STIMPSON AND CO.

Aquaculture Risk Management Options

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Contents

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Summary

Introduction

This report seeks to:

- identify risk management issues that might arise from aquaculture activities in the coastal marine area
- explore risk management options available to both local government and the aquaculture industry.

There are knowledge gaps in risk assessment and management, and councils want to understand the potential usefulness of bonds on marine farming consents to cover the costs of clean-up if a farm is abandoned. Councils and unitary authorities (referred to here as "councils") are likely to incur these costs only where a marine farming business has failed and the site has been abandoned, with no buyer willing to take on the consent and restore the site to operation. Industry considers the risk of abandonment to be minimal and bonds to be an unnecessary financial burden. Councils have remained open to other methods of protecting against the risk, but no workable alternative has previously been suggested.

In June and July 2007 over 60 aquaculture stakeholders from 29 organisations, including industry participants, industry bodies, research entities, councils and government departments and agencies, were interviewed. National and international best practice for risk management and risk mitigation relating to aquaculture and comparable activities was evaluated.

The industry

The New Zealand aquaculture industry includes several mature sectors characterised by well-established, well-resourced and sophisticated firms that have developed effective risk management for typical operating risks, and have shown an ability to collaborate at a regional level to manage more significant external risks. There is a robust and growing global market for aquaculture products, which has led the Government to give the industry a strong mandate and support to grow in a sustainable way.

The industry acknowledges the importance of good environmental practice to maintaining a clean and viable production space in the coastal marine area, to the public perception of its activities, and to its marketplace. Increasing collaboration has resulted in the establishment of an industry organisation, Aquaculture New Zealand, which should enable the industry to establish more and better cross-species and nationwide initiatives, and strengthen and broaden its self-regulation activities to achieve agreed environmental objectives and fulfil obligations to regulators.

The regulatory framework

Since the introduction of the aquaculture reform legislation in 2005, councils are the primary regulatory decision-makers affecting marine farming. Councils must balance environmental and economic development objectives and the competing uses and values of other users of the coastal marine area, and central government's goal for sustainable growth of aquaculture. The new regime remains largely untested: a new

aquaculture management area has yet to be created under the new provisions in the Resource Management Act (RMA), and it is unclear how the process will proceed in practice.

Despite current difficult economic conditions, in which the high value of the New Zealand dollar is eroding export revenue, there is likely to be a market premium for already-consented space, even if clean-up and structure removal are required. Councils remain concerned that there are circumstances in which they could find themselves responsible for restoring abandoned farm sites. However, industry and councils have been unable to reach a consensus on the level of risk to which councils are exposed or the possible costs of restoration.

Risk management

Managing risk is an integral part of good business practice generally. Learning how to manage risk effectively enables decision-makers (and other stakeholders) to achieve improved outcomes by identifying and analysing the wider range of issues and providing a systematic way to make informed decisions. A structured risk management approach also encourages the identification of opportunities for continuous improvement through innovation. AS/NZS 4360:2004 Risk Management is an ISO-approved, internationally recognised standard for generic risk management and should be used for all aspects of risk management.

Although many industries have implemented structured risk management programmes for over 50 years, such an approach is not consistently used in the aquaculture industry, nor in councils. There are no current risk-based approaches for determining the use of risk mitigation instruments within councils (such as bonds, pooled funds or insurance), but a very good model exists in the New Zealand Oil Pollution Fund.

Risk assessment

In the absence of data to support a robust quantitative analysis, it was agreed with the steering group for this report that a qualitative risk analysis should be used. Residual risk of abandonment (risk after the application of current controls) was assessed based on the evidence of established risk management by the industry.

A fault tree was created, demonstrating that farm abandonment is a two-stage process:

1. a marine farming business must fail or otherwise be unable to meet its consent responsibilities at the site
2. no owner prepared to restore the farm to viable operation within the consent conditions can be found.

If the farm site is sold to another marine farmer, abandonment is avoided.

A quantitative approach was constrained by the absence of comprehensive data from research and industry sources. It was particularly difficult to address the need for data that captures the likelihood of a site that has had a business failure being returned to operation. Therefore, a predominantly qualitative approach to risk analysis is used in this report, informed, where possible, by the available quantitative data. Controls are already in place that may prevent, detect or lower the consequences of potential undesirable

events, so this risk assessment focuses on the risk *after* these controls have operated as designed – known as the "residual risk".

A qualitative residual risk assessment technique was trialled in a multi-stakeholder workshop, including representatives from councils, industry, central government and research providers on 13 July 2007. The technique provides a residual risk weighting or score based on the assessed likelihood and consequence of risks identified by workshop participants. At the workshop trial, the highest scored risks identified as possibly leading to business failure were predominantly external, and included:

- catastrophic natural disaster
- biosecurity threats
- exchange rate fluctuations
- water quality changes that may result from spillages or sewage system failures.

None of the risks identified were so high that aquaculture, as practised and controlled today, is so risky that it should not be permitted.

The residual risk to councils of marine farm abandonment is further reduced by the likelihood that the site of a failed business will be bought and restored to operation by another marine farmer. Under present conditions it is economic for industry participants to buy and restore consented marine farming space if a marine farming business fails, even if remediation needs to be carried out.

Residual risk of abandonment

The key conclusions from the investigation of the New Zealand aquaculture context and workshop testing of the qualitative risk assessment process are as follows.

- *Mussels:* The residual risk to councils of mussel farm abandonment in the current New Zealand aquaculture context is negligible. In other words, any risk mitigation benefits would be far exceeded by the cost of setting and collecting a levy through a risk mitigation instrument.
- This largely qualitative assessment is supported by the following points including some quantitative data:
- Zero mussel farm forfeitures from a total of 521 leases during the Ministry of Fisheries' tenure of administrating aquaculture (1964-2004) (there is an informal report not captured in official data of a mussel farm using experimental structures being abandoned in the Kaipara harbour in the 1980s).
- A trial qualitative assessment completed as part of this report of the likelihood of marine farm business failure in the current New Zealand aquaculture context.
- The capital value of mussel farming structures makes it unlikely that structures would be left in the water.
- The value of consented marine farming space makes it unlikely that the space would not be restored to operation.

- *Finfish (salmon):* The residual risk to councils of salmon farm abandonment in the current New Zealand aquaculture context is negligible. In other words, any risk mitigation benefits would be far exceeded by the cost of setting and collecting a levy through a risk mitigation instrument.

- *Oysters:* Of a total of 337 oyster farm leases under Ministry of Fisheries regulation (1964-2004), 89 forfeiture notices were served to farmers. Most of these notices stemmed from historic management practices and regulatory regimes, meaning that a number of oyster farm were situated on unproductive sites or unable to effectively make the transition from rock oyster culture to Pacific oyster culture. Management practices and risk management through zoning and monitoring by consent authority have shown ongoing improvement. Although there are still 10 farms under outstanding forfeiture action (including those in Waikare Inlet, the site of a contamination incident in 2001), and a number oyster farms recently transferred to the jurisdiction of Northland Regional Council that pose a higher relative risk of abandonment, only one oyster farmer has failed to comply and forfeited their lease. There is an unofficial report that two small oyster farm sites were restored by the Ministry in the late 1960's.

  Despite some history of issues with maintaining operational viability on oyster farming sites, the residual risk to councils of oyster farm abandonment in the current New Zealand aquaculture context is low; i.e. it may be economically rational for councils to require some form of financial risk mitigation. This largely qualitative assessment is supported by the following points including some quantitative data:
  - A trial qualitative assessment of the likelihood of oyster farm business failure in the current New Zealand aquaculture context.
  - Continually improving risk management of oyster farms through industry good practice, and zoning and monitoring by councils.
  - The willingness of the oyster industry to undertake structure removal and site restoration on derelict or abandoned farms.
  - The value of consented marine farming space makes it unlikely that the space would not be restored to operation.
  - These risk assessments are sensitive to changes in the likelihood of the highest-scored risks (biosecurity events, natural hazards, exchange rate fluctuations and water-quality changes). Ongoing monitoring of all risks, especially those scoring highest in the trial assessment, will be key to future risk assessments.

Risk evaluation

There are no current guidelines for the acceptability of risk in the coastal marine area. Councils have set their own parameters through approving the ongoing operation of certain coastal marine area structures (e.g. wharves and marinas) with no bond requirements. Common law and such bodies as the Environmental Risk Management Authority use the "As low as reasonably practicable" approach to determine risk acceptability criteria.

Risk mitigation tools

The following residual risk financial mitigation tools have been examined in the current New Zealand aquaculture regulatory context, with a focus on farm abandonment:

- RMA bonds
- private and mutual insurances
- remediation pool funds
- voluntary approaches by industry.

RMA bonds

RMA section 108(b) provides for bonds to be required from parties before they begin consentable activities. The bond is imposed to provide the council with sufficient funds to cover, to an acceptable extent, the cost of any required remediation. Bonds are widely understood and the mechanism is familiar to both councils and industry. They are simple to administer through existing policies and processes, and give councils certainty as to the extent of cover for any given consent.

However, they don't provide for pooling of risk: the bond must remain tied to the consent on which it is imposed. Therefore, a "best estimate of worst case" of restoration costs would be the only way for councils to ensure that bonds provide acceptable coverage in the event of abandonment requiring restoration. This is likely to require setting large bonds, which could affect business viability and/or growth prospects across the industry.

Bond setting is based on a residual risk assessment process, as detailed in this paper. Councils should carefully consider the risk level they deem acceptable and apply bonds only to those applicants that exceed this risk level. Where bonds are used, consent conditions should set periods for reviewing the residual risk appropriate to the nature of the activity. Reviews would ensure that bond liabilities can be retained if necessary, or removed once conditions of profitable or stable operation are demonstrated (i.e. the residual risk from the operation is acceptable). Councils should consider clearly defining the performance conditions for site restoration.

However, bonds can only be imposed when consent conditions are being set or reviewed, so there is likely to be a long lead-time during which a significant number of marine farms would not be covered by bonds, or any other risk mitigation instrument that can be imposed as a consent condition. Bond review conditions also need to be carefully crafted, and may present difficulties for councils by increasing bond liabilities where remediation costs are expected to rise.

Bonds would appear to be most appropriate for applicants with a residual risk profile that is unacceptable, such as those using new marine farming technologies, or atypical or speculative water space, in the absence of more efficient risk mitigation instruments.

Insurance

The use of private insurance for abandonment or bond costs is constrained by the limited data available for making actuarial assessments of the risks involved. Insurers are therefore likely to be cautious, insisting on high premiums and high excess levels – or not offering insurance at all. From a council's perspective, insurance is uncertain: it may pay nothing if refuted, or the excess may leave the policy holder still liable.

Insurance is not currently generally acceptable to industry at its present levels of premium, cover and excess.

Pooled funds

A remediation pool fund is a dynamic risk-sharing instrument which can be used when all other remediation mechanisms fail (i.e. restoration by owner or sale of site) and a residual risk is left with a party (such as a council). The fund enables the full cost to be met.

Such a fund would finance a defined response to set conditions of abandonment under a binding contract between the fund operator and participating councils. It would require levy contributions from marine farmers, determined by an industry committee based on a risk assessment, updated triennially. The fund would be capped at a limit providing for the residual risk restoration costs determined by the risk assessment, other than those recoverable by other mitigation means such as insurances. The fund level would be topped up with reinsurance until it had built up sufficient reserves to provide for all expected costs. Reinsurance could also be used to cover catastrophe risk.

A risk-based pool fund provides efficient cost of cover and limits the financial burden on individual marine farmers to a sum that reflects their share of the total risk. This approach also provides incentives to industry for ongoing reduction of operating risks, which would reduce the total risk from aquaculture activity nationwide, thereby reducing the fund's levy requirements.

The key features of such a fund include:

- establishing the residual risk every three years with a detailed-as-possible quantitative analysis
- fund governance by the industry (the pooled fund would preferably be industry driven and operated)
- a detailed set of fund rules
- an efficient means of contribution recovery and establishment of a threshold below which those not adding to the risk do not contribute to the fund.

These could be captured under current legislation by a voluntary pool fund established by the industry. Bonds could still be required from high-risk marine farmers, or those that decide not to contribute to the fund. This type of fund could be established initially on a regional basis, starting in one region where unacceptable residual risk is an issue. A regional fund could serve as an intermediate step to a national fund.

The New Zealand Oil Pollution Levy Fund is a good model for such a fund. It also has the additional advantage of being able to enforce contributions from all risk contributors from the time of fund establishment. Specific legislation would be necessary to require contributions from marine farmers. A voluntary fund could form the basis for a legislated approach, if such an approach were found to be desirable.

If an industry-based voluntary pool fund approach is pursued, the industry group running the pool fund could test industry willingness to make contributions to the fund prior to contributions being required to meet conditions of their specific resource consents. In this way, a voluntary pool fund could quickly achieve broader coverage and greater

efficiency (but probably not complete coverage) than the imposition of bonds. Councils would need to develop policies and processes that recognise the fund and set out related consent conditions and responses.

There are challenges and lead times involved in establishing any form of remediation pool fund, including establishing a suitable structure and ownership, and agreement on risk assessment and response mechanisms that satisfy councils. A remediation pool fund is seen as the optimal approach for managing the residual risk of marine farm abandonment due to the greater certainty of coverage for councils and higher efficiency achieved by the sharing of risk.

Industry voluntary approaches

New Zealand aquaculture conditions suit a large measure of industry self-regulation. It is important for councils to familiarise themselves with the range of current industry-led voluntary approaches for risk reduction and management, including codes of practice, working groups and voluntary initiatives. Councils and industry are encouraged to foster a partnership approach to identifying mutual objectives and assessing where and how self-regulation can meet these objectives, especially those that reduce the residual risk of abandonment. Industry voluntary approaches could extend to mechanisms for site remediation at a local or species level, further reducing the residual risk of abandonment.

Legacy issues

A number of Northland oyster farms have recently been transferred from the Ministry of Fisheries regime, in moderate or poor condition, to the responsibility of the Northland Regional Council under the RMA. These farms have ongoing consent compliance issues that may threaten business or even short-term site viability, and thus represent an ongoing risk management issue. Northland Regional Council is concerned that these farms pose an unacceptable residual risk of abandonment.

The best option for managing the risk of these farms is for regulatory parties and industry to intervene to re-establish their ongoing viability. Only once this has been achieved should farms be included under any pooled risk scheme. If business re-establishment cannot reasonably be achieved, or a farm continues to pose an abandonment risk, then bond setting should be used as an incentive for the business owner to comply or exit the business.

Recommendations

Following are the recommended next steps for councils, industry and government agencies. Where one or more groups are involved, the recommendations are repeated. They are grouped under the following standard risk management steps:

- risk reduction
- risk assessment
- risk evaluation
- risk mitigation
- risk communication.

Risk reduction

Councils and the aquaculture industry are the key stakeholders for ensuring that risk management activities continue to be developed so that risk is reduced to "As low as reasonably practicable". To do this the following actions are suggested.

1. *Councils*

a) Ensure consent conditions establish a clear specification standard and permitted process for site restoration in the event that consents are not re-issued.
b) Recognise the higher risks involved in aquaculture research and development and early stage commercialisation activities by giving consideration, during the development of aquaculture management areas, to suitable areas where such activities could take place with minimum risk.
c) Work with industry to develop, promote and monitor adherence to codes of practice that reduce risks.

2. *Industry*

a) Continue to develop codes of practice, in conjunction with relevant agencies and councils, which will reduce both the likelihood and impact of events on individual farms, and promote these as the best practice for all marine farmers.
b) Establish Aquaculture New Zealand as the data repository of the industry. Data could include:
    - number of entrants and exits by participants
    - number of business failures/bankruptcies
    - farm profitability
    - farm capital costs
    - farm operating costs
    - insurance cost and claim data
    - incidents and their causes
    - levels of industry threat/risk
    - industry codes of practice and risk reduction measures
    - representative costs of structure removal and site clean-up.
c) Support the development of quantitative risk models for aquaculture by collecting data at an individual farm level and making this available to Aquaculture New Zealand.

3. *Government agencies*

Support the development, enhancement and integration of risk management tools for the aquaculture industry and its regulators, especially:

- systems model-based tools for coastal planning
- bio-indicators for ongoing monitoring of contaminants and pollutants in the coastal marine area
- ecological effect tools for evaluating new species and/or new technologies
- qualitative tools for determining the achievement of goals and objectives
- natural hazard effects tools as an extension to those NIWA is developing for the land-based effects of natural disasters.[1]

[1] http://www.niwascience.co.nz/rc/prog/chaz/news/hazard

Risk assessment

To better determine the residual risks in the aquaculture industry, or in certain sectors/ locations, regular risk assessments should be carried out using both qualitative and quantitative tools (when these are developed). This work would be led by councils with the following specific roles and involvement of the other stakeholders.

4. *Councils*
Use the qualitative approach to risk analysis, trialled in this study and described in section 4.5 of this report, to determine the residual risks of structures in the coastal marine area under consideration.

5. *Industry*
Participate in risk analyses with councils to ensure proper communication of industry practices, controls and responses to incidents, and provide relevant data not kept by councils related to the risks under consideration.

6. *Government agencies*
Work with industry and councils to ensure that risk assessment skill and capacity development are resourced.

Risk evaluation

Once risk assessments have been made, councils need to determine if the residual risks are acceptable and can be borne by the council or society at large, or whether they require further mitigation measures to be put in place.

7. *Councils*
Develop policies for risk acceptability to be used by council officers when making decisions about consentable aquaculture activities. Such policies should be consistently applied, no matter what structures are being considered.

8. *Government agencies*
Develop national guidance documents for risk acceptability criteria for aquaculture activities.

Risk mitigation

If a current residual risk is determined to be unacceptable, councils need to have a number of options to further reduce the risk or finally mitigate its effects if all other controls and mitigations fail.

9. *Councils*

a) Ensure that any risk reduction measures established in consent conditions are related to the residual risk determined using the recommended risk assessment approach for the particular farm or groups of marine farms.
a) Use a process such as that shown in Figure 3 (section 5.1), acknowledging council policies for risk acceptability, to identify any residual financial risks from aquaculture activities that are deemed to be unacceptable.
    i) Where an unacceptable residual risk of abandonment is deemed to exist, require evidence of a risk mitigation instrument that satisfies the council

(such as contribution to a pooled fund) as a consent condition for each such consent applicant.

ii) Where a pooled fund approach is not available, a bond can be applied with time-bound review conditions to ensure the bond only applies while the residual risk is unacceptable. Bonds should be applied on the condition that they are removed if a pooled fund option becomes available.

b) Ensure that risk mitigation provisions for aquaculture are not inconsistent with risk mitigation provisions for other structures in the coastal marine area.

10. *Industry*

a) Lead, with key council stakeholders, the establishment of a regional/national pooled fund for mitigating possible abandonment of marine farms, recognising that such an establishment should probably commence as a pilot (e.g. for oyster farms in Northland).

b) Make provision for the proper establishment, operation and maintenance of the fund. An industry-led pooled fund should be developed that:

i) recognises the actuarial likelihood of calling on the fund across a group of structures sharing an industry subsector or geographical/location profile; or failing that, uses an individual approach that attributes the specific risk of abandonment to the farm, or other structure in the coastal marine area, where it cannot be grouped actuarially for the purpose of a pooled fund (e.g. an experimental new species farm in the outer regions of the coastal marine area)

ii) builds the fund to a size that is directly related to the agreed cost of remediation of the structure(s) by the most efficient means, as it is reviewed from time to time (Note: If the available technology changes and the financial risk reduces/increases, then the size of the fund or security must also change. It has been determined in the report that in the current New Zealand aquaculture context such a pooled fund approach is only necessary for oyster farms. A regional fund in the order of $50,000 may need to be built up over a period of the half life of typical consents.)

iii) is satisfactory to and accessible by councils for funding a defined response to a defined abandonment event.

