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Manatū Ahu Matua

Managing Biosecurity Risk for Business Benefit

Aquaculture Biosecurity Practices Research

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MANAGING BIOSECURITY RISK FOR BUSINESS BENEFIT

(Images: C. Sim-Smith)

AQUACULTURE BIOSECURITY PRACTICES RESEARCH

REPORT FOR THE MINISTRY FOR PRIMARY INDUSTRIES

Coast & Catchment Ltd
Environmental Consultants

MANAGING BIOSECURITY RISK FOR BUSINESS BENEFIT

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26 July 2016

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Foreword

New Zealand's geographical isolation and border controls have kept New Zealand relatively free from pests and diseases that commonly affect aquaculture production elsewhere in the world. However, biosecurity and biological threats remain a threat to New Zealand's aquaculture and fisheries industries, as this can lead to losses in production and potential impacts to trade and tourism caused by emerging or introduced pests and diseases. These risks can be managed through the implementation of border controls, marine users taking steps to prevent pest and disease spread and farm operators using farm management practices such as good husbandry and having on-farm biosecurity plans.

The Ministry for Primary Industries (MPI) and Aquaculture NZ have collaborated on a project entitled "*Identification of On-Farm Aquaculture Biosecurity Management Options*". The project provides options to enhance on-farm biosecurity protection for New Zealand's commercial and non-commercial aquaculture sectors.

In order to develop the on-farm biosecurity management options, it was first necessary to understand the current farming practices, on-farm biosecurity management, and concerns and perceptions of the farmers themselves. MPI contracted Coast and Catchment Ltd to carry out this research with the in-kind support from Aquaculture NZ.

The research findings presented in this report have been combined with the assessment of information on the potential biosecurity risks to the aquaculture industry and trout producers (organisms and pathways). MPI, with input from the aquaculture industry, and trout producers have developed, a set of relevant best practice options to inform on-farm biosecurity management. The final product is practical and effective in preventing and reducing pests and diseases impacting commercial and non-commercial aquaculture facilities. Uptake of options can flow into updated industry environmental management systems, sustainable management frameworks, operational procedures and any future biosecurity planning whether voluntary or more formally agreed readiness and response measures as part of a Government Industry Agreement.

Good biosecurity management at the farm level both strengthens the sectors' role as responsible users of the aquatic environment and maintains New Zealand's reputation for high environmental performance. The *Identification of On-Farm Aquaculture Biosecurity Management Options* project supports the sustainable growth of the aquaculture sector and non-commercial sectors.

The final documents produced from the project are:

- *Aquaculture Biosecurity Handbook – Assisting New Zealand's commercial and non-commercial aquaculture to minimise their on-farm biosecurity risk.*
- Technical Reference Document "*Options to Strengthen On-Farm Biosecurity Management for Commercial and Non-Commercial Aquaculture*"

Both documents can be found on the MPI website www.mpi.govt.nz

1 Executive Summary

The health of farmed species and the aquatic environment is recognised as paramount to the sustainable growth of New Zealand's aquaculture industry. One of the key risks to the aquaculture industry is losses in production and potential impacts to trade caused by the introduction or exacerbation of pests and diseases. Historically, the New Zealand aquaculture industry has been largely free of any serious pests or diseases. However, the recent outbreak of the oyster herpes virus and the spread of several introduced pest species around the country demonstrate that biosecurity practices in New Zealand can be strengthened.

The aim of this project was to produce a snapshot of current biosecurity practices, perceptions, needs and awareness in the major aquaculture sectors in New Zealand (salmon, trout[1], paua, oysters, mussels (including mussel spat harvesting) and aquaculture research). These results will be used to provide baseline information that will assist in improving the management of biosecurity risks to New Zealand's aquaculture industry.

The biosecurity practices, perceptions, needs and awareness in the major aquaculture sectors were surveyed in two stages: 1) an on-line survey was sent to all contactable marine farmers and land-based fish farmers that farm species within the research scope[2]; and, 2) on-site interviews were subsequently conducted at a range of aquaculture sites that encompassed all the major aquaculture sectors and the major farming locations in New Zealand. The overall response rates for the on-line survey and on-site interviews were 29% (n = 64) and 94% (n = 51), respectively. Personal, face-to-face contact with farmers appears to be the preferred method of contact for the majority of the industry for information sharing.

There is a diverse range of farming operations and opinions regarding biosecurity within the aquaculture industry. The major points that arose from this project are summarised below:

Biosecurity awareness, perceptions and concerns of the aquaculture industry:

- 88% and 89% of respondents were moderately to very concerned about preventing and managing pests and diseases on their farm, respectively;
- the most concerned industries were the oyster, paua and aquaculture research facilities, who had all experienced significant disease outbreaks;
- the industry believes that the most likely transmission vectors for pests and diseases are 1) water, 2) international shipping vessels, 3) recreational vessels and 4) stock transfers;
- most respondents believe that nothing can be done to stop waterborne transmission, and therefore, many marine farmers believe that on-farm biosecurity measures are futile. The majority of farmers appear unaware of biosecurity measures e.g., Aquaculture Bay Management Area Agreements and site fallowing, that have been used overseas to reduce the incidence of pests and diseases in open farms located in the sea or natural waterways;
- MPI's border control and surveillance of pests and disease is perceived by many respondents as inadequate, particularly their management of the international shipping biosecurity risk;
- eradication of pests and diseases is thought to be impossible by many farmers, and they believe that MPI shouldn't waste money on eradication programmes;

[1] Commercial farming of trout is prohibited, however to ensure the associated risks of salmonid species that are farmed commercially or non-commercially, trout is included in this research. Their inclusion will facilitate the development of appropriate recommendations for on-farm biosecurity management options to mitigate biosecurity and environmental risk.

[2] Land-based fish farms were confined to those farming salmonids, paua, oysters and mussels who are licensed by MPI, and Fish & Game New Zealand hatcheries.

- pest species are defined by industry as species that negatively affect their business (whether native or introduced), and therefore, not all introduced species are regarded as pests by industry;
- industry are concerned that the cost of any biosecurity measures required of them will be too high, however industry does not have a good estimation about how much 'doing nothing' costs their business with respect to losses in productivity, increased labour and reduced market access; and,
- 34–45% of questionnaire respondents don't know much about MPI's aquatic biosecurity capabilities.

Biosecurity practices of the aquaculture industry:

- there is a large variation in biosecurity practices within the industry and the high level of industry concern regarding pests and diseases is not always reflected in their biosecurity practices;
- the top three sources of biosecurity information for farmers are 1) other farmers, 2) industry associations and 3) the internet. MPI is infrequently the 'first-port-of-call' when farmers need biosecurity advice or have a biosecurity issue;
- research facilities and the land-based paua facility visited implemented the most rigorous biosecurity measures, which are generally consistent with international best management practices. Most of these facilities treated all of their intake water and they used a wide variety of methods to reduce the risk of pests and diseases entering their facility. These facilities are also very proactive in staff education regarding biosecurity;
- commercial salmonid farms (freshwater and marine) have moderate biosecurity measures including regular disease testing, routine disinfection of equipment, use of footbaths; not sharing equipment among farms and regular removal of mortalities. However, none of the freshwater hatcheries surveyed treated their incoming water;
- non-commercial salmonid farms utilised fewer biosecurity measures than commercial farms. They disinfect their equipment prior to transfer, limit the sharing of equipment among farms, and regularly remove mortalities. However, they do not treat their intake water, do not use footbaths and regularly bring wild broodstock on-site; and,
- oyster and mussel farms employ few biosecurity measures. They regularly check for pests, manually remove pests, antifoul their boats and educate their staff. However, with the exception of Stewart Island farmers, stock is freely moved around the country without treatment or testing for pests and diseases, equipment is rarely disinfected, and pest species and mortalities are frequently discarded back into the sea in close proximity to the farms.

Biosecurity needs of the aquaculture industry:

- better education of the industry on biosecurity, particularly on:
  - the importance of preventative biosecurity measures;
  - the main methods of pest and disease transmission among farms;
  - the need for early pest and disease detection and rapid action;
  - biosecurity measures that have been successfully used overseas to reduce the incidence of pests and diseases in open farms;
  - effective on-farm biosecurity methods that farmers can implement; and,
  - the business cost of 'doing nothing' regarding biosecurity (in terms of increased labour, loss of production and decreases in the market value of products).
- industry specific Codes of Practice regarding biosecurity that have been developed with industry input and consider all types of farming operations;

- development of practical methods to minimise the transmission risk associated with stock transfers;
- establishment of appropriate geographical zones (Aquaculture Bay Management Areas) for biosecurity management;
- establishment of a national pest and disease testing and reporting system;
- more sharing of industry knowledge regarding biosecurity;
- research on the poor performance of Kaitaia spat, and whether this is disease-related;
- better biosecurity information from MPI (in terms of frequency, relevance, format and delivery methods);
- a better MPI-industry relationship;
- proactive government leadership regarding biosecurity;
- remediation of poor water quality issues in farming areas to reduce the relaying of untested stock; and,
- better biosecurity information for the general public.

Barriers to biosecurity best practice in the aquaculture industry:

- the widespread industry belief that 'nothing can be done' to stop pest and disease transmission to open farms;
- a lack of engagement by farmers for biosecurity measures because past measures are viewed as ineffective and a waste of time and money;
- the cost (perceived and real) of biosecurity measures;
- a lack of engagement and adherence by farm workers for biosecurity protocols;
- the widespread movement of untested stock around the country and the belief that this is not a high transmission risk;
- the use of wild broodstock, often without disease testing, quarantine or treatment;
- difficulty in the identification and collection of unusual biofouling species;
- a lack of treatment of intake and effluent water in land-based facilities because of the capital cost required and the perceived lack of need;
- a lack of farm space to allow for fallowing and single year-class culture; and,
- a lack of use of aquatic health specialists within the shellfish sectors.

Engagement of the aquaculture industry is critical to ensuring effective uptake of biosecurity best practice in New Zealand. In order to facilitate industry engagement for biosecurity, the following recommendations are made:

- on-farm biosecurity measures must have some demonstrable 'business benefit' to farmers, e.g., increased productivity, reduced labour time, increased market access and/or retention of existing markets. A cost-benefit analysis of biosecurity practices should be conducted for the aquaculture industry to demonstrate the business benefit of biosecurity;
- biosecurity measures need to be shown to be effective to the industry. There needs to be a fundamental change in belief in the aquaculture industry from 'nothing can be done' to a realisation that biosecurity practices can be effective in minimising pest and disease risks. Education of the industry in the following areas is needed to increase industry engagement:
    - the importance of preventative biosecurity measures;
    - the need for early detection and rapid action against pest and disease incursions/outbreaks;
    - the main methods of pest and disease transmission among farms;
    - biosecurity measures that have been successfully used overseas to reduce the incidence of pests and diseases in open farms; and,
    - effective on-farm biosecurity methods that farmers can implement.

- better education of farm staff to encourage engagement and adherence to biosecurity measures;
- development of industry-specific Codes of Practice regarding biosecurity in consultation with industry;
- MPI needs to work on improving their relationship with the aquaculture industry by:
  - updating their contact database of aquatic farmers to ensure that their communications to industry are received by all relevant parties;
  - providing better quality biosecurity information to the industry that is easy to interpret, relevant, concise and up-to-date;
  - Better communication to the industry is required regarding MPI's biosecurity capabilities, biosecurity measures that are currently in place in New Zealand, and points of contact and responsibility of various MPI departments used by the aquaculture industry;
  - spending more time 'on the ground' with industry through industry working groups, conferences and personal contacts;
  - providing effective, coordinated and helpful service across all MPI departments;
  - taking responsibility for biosecurity issues and demonstrating that they are working on biosecurity risk management across all aquatic users;
  - work with regional councils, land and water users, and stakeholders to improve water quality issues so that farmers do not need to relay stock;
  - give serious consideration to concerns raised by industry and responding to concerns in a prompt and courteous manner;
  - promoting a 'no-blame' culture to encourage the sharing of information; and,
  - providing effective, evidence-based information to the media to counteract the 'scaremongering' that occurs in the media about pests and diseases in aquaculture.

In addition, the following recommendations are made to improve biosecurity best practice in New Zealand:

- biosecurity should be managed in appropriate geographic zones, i.e., Aquaculture Bay Management Areas, that are sufficiently separated and align with hydrographic boundaries;
- single-year class production and fallowing should be implemented for finfish farms to minimise pest or disease transmission as part of Aquaculture Bay Management Area agreements. Note that additional farm space will be required in order to implement these measures without a reduction in annual production;
- establishment of a national pest and disease testing and surveillance system that facilitates the routine disease testing of stock;
- development of practical methods to reduce the risk of pest and disease transmission with stock transfers, such as:
  - continued research on disease-resistant oysters;
  - the development of remote setting technology for oysters in New Zealand to reduce the dependence on wild spat and allow all farmers to access disease-resistant oysters;
  - the installation of depuration facilities for shellfish to remove the need for relaying shellfish;
  - use of freshwater baths, hot water dips or air exposure on stock prior to transfer to reduce fouling pests;
  - biosecurity certification of hatcheries to ensure hatchery stock are pest and disease-free;
  - implementing routine disease testing of stock prior to stock transfers among Aquaculture Bay Management Areas (once established);

  - implementing quarantining and routine disease testing for wild broodstock;
  - implementing routine egg disinfection; and,
  - preventing stock transfers or releases from sites where pests and diseases are present to sites where they are absent.
- research on the causes behind the poor performance of Kaitaia spat and whether it disease-related;
- development of more user-friendly tools and methods to assist farmers with pest identification and collection, e.g., an industry-specific biosecurity phone application; and,
- better collaboration and education on biosecurity issues both within industry and between industry and the general public. This can be achieved through internal industry working groups and industry participation in external stakeholder groups.

The diverse range of farming activities and opinions of aquatic farmers in New Zealand makes it a challenge to develop effective biosecurity measures that are embraced by all of the aquaculture industry. Engagement and involvement of the aquaculture industry in biosecurity planning is critical to ensuring effective uptake of biosecurity best practice. Good biosecurity management is a common goal for the aquaculture industry and government, and one that they should work towards together.

2 Introduction

Over the past 45 years, aquaculture has grown into one of New Zealand's most important aquatic industries. The New Zealand aquaculture industry generated a revenue of around $400 million in 2011, and aims to reach $1 billion in annual revenue by 2025 (Aquaculture NZ, 2012). The health of farmed species and the aquatic environment is recognised as paramount to the sustainable growth of the aquaculture industry. One of the key risks to the aquaculture industry is losses in production and potential impacts to trade caused by the introduction or exacerbation of pests and diseases.

Historically, the New Zealand aquaculture industry has been largely free of serious aquaculture diseases and parasitic pests, such as infectious salmon anaemia, infectious haematopoietic necrosis, abalone ganglioneuritis and *Argulus* lice, which have severely affected overseas aquaculture industries (Chang *et al.*, 2007; Hooper *et al.*, 2007; Tubbs *et al.*, 2007; Castinel *et al.*, 2014). However, the spread of several introduced pest species (e.g., *Styela clava, Sabella spallanzanii* and *Didemnum vexillum*[3]) around marine farms in New Zealand; mortalities of cultured fish and shellfish from harmful algae blooms (Chang *et al.*, 1990; MacKenzie *et al.*, 2011); and the widespread Pacific oyster mortality caused by outbreaks of oyster herpes virus (OsHV-1) since 2010, demonstrate that biosecurity practices can be strengthened in New Zealand.

The Ministry for Primary Industries (MPI), in collaboration with Aquaculture New Zealand (AQNZ), commissioned[4] Coast and Catchment Ltd to survey the biosecurity awareness, perceptions, needs, concerns and practices of the New Zealand aquaculture industry[5] via an on-line questionnaire and on-site interviews. The aim of the project was to produce a snapshot of the current biosecurity practices, perceptions, needs and awareness in the major aquaculture sectors:

- freshwater salmonid farmers;
- saltwater salmonid farmers;
- green-lipped mussel farmers and spat collectors[6];
- Pacific and flat oysters farmers and spat collectors;
- paua farmers;
- aquaculture research facilities; and,
- green-lipped mussel spat harvesters[7] (Kaitaia spat).

Information produced by this project will be used to:

- increase our understanding of the perceptions, concerns and needs of the aquaculture industry;
- increase our understanding of the range of biosecurity planning, on-farm implementation and barriers to implementation of biosecurity best practice management in the aquaculture industry;
- inform risk profiling of the industry; and,
- assist with planning for greater resilience to biosecurity threats.

[3] In this report the common name of a species or just its genus is used after the first instance, i.e., '*Styela*' or 'clubbed sea squirt' rather than the normal convention of *S. clava*, because this is how the farmers commonly refer to the organisms.
[4] Contract 16480, Aquaculture Biosecurity Practices Research.
[5] The term 'aquaculture industry' is used in this report to refer to the seven major aquaculture sectors listed. It does not include businesses that farm species other than those listed.
[6] Spat collectors have a resource consent to catch spat directly from the water within their farming areas.
[7] Spat harvesters have fishing quota or annual catch entitlement (ACE) to collect mussel spat attached to seaweed that is washed up on Ninety Mile Beach. This spat is commonly referred to as 'Kaitaia spat'.

3 Methods

There were two main stages to this project:

1. an on-line questionnaire that was sent to all marine farmers and land-based fish farmers that farm species within the research scope[8] (for which we had appropriate contact details) in the major aquaculture sectors; and,
2. subsequent on-site interviews to a minimum of 40 aquaculture sites that encompassed all the major aquaculture sectors and the major farming locations.

The questionnaires and interview questions were designed to cover the following areas:

1. facility background information (e.g., production, farming methods used, species farmed, etc.);
2. animal welfare and husbandry practices;
3. pest[9] and disease[10] awareness and management practices;
4. staff perceptions, knowledge and experience;
5. best practice initiatives that could improve biosecurity through preventative and management actions; and,
6. how the aquaculture industry and MPI can best act to improve biosecurity management.

Collaboration with the aquaculture industry was identified as a key requirement for this project, therefore considerable effort was made to involve industry in the design of the on-line questionnaire and interview questions, and to foster industry engagement with the project. Actions taken to facilitate industry engagement included:

- development of a communication strategy by an industry engagement specialist;
- attendance at the AQNZ conference to meet farmers and industry representatives, and promote the research project;
- liaison with 11 industry representatives about the approach to the research and the development of the on-line questionnaire;
- testing the on-line questionnaire with industry representatives from the salmon, trout, paua, oyster and mussel industries;
- discussion of questionnaire feedback with industry representatives, and incorporation of feedback into the questionnaires; and,
- review of the on-site interview questions by AQNZ.

3.1 QUESTIONNAIRE DESIGN & DEPLOYMENT

3.1.1 On-line questionnaire

Initial draft questionnaires for freshwater finfish farmers, saltwater finfish farmers, mussel farmers and spat collectors, oyster farmers and spat collectors, and paua farmers were provided to Coast and Catchment by MPI. The questionnaires were modified by Coast and Catchment and suitably formatted for on-line deployment using Survey Monkey (www.surveymonkey.net). In addition, Coast and Catchment added questionnaires for two additional industry sectors, aquaculture research facilities and mussel spat harvesters, because these sectors are also likely to affect nationwide biosecurity. All questionnaires were reviewed and tested by MPI, AQNZ and relevant aquaculture industry representatives. Final questionnaires are provided in Appendices 8.1–8.7.

[8] Land-based fish farms were confined to those farming salmonids, paua, oysters and mussels who are licensed by MPI, and Fish & Game New Zealand hatcheries.
[9] Pest species are defined in this report as any native or introduced species that negatively affects aquaculture operations.
[10] Disease agents are defined in this report as bacteria, fungi, viruses or parasites that cause adverse effects on the host species.

In order to optimise questionnaire completion rate, the questionnaires were designed so that they were:

- short (around 15 minutes in length);
- simple to navigate and read;
- mainly consisted of tick boxes with a limited number of open-ended questions; included a progress bar;
- organised into topics; and,
- generally progressed from easy questions to harder questions (after Burgess, 2001; Schonlau *et al.*, 2006; Vicente & Reis, 2010).

Skipped logic was also applied to the questionnaires, where for example, if respondents answered "no" for a particular question, subsequent questions that were only relevant if he/she answered "yes" were automatically skipped.

In order to reduce the likelihood of incorrect or false answers, the on-line questionnaires contained no forced answers (i.e., respondents were not required to answer any particular question), and respondents were also offered a 'don't know' or 'other' answer option for most questions (Schonlau *et al.*, 2006; Vicente & Reis, 2010).

MPI provided Coast and Catchment with the initial contact database for the questionnaires. The database included details of registered marine farmers and land-based fish farm licence holders. Farm details included farm location, species permitted to be farmed, and postal addresses. However, MPI acknowledged that the database required updating and was likely to be incomplete. Furthermore, the MPI database only contained email addresses for some of the land-based fish farm licence holders. Coast and Catchment updated the database by obtaining contact information from regional councils, Fish and Game, industry representatives and the internet. The updated database contained considerably more contact information than the initial database. However, it is noted that:

- phone numbers and email addresses for some individuals/companies were not available from our information sources;
- some records only contained generic company contact information;
- the database may include companies that are no longer operational or have been sold;
- the owners and operators of marine farms may be different; and,
- farmers may not culture all of the species they have resource consent for.

Despite this, liaison with AQNZ indicated that, with the exception of mussel farmers, the information compiled through this process was similar to that held within AQNZ's database. AQNZ are likely to have the most comprehensive and up-to-date contact records, as they estimate that 95% of farmers are levy holders[11]. However, AQNZ's privacy policy prevented them from providing contact details directly to MPI or Coast and Catchment. AQNZ therefore assisted by facilitating the distribution of the questionnaire directly to their mussel farming levy holders, while other aquaculture sectors were contacted directly by Coast and Catchment using the information compiled by us.

Farmers, spat harvesters and researchers were emailed an advance notice of the launch of the questionnaire on the 14 November 2013 (Appendix 8.9). This email introduced the project, explained its aims, and provided further background information about the research project and where it sat within wider MPI biosecurity initiatives (Appendices 8.10 and 8.11). Farmers were also reassured that their responses would be kept confidential and they would not be individually identified. A week later the link to the on-line questionnaire was emailed to the

[11] Under the Commodity Levy Act it is mandatory of all farmers to pay the AQNZ levy.

farmers, spat harvesters and researchers (Appendix 8.12). Two weeks after the launch of the questionnaire a reminder email was sent out to all survey recipients to remind them to complete the questionnaire (Appendix 8.13).

During the subsequent on-site interviews, respondents that hadn't filled in the on-line questionnaire were asked whether they would be able to fill it in. Willing respondents were provided with a paper copy of the survey or were emailed the link to the relevant on-line survey.

3.1.2 On-site interviews

The aims of the on-site interviews were to:

- validate the on-line questionnaire responses;
- capture the more complex or subtle issues;
- address data gaps from the on-line questionnaire;
- further explore any issues that arose from the on-line questionnaire; and,
- gain an insight into the level of concern of biosecurity issues from staff at different managerial levels.

Twenty five respondents of the on-line questionnaire had agreed to help with the on-site interviews. A list of additional potential farms to visit was compiled in order to provide a good representation of the species farmed, geographical location, and company size for the on-site interviews. For large companies that had farms across the country, we aimed to visit farms across their geographical range.

Farm owners and managers were contacted by telephone to explain the project and establish a suitable time for an interview. Meeting times and locations were flexible, which allowed farmers to accommodate us within their work schedule. Meeting times ranged from 7:30 am – 9:30 pm and meeting locations included farmers' homes, offices, shops, wharves, boats and off the back of their trucks. This flexible meeting approach was used to maximise input by engaging with farmers on their terms. For larger companies that have numerous staff, we requested interviews with a range of staff from different managerial levels or roles, to try and capture any differences in biosecurity concerns or practices within a company.

Where possible, we requested that farmers showed us around their site and explain their farming process, particularly their on-site procedures for biosecurity. We emphasised that the site tours were not audits of their farms, but we did ask questions and make observations about their biosecurity procedures.

The on-site interview process had a 'snowball effect' where interviewees provided us with contact details of other farmers who may be interested in assisting with the project. We would then contact the suggested farmers, explain the project and request an interview. This referral system from other farmers provided a common ground for us and probably increased the likelihood of other farmers agreeing to interviews. It also built up a local awareness in the industry that the project was not restricted to specific companies or individuals, but aimed to capture a broad spectrum of opinions and information across the industry.

The on-site interviews were conducted in a conversational-style manner and were based on 17 key lines of enquiry (Appendix 8.8). The interview questions had been reviewed by MPI and AQNZ. At the start of the interview, farmers were given a flyer explaining the project and containing the relevant staff contact details at Coast and Catchment, MPI and AQNZ. Farmers were also reassured that their responses would be kept confidential and they would not be individually identified.

Notes were taken during the interviews and we often repeated/clarified key answers to reassure farmers that we had captured their responses accurately. Additional discussion points often arose as part of the conversation and these were also noted. At the end of the interview we asked farmers whether they would like to receive a copy of their interview transcript, to further reassure them that their responses had been captured accurately.

3.2 DATA ANALYSES

Responses to the on-line questionnaires were collated by aquaculture sector. Responses to questions that were common to all the questionnaires were also analysed across all aquaculture sectors, where relevant. The number of respondents in each sector was too low to perform any statistical tests on the data, therefore, responses are simply presented graphically and as a proportion of respondents for each question, e.g., 2/10. Note that the number of respondents varies for each question because some respondents didn't answer all questions.

Individual interview responses were grouped into common themes and the number of respondents that expressed similar opinions was tallied. The number of respondents that express a similar opinion is presented in parentheses after each statement e.g., (five interviewees). Note that because multiple interviews were conducted at some sites with different respondents, the number of respondents is greater than the number of sites visited, and therefore, the same site may be represented more than once in a tally.

We have used quotes from interviewees to illustrate their opinions regarding certain issues. Note that some of the quotes presented have been slightly paraphrased because of the necessity of writing shorthand during the interviews.

The statements presented in the Results section are based on the views and farming practices of the respondents, not the opinions of Coast and Catchment staff. We have interpreted these results in the Discussion section based on the scientific literature on biosecurity best management practices and our knowledge of New Zealand's aquaculture industry.

4 Results

4.1 GENERAL RESPONSE RATE

4.1.1 On-line questionnaire

220 questionnaires were sent to members of the aquaculture industry, of which, 50 completed[12] questionnaires were received prior to the on-site interviews, and a further 14 completed questionnaires were received after the on-site interviews, giving an overall response rate of 29%.

The response rate varied among the sectors with mussel spat harvesters, research facilities and freshwater salmonid farmers having the highest apparent response rates, and the mussel and paua sectors having the lowest (Table 1). However, these response rates need to be interpreted with caution for a number of reasons:

1. The contact database supplied by MPI requires updating and is very likely to contain incorrect contact details or aquaculture companies that are no longer in business. For example, 16 paua questionnaires were sent out, however, subsequent discussion with

[12] Questionnaires that were at least two-thirds complete were counted as completed questionnaires.

paua farmers during the on-site interviews revealed that only three or four paua farms are currently operating, some of which, are very small operations. Therefore, the actual response percentages are likely to be higher than reported.

2. Single farmers often managed multiple sites for a number of companies, and therefore, one questionnaire response may cover multiple sites and/or companies. For example, the 19 oyster responses received accounted for more than 102 sites.
3. Incomplete questionnaires were not included in the response percentage calculations. However, the answers for incomplete questionnaires were still included in the individual results summaries. The numbers of incomplete responses per category are given in Table 1.

Table 1: Response rates of the on-line questionnaire for each aquaculture sector.

Aquaculture sector	Number of questionnaires sent	Number of complete responses	Number of incomplete responses	Response rate*	Number of sites managed by respondents
Freshwater salmonids	24	13	0	54%	21
Saltwater salmonids	7	2	1	29%	7
Paua	16	2**	2	6%**	1
Oysters	68	20	4	29%	> 102***
Mussels	90	19	5	21%	> 151***
Mussel spat harvesters	6	4	1	67%	4
Research facilities	9	5	1	56%	5
TOTAL	**220**	**64**	**14**		**> 290**

* Only questionnaires that were at least two-thirds complete were counted for the response rate percentage.

** These two respondents came from the same site and therefore were only counted once in the response rate.

*** The exact number of sites managed by respondents is unknown because some respondents just answered "multiple" when asked how many farms they managed. These respondents were counted as > 1.

4.1.2 On-site interviews

In total, 51 aquaculture sites were interviewed[13] and 80 individual interviews were conducted. The sites were distributed throughout the country and covered a range of species (Table 2). With the exception of one site[14], we always interviewed the farm owner and/or manager of the site. Where possible, we also interviewed farm workers to obtain a range of opinions from the different levels of management (Table 3). Site visits usually occurred in the owner's or manager's office or house, though some interviews were conducted on wharves, boats or off the back of their trucks. Two Skype/telephone interviews were conducted: one for a manager who was based overseas (we visited their New Zealand farm site); and one for a manager that wasn't available when we were in the area (no site visit).

Overall, the industry was very supportive of this stage of the project and farmers seemed to appreciate the face-to-face approach to discuss issues. The overall response rate for the on-site interviews was 94%. Out of the 54 sites that we requested interviews with, only two farmers that we contacted were not interested in meeting with us when we were in the area, and one farmer didn't show up for the arranged meeting time. Even though 25 of the sites we contacted had already indicated that they would help out with the on-line interviews, the response rate for 'cold-calls' was 90% (26/29).

[13] One site was interviewed via Skype.

[14] At one site only the farm worker was present when we arrived.

Most farmers were quite candid with their responses and many felt strongly about various biosecurity and farming issues. Farmers were very generous with their time and individual interview times ranged from half an hour to two hours. Several farmers also took us out on the water to visit their farms. We spent a morning watching mussel harvesting and reseeding in Coromandel; two days on the water with mussel sourcers[15] in Pelorus Sounds; and, one day watching farm maintenance with a mussel and oyster farmer in Stewart Island. We were also shown around six land-based salmonid farms and two research facilities.

Table 2: Types of aquaculture farms interviewed in each region.

	Northland	Auckland	Coromandel	Central North Island	Marlborough, Nelson & Tasman	Canterbury	Southland	TOTAL
Freshwater salmonids				1	2	6		**9**
Saltwater salmonids					1	1	1	**3**
Paua*								**2**
Pacific oysters	9	5	1					**15**
Flat oysters							3**	**3**
Mussels		1	5		8		4**	**18**
Mussel spat harvesters[16]	1							**1**
Research facilities	1				1			**2**

* The location of the paua farms have been omitted from the table to protect the identity of the paua farmers because there are so few paua farms in the country.

** Note that two of these farms cultured both mussels and oysters and have been counted for both species. Therefore the total number of farms interviewed appears to be 53 in this table instead of the 51 sites actually interviewed.

Table 3: Management levels of the interviewees. Paua farms have been omitted from the table to protect the identity of respondents because there are so few paua farms in the country.

	Owner	Manager	Worker
Freshwater salmonids	4	9	3
Saltwater salmonids	1	3	1
Pacific oysters	12	4	7
Flat oysters	3*		
Mussels	9*	11	6
Mussel spat harvesters	1		
Research facilities		3	2
TOTAL	**29**	**31**	**20**

* Note that two of these farms cultured both mussels and oysters on the same site and have only been counted once in the total.

[15] The role of mussel sourcers is to check whether mussels are in suitable condition for harvesting. In large companies, this role is a full-time job for one or more staff members.

[16] Mussel spat harvesters collect mussel spat attached to seaweed from the surf zone of Ninety Mile Beach.

4.2 DEMOGRAPHICS OF RESPONDENTS

4.2.1 Freshwater salmonids

Thirteen freshwater salmonid farm managers completed the on-line questionnaire, who collectively manage 21 sites. Eight freshwater salmonid farms were visited and one farm was interviewed remotely. Respondents' farms are located in central North Island, Tasman, Canterbury and Otago. The main farm water sources are surface water (8/13), spring water (3/13) or well/bore water (2/13). The main purpose(s) of the farms varies from hatcheries, on-growing, food production and/or fish-out ponds. Multiple life stages are held at most farms. The majority of farms rear Chinook salmon (*Oncorhynchus tshawytscha*), with a few farms rearing rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*) and tiger trout (*S. trutta* × *Salvelinus fontinalis*). Farms obtain their broodstock from various sources (wild, other farms, and self-supplied[17]). Most farms produce less than 1000 MT per annum (Figure 1 & Figure 2).

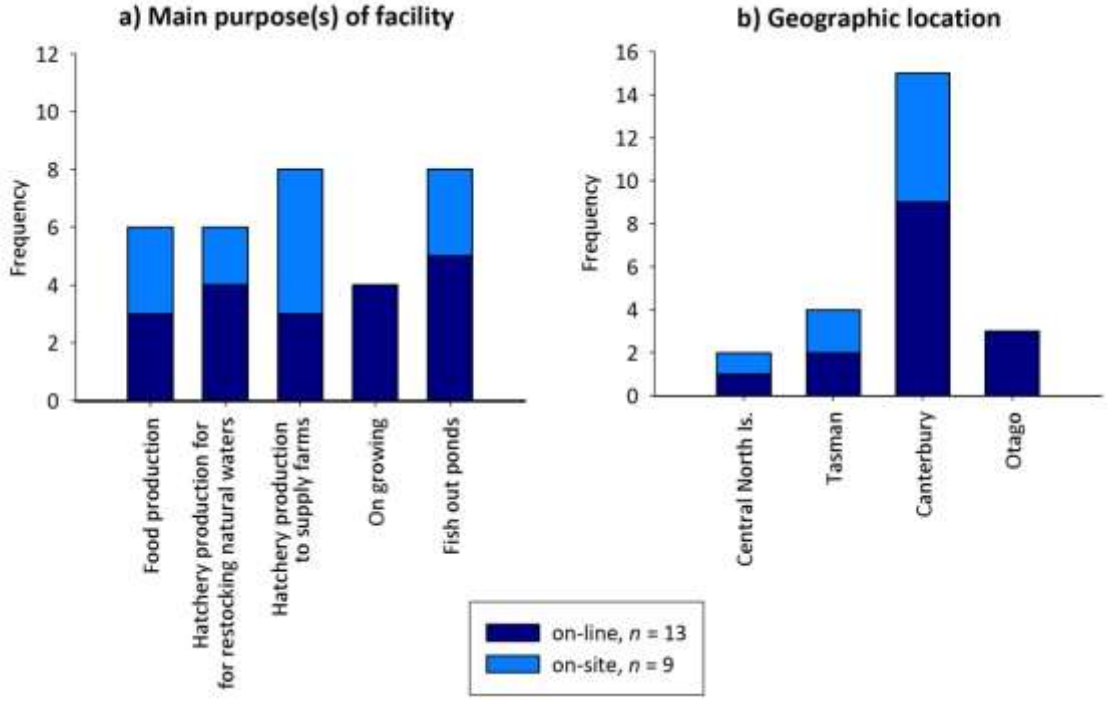

Figure 1: a) Main purpose(s) and b) geographic location of freshwater finfish farms surveyed in the on-line questionnaire and through on-site interviews. Note that respondents sometimes provided more than one answer for each question so the cumulative frequency may be greater than the number of respondents (*n*).

[17] Self-supplied broodstock are fish that have been reared by the farm for breeding.

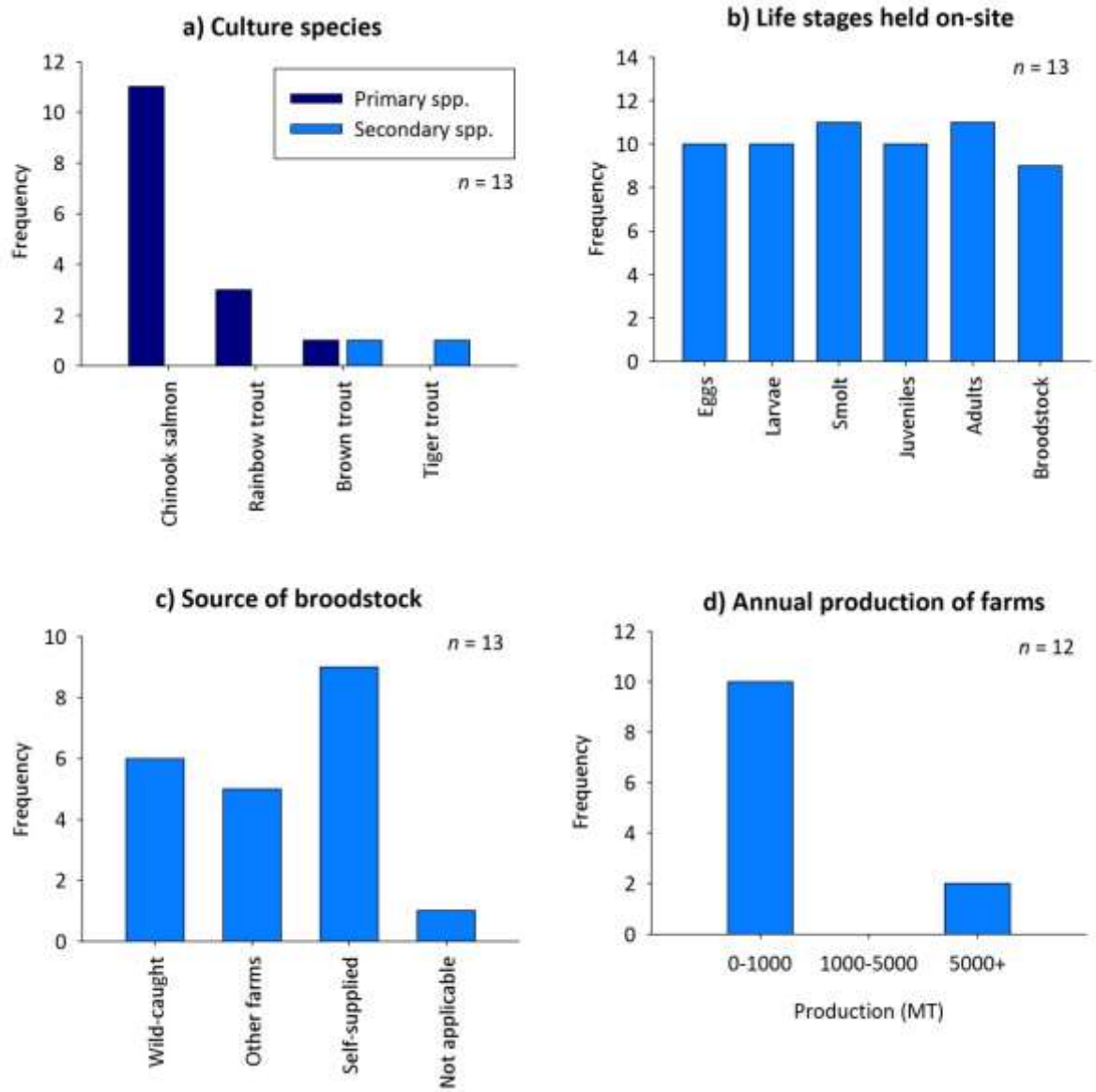

Figure 2: a) Species cultured, b) life stages held on-site, c) sources of broodstock and d) annual production of freshwater salmonid farms surveyed in the on-line questionnaire. Note that respondents sometimes provided more than one answer for each question so the cumulative frequency may be greater than the number of respondents (*n*).

4.2.2 Saltwater salmonids

Two saltwater salmonid farmers, who collectively manage seven sites, completed the on-line questionnaire. One farmer partially completed the questionnaire. Three saltwater salmonid farms were visited. Respondents' farms are located in Marlborough, Canterbury and Southland. All respondents farm Chinook salmon exclusively and annual production varies from less than 1000 MT to greater than 5000 MT (Figure 3).

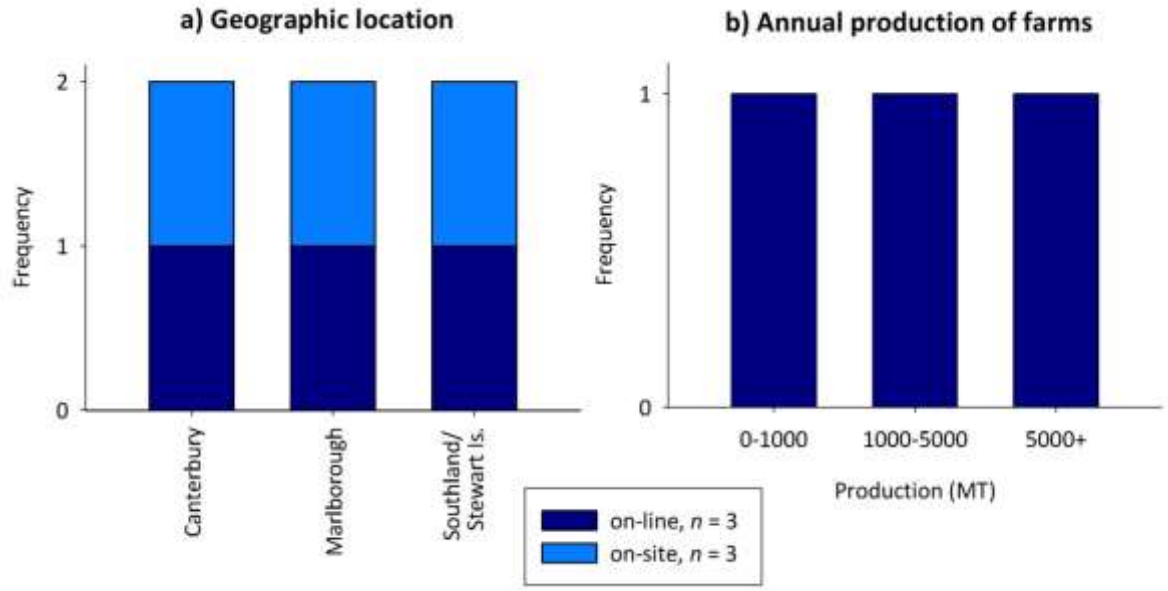

Figure 3: a) Geographic location and b) annual production of saltwater salmonid farms surveyed in the on-line questionnaire and through on-site interviews.

4.2.3 Paua

Two paua farmers, who were both from the same site, completed the on-line questionnaire. Two other farmers partially completed the questionnaire. Two paua farms were visited, of which, one was land-based and one was sea-based. The main purpose of the farms is either food production or pearl production. Farms obtain their broodstock from other farmers (1/3) or were self-sufficient (2/3). All farms (4/4) produce less than 250 MT per annum (Figure 4).

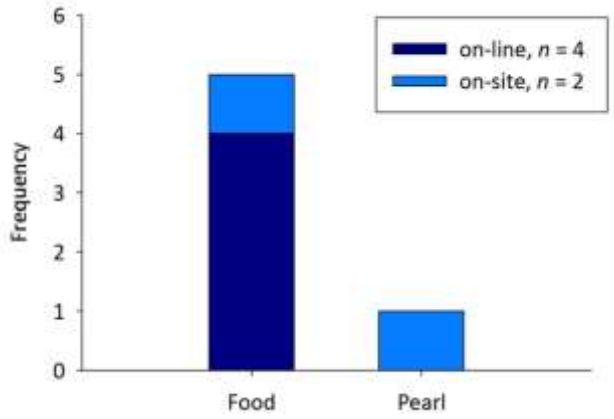

Figure 4: The main purpose of the paua farms surveyed in the on-line questionnaire and through the on-site interviews.

4.2.4 Oysters

Twenty oyster farmers completed the on-line questionnaire and four farmers partially completed the questionnaire. In total, questionnaire respondents manage more than 102 sites. Fifteen Pacific oyster farms and three flat oyster farms were visited. All questionnaire respondents farm oysters in the sea, and only one interviewee farms oysters on land. The main purpose of most farms is food production, and a large variety of farming methods are used. Respondents' farms are mainly located in Northland and Auckland (Figure 5).

Farmers mainly catch their own oyster spat from the wild or purchase it from other hatcheries. The main spat catching areas are the Kaipara Harbour, Mahurangi Harbour and east Northland harbours, with many farmers catching spat in water bodies that are different from their own farming areas (six interviewees) (Figure 6). Large operators rely heavily on relaying harvestable oysters to different areas around the country to avoid harvest closures because of contamination of the water with pathogens that can affect humans. Five questionnaire respondents relay oysters outside of their farming region[18], and six respondents relay oysters among farms within a region (Figure 7). Annual production of questionnaire respondents varies from less than 10,000 dozen to more than 300,000 dozen (Figure 6).

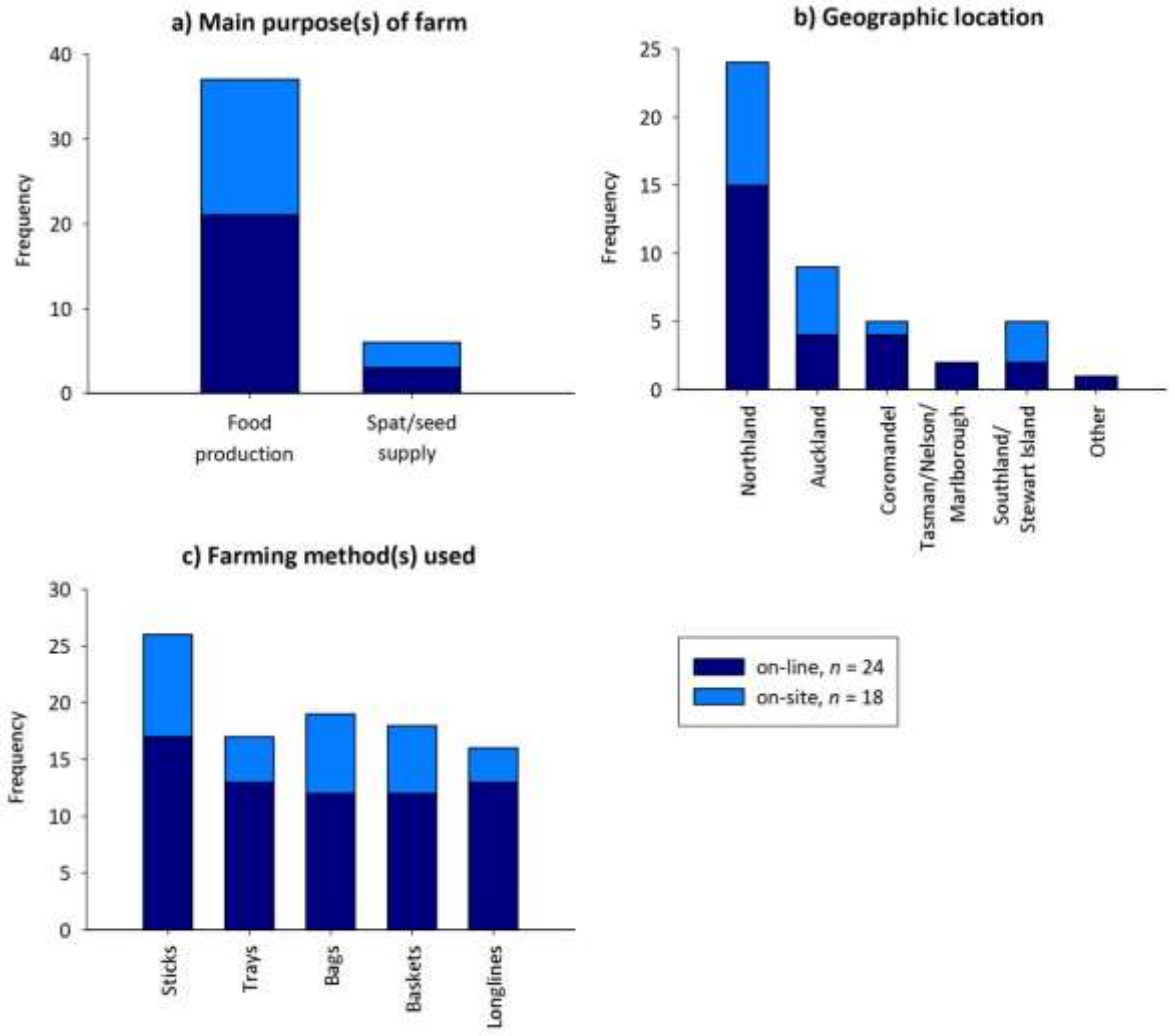

Figure 5: a) Main purpose(s) of farm, b) geographic location, and c) farming methods used by oyster farmers surveyed in the on-line questionnaire and through on-site interviews. Note that respondents sometimes provided more than one answer for each question so the cumulative frequency may be greater than the number of respondents (*n*).

[18] Defined by regional council boundaries.

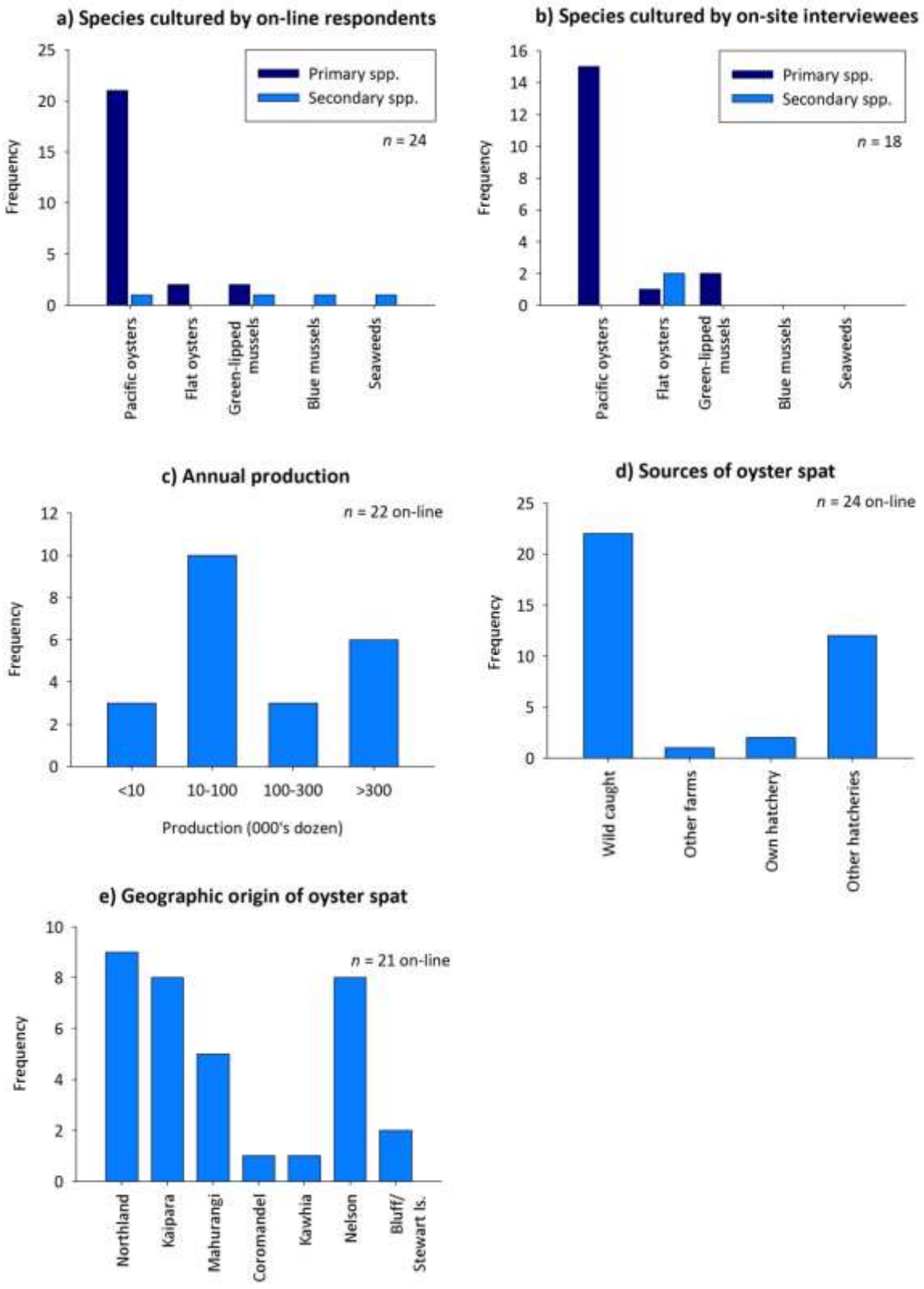

Figure 6: a) Primary and secondary species cultured by on-line respondents, b) primary and secondary species cultured by on-site interviewees, c) annual production, d) sources of oyster spat, and e) geographic origin of oyster spat. Note that respondents sometimes provided more than one answer for each question so the cumulative frequency may be greater than the number of respondents (*n*).

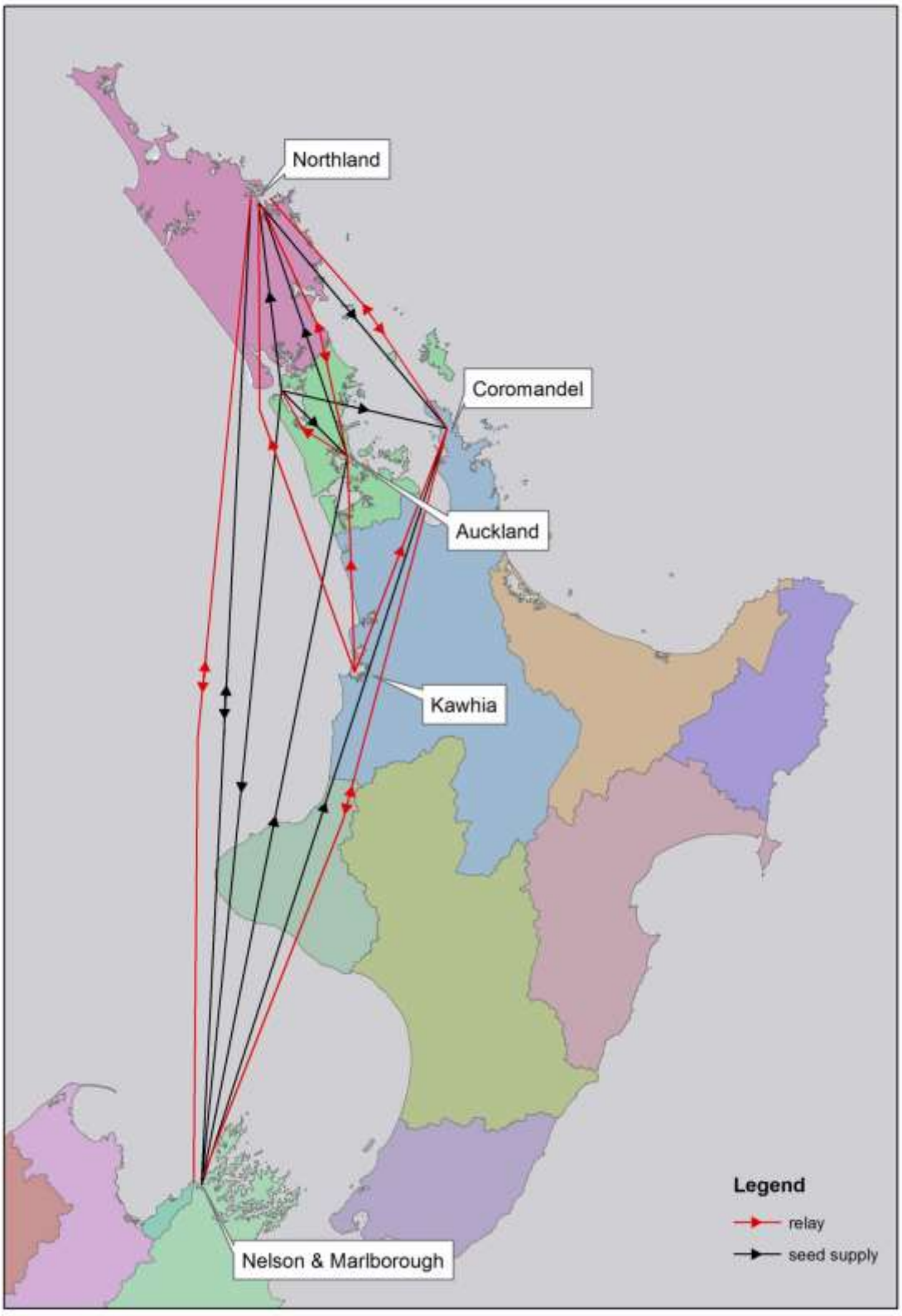

Figure 7: Transfers of oyster seed and relayed oysters around New Zealand by on-line questionnaire respondents. Note, that while the figure indicates transfers to and from point sources, they encompass transfers to the whole region (defined by regional council boundaries). Respondents that farm oysters in Stewart Island transfer oyster seed from Bluff to Stewart Island.

4.2.5 Mussels

Nineteen mussel farmers completed the on-line questionnaire and a further five farmers partially completed the questionnaire. In total, questionnaire respondents manage more than 151 sites. Eighteen mussel farms were visited for the on-site interviews. The majority of farms are located in Marlborough, Tasman and Coromandel. Most farmers (17/23) exclusively culture green-lipped mussels for food production, but five farmers also culture oysters (Pacific and flat). Annual production varies from less than 500 MT to more than 5000 MT. Almost all respondents (10/11) obtain some spat from Ninety Mile Beach (known as Kaitaia spat) (Figure 8).

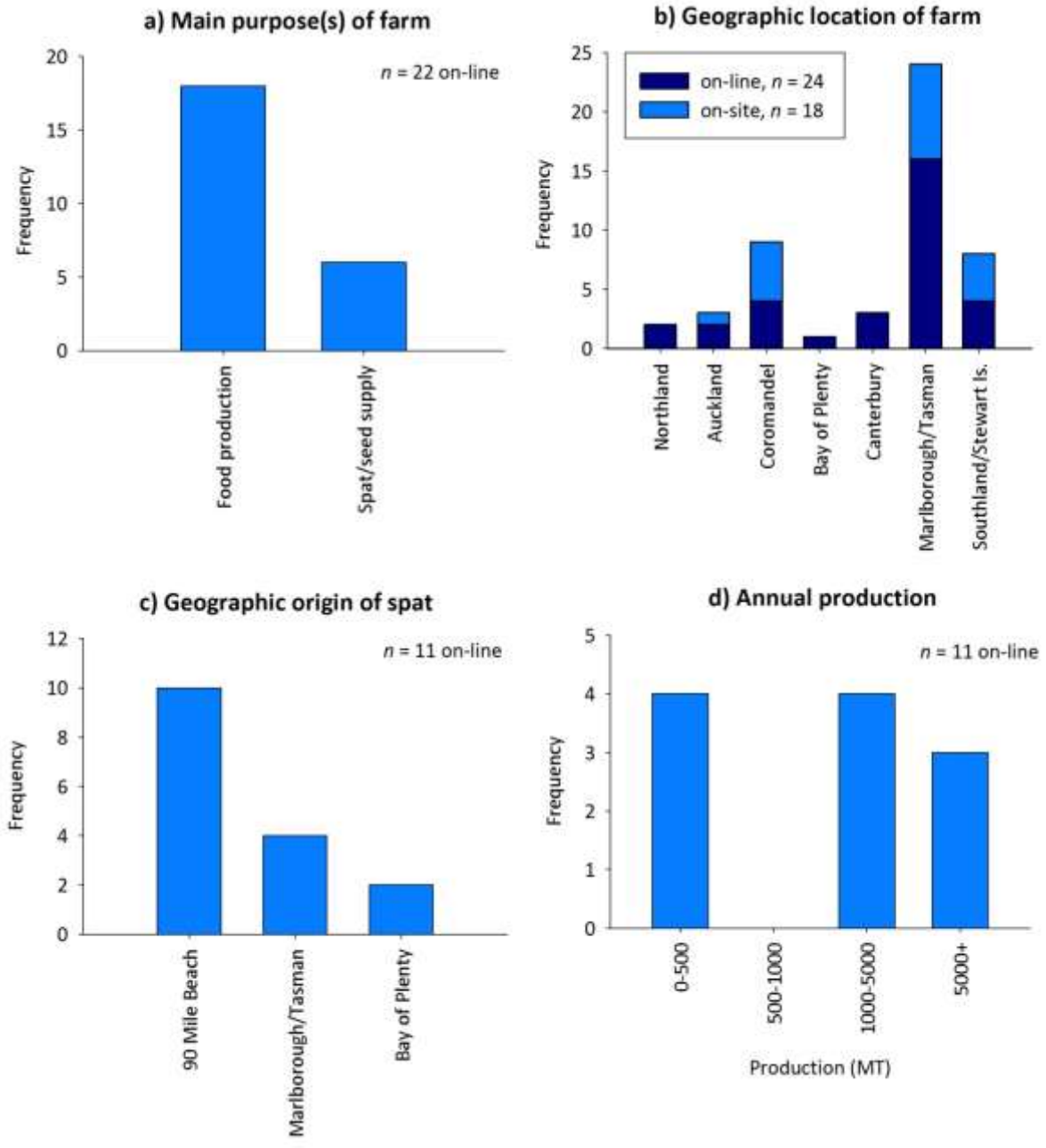

Figure 8: a) Main purpose(s) of farm, b) geographic location of mussel farms, c) geographic origin of mussel spat, and d) annual production of mussel farms. Note that respondents sometimes provided more than one answer for each question so the cumulative frequency may be greater than the number of respondents (*n*).

4.2.6 Mussel spat harvesters

Harvesting of beach-cast mussel spat attached to seaweed only occurs on Ninety Mile Beach, Northland. Four mussel spat harvesters completed the on-line questionnaire and one spat harvester partially completed the questionnaire. One spat harvester was visited in the on-site interviews. Annual harvest volume varies from 10–50 MT to more than 200 MT (weight of spat plus seaweed). Respondents send their mussel spat to Coromandel, Marlborough and Southland (Figure 9).

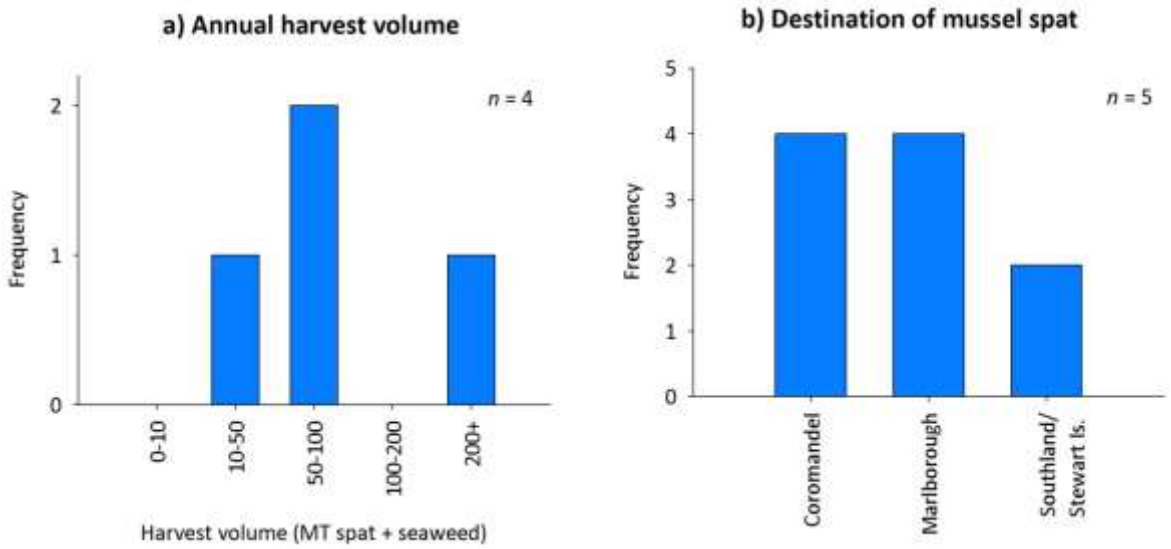

Figure 9: a) Annual harvest volume and b) destination of mussel spat reported by on-line questionnaire respondents. Note that respondents sometimes provided more than one answer for each question so the cumulative frequency may be greater than the number of respondents (*n*).

4.2.7 Aquaculture research facilities

Five aquaculture research facilities completed the on-line questionnaire and one research facility partially completed the questionnaire. Two research facilities were visited during the on-site interviews. All research facilities are land-based and use pumped seawater for organism culture. One research facility also uses municipal water for organism culture. Research facilities culture a wide range of species (Figure 10). Several species (green-lipped mussels, Pacific and flat oysters, grass carp, silver carp, giant kokopu, banded kokopu, short jaw kokopu and perch) are distributed to other growers for on-growing.

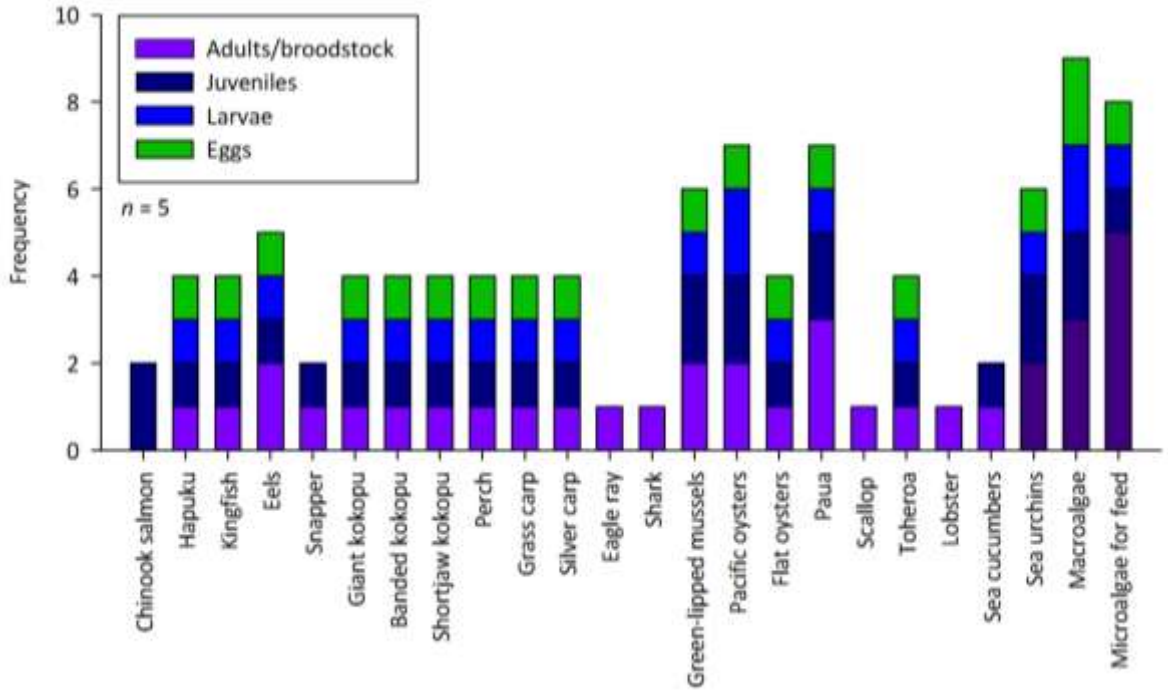

Figure 10: Species and life-stages cultured at aquaculture research facilities surveyed in the on-line questionnaire.

4.3 BIOSECURITY AWARENESS, PERCEPTIONS & CONCERNS OF THE AQUACULTURE INDUSTRY

4.3.1 Overall industry

Level of industry concern about pests and diseases

Overall, there is a high level of concern within the aquaculture industry about preventing and managing pests and diseases on their facilities. Eighty eight percent (63/72) of questionnaire respondents are moderately or very concerned about preventing and managing pests on their facilities, and 89% (58/65) of respondents are moderately or very concerned about preventing and managing diseases on their facilities (Figure 11 & Table 4). Similarly, 42 interviewees expressed concerns about preventing and managing pests and diseases.

However, there is a small proportion of the aquaculture industry that is unconcerned about on-farm biosecurity (Figure 11). This lack of concern appears to be because farmers haven't really thought much about biosecurity, or they perceive that the risk is low because of a lack of pest and disease problems in the past (six interviewees):

- *"it's hard for me to think along these lines (biosecurity issues) because we don't have any problems"*
- *"it's (biosecurity) not something that you are consciously thinking about every day"*
- *"when things are going well, biosecurity is not a focus."*

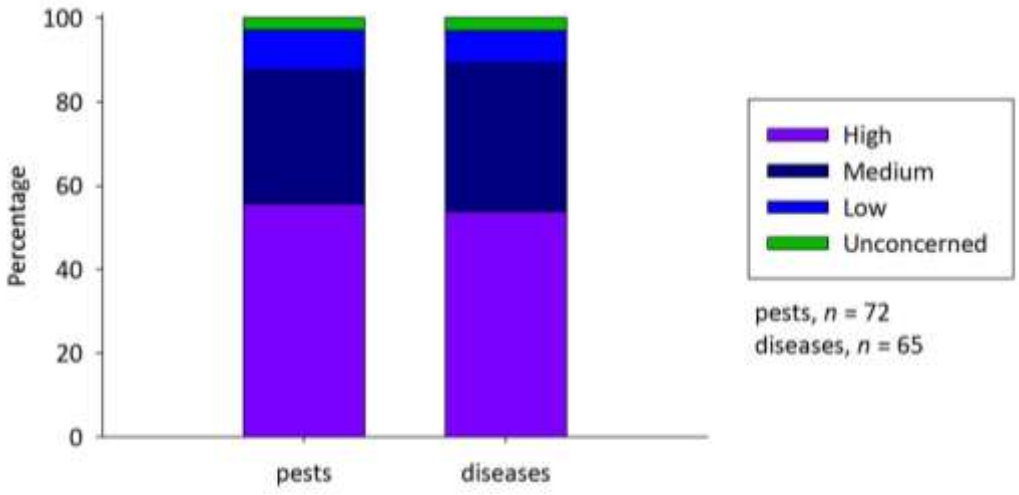

Figure 11: Overall level of concern from the aquaculture industry in the on-line questionnaire about preventing and managing pests and diseases on their facilities.

Table 4: Level of concern from the different aquaculture sectors surveyed in the on-line questionnaire about preventing and managing pests and diseases on their facilities. Results are given as a proportion of respondents and as a percentage in parentheses.

	Pests				Diseases			
	Not concerned	Low	Medium	High	Not concerned	Low	Medium	High
Freshwater salmonids	0/13 (0%)	4/13 (31%)	3/13 (23%)	6/13 (46%)	0/13 (0%)	2/13 (15%)	7/13 (54%)	4/13 (31%)
Saltwater salmonids	0/3 (0%)	0/2 (0%)	1/2 (50%)	1/2 (50%)	0/2 (0%)	0/2 (0%)	1/2 (50%)	1/2 (50%)
Paua	0/3 (0%)	0/3 (0%)	0/3 (0%)	3/3 (100%)	0/2 (0%)	0/2 (0%)	0/2 (0%)	2/2 (100%)
Oysters	0/23 (0%)	0/23 (0%)	9/23 (39%)	14/23 (61%)	0/20 (0%)	0/20 (0%)	5/20 (25%)	15/20 (75%)
Mussels	1/21 (5%)	3/21 (14%)	6/21 (29%)	11/21 (52%)	2/19 (11%)	1/19 (5%)	9/19 (47%)	7/19 (37%)
Mussel spat harvesters	1/5 (20%)	0/5 (0%)	2/5 (40%)	2/5 (40%)	0/4 (0%)	1/4 (25%)	0/4 (0%)	3/4 (75%)
Research facilities	0/5 (0%)	0/5 (0%)	2/5 (40%)	3/5 (60%)	0/5 (0%)	1/5 (20%)	1/5 (20%)	3/5 (60%)

The aquaculture industry regards 'pest or nuisance' species as species that have negative impacts on their business by interfering with the farming process or reducing productivity. Pest species may be native or introduced species, and some of the worst pest species for the industry are native species e.g., blue mussels and barnacles. Not every introduced species is a threat to the aquaculture industry, and interviewees think that MPI need to 'weigh up' the risk an introduced species poses to the industry versus the cost of control measures (four interviewees). Three interviewees are concerned that biosecurity measures are implemented before there is a good understanding of the risk:

- *"don't cry wolf...not every species is a threat to the industry"*
- *"it's important to ask, is the pest causing a problem for us (the industry)?"*

Many farmers reported that pest species are ephemeral and farmers are not troubled by the same species every year (20 interviewees). Farmers believe that while introduced pests species may bloom in abundance for the first few years, abundances naturally declined to a non-problematic level. Furthermore, most farmers (35 interviewees) believe that it is futile to try and eradicate or control the spread of pest or disease species once they becomes established in New Zealand:

- *"once they are here the horse has bolted"*
- *"by the time you realise you have a problem, it's too late."*

Perceived biosecurity risks for the aquaculture industry

Questionnaire respondents believe that the major methods that pests and disease are transported to farms are via: natural water movement; shipping vessels; recreational boats; stock transfers; and other wild animals (in order of importance) (Figure 12 & Figure 13). Natural water movement was identified as the most likely method that pests and diseases are transported to farms. While land-based farms have the option of treating their intake and effluent water, this is impossible for open farms based in the sea or natural waterways, and many farmers believe that nothing can be done to prevent pest and disease transmission via water (20 interviewees). Only two farmers interviewed suggested that waterborne pest and

disease transmission to open farms may be manageable through methods like Aquaculture Bay Management Area Agreements (see Section 5.6 for more detail).

International shipping is thought to be the second highest transmission risk for pests and diseases. Many farmers believe that the government should be doing more to prevent pests and diseases being introduced into the country via international ships (24 interviewees):

- *"I really worry about what they (international ships) bring in"*
- *"shipping ballast water is the biggest threat"*
- *"keep stuff out, maintain a stronger front line"*
- *"stop bringing in foreign vessels that have not been antifouled and cleaned."*

Poor water quality in farming areas because of sewage (human and animal) contamination and sedimentation is a major concern for 12 interviewees:

- "*If we haven't got clean water, we don't have an industry*"
- "*Our biggest problem is (poor) water quality"*
- "*We have no control over our own business.*"

Respondents are also very aware of the need to protect their 'clean and green' image for customer assurance.

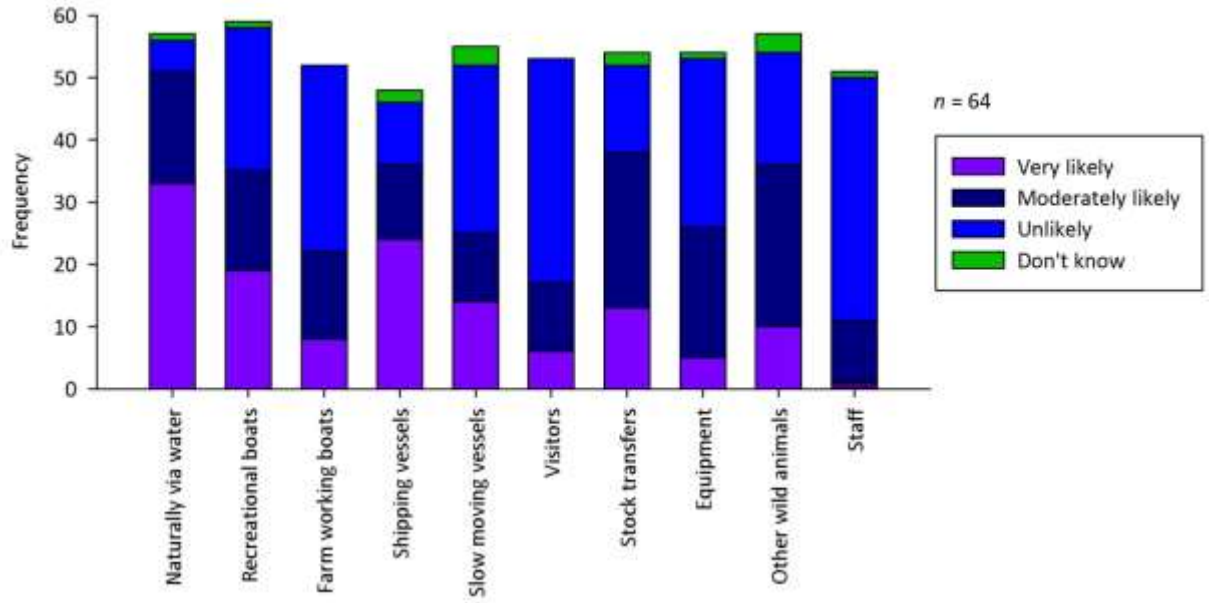

Figure 12: On-line questionnaire respondents' opinions on the likely ways that pests can enter their facility. The cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

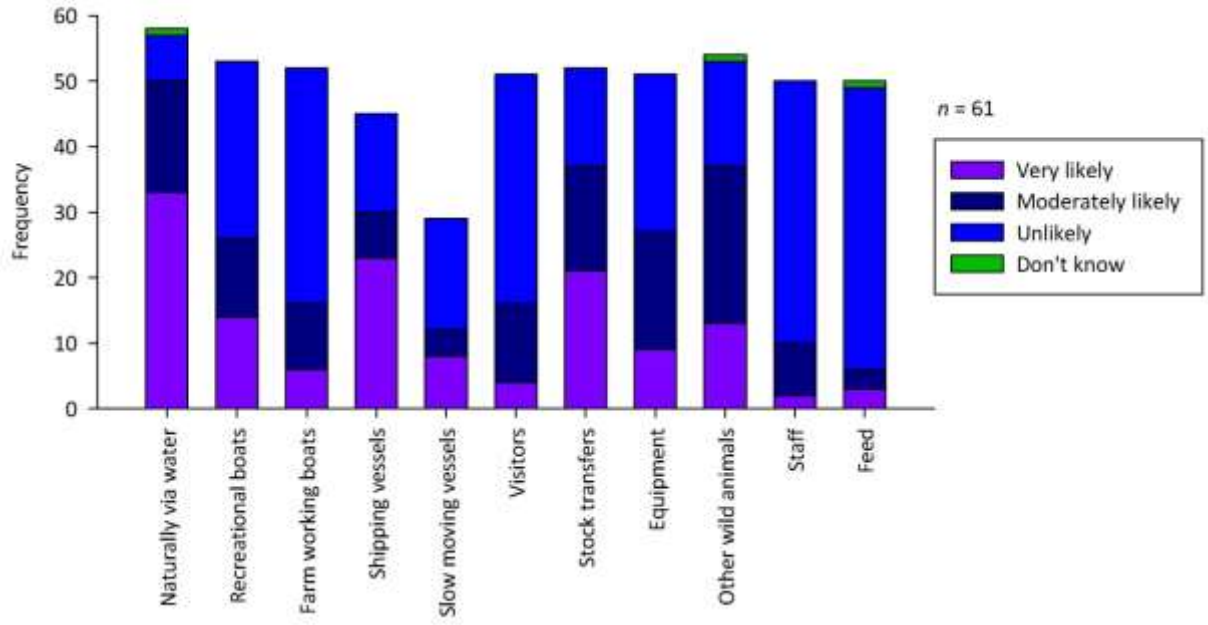

Figure 13: On-line questionnaire respondents' opinions on the likely ways that diseases can enter their facility. The cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

Industry's concerns about the cost of biosecurity

Several farmers are generally worried about the increasing regulatory and compliance costs of aquaculture, and they worry that they will have to pay for the implementation of new biosecurity procedures (six interviewees):

- *"compliance and monitoring costs are killing the industry"*
- *"I wouldn't like to see too many industry/government programmes. The costs are too high and I fear that farmers will have to pay for them"*
- *"the Didemnum eradication programme cost small farmers $100–200 k, it almost closed down the individual farmers."*

Furthermore, farmers believe that many biosecurity risks are outside the aquaculture industry's control, however, all the onus of biosecurity management is being put on the aquaculture industry. The aquaculture industry is not responsible for bringing pests and diseases into the country, and they are not the only transmission vector (e.g., recreational boats and commercial fishing boats). Farmers think that it is unfair that the aquaculture industry is expected to pay for numerous biosecurity procedures (e.g., pest surveillance and control costs), while other water users (e.g., recreational and commercial fishers, boat owners, marinas, ports) are not required to pay for biosecurity procedures (10 interviewees):

- *"the government is putting biosecurity surveillance responsibility onto the industry"*
- *"measures need to be put in place to protect farmers rather than more regulations for farmers"*
- *"there are no ramifications for these people (boat owners)...and the aquaculture industry is left to carry the costs"*
- *"aquaculture is only one part of the story, but it is the aquaculture guys that will suffer...aquaculture guys are moving things around but they don't put things there in the first place."*

Industry's perception of MPI's role in biosecurity

In general, a large percentage of the aquaculture industry doesn't know whether MPI is effective or ineffective at its various biosecurity functions. Only 25% (14/56) or less of the industry believe that MPI performs effectively in its various functions. MPI is seen as most effective in its roles in pest expertise, diagnostic services, and controls on imports and exports (Figure 14).

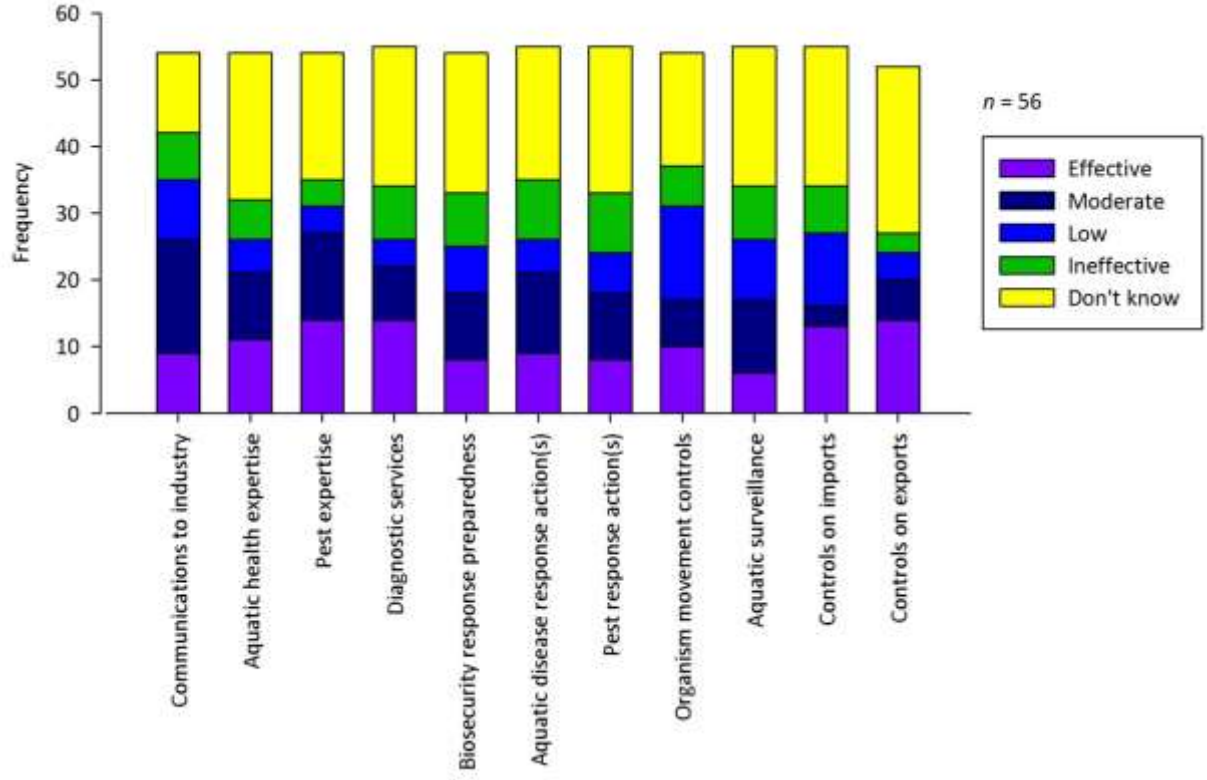

Figure 14: The opinion of on-line questionnaire respondents on the effectiveness of MPI's biosecurity functions.

MPI's border control and surveillance of introduced pest and disease species is perceived as inadequate by several farmers:

- *"New Zealand biosecurity is quite lax"*
- *"I'm highly sceptical of how biosecurity works (in the government)"*
- *"no existing biosecurity measures are in place, biosecurity is an absolute joke"*
- *"what systems are in place to stop species coming in?"*
- *"in general, biosecurity practices in New Zealand are low key compared to other countries such as Europe."*

In contrast, two interviewees believed that MPI had done a pretty good job of not letting pests and diseases into the country: *"the closed border system in New Zealand is fantastic."*

Twenty eight interviewees believe that MPI should be putting more effort into preventing pests and diseases from entering the country, particularly via international ships: *"just keep disease out of New Zealand, that's what I care about."* Five interviewees think that MPI needs to be more proactive in preventing incursions, rather than reactive once an incursion is detected: *"they (MPI) shouldn't be the ambulance at the bottom of the hill."* Five interviewees believe that the import of chilled or live fish/shellfish products, particularly salmonids and oysters, should be prohibited.

Eradication of pest and disease species is generally viewed as impossible by farmers and seven interviewees believe that MPI waste too much money trying to control incursions of pest species:

- *"I have never seen an eradication protocol that works, they end up spending a lot of money with little results"*
- *"it was a waste of money and ineffective"* (regarding the trials to control *Didemnum* with plastic wrap).

Conversely, two interviewees believe that the Department of Conservation should have continued trying to eradicate Japanese kelp (*Undaria pinnatifida*) from Stewart Island because they were *"almost there."*

MPI is perceived by some farmers as being unprepared for a disease outbreak.Three interviewees stated that MPI needs to have a clearly defined action plan for potential disease outbreaks because an outbreak will happen one day:

- *"it's inevitable that there will be an event, it's important to know how to deal with it"*
- *"it's not if, it's when"* (regarding a disease outbreak).

Two interviewees stated that with the move towards farming native fish species, MPI also needs to be prepared to deal with commercially significant endemic diseases and needs to ensure that these don't affect the salmonid industry. Five interviewees are concerned that if a serious disease outbreak were to occur, there are no readily available vaccines in the country. These interviewees would like to see more information and progress on the development of vaccinations for New Zealand fish (a current Aquaculture New Zealand project). One interviewee stated that MPI needs the ability to identify foreign diseases quickly.

4.3.2 Freshwater salmonids

Most (9/13) questionnaire respondents are moderately or very concerned about preventing or managing pest species on their farms, particularly Didymo (*Didymosphenia geminata),* other microalgae and aquatic plant species (Figure 15). Similarly, 11/13 questionnaire respondents are moderately or very concerned about preventing or managing diseases on their farms (Figure 16). Respondents are concerned about both diseases already present in New Zealand (e.g., bacterial gill disease (*Flavobacterium* sp.), *Aeromonas* bacteria, white spot (*Ichthyophthirius multifiliis),* infectious pancreatic necrosis (*Aquabirnavirus* spp.) and *Saprolegnia* fungi) and those that are not in the country but are problematic overseas (e.g., bacterial kidney disease (*Renibacterium salmoninarum*)).

The most likely vectors of pest and disease transmission are thought to be water, wild animals (particularly birds (seven interviewees)), stock and equipment transfers and visitors (Figure 17 & Figure 18). A number of the freshwater fish farms are located in close proximity of one another and five interviewees are concerned about inter-site biosecurity. These farmers feel that they are vulnerable to the farming practices of other farmers that share their waterways. Some of these farmers have raised the possibility of developing common biosecurity practices with their neighbouring farms, but not all farmers are interested in a collaborative biosecurity approach. Farmers are also worried about the general public introducing pests or diseases into their waterways (three interviewees). One farm is situated next to a large tourist destination, whilst two farms are next to recreational fishing spots. Farmers that have farms situated near the head of a spring believe that the risk of pests or diseases being introduced via water is low (four interviewees).

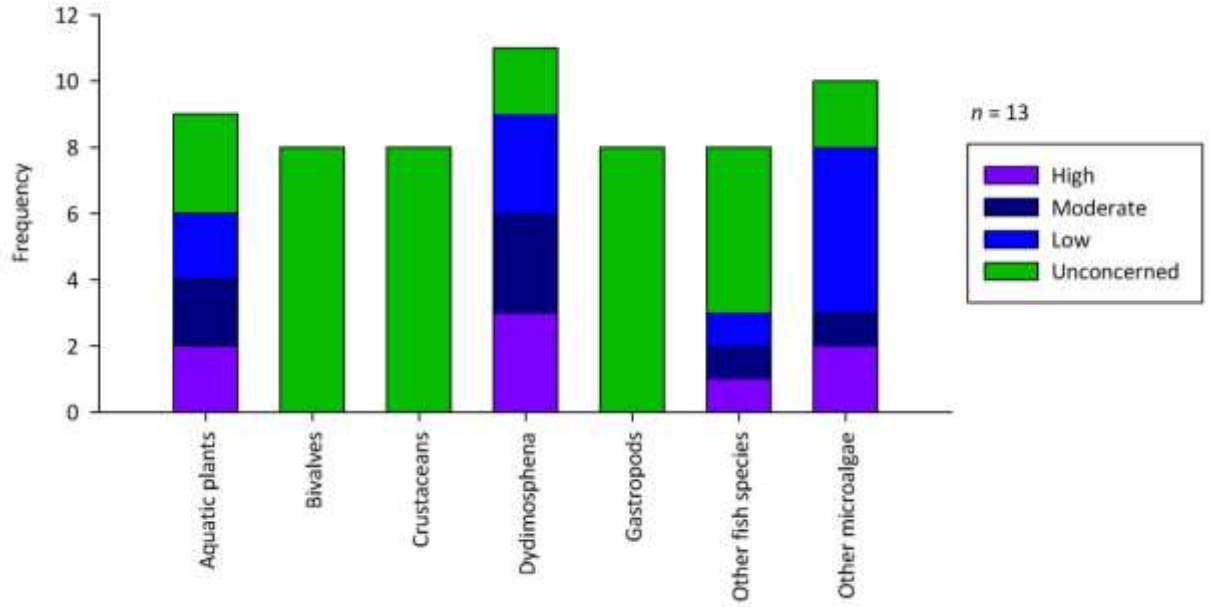

Figure 15: Level of concern about different types of pests from freshwater salmonid farmers in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

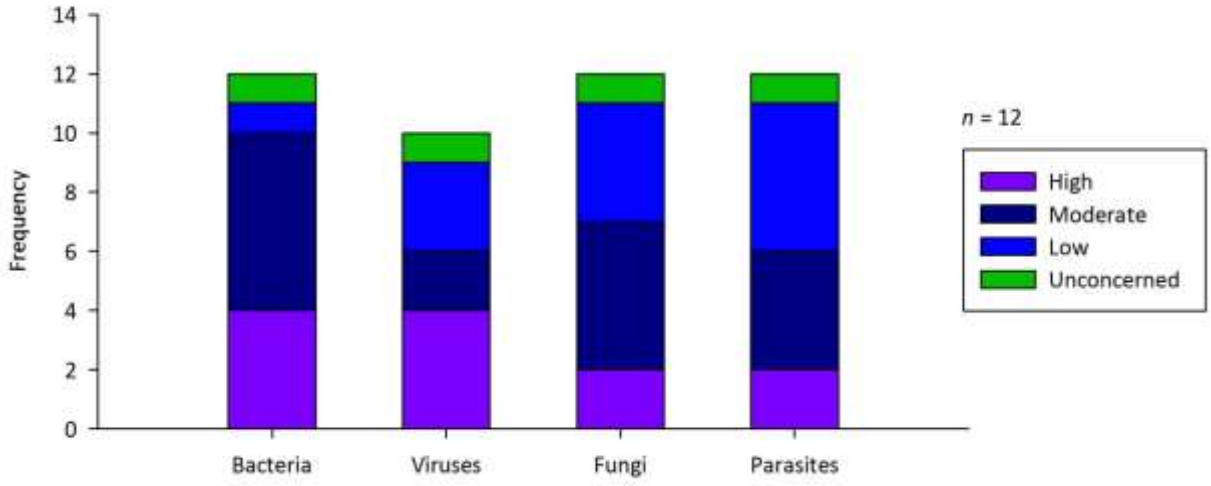

Figure 16: Level of concern about different types of disease agents from freshwater salmonid farmers in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

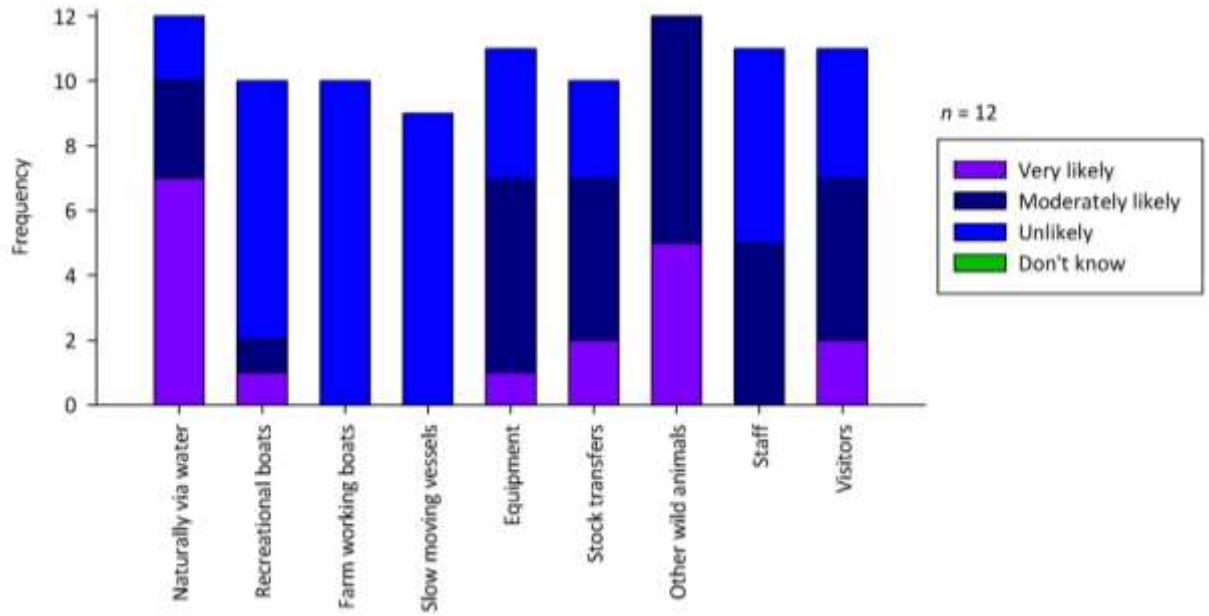

Figure 17: Freshwater salmonid farmers' opinions in the on-line questionnaire on the likely ways that pests can enter their farm. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

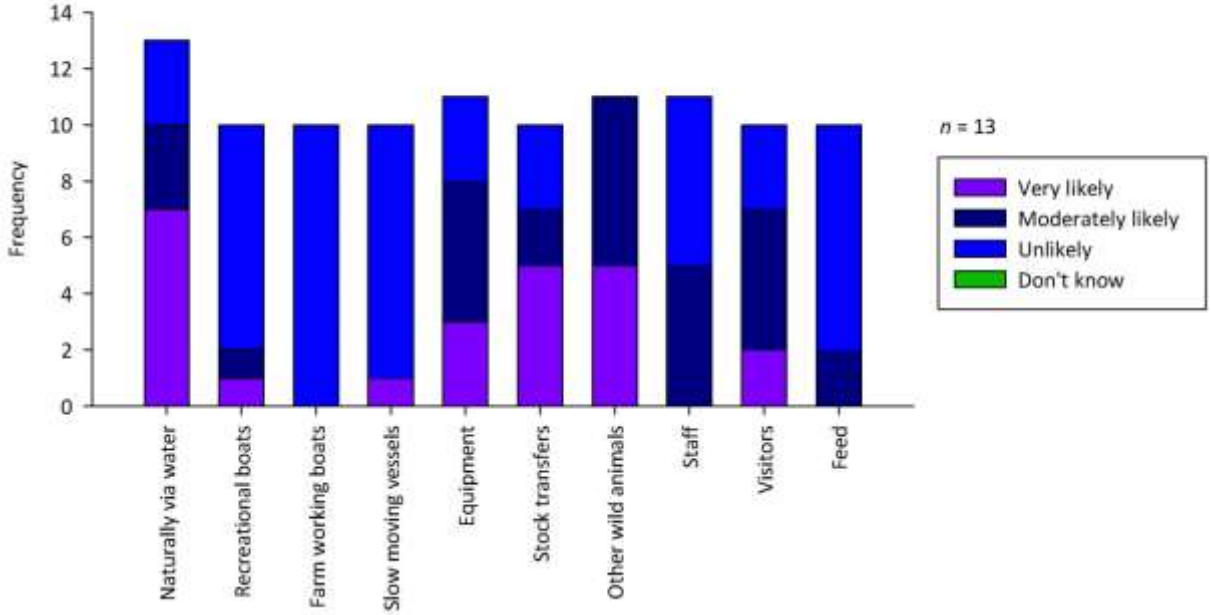

Figure 18: Freshwater salmonid farmers' opinions in the on-line questionnaire on the likely ways that disease agents can enter their farm. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

4.3.3 Saltwater salmonids

Both (2/2) questionnaire respondents are moderately or very concerned about preventing or managing pest and disease species on their farms, particularly harmful microalgae, amphipods/isopods, hydroids, bryozoans and bacteria (Figure 19 & Figure 20). The most likely vectors of pest and disease transmission are thought to be water, boats (recreational, farm working and shipping), and other animals (Figure 21 & Figure 22). Farmers are also concerned that tourists to the region have the potential to introduce new pests and diseases to New Zealand, e.g., via dirty footwear or boats (two interviewees).

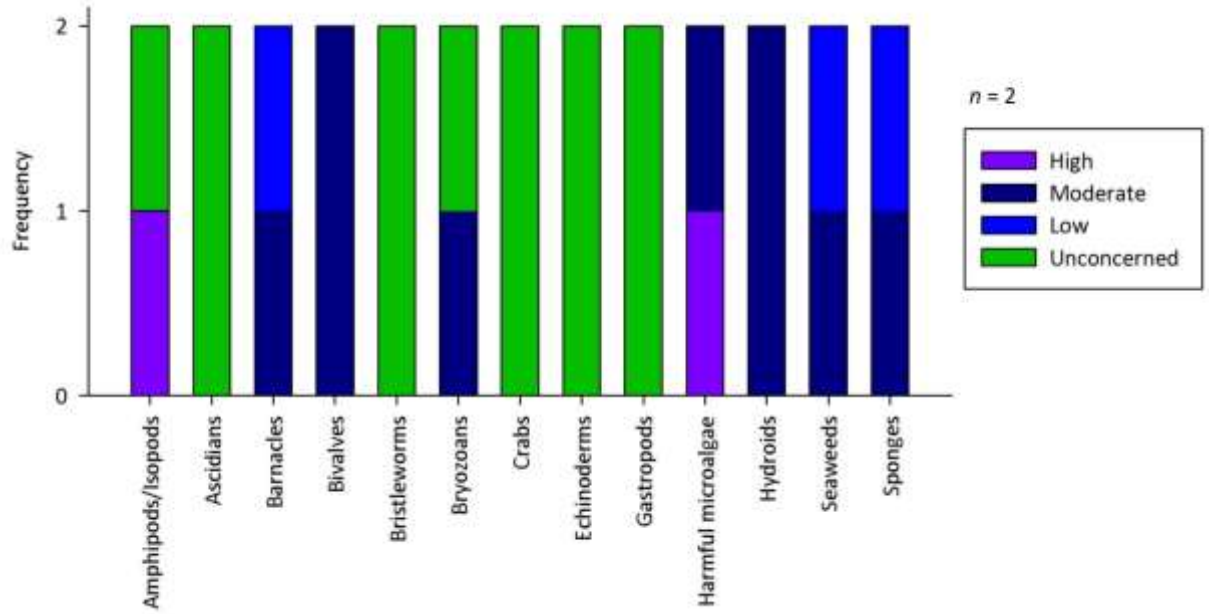

Figure 19: Level of concern about different types of pests from saltwater salmonid farmers in the on-line questionnaire.

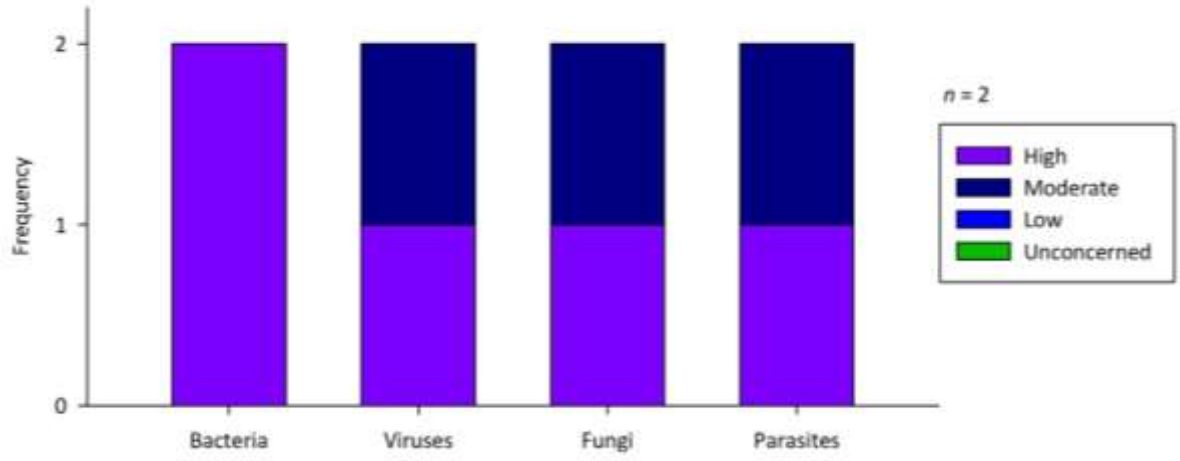

Figure 20: Level of concern about different types of disease agents from saltwater salmonid farmers in the on-line questionnaire.

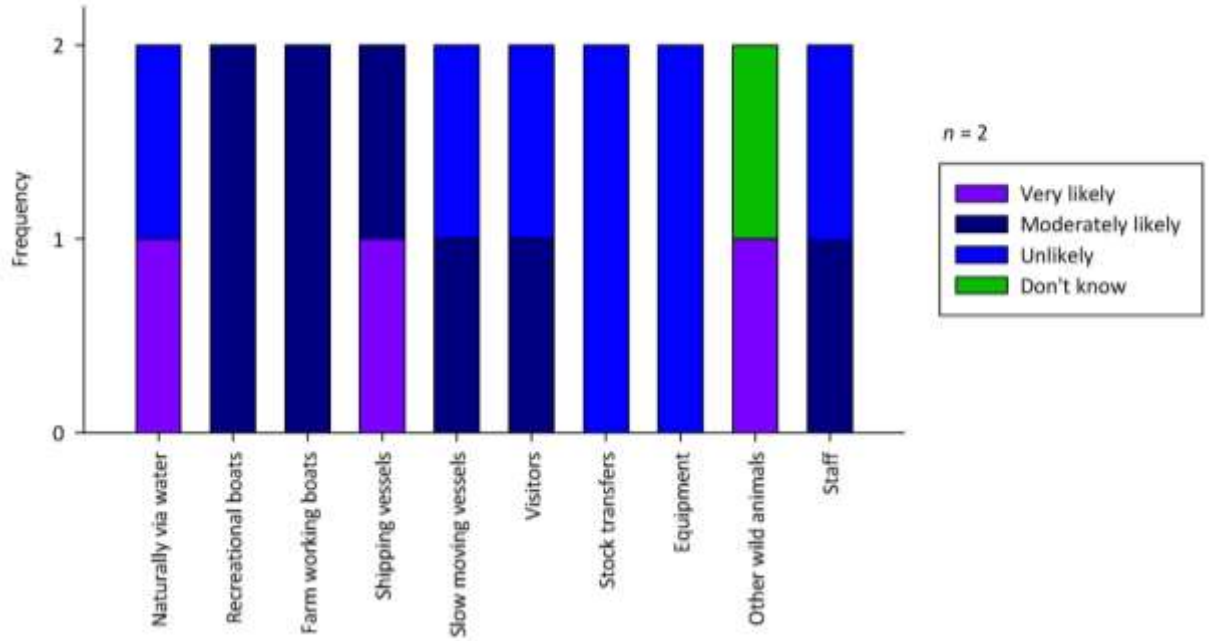

Figure 21: Saltwater salmonid farmers' opinions in the on-line questionnaire on the likely ways that pests can enter their farm.

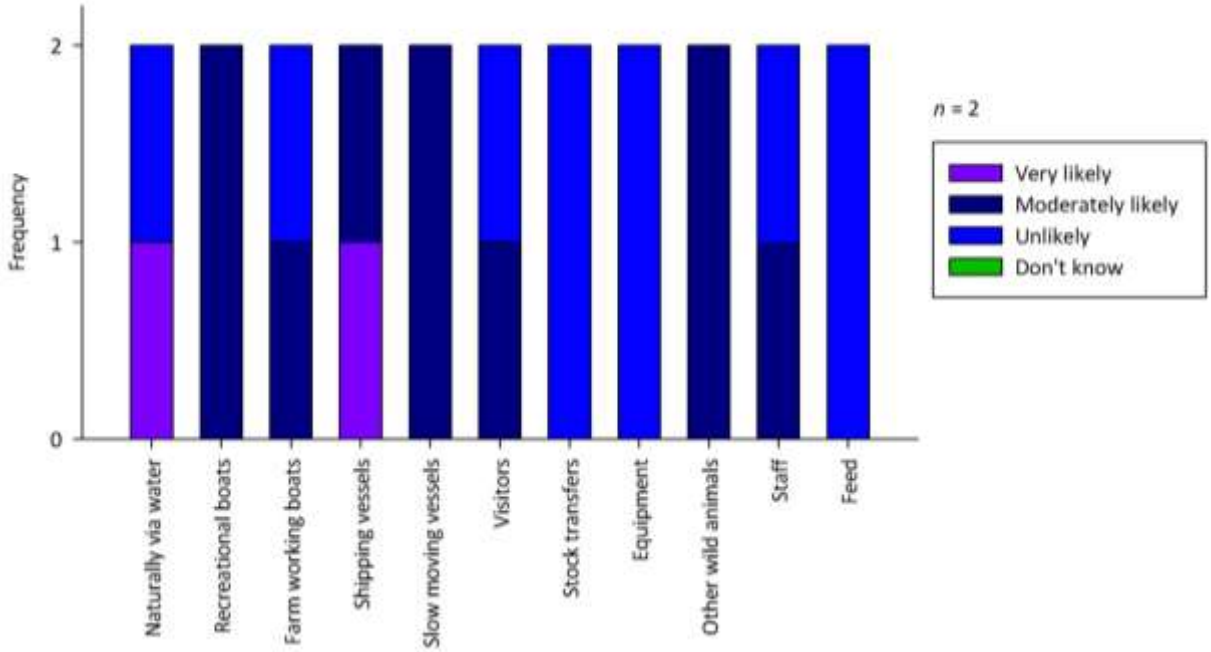

Figure 22: Saltwater salmonid farmers' opinions in the on-line questionnaire on the likely ways that disease agents can enter their farm.

4.3.4 Paua

All (3/3) questionnaire respondents are very concerned about preventing or managing pest species on their farm, particularly harmful microalgae (Figure 23). Mud worms (n = 2), white worms (n = 1) and sea anemones (n = 1) were specifically noted as the pests species that respondents are most concerned about. Similarly, all (2/2) respondents are very concerned about preventing or managing diseases on their farm, particularly *Perkinsus olseni* (n = 2) and *Vibrio* spp. (n = 1) (Figure 24). The most likely vectors of pest and disease transmission are thought to be water, stock transfers and wild animals, particularly birds (one interviewee) (Figure 25 & Figure 26).

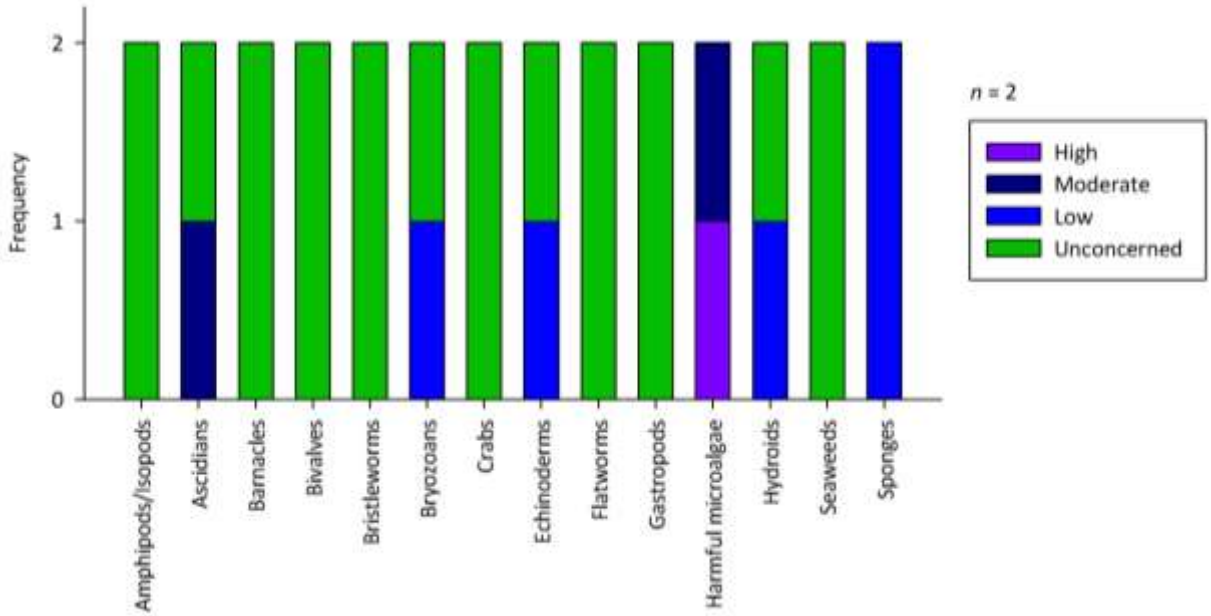

Figure 23: Level of concern about different types of pests from paua farmers in the on-line questionnaire.

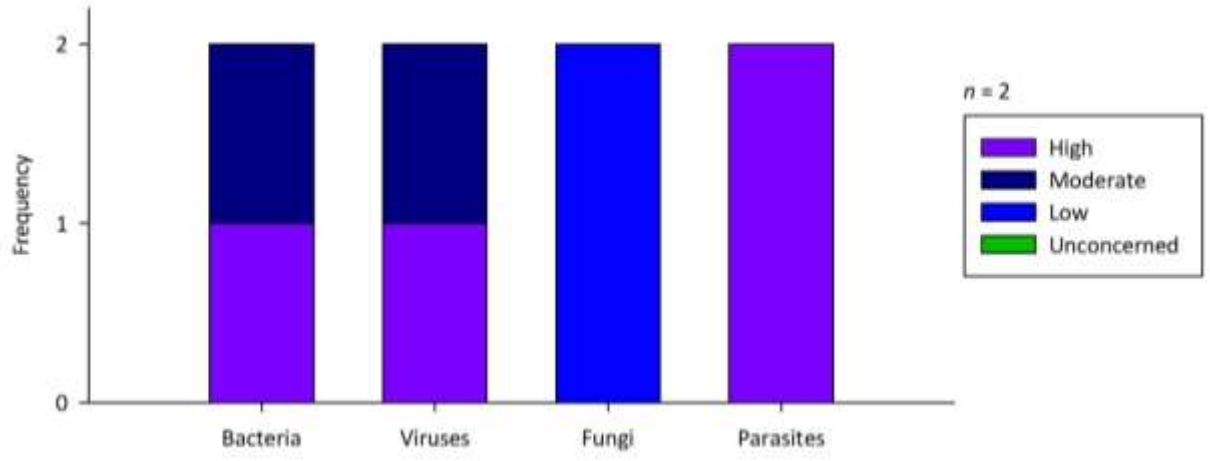

Figure 24: Level of concern about different types of disease agents from paua farmers in the on-line questionnaire.

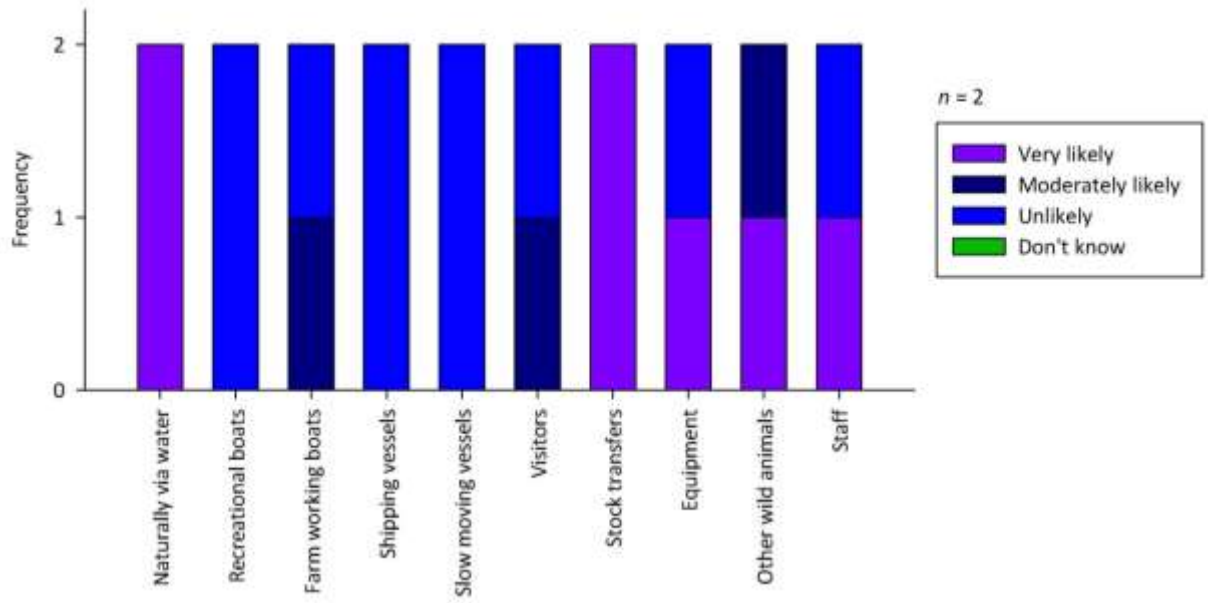

Figure 25: Paua farmers' opinions in the on-line questionnaire on the likely ways that pests can enter their farm.

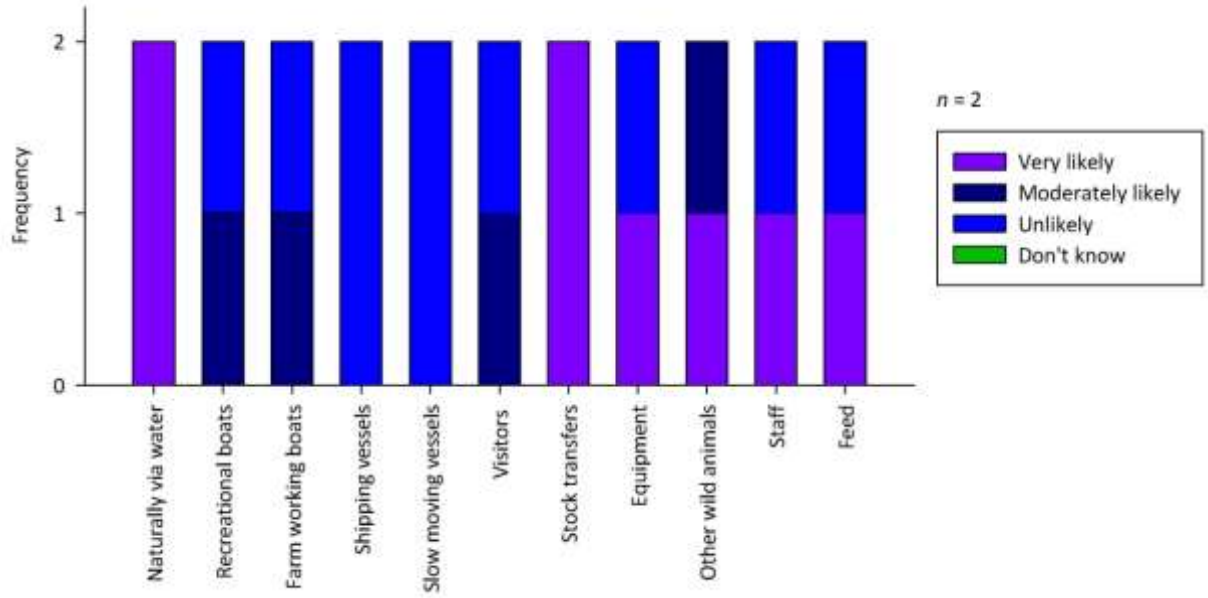

Figure 26: Paua farmers' opinions in the on-line questionnaire on the likely ways that diseases can enter their farm.

4.3.5 Oysters

All (23/23) questionnaire respondents were moderately or very concerned about preventing or managing pest species on their farm, particularly harmful microalgae, flatworms, ascidians and mussels (Asian bag mussel (*Arcuatula senhousia*), black flea mussel (*Limnoperna pulex*) and blue mussel (*Mytilus galloprovincialis*)) (Figure 27). However, nine interviewees reported that pest species were more of a nuisance and didn't affect their business much. These interviewees reported that biofouling species increase labour costs during harvesting but do not appear to adversely affect the growth or survival of oysters. In contrast, four interviewees believe that biofouling species compete for food and reduce the growth of oysters.

All (20/20) respondents were moderately or very concerned about preventing or managing diseases on their farm, particularly OsHV-1 and norovirus (Figure 28). Nearly all Pacific oyster farmers (12 interviewees) lost more than 70% of their stock to OsHV-1 between 2010 and 2012. One spat collector no longer has any clients because of the disease and two farmers can no longer afford to stock their farms, so they are currently contract growers for larger companies. Farmers are still losing a large proportion (40–60%) of both hatchery-supplied seed and wild spat to the virus when they are seeded out on their farms.

The most likely vectors of pest transmission are thought to be water, shipping vessels, recreational boats, farm working boats, wild animals and stock transfers (Figure 29). Similarly, the most likely vectors of disease transmission are thought to be water, shipping vessels, slow-moving vessels, recreational boats and stock transfers (Figure 30).

There are differences in opinion about the pest and disease transmission risk associated with stock transfers. Ten interviewees believe that stock transfer is a potential disease transfer vector and may hasten the spread of pests and diseases. However, only four interviewees believe that stock transfers should be prohibited: *"short-term hardship for long-term gain."* Other farmers believe that pests and diseases will be transferred around the country eventually by other transmission vectors (four interviewees). Stock movement is viewed as being essential to the Pacific oyster industry and four interviewees think that prohibiting stock movement would cripple the industry.

Conversely, two interviewees believe that it is beneficial to spread a disease around the country to allow wild spat to develop resistance to it: *"let Mother Nature build up a resistant strain."* For example, oysters from Kawhia Harbour are OsHV-1-free (Whittington *et al.*, 2012), however, other oyster farmers do not want to buy Kawhia spat because it has no resistance to the virus and it dies as soon as it is moved out of Kawhia Harbour[19].

Some farmers appeared unconcerned or unaware of the disease transmission risk associated with stock movement and continued to move stock around the country during the OsHV-1 outbreak:

- *"when the virus first hit, their response was to rush oysters down to the Kaipara"*
- *"some oyster farmers were bringing up untested spat from Nelson in the middle of the virus."*

[19] This was a general belief among oyster farmers that was reported to us by one interviewee.

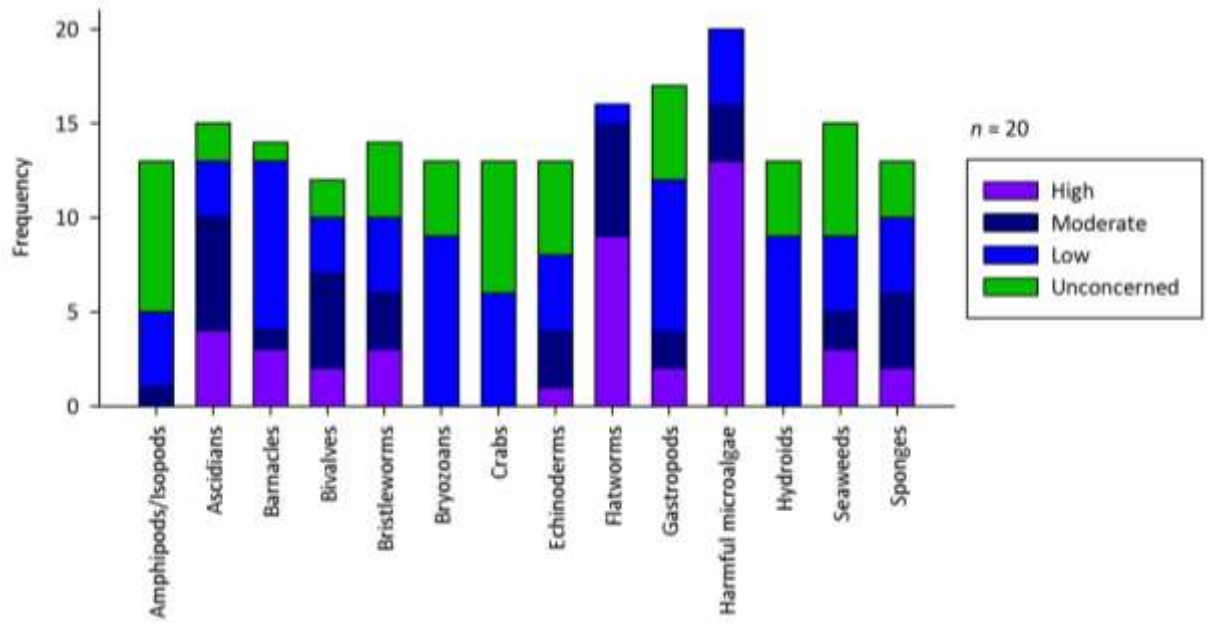

Figure 27: Level of concern about different types of pests from oyster farmers in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

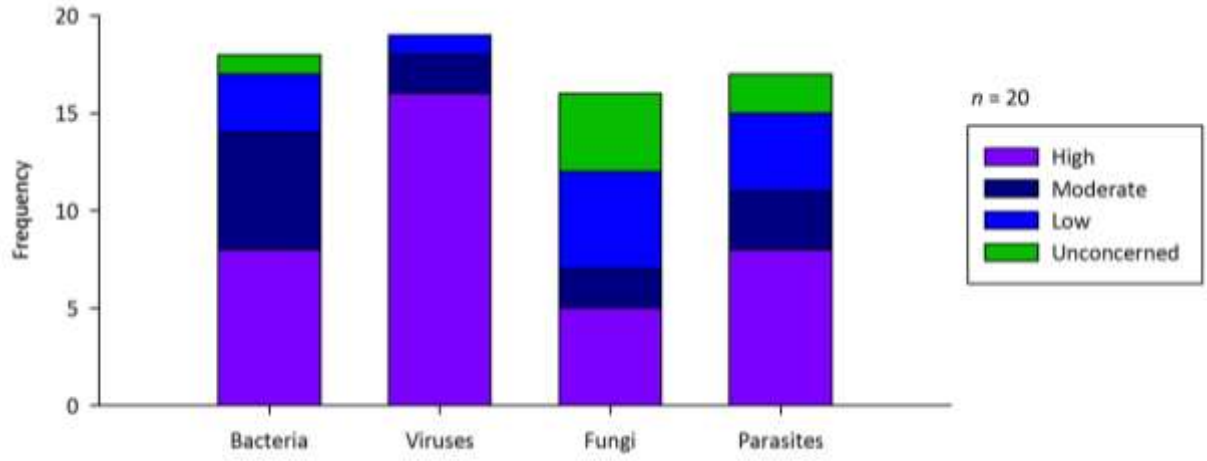

Figure 28: Level of concern about different types of disease agents from oyster farmers in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

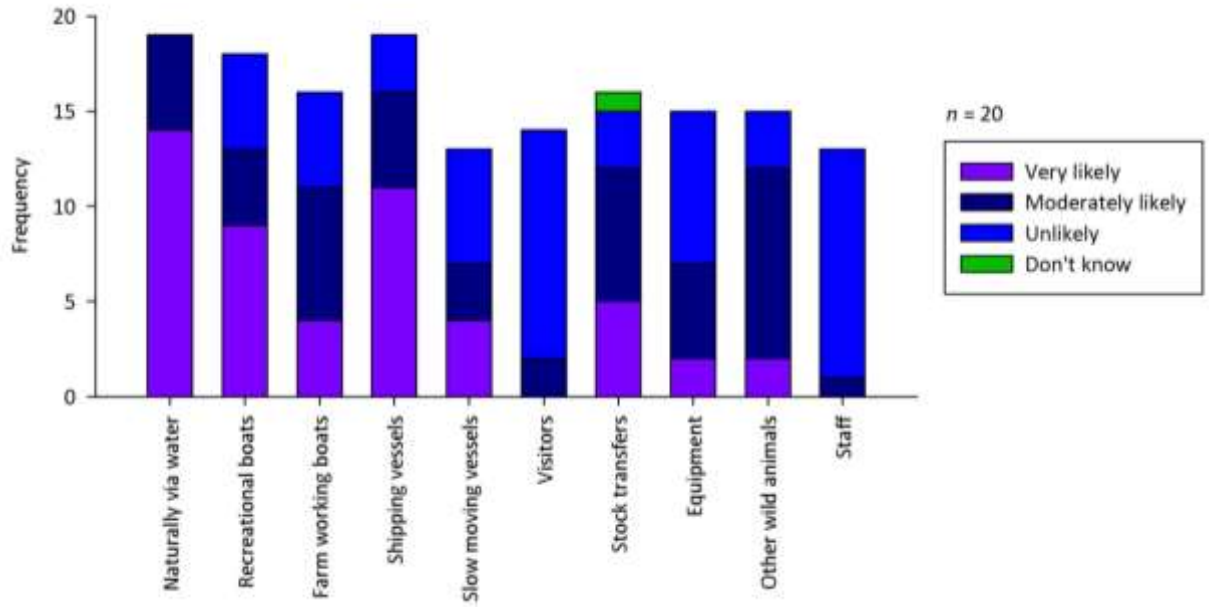

Figure 29: Oyster farmers' opinions in the on-line questionnaire on the likely ways that pests can enter their farm. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

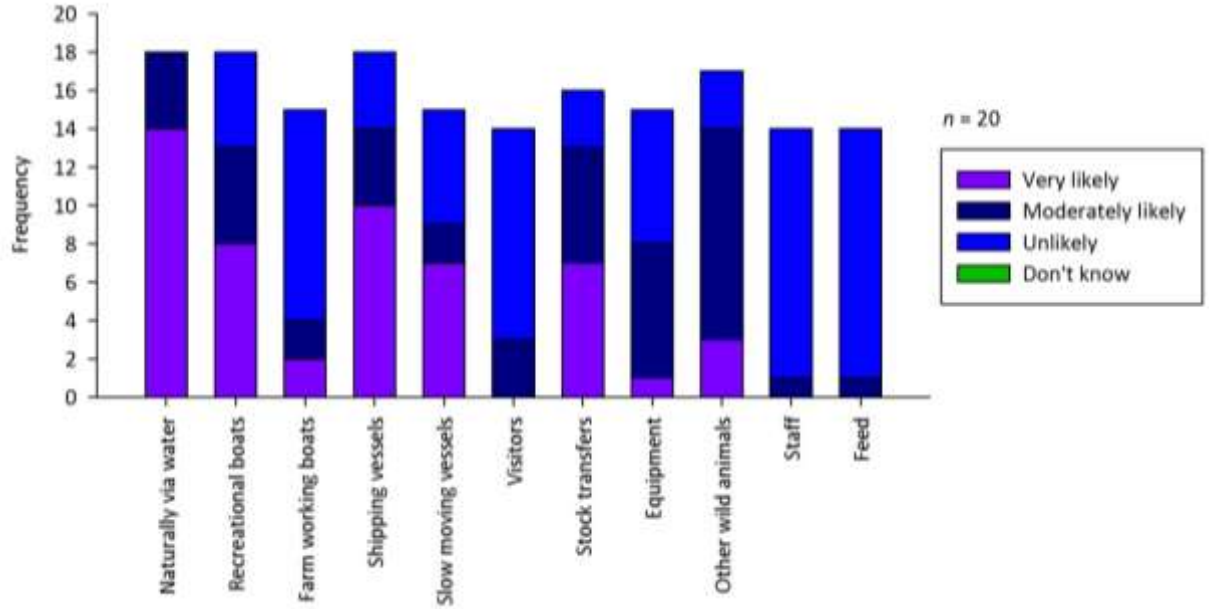

Figure 30: Oyster farmers' opinions in the on-line questionnaire on the likely ways that diseases can enter their farm. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

4.3.6 Mussels

Most (17/21) questionnaire respondents are moderately or very concerned about preventing or managing pest species on their farms, particularly harmful microalgae, ascidians (e.g., Whangamata sea squirt (*Didemnum vexillum*) and the vase tunicate (*Ciona intestinalis*)) and bristleworms (e.g., Mediterranean fanworm (*Sabella spallanzanii*)) (Figure 31). By contrast, six interviewees are generally not worried about soft fouling species; their only concern is the hard fouling species like blue mussels and barnacles, which are not removed by the tumblers[20]. The most likely vectors of pest transmission are thought to be shipping vessels, slow moving boats, recreational boats, water and stock transfers (Figure 33 & Figure 35).

Most (16/19) respondents are moderately or very concerned about preventing or managing diseases on their farms. In general, respondents are most concerned about viruses and parasites (Figure 32), although very few respondents named specific diseases that they are concerned about. The most likely vectors of disease transmission are thought to be shipping vessels and water (Figure 34).

There are differences in opinion about the pest and disease transmission risk associated with stock transfers. Seven interviewees believe that stock transfer is a potential pest and disease transmission vector, while six interviewees don't. Blue mussels are believed to have been introduced to Coromandel and Golden Bay by farmers transferring green-lipped mussel seed (seven interviewees), and one interviewee believes that *Undaria* was transferred to Marlborough with Kaitaia spat. One farmer believes that seed should not be transferred outside of their farming region, and three farmers believe that mussel seed should not have been brought up from the South Island to the North Island. However, two farmers think that there is no point in stopping transfers now because most of the pest species have already been introduced to the North Island:

- *"transferring anything into your area is wrong and there should be more regulations...however, the horse has bolted already."*

Kaitaia spat is believed to pose less of a transmission risk than other sources of spat (two interviewees), and many farmers believe that there is little risk of transmitting pests and diseases with Kaitaia spat (seven interviewees). Only one interviewee believes that Kaitaia spat should not be shipped around the country.

[20] During harvest or reseeding, mussels are mechanically stripped from the ropes and passed through tumblers, which agitate the mussels to remove any attached soft biofouling organisms.

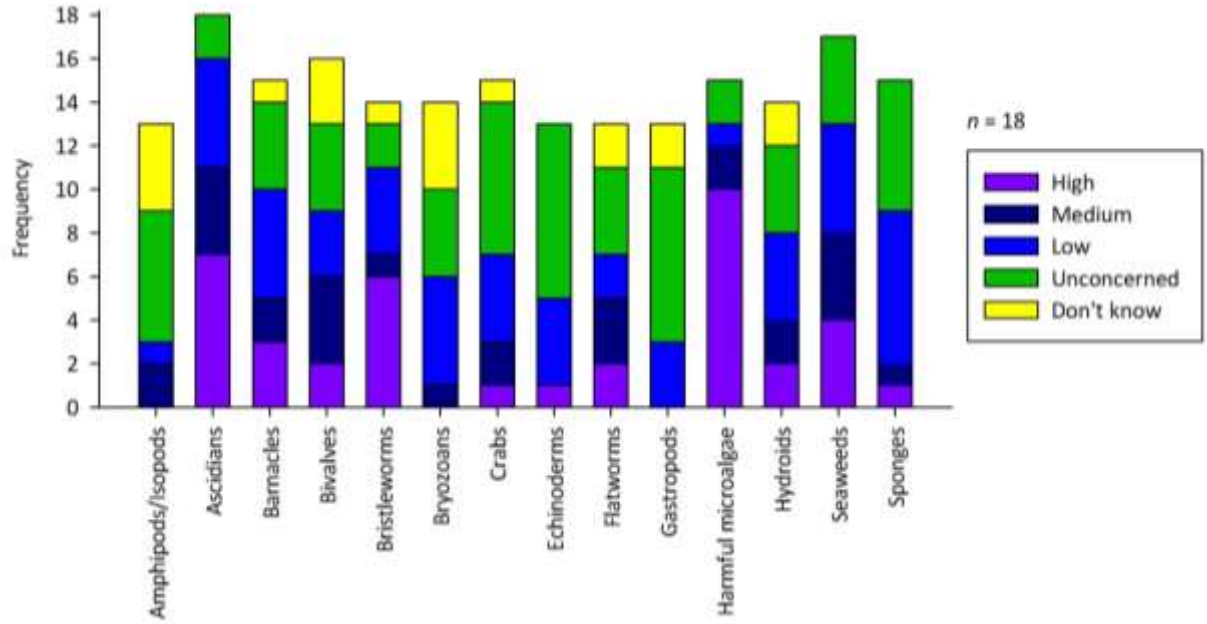

Figure 31: Level of concern about different types of pests from mussel farmers in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

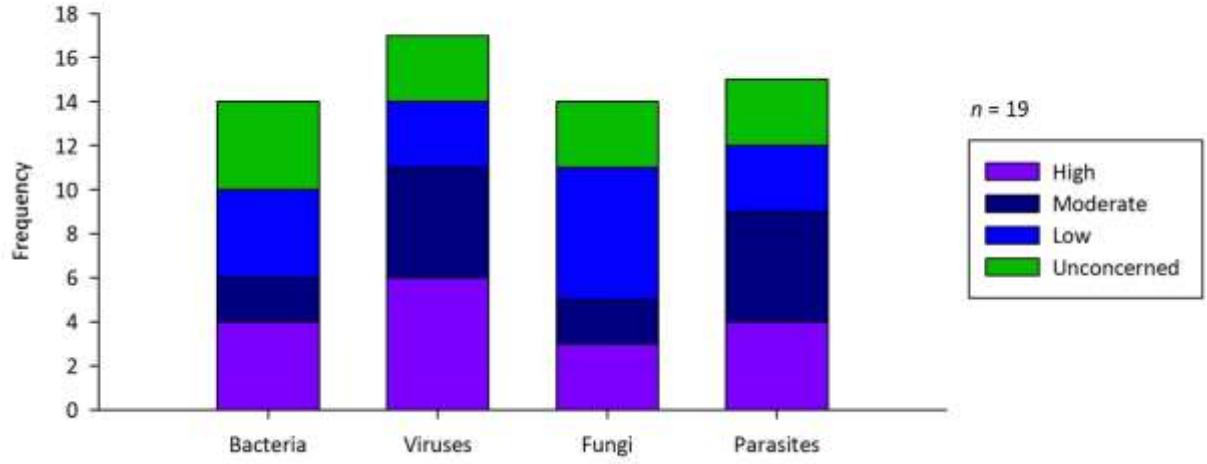

Figure 32: Level of concern about different types of disease agents from mussel farmers in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

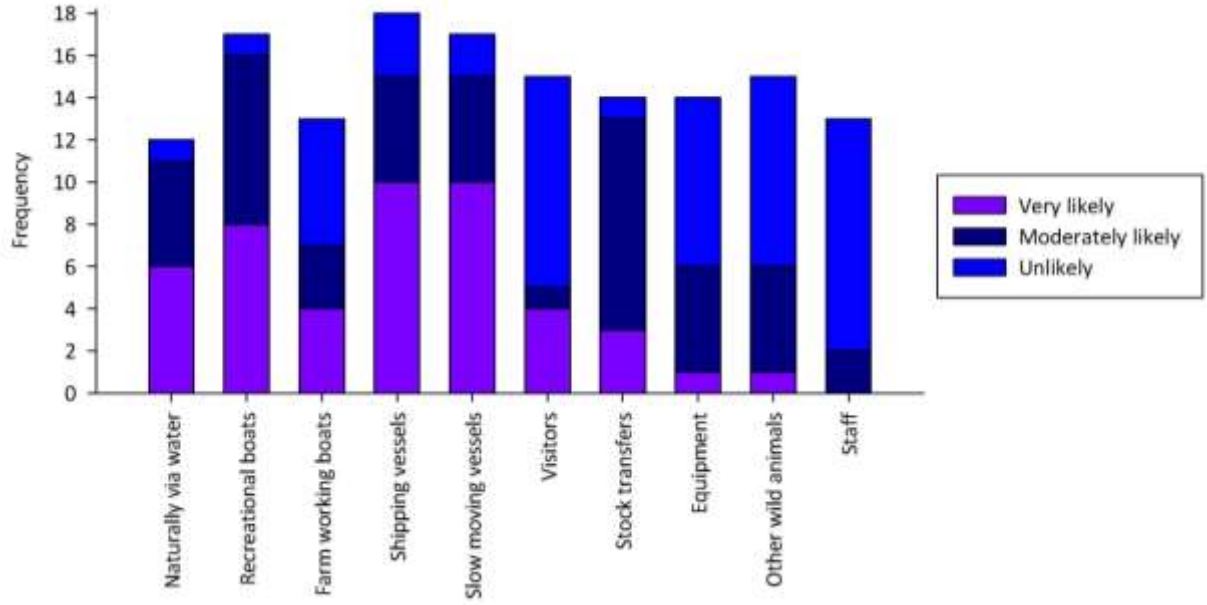

Figure 33: Mussel farmers' opinions in the on-line questionnaire on the likely ways that pests can enter their farm. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

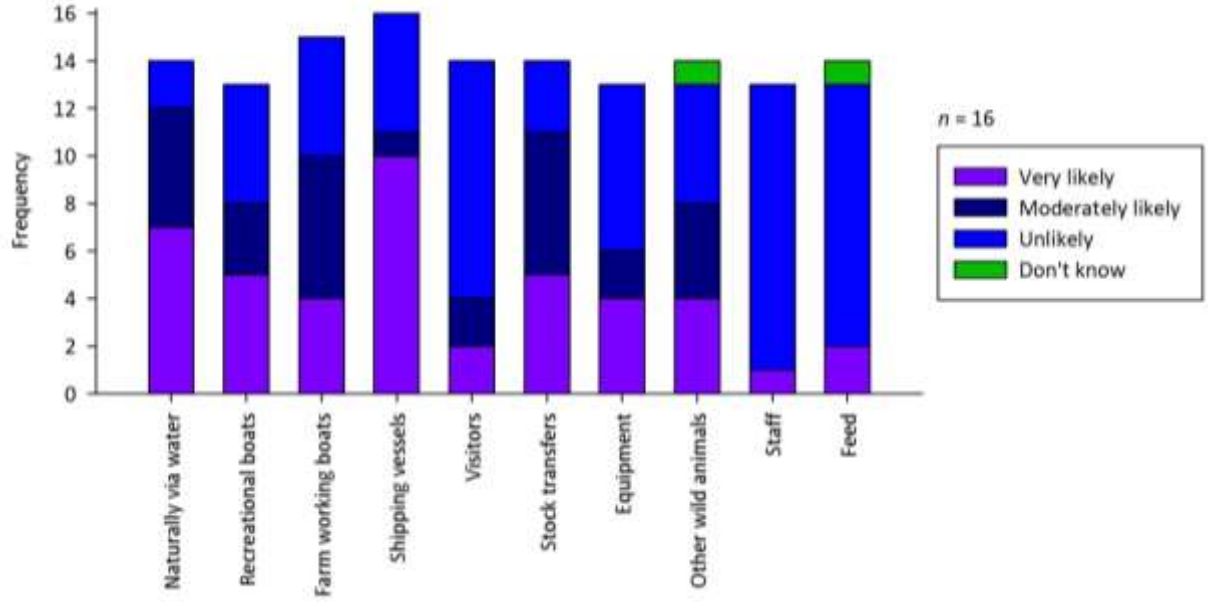

Figure 34: Mussel farmers' opinions in the on-line questionnaire on the likely ways that diseases can enter their farm. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

Figure 35: Recreational fishing boats clustered around a mussel harvester. Many mussel farmers believe that recreational boats are a likely transmission vector of pests and diseases onto their farms. Mussel harvesters request that recreational fishers stay at least 30 m away from their harvesting barges for the safety of their staff, however, there are no legal requirements regarding minimum distances that general public must keep from sea-based aquaculture facilities or vessels (Image: C. Sim-Smith).

4.3.7 Mussel spat harvesters

Most (4/5) questionnaire respondents were moderately or very concerned about preventing or managing pest species on their facility. Despite their general concern, few respondents identified specific pest species that they were concerned about. Two respondents were highly concerned about harmful microalgae and seaweeds (Figure 36). Similarly, 3/4 respondents were moderately or very concerned about preventing or managing diseases on their facility (Figure 37). However, it should be noted that there is a misunderstanding about disease agents among respondents, with all (4/4) respondents most concerned about species of harmful microalgae (which are a pest not a disease). The most likely vectors of pest and disease transmission are thought to be water and shipping vessels (Figure 38 & Figure 39).

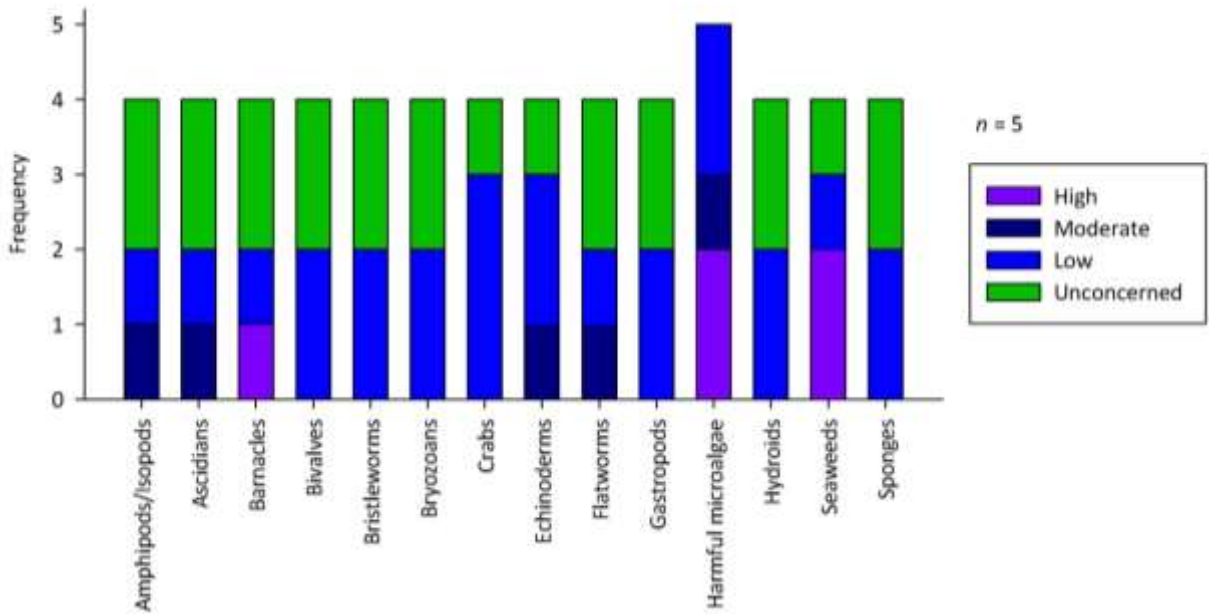

Figure 36: Level of concern about different types of pests from mussel spat harvesters in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

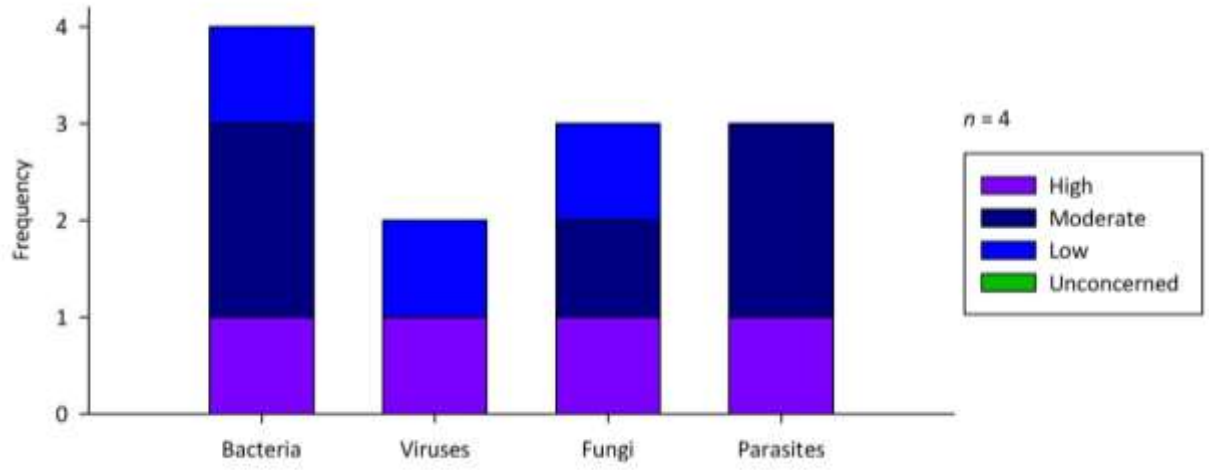

Figure 37: Level of concern from mussel spat harvesters about different types of disease agents in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

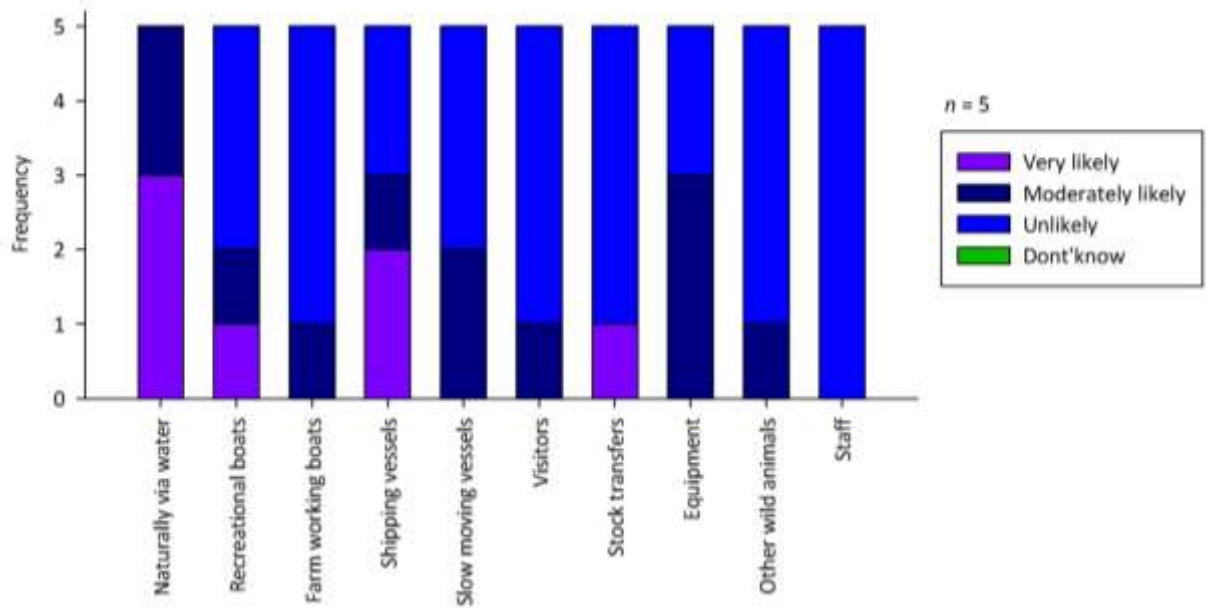

Figure 38: Mussel spat harvesters' opinions in the on-line questionnaire on the likely ways that pests can enter their facility.

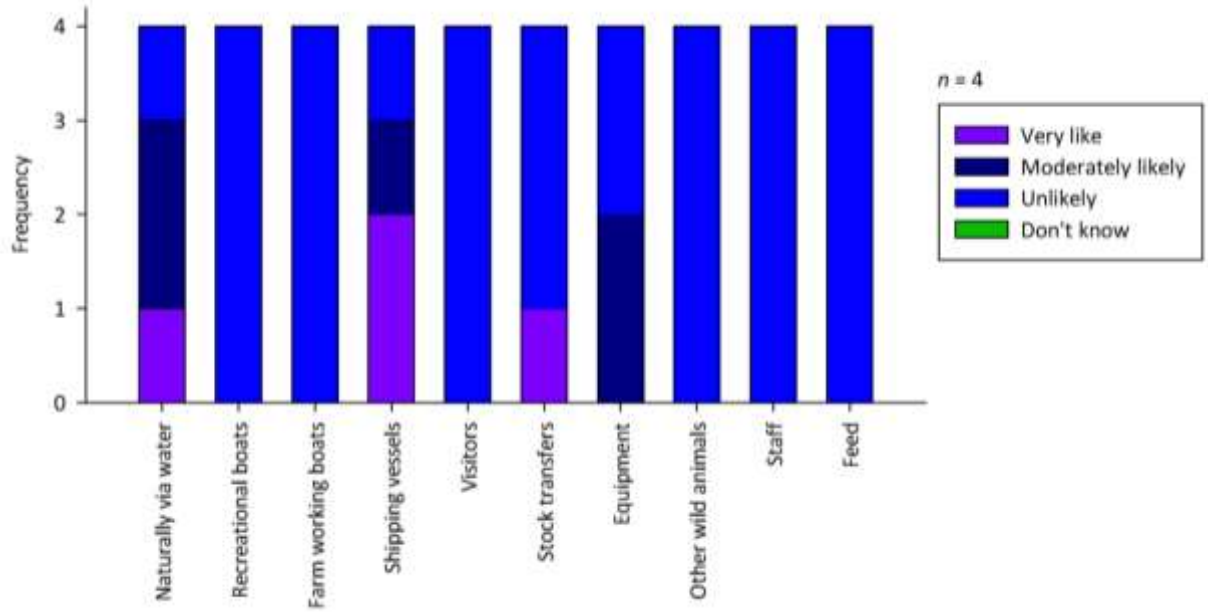

Figure 39: Mussel spat harvesters' opinions in the on-line questionnaire on the likely ways that diseases can enter their facility.

4.3.8 Aquaculture research facilities

All (5/5) respondents are moderately or very concerned about preventing or managing pest species in their facility, particularly harmful microalgae, flatworms, bristleworms, ascidians (Figure 40). One respondent is also specifically concerned about mosquito fish (*Gambusia affinis*). The most likely vectors of pest transmission are thought to be water, wild animals, stock transfers and equipment (Figure 42).

Most (4/5) questionnaire respondents are moderately or very concerned about preventing or managing diseases in their facility (Figure 41), particularly OsHV-1, white spot, columnaris (*Flavobacterium columnare*), *Vibrio* spp., scuticociliate parasites, *Benedenia seriolae* and *Zexapta seriolae*. The most likely vectors of disease transmission are thought to be water, stock transfers and equipment (Figure 43). Birds are also thought to be a potential disease vector because they defecate and bring wild shellfish on-site (two respondents), and fluke transmission is thought to be airborne (one respondent).

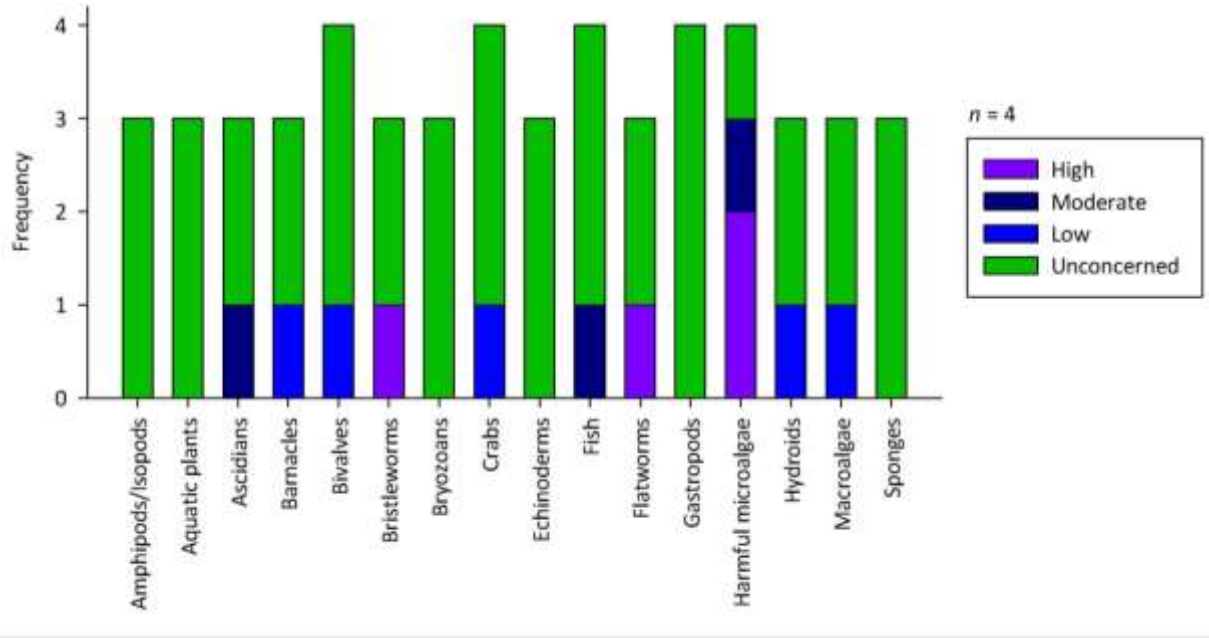

Figure 40: Level of concern about different types of pests from aquaculture researchers in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

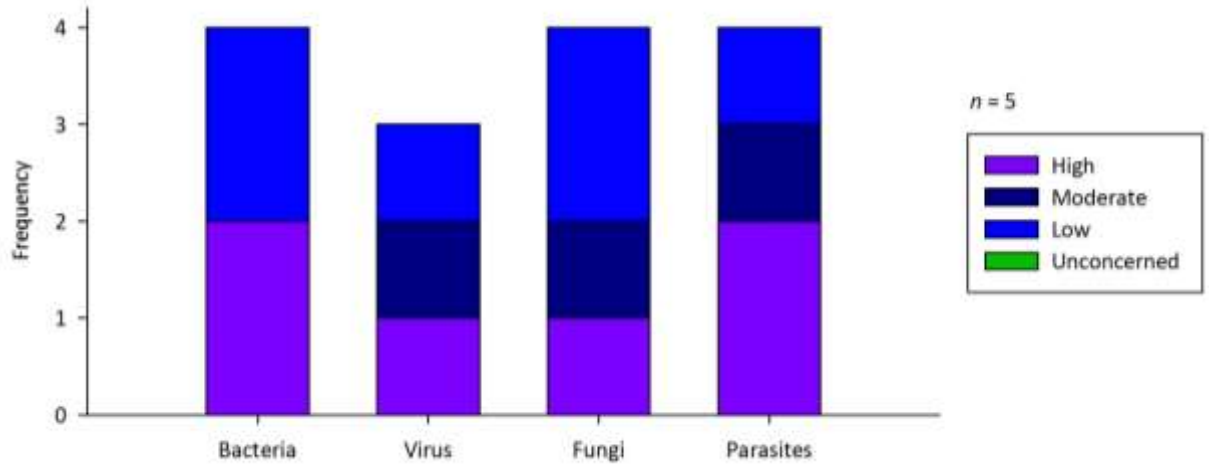

Figure 41: Level of concern about different types of disease agents from aquaculture researchers in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

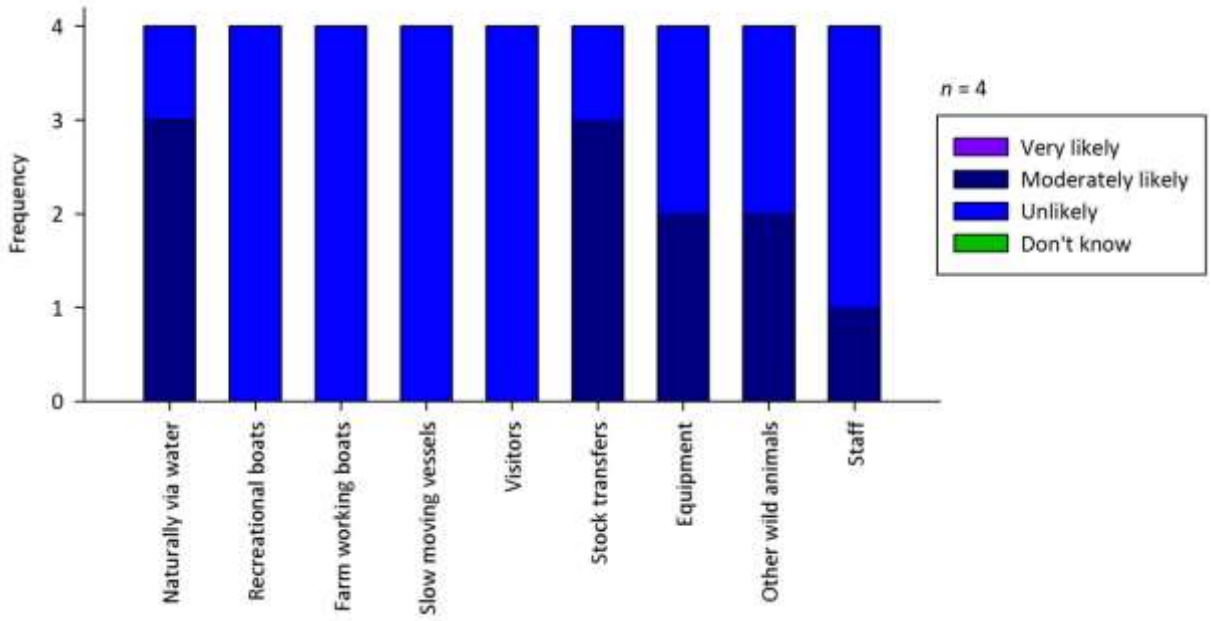

Figure 42: Aquaculture researchers' opinions in the on-line questionnaire on the likely ways that pests can enter their facility. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

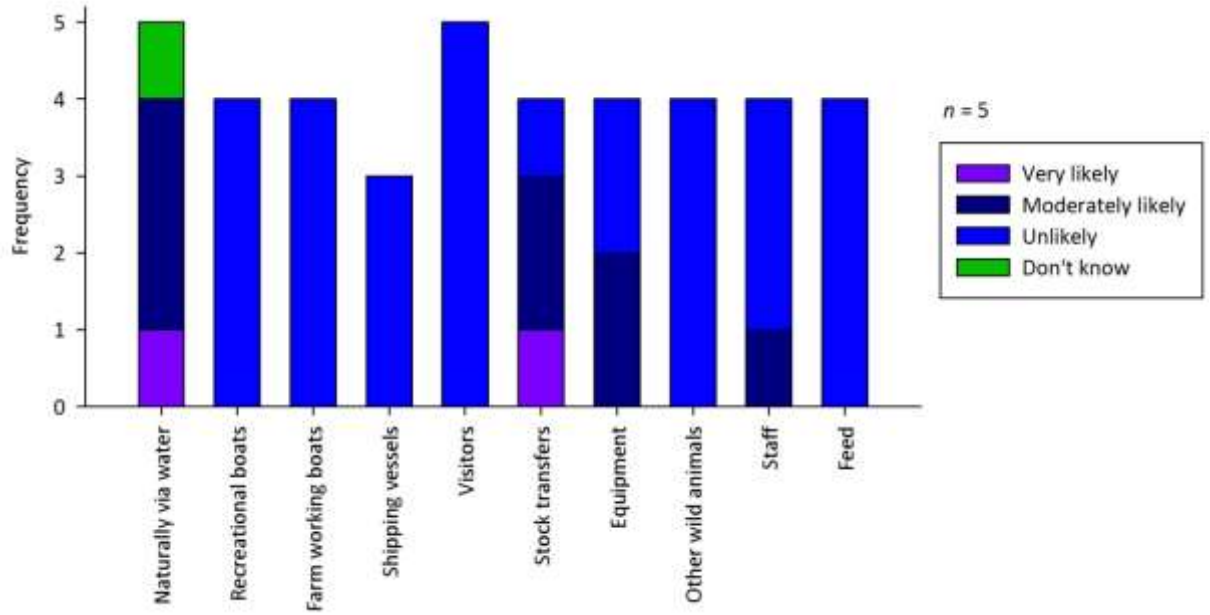

Figure 43: Aquaculture researchers' opinions in the on-line questionnaire on the likely ways that diseases can enter their facility. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

4.4 BIOSECURITY PRACTICES OF THE AQUACULTURE INDUSTRY

4.4.1 Overall industry

The top three main sources of biosecurity information for questionnaire respondents were other farmers, industry associations and the internet. Around 30% of respondents use MPI as a source of biosecurity information, while very few respondents use regional councils or the Department of Conservation (DOC) (Figure 44).

Only half (31/61) of the questionnaire respondents were aware of MPI's 0800 biosecurity number prior to the questionnaire, though 73% (44/60) said that they would now use it to report future biosecurity issues. Respondents that had concerns about using the MPI 0800 number were mostly unaware of the 0800 process (9/19), or were worried that they would be excluded from the decision-making process (6/19). Four respondents said that they didn't have any specific concerns, but they would talk to other farmers and industry first before calling MPI: *"our first response is to discuss with AQNZ and possibly Cawthron. We are unsure what expertise MPI has in bivalve pathology."*

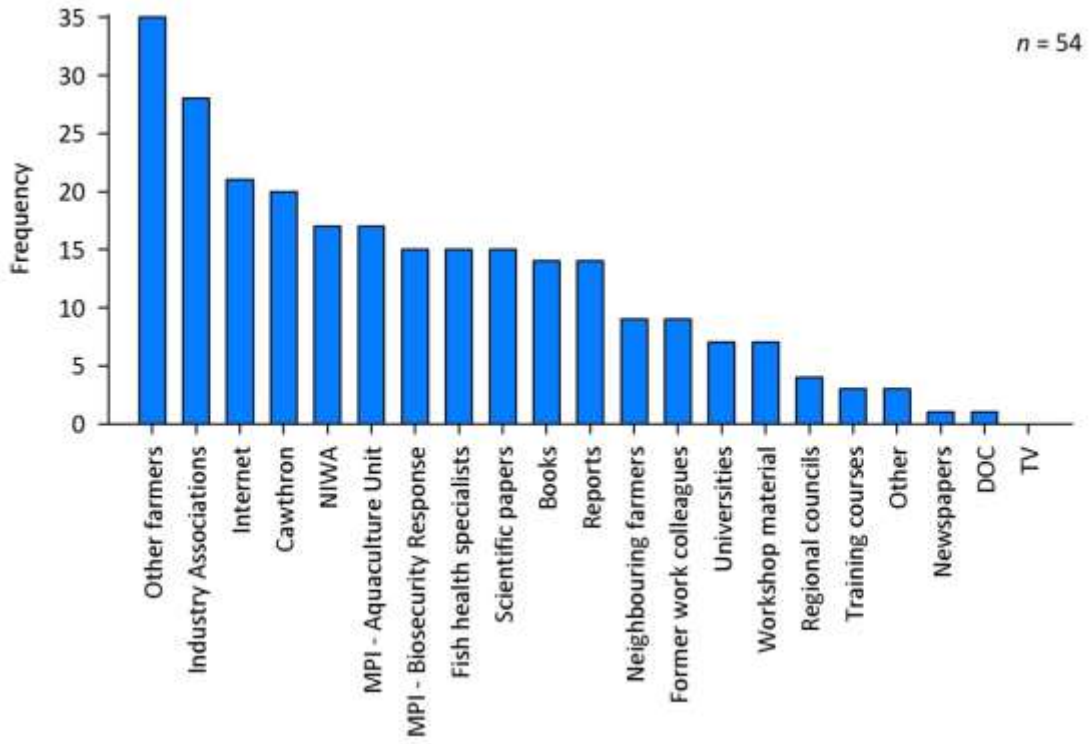

Figure 44: Sources of biosecurity information for the aquaculture industry.

4.4.2 Freshwater salmonids

General monitoring & biosecurity practices

Water temperature, dissolved oxygen concentrations and feeding rate are monitored at least weekly by the majority of questionnaire respondents while pH, ammonia, total nitrogen and feed wastage are generally monitored only occasionally (Figure 45). All questionnaire respondents (13/13) keep records of stock transfers.

The majority of respondents remove mortalities from culture units either daily or immediately when observed (12/13). Mortalities are immediately disposed of in compost pits located on-

or off-site (2/13); or stored in sealed, water-tight containers (4/13), rubbish bags/bins (5/13) or open containers (2/13) prior to disposal.

Feed is typically stored in bags (6/13) or in sealed containers (4/13), and most (9/13) questionnaire respondents use predator nets to exclude birds from culture units.

Approximately half (7/13) of questionnaire respondents thought that it was important that a fish health specialist regularly visited their site, with health specialists usually visiting every 3–12 months (five interviewees). Most (10/13) respondents have a health specialist on-call if required.

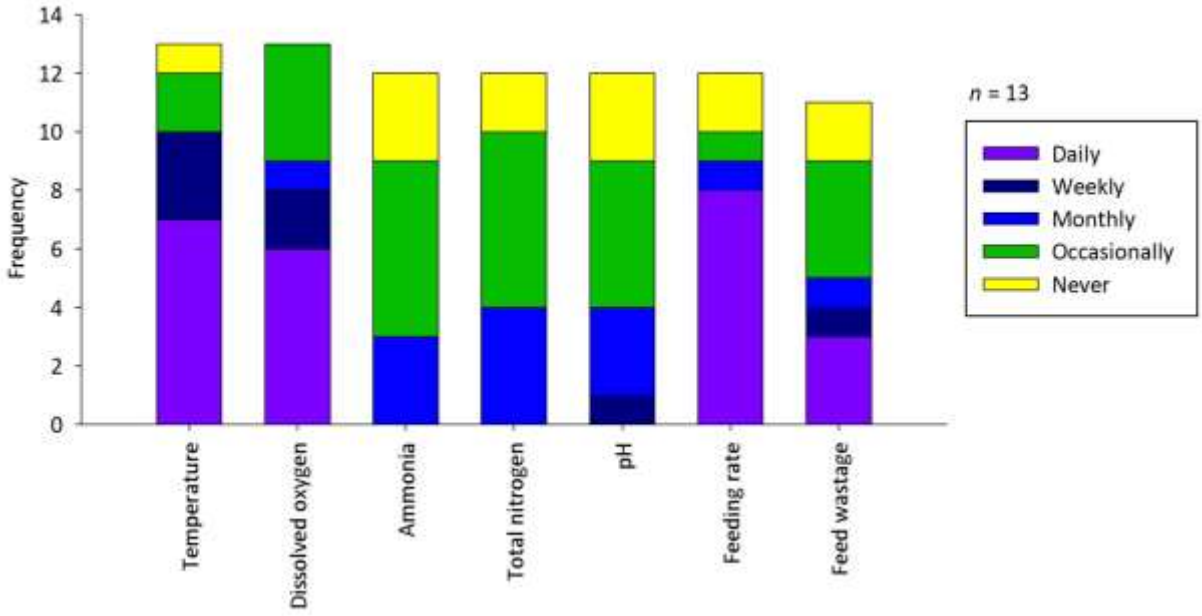

Figure 45: Monitoring frequency for various environmental parameters by freshwater salmonid farmers reported in the on-line questionnaire. Note that the cumulative frequency of some parameters is less than *n* because some respondents didn't provide answers for all parameters.

Current management methods for pests and diseases on freshwater salmonid farms

The main methods used by questionnaire respondents to manage the risk of pest or disease entry, exacerbation or transfer are: staff education; restricting access to the facility; routinely disinfecting equipment; and, preventing the sharing of equipment among farms (Figure 47 & Figure 48). In addition, respondents apply best management practices (BMP) in respect to fish welfare and health to manage the risk of disease entry, exacerbation or transfer. Other suggested methods of pest or disease management are generally regarded as unnecessary, impractical or not possible (Table 5 & Table 6).

Five of the nine freshwater farms interviewed have standard operating procedures (SOP) that requires staff and visitors to use footbaths to disinfect their footwear. None of the fish-out sites used footbaths, but one fish-out site reduces the risk of visitors introducing pests and diseases by not allowing visitors to use their own fishing rods or waders on-site. Seven sites interviewed reduce the risk of pest and disease transmission via equipment by cleaning and disinfecting all equipment prior to transfer among sites, or by not sharing equipment and protective clothing among sites. Two sites interviewed do not permit visitors/contractors to

use their own equipment or protective clothing on-site unless the equipment is first disinfected.

Large equipment such as fish pumps are sometimes shared among sites, which is a potential pest and disease transmission risk. One interviewee stated that their fish pump is not disinfected between each use, but is just left to dry out.

None of the questionnaire respondents (0/13) treat their incoming water and only one respondent treats their effluent water. This respondent is required to treat effluent water from the hatchery for Dydimo. One interviewee is in the process of installing a drum filter and UV treatment for their hatchery water intake.

Figure 46: Examples of biosecurity procedures signage for visitors of two freshwater salmonid farms (Photos: C. Sim-Smith).

Of the eight questionnaire respondents that use live fish transporters, only two treat their transport water (by adding salt to obtain a salinity of 10 ppt). One interviewee only fills his transporter with bore water, which fish are not reared in, to reduce the chance of disease transmission. After transport, the bore water is disposed of on the ground. Three interviewees wash their transporter out between each use, while one farmer indicated that their transporter is cleaned irregularly. One interviewee used to rent out his fish transporter to other farmers but he has now ceased this because of biosecurity concerns. Now fish only leave his farm in the transporter and then it is cleaned and disinfected before going to a new site.

Three sites interviewed use wild broodstock captured each year. Broodstock are visually examined but are not treated or tested for pests or diseases. Two interviewees reduce the risk of introducing disease with wild broodstock to their own farm by keeping broodstock in

isolation, downstream of the hatchery. No broodstock holding water is introduced into the hatchery and only milt and eggs from wild broodstock are brought up to the hatchery (two interviewees).

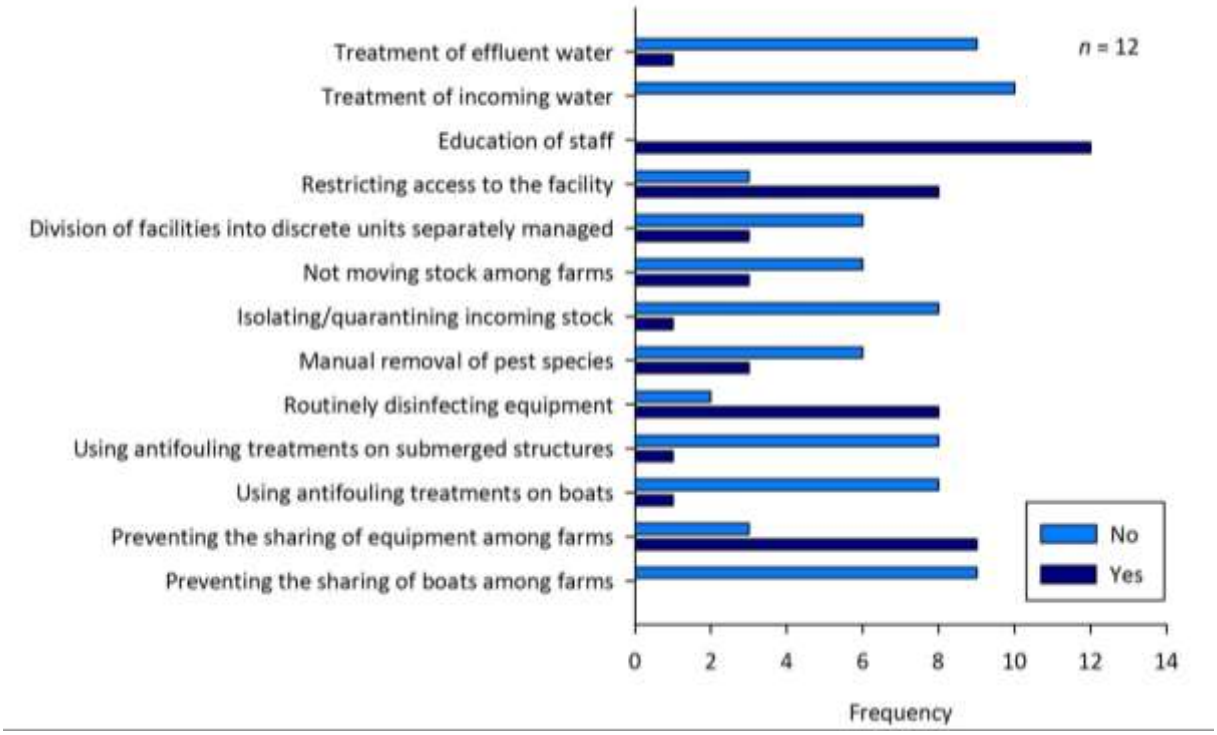

Figure 47: Methods used by freshwater salmonid farmers to manage the risk of pest entry, exacerbation or transfer reported in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

Table 5: Reasons why freshwater salmonid farmers (*n* = 12) don't use the following methods to manage the risk of pest entry, exacerbation or transfer.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Treatment of effluent water	3			2	2	1
Treatment of incoming water	5			2	2	
Education of staff				1		
Restricting access to the facility			1			
Division of facilities into discrete units that are managed separately	2			3	1	
Not moving stock among farms	3				2	
Isolating/quarantining incoming stock	4		1	2	1	
Manual removal of pest species	1			3		1
Routinely disinfecting equipment				2		
Using antifouling treatments on submerged structures				3		
Using antifouling treatments on boats				6		
Preventing the sharing of equipment among farms	1			2		
Preventing the sharing of boats among farms				1	1	

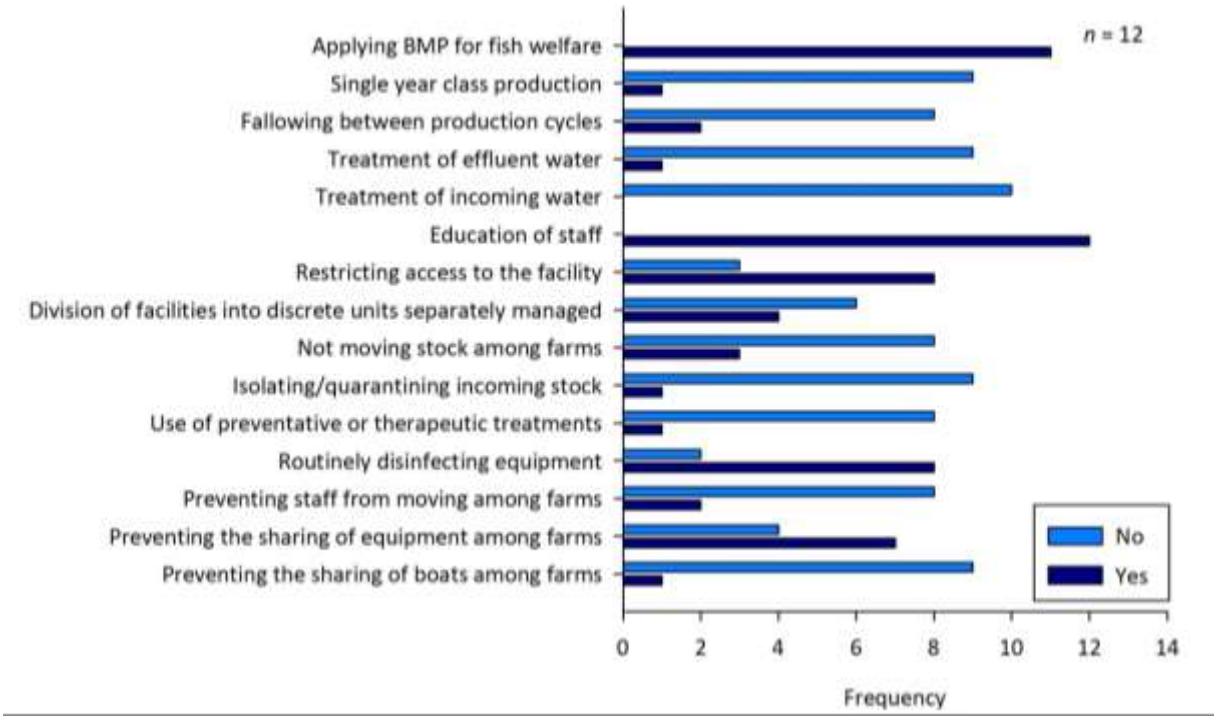

Figure 48: Methods used by freshwater salmonid farmers to manage the risk of disease entry, exacerbation or transfer reported in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

Table 6: Reasons why freshwater salmonid farmers (*n* = 12) don't use the following methods to manage the risk of disease entry, exacerbation or transfer.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Single year class production	5				2	
Fallowing between production cycles	3			4		
Treatment of effluent water	2	1		2	1	
Treatment of intake water	3			3	1	
Restricting access to the facility				1	1	
Division of facility into discrete units with separate management	4				2	1
Not moving stock among farms	3			2	2	
Isolating/quarantining incoming stock	5			1	1	1
Use of preventative or therapeutic chemical treatments on fish	1	1		4		2
Routinely disinfecting equipment				1		
Preventing staff from moving among farms	3			3	1	
Preventing sharing equipment among farms	2			2		
Preventing the sharing of boats among farms				7	2	

The majority of questionnaire respondents (8/13) checked for the presence of pest species on their farms at least monthly, with 6/12 questionnaire respondents removing biofouling from their farms at least quarterly. The other six respondents never remove biofouling species from their sites. Respondents that do remove biofouling species clean farm structures on-site and leave the waste to disperse through the water (5/6), or dispose of biofouling material in a landfill (1/6). Antifouling paint is used as a method of biofouling control by 2/12 respondents.

The only pest species that were reported to trouble freshwater salmonid farmers in the on-site interviews are Dydimo (three interviewees), other microalgae (two interviewees) and birds (four interviewees).

Just over half (7/12) the questionnaire respondents periodically test for diseases, and one respondent also tests for diseases prior to transfer on- and off-site. Four interview respondents reported that they are required to routinely test for diseases as part of their international certifications, e.g., Australia's disease-free export programme and Global Aquaculture Alliance's (GAA) Best Aquaculture Practices Certification.

The only diseases interviewees have personally experienced on their farms are: enteric red mouth (*Yersinia ruckeri*) (one interviewee); white spot (two interviewees); amoebic gill disease (*Neoparamoeba* spp.) (one interviewee); whirling disease (*Myxobolus cerebralis*) (one interviewee); and, fungal infections (two interviewees). Disease events are infrequent (years apart) and interviewees report that disease events were typically the result of poor husbandry and can be eliminated with the improvement of farm management (four interviewees). The majority of questionnaire respondents (11/13) don't routinely use any therapeutants, chemicals or salt to treat diseases in their stock.

Pests and diseases are currently managed as follows:

- white spot:
  - treated with salt (two interviewees). One respondent has used salt to treat white spot in fish over the past two years. Note that white spot is widespread throughout the natural environment and in wild fish populations.
- fungal infections:
  - fish are bathed in a disinfectant (Halamid) annually (one interviewee); and,
  - incubating eggs are preventatively treated with an antifungal chemical (one interviewee).
- Dydimo:
  - regularly cleaning of nets (four interviewees);
  - fish from Dydimo-positive areas cannot be transported to Dydimo-negative areas; and,
  - eggs from a Dydimo-positive area are treated to kill the Dydimo, e.g., with Uncle Jack's Dydimo bath[21] prior to transfer to a Dydimo-negative area (three interviewees). One farm then quarantines the disinfected eggs for a month to ensure that there is no Dydimo.
- whirling disease:
  - raceways have concrete bottoms (not gravel); and,
  - fish are regularly tested for the parasite.

[21] 3% benzalkonium chloride.

Comparison of biosecurity practices among freshwater salmonid farms

There is a large variety of purposes amongst the freshwater salmonid farms surveyed, from hatchery production, food production, fish-out ponds and enhancement of wild fish stocks. There were also some noticeable differences in the biosecurity practices among the different types of farms interviewed. Commercial farms that are part of the food-production chain have a strong focus on preventing diseases from entering their sites. These farms: disinfect their equipment before transfer among sites (6/6 commercial sites); use footbaths on-site (4/6 sites); and are concerned about inter-site biosecurity (five interviewees) and the risks associated with other farmers (in particular, non-commercial farmers) transferring stock around the country (three interviewees). Two freshwater farms have GAA Best Aquaculture Practices certification (GAA, 2011), and three freshwater farms belong to Australia's disease-free export programme[22].

In comparison, farmers that rear fish for enhancing wild populations or for fish-out ponds have a much lower focus on preventing pests and diseases from entering their own facility. These farms are accessible to the public (2/3 sites); do not use footbaths on-site (3/3 sites); bring wild broodstock on-site without disease testing (2/3 sites), and are generally less concerned about biosecurity (four interviewees). However, non-commercial farms do have a strong focus on preventing pest and disease transmission around the country, and 2/2[23] farms have strict washing and disinfecting protocols for their equipment and protective gear that is taken off-site.

4.4.3 Saltwater salmonids

General monitoring & biosecurity practices

Water temperature, dissolved oxygen concentrations, feeding rate and feed wastage are monitored at least weekly by two questionnaire respondents, while pH, ammonia and total nitrogen are never monitored (Figure 49). All respondents (3/3) keep records of stock transfers.

All questionnaire respondents (2/2) remove mortalities from their farm daily or immediately when observed. Mortalities are stored in sealed, water-tight containers (1/2) or open containers (1/2) prior to disposal. Feed is stored in bags (2/2) and one respondent uses predator nets to exclude seals, sharks and birds from the culture units.

All questionnaire respondents (2/2) thought that it was important that a fish health specialist regularly visited their site. However, only one respondent was regularly visited by a health specialist (every month) and this farmer also had a health specialist on-call.

Current management methods for pests and diseases on saltwater salmonid farms

The main methods used by questionnaire respondents to manage the risk of pest entry, exacerbation or transfer are: routinely disinfecting equipment; staff education; restricting access to the facility; manual removal of pest species; and applying BMP for fish welfare (Figure 50). Other suggested methods of pest management are generally considered impractical (Table 7).

All (2/2) questionnaire respondents routinely check and remove biofouling daily. Fouling material is either cleaned on-site and left to disperse through the water (2/2) or disposed of in

[22] One freshwater farm has both GAA certification and Australia's disease-free certification.
[23] One fish-out farm interviewed did not transfer fish or equipment off-site.

a landfill (1/2). None (0/2) of the respondents use antifouling paint on their farming structures. Common pest species on saltwater salmonid farms include the Whangamata sea squirt, other ascidians, Japanese kelp and jellyfish (three interviewees).

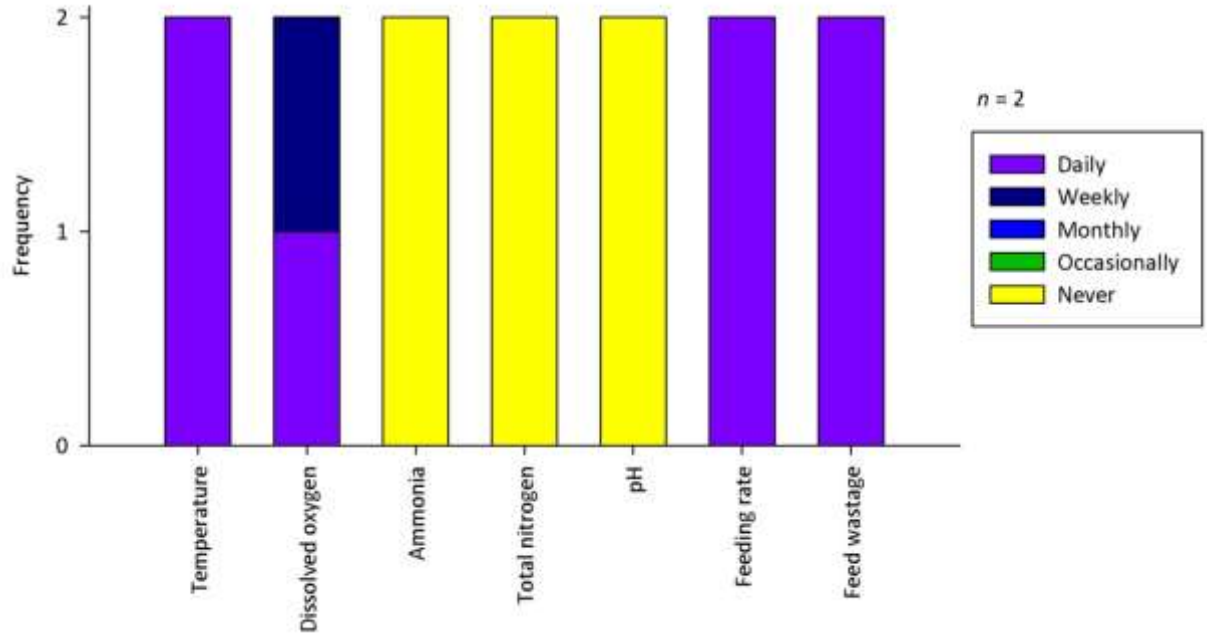

Figure 49: Monitoring frequency for various environmental parameters by saltwater salmonid farmers reported in the on-line questionnaire.

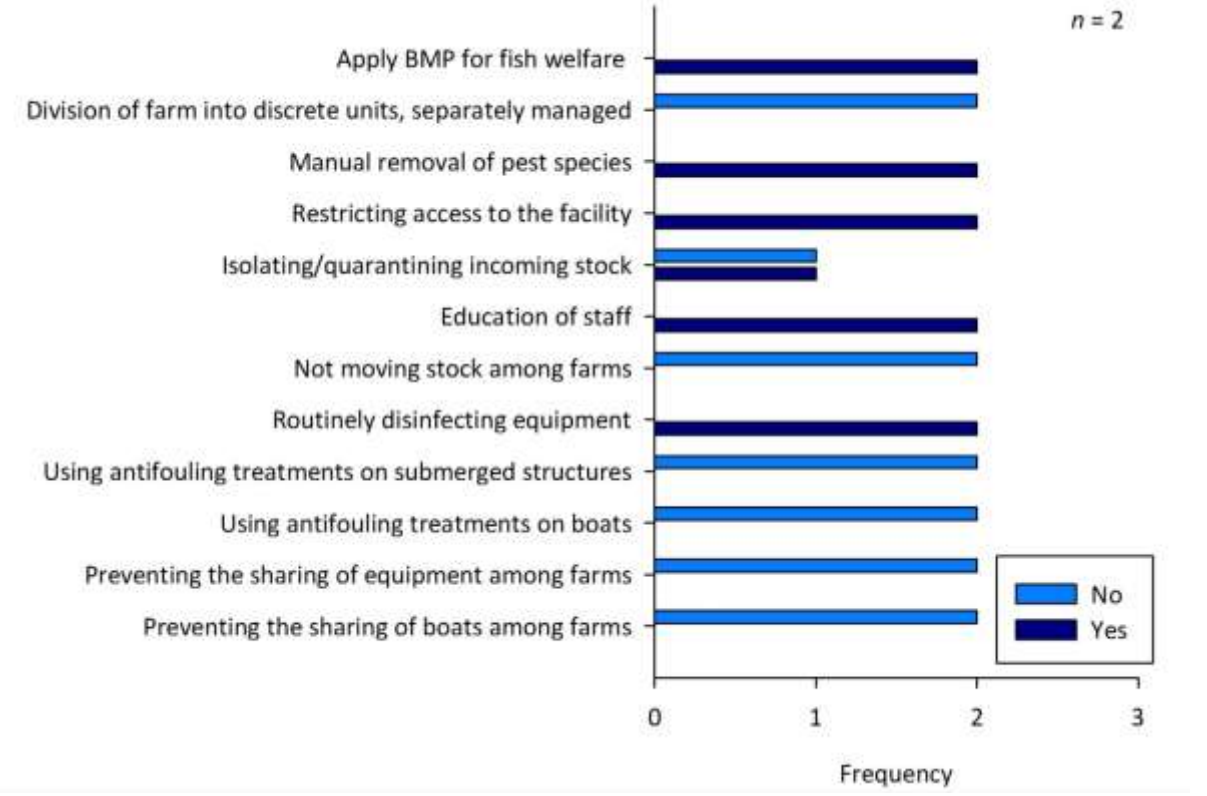

Figure 50: Methods used by saltwater salmonid farmers to manage the risk of pest entry, exacerbation or transfer reported in the on-line questionnaire.

Table 7: Reasons why saltwater salmonid farmers don't use the following methods to manage the risk of pest entry, exacerbation or transfer. The number of responses may be greater than the number of respondents (*n* = 2) because multiple answers were allowed.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Preventing the sharing of boats among farms	2	1				
Preventing the sharing of equipment among farms	1					
Using antifouling treatments on boats		1	1	1		
Using antifouling treatments on submerged structures		1	1	1		
Not moving stock among farms	1				1	
Isolating/quarantining incoming stock	1					
Division of facilities into discrete units separately managed	2					

The main methods used by questionnaire respondents to manage the risk of disease entry, exacerbation or transfer are restricting access to the facility and applying BMP for fish welfare (Figure 51). Other suggested methods of disease management are generally regarded as impractical or not possible (Table 8).

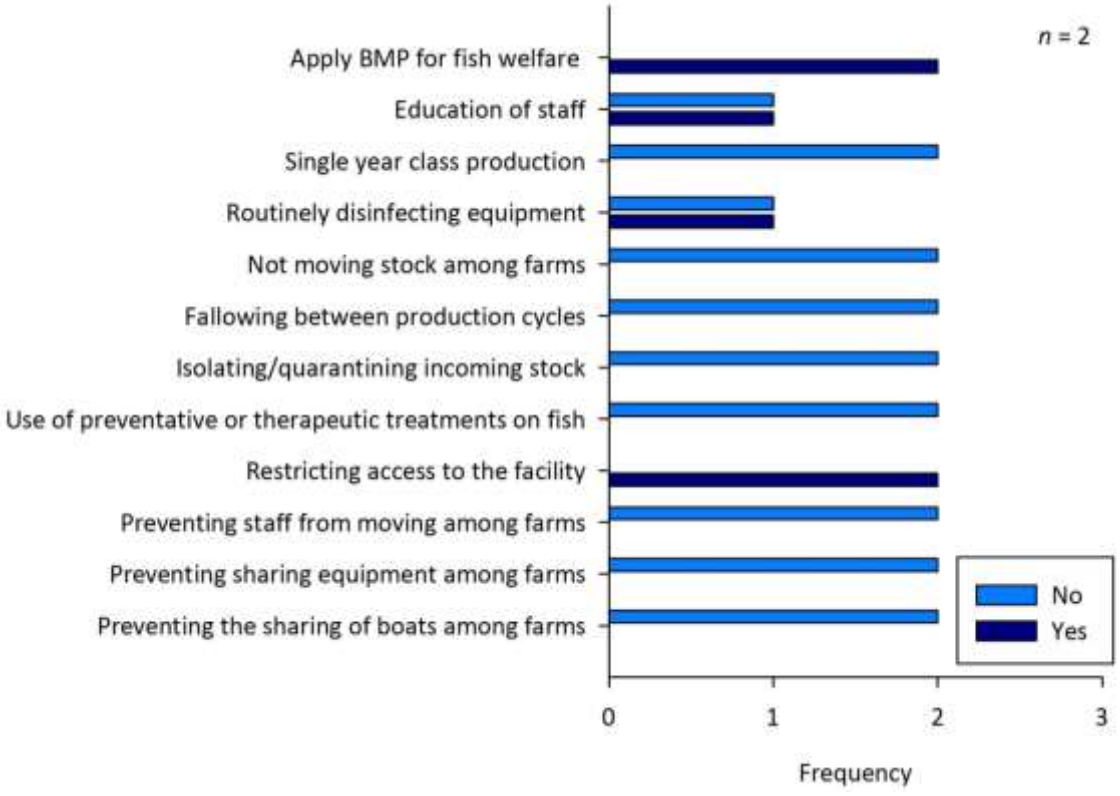

Figure 51: Methods used by saltwater salmonid farmers to manage the risk of disease entry, exacerbation or transfer reported in the on-line questionnaire.

Table 8: Reasons why saltwater salmonid farmers don't use the following methods to manage the risk of disease entry, exacerbation or transfer. The number of responses may be greater than the number of respondents (*n* = 2) because multiple answers were allowed.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Preventing the sharing of boats among farms	2	1				
Preventing sharing equipment among farms	1	1				
Preventing staff from moving among farms	2					
Use of preventative therapeutic/chemical treatments on fish					1	
Isolating/quarantining incoming stock	1			1		
Fallowing between production cycles	2				2	
Not moving stock among farms					1	
Routinely disinfecting equipment			1			
Single year class production	2				1	
Education of staff						1

One farmer interviewed reduces the risk of disease transmission via equipment by cleaning and disinfecting all equipment prior to transfer among sites, or by not sharing equipment and protective clothing among sites. Another farmer interviewed only disinfects equipment and prohibits the sharing of equipment when there is a reason to, e.g., a disease outbreak or unexplained mortality event. One farmer has two farms in close proximity to one another that are managed as a single, large site.

All (2/2) questionnaire respondents routinely test for diseases, with testing occurring periodically, prior to transfer on site, or when fish are sick/dying. No primary disease pathogens have been identified from fish cultured in the sea (two interviewees). Two farms interviewed have signed up to international BMP certification programmes (e.g., GAA's Best Aquaculture Practice, and the disease-free programme for export to Australia), which require compliance with certain biosecurity protocols, e.g., routine testing for pathogens every six months. Another interviewee has developed an in-house exotic disease response protocol based on the old Ministry of Agriculture and Fisheries (MAF) programme 'Guidelines for exotic disease control in the aquaculture industry'. None (0/2) of the questionnaire respondents routinely use therapeutants on their fish.

Comparison of biosecurity practices among saltwater salmonid farms

Biosecurity practices among the three saltwater farms interviewed appear to be quite similar. All farms regularly test their fish for diseases; have SOP or international certification requirements regarding biosecurity; and are generally concerned about on-site biosecurity (four interviewees). One farm has GAA's Best Aquaculture Practice certification and another farm belongs to Australia's disease-free export programme. Protocols regarding equipment disinfection differ among the three farms: one farm requires disinfection of all shared equipment; one farm only requires disinfection when there has been a mortality event; and one farm is managed as a single site[24] so there is no transfer of equipment among sites.

[24] This farm has resource consents for two farming sites that are in close proximity to one another. The two sites are managed as one large site.

4.4.4 Paua

General monitoring & biosecurity practices

Water temperature, dissolved oxygen concentrations, ammonia and pH are monitored at least weekly by all (3/3) questionnaire respondents[25], and total nitrogen concentrations are monitored at weekly to monthly intervals (Figure 52). All respondents (3/3) keep records of stock transfers.

All (2/2) questionnaire respondents remove mortalities from the farm daily or immediately when observed. Mortalities are frozen or stored in lidded rubbish bins before disposal in a landfill or in a mortality pit on-site.

All respondents (3/3) transport paua around the country, with paua being transported without water.

All respondents (2/2) thought that it was important that a shellfish health specialist regularly visited their farm, with a health specialist visiting every 6 months.

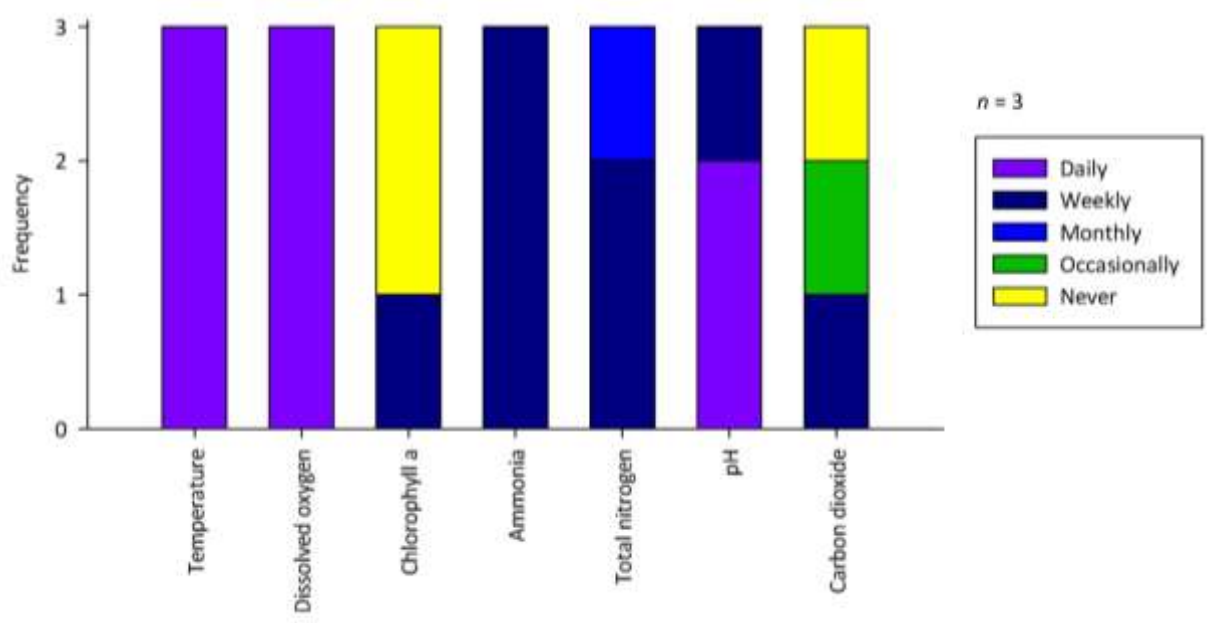

Figure 52: Monitoring frequency for various environmental parameters by paua farmers reported in the on-line questionnaire.

Current management methods for pests and diseases on paua farms

The main methods used by questionnaire respondents to manage the risk of pest entry, exacerbation or transfer are: routinely disinfecting equipment; staff education; isolating/quarantining incoming stock; manual removal of pest species; and treatment of incoming and effluent water (Figure 53). Incoming water is treated with particulate filtration, a drum filter, a biological filter and then ultraviolet (UV) light (two interviewees). Effluent water is currently treated with sedimentation (2/2). Other suggested methods of pest management are generally regarded as unnecessary (Table 9).

[25] Two of the paua questionnaire respondents were managers of the same site.

All (2/2) questionnaire respondents check for, and remove biofouling species daily. Biofouling material is either cleaned on-site and left to disperse through the water, or disposed of in a landfill.

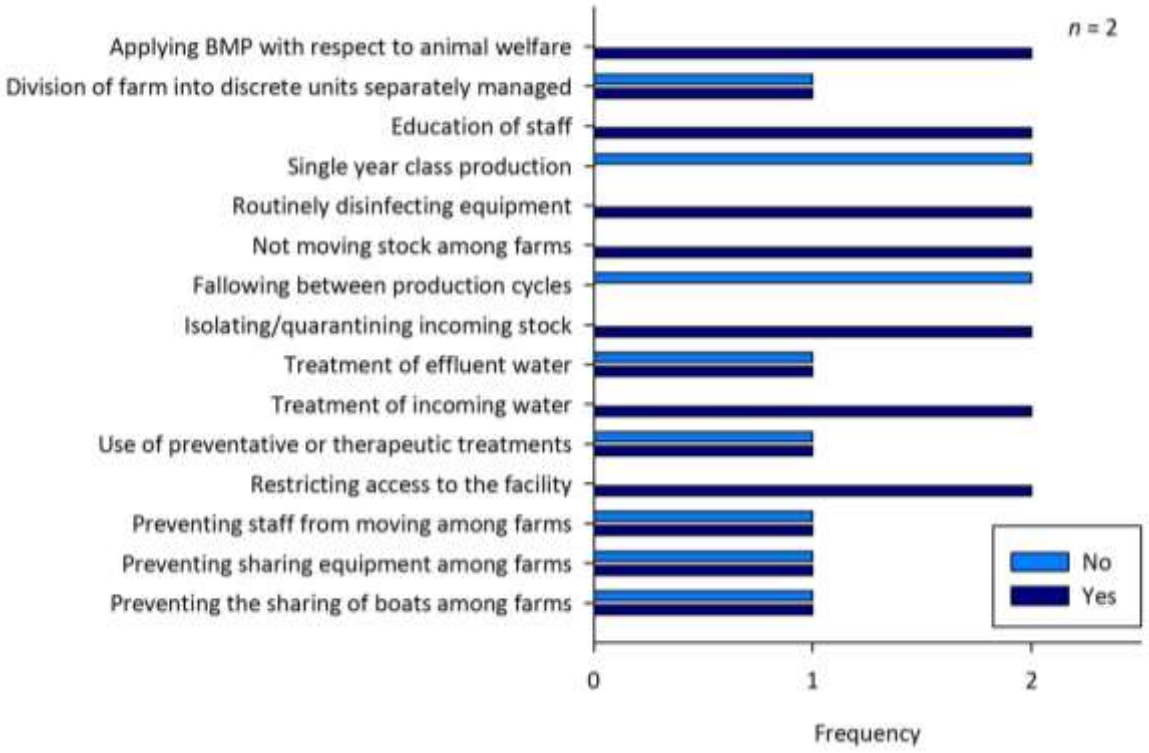

Figure 53: Methods used by paua farmers to manage the risk of pest entry, exacerbation or transfer reported in the on-line questionnaire.

Table 9: Reasons why paua farmers (*n* = 2) don't use the following methods to manage the risk of pest entry, exacerbation or transfer.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Preventing the sharing of boats among farms				1		
Preventing the sharing of equipment among farms				1		
Using antifouling treatments on boats				1		
Using antifouling treatments on submerged structures				2		
Division of facilities into discrete units separately managed					1	

The main methods used by questionnaire respondents to manage the risk of disease entry, exacerbation or transfer are: restricting access to the facility, isolating/quarantining incoming stock; not moving stock among farms; routinely disinfecting equipment; staff education; treatment of incoming water; and applying BMP for animal welfare (Figure 54). Other suggested methods of disease management are considered unnecessary, impractical or not possible (Table 10).

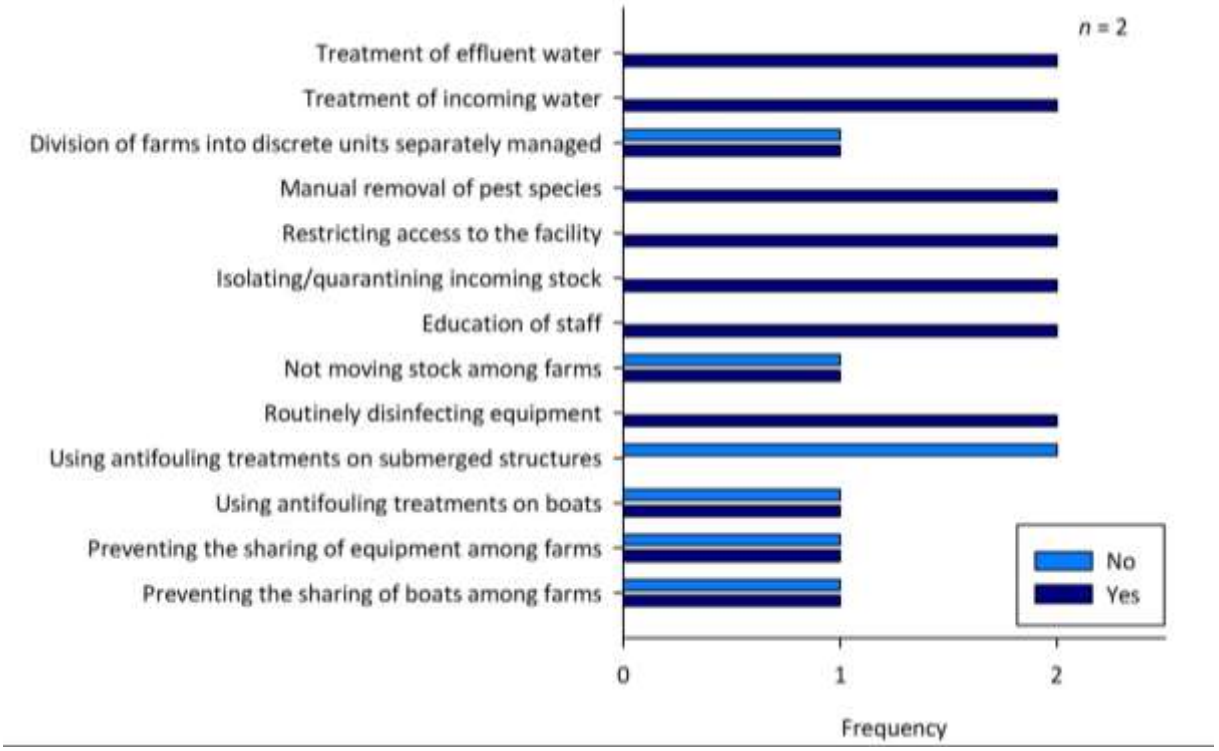

Figure 54: Methods used by paua farmers to manage the risk of disease entry, exacerbation or transfer reported in the on-line questionnaire.

Table 10: Reasons why paua farmers (*n* = 2) don't use the following methods to manage the risk of disease entry, exacerbation or transfer.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Preventing the sharing of boats among farms				1		
Preventing sharing equipment among farms				1		
Preventing staff from moving among farms				1		
Fallowing between production cycles	1					
Single year class production	1				1	
Division of farm into discrete units separately managed					1	

Note, that there were differences in the risk management answers between the two respondents even though they came from the same site (Figure 53 & Figure 54). Most of these differences can be attributed to misinterpretation of the question; one respondent answered 'yes' for questions that were only applicable to multi-site operations even though they were a single-site operation. One respondent replied that the farm was divided into separately managed units whereas the other respondent replied that this was 'not possible'. Subsequent discussion with respondents in the on-site interviews clarified that staff are allocated to only work in certain areas and not across the whole site. A further difference in the responses concerns the treatment in effluent water. While both respondents replied that effluent water was treated in the pest risk management question (Figure 53), one respondent replied it was not treated in the disease risk management question (Figure 54). Subsequent clarification

during the on-site interviews revealed that effluent water is currently only treated by sedimentation, but the farm is in the process of installing a particulate filter and UV treatment to treat their effluent water.

None (0/2) of the questionnaire respondents routinely test for diseases. Therapeutants are sometimes used to treat disease outbreaks (1/2). One site interviewed has recently experienced a disease outbreak. There is no known effective treatment for this disease so affected animals are just culled (one interviewee). As a consequence of the disease outbreak, the company has ceased transporting paua around the country and biosecurity measures on-site have been greatly improved to now include:

- treatment of all[26] incoming water;
- separate on-site and off-site footwear;
- footbaths and hand sanitisers around the site;
- regular cleaning and disinfection of equipment;
- storage of food in rodent and bird-proof containers;
- regular staff meetings where biosecurity is discussed;
- restriction of staff to certain zones on-site; and,
- their own company biosecurity BMP protocol, which has been reviewed by MPI.

The interviewee stated that their biosecurity was "pretty basic" before the outbreak.

4.4.5 Oysters

General monitoring & biosecurity practices

Few environmental water parameters are monitored by questionnaire respondents, apart from water temperature, which is monitored at least weekly by 7/21 respondents (Figure 55). Three respondents also monitor salinity, which is used to determine harvest closures. The majority (20/23) of questionnaire respondents keep records of stock transfers.

Most respondents never remove mortalities from their farm (10/20) or only remove mortalities when working with stock or during harvest (6/20). Only 2/20 respondents remove mortalities from their farms at least weekly or immediately when observed. As a consequence, very few farmers collect dead oysters where the flesh is still present. Mortalities are disposed of on land (9/10) or in the sea within the farm resource consent boundaries (1/10).

The majority (14/19) of questionnaire respondents don't think it is important that a shellfish health specialist visits their farm. Only 2/20 respondents are routinely visited by a health specialist every 6–12 months, and only three respondents have a health specialist on-call.

[26] Prior to the disease outbreak water from one pump on the site was untreated.

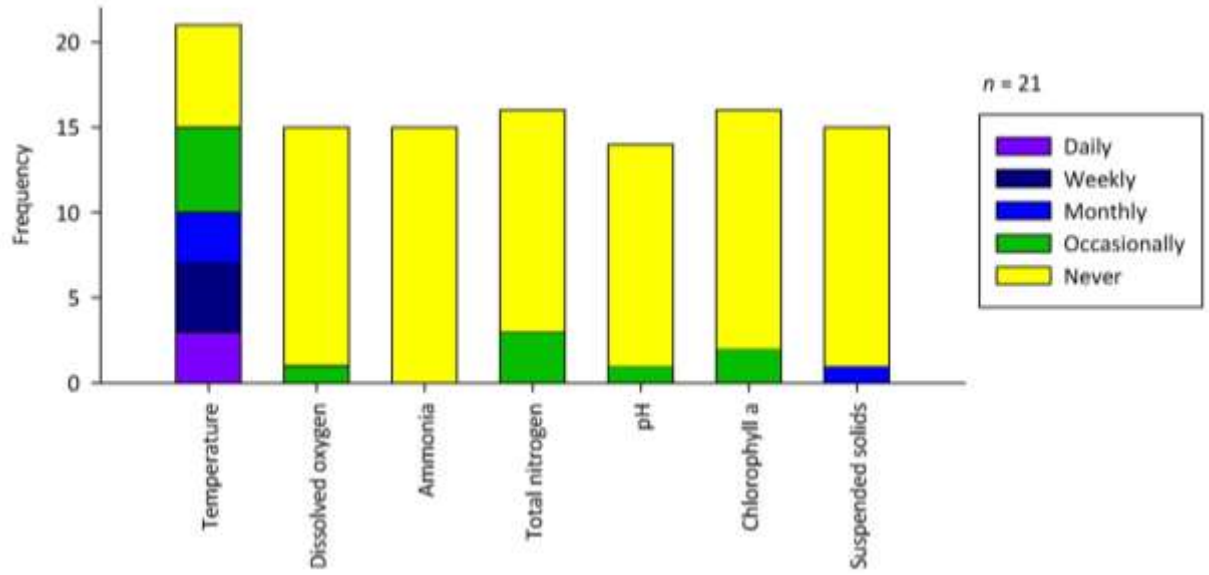

Figure 55: Monitoring frequency for various environmental parameters by oyster farmers reported in the on-line questionnaire. Note that the cumulative frequency of some parameters is less than *n* because some respondents did not provide answers for all parameters.

Current management methods for pests and diseases on oyster farms

The main methods used by questionnaire respondents to manage the risk of pest entry, exacerbation or transfer are: testing for harmful microalgae blooms; staff education; manual removal of pest species; and, using antifouling paint on boats (Figure 56). Other suggested methods of pest management are generally regarded as impractical or unnecessary (Table 11).

Most (14/21) questionnaire respondents routinely check for the presence of pest species on their farms, with 11/21 respondents monitoring for pest species at least monthly. Biofouling is removed from farms at least quarterly by 10/21 respondents. Three respondents never remove biofouling material from their farms. Biofouling material is cleaned on-site and left to disperse through the water (8/17), disposed of in a landfill (9/17) or disposed of on private land (2/17).

The most common pest species on oyster farms reported by interviewees are flatworm, Asian date mussel, black flea mussel, droplet tunicate (*Eudistoma elongatum*) and other ascidians. Similar pest species occurred in Auckland and Northland, but a different suite of pest species occurred in Southland (Figure 57 & Figure 58).

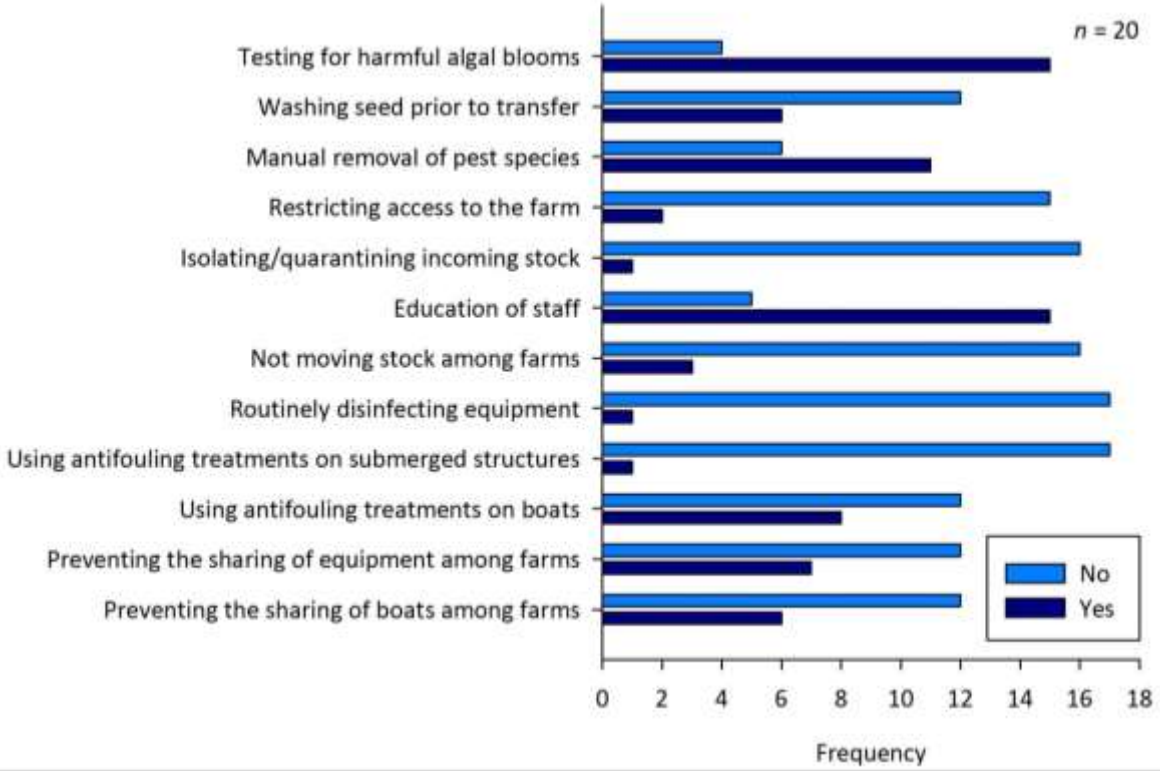

Figure 56: Methods used by oyster farmers to manage the risk of pest entry, exacerbation or transfer reported in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

Table 11: Reasons why oyster farmers (*n* = 20) don't use the following methods to manage the risk of pest entry, exacerbation or transfer.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Preventing the sharing of boats among farms	8	1	1	4		1
Preventing the sharing of equipment among farms	5		1	2		1
Using antifouling treatments on boats	2		1	4		1
Using antifouling treatments on submerged structures	6	2	1	2	1	1
Routinely disinfecting equipment	7		2	4		3
Not moving stock among farms	1		2	2		1
Education of staff	1				2	2
Isolating/quarantining incoming stock	5		1	4	2	1
Restricting access to the facility	6	1	1	2	4	1
Manual removal of pest species	3	1	1			1
Washing seed prior to transfer	3	1		4		1
Testing for algal blooms		1				2

Pests are currently managed as follows:

- Flatworm:
  - mud and dead oysters are regularly cleaned off the farm (three interviewees); and,
  - baskets or bags are regularly rotated or rumbled (three interviewees). Flatworm don't like exposed conditions that increase oyster movement.
- Asian date mussel:
  - bags are regularly changed. Mussels are scraped off bags and the bags are left to dry in the sun (two interviewees).
- ascidians, sponges, seaweeds:
  - subtidal baskets are raised to intertidal levels every three months so that they are exposed for 3–4 hours each tide. This kills off most of the biofouling organisms that require subtidal conditions (one interviewee); and,
  - bags are regularly changed and left to dry out (one interviewee).
- black flea mussel:
  - lowering the farm to reduce settlement (one interviewee).

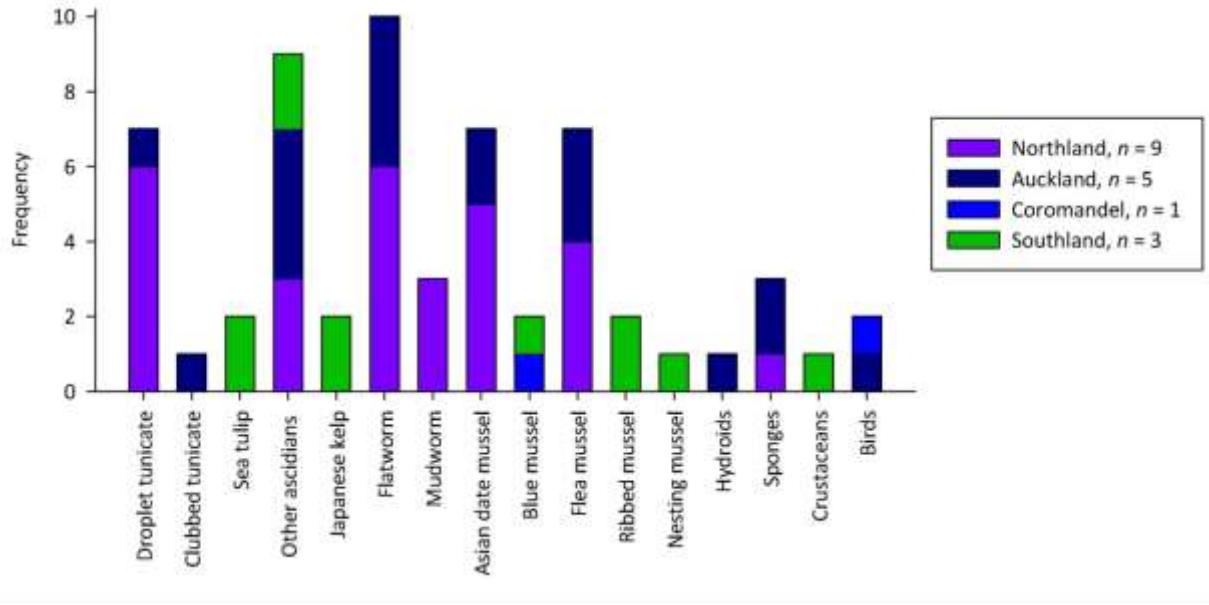

Figure 57: Pest species on oyster farms reported in the on-site interviews.

Oyster farmers use few methods to manage the risk of disease entry, exacerbation or transfer. The main methods used by questionnaire respondents are staff education and applying BMP for shellfish welfare (Figure 59). Other suggested methods of disease management are generally regarded as impractical, ineffective, unnecessary, impossible or haven't been considered (Table 12).

Under half of questionnaire respondents (8/20) routinely test for diseases, with disease testing occurring periodically (5/20), prior to transfer off-site (2/20) or when animals are showing disease symptoms (1/20). The majority (19/20) of respondents do not routinely use therapeutants on their animals. Only one respondent routinely uses therapeutants as a preventative treatment.

Figure 58: Farmed flat oysters fouled with various ascidians, mussels and seaweeds (Image: C. Sim-Smith).

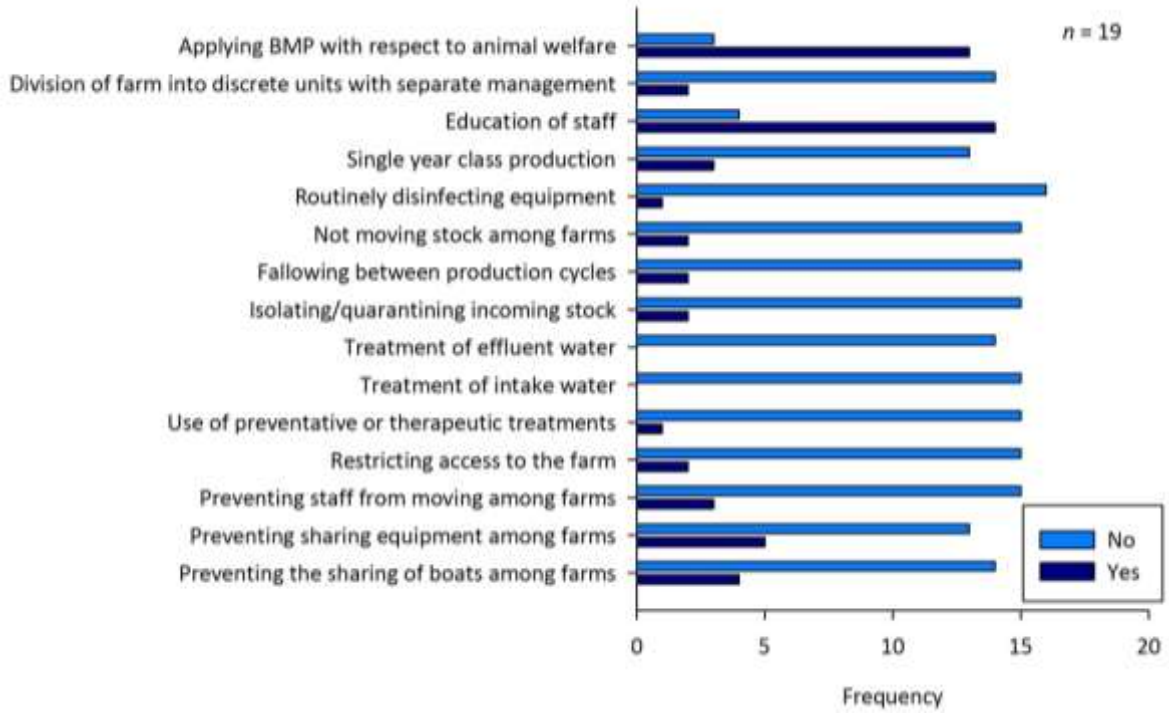

Figure 59: Methods used by oyster farmers to manage the risk of disease entry, exacerbation or transfer reported in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

Table 12: Reasons why oyster farmers (*n* = 19) don't use the following methods to manage the risk of disease entry, exacerbation or transfer.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Preventing the sharing of boats among farms	1	6	2	3	1	1
Preventing sharing equipment among farms		5	2	3		1
Preventing staff from moving among farms		7	2	3		1
Restricting access to the facility		5	2	1	4	1
Use of preventative or therapeutic chemical treatments on fish		3			2	3
Isolating/quarantining incoming stock		3	1	3	4	1
Fallowing between production cycles	1	3	4			3
Not moving stock among farms		6	2	1	1	1
Routinely disinfecting equipment		3	3	1		4
Single year class production	2	2	1		2	1
Education of staff		1			1	1
Treatment of incoming water		3		3	3	1
Treatment of effluent water		2	1	1	3	1
Division of farm into discrete units separately managed		5	1		2	1
Applying best management practice with respect to animal welfare and animal husbandry						1

Nearly all Pacific oyster farmers interviewed (12 interviewees) lost more than 70% of their stock to OsHV-1 between 2010 and 2012. Farmers are still losing a large proportion (40–60%) of both hatchery-supplied and wild spat to OsHV-1. Farmers manage the impacts of the virus by:

- catching more wild spat from the Mahurangi Harbour, Waikare Inlet and Orongo Bay. Interviewees believe spat from these harbours are more resistant to the virus;
- catching spat later in the season when water temperatures are cooler, because high water temperatures (> 17 °C) increase the mortality rate of spat;
- catching more spat than they need to account for the high mortality rate of spat;
- reducing spat handling in summer to minimise oyster stress; and,
- stocking hatchery spat that has been bred to be more virus-resistant. However:
  - two interviewees stated that they cannot afford to buy hatchery spat;
  - single seed spat cannot be farmed on sticks. One interviewee stated that the capital investment required made changing from sticks to baskets uneconomic, and two interviewees stated that the higher labour costs associated with basket culture made it uneconomic; and,
  - three interviewees don't agree with the family breeding programme but prefer to see genetic diversity maintained.

A few interviewees recall other large mortality events occurring in the past[27], though none knew of any primary pathogen being identified as the cause of death.

[27] One interviewee in Waikare lost 30–40% of his stock around 2006–2007. Affected oysters couldn't close their valves properly.
One interviewee reported a large mortality event in the Kaipara around 2006.
One interviewee recalled a large mortality event, possible due to a virus around 20 years ago.

Comparison of biosecurity practices among oyster farms

The majority of Pacific oyster farmers interviewed did little to intentionally manage the biosecurity risk on their farms. Two interviewees only caught local spat and did not move stock outside of their farming area because they believe that stock should not be moved around the country. One interviewee routinely tested his oysters for OsHV-1 and prohibited movement of equipment between his sites, however, he still moved stock between sites. One interviewee regularly washed all his equipment down with hot water.

The three flat oyster farmers interviewed moved oysters to Stewart Island. Oyster farmers located in Stewart Island have agreed as a condition of their resource consent renewal[28] to treat all oyster seed brought to Stewart Island with 5% acetic acid for 60 seconds. However, resource consent conditions do not specify a maximum time period between treatment and transfer (M. Hoffman, Environment Southland, pers. comm.) and one farmer reported that he knows of some farmers that have treated their stock with acetic acid and then put them back out in Bluff Harbour for a week before transferring them Stewart Island, which makes treatment pointless.

In addition, all equipment brought onto the island must be new or disinfected. One interviewee also treats his broodstock oysters to kill any *Bonamia*. Two of the interviewees believed that pest eradication is worthwhile and they contributed significant amounts of time and money to assist with Department of Conservation's *Undaria* eradication programme.

4.4.6 Mussels

General monitoring & biosecurity practices

Few environmental water parameters are monitored by questionnaire respondents. Water temperature is monitored at least weekly by 4/16 respondents (Figure 60). Most (8/10) respondents keep records of stock transfers.

Mortalities are typically never specifically removed from the farm (7/14) or only removed at the point of harvest (7/14). Mortalities are rarely stored (1/9) but are generally returned to the sea (6/10) or disposed of in a landfill, post-processing (4/10).

Few (4/19) questionnaire respondents believe that it is important that a shellfish health specialist regularly visits their site. Only 2/19 respondents have ever been visited by a health specialist or have a health specialist on-call if needed.

[28] Initial oyster farm resource consents on Stewart Island only permitted the use of oyster spