an algal bloom in 1995 which wiped out 5000 fish.\textsuperscript{114}

Algal blooms are generally benign to shellfish, which eat the algae and so have an increased food supply, thereby accelerating growth rates. However, the blooms can be harmful to humans if infected shellfish is consumed. For this reason, when a bloom toxic to humans develops, the harvesting of shellfish is often delayed until two to three weeks after the algae has left the area.\textsuperscript{115}

Algal cysts can become embedded in sediment, particularly in bays with poor circulation, generating successive blooms when the conditions are favourable, usually during the warm summer months. Cysts for Alexandrium pacificum have been identified in Nydia Bay (at the head of Pelorus Sound) and Onapua Bay (in Tory Channel). The species are responsible for outbreaks of paralytic shellfish poisoning. Unusually, in 2018 a Nydia Bay-sourced outbreak of Alexandrium cattenella occurred during the cold winter months, perhaps indicating that the warming seas are contributing to increased risk.\textsuperscript{116} Around 150 mussel farms were closed as a result, the biggest shutdown since 1993. Worryingly, it was the first time the bloom had entered Pelorus Sound.\textsuperscript{117}

Disease has been a particular risk for oyster farming. As already mentioned, in 2010 the Pacific oyster farming industry was heavily affected by an oyster herpes virus (Ostreid herpesvius) with farmers losing over half their crops and in some cases up to 80 per cent of juvenile oysters.\textsuperscript{118} In addition, the flat oyster farming industry has been closed down completely to protect the wild fishery due to the discovery of the blood parasite Bonamia ostreae. Under climate warming, more
pests and diseases will be able to survive during the warmer winter temperatures, creating elevated biosecurity risks.

Seawater warming will also likely increase bio-fouling on nets and other equipment. Bio-fouling is becoming an increasing problem in the industry as invasive species become established and grow over nets, lines and buoys. They take up space on the lines and racks that the farmed shellfish would normally occupy, and may compete for food. They can also grow over the shellfish themselves, potentially leading to suffocation. Oysters are less prone to bio-fouling due to their location in the intertidal zone, with many biofouling species unable to survive being out of seawater during each tide.

Increased storm events will likely result in more sediment entering coastal waters, creating increased turbidity, and may also result in increased sewage runoff if wastewater treatment systems are overwhelmed. The growing population – the New Zealand population is predicted to reach 5.8 million by 2038 – is likely to accentuate such catchment impacts. Heavy sediment loadings can negatively affect spat and small mussels. Increased sewage runoff can contaminate shellfish, making consumption a health risk. As already noted, sewage contamination shut down the most productive oyster producing area in the country for some years. And harvesting of mussels and oysters is already regularly put on hold after heavy rainfall events as a precautionary measure to avoid the possibility of contamination by faecal matter.

Overall, these climate change impacts mean that sites that have been suitable for aquaculture in the past may not be suitable in the future. Farms may need to move. In addition, successful farmers will likely need a portfolio of sites in different areas to better manage risk, so when one area is affected by, say, warm water or invasive species, another area can continue to produce. It also means that farm operational practices will need to change to better manage risk. Marine farming is likely to become more complex and will require more skill. The need for a high quality, systematic science effort is also likely to increase. Selective breeding may produce stock that is more resilient to likely environmental changes, but genetic risks to wild stocks will need to be carefully assessed and managed.

Climate change could have serious implications for the aquaculture industry in New Zealand.
The benthic effects of shellfish farming are relatively small in terms of severity but can take some years to reverse if farms are poorly sited. There can potentially be some positive benthic effects through the deposition of shell on the seabed and support for reef restoration projects, but these will be case-specific.

Salmon farming (and potentially other finfish farming) can have serious effects on the seabed beneath and around farms, fundamentally changing seabed communities. The impacts are greater in shallow, low flow sites, which is where most salmon farms were originally located and where some still operate. Benthic environmental quality standards, which are currently being applied to salmon farming, are an improvement, but still allow significant (although potentially reversible) degradation of natural seabed systems under the farms.

The effects of marine farming on the water column can include local scale stimulation and depletion of phytoplankton and depletion of zooplankton (including fish larvae) by shellfish farms, and increased nitrogen inputs from finfish farms. Eutrophication of the seabed beneath salmon farms can also potentially deplete oxygen levels near the seabed.

The EDS v King Salmon case, through setting clear environmental bottom lines, has provided much greater certainty around the interface of marine farming and landscape and natural character. Marine farms are generally incompatible with outstanding natural landscape, natural character and biodiversity values.

Marine farms can impact marine mammals and seabirds, but such effects have been minimised by siting farms away from their key habitat and good management of farm equipment.

There is evidence of genetic mixing in New Zealand’s endemic wild green-lipped mussel populations from mussel farming activities. The risk of genetically changing wild populations through the use of hatchery-bred spat and smolt will need careful management.

Marine farming can result in the accumulation of zinc (from fish feed), copper (from anti-fouling) and plastics (from farm equipment) in the marine environment. Efforts have been made to reduce their use in farming systems, with anti-fouling no longer used on salmon nets and zinc additives to feed significantly reduced.

Biosecurity is a major risk for the industry and one that marine farming operations also amplify. Many pathway and on-farm risks remain unregulated and are likely to increase if new species are farmed.

Catchment impacts can be very damaging to marine farms, indicating a stronger need for integrated management.

The cumulative effects of marine farming are poorly understood, hampered by the lack of baseline information and good monitoring. Better science is required to understand such risks and their broader impacts on the marine ecosystem.

Climate change may have significant implications for the aquaculture industry, including ocean acidification, warming seawater, more frequent outbreaks of algal blooms, greater disease risk, more biofouling and increased coastal pollution. Marine farming practices will need to change in response and sites that have been suitable for aquaculture in the past may not be in the future.
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PART C: RECOMMENDATIONS

Chapter Eight

Key recommendations

Mussel farm off the Coromandel coast
Drawing from the above analysis, we have developed a set of six recommendations for a future regulatory regime for aquaculture. These are described below.

8.1 Spatial marine management

New Zealand should move to a system of marine management based on the identification of areas or ‘zones’ for which a range of environmental quality outcomes and associated standards are prescribed in regional coastal plans, starting in places where ecological health is currently an issue. These would be designed to address cumulative effects from all activities impacting on the marine area. These outcomes and standards should be developed through a collaborative process involving iwi, regulators, scientists, industry, community members and other stakeholders. They need to be ambitious and may necessitate restorative measures to be undertaken in order for them to be met. They could include a transitional pathway so that more stringent standards are applied over time to meet the desired outcomes. Many of our inshore coastal areas are severely degraded from the cumulative impact of a range of human-induced stressors, and the task before us is not to mitigate future impacts, but to proactively improve environmental health. This could help drive a move towards creative approaches to introducing multi-trophic and restorative aquaculture on a zone-wide scale.

Proactive planning for potential activities within each zone, including but not limited to aquaculture, can take place within the envelope provided by the outcomes and standards. Science and monitoring can then focus on the area-based scale rather than on individual marine farms. Regular (or real-time) monitoring should be undertaken on an area basis to determine whether the standards are being met. This, in turn, can feed in to state of the environment monitoring and reporting at a regional scale. Such standards could relate to water quality, seabed condition an indicators of overall ecosystem health. Clear triggers should be identified as to when management action will occur in response to the standards not being met. The lessons from the application of the ‘limits of acceptable change’ approach to the Wilson Bay marine farming zone can be drawn on (see Section 2.5). Actions will need to address both marine- and catchment-based stressors.

Collaborative and integrated marine spatial planning exercises, drawing on the lessons learnt from the Sea Change Tai Timu Tai Pari process, could be used to identify appropriate zones and environmental quality standards, amongst other things. EDS is proposing a new regime for marine spatial planning in New Zealand in a forthcoming report titled Healthy Seas: Implementing Marine Spatial Planning in New Zealand. This recommends that a statutory framework be established for marine spatial planning in New Zealand and that the plan making process be guided by the development of a ‘Marine Spatial Planning Strategy’ prepared by the Ministry for the Environment and approved by the Minister, with the EPA tasked with its implementation. Marine spatial planning projects would be undertaken within the auspices of regional ‘Marine Planning Partnerships’ consisting of senior level and/or political representatives from relevant agencies and iwi/hapū organisations. The plans themselves would be developed through a collaborative process involving iwi/hapū, stakeholders and senior agency staff. The resultant plans would include statutory and non-statutory components, with the statutory parts to be considered as an integrated whole by the Environment Court before implementation. The EPA would be responsible for oversight and coordination of monitoring, with on-the-ground efforts largely undertaken by regional councils. A formal review of the plans would be undertaken by the EPA every five years. The proposals also address the need to develop capacity in New Zealand for marine spatial planning and provide suggestions on how this might be achieved.

8.2 Flexible regulatory regime

We were attracted to the more flexible regulatory regime applied in Norway, where licences are attached to biomass which could be moved between different aquaculture areas depending on environmental conditions and market requirements. This could help avoid farmers being trapped into marginal or unsuitable sites, which does not benefit the farmer or the environment. It could assist the industry in becoming more resilient and adaptable to changing conditions. This idea would need more detailed thought and design in order to tailor it to the New Zealand context, but we think it merits close consideration, particularly given likely future changes to technology and the marine environment.

8.3 Stronger risk management

The biosecurity risks to the aquaculture industry in New Zealand are likely to increase in the future, and we were not convinced that the current system is up to the task of adequately managing them. The avoidance of problems in some sectors may be due more to good luck than good management. The experience of other countries is a salutary lesson, where there are serious problems with sea lice and disease that costs millions of dollars in lost production and treatment expenses each year. As the industry in New Zealand grows and diversifies into new species, we need to develop a much more robust biosecurity system which integrates matters such as information collection, regional biosecurity zones, farm separation, single cohort production, fallowing, and so on. There also needs to be a strong inspection and enforcement effort to make sure that the rules are complied with, as one breach can risk whole sectors of the industry.
8.4 Allocation and de-allocation framework

A more developed allocation framework needs to be developed for marine space alongside the use of other public resources. This should address both allocation of space and de-allocation when environmental quality limits have been exceeded. The framework should set out a series of principles that will apply and would need to be cognisant of Treaty requirements. It could take the form of separate legislation (an Allocation Act) or a more fully developed section of the RMA. Allocation for marine farming could be of farmed biomass, rather than a defined area of seabed, to enable flexibility in location of farms over time.

A fair charge (whether it takes the form of a rental, tax or upfront licence cost) should be imposed for the private use of the marine commons. The proceeds could be used to improve marine management and monitoring, which is severely underfunded. Currently, holders of coastal permits for marine farms can sublease the space and charge a rental for it, even though they have effectively been given the use of public space for free. We were told that this is a common practice, and it seems unfair.

8.5 Stronger national direction and role of the EPA

There is a need for stronger national direction, particularly for future aquaculture siting decisions, which are critical in achieving good environmental quality standards as well as operating requirements. The EPA, as an independent and technically skilled agency, could usefully play a role in developing such direction, which under the current regime could take the form of a national policy statement or national environmental standard.

For offshore aquaculture, we think a stronger national role is merited, given that there currently exists a very thin policy and planning framework to guide decision-making, and a paucity of science. We suggest that the EPA may be a better decision-making authority in this area than councils, given the agency’s role in decision-making for the exclusive economic zone. There is the prospect under future oceans reform for the RMA and exclusive economic zone legislation to be combined, and this would provide a more integrated platform for managing across the boundary. This is an area that needs urgent attention and focused policy development.

8.6 Transparency of information

Monitoring information, including monitoring undertaken on marine farms as part of consent conditions and state of the environment monitoring, should be made accessible to the general public via the web in a timely fashion. Regular reviews, summarising the significance of the information for the layperson, would also be very useful. This will help to engender public confidence in the industry and the regulators. Some national guidance on what is expected from councils in this regard could be useful. Marlborough District Council’s Smart Services Project is an interesting development in this area, which is looking to connect all marine farms in the Marlborough Sounds to sensors that report live environmental data.2

8.7 Greater support for research and development

Although the aquaculture industry has got a long way through trial and error, future success is likely to rely on a much stronger science-based approach. This will require greater institutional and financial support from both government and industry and could also merit the creation of research and development hubs and pilot farms.

8.8 Concluding comments

This research project has identified the considerable strengths of the aquaculture industry in New Zealand but also some key weaknesses, including in the current management regime for the industry. The forthcoming resource management law reform process provides an excellent opportunity to remedy some of these weaknesses. Designing a regulatory regime that will better provide for the industry, while protecting and restoring the marine environment, is beyond the scope of this project but something that merits considered attention. We believe that we can and should do better.
Endnotes

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Appendix: Summary of lessons learnt from Sea Change Tai Timu Tai Pari

Sea Change Tai Timu Tai Pari was the first fully-integrated marine spatial planning (MSP) project in New Zealand. In the context of international MSP practice, Sea Change was ground-breaking. It built on an international review of MSP commissioned by the Hauraki Gulf Forum in 2011, but very much adapted international practice to the local context. It brought together several strands of evolving natural resource management practice in New Zealand, including the establishment of Crown-iwi partnership, co-governance and co-management structures, the use of multi-stakeholder collaborative processes, and the integration of mātauranga Māori and scientific approaches.

Sea Change was the most ambitious marine planning exercise ever to be undertaken in the country. It took place in the most contested marine space in New Zealand. Completing the plan through a consensus process was a major achievement and something that has yet to be attempted in MSP overseas. The integrated planning process enabled a strong focus to be placed on strategic drivers of environmental decline in the Hauraki Gulf and how to address them. The plan itself sets out a roadmap for action to reverse this decline, while providing for current and future uses. What Sea Change has also provided is a rich learning ground which future projects can benefit from, by building on the project’s strengths and putting in place mechanisms to address its weaknesses.

Several book chapters and articles have been published which describe the Sea Change project and its outcomes. In addition, the Office of the Auditor General has undertaken a performance audit looking at how effective the process was to develop and implement the first attempt at a MSP in New Zealand. The following sections summarise the main findings of the EDS review of Sea Change and are reproduced here from the EDS publication Turning the Tide: Integrated Marine Planning in New Zealand.

Impetus

The impetus for Sea Change was growing concern about the ecological decline of the Hauraki Gulf, as highlighted by the Hauraki Gulf Forum’s State of Our Gulf reports, as well as growing conflicts over its use. Efforts to obtain new water space for both marine protection and aquaculture had been stymied by strong opposition. The Hauraki Gulf Forum and staff at both Auckland Council and the Waikato Regional Council, supported by EDS, strongly championed the idea of developing a MSP for the Gulf. There was a strong constituency for change.

The willingness to embark on such a project at that time, however, was not as strong in the political realm. It took a year for Auckland Council to approve the project, and with councillors evenly divided on the matter, the project only proceeded on a casting vote by the then chair. There were also competing agendas at central government level, with the launch of a proposal to establish a recreational fishing park in the Hauraki Gulf not long after Sea Change got underway.

This experience highlights the importance of strong champions for a MSP project in order to bring on board all the relevant players. Support is more likely if there are serious and well-articulated problems which current management efforts are failing to address and clear opportunities to achieve positive change. As discussed further below, it is also important that strong agency and political champions are retained and engaged throughout the planning process and into the implementation phase.

Project structure and resourcing

The project design was complex, reflecting the multi-agency, co-governance and collaborative nature of the plan making process. Overseeing the project was a Project Steering Group (PSG) consisting of council politicians, central government agency officials and mana whenua. It was advised by an Independent Review Panel consisting of national and international experts whose role was to assess the Sea Change project against the UNESCO framework and report to the PSG. A Project Board consisting largely of agency staff oversaw the nuts and bolts of the project including budgets, resourcing and timeframes. A Project Manager was tasked with day-to-day management of these aspects. There were also ‘business owners’ in each participating agency. The actual plan making process was undertaken by the Stakeholder Working Group (SWG) under the guidance of the Independent Chair. The Independent Chair was tasked with the challenging role of shepherding the SWG through a collaborative process to deliver a plan within a tight timeframe, as well as to provide a conduit between the SWG and the other project groupings.

Problems were encountered with this somewhat complex structure. At times, accountabilities became opaque to those involved in the project. Partway through the project, relationships became strained between the PSG and SWG, between the SWG and agencies, and between mana whenua, the Independent Chair and the project team. This generated a partial restructure which improved matters considerably.

Substantial resources were made available to the project. However, Sea Change did not have dedicated project staffing, with most staff being seconded from agencies, and additional expertise being provided through short-term external contracts from time to time. Some staff were seconded full time but others had
only a small proportion of their time assigned to the project. The skills of the seconded staff did not always match the project’s requirements. Auckland Council was undergoing several rounds of restructuring which resulted in an uncertain environment for its staff. Auckland Council was developing its Unitary Plan and the Waikato Regional Council was undertaking a major planning exercise in the Waipā and Waikato rivers which absorbed much political and staff attention. All these factors hindered the development of a strong core project team.

There are lessons from this experience for future MSP projects. Multi-agency projects are complex with multiple lines of accountability and reporting, various budgetary cycles and the like. However, to the extent possible, the project structure needs to be streamlined. There should be a dedicated project team carefully selected to meet the skills required to deliver the project. Strong working relationships need to be built between all the different elements of the project, and the more streamlined the structure, the easier this task will be.

**Project design**

The project encompassed the entire Hauraki Gulf Marine Park, as well as its catchment areas to the extent these impacted on the Park. This broadly coincided with the coastal marine ecosystem. It also included all functions and activities within the Park including fisheries and marine protection. This broad geographical and functional scope enabled the development of an integrated and ecosystem-based plan and it reflected the approach in the Hauraki Gulf Marine Park Act 2000. Such an integrated approach is also identified as desirable in MSP literature, but it is rarely achieved in practice, and so in this respect Sea Change can be described as world-leading.

From the outset, there was a range of views as to how much leeway should be given to the SWG to develop the plan. One view, which ultimately prevailed, was that there should be minimal constraints on the process so that the collaborative group could innovate to develop solutions to the complex problems facing the Gulf. An alternative view was that the project scope and deliverables should be more tightly defined so that the final outputs were more predictable and could align well with agency functions, funding cycles and support initiatives already underway.

The broad brief given to the SWG did enable innovation, and parts of the plan have been challenging for implementing agencies. Arguably innovation was required in this case if the intractable issues affecting the Gulf were to be resolved. But one of the downsides of such a fluid approach was that there remained a wide variation in expectations amongst implementing agencies commissioning the plan and others as to what the project would deliver. Inevitably, not all of these expectations were met. More effort needs to be put into managing expectations in future MSP projects. Where possible, these should be explicit and agreed amongst the sponsoring agencies.

The project was given a short timeframe of 18 months to deliver a plan. In hindsight, producing a meaningful plan for a such large and well-utilised area which was experiencing complex problems – using a collaborative process and by integrating mātauranga Māori – was very ambitious. Although setting a tight timeframe helps to focus attention, it does create more stress. In the case of Sea Change, the initial tight timeframe contributed to a weakening of relationships and the project was paused for several months (hereafter referred to as ‘the Pause’) before continuing in a reconfigured form. The final plan was delivered after 3 years. A project timeframe of 3–4 years is more the norm for international MSP projects and we would suggest that a 3-year timeframe would likely be appropriate for future MSP projects in New Zealand (depending on scope), particularly if it was preceded by a period of baseline data gathering.

**Co-governance**

As already described, the governance body for Sea Change (the PSG) was a mix of local government politicians, central government officials and mana whenua. This usefully brought together all the different agency sponsors of the plan in partnership with mana whenua. The PSG’s role was to provide overall leadership and high level oversight of the plan making process, to approve the plan on completion by the SWG and to advocate implementation by their respective agencies.

The Mātauranga Māori Roundtable (which was established around October 2014 and renamed the Mātauranga Māori Representative Group in September 2015) brought together the mana whenua members of the PSG and SWG, thereby breaching the structural governance/operational divide between the two bodies. This was of concern to some interviewees. On the positive side, this arrangement proved effective in supporting the mana whenua members of the SWG, and it helped to embed mātauranga Māori into the plan. However, the short project timeframe made effective dissemination of material to the wider Hauraki Gulf iwi and hapū groups challenging.

The PSG was disestablished after approving the plan and handing it over to the sponsoring agencies, so it was not able to undertake the later role of advocating implementation. This role was also compromised by the local government elections, which were held just prior to the plan’s release, where several key members of the PSG lost their seats. These events highlight a weakness in the Sea Change project structure, which saw all the project entities (including the PSG, SWG, Independent Chair, project team and communications lead) disestablished once the plan was publicly launched. No formal multi-agency or
stakeholder structure was retained, or put in place, to oversee implementation, monitoring and review of the plan (although informal liaison between agencies has occurred). No specific budgetary provision or resourcing was made available for the implementation stage. International experience indicates that implementation is one of the most challenging phases of MSP. It needs considered thought and design during the plan making process and dedicated resource once the plan is completed. Future MSP projects in New Zealand need to consider implementation structures and processes (including monitoring and reporting on effectiveness) at the outset of the project.

**Selection of SWG members**

It was broadly recognised that getting the right people onto the SWG was critical to the success of the project. Selecting 10 people to represent the myriad of stakeholder interests in the Hauraki Gulf was never going to be easy. The selection process came under some criticism, including that it was only those who turned up to the selection meeting that were chosen. But it did enable sectors to identify their own representatives (which meant that SWG members were to some extent mandated by their sectors), and it also included a screening mechanism to exclude potentially disruptive people. An additional four mana whenua members were selected through a tikanga Māori process. The members of the Sea Change SWG were high calibre, constructive and able to effectively collaborate. However, some sectors were not well represented. Future MSP projects will need to further refine processes to ensure that good representation is obtained on the SWG.

**Collaborative process**

Although the collaborative process proved challenging, it was also one of the notable strengths of the Sea Change process. Stakeholders with a myriad of different interests and worldviews came together with mana whenua, and all agreed on a package of measures for the Hauraki Gulf. A close relationship developed between the SWG members, and this social capital has beneficially flowed into other Gulf initiatives since the plan was completed. People shifted their positions considerably during the process, enabling agreements to be reached. The collaborative process was very time-consuming for participants, but individuals were positive about the personal benefits they gained in return. Future MSP projects would do well to consider incorporating collaboration into the plan making process as part of broader engagement.

One of the challenges with collaborative plan making is the interface between the collaborative body (in this case the SWG) and the agencies which both sponsor the process and are the implementing bodies. In Sea Change, the agencies were largely kept outside of the collaborative process. This is in contrast to the approach taken in other similar processes, such as the Land and Water Forum, where agency staff participated as ‘active observers’. ‘Agency conduits’ were established in the later stages of the Sea Change project which went someway down this path. The uneasy relationship between the agencies and the SWG caused some difficulties and plan implementation challenges. Future MSP projects will need to design in a more effective interface between the two groupings, which could consist of agency staff being around the SWG table as ‘active observers’, having long-term secondments into the project team, or being more closely integrated as members of working groups (such as the Roundtables).

A further challenge is the relationship with members of the public and local communities, who can feel alienated from the process. They can also be uncomfortable with a planning process which is novel and different to statutory plan making. This is why well-constructed and communicated community engagement mechanisms are an important part of collaborative planning processes.

**Roundtables**

Six Roundtables were established to focus on specific aspects of the plan and to involve a broader range of stakeholders in the plan development work. The Roundtables met monthly for six months and then reported back to the SWG, after which they were disestablished. Overall, the Roundtables were seen as a very positive element of the project. They should be considered for incorporation into future MSP projects. They could be improved through bringing all the groups together from time to time to discuss overlaps and synergies. The groups could also be retained to act as sounding boards later on in the project, as the plan provisions are developed, and could review draft output.

**Mātauranga Māori**

It was agreed from the outset that mātauranga Māori would be incorporated into the plan, but this was not well defined and did not prove easy to achieve in practice. There are around 26 iwi and hapū groups with an interest in the Hauraki Gulf and it was difficult for the four mana whenua members of the SWG to fully represent them. It took some time for an effective mātauranga Māori support structure to be put in place, and with the tight initial timeframe for the completion of the plan, this made effective integration challenging.

The establishment of the Mātauranga Māori Roundtable with specialist technical support was a positive step, as was engaging a Māori writer, designer and GIS expert to assist the plan writing and production team. Overall, interviewees thought that mātauranga Māori had strengthened the plan considerably and that Sea Change had made more progress in this area than other planning exercises in
New Zealand. Future MSP projects would benefit from designing in a mātauranga Māori support structure from the outset and should consider resourcing the development of mātauranga Māori material prior to the formal plan making process commencing.

Science

The science underpinning Sea Change was generally regarded to be of very high quality. Many scientists, who were senior experts in their field, presented their work directly to the SWG and Roundtables. The science needs of the project were largely identified by the SWG with assistance from the project team. At times, the scientific information was gathered on request between monthly SWG and Roundtable meetings, rather than a coherent science programme being constructed in advance. However, the science drawn on was broad and fairly comprehensive.

At times, some of the SWG and Roundtable members felt swamped with science, and they had too little time to digest it adequately. On the other hand, several SWG and Roundtable members commented very positively on what they had learnt from the scientific presentations, and these learnings were one of the highlights of their involvement in the process. Later on in the project, two science conduits were engaged to assist the SWG in the plan writing stage, and this worked well. Many overseas MSP projects establish a technical advisory body to help manage the technical input into the plan and provide quality assurance, and this was the approach taken in the Land and Water Forum. Such a body could include senior scientists, mātauranga Māori experts, economists and policy advisors.

The Department of Conservation put considerable resource into developing the web-based mapping software SeaSketch and populating it with datasets. Auckland Council and WRC staff also spent considerable time on this task, assembling datasets and sending them through to the Department for uploading. Most interviewees considered SeaSketch to be helpful, but it could have been more fully utilised in the planning process. Initially, SWG members were expected to use SeaSketch directly after a short training session, but the software proved more complex to use than anticipated. Later on in the process a dedicated technician was provided by the Department to use SeaSketch during SWG discussions and this worked well.

The key lesson from the use of science in the Sea Change project is that future MSP projects could benefit from including a strong science lead to help curate and interpret the science for SWG members. This could be in the form of a Chief Scientist, one or more science conduits, or a hands-on scientific advisory body. A scientist could also be included on the SWG, although this may unhelpfully blur the line between independent science and sectoral representation.

Public engagement and communication

Much effort was put into the engagement and communications effort during the early phases of the project with ‘Listening Posts’, surveys, outreach to public events, an active website and public meetings. The effort wound down during the later stages and the communications function was disestablished after the plan was publicly launched. Several interviewees identified the Listening Posts as being particularly valuable.

Despite the considerable effort and expenditure of resource, many interviewees thought that engagement and communications was one of the weaker parts of the project. There are several likely reasons for this. There was no communications plan or lead when the project began and the role was occupied by various people during the duration of the project, making continuity difficult. The connection between the communications team and the SWG could have been stronger, so that information gathered through surveys was better utilised. There was a paucity of public information during the last year or so of plan development, creating uncertainty amongst the public as to what was happening. Insufficient time was provided to prepare for an effective public launch of the plan when it emerged. There was also a lack of clarity as to whether the draft plan would go out to public consultation, with a decision not to include this step only made by the PSG during the latter stages of the project.

Communications and public engagement is a crucial part of any future MSP project. It needs to be carefully planned ahead of time, be consistent throughout the entire project, and continue through into the important implementation phase. A senior communications person should be a dedicated part of the project team from the outset and could liaise with the SWG and the Independent Chair through a communications subgroup. The process for engaging sectoral groups and members of the public in the project should be decided and communicated upfront, including when consultation will take place and whether draft plan material will be made available for comment.

The plan and implementation

Interviewees were generally very positive about the final plan that emerged from the process. It was described by some interviewees as balanced, future-looking, ambitious, and an excellent start. It includes new initiatives for biodiversity and habitat restoration, sediment reduction, and co-governance of local marine areas.
Conclusions

The completion of the Sea Change project is a major milestone for the management of marine space in New Zealand. The project achieved a lot, not least that mana whenua and stakeholders agreed on a common action plan for the Hauraki Gulf. The project was ambitious, charting new ground, and the process provides very rich lessons. Sea Change provides a solid base to build on and an indication of what can be improved in future MSP projects.

It provides for the expansion aquaculture and marine protection. It proposes new management settings for fish stocks and a strategy to transition commercial fishing to a higher value and less environmentally damaging model, amongst many other things.

However, no MSP is perfect and some interviewees identified weaknesses in coverage in areas such as infrastructure, biosecurity and climate change. Others thought that it lacked detail and could have been more spatially referenced. Yet others felt that some of the recommendations were impractical, unfeasible or technically unachievable. A consensus process necessarily generates compromise solutions which do not find favour with everyone. Internationally, MSPs are often seen as a work in progress, to be further developed over time as experience is built up. Several plans developed in other countries are now into their second generation and have become more fully fleshed out over time.

Implementation is one of the most important phases of a MSP project and there is broad consensus that Sea Change has encountered difficulties in this area. Nearly two years after the plan was finalised, only a patchy implementation effort is evident. In hindsight, there are a number of factors that have contributed to this situation and that will need to be addressed in future MSP projects. They include:

- Insufficient time to fully test draft plan provisions with agencies, key stakeholder sectors and the general public prior to plan finalisation
- Lack of prioritisation of actions
- Lack of specific budgetary provision for the implementation of the plan
- Local government elections being help just prior to the plan’s release with central government elections the following year
- The disestablishment of the PSG and SWG on plan completion with no formal multi-agency implementation mechanism put in place
- Poor communications when the plan was publicly released and subsequent discontinuance of that function
- No one agency or Minister being given overarching responsibility for the implementation of the plan
- The lack of champions for the plan amongst implementation agencies (with many of the initial champions having moved on and a failure to effectively develop new champions)
Endnotes

1  Hauraki Gulf Forum, 2011
2  See Peart 2017a, 2017b and 2019; Majurey and Beverley, 2017
3  Controller and Auditor General, 2018
4  Peart, 2018a
Aquaculture is a substantial and growing industry in New Zealand. It produces healthy and highly sought-after food products as well as health supplements. It provides well-paid jobs, supports whānau, hapū and small communities, and generates important export income. It has the potential to contribute to marine restoration. It is generally positively viewed by the New Zealand public. Managed well, the industry has a positive outlook for the future.

The government has recently announced a review of the resource management system. This provides the opportunity to rethink the future management regime for aquaculture in the context of growing pressures on coastal systems, a changing climate and new technologies.

This report surveys the development of the industry, its potential effects on the marine environment and current management settings. It reviews aquaculture management in other jurisdictions and provides recommendations for a new management approach in New Zealand. The report draws on the EDS Resource Management System Reform project, which has undertaken a first principles look at the resource management system and developed options for future reform.