11. *Government agencies*

a) Confirm to councils the level of the Government's response to the effects of low-frequency, high-impact natural hazard and catastrophic biosecurity events whose effects are likely to transcend regional marine boundaries or be of such magnitude of impact (including the possible abandonment of structures in the coastal marine area) that they attract a national response.

a) Support the initiation and facilitation of an industry-led remediation pool fund through all stages (i.e. pooled funds at regional or national level, and, potentially, a legislated model).

Risk communication

This is a significant component of risk management, which helps build robust frameworks for risk management decision-making and implementation.

12. *Councils*

Ensure that risk assessments are well communicated to stakeholders, and are revisited – preferably once every three years, or as key circumstances change.

13. *Industry*

Regularly communicate risk-based advice to participants that ensures best practice risk management is widely recognised and implemented.

1 Introduction

The need for this work was driven by regional councils and unitary authorities (hereafter referred to as councils) wanting to put bonds on marine farming consents to cover the costs of clean-up in the event that farms become derelict, abandoned or break free from their moorings. Industry has considered the risk to be minimal and bonds to be an unnecessary financial burden. Councils have remained open to other methods of protecting against the risk, but neither councils nor industry have been able to suggest workable alternatives.

The across-government aquaculture implementation team sought to assist by commissioning independent expert advice from Stimpson & Co. on options for risk assessment and risk management relevant to aquaculture activities in the coastal marine area.

1.1 Purpose of the project

The defined purpose of this project was to:

- identify risk management issues that may arise from aquaculture activities in the coastal marine area
- explore risk management options available to both local government and the aquaculture industry.

Councils requested this work to address the gaps in knowledge of risk assessment and management (listed in section 1.4 below), in order to inform the review process of existing marine farms and to be prepared for future decision-making. The aquaculture industry is developing operating standards and other self-regulating tools to manage their own activities. This work will add value to the investigation of bonds and may help formulate of a range of industry management policies which the industry can adopt and apply. This report should help inform current industry projects.

Accurate information, sound resource management, and inclusive planning processes are all vital to successfully managing the coastal marine area.

1.2 Background

The definition of aquaculture that has been adopted in this report is that used in the Resource Management Amendment Act (No 2) 2004:

> *aquaculture activities –*
>
> *(a) means the breeding, hatching, cultivating, rearing, or ongrowing of fish, aquatic life, or seaweed for harvest if the breeding, hatching, cultivating, rearing, or ongrowing involves the occupation of a coastal marine area; and*
> *(b) includes the taking of harvestable spat if the taking involves the occupation of a coastal marine area; but*
> *(c) does not include an activity specified in paragraph (a) if the fish, aquatic life, or seaweed –*

i) are not in the exclusive and continuous possession or control of the person undertaking the activity; or
ii) cannot be distinguished or kept separate from naturally occurring fish, aquatic life, or seaweed.

Note that the above definition does not include aquaculture activities located entirely on shore. Although such activity does form part of aquaculture in New Zealand, the focus of this report is solely on the activities that take place below the mean high water springs and out to 12 nautical miles around the entire New Zealand coastline, this being the consentable region within which marine farming may take place.

The New Zealand aquaculture sector is a NZ$390 million per annum industry[2] currently focused on three species – New Zealand Greenshell™ mussels, Pacific oysters and salmon – with established operations centred on a limited number of coastal regions. Global market growth, pressure on capture and wild fisheries and the opportunities presented by New Zealand's extensive coastline and clean, green image have encouraged the industry to set a target of $1 billion in sales by 2025.

The recent development of an underpinning sector strategy supported by a whole-of-government initiative, and the resulting establishment of a nation- and sector-wide industry body, Aquaculture New Zealand Limited, exemplify the concerted public and private efforts to better prepare the sector to grow and develop sustainably. The achievement of long-term growth targets will require an increase of water space supporting aquaculture, and will involve broadening the range of species, culture methods, geographic locations, and value-adding processing technologies used in aquaculture in New Zealand.

Aquaculture provides an opportunity for environmentally sustainable economic growth and relies on the responsible use of the shared water resource for its existence. Underpinning the industry sector strategy is a commitment to environmental sustainability and stakeholder partnerships. Central and local government and communities are seeking to maximise the economic development benefits of a thriving aquaculture industry while minimising the possible negative impacts.

Councils regularly use mechanisms in the Resource Management Act (RMA) to recover the costs of consent processing and compliance monitoring, thereby reducing ratepayer costs and implementing user-pays principles. Otherwise the site costs of mitigation and clean-up of any adverse effects are left to the relevant local authority. To reduce the potential risk, a number of councils are placing – or are considering placing – bonds, or a requirement to provide a copy of an insurance policy, on both deemed coastal permits they have inherited responsibility for and all future marine farms. The industry is concerned about the generalised application of bonds, noting that amounts have been suggested in excess of the actual residual risk and that bond imposition may impose an undue financial burden on aquaculture businesses. All stakeholders are open to considering alternatives.

In order to achieve stakeholder goals, the resource management framework has to apply a consistent and equitable assessment of risks that accurately reflect the conditions in

[2] New Zealand Aquaculture Council, Annual Report 2006/07.

which aquaculture is managed in New Zealand, and that will facilitate the sustainable growth of the sector.

1.3 The approach

Stakeholder engagement has been critical to ensuring a successful outcome from this project. Information and insight were sought from a broad range of aquaculture stakeholders, including industry participants, industry bodies, research entities, councils, and government departments and agencies. Stakeholders have been consistently eager to achieve greater consensus on aquaculture risk management and residual risk treatment.

1.4 The report's scope and aims

This report:

- informs councils that are developing policy on risk assessment and management, and considering bonds and other alternatives to address any residual risks, and details the context within which these risks may arise in relation to aquaculture
- provides an independent source of information for councils, industry and coastal communities
- evaluates a range of risk management tools that can be used by councils
- recognises industry best practice and reviews its contribution to the issue of risk management.

The report aims to provide a reliable point of reference for councils, industry and others dealing with the broad range of aquaculture risk management issues. To achieve this, it:

- establishes risks and risk contexts with industry, regulators and community stakeholders
- reviews risk assessment methodologies relevant to the New Zealand aquaculture setting
- recommends a risk assessment technique applicable to aquaculture activities
- conducts a preliminary assessment of the risks that may lead to farm abandonment
- identifies, describes and evaluates a range of risk mitigation instruments, including those available under the RMA framework and risk treatment approaches for councils, with a particular focus on farm abandonment.

Key to the report is an understanding of the current set of aquaculture practices, economic conditions and regulatory framework relevant to New Zealand aquaculture, and the effect these have on the risks of farm abandonment and risk mitigation. Overall, the report delivers a framework for all sectors and stakeholders in the aquaculture industry in New Zealand that is sufficiently dynamic to be integrated into future aquaculture environments and future uses of the coastal marine area.

2 The aquaculture industry in New Zealand

This section should be read in conjunction with the supporting material in Appendix 1.

2.1 *Key points and implications for risk management*

2.1.1 Mature industry sectors

New Zealand's mussel, oyster and salmon sectors are now mature industries that have grown from experimental and small-scale operations to broad participation, including major corporate interests, research capability and supporting players. There are now companies, individuals and researchers across the country with significant experience and knowledge of aquaculture in New Zealand conditions.

Many marine farms are using sophisticated and tested technology with significant capital value, which can be recovered and reused. Significant improvements to systems have resulted in stronger structures with greater ability to resist tidal and weather events. There is also a deepening body of knowledge on the impacts of marine farming activities on the coastal marine environment, and this is shared between researchers, farmers and regulators.

2.1.2 Increasing industry concentration

Increasing industry concentration is leading to a smaller number of industry participants that are typically well resourced and have long-term perspectives for their businesses and the shared resource in which they operate. They are equipped to assess and mitigate their operating risks and manage and withstand external risks. They are also able to take over the marine space vacated by smaller participants exiting the industry for a variety of reasons.

The maturity of species sub-sectors and broader experience in withstanding risks to viability has led to industry-level strength in managing business risks, and improved awareness and mitigation of external risks and management of the impacts of risk events. Committed and well-resourced companies that share these characteristics are likely to take the industry forward: the current consent and investment requirements in New Zealand aquaculture are not likely to attract "cowboy" or "fly-by-night" entrants.

2.1.3 Industry collaboration

The aquaculture sector is typified by a strong sense of informal collaboration, particularly at sub-sector and regional levels. Marine farmers have a high awareness of other farmers' activities in their regions and among species sub-sectors. Formal industry collaboration is evident in a number of regional and species sub-sector groups, and in the industry-driven development of an Aquaculture Sector Strategy (the Sector Strategy).

With the establishment of Aquaculture New Zealand, the national sector-wide industry body envisaged by the Sector Strategy, the aquaculture industry is better organised and resourced than ever before to build on the existing informal collaboration, co-ordinate existing formal collaboration, and undertake sector- and nationwide initiatives. These

may include facilitating the development and adoption of national standards for coastal marine space and aquaculture activities, and facilitating better risk monitoring and management in aquaculture. Aquaculture New Zealand is well positioned to act as a repository for aquaculture industry data, which can be used to inform risk assessment by a range of stakeholders.

2.1.4 Global market growth

A strong and sustainable market for seafood products is expected in the foreseeable future. Market growth will be driven by world population increases and a growing preference for seafood as a protein source. The aquaculture share of the seafood market is likely to increase given that there is already considerable pressure on wild fisheries. The ability of New Zealand's aquaculture sector to deliver consistent, high-quality product will help ensure ongoing marine farm viability over the next several decades.

2.1.5 Strong incentives for sustainability

The aquaculture industry has strong production, marketing and reputation incentives for being proactive about sustainable development. New Zealand's high water quality and low endemic biosecurity threats have significant positive impacts on productivity, product quality and market acceptability and differentiation. Marine farmers also value positive public perceptions of their operations as sustainable, because this has positive impacts for coastal planning, may reduce objections in consent processes, and may help build a premium in the domestic market for aquaculture products. This is reflected in the Sector Strategy, and initiatives are underway to build a public perception of the industry that reflects aquaculture as it is practised in New Zealand.

Throughout the aquaculture industry there is awareness that poor risk management can have significant adverse effects on the wider industry, and this creates a climate highly conducive to industry self-regulation. Efforts in this area include recently developed environmental codes of practice (see Appendix 1).

2.1.6 Value creation and growth

The Aquaculture Sector Strategy is not based on access to large amounts of new water space. Extracting additional value from existing farms is a major thrust, but small areas of new water space may be critical to experiment with and test high added value species or techniques. Also, new space could be better suited for aquaculture, replacing existing space. For example, marine farmers are keen to explore the link between low ecological impact sites and better production conditions.

The aquaculture industry has a strong signal that its growth is desirable, meets a number of national objectives, and will be supported so long as it meets sustainability criteria. This is set out in *Our Blue Horizon: The Government's Commitment to Aquaculture*.

2.1.7 Threats to viability

A number of external factors can affect – and have already affected – marine farming profitability and therefore viability. Periodically, returns have been driven down by exchange rate pressures and falling international prices, but businesses have withstood these pressures and have sought ways to maintain international competitiveness.

Biosecurity threats can deliver a range of impacts, from small productivity losses to massive stock mortality. Although there is no history of biosecurity threats having caused severe impacts on New Zealand aquaculture, controls are being established in conjunction with the Government to manage the current risks and reduce the impact of future risks. Pollution events in the coastal marine area can cause stock to fail to meet sanitation requirements and result in limits on harvesting. These are typically outside the direct control of marine farmers.

Despite a history of fluctuating profitability and current pressures from a high New Zealand dollar, industry players have few concerns about the ongoing viability of their operations, and there is widespread confidence in the industry's ability to withstand future external pressures.

3 Aquaculture regulatory framework

3.1 Overview

New Zealand's long, indented coastline of some 17,000 km and relatively clean, unpolluted waters are important features favouring aquaculture development and have to be adequately protected for a sustainable aquaculture industry to flourish. New Zealand's foreshore and seabed is publicly owned and, as such, New Zealanders have an expectation of free access to it.

The Minister of Conservation and regional and unitary councils jointly manage the coastal marine area, which includes the foreshore and seabed (and coastal water and the air space above it) from mean high water springs out to 12 nautical miles. The developing aquaculture industry and relevant regulators have had to navigate tensions between sustainable industry development and other uses and values of the coast, including the high recreational and natural character values that New Zealanders place on coastal space.

Since the aquaculture reform legislation was passed in 2004,[3] the lead role in aquaculture regulation lies with New Zealand's 12 regional councils and four unitary authorities. They are responsible for coastal management, including deciding where marine farming is appropriate, and processing consent applications for individual farms under the RMA. The establishment of aquaculture management areas, the resource consent process and other legislation are considered below as part of the wider regulatory context that impacts on managing the risks to and from aquaculture, with particular regard to business failure that could ultimately lead to farm abandonment.

Overviews of the relevant legislation and processes for all aquaculture activities can be found at the websites of the Ministry for the Environment and the Food and Agriculture Organisation (FAO) of the United Nations:

- http://www.mfe.govt.nz/issues/aquaculture/index.html
- http://www.fao.org/fi/website/FIRetrieveAction.do?dom=legalframework&xml=nalo_newzealand.xml

This section should be read in conjunction with the supporting material in Appendix 2.

[3] The aquaculture reform legislation, which took effect on 1 January 2005, includes five amendment acts and two new acts:

- Resource Management Act (No. 2) 2004
- Fisheries Amendment Act (No. 3) 2004
- Conservation Amendment Act 2004
- Biosecurity Amendment Act 2004
- Maori Commercial Aquaculture Claims Settlement Act 2004
- Te Ture Whenua Maori Amendment Act (No. 3) 2004
- Aquaculture Reform (Repeals and Transitional Provisions) Act 2004.

3.2 Implications for risk management

3.2.1 Councils determine regulatory risk management

Under the reformed legislation, councils are responsible for the management of marine farming activities in their jurisdiction. This spans high-level planning for the coastal marine area, managing the RMA consent process, developing consent conditions, and ongoing monitoring of marine farming sites for compliance issues and environmental impacts to reduce risk.

Councils are also responsible for maintaining and enhancing water quality in their regions, which is important for marine farming. Councils impose fees and charges for the use of coastal facilities that are critical to marine farming operation, including wharves and boat ramps. Aquaculture businesses can be vulnerable if water quality or farm site access is compromised.

Central government provides guidance only for the management of the coastal marine environment, and aquaculture in particular, via the aquaculture implementation work of the across-government aquaculture implementation team. It takes an advisory role with councils, supplemented by staff-level interactions in the regions (e.g. interactions between councils and Department of Conservation conservancy staff).

Councils deliver regionally tailored approaches to coastal planning that reflect the characteristics of the region's coastal marine area and constituents' views on its appropriate use. This has resulted in different approaches to aquaculture being developed all over New Zealand, and marine farmers operating in different jurisdictions can face significantly different regimes – even in the same body of water. However, it is understood that there is growing knowledge transfer from those councils that have a longer and more varied experience of marine farming.

3.2.2 New regime is largely untested

Central government and industry acknowledge that new marine space and the efficient use of existing space, among other things, are important to progressing the industry strategy towards the nominated growth target. The new process for establishing aquaculture management areas is yet to be tested, although initiatives are underway in some regions. There have been no new marine farm consents granted under the new legislation introduced in 2005, and industry participants remain uncertain about the conditions councils might place on consents for new space and new consents for existing space once they expire.

The work on implementation of *Our Blue Horizon* acknowledges that support with the planning process is important to achieving the process efficiencies that were the aim of the aquaculture law reform.

3.2.3 Legislation reform positive for aquaculture risk management

There seems to be little formal risk assessment required of, or undertaken by, councils in relation to consents in the coastal marine area. Consents are assessed on a case-by-case basis, and informed by institutional knowledge within councils and the accompanying assessment of potential environmental effects. In most cases, a council will undertake constraints mapping (or opportunities mapping, or use and values

mapping) before proceeding with plan changes. Such information collection will introduce effective regional risk assessment at the front end of the planning process.

3.2.4 Regulation, perceptions and marine farm market value

Consented marine farming space with proven productivity and proximity to existing facilities is currently scarce. Many industry participants are keen to extend their operations without having to expose themselves to the lead times and uncertainties of the still-unproven aquaculture management area creation process. While the allocated marine farming space has risen steadily due to pre-reform applications being processed under the old legislation, there is still an active market for developed marine farming space.

Iwi claims to space are also likely to have a direct impact on the market for and value of marine space, as the Crown may become a significant marine farm purchaser to fulfil its settlement of the Crown's obligation to Maori for commercial aquaculture. Another possible outcome is that the Crown will choose to initiate aquaculture management areas to meet its obligations to iwi.

3.2.5 Public consultation and valuations of the coastal marine area

Developed areas with high population density are likely to have high competing demands for use of the coastal marine area, and different groups will place differing values on it. Balancing these different values can be difficult. There is little independent information that outlines the risks from aquaculture, compares these risks to other activity risks in the coastal marine area, and shows how these risks can be managed. In an effort to avoid consent delays caused by public opposition, some applicants have proposed marine farming in speculative spaces where the risks of pursuing aquaculture are less well known, and risk management strategies relevant to in-shore aquaculture are possibly not proven.

4 Risk management frameworks

This section puts the use of risk management tools and techniques into perspective, looks at the use of such tools in other industries and regulatory frameworks, explores the AS/NZ Standard 4360 for Risk Management, and reaches a conclusion about the applicability of the appropriate tools for examining the risks associated with aquaculture.

4.1 Introduction to risk management

Managing risk is an integral part of good business practice. Learning how to manage risk effectively enables decision-makers (and other stakeholders) to achieve improved outcomes by identifying and analysing a wider range of issues and providing a systematic way to make informed decisions. A structured risk management approach also encourages the identification of opportunities for continuous improvement through innovation.

The underlying principles of managing risk are largely generic, but the specific environment of each industry – comprising its legal, cultural, shareholder, socioeconomic and physical attributes – determines the context for managing risk. Industries such as aquaculture will face risks in a number of different areas, and a comprehensive risk management programme will provide a means of identifying and prioritising risk areas as well as specific risks.

Risk management techniques provide decision-makers at all levels with a systematic approach to identifying, assessing and managing the risks that are integral parts of their responsibilities.[4] The process used and proposed for future use is AS/NZS 4360:2004 Risk Management. This was the world's first and leading risk management standard, originating in 1995, and is one of the three standards that is internationally accepted by ISO (the others are from Canada and the UK). AS/NZS 4360 has been used in a number of international public and private sector contexts, including national-level risk management for health sectors in the UK, Canada and Korea.

[4] AS/NZS 4360:2004 Risk Management

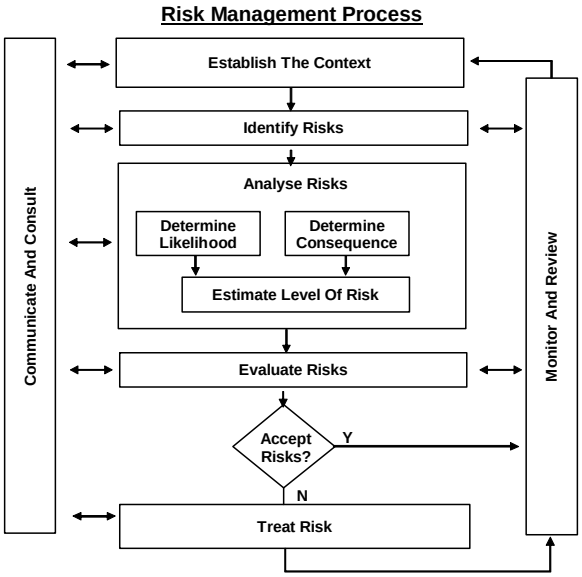

Figure 1: Diagrammatic representation of AS/NZS 4360:2004 Risk Management

4.2 Best practice

Globally, risk management practices have been formally recognised for over 55 years. A science and practice has developed since then, such that there is considerable maturity in the principles, practice, methodologies, tools and education that goes with them.

A lot of codified best practice in the marine environment has been driven by oil industry activity and the potential impacts of these activities. Major losses and spillages that have had significant economic and environmental impacts have been particularly influential, with *Torrey Canyon* (1967), *Amoco Cadiz* (1978) and *Exxon Valdez* (1989) being the most notable. The oil industry has a major component of its operations at sea from fixed and floating drilling rigs, through supertankers, marine terminals, and coastal tanker and barge operations. It has also been through considerable numbers of lifecycles of equipment reaching the end of its operational life, or being damaged in major hazard events. For example, Hurricane Katrina in 2006 caused damage in excess of US$1.4 billion to oil rigs in the Gulf of Mexico, yet none were totally abandoned, mainly due to oil's current scarcity.[5]

North Sea oil rigs reaching the end of their natural life and facing possible abandonment gave rise to considerable public debate in Europe. This resulted in the development of protocols to accept the sinking of such structures on the sea bed after extensive clean-up. (The first end-of-life oil production structure, *Brent Spar*, had meanwhile been towed to land and dismantled.) In 1989 the International Maritime Organization of the United

[5] http://www.iht.com/articles/2006/03/01/business/gulf.php

Nations set a series of guidelines regarding the removal of offshore installations. Oil rigs that are in water less than 100 metres deep had to be completely removed, but those in deeper water could be sunk as long as they had 55 metres of clear water over them.[6] It is likely that these protocols would be followed today if something happened to, for example, the Maui platform, once the risk of oil spill had been reduced to "as low as reasonably practicable".

The marine industry, particularly that involving shipping and drilling activities, has adopted a number of risk management-based conventions. For example, MARPOL (Marine Pollution Regulations), although not mandatory, effectively mean that any vessel owner not prepared to operate accordingly will not get contracts to carry cargoes or be permitted to dock at most oil facilities worldwide.

The marine insurance industry rating of ships is completely risk based. Similarly, the oil industry has very sophisticated and dynamic risk-based mathematical models, which are widely used in daily operation to govern the safety of its operations because of the extensive data available. This sort of confidence and extensive use of failure and event data is one of the reasons more hazardous activities can be permitted by regulatory authorities.

Within New Zealand, similar use has been made of such mathematical techniques. The Maritime New Zealand 2004 *Oil Spill Risk Assessment* report concluded as follows:

> *The 2004 risk assessment gives an updated (and we believe) more reliable picture of the likelihood of an oil spill in New Zealand waters than the previous study. It also includes better information on fishing vessels and smaller vessel activity and their contribution to the overall spill risk. Overall, it should provide greater insight into the patterns of shipping activity and the relative contribution to oil spill risk from the different risk creators, as well as giving an improved picture of the geographical spread of spill risk. It must be emphasised that the oil spill risk assessment is an ongoing process, with the aim over time of improving the characterisation of the risk so as to better understand it, while at the same time actively working to reduce that risk.*[7]

This sort of approach for a potentially hazardous activity that is widely accepted as being necessary reflects current best practice in risk management. It makes an informed risk assessment, then makes provision to remediate the risk by providing a pooled national response resource, operated by both regional councils and Maritime New Zealand, which is paid for by an oil pollution levy based on the risk of oil spillage.

Mining is another industry that operates extensively in coastal marine areas with a wide range of mining methods. One of the most wide-ranging approaches to remediation is the Code of Practice for Marine Mining adopted by the International Marine Mineral Society, based on international experience and environmental referencing going back to 1873[8]. Its environmental risk management approach is quite specific about the decommissioning phase:

[6] http://www.american.edu/ted/shellrig.htm
[7] http://www.maritimenz.govt.nz/publications/pollution_response/Risk_asmnt_final_report2004.pdf
[8] http://www.immsoc.org/IMMS_downloads/codefeb2002.pdf

Rehabilitation and Decommissioning
Ensure that decommissioned sites are rehabilitated and left in a safe and stable condition, after taking into account beneficial uses of the site and surrounding seabed.

1. *Incorporate rehabilitation and decommissioning options in the conceptual design of operations at the feasibility stage.*
2. *Develop clearly defined rehabilitation plans, monitor and review rehabilitation performance and progressively refine such plans.*
3. *Determine and account for rehabilitation and decommissioning costs and periodically review their adequacy during the life of the operation.*
4. *Establish a program of progressive rehabilitation commensurate with the nature of the operation and the type and rate of disturbance.*
5. *Periodically review the rehabilitation and decommissioning strategies during the period of operations so as to incorporate changing regulatory requirements, public expectations, and environmental and cultural information.*
6. *Address issues and programs related to long-term responsibility for the seabed in the final decommissioning plan.*

Risk management best practice for aquaculture is not as well established. It typically takes the form of industry- and regulator-mandated codes of practice and other types of voluntary agreements, along with consent conditions on marine farming permits. Consent conditions typically require the removal of structures and site remediation to the condition at the commencement of activity.

International commentary indicates that risk management is not comprehensively incorporated into the approval conditions for aquaculture in jurisdictions across Australia, the United States of America and Europe, let alone in the many developing economies in which aquaculture has taken (or is taking) hold. There are concerns that risk management tools are not applied evenly throughout national aquaculture sectors, and that there has been limited scientific risk analysis and assessment applied to aquaculture.

A more scientific approach would yield a more effective aquaculture regulatory environment, but rigour must be balanced by practicality in terms of using risk management tools that have potential benefits that outweigh the costs of establishment, development, monitoring and administration. However, there is an increasing understanding of aquaculture risks and how these can be managed, and this knowledge is being slowly integrated into management practices and regulatory frameworks.

4.2.1 Environmental management systems

Environmental management systems are frameworks that can be applied to the management of an enterprise to help identify, prioritise and manage environmental impacts in a systematic and continuous manner. They are adopted for their direct economic benefits as well as to demonstrate commitment to sound environmental practice. Limits on the adoption of environmental management systems are cost and compliance burdens. These costs and burdens are typically taken on to provide business with economic and marketing advantages, and their management for protection of the public good is not well established.

4.3 Risk management contexts

In any risk management study the first stage is to establish the contexts in which risk is to be analysed and assessed.

For aquaculture there appear to be three risk contexts that cover the entire risk profile of the industry, as it exists at present and is likely to evolve in the future. With this approach, users will also be able to adapt and utilise the frameworks to the individual contexts of the land-based aspects of aquaculture. This is useful because it does not appear logical to separate these activities, there being no aquaculture facility in New Zealand that is completely independent of shore-based facilities.

The three contexts are:

- research and development
- early stage commercialisation
- full commercialisation.

A brief description of each of these contexts sets the background within which users of risk management frameworks can perform their risk analyses.

4.3.1 Research and development (R&D)

The R&D phase is necessary for the enrichment and ongoing development of this growing industry as it seeks to embrace new species and new methods of efficient marine farming. R&D activities cover aspects of improvements to existing species, new species biology, and new technologies (e.g. feeding and breeding habits, performance in different habitats, interaction with flora and fauna, growth studies, structures for farming, economic studies, and marketing and technology studies).

In New Zealand, major research contributors include the Cawthron Institute, NIWA Aquaculture, and the marine biology departments of universities. More recently aquaculture companies are joining Foundation of Research, Science and Technology and privately funded studies to ensure the research has a commercial focus.

R&D studies can be extensive and include significant public sector involvement. For example, a joint study by the Universities of Otago and Auckland into specialised enhancement of kina roes involved 12 private companies over three years and over $3 million of Crown funding, plus private equity funding from other participants.[9] The typical timeframe for new species development is 7 to 10 years.

The primary objective of the R&D phase, against which risk can be analysed, is the development of innovative and value-added research that will make the aquaculture industry in New Zealand grow and be more profitable. In this phase the risks of failure are potentially very high and could lead to the abandonment of especially set-up facilities. These facilities might be established at great cost by the various equity partners, and there may be no apparent parties to take over the specialised assets.

[9] http://www.otago.ac.nz/news/news/2004/20-04-04_press_release.html

There would appear to be little recognition of this phase in existing New Zealand aquaculture risk management. By comparison, in other jurisdictions (Chile, Norway, Canada and Australia) considerable risk is borne by the Government and local authorities. A broad range of consent (or no consent) conditions are permitted to facilitate this critical phase, and some international jurisdictions have provided economic instruments to support sustainable development.[10] There is no available literature about who bears the cost of any abandonment during this phase.

4.3.2 Early-stage commercialisation

Early-stage commercialisation is where licensed technology, or that derived from the R&D phase, is taken by an investor or group of investors to a commercial stage. In aquaculture this usually occurs over two to three years. In this phase, activities include business and marketing planning, market exploration, contracting for supplies and broodstock, farm licensing or water leasing, capital equipment purchase, employee sourcing and contracting, and further specialised R&D. Adequate private equity and a reasonable degree of security about the risks expected in this phase are often necessary for the venture to proceed. The New Zealand salmon and mussel industries are good New Zealand examples where commercialisation of R&D has occurred, according to the sources interviewed.

New Zealand, although a good place to practise aquaculture, has suffered from a lack of sound business cases to get investors involved in any significant projects. Industry sources cite a number of abandoned land-based – and some water-based – facilities or very limited, non-commercial hobby farming approaches to aquaculture.

This phase has a high cost of entry compared to other protein farming activities. Whereas other start-up businesses may expect to have a positive return on capital within three to five years, new forms of aquaculture are, by all accounts from well-established marine farmers, some 12 to 15 years from concept to liveable income. As a result they require quite different investment cultures and/or strategies.

There may be a number of competing objectives in the early commercialisation phase, including:

- proving the scalability of R&D concepts, science and technology
- establishing markets
- establishing management regimes
- building core competence and capability
- generating cash flow and staying solvent
- building and protecting intellectual property
- building rapport with regulators
- attracting further investors, as necessary.

Because the scale at this stage may be small (many oyster farms started off with one or two hectares), the possible environmental impacts are similarly reduced, although this depends on the activity being undertaken (e.g. moving from mussels to paua or finfish

[10] http://padh.gpa.unep.org/page.cfm?region=1&theme=3&topic=3

on an existing farm, or a new site, could have significant effects). There is a specific risk profile of activities in this phase that requires recognition during the risk analysis phase.

4.3.3 Full commercialisation

The full commercialisation phase is most familiar to regulators and the one most widely studied and analysed in New Zealand aquaculture. However, this phase was not reached without many players passing through the R&D and early-stage commercialisation phases described above.

For an industry to be recognised as being in this phase, some of the key questions to ask are:

- Is it geographically widespread?
- Is it profitable?
- Do people want to enter the industry?
- Is it growing as demand grows?
- Is there ongoing investment in R&D to make it more profitable?
- Are all the underlying infrastructural elements in place (e.g. training and education, industry associations, equipment producers, maintenance contractors, upstream and downstream processors?).

Marine farming species in this phase are Greenshell™ mussels, oysters and king salmon, as noted previously. Emerging aquaculture species such as paua, kingfish and kina are mostly in the previous two phases, but may be expected to become fully commercial under the right conditions.

4.4 Risk analysis methods and their applicability

As part of this study, quantitative and qualitative methods were examined to establish risk analysis methodologies appropriate for studying the aquaculture industry in New Zealand. Qualitative methods rely on opinion, informed judgement and creative analysis. They can include using techniques such as:

(a) brainstorming
(b) evaluation using multidisciplinary groups
(c) specialist and expert judgment
(d) structured interviews/questionnaires.

This report used techniques (c) and (d) with participation from a wide range of experts and stakeholders, culminating in a facilitated session to test the approach in (d) using a multidisciplinary group of government officials, council planners, and research and industry participants.

In contrast, quantitative methods can include:

- consequence analysis
- decision trees
- fault tree and event tree analysis
- influence diagrams
- lifecycle cost analysis

- network analysis
- probability analysis
- simulation/computer modelling
- statistical/numerical analysis
- test marketing and market research.

Part of the study considered whether there was sufficient information within the aquaculture industry to support a quantitative approach to risk analysis. A fault and event tree was created to assess the risk of marine farm abandonment. The fault tree shows that farm abandonment is a two-stage process. First, a marine farming business must fail or otherwise be unable to continuing farming activities at the site. Secondly, the farm must remain with no owner present. If the farm site is then sold to another marine farmer or farming activity otherwise resumes, abandonment is avoided.

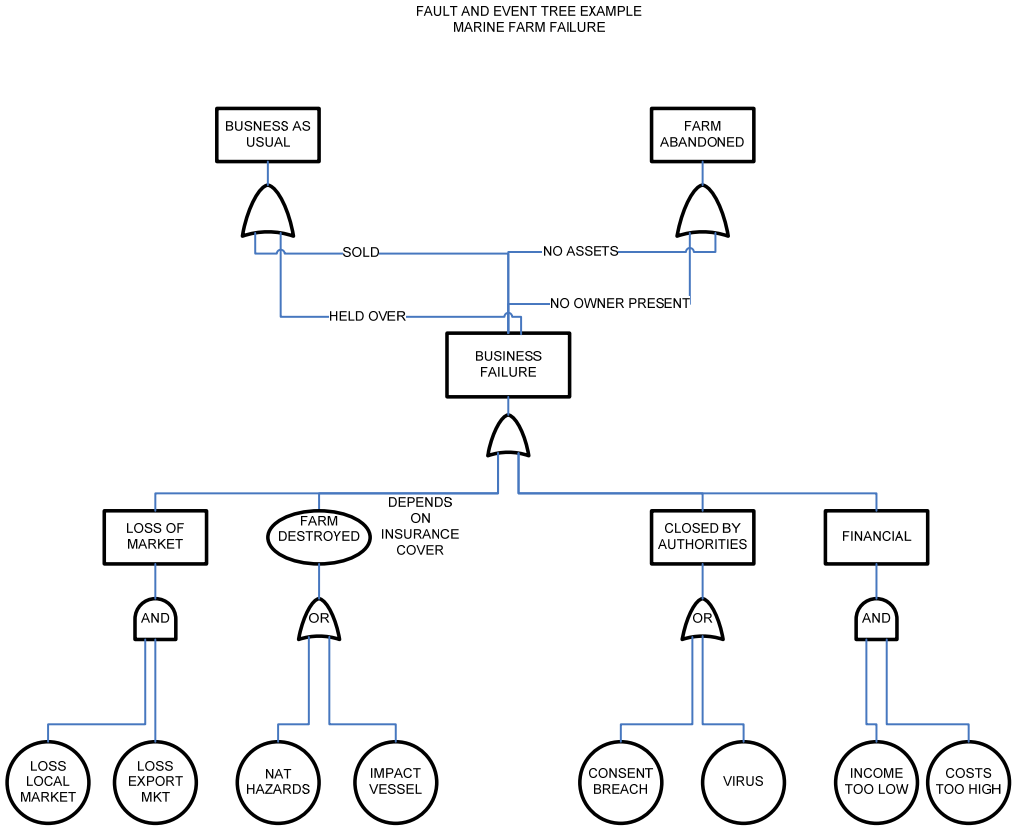

Figure 2: Fault and event tree: marine farm business failure

Further application of such a quantitative approach was constrained by the absence of available data from research and industry sources to populate a fault and event tree. It was particularly difficult to address the need for data that captures the likelihood of a site

that has had a farm failure on it being returned to business as usual. It is hoped all relevant data may be more easily captured in the future with the formation of Aquaculture New Zealand as the industry's single representative body.

It was concluded that, at this point in time, a qualitative approach to risk analysis would have to be used. The fault and event tree above is, however, an instructive conceptual model for understanding how the risks to aquaculture in general might lead to abandonment. Where there is particular historical data that is credible both to the industry and to councils, this could be used to inform an assessment of the risk of abandonment.

4.4.1 Pure risk versus residual risk analysis

Within the risk analyses that could be performed there are several different sub-approaches. The first decision to make is whether to measure pure risk (the risk not taking into account any current controls) or the residual risk (the risk remaining after established controls have operated as designed). To do this, several key questions need to be asked:

- What are the current controls that may prevent, detect or lower the consequences of potential or undesirable risks/events?
- What is the potential likelihood of the risks?
- What are the potential consequences of the risks if they do occur?
- What factors might increase or decrease risk?
- How confident are the judgements of likelihood and consequences?

If the aim of the risk analysis is to examine a completely new activity, where no previous experience can be drawn upon from this industry or a comparable one, and where the confidence about the judgements is low, then risk analysis will typically consider pure risk.

Where the industry is reasonably mature, there have been incidents with known outcomes, and where there are controls to reduce either the likelihood of a particular risk or reduce the effect of its consequences, then residual risk analysis is the preferred approach. Because there is a focus in this report on the risk of abandonment of marine farms, a residual risk approach was trialled, as described below.

4.5 Multi-stakeholder risk analysis

This section describes the qualitative risk analysis process trialled by Stimpson & Co. in a multi-stakeholder workshop on 13 July 2007. It is also recommended later in this report to be used for all aspects of measuring residual risks of aquaculture activities in national, regional or smaller location-specific settings. This process provides a way of establishing a risk weighting or score based on the assessed likelihood and consequence of a particular risk. This section should be read in conjunction with the Excel file "Aquaculture Risk Analysis Trial July 2007.xls".

4.5.1 Risk analysis

After the risks are identified, they are analysed and scored against the:

- potential consequences
- likelihood of occurrence.

It should be noted that existing management, technical systems, controls and procedures are taken into account when analysing risk.

Consequence

Consequence is the potential worst-case impact to the organisation from the risk after the magnitude of the loss is mitigated by current controls. Categorised as catastrophic, severe, major, moderate or minor, it can be thought of in terms of impact to health and safety, image, environment, stakeholder interest, or cost or delays to major projects or activities.

In circumstances where it is hard to equate several differing types of consequence (e.g. fatalities against cost) in a meaningful way, both consequences and the probability of their separate occurrence can be measured and recorded. The consequences have been matched in magnitude to the present size and shape of the aquaculture industry in Table 1 below. For different industries and objectives this table can be changed to suit.

Table 1: Scoring consequence and consequence type

	Consequence type						
	Health & safety	Image	Environment	Stake-holder Interest	$ extra cost or loss	Major project or activity delays	Score
Catastrophic	Multiple fatalities	International media cover	Permanent widespread ecological damage	Special board meeting	> 1 million	> 1 year	5
Severe	Several fatalities	Sustained national media cover	Heavy ecological damage, costly restoration	Raised at board meeting	500,000–1 million	> 6 months	4
Major	Single fatality	Regional media cover or short-term national cover	Major but recoverable ecological damage	Share-holder enquiry	250,000–500,000	> 3 months	3
Moderate	Serious injuries	Local media cover	Limited but medium-term effects	Union raise issue	100,000–250,000	> 1 month	2
Minor	Minor injuries	Brief local media cover	Minor short-term effects	Staff raise issue	< 100,000	> 1 week	1

Note: In the case of an opportunity risk, the relative loss from not taking the opportunity is assessed.

Likelihood

Likelihood is the probability of the worst-case outcome eventuating after existing controls are considered. These are categorised as frequent, probable, occasional, remote or improbable. This table tends to remain the same for any type of project, industry, etc. If an actual frequency of consequences is known, this should be used rather than the qualitative likelihood.

Table 2: Scoring likelihood

	Frequency	Qualitative	Threat score
Frequent	At least once per year	Almost certain	5
Probable	At least once per 5 years	Likely	4
Occasional	At least once per 10 years	Possible	3
Remote	At least once per 50 years	Unlikely	2
Improbable	Less than once per 50 years	Rare	1

Note: In the case of an opportunity risk, the likelihood of failure of actions intended to seize the opportunity is assessed. The overall score for a risk is determined by multiplying together the risk scores for consequence and likelihood. The spreadsheet does this automatically.

4.5.2 Risk assessment

After ranking the risk analysis, use Table 3, or a modified one that better suits the defined purpose, to decide what risk mitigation treatment may be used for each risk measured.

Table 3: Risk assessment and mitigation treatment

	Minor (1)	Moderate (2)	Major (3)	Severe (4)	Catastrophe (5)
Frequent (5)	**Low risk** ▪ Enhance systems to minimise potential ▪ Accept ▪ Repair	**Moderate risk** ▪ Enhance systems to minimise potential	**Very high risk** ▪ Immediate action ▪ Avoid ▪ Enhance systems to minimise potential	**Extreme risk** ▪ Immediate action ▪ Cease activity ▪ Avoid or eliminate threat	**Extreme risk** ▪ Immediate action ▪ Cease activity ▪ Avoid or eliminate threat
Probable (4)	**Low risk** ▪ Enhance systems to minimise potential ▪ Accept ▪ Repair	**Moderate risk** ▪ Enhance systems to minimise potential ▪ Insure	**Very high risk** ▪ Immediate action ▪ Enhance systems to minimise potential	**Very high risk** ▪ Immediate action ▪ Avoid ▪ Contingency plans	**Extreme risk** ▪ Immediate action ▪ Cease activity ▪ Avoid or eliminate threat

Occasional (3)	**Negligible risk** ▪ Accept ▪ Repair	**Moderate risk** ▪ Enhance systems to minimise potential ▪ Insure ▪ Contingency plans	**Very high risk** ▪ Immediate action ▪ Insure ▪ Contingency plans	**Very high risk** ▪ Immediate action ▪ Avoid ▪ Contingency plans	**Very high risk** ▪ Immediate action ▪ Avoid ▪ Contingency plans
Remote (2)	**Negligible risk** ▪ Accept ▪ Repair	**Low risk** ▪ Accept ▪ Repair	**High risk** ▪ Monitor ▪ Insure ▪ Contingency plans	**High risk** ▪ Monitor ▪ Insure ▪ Contingency & disaster plans	**Very high risk** ▪ Monitor ▪ Insure ▪ Contingency & disaster plans
Improbable (1)	**Negligible risk** ▪ Accept ▪ Repair	**Low risk** ▪ Accept ▪ Repair	**Moderate risk** ▪ Monitor ▪ Insure ▪ Contingency plans	**High risk** ▪ Monitor ▪ Insure ▪ Contingency & disaster plans	**High risk** ▪ Monitor ▪ Insure ▪ Contingency & disaster plans

4.5.3 Risk registers and treatment plans

The outcome from a risk identification, analysis and evaluation activity should be documented using a risk register (Excel/Access), or a specialised database-driven product. The register details the:

- risk description
- risk consequence and likelihood
- risk score
- highest priority risks drawn from the risk register
- proposed treatment
- responsible personnel
- target dates for any action (e.g. risk reduction measures).

The risk register should be revisited as circumstances change, or as risks are reduced by agreed action.

4.5.4 Other uses of the risk analysis approach

In the attached spreadsheet only one set of risks against particular objectives has been addressed for this project – business failure – which may or may not lead to abandonment of the marine farm. The spreadsheet includes, by way of example, other objectives and risks related to aquaculture that may prove helpful. These have not been evaluated because the key concern of this project is marine farm abandonment.

4.5.5 Best use of the approach

The best use of this approach is as follows.

1. Gather a multidisciplinary group of people together (10–12 is a good-sized group). These should be people who have input based on their knowledge of the topics being risk scored.
2. Secure an independent facilitator to arbitrate and maintain progress.
3. Have one person recording scores directly into the register, projected on a screen.
4. Give everyone a list of the scoring sheets to be used and ensure they understand the process.
5. Make any changes to the scoring or evaluation sheets before beginning the risk analysis.
6. Agree on the objectives that are having their risks analysed.
7. Brainstorm the risk to be assessed. It may be useful to start with a partially pre-populated register, or run over previous scoring.
8. Get a consensus on any risk metrics that are important and put these in a visible place (e.g. costs of delays, possible size of losses) so there is consistency between risks.
9. Decide if a risk is general or varies across different sectors of an industry (e.g. mussels, oysters, finfish), or only applies in a differing risk context (e.g. the Research & Development (R&D) phase only).
10. Do not try to score more than about 40 risks in any one session: people lose focus!
11. Use the risk register as the minutes of the meeting.

4.6 Risk evaluation

Once the residual risk has been ascertained, the next step is to evaluate the risks and decide whether they are acceptable or not. The process followed in the trial risk analysis has a suggested evaluation table for risk acceptability (Table 3), which follows some norms used for national infrastructural industry. It should be noted, however, that societal norms and values change over time, as do the perspectives of stakeholders, so any risk acceptability criteria must be reviewed from time to time.

There are no sets of prevailing guidelines about the acceptability of risk in the coastal marine area. Councils have set their own parameters through approving the ongoing operation of certain coastal marine area structures (e.g. wharves and marinas) with no bond requirements. Common law and such bodies as the Environmental Risk Management Authority use the “As low as reasonably practicable” approach to determine risk acceptability criteria.

4.6.1 History of abandonment of marine farms in New Zealand

For the period 1971 to 2004, when the Ministry of Fisheries and its antecedents governed and permitted aquaculture, forfeiture notices were served to abandoned and/or derelict farms. The Ministry of Fisheries reports the following.

- There are only 10 leased areas still in the forfeiture process. Nine are at Waikare Inlet. Now that court proceedings against Far North District Council are concluded and stock-relaying requirements have been amended (but are still required), all seven lessees have indicated to the Ministry of Fisheries that they intend to comply with their forfeiture notice (i.e. put the areas into good order and

repair and operate them as viable farms). All lessees except one have gone some considerable way to comply.

- At Mahurangi, in the Hauraki Gulf, the Ministry of Fisheries has been unable to locate the one lessee whose lease is undergoing forfeiture. The area is very small and carries only a few bundles of catching sticks. The Ministry is considering forfeiture, and local oyster farmers indicate they will clear the area and keep the timber structure and sticks.
- Of all the forfeiture notices the Ministry has issued, only one lessee has failed to comply. That lease was forfeited and local marine farmers have almost completed clearing the area at their own cost.

Table 4: Summary of forfeiture action taken and the number unresolved

Type of farm	Number of forfeiture notices served in the past	Number with outstanding forfeiture action	Total number of leases or licences
Finfish farms	0	0	30
Mussels	9	0	521
Oyster farms	89	10	337

Source: Ministry of Fisheries

This forfeiture data is not a definitive record of marine farm abandonment. Some abandonment events known to the Ministry have not been captured in available records, including:

- the abandonment of a mussel farming enterprise using experimental structures in Kaipara Harbour in the early 1980s
- the Ministry of Fisheries contracted removal of a small (around 1 ha) oyster farm in Northland that had been established several miles away from its proposed location on an unproductive site in the late 1960s
- the Ministry of Fisheries undertook removal of a small oyster farm in Tauranga harbour in the late 1960s.

The total instances of marine farm abandonment are more accurately reflected by the following figures:

- mussel farm abandonments – 1 (experimental farm)
- finfish farm abandonments – 0
- oyster farm abandonments – 3.

These values will be used to inform the assessment of the risk of marine farm abandonment in section 6.4 of this report.

The data demonstrates that finfish farms have no history of abandonment and/or dereliction and mussel farms have a negligible history of abandonment and dereliction. This history therefore does not indicate an unacceptable residual risk of abandonment for finfish and mussel farms.

The history of oyster farm abandonment is somewhat more problematic, but better knowledge and application of site selection criteria will likely mitigate many of the risks that have led to previous abandonment, as will the more intense monitoring regimes used now and the application of codes of practice.

The issues of previous poor site selection on long-standing farms and vulnerability to site pollution will remain important in considering risks to pockets of the oyster farming sector. The analysis carried out shows that the likely rate of abandonment, dereliction and/or failure to maintain operating standards leading to forfeiture notices in the future across the sector as a whole is not as significant as the historical data suggests. Ongoing improvement to farming practice, zoning water space and monitoring for marine farming and consenting of land-based pollution sources is significantly reducing the rate at which abandonment can be expected in the future.

4.6.2 Qualitative assessment of the residual risk of marine farm business failure

At the risk scoring workshop on 13 July 2007, a partial risk assessment was trialled for the full commercialisation phase of aquaculture, focusing on the risk of business failure, which may or may not lead to farm abandonment. The assessment was a trial exercise which provided a general indication only of the residual risk of marine farm business failure. The risk analysis procedure should be repeated in a localised setting where those with local history and industry practice can assess the risks together.

The risk assessment was based on the possible failure of individual businesses rather than the industry as a whole, so any risk evaluation would have to ask which of these risks could pose a cumulative effect on the industry and how such a cumulative effect should be dealt with; for example, is this a risk the Government accepts, as it does with foot and mouth disease?

Out of some 27 business failure risks assessed, eight were within the range that would probably not be deemed acceptable residual risks to industry and other stakeholders. These residual risks and their controls are outlined in Table 6. One of these risks, unsustainable losses resulting from an unproductive site (Risk 2 on Table 6), is applicable to oyster farms that existed before the RMA.

A notable ongoing risk management issue is presented by a number of Northland oyster farms that have recently been transferred from the Ministry of Fisheries regime in moderate or poor condition to the responsibility of the Northland Regional Council under the RMA. These farms have ongoing consent compliance issues that may threaten their business, and even short-term site viability. Northland Regional Council is concerned that these farms pose an unacceptable residual risk of abandonment. Unsustainable losses due to an unproductive site may also be a risk to oyster farms consented after the RMA, but the risk is lower due to improved zoning, planning and farming practice. The risk posed by water quality changes from sewage plant failures applies predominantly to oyster farms, but may also apply to other inter-tidal cultures.

The other risks apply to all other marine farms, now and in the future. Six of the eight are external risks beyond the control of the marine farmer. None of the risks identified were so high that it would be deemed that aquaculture, as practised and controlled today, is so risky a business that it should not be permitted.

The highest-ranked risk identified was a major biosecurity event. This was considered likely to be the result of the failure of a national system, in this case biosecurity control. This could be a national issue with a national response forthcoming,[11] or focused in one location. It could affect a broad spectrum of marine life or a single aquaculture species. However, the New Zealand aquaculture industry has coped well with such situations, which have only had a significant effect on industry production for a relatively short time: six months, during an algal bloom incident in 1993, is cited as the longest time for harvesting limitations for oyster and mussel farms.

Those companies that have diversified in different regions around New Zealand are best able to cope because their stock can be removed and re-laid elsewhere. Furthermore, biosecurity risk management is an area of ongoing and industry-driven improvement, with a sophisticated biotoxin monitoring system in place, and a biosecurity monitoring code of practice is being developed in conjunction with Biosecurity New Zealand.

The risk of systemic widespread business failure due to biosecurity hazards leading to gross abandonment, given the history within the industry and the risk controls in place, does not appear to be significant.

The seventh-ranked risk, a major natural hazard event (Risk 2 on Table 5), would probably mean that considerably more of New Zealand's coastal and/or land-based structures and systems were at risk than just marine farms. The severity of this outcome would likely attract a national response in which marine farm abandonment would be only one of many considerations. Widespread, severe impacts resulting in unsustainable losses affecting business viability could also come about from fluctuations in the New Zealand dollar exchange rate, primarily against the US dollar.

These external factors are likely to significantly reduce business revenue through reduced productivity or profit, which can lead to business failure. It can be assumed that natural hazard and biosecurity failure effects are likely to be more random and uncertain, than the New Zealand dollar exchange rate. However, there needs to be ongoing review by industry and consenting authorities of such overarching effects and how they may affect the risk profile of industry participants.

High operating costs causing unsustainable losses is the most significant internal risk for marine farm business failure. Marine farmers facing unsustainable losses are likely to exit the industry by sale or rationalisation.

Over the long lifetime of marine farms and consent periods there will be fluctuations in the key profit drivers (such as the exchange rate), and there will undoubtedly be further incursions of various unwanted biological organisms with unknown or unpredictable effects, much of which is paralleled in land-based agriculture. Climate change may generate more severe weather events, and the frequency of these may increase in New Zealand. However, marine farming has withstood these events and adapted its systems accordingly.

[11] Note that in the Biosecurity Act 1993 there is a provision for a special levy to be imposed by the Minister as part of a pest management strategy and used for the purpose for which it is imposed. This is a further mitigation of potential biosecurity threats, especially slower acting incursions, which may be withstood with concerted and well-resourced efforts.

All of these events are components of cyclical, often self-correcting systems that are 'business-as-usual' for primary production operators, as witnessed by the survival of participants in pastoral farming, forestry, fishery and aquaculture over many such cycles. Overall, the qualitative risk assessment showed that there are a number of possible circumstances that may result in business failure, but that the general risk of marine farm business failure is low in the current New Zealand aquaculture context.

Table 5: Highest risks to business failure, as identified by stakeholders at a trial risk scoring workshop, 13 July 2007

	Type of marine farm	Risk	Risk contributor	Internal (manageable) or external (strategic)	Consequence type	Consequence rating	Likelihood rating	Current controls	Business failure risk score (ranking)
1	All	Business failure	Failure of border control – biosecurity failure	External	Cost	Severe	Occasional	Management, eradication, control, in first instance – incursion prevention	12 (1)
2	Oyster	Business failure – first granting pre-RMA	Unsustainable losses – income too low, site not productive	External	Environment	Major	Occasional	None	9 (2=)
3	All	Business failure	Unsustainable losses – operating costs too high	Internal	Cost	Major	Occasional	None	9 (2=)
4	All	Business failure	Water quality changes – change to land use	External	Cost	Major	Occasional	Regional planning input, reverse sensitivity issues, effective sanitation, input into NZCPS review	9 (2=)
5	Oyster	Business failure	Unsustainable losses – income too low, site not productive	External	Cost	Major	Remote	Exit/rationalisation (sale), maintaining working capital – debt, value maximisation from product (branding, etc)	6 (5=)
6	All	Business failure	Consent/compliance costs too high	External	Environment	Major	Remote	Exit/rationalisation, submission to planning process	6 (5=)
7	All	Business failure	Disease/pathology impact	Internal	Cost	Major	Remote	Treatments, water quality, change management	6 (5=)
8	Oyster	Business failure	Water quality changes – spillages from sewage plants system failure	External	Cost	Moderate	Occasional	District plans, consent requirements, monitoring, warning systems, input in regional plans and NZCPS review	6 (5=)

Note: This table represents the result of the risk assessment methodology trialled in a workshop setting. It does not represent an endorsed expert assessment of these risks relative to each other, or to the consequence and likelihood ratings recommended in Tables 1 and 2. It is to be used as a worked example for councils undertaking this risk assessment methodology in a localised setting. NZCPS – New Zealand Coastal Policy Statement.

4.6.3 Water space value and structure value reduce the residual risk of abandonment

In the event of marine farm business failure in the current aquaculture context, the residual risk that councils will be required to restore sites is reduced further due to favourable conditions for on-sale of water space and/or the removal and on-sale of structures.

When the export business for aquaculture is sufficiently profitable (current industry opinion suggests this means an exchange rate less than US$0.75 to NZ$1), any business failure is likely to result in on-sale to another party. Sales of consented, farmed space occur 20–30 times per annum across the industry as farmers exit the industry for a range of reasons, much as they do in land-based primary production. When there are pressures on industry revenue and increases in participants exiting the industry, water space may be purchased for strategic reasons by larger companies to spread risks or to develop alternative species or means of farming, or by smaller players wishing to increase the scale of their operations. This has proven true even in the current state of the New Zealand aquaculture industry, where water space values recently reached an all-time high.

In the current New Zealand aquaculture context, the capital value of sea cage and long-line culture structures provides a reliable incentive for owners or other farmers to remove these structures from abandoned sites, whether or not the site will be farmed again. The wholesale value of stock currently exceeds the costs of harvest and recovery by a factor greater than two. The market value of recovered long-line structures also exceeds the cost of recovery. The complexity of sea cage structures suggests that their residual value will also be much greater than the cost of recovery. It is very unlikely that long lines or sea cages would be abandoned in the coastal marine area, provided industry participants have access to the site to undertake recovery.

The residual value of rack culture structures is much lower, but could provide some additional incentive for structure removal. Low-value, difficult-to-remove fixtures such as posts are the most likely to be left in the coastal marine area.

Overall, in the current industry context the cost of remediating sites with left-over structures seems unlikely to deter potential buyers of marine farming space.

4.6.4 Residual risk of adrift farm structures

The residual risk from adrift farm structures was analysed and only one risk scenario, that of a one-in-50-year storm affecting a number of mussel farms, caused concern. In this scenario, boat entanglement in submerged mussel lines (as recreational boating often occurs near mussel farming sites) is a possible but highly unlikely consequence. In such a scenario, insurance may meet some liability claims and marine gear, and the mussel lines could be recovered at some cost to the marine farmers. It seems unlikely that this sort of event would lead to farm abandonment on any scale.

The case of an adrift salmon farm structure in the Marlborough Sounds in 2005 is instructive of how risk from adrift structures is minimised by current controls. According to farm owners, the combination of the year's highest spring tides and already fast currents resulted in excessive pressure, which snapped two moorings. Within 10 minutes the farm was broadside to the current, compounding the strain on the remaining extensive configuration of moorings. Other moorings then consecutively snapped, allowing the farm to drift from its inshore position some 200 metres or so towards the centre of the channel. Within two hours the farm was secured to numerous tug boats, and was moored in an alternative site within 24 hours. The harbour master was directly

involved throughout the recovery operation, and the cost of tug boat use was met directly by the salmon farmer.

The operators of this and other large structures now take a “belt and braces” approach to risk reduction, with double moorings and larger anchor blocks in use. In future, more open sea environments may be used for finfish farms. These must be analysed for the potential of increased risk, particularly from tidal and tsunami events.

4.6.5 Clean-up and restoration costs for marine farms

It is difficult to propose standardised costs for the clean-up and restoration of marine farm sites because there are so many variables. Potential contributing costs include:

- the type of structures at the site
- the species being farmed
- the length of time the farm has been operating poorly before abandonment
- the presence of stock on the structures
- site-specific conditions that may affect the level of environmental impact from farm abandonment
- site-specific conditions that may hinder clean-up or restoration efforts
- who undertakes the clean-up work
- the requirement to have resource consent for undertaking restoration activities.

As part of the study, stakeholders were asked to provide indicative estimates of potential clean-up and restoration costs (all costs are in 2007 rates).

- One corporate marine farmer estimated that they could decommission an unused mussel line for $3,000 (at three to four lines per hectare the cost could be up to $12,000 per hectare).
- Industry estimates the cost of removal of redundant oyster farming structures as $3,250 plus GST per hectare, as undertaken at full cost by an independent contractor.
- Clean-up of a long-defunct oyster farm site would typically focus on sediment removal. One council estimated that such a clean-up could cost up to $30,000 per hectare in dredging costs alone, without considering the cost of structure removal and obtaining resource consent for dredging and dumping activities.
- There are no estimates for the costs of restoring a finfish farm site.

These estimates are not comprehensive, qualified or rigorously supported, but have some utility in providing an order of magnitude of costs that can inform risk assessment and analysis of potential risk mitigation. Better-supported estimates are becoming available, but the cost of remediation remains an information gap that councils should seek to fill in consultation with industry.

4.7 Monitoring risk and communication

Risk monitoring is a key part of any risk management process. Once key risks have been identified – as they have been in this study – then ownership of risk monitoring has to be taken as circumstances change.

Councils usually monitor their consent conditions in detail once every two years. Industry parties (typically groups of farmers in an area, or larger companies) have their own risk monitoring regimes, particularly with regard to any Environmental Monitoring System (EMS) requirements (such as ISO 14001), water quality requirements for food safety reasons, or as part of preventive maintenance programmes to reduce the physical risks of equipment failure. Evidence was obtained during site visits to Northland and

Coromandel of good industry practice, including inspection regimes and regular gear replacement.

Tools with considerable potential for more effective risk monitoring in the coastal marine area are emerging from New Zealand research programmes. For example, Integrated Catchment Management (ICM) for the Motueka River is a collaborative project led by Landcare Research, with the participation of Tasman District Council, other science providers, iwi and local communities.[12] An ICM approach provides an essential framework in which to link research on physical hydrology with research on and management of, for example, water quality, soil quality, vegetation dynamics and land use. In the Motueka/Tasman Bay area, near-shore fishing and aquaculture interests are increasingly concerned that land-based activities may have detrimental effects on the productivity or quality of their harvests. An ICM framework is the ideal approach to address these issues because the components have complex interactions, are spatially distributed, and have long-term impacts that are socially and economically important.

Bio-indicators – species whose function, population or status can be used to assess environmental integrity – show potential to meet a need for ongoing monitoring of contaminants from stormwater and land run-off in the coastal marine area. Landcare Research has recently developed a whole-organism bio-indicator providing the means to assess the health of inter-tidal sediments and water quality. This can act as an 'early-warning' signal of adverse environmental effects. This particular bio-indicator will have direct relevance to the oyster industry in particular, where farms are susceptible to land run-off, leachate, etc. The development of further bio-indicators suitable for deep water farms is proposed.

The use of bio-indicators will provide regional councils and the New Zealand aquaculture industry with the tools to protect the long-term viability of farms and ensure the sustainability of the industry. The development of these and other such tools should be monitored and supported by central government, councils and industry groups.

Risk communication is essential in decision-making by enabling wide participation in deciding how risks should be managed. Communication is also a vital part of implementing decisions – whether explaining mandatory regulations, informing and advising parties about the risks they can control themselves, or dissuading parties from risky behaviour or practices. The risks in the practice and regulation of aquaculture in New Zealand have not been well promulgated up until now. However, risk communication is an essential part of developing public awareness of the industry's position, particularly with respect to managing its own risks in a responsible manner.

[12] http://icm.landcareresearch.co.nz/

5 Risk mitigation instruments

If at the end of any comprehensive risk assessment there is an unacceptable residual risk (e.g. of marine farm abandonment), then there is a range of mitigation instruments – financial and otherwise – to consider. These can be applied to activities that use a shared resource and present the risk of adverse effects on a site that may require remedial action to return it to its original condition, without cost to the public.

Risk mitigation instruments should accurately reflect the current knowledge of residual risk, and balance the costs and benefits to stakeholders. They should also be considered within the New Zealand aquaculture context, including the industry and regulatory environment. This section describes and assesses the risk mitigation instruments most likely to be successfully applied to aquaculture in the current New Zealand setting. The options are divided into those that are currently available:

- permanent RMA bonds, payable in cash or surety/guarantee, or with the liability met by insurance
- private insurance

and those that would require new industry initiatives and/or modification of council policy and process to be applicable:

- remediation pool funds
- mutual insurance.

There is also a discussion of non-financial risk mitigation tools.

Each option is evaluated against its ability to:

- address risks
- be set up and administered
- fulfil statutory obligations
- be acceptable to industry
- be acceptable to stakeholders.

5.1 Risk mitigation tools currently available

5.1.1 Environmental assurance bonds/sureties

Environmental assurance bonds are used to help ensure that the costs of environmental damage are borne by the parties undertaking activities that may lead to clean-up or remediation costs. Before beginning the activity, the party purchases a bond or a surety that specifies environmental performance over a certain period. In a specified situation during or at the end of the period, the party is either refunded the bond or the bond is used to ameliorate environmental damage that has occurred. The general principle of such bonds/sureties is that the supervising government agency is guaranteed sufficient funds to cover, to an acceptable extent, the cost of rehabilitation if the enterprise concerned fails to meet the agreed conditions of consent. There are a number of differing forms of bonds/sureties, each giving a specific form of guarantee to the issuer/guarantor.

Bonds are widely understood and both councils and industry are familiar with how they work. They are simple to impose and administer through existing policies and processes,

and give councils certainty as to the extent of cover for any given consent. They are best suited to situations where there is one source of potential environmental damage (or non-performance) so that the resulting costs can be reasonably estimated.[13]

The key challenge is to calculate bond amounts that accurately reflect the remediation costs associated with the type of production in question. Setting an appropriate bond amount in year 1 of a 20–35-year period of operation to reflect the possible remediation costs of an undesirable outcome at the end of that period, or any point within it, requires considerable data and experience. There is high confidence of the likely cost of remediation over periods of up to three years, but it decreases beyond that.

If the bond amount is highly uncertain or extremely large, direct regulation of the activity may be a better risk management tool. The bond amount should also not put an unreasonable financial burden on regulatory or industry parties, and the cumulative financial effect of the whole of the regulatory/compliance environment must be considered.

Bond regulation and setting

In the New Zealand aquaculture context, bonds can be set by councils through the consent process in accordance with section 108(1)(b) of the RMA. Provisions under the RMA give councils the freedom to deal with consents on a case-by-case basis and do not require any specific level of supporting analysis, although the consent process does require dialogue with the owner. As an example, Northland Regional Council's financial contributions policy (also covering bonds) is as follows:

> *In accordance with Section 108 of the RMA, the requirement of a financial contribution, including bonds, is considered appropriate in circumstances where the Regional Council may be required to undertake any of the following actions in the event of a coastal permit holder's failure to avoid, remedy or mitigate adverse effects of the consent holder's activity:*
>
> - *completion of any works or structures*
> - *operation of any works or structures*
> - *alteration or removal of structures and any restoration works following any works or activity being completed or ceasing*
> - *completion or compliance with any other conditions of the consent granted.*
>
> *Assessment criteria for whether or not to impose financial contributions, the types of contribution and their value on coastal permit applicants focus on consideration of councils' coastal objectives, how applicants' activity may impact on the achievement of these objectives and whether and how a financial contribution may offset potential impacts.*

There is no clear provision under the RMA for risk pooling, such as would occur in an insurance or fidelity fund scheme. Bond setting seeks to recover the full amount, or a median "worst case" amount required for remediation. Bonds can be permanently set for the length of the consent, although bond conditions can be reviewed at any time at the request of the consent-holder (section 127), or by the council if the consent conditions provide for such a review (section 128).

[13] Victorian Environment Protection Authority 1994. Victoria's environment protection system: Innovative approaches and economic instruments. In: *Environmental Economics Update.* Environment Protection Authority: NSW.

An approach to bonds that takes into account the probability as well as the cost of remediation would result in bonds being set at an amount less than the expected full amount required for remediation. This would require the council to accept some exposure to the risk of farm abandonment, as it would not have dedicated funds to meet the full cost of remediation. In bond setting, a risk assessment should be used only for considering risk acceptability – whether or not a bond should be imposed at all. See Figure 3 for a possible risk-based bond-setting process.

The risk-based process outlined below could be used by councils to set bonds, but requires the use of a substantial amount of hitherto invalidated data to assess both the probability and cost of remediation to a high degree of accuracy. Councils should consider what constitutes an acceptable level of risk as part of the risk assessment process (discussed in section 4).

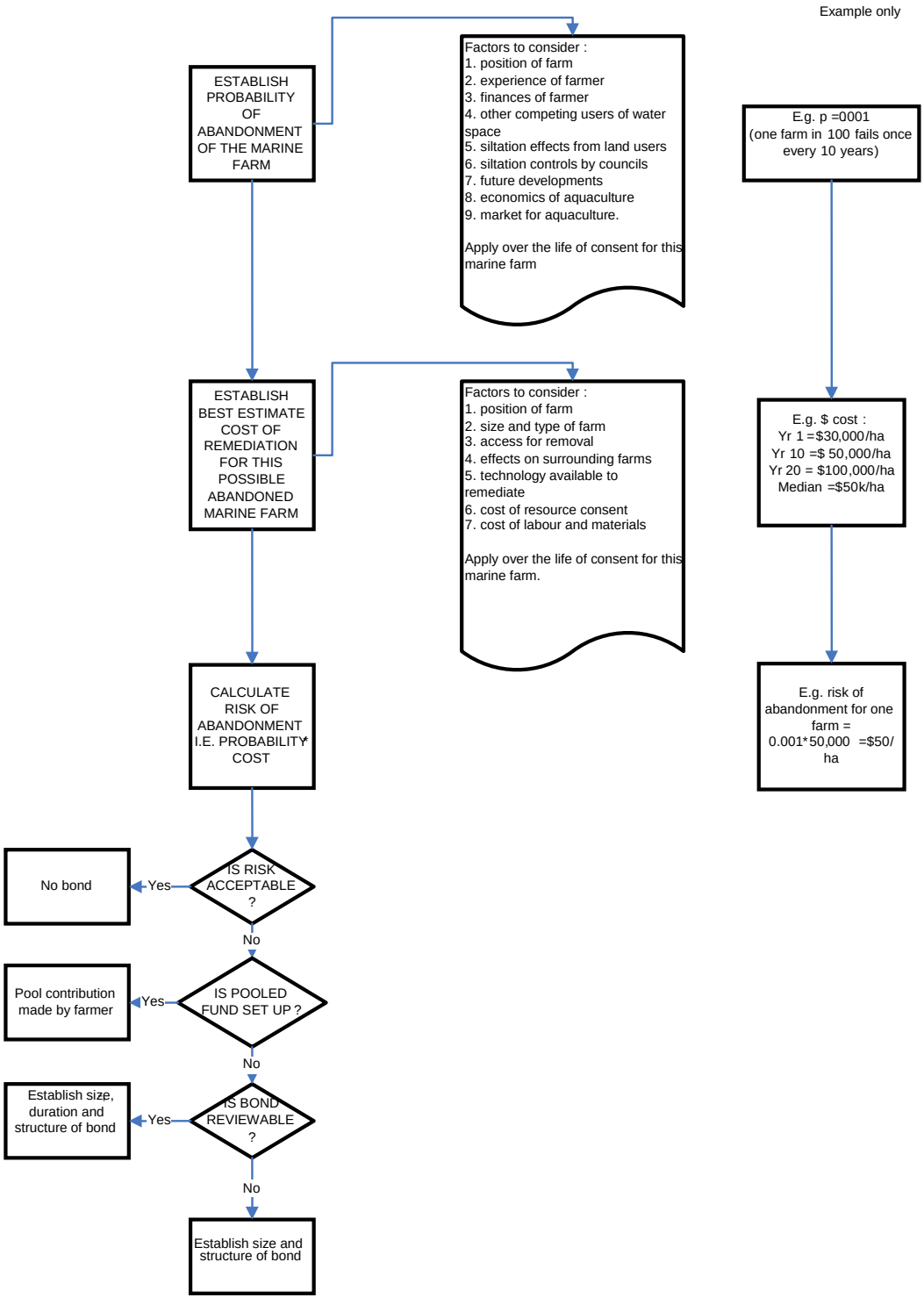

Figure 3: Suggested process for risk-based bond setting

Meeting bond liabilities

Up-front payment to consenting authorities and unpaid security through a bank guarantee are the common options for establishing a bond. The bank guarantee option has been favoured by councils under the RMA, especially for temporary construction or

site development bonds. Using unpaid guarantees for low-risk ventures (i.e. familiar technology in typical locations) is common in the mining sector in Australia. Meeting bond liabilities with a surety is a form of private insurance (discussed in section 5.1.2).

Regardless of its form, a bond is a cost to marine farmers. A bond is treated as another loan from the bank (even when it is a bank guarantee), and in tight economic periods it could affect the financial viability of some operations.

Bond use in New Zealand

Some councils are concerned about ratepayers bearing the risk of marine farm abandonment and so impose bonds, as the risk mitigation instrument available under the RMA, to ensure that marine farmers bear this risk.

Councils take a variety of approaches to imposing bonds on marine farm consents. These are only becoming apparent as new consents and consent re-applications have arisen under the RMA framework. In the light of high-profile farm failures like those in the Waikare Inlet, the appetite for bond setting has increased. Indications are that bond-setting to recover a proportion of restoration costs over the life of the consent is being used (e.g. by Northland and Auckland Regional Councils), with farms either assessed on a case-by-case basis or profiled on a species basis. However, the risk assessment and the level of risk acceptance have not been made clear. Bonds are also imposed on other marine structures, such as new wharves and marinas, but these are typically temporary and expire at the end of the construction period (i.e. when the structure is likely to form the basis for an ongoing operation).

Marlborough District Council, the regional authority for the region with the greatest amount of aquaculture activity, is comfortable with the industry's track record and has no intention of requiring bonds for new consents for marine farming practices that are familiar or typical in the region. However, bonds have been put in place on large offshore marine farms where the structure's technology is untested.

Other agencies in New Zealand also set bonds for the commercial use of shared resources. The Department of Conservation, for instance, applies bonds as a condition of access for mining operations on conservation land under the Crown Minerals Act. The aim of these bonds is to restore the site to a defined condition should the site be abandoned or if the operator is unable to restore the site at the end of the consent. The bond amount, usually provided as a bank guarantee, is decided by agreement between the applicant and the Department, a process that typically involves input from third party experts. The amount is recalculated each year based on the operation's status and planning evidence in the operator's management reports, with the Department aiming to recover by way of bond an amount equal to 80–95% of the full cost of restoration. An RMA bond payable to councils may also be required if there is activity on council-owned land.

The mining industry and its regulation are not sufficiently comparable to the current New Zealand aquaculture context to provide a suitable model for applying bonds to marine farms. In surface mining, for example, there is a long history of data collection for environmental impacts, decommissioning, restoration and catastrophic events, and, importantly, a long history of bond setting and the use of bonds to fund site restoration where operators have failed or have abandoned the site. This history allows the scope of remediation to be more tightly defined and the costs more reasonably estimated. The availability of actuarial data has allowed a surety bond market to develop where the operator is able to provide a guarantee for the resulting large bond amounts by paying a premium for the full amount of coverage to the surety provider on an actuarially

determined basis.[14] These conditions are significant in making mining an activity to which consenting authorities can apply bonds with a satisfactory level of confidence as to the extent of bond coverage. Section 5.1.2 notes that using surety for bonds in the New Zealand aquaculture setting is not currently viable.

International bond practice

The international experience of bonds in marine aquaculture is not significant, and there is no clear best practice that is relevant to the New Zealand context.

In the UK, the seabed is owned by the Crown Estate, which grants the leases via local authorities. No bond is required, but the lease goes back to the local authority if the lease terminates or the farm becomes inactive. If equipment remains on a site, then the farm is judged to be still active. The risk of clean-up lies with the local authority. The local authority is also liable for structure removal, but only when the consent lapses.

In the USA, the National Offshore Aquaculture Act 2005 requires that bonds be set for site remediation. Similar systems operate in parts of Canada under provincial statutes. There are no broadly standardised approaches and little up-to-date information available on how local authorities set bonds, although it appears that bond setting on a case-by-case basis is prevalent.

Analysis of aquaculture bond regimes in Australia shows that a similar stage has been reached as in New Zealand: consent authorities are interested in alternatives for residual risk management and are looking at standardised approaches at a state level. Current bond impositions are typically low. In New South Wales, the Department of Primary Industries requires a one-off bond (cash or guarantee) of AU$1,000 per hectare before issuing a lease, or AU$40 per hectare per annum as a 'bond' from oyster farmers only, which can be used as a last resort when all reasonable measures to get a permit holder to rectify a lease management problem have failed (around 90% of lease holders opt for the annual contribution). Annual contributions and cash payments of bonds are pooled in separate and dedicated interest-bearing trust accounts. Guarantees are cancelled and cash bonds returned at the end of the lease, but annual contributions are not refundable and are used to build the fund for any future remediation activity.

Evaluation

From a council perspective, bonds are a familiar instrument which are easy to set up and administer under the RMA, and which provide certainty to councils about the extent of coverage if remediation is required. They fulfil statutory obligations when properly defined.

In deciding whether or not to impose bonds, risk assessment (probability multiplied by cost) is used to determine the acceptability of the risk, not to establish the amount of the bond. In the example in Figure 3, the risk assessment calculation gives a risk estimate of $50/ha. If the council deems this risk unacceptable a bond may be imposed, but if the council wishes to fully cover its worst-case scenario, the bond quantum would be based on the worst case-remediation cost of $50,000/ha. This example demonstrates the potential inefficiencies of bonds compared to risk-pooling instruments, which would provide coverage at rates closer to $50/ha. Councils setting bonds should be clear about the level of risk they deem acceptable. Ongoing review of the residual risk assessment will help to ensure that bonds are not imposed on consents where the residual risk has become acceptable.

Industry buy-in to bonds is likely to be limited because bond amounts set to meet full costs of restoration are likely to be a significant financial burden, whether they are paid

[14] http://www.osmre.gov/bonding.htm

upfront or as a bank guarantee. Bond regimes do not offer the advantage of pooling the risk for increased efficiency of coverage. A bond regime also provides fewer direct incentives to improve risk management practices, even if there are regular reviews of residual risk. If the residual risk, as determined using the technique in Figure 3, reduces to an acceptable level, the bond liability is removed. If the residual risk remains unacceptable, the amount may not change because the amount of each bond is related to the cost of remediation. The applicant is only rewarded for improved risk management if their risk management has resulted in the residual risk from their activity becoming acceptable or has reduced the potential remediation cost.

Bonds would appear to be most appropriate for applicants with a residual risk profile that is unacceptable or unknown, such as with the use of new marine farming technologies, or atypical or speculative water space, in the absence of more efficient risk mitigation instruments. The generalised application of permanent bonds over the life of a farm in the absence of ongoing residual risk analysis appears to be a coarse instrument for managing the residual risk of abandonment in the current New Zealand aquaculture context.

5.1.2 Private insurance[15]

Aquaculture is a growing market for private insurers, with demand for aquaculture insurance higher than ever before as the industry grows globally. Although the range of species and culture systems covered under aquaculture policies worldwide is diverse, aquaculture insurers retain a cautious approach to aquaculture due to the limited data available for valuation and making actuarial assessments of the risks involved, particularly to stock. This caution leads to higher premiums and excesses, as well as a limited choice of insurers.

The use of private insurance is patchy across New Zealand's aquaculture sector. Insurance of stock is mainly taken up by major aquaculture enterprises, which are generally insuring growing finfish, not mussels and oysters. Around 90% of New Zealand's farmed salmon is insured. Most medium to large marine farmers appear to have insurance for structures and equipment as part of normal business operations, often purchased as a result of pressure from banks and/or other investors. Smaller producers may not have any insurance. Interest in insurance is typically constrained by cost. Premiums are mostly in the range of 2.5 to 5% of the insured value of the farm, less for equipment alone, and typically with a 20% excess.

Private insurance is often neither available nor affordable for comprehensive cover to third parties, particularly for site remediation. The high excess also makes insurance effectiveness uncertain under the circumstances in which abandonment is most likely to occur; i.e. where a marine farming business owner is unavailable to mitigate the effects.

Finite risk insurance (multi-year insurance contracts, where the insurer bears the risk for a known loss) for businesses to cover agreed costs to councils in the case of tightly defined abandonment or forfeiture conditions, or the costs of RMA bonds to cover such conditions, have been proposed both in New Zealand and offshore. Similar to private insurance is performance surety bonding, a three-party instrument between a surety issuer, the marine farmer and the council. The agreement binds the marine farmer to comply with the terms and conditions of a contract. If they are unable to do this successfully, the surety issuer assumes the marine farmer's responsibilities and ensures

[15] Data mainly comes from private correspondence with Sunderland Marine Mutual Insurance, Nelson.

that the defined terms are completed. New Zealand firms seeking sureties are likely to have to look offshore to find specialist surety issuers.

Some councils retain a provision for insurance instruments to be used to cover bond requirements in their plans. Where insurances are used in this way, a third party (the council) has a significant role in determining if a clean-up is required as well as in determining the extent and cost of the clean-up. Councils have no real financial accountability because they pay no premium, yet they may decide what happens regarding the expenditure against the claim. There is a possibility that with such cover in place, a council could insist that businesses activate the cover when perhaps lower-cost or alternative options could be pursued, such as finding a new lease holder who might be willing to remediate and utilise the site. The council could also invoke the cover to provide backup where an inappropriate aquaculture site or project may have been approved. On the other hand, councils may encounter difficulties in accessing the cover due to problems establishing proximate cause.

Evaluation
Insurance, by its nature, is risk based and insurances are constructed to address defined residual risks of whatever nature as long as they are not solely financial risks, where the failure is caused by trade changes.

Insurance may fulfil statutory obligations when included in policy under the RMA, but from a council's perspective insurance is uncertain: it may pay nothing if refuted, or the excess may leave the owner still liable. Insurance is not currently generally acceptable to industry at its present levels of premium, cover and excess.

There is, however, significant positive value from aquaculture enterprises having insurance: most importantly, it can facilitate the ongoing operation of aquaculture businesses within consent conditions despite various external impacts and events, thereby ensuring sites remain operationally viable.

5.2 Risk mitigation tools requiring industry and/or council changes

5.2.1 Remediation pool funds

A remediation pool fund is a very different approach to a bond. It is a dynamic, risk-based instrument which is administered in such a way that when all other remediation mechanisms fail, and a residual risk is left with a party such as a council, there is a fund that can meet the full cost.

This sort of risk treatment recognises that:

- considerable work goes on day-by-day to minimise risk by both industry players and regulators
- risk analysis can be used as a tool to define the residual risk to be managed
- apportionment of the required funds for the residual risk by councils can be made in a fair manner, based on the risk contributed by the individual players in the industry
- there is a level below which the residual risk of abandonment, pollution, etc. by an individual player or class of players is acceptable
- there is a need to revisit both the residual risk and the levy contributions from time-to-time as risk continues to vary
- costs may fall in an unpredictable manner (e.g. a spill may occur in one council area, but the effects of the spill are actually borne by another council due to wind

and tidal effect; the same could happen in the future as aquaculture moves further offshore).

Use of remediation pool funds

There is wide international use of such funds for diverse purposes, including toxic waste site remediation in Californian schools, coal dump site remediation in the UK, revitalising industrial sites in Northwest USA, and Japanese nuclear site remediation.

Setting remediation pool funds

In discussing the setting of remediation pool funds, the approach used by the New Zealand Oil Pollution Levy Fund represents good practice risk mitigation being applied at a national level in New Zealand. It has wide acceptance by the various contributors to and users of the fund. The Oil Pollution Levy Fund is familiar to councils and its terms and conditions are administered regularly by Orders in Council. The fund is industry governed, with an industry-based committee ensuring equity of levies and payments. Triennial risk re-assessment is funded by Maritime New Zealand. The fund is capped at a limit providing for the residual risk clean-up costs determined by the risk assessment, other than those recoverable by other mitigation means such as insurances.

Such a fund could either be solely aquaculture based, or could be more widely contributed to by other present and future operators of structures in the coastal marine area (e.g. floating hotels, mining structures, wharves, jetties, marinas, wind farms, tidal and energy barriers) having similar abandonment risks. It is important to define at the outset if the fund retains the option of including other such coastal marine area users.

The primary advantage of this approach is the efficiency of risk sharing and coverage, with resulting benefits for all aquaculture stakeholders. Councils would receive an assurance that marine farm abandonment would be dealt with to its satisfaction (provided the council fulfils its clearly defined obligations). The development of a standard approach would also deliver business process efficiencies to councils. Industry could set levy contributions that reflect a range of risk variables (species, technology and location to name a few) according to their knowledge and experience. Operators would have a strong incentive to instal effective risk management and have insurance, as this would probably result in reduced levy contributions. At a higher level, this would also result in reductions to the total risk from aquaculture operations nationwide.

The fund in its early days, when data for setting levies is relatively coarse, could be established using the finite risk reinsurance funded approach illustrated in Figure 4.

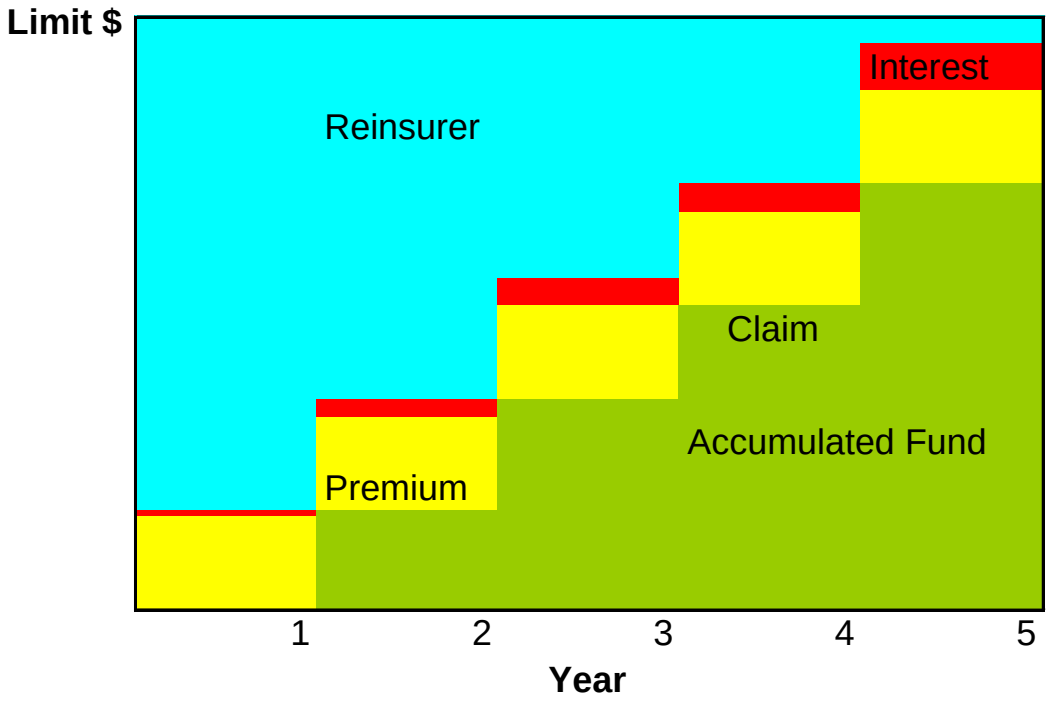

Figure 4: Finite risk reinsurance fund model

In this approach, the finite risk reinsurer funds any losses that occur in the years during which the fund is built up, in return for a premium/levy payment from the fund which reduces as the reinsurer's liability becomes smaller. If some form of industry-wide catastrophic event were deemed to be an event that should be covered by the fund (e.g. a tsunami), then some form of catastrophe risk-layered insurance would be purchased by the fund.

Levies

The contributions to such a pool would be determined according to a set of risk-based rules, which would be independently assessed nationwide to ensure equity. As with the Oil Pollution Levy Fund, there is a pre-determined level of risk below which no levy is collected. For example, the risk of abandonment for inshore mussel farms may be deemed to be below such a level of risk of abandonment.

A slightly different approach to funding is being proposed for use in the North Sea by the UK Government. This involves a decommissioning fund for offshore energy operators of wind and tidal farms, whereby the fund is only contributed to in the mid-life operational period of the installation when it is making profits and before the end-of-life phase where risks might be greater. Again, much of the analytical work is risk based to determine appropriate levels of the fund.[16]

Operation

A pool fund could operate as follows. If a business failure occurs and a coastal marine area structure is left in an abandoned state, a first approach would be made to the industry to assist according to its code of practice or by a takeover of responsibilities by another operator. Failing this, the fund would be invoked by a council making a claim on the fund, according to fund operating rules. If the cost of remediation and removal exceed the fund, then the finite risk reinsurer would top up the claim. The fund may then have to make some adjustments on an actuarial basis for future levies.

[16] *Climate Change Capital*, Offshore Renewable Energy Installation Decommissioning study, 2006.

There would be no good reason, other than the cost of overheads being more concentrated, why such a fund could not operate in a region that has a concentration of residual risks. This regional approach may be attractive in Northland, where oyster farms consented under previous regimes present a unique challenge to industry and regulators.

Ownership of and responsibility for a remediation pool fund is a critical issue in fund establishment and operation, and there are several options for how such a fund could be structured. A nationwide, industry-based fund with input from central government, like the Oil Pollution Levy Fund, has been proven to meet stakeholder requirements for cover and efficiency. A pooled fund with similar features could be operated under the auspices of a sub-sector or regional industry group.

The key features of the New Zealand Oil Pollution Levy Fund that could be replicated are:

- establishing the residual risk every three years with a detailed-as-possible quantitative analysis
- fund governance by the industry
- a detailed set of fund rules
- an efficient means of recovering contributions
- a threshold below which those not adding to the risk do not contribute to the fund.

Under current legislation, contributions to a pool fund could be required as a consent condition. To meet this requirement, a voluntary remediation pool could be established and operated by the industry. Contributions would have to be voluntary, but a bond could be required from high-risk marine farmers who decide not to contribute to the fund. This sort of fund could be established initially on a regional basis, starting in a region where bonds are an issue (e.g. the Northland or Waikato regions).

Use of such a fund by councils would require policy changes to recognise the fund and to develop alternative conditions for farmers not contributing to the fund. Councils would also have to be involved in mutually determining the risks to be pooled and the details of fund responses to abandonment conditions. Although this approach shares many of the above features and benefits, it does not provide the extent of certainty of cover because it lacks statutory powers to require contributions. It could, however, serve as an intermediate step to a national fund, or serve as the basis for a future, legislated fund if desired.

Evaluation

Pool funds are by nature risk based and are constructed to address defined residual risks of whatever nature is decided (e.g. abandonment). They are initially complex to set up and administer from the councils' and industry's perspective, but efficiencies would result in better ongoing risk management. They also require risk analysis to be updated frequently.

Pool funds are generally acceptable to all stakeholders when they have sufficient input and involvement in determining the funds operating parameters. They fulfil statutory obligations when properly legislated for.

Establishing a nationwide remediation pool fund presents an opportunity to efficiently mitigate the residual risks to councils from aquaculture (or, potentially, a wider range of activities in the coastal marine area) while achieving a reduction in total risk as a spill-over benefit. A voluntary approach under current legislation would rely on industry buy-in, but could be integrated with judicious use of bonds for an efficient risk mitigation scheme

providing coverage for councils. A legislated approach may prove to be more efficient and robust and should remain a consideration over the longer term. It may also facilitate the expansion of the pool fund to cover other structures in the coastal marine area.

5.2.2 Industry mutual insurance schemes

A mutual fund is an insurance-based financial instrument in which there is mutual accord and membership of the fund, and where any benefits are shared solely among the members. It is rules bound and uses a wide variety of top-up / finite risk insurance mechanisms to get the fund established against losses in the early days of the fund. Mutual insurance is still insignificant in the global aquaculture industry, although some frameworks are being developed, such as a Chinese regional scheme covering risks to vessels, gear and stock.[17]

A New Zealand industry "protection and indemnity club" approach (a mutual fund, covering third-party liability for the risk of adrift farm structures) was investigated by the industry several years ago but was not pursued by industry or councils. This may have been due to a lack of demand for security covering adrift structures alone. Large adrift structures, such as mussel lines and salmon pens, are infrequent occurrences and are expected to be rapidly dealt with by marine farmers. Adrift debris from farms should be retrieved under codes of practice and industry initiatives developed by regional and species-specific industry groups.

Evaluation

In the long term a robust mutual insurance scheme that deals with specific aquaculture risks may become viable under the umbrella of Aquaculture New Zealand. However, it is not feasible with the current lack of actuarial data. Industry demand for a mutual scheme is also limited.

Mutual funds are similar to pooled remediation funds. If a voluntary pooled fund is pursued, it is unlikely that a mutual fund option would be required to address the residual risk of abandonment.

5.3 Non-financial voluntary approaches

Non-financial voluntary approaches include standards and agreements that require voluntary adoption by industry participants as part of their business practices. They may increase the capacity of the aquaculture industry to manage environmental impacts and other foreseeable situations, and can augment or even replace some regulatory approaches.

Buy-in from industry must be established by identifying clear benefits to firms from their participation. These may be least-cost ways to meet regulatory requirements, increased market acceptance and/or access to shared knowledge resources. Voluntary approaches are more likely to be taken up where there is:

- established collaboration within the industry or sector that allows tapping into the existing knowledge and relationship base
- clearly defined and quantified jurisdiction-wide objectives.

The former of these conditions is certainly present in New Zealand aquaculture. The condition of having clearly defined objectives is being developed through the concerted efforts of a range of stakeholders, and should be further assisted by the Government's aquaculture implementation team and the establishment of Aquaculture New Zealand.

[17] van Anrooy, R, Secretan, PAD, Lou, Y, Roberts, R, Upare, M 2006. *Review of the Current State of World Aquaculture Insurance*. FAO Fisheries Technical Paper.

Industry management agreements
Industry management agreements shift the responsibility for the resource in question to producers, subject to achieving environmental objectives agreed to with regulators. This arrangement is best suited to a homogeneous or regionally focused sector with few participants and sufficient commonality of conditions and production methods to make co-operative management viable.

These conditions favour species groups developing and enforcing management agreement conditions which now may fall under Aquaculture New Zealand branding and administration. Higher-level undertakings, such as commitments to biosecurity monitoring, are currently in development. There are excellent incentives for New Zealand's aquaculture industry to self-regulate using industry management agreements, given both the production and reputation impacts on marine farms of poor aquaculture practices in the coastal marine area.

Codes of practice
A code of practice is a document that provides information and guidance to industry participants about ways to achieve best management practice. Documents vary from guidelines to detailed checklists, and range from whole-of-operation to specified environmental impacts.

A potential extension of a code of practice is for regulators to allow operators to be "deemed to comply" with regulations if they follow the practices outlined in their code. This is a flexible partnership approach to regulation which:

- can be updated more easily than government regulations
- incorporates the expertise of those being regulated, which may build industry acceptance and willingness to comply
- offers industry well-defined consent requirements, eliminating grey areas around the implementation of requirements.

The effectiveness of a code of practice is ultimately determined by the extent and coverage of the code and its rate of adoption by industry participants. In the New Zealand setting, codes of practice developed by mussel and oyster farmers' associations have been integrated into council monitoring regimes in Marlborough district, for example. The development of existing and further codes of practice is underway in partnership with public sector stakeholders, including Biosecurity New Zealand, an approach which is to be encouraged.

Evaluation
Voluntary approaches would not give councils sufficient assurance that the residual risk of abandonment has been entirely mitigated. However, the increasing breadth of voluntary approaches reinforces the readiness of the New Zealand aquaculture industry to reduce risks by undertaking self-regulation. Voluntary approaches must be considered as an overall part of the risk mitigation mix as councils assess what constitutes satisfactory assurance that its residual risk is "as low as is reasonably practicable". This approach permits councils to consult with industry to identify where regulation can effectively be shifted from councils to industry.

5.4 Other regulatory approaches

Literature on risk management tools for shared resource use lists a number of other instruments, including demerit schemes for consent breaches, offsets for environmental impacts, and market-based approaches such as tradable permits and auctions for

shared resource use.[18] These are incompatible with the aquaculture regulation context in New Zealand for a variety of reasons, such as insufficient data and/or hard science regarding industry activities and their interaction with the environment, and the expense and complexity of setting, establishing and operating the proposed regulatory instruments. However, the main reason for not considering these alternative tools is that they primarily seek to minimise the environmental impacts from activities rather than address business failure and mitigate the subsequent impacts.

5.5 Summary

A summary of risk mitigation tools and their implications for stakeholders is given in Table 6. The table has been divided into two sections:

- risk mitigation tools that are available under current legislation, with current council policies and processes and current industry structures
- risk mitigation tools that require new industry initiatives and/or modification of council policies and processes.

[18] These are outlined in http://www.coastal.crc.org.au/pdf/economic_instruments.pdf

Table 6: Summary of risk mitigation tools and implications for stakeholders

Options	Description	Implications for councils	Implications for industry	Where used
A) Under existing legislation and within current aquaculture context				
RMA bonds paid up front	A monetary instrument paid up front by the owner to the council against a future event.	• The council has certainty of level of coverage, but there may be difficulties maintaining adequacy of the bond over time. • Legislation exists to enable implementation. • Requires assessment of the residual risk to ensure imposition of reasonable costs only. • Requires ongoing reassessment of residual risk acceptability. • Contestable by industry in Environment Court.	• Imposes higher costs relative to options that share risk across sites. • Review conditions may reward good risk management practice through removal or reduction of bond liability.	• NSW oyster farms. • Regional councils.
RMA bonds paid by guarantee	A monetary instrument paid by the owner to the council by means of a bank, or some other guarantee against a future event.	• As above. • Possible uncertainty over the security of the guarantee in the long term.	• As above. • Limited market for guarantees may lead to high transaction costs.	• Prevalent in mining. • NSW oyster farms. • Regional councils.
Private insurance	A liability insurance or special risk policy covering a defined event, held by council as the beneficiary, from a private. insurance company.	• The claim is contestable by the insurer. • May not know security of insurer long term.	• Additional cost in a very limited market. • Council could seek to invoke policy inappropriately.	• Large-scale environmental liabilities (e.g. mining, oil, civil).

B) Under existing legislation but requiring industry and/or council changes				
Voluntary pooled fund	A cash fund operated by industry, probably regionally, to pool particular risks.	• May not know security of industry commitment long term. • Risks and responses have to be satisfactory to councils and recognised in policy. • Requires increased engagement with industry to monitor the fund and practices. • Non-covered operators will require a separate risk mitigation process.	• Council could seek to invoke a response inappropriately. • Ongoing commitment to lead set-up and administration. • Marine farmers choosing to operate outside industry norms may require special treatment. • Residual risk reduction is incentivised through reduction in levies.	• Trade associations to protect members.
Mutual insurance	A liability insurance or special risk policy covering a defined event, held by the council as beneficiary, from a mutual insurance company (e.g. industry or council owned).	• The claim is contestable by the mutual company. • May not know security of industry commitment long term. • Requires tightly defined event to occur.	• The council could seek to invoke the policy inappropriately. • The cost of mutual set-up and administration. • Pooled risk concept, based on an event the council defines.	• Large-scale environmental liabilities (e.g. mining, oil, civil especially government schemes).
Aquaculture levy fund	A legislated pool fund, like the New Zealand Oil Pollution Levy Fund, into which all farmers are required to contribute on a risk basis and which councils claim from.	• Pool of risks needs tight definition. • Fund responses need tight definition.	• Involved in set-up and administration. • Identify areas of acceptable risk (e.g. in-shore mussel farming). • Residual risk reduction incentivised through reduction in levies.	• New Zealand Oil Pollution Levy Fund. • Offshore Renewable Energy Installation Decommissioning Fund (UK).

6 Conclusions

This report has examined the broad features of the aquaculture industry, its regulatory framework, risk management approaches and specific risk treatment options. A wide range of stakeholders have been interviewed, marine farms have been visited, and the recommended qualitative approach to risk analysis has been trialled with a stakeholder group.

Although councils require a recommendation for managing the risk of marine farm abandonment, the scope of this exercise has allowed for the development of a framework that can be used to inform a range of stakeholders about aquaculture risks, both now and in the future. As a result, the conclusions reached cover the specific issue of marine farm abandonment as well as broader aspects of risk management in New Zealand aquaculture.

6.1 The industry

The New Zealand aquaculture industry includes several mature sectors characterised by well-established, well-resourced and sophisticated firms that have developed effective risk management for typical operating risks and shown an ability to collaborate at a regional level to manage more significant external risks. There is a robust and growing global market for aquaculture products which has led government to give the industry a strong mandate and support to grow in a sustainable manner.

The industry has significant sustainability drivers that acknowledge the importance of good environmental practice: in maintaining a clean and viable production space in the Coastal Marine Area (CMA); in public perception of its activities, and in its marketplace. An increasing sense of collaboration has resulted in the establishment of an industry organisation, Aquaculture New Zealand, which should enable the industry to establish more and better cross-species and nationwide initiatives, and strengthen and broaden its self-regulation activities to achieve agreed environmental objectives and fulfil obligations to regulators.

6.2 The regulatory framework

Since the introduction of the aquaculture reform legislation in 2005, councils are now the primary regulatory decision-makers affecting marine farming. Councils must balance environmental and economic development objectives and competing uses and values of other users of the CMA, and central government's support for sustainable growth of aquaculture.

The new regime remains largely untested: a new Aquaculture Management Area (AMA) is yet to be created under the new provisions in the RMA, and there is uncertainty over how the process might proceed in practice. Despite current difficult economic conditions in which the high value of the New Zealand dollar is eroding export revenue, there is likely to be a market premium for already-consented space, even if clean-up and structure removal is required. Councils remain concerned that there are circumstances under which they could find themselves responsible for restoring abandoned farm sites. However, there has previously been no consensus between industry and councils as to the level of risk to which councils are exposed or the possible costs of any restoration.

6.3 Risk assessment in New Zealand aquaculture

The aquaculture sector at present does not use formalised or standardised risk assessment tools. Some of the supportive work on elements such as biosecurity and new technologies is based on discrete risk analysis, but risk assessment is not carried out as a matter of course by councils.

A predominantly qualitative risk assessment approach has been used because of the lack of consistent and qualified quantitative data. This assessment has been informed where possible by the available quantitative data. A residual risk analysis approach should be used because it is evident that the industry is working to reduce risk day-by-day.

A multi-stakeholder risk assessment workshop determined that this sort of analysis is useful for informing opinions on the true level of residual risk. Aquaculture should also be examined within three risk contexts – Research & Development (R&D), early commercialisation and full commercialisation – because each has distinct risks and differing time periods over which these may occur. At present, authorities make little differentiation between these contexts.

6.4 Risk evaluation

The risk scoring workshop demonstrated that current controls and voluntary approaches have reduced the risks to a manageable level, with industry participants treating many of the identified risks as business-as-usual. The current residual risk to councils of marine farm abandonment is very low, due to industry conditions that support the purchase and remediation of abandoned marine farming sites.

The residual risks to the industry are predominantly external. The risk from natural hazard events is no different to that for many other structures in the coastal marine area today. Major natural hazard or biosecurity events with similarly major impacts on marine farming activities are likely to attract national responses in which marine farm abandonment would be only one of many considerations. In the history of New Zealand aquaculture, biosecurity hazards have not resulted in major, ongoing impacts to farm productivity.

Marine farming space is a valuable commodity, which is presently limited. There is a general consensus among those in the industry that if industry profitability continues, it will remain economic for other marine farmers to acquire and clean up sites where marine farm business failure has occurred, provided these sites are still viable for farming. The industry has weathered a number of exchange rate fluctuations that have reduced export revenue while retaining the capacity to purchase and operate sites that come up for sale.

Mussels

The residual risk to councils of mussel farm abandonment in the current New Zealand aquaculture context is negligible; i.e. any risk mitigation benefits would be far exceeded by the cost of setting and collecting a levy through a risk mitigation instrument. This

largely qualitative assessment is supported by the following points, including some quantitative data.

- There have been no mussel farm forfeitures from a total of 521 leases during the Ministry of Fisheries' tenure of administering aquaculture (1964–2004). (There is an informal report, not captured in official data, of a mussel farm using experimental structures being abandoned in the Kaipara Harbour in the 1980s).
- A trial qualitative assessment, completed as part of this report, indicated that the likelihood of marine farm business failure in the current New Zealand aquaculture context is negligible.
- The capital value of mussel farming structures makes it unlikely that structures would be left in the water.
- The value of consented marine farming space makes it unlikely that the space would not be restored to operation.

Finfish (salmon)

The residual risk to councils of salmon farm abandonment in the current New Zealand aquaculture context is negligible; i.e. any risk mitigation benefits would be far exceeded by the cost of setting and collecting a levy through a risk mitigation instrument. This largely qualitative assessment is supported by the following points, including some quantitative data.

- There have been no salmon farm forfeitures from a total of 30 leases during the Ministry of Fisheries' administrative tenure.
- A trial qualitative assessment, completed as part of this report, indicated that the likelihood of marine farm business failure in the current New Zealand aquaculture context is negligible.
- The capital value of salmon farming structures makes it highly unlikely that structures would be left in the water.
- The value of consented marine farming space makes it unlikely that the space would not be restored to operation.

Oysters

Of a total of 337 oyster farm leases under Ministry of Fisheries regulation (1964–2004), 89 forfeiture notices were served to farmers. Most of these notices stemmed from historical management practices and regulatory regimes, meaning that a number of oyster farms were situated on unproductive sites or were unable to effectively make the transition from rock oyster culture to Pacific oyster culture.

However, management practices and risk management through zoning and monitoring by consent authorities have shown ongoing improvement. Although there are still 10 farms under outstanding forfeiture action (including those in Waikare Inlet, the site of a contamination incident in 2001), and a number of oyster farms recently transferred to the jurisdiction of Northland Regional Council that pose a higher relative risk of abandonment, only one oyster farmer has failed to comply and forfeited their lease. (There is an unofficial report that two small oyster farm sites were restored by the Ministry in the late 1960s.)

Despite some history of issues with maintaining operational viability on oyster farming sites, the residual risk to councils of oyster farm abandonment in the current New Zealand aquaculture context is low; i.e. it may be economically rational for councils to

require some form of financial risk mitigation. This largely qualitative assessment is supported by:

- a trial qualitative assessment of the likelihood of oyster farm business failure in the current New Zealand aquaculture context
- continually improving risk management of oyster farms through industry good practice, and zoning and monitoring by councils
- the willingness of the oyster industry to undertake structure removal and site restoration on derelict or abandoned farms
- the value of consented marine farming space, which makes it unlikely that the space would not be restored to operation.

History and industry consultation show that occurrences of adrift marine farm structures are relatively rare. In most cases where structures break their moorings, the marine farmer will aim to recover them as soon as possible because structures and stock have significant residual value.

6.5 Risk mitigation instruments

There is a range of risk mitigation instruments that may contribute to improved risk management in the New Zealand aquaculture context, but only two of these have universally applicable prospects to effectively address the residual risk of abandonment of marine farms: a remediation pool fund and/or use of bonds. Either, or a mix, of these tools could provide residual risk coverage for councils and be written into resource consent conditions. There are also opportunities for collaborative efforts that would reduce risks such that the residual risk of abandonment is acceptable to councils.

RMA bonds

There are conditions in which use of bonds may be appropriate for managing the residual risk of abandonment in the current New Zealand aquaculture context. However, the generalised application of permanent bonds over the life of a farm in the absence of ongoing residual risk analysis appears to be a coarse instrument for managing this risk.

RMA bonds do not provide for pooling of risk, thus the bond must remain tied to the consent on which it is imposed. Therefore, a 'best estimate of worst case' of restoration costs would be the only way that councils have to ensure that the bonds' quantum would provide acceptable coverage in the event of abandonment requiring restoration. This is likely to require setting of large quantum bonds that could affect business viability and/or growth prospects across the industry.

When an unacceptable risk of potential business failure has been identified with any particular application, there is a basis for a bond with periodic review conditions, similar to what councils impose during wharf and marina construction periods. When stable conditions (e.g. ongoing profitable operation) prevail, the risk is likely to become acceptable and such a condition should be removed. Bonds should also be removed in the event that an alternative mitigation of residual risk, such as a remediation pool fund, is established.

Bonds should wherever possible be based on a guarantee from an acceptable financial institution, e.g. one with Standard and Poors' or better rating.

Pooled funds

There is a strong basis for councils to have access to a generalised risk-based pool fund for any structures in the CMA, not solely focused on marine farms, but also covering marinas, wharves, jetties, moorings and future structures such as tidal barriers, wave generators, and offshore wind generators. While there are challenges and lead times involved in establishing a remediation pool fund, this option represents the most efficient and effective way to mitigate the residual risk of abandonment of marine farms and, potentially, other structures in the CMA. It also provides strong incentives to marine farmers to install and maintain effective risk management and mitigation, thus reducing the total risk from activities in the CMA.

The key features of such a fund include:

- establishing the residual risk every three years with a detailed-as-possible quantitative analysis
- fund governance by the industry (the pooled fund would preferably be industry driven and operated)
- a detailed set of fund rules
- an efficient means of contribution recovery and establishment of a threshold below which those not adding to the risk do not contribute to the fund.

The features above could be captured under current legislation by a voluntary pool fund established by the industry. Bonds could still be required from high risk marine farmers, or those that decide not to contribute to the fund. This type of fund could be established initially on a regional basis, starting in one region where unacceptable residual risk is an issue (e.g. Northland or Waikato regions). A regional fund could serve as an intermediate step to a national fund.

The New Zealand Oil Pollution Levy Fund has been identified as good practice for such a fund. This model has the additional advantage of being able to enforce contributions from all risk contributors from the time of fund establishment. Specific legislation would be necessary to require contributions from marine farmers. A voluntary fund could form the basis for a legislated approach, if such an approach was found to be desirable in the future.

If an industry based voluntary pool fund approach is pursued, the industry group running the pool fund might test industry willingness to make contributions to the fund before contributions being required to meet conditions of their specific resource consents. In this way, a voluntary pool fund could quickly achieve broader coverage and greater efficiency (but probably not complete coverage) than the imposition of bonds. Councils will need to develop policies and processes that recognise the fund and set out related consent conditions and responses.

Industry voluntary approaches

Aquaculture industry conditions, such as increasing collaboration and the implications of shared resource use, are favourable for industry self-regulation. It is important for councils to be fully aware of voluntary approaches to risk management in their jurisdiction and to foster partnerships with industry on further developing such voluntary approaches. Well-canvassed voluntary approaches should help to address council concerns and may allow councils to shift some regulatory activity to industry. Industry

voluntary approaches may extend to mechanisms for site remediation at a local or species level that will further reduce the residual risk of abandonment.

The recommended option for managing the risk from those oyster farms in Northland that have been transferred from Ministry of Fisheries administration in poor condition is for current and former regulatory parties and industry to intervene to re-establish ongoing viability. Only once this has been achieved should farms be included under any pooled risk scheme. If business re-establishment cannot reasonably be achieved, or the farm continues to pose an abandonment risk, then bond setting may be used as an incentive for the business owner to comply or exit.

Appendix 1: The aquaculture industry in New Zealand

This appendix considers the key features of the New Zealand aquaculture industry and their implications for developing the risk context, risk analysis and risk assessment. It considers the industry's history, present and future, and the effects of the salient internal and external factors.

History

The New Zealand aquaculture industry began in the mid-1960s with marine farming of oysters and then mussels, typically by small, innovative operations. It quickly established a domestic market and began making inroads into export markets in the 1970s. As aquaculture techniques and value chains became more sophisticated in the 1980s, small owner-operator farms became less common and aquaculture/seafood-related companies expanded and consolidated. Production efficiency, control of stock and cost reduction dominated industry thinking as export markets expanded.

During the 1990s global competition in seafood products intensified, driving further consolidation of the industry in an attempt to achieve increased production and marketing efficiencies. With the introduction of the Resource Management Act in 1991, the expanding industry began to focus on sustainable production, acknowledging its associated environmental and social issues. The aquaculture industry was also threatened by biotoxin events, which gave rise to both water and food quality monitoring programmes. With pressures on the market for oysters and mussels, the sector began to diversify and the 1980s and 1990s saw the establishment and growth of the salmon industry.

New Zealand's aquaculture sector has grown steadily since the late 1980s at an average annual rate of 11.7% by volume over the 20 years up to 2005. Despite this expansion, the sector retains considerable potential for profitable growth.

New Zealand's aquaculture industry today has three mature sectors – mussels, oysters and salmon – and a range of other sectors at varying stages of development. Constraints to growth are the key challenges. Broadly speaking, the industry is meeting these challenges through attempts to access new water space and by generating greater value from the existing water space. The former can be achieved by working in partnership with government, councils and the public, while the latter can be achieved by focusing on innovation in production, processing and marketing.

Structure of the industry

New Zealand's coastal waters are host to approximately 1,200 marine farms.[19] The total water space occupied is around 5,800 hectares (an industry estimate), including some freshwater farms and spat-catching areas. This space represents approximately 0.2% of New Zealand's coastline out to 12 nautical miles and is similar in total area to one average-sized high country farm. The total space allocated to aquaculture in the coastal

[19] Ministry for the Environment 2005. *Aquaculture Reform: An Overview*. Ministry for the Environment: Wellington.

marine area is more than 13,000 hectares, with much space yet to be consented or developed.

According to the 2006 Census the aquaculture industry employs 1,086 people. This figure refers to those directly involved in marine farming, and the number involved in downstream processing and supporting activities is likely to be closer to 2,500, which is the figure provided by the New Zealand Aquaculture Council. The industry delivers a range of employment opportunities, from specialised technical and research positions to low-skilled opportunities in predominantly rural areas around New Zealand.

Aquaculture is currently undertaken in the following major locations spread across New Zealand (see Figure A1).

Figure A1: Aquaculture in New Zealand
Source: Courtesy New Zealand Marine Farmers Association

There are well-established aquaculture regions in the top of the South Island and the top of the North Island, with a long history of business operation and growth, along with established aquaculture regions with smaller concentrations of operations (e.g. Canterbury and Southland). A number of regions have emerging aquaculture sectors that have the potential to be dynamic contributors to regional economic growth or that are exploring options (e.g. Bay of Plenty, Gisborne and Hawke's Bay). There are also regions that are unlikely to support aquaculture in the near future due to their characteristic coastal marine conditions (e.g. the North Island's west coast).

The majority of aquaculture activity is undertaken by corporate concerns, including wild fishery companies that have diversified into aquaculture. A range of farm operating models are used, including operating their own farms, share farming arrangements, and providing farm management for absentee farm owners. Corporate participants have expanded production by buying out or partnering smaller farmers. Here, seamless transfer of farm ownership has been preferred to deliver value from stock transferred with sale and/or to best maintain equipment in the water. Buyouts have historically occurred as companies have sought to diversify operations over a range of sites as a risk management measure.

Larger and corporate participants go to considerable lengths to monitor their farm sites, and some have adopted environmental management systems such as ISO 14000 and/or have achieved organic certification for their production and processing. Corporate operations favour vertical integration, and achieve efficiencies from large processing sites. The number of owner-operators continues to dwindle as operating efficiency throughout the value chain becomes increasingly important to viability, particularly in mussel and oyster production.

The growth of the New Zealand aquaculture industry has resulted in the development of a range of supporting capabilities. Crown Research Institutes, universities and private sector researchers undertake Research & Development for aquaculture production and processing technologies and the sustainability of aquaculture in coastal marine environments. Ongoing R&D focuses on increasing productivity and product value and studying aquaculture activities in their environmental context.

Industry training is supported directly by the Seafood Industry Training Organisation, and tertiary institutions around the country offer marine science degrees with an aquaculture flavour. A new aquaculture research and education facility at the Mahurangi Technical Institute in Warkworth was opened recently. Aquaculture has also attracted supporting commercial interests, including engineering firms developing aquaculture structures and equipment and the long-established presence of a major international marine and aquaculture insurer in Nelson.

There is a substantial history of sector organisation at the species and regional level in New Zealand aquaculture dating back to the 1970s. Established groups include the New Zealand Mussel Industry Council, New Zealand Oyster Farmers Association, New Zealand Marine Farmers Association and Coromandel Marine Farmers Association. Industry participants report strongly aligned incentives and steadily improving co-operation throughout the industry, culminating in the recent development of a sector-wide strategy and industry body, Aquaculture New Zealand.

Ongoing initiatives in specific sub-sectors include marketing, advocacy and environmental and biosecurity codes of practice for production, some of which are implemented in conjunction with government agencies. Environmental codes of practice for mussel and oyster farmers have recently been reviewed, and a salmon farming code is in development. These will continue to be governed by species groups because they are species-specific, although it is worth noting that some best practice components can be transferred to other species sectors as they develop. Regional groups are also working on regional issues, such as implementing food safety programmes, developing

responses to biosecurity threats, and even undertaking beach clean-ups near aquaculture areas or setting up toll-free numbers for reporting marine farm debris.

Aquaculture species

Three main species are prominent in New Zealand aquaculture: the Greenshell™ mussel (*Perna canaliculus*), the king salmon (*Oncorhynchus tshawytscha*), and the Pacific oyster (*Crassostrea gigas*). Table A1 presents industry estimates of farming activity in these species.

Table A1: Marine farming activity in New Zealand

Species	Number of farms	Hectares of water space utilised	Tonnes harvested
Greenshell™ Mussels	645	4,747	97,000
King salmon	23	60	7,721
Pacific oysters	230	750	2,800

Source: Courtesy New Zealand Marine Farmers Association, 2007

Notes: Salmon statistics include both marine and freshwater farms. This table does not reflect diversification into new species and new products.

Greenshell™ mussels were New Zealand's most exported species by value in 2006.The New Zealand mussel industry is predominantly situated in Marlborough (around 75%) and Coromandel (around 20%), with farms in a number of other sites spread around the country. The Greenshell™ mussel is a New Zealand native, and New Zealand is the only country supporting commercial Greenshell™ aquaculture and an export industry. Due to New Zealand's high water quality, farmed mussels do not require depuration, unlike the blue and brown mussels that dominate international production. New Zealand marine farmers predominantly culture mussels using long-line systems in sheltered coastal waters.

Pacific oysters took over from the native rock oysters in oyster farms due to their faster growth rate and higher yield. The Pacific oyster is likely to have come to New Zealand in ship ballast water. Oysters are farmed predominantly in Northland and the Firth of Thames, although there is a small industry in Marlborough. Oysters can be grown in two systems, sub-tidal and inter-tidal. The New Zealand industry is predominantly inter-tidal, resulting in slower growth but cleaner, stronger oysters. Some farmers integrate the systems, accessing fast sub-tidal growth while retaining the benefits of inter-tidal culture. Water quality is a significant issue for oyster farmers. New Zealand's clean water makes it possible for oysters to be eaten raw, which is a significant marketing advantage over international competitors.

King salmon, the predominant finfish species farmed in New Zealand, is a premium salmon comprising only 8% of salmon farmed worldwide. It is an introduced species, and the lack of endemic pests and diseases has helped New Zealand avoid some of the disease and resulting environmental events that have occurred in salmon farming areas elsewhere in the world. New Zealand is therefore the only source of salmon that is not routinely treated with therapeutants. The larger salmon farming operations produce in sea-cages in Marlborough, Stewart Island and Banks Peninsula. Sites with deep, cool

water and sufficient current flow are favoured, providing adequate flushing to prevent build-up of sedimentation on the sea-bed and reducing water quality impacts.

Other species are being developed in scale, most notably paua and kingfish. The paua industry began in the 1980s and includes production of meat and paua pearls, predominantly from land-based operations located adjacent to the coast. The industry is yet to achieve a significant scale. A kingfish aquaculture research programme began in 2000 at NIWA together with industry collaborators. The programme has achieved transfer of fingerlings to farms around New Zealand and continues to refine production techniques.

A range of new species is currently in, or proposed for, research and commercialisation. These include rock lobster, kina, sea cucumbers, eels, sea sponge, seaweeds, groper and other finfish.

Market trends and drivers

A strong and sustainable market for seafood products is expected into the foreseeable future. Global demand is rising rapidly, with volumes expected to continue to follow – if not exceed – the trend that has seen global seafood consumption double since the mid-1970s. Market growth will be driven by world population increases and a growing preference for seafood as a healthy protein option, rich in vitamins and fatty acids. Consumer demand is likely to put pressure on global supply, boosting seafood prices. With wild fisheries' production static because of declining stocks, global aquaculture is poised to capitalise on a massive growth opportunity.

Aquaculture's sustainability also makes it attractive to sophisticated markets: lower impacts on wild stocks and efficiencies over capture fishery (specifically lower fossil fuel usage, which reduces both costs and the industry's "carbon footprint") are significant market advantages. Traceability of primary products is becoming increasingly desirable in sophisticated markets, and aquaculture is well positioned to deliver complete traceability of seafood products.

The ability of New Zealand's aquaculture sector to deliver consistent, high-quality product will help ensure ongoing marine farm viability over the next several decades. New Zealand aquaculture participants are particularly aware of sustainability market drivers, and they noted the potential to attract a premium for environmentally friendly products with a 'sustainability mark', underpinned by transparent and broadly applicable production criteria.

Investment and profitability

Marine farms represent significant investment in structures and stock. Industry participants have provided estimates for investment in structures on a per hectare basis. While these have been quoted for species, it is likely that other species will use culture technology (racks, long lines and sea cages) that will not be dissimilar in cost to those used for oysters, mussels and finfish, respectively.

Table A2: Marine farming structure investment

Culture technology	Investment in structures per hectare	Notes
Rack culture	$20–40,000	Range reflects use of sticks or bags
Long-line culture	$30–40,000	Three to four long lines per hectare
Sea cage culture	$3.5–4 million	Major investment in sea cages

Source: Estimates from Risk Assessment Workshop, 13 July 2007

The recent market for water space has seen prices of up to $200,000 paid per hectare. A conservative intrinsic value of marine space has been estimated as $30,000 per hectare. High site value has made farm sale an attractive exit strategy for less committed marine farmers.

Stock values can vary significantly, depending on maturity, productivity and market price. Estimates of values per hectare at harvest include $50,000 for oysters, $60,000 for mussels and up to $4 million for salmon. Importantly, the productivity of aquaculture per hectare is significant in comparison to other primary industries.

Table A3: Marine farming average revenues

Species	Revenue per annum per hectare
Greenshell™ mussels	NZ$43,000
Pacific oysters	NZ$35,000
King salmon	NZ$1,130,000

Source: Courtesy New Zealand Marine Farmers Association, 2007

The high productivity is to some extent offset by the significant initial capital costs and operating costs of marine farming. However, marine farming has been profitable for many and has attracted significant investment in the development, commercialisation and expansion of species and sites during its 40-year history in New Zealand.

A number of external factors can and have affected marine farming profitability. International competition has periodically driven down the international price of seafood sharply. This has been noted in section 2.1 as a driver for increasing production and marketing efficiencies in the shellfish sectors throughout New Zealand's marine farming history. The international salmon glut of the early 1990s was another driver of production efficiencies and adding value post harvest.

With the New Zealand dollar as high as US$0.79 during the time of writing, aquaculture ventures are seeing export revenues eroded. This, too, is driving investment towards higher added value from existing space, and to better establishing points of difference for New Zealand seafood products in international markets. It has also driven further development of the domestic market for aquaculture products. While many businesses have adapted, there has been further attrition of smaller operators.

Biosecurity threats to production and market acceptability have also affected profitability in the past. Pests, diseases and biotoxins can deliver a range of impacts, from small

productivity losses to massive stock mortality. The New Zealand aquaculture industry has not been hit by a particularly severe biological event in its history, and has developed effective collaborative programmes to minimise the impacts of previous and ongoing biosecurity risks.

Protection of farm sites from pollution from land-based activities is an ongoing challenge to profitability, particularly for farmers operating near coastal property developments. Due to the proximity of oyster farms to coastal developments, pollution incidents are likely to be a more significant threat to this sector than to culture further from the shore. Where pollution events occur, such as at the Waikare Inlet, Northland, in 2001, water quality around the farms does not meet sanitation requirements and the site is classified as restricted, with considerable limits placed on harvesting. It is difficult for farmers to manage the risk of pollution because it lies outside their farm management systems.

Despite a history of fluctuating profitability and current pressures, industry players have few concerns about the ongoing viability of their operations, and there is widespread confidence in the industry's ability to withstand future external pressures. With industry concentration continuing, the typical aquaculture venture is well resourced and resilient.

There is only limited anecdotal evidence of the failure of individual operators due to lack of profitability. Typically, these situations have been resolved by larger farmers partnering or buying out the struggling farmer.

The profitability and viability of aquaculture are likely to increase as industry focuses move away from commodity sales to increasing added value. Although it is likely that many New Zealand marine farms can still wring further efficiency from their operations, the preferred approach is to develop high-value products to meet demand in robust markets that are less subject to external pressures. Stakeholders note a major role for R&D throughout the value chain in maintaining and increasing the profitability of aquaculture in New Zealand.

Industry strategy

The sector- and nation-wide strategic aim of the aquaculture industry is enshrined in *The New Zealand Aquaculture Strategy*. This document was commissioned by the New Zealand Aquaculture Council in 2005 and the strategy's development was driven by industry. The project was completed with support and assistance from the New Zealand Seafood Industry Council and the Ministry of Economic Development.

The goal of the strategy is that by 2025 the New Zealand aquaculture sector will have sales of $1 billion per annum. The strategy takes into account the following guiding principles.

- the strategy is market-driven, industry-led, commercially viable and sector-wide
- it requires the collective action of industry participants
- growth will be driven by innovations in existing and new space, species, products and markets
- growth will take place within an environmentally sustainable framework
- the strategy will be implemented through a partnership between industry and government, communities, iwi, regions, and research/education/training providers.

A 10-point plan encapsulates the objectives of the industry. The plan will:

1. establish a new national sector organisation
2. strengthen the partnership with government
3. strengthen other stakeholder partnerships
4. secure and promote investment in aquaculture
5. improve public understanding and support for aquaculture
6. promote success in aquaculture
7. develop the market for New Zealand aquaculture products
8. maximise opportunities for innovation
9. promote the environmental sustainability and integrity of aquaculture
10. invest in training, education and workforce promotion.

A number of these objectives emphasise partnerships with regulators and improving public and market perceptions to enable aquaculture industry growth. Critical to achieving this is a risk management environment in which risks are accurately represented, and in which all aquaculture stakeholders have confidence.

The adoption of the aquaculture sector strategy quickly led to the establishment of Aquaculture New Zealand Ltd, the new national sector organisation identified in the strategy. Aquaculture New Zealand will co-ordinate the implementation of the strategy in co-operation with stakeholders and establish a monitoring and evaluation process to measure the impact of the strategy.

The establishment of Aquaculture New Zealand and its implementation of the sector strategy should have a positive impact on aquaculture risk management. The environmental codes of practice mentioned in section A1 will come under Aquaculture New Zealand branding, and will be harmonised to achieve efficiencies and transferability of higher-level, less species-specific components. Aquaculture New Zealand is well positioned to further facilitate filling knowledge gaps in councils regarding the effects of aquaculture, and to facilitate broad uptake of research or the latest thinking into aquaculture risk management. Effective risk management is important to achieving the conditions in which aquaculture can grow.

Government support

In *Our Blue Horizon – The Government's Commitment to Aquaculture*, the Government provided not just a response to the Aquaculture Sector Strategy, but a commitment to facilitating the sector's 10-point plan in areas where the Government has leverage.

The five key objectives are to:

- build the confidence to invest
- improve public support
- promote Maori success
- capitalise on research and innovation
- increase market revenues.

Within each of these objectives the Government has identified a number of initiatives, which form the Government's commitment in the short term. Better understanding of

aquaculture risks and risk management options contributes to several of these initiatives, most directly to:

- *building confidence to invest – planning support:* support tools are being developed to encourage good practice and reduce the costs associated with aquaculture development, and these tools will help regional councils and industry with planning and management
- *improving public support – filling the information gap:* government and industry will work together to ensure regional decision-makers and the public have accurate, timely and independent information about the benefits and effects of aquaculture.

Our Blue Horizon is signed and supported by six ministers – Environment, Conservation, Maori Affairs, Industry and Regional Development, Fisheries, and Local Government. The engagement is being led by the Ministry of Fisheries. An implementation team of managers and advisors is undertaking work on the initiatives, with a Chief Executives' Group and Ministers' Group focusing on the objectives at a higher level.

Appendix 2: Aquaculture regulatory framework

Aquaculture regulation before the Aquaculture Reform Act

Until 1991 (when the RMA was passed), permits for marine farming were issued by Fisheries authorities solely for farming and spat-catching activities. There was a two-year period between 1991 and 1993 when a resource consent could authorise occupation and the placement of marine farming structures, but there was no legislative provision allowing fish stock to be taken and held on those structures, or harvested from them. In 1993, the amendment to the Fisheries Act 1986 enforced a dual permitting system, requiring an RMA coastal permit from councils first (for occupation, structures and, if necessary, discharges), and then a marine farming or spat-catching permit under the Fisheries Act.

Under the Marine Farming Act 1971 the Ministry of Fisheries had the power to take forfeiture action against marine farms that breached the conditions on their lease or licence (typically if abandoned, undeveloped or in a state of disrepair). The Fisheries Act does not include a provision for forfeiture action, and neither does the RMA. Instead, councils have the responsibility for managing any adverse effects under the RMA and the ability to take enforcement action against consent holders who breach their consent conditions.

The Government instituted a moratorium on new marine farm consents at the end of 2001 to abate the large number of applications for marine farm space that were over-burdening the previous legislative and planning framework. There is still a backlog of such marine farming applications from the date of the moratorium, and these are being processed under the old legislative system.

Aquaculture reform legislation

The aquaculture reform legislation sought to create a more integrated aquaculture management regime in New Zealand, balancing economic development, environmental sustainability, Treaty of Waitangi obligations and community concerns. The reforms reduced the dual permitting system to a one-step process managed under the RMA, giving councils full responsibility for managing aquaculture in their regions.

The aquaculture reform legislation created a new process for aquaculture planning under the RMA. New marine farms can now only be established in areas specifically zoned for that use in regional coastal plans. These areas are called aquaculture management areas, often referred to as AMAs. The establishment of aquaculture management areas in regional coastal plans is by a plan change undertaken in accordance with the first Schedule of the RMA; i.e. involving a full public process. Plan changes to establish aquaculture management areas can be initiated by regional or unitary councils, or by private interests.

Existing marine farm leases and licences issued under the Marine Farming Act or a marine farming or spat-catching permit issued under the Fisheries Act have been deemed to be RMA coastal permits by transitional provisions.[20] The transitional

[20] Aquaculture Reform (Repeals and Transitional Provisions) Act 2004, sections 10, 20, 21 and 45

provisions also deem the areas with deemed coastal permits to be aquaculture management areas.

The roles and responsibilities of regional and unitary councils have been clarified. They are responsible for managing all the environmental effects of marine farming, including any effects on fisheries and other marine resources through the RMA process. There are also new provisions relating to the allocation of space in the coastal marine area.

Before the reform of the legislation, individual applications for new marine farms were assessed in terms of their effects on fishing and fisheries resources (i.e. the wider ecosystem) through an undue adverse effects test under the Fisheries Act. The reform legislation has narrowed the scope of the undue adverse test to customary, recreational and commercial fishing, and the test is undertaken on the proposed aquaculture management area as part of the aquaculture management area planning process before it is publicly notified (not on individual consent applications).

The aquaculture reform legislation also addressed Treaty of Waitangi claims to commercial aquaculture after 21 September 1992 by allocating 20% of new space and 20% of “pre-commencement space” to iwi. Pre-commencement space is space that was granted between 21 September 1992 and 31 December 2004, and includes space consented to after 31 December 2004 if the consents were applied for under the old legislation. The aquaculture reform legislation allows the Government to meet its obligation for 20% of pre-commencement space in three ways:

- it can require an additional 20% from new space where the plan change to establish the aquaculture management area was council initiated, or
- it can purchase existing marine farming space from 1 January 2008 onwards, or
- from January 2013 any remaining obligation to iwi can be covered by a financial equivalent.

Resource Management Act

The Resource Management Act 1991 aimed to create an integrated and legal framework for the management of environmental effects from all uses of land, air, fresh and marine waters, with the purpose of "promoting the sustainable management of natural and physical resources". Sustainable management of natural and physical resources, as defined in the purpose of the Act, means managing the use, development and protection of natural and physical resources in a way, or at a rate, that enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety while:

> *(i) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations;*
> *(ii) safeguarding the life-supporting capacity of air, water, soil and ecosystems; and*
> *(iii) avoiding, remedying and mitigating the adverse effects of activities on the environment.*

The aim of the Act is permissive rather than prescriptive in the sense that the use and development of resources is permitted provided that the environmental outcomes are acceptable and sustainable.[21]

From a risk management perspective the RMA has given rise to a government agency (the Environmental Risk Management Authority), whose business is to assess the environmental impacts and risks of hazardous substances, as well as to a substantial body of case law and advisory documentation for councils from government departments such as the Ministry for the Environment and the Department of Conservation. This activity substantially reduces the risk of a council making a wrong decision with respect to consenting conditions, or the allocation of aquaculture management areas.

The creation of a new aquaculture management area, whether a council-initiated plan change or from a private plan change, is undertaken in accordance with the First Schedule of the RMA, involving a full public process. In some regions there is fierce competition for the use of space in the coastal marine area, and it is realistic that aquaculture management area creation could take five years or more.

All consents for marine farming are now under the RMA. Deemed coastal permits and new consents will have a finite consent duration, although the underlying aquaculture management area remains in the regional coastal plan unless specifically removed. Before the consent expires, the marine farmer will need to apply for a new consent. The holder of a deemed coastal permit from a former lease or licence has one preferential right of application for a further term of occupation under section 49 of the Transitional Act.

The RMA also provides a preferential right of application to the incumbent so long as the permit was in force at the time of application, applies to an area located in an aquaculture management area, and complies with section 124 of the RMA.

New Zealand Coastal Policy Statement

The New Zealand Coastal Policy Statement (NZCPS) is the only mandatory national policy statement under the RMA. The purpose of the NZCPS is to state policies to achieve the purpose of the RMA – to promote the sustainable management of natural and physical resources – in relation to the coastal environment of New Zealand.

The NZCPS sets out policies regarding the management of natural and physical resources in the coastal environment. Local authorities are required by the RMA to give effect to the NZCPS through their plans and policy statements. Resource consent decision-makers must also have regard to relevant NZCPS policies.

The Department of Conservation is currently reviewing the NZCPS as part of the statutory requirement under the RMA. Part of this review will give consideration to whether and how the NZCPS contributes to the Government's goals for aquaculture by directly or indirectly addressing aquaculture activities. Another significant area of review is developing coastal water quality standards that may reduce the risks to aquaculture operations from coastal water contamination.

[21] MAF 2002. *The Role of On-Farm Quality Assurance and Environmental Management Systems (QA/EMS) in Achieving Sustainable Agriculture and Sustainable Land Management Outcomes*

One of the key approaches being considered for this work is to use a risk assessment approach similar to that advocated in this report.

Regional coastal plans

Each regional council and unitary authority must prepare a regional coastal plan. Coastal plans are the only mandatory regional plans under the RMA. In the case of unitary authorities, the regional coastal plan may be part of the district plan. The rules within regional coastal plans define what type of activities can take place in that region's coastal marine area, including types of marine farming. New aquaculture management areas are established as a plan change in accordance with Schedule 1 of the RMA and will be developed and consulted upon by councils or private interests accordingly.[22]

The Government's aquaculture implementation team has almost completed a guide to aquaculture provisions in regional coastal plans.[23] This guide provides support and advice on the aquaculture reform and its implications for new aquaculture provisions in regional coastal plans prepared under the RMA.

Local Government Act 2002

The Local Government Act 2002 is a key piece of reform relating to the powers and intent of local authorities. The Act states the purpose of local government as being:

(a) to enable democratic local decision-making and action by, and on behalf of, communities; and
(b) to promote the social, economic, environmental, and cultural well-being of communities, in the present and for the future.

Section 14 of the Act establishes a number of principles relating to the role and performance of local authorities. Those with particular relevance to sustainable development of resources are noted below:

(g) a local authority should ensure prudent stewardship and the efficient and effective use of its resources in the interests of its district or region; and
(h) in taking a sustainable development approach, a local authority should take into account
(i) the social, economic, and cultural well-being of people and communities; and
(ii) the need to maintain and enhance the quality of the environment; and
(iii)the reasonably foreseeable needs of future generations.

The Sector Strategy states that aquaculture is an industry that sets out to be sustainable in the long term. In applying these Local Government Act principles to the resource consents for aquaculture activity, local authorities must finely balance consent conditions so social and economic wellbeing goals are achievable. They must also consider coastal communities where environmental quality may be at stake.

[22] Instructive examples include Marlborough District Council's zoning of the Marlborough Sounds (see http://www.marlborough.govt.nz/rma/imagemap_template.cfm) and Northland Regional Council's aquaculture management area proposals (see http://www.nrc.govt.nz/upload/1850/Aquaculture%20Timeline%20(Jun%2007).jpg)
[23] The guide will be available at http://www.aquaculture.govt.nz

The Local Government Act gives specific direction to councils on collaboration to achieve outcomes:

> *(e) a local authority should collaborate and co-operate with other local authorities and bodies as it considers appropriate to promote or achieve its priorities and desired outcomes, and make efficient use of resources.*

The wishes of Maori with respect to aquaculture and the special consultative provisions of both the Local Government Act and the Aquaculture Reform legislation also bring with them interesting aspects of consent provisioning to meet their specific requirements.

Fisheries regulation

For plan changes to establish new aquaculture management areas, the Ministry of Fisheries undertakes an assessment of undue adverse effects (UAE) of proposed aquaculture management areas on recreational, customary and commercial fishing. This is called an aquaculture decision. Councils request the Chief Executive of the Ministry of Fisheries to make an aquaculture decision before publicly notifying a proposed plan change to establish an aquaculture management area. The Ministry of Fisheries has six months to make this decision, with a further three months during which the decision-making process can be contested (i.e. a judicial review). The Ministry of Fisheries can have input into aquaculture consent processes as a submitter if the consent application is publicly notified.

The Ministry of Fisheries also maintains a register of all freshwater and marine farms to track the movement of farmed products. The register keeps information such as the name of the fish farmer; the location and boundaries of the fish farm, and the species of fish, aquatic life or seaweed that may be farmed.

Other regulatory and legislative considerations

Maritime New Zealand guidelines

Maritime New Zealand has developed guidelines for the aquaculture industry and consent authorities on navigation-related matters. These guidelines cover the lighting and marking of marine farm structures in designated aquaculture management areas, but do not cover the location of designated aquaculture management areas. It is the responsibility of councils to ensure that existing and new aquaculture management area locations do not result in marine farms becoming navigational hazards, and to monitor farms for ongoing compliance. This makes up a significant component of councils' compliance monitoring of marine farms.

New Zealand Food Safety Authority

The New Zealand Food Safety Authority (NZFSA) sets standards, regulations and specifications for human health acceptability for all commercial shellfish products for sale from New Zealand waters. Standards are implemented through sampling of harvested shellfish and routine testing of farm environments. This is a user-pays service to the industry, which delivers proof of market acceptability. The regulations and specifications were developed in 2006 and represent an exacting standard, which means that New Zealand shellfish products meet or exceed the food safety requirements of markets worldwide.

NZFSA can also classify areas as restricted or prohibited from harvesting shellfish due to the potential for human health impacts from waterborne contaminants. These classifications can be long term due to site conditions, or short term due to events (e.g. NZFSA sets the site-specific restrictions on harvesting due to rainfall events). The prohibited classification has never been imposed on an existing marine farm site.

Building Act

This Act, administered by local authorities, provides for the regulation of building work, the establishment of a licensing regime for building practitioners, and the setting of performance standards for buildings.

While at first it may not be apparent that there is a link between coastal marine aquaculture and this Act, a visit to any part of the industry will show quite clearly the operational importance of buildings. Onshore these include warehouses, processing plants, equipment stores, workshops and offices. In the case of finfish farms, the structures in the water may include living quarters. Future structures, especially if further offshore, may also include sizeable building structures to support their operations.

The Building Act has made new building or modifications more demanding, and it is taking longer to get them authorised. The risks related to the timing of new marine farm businesses now have an added planning complexity with the workings of this Act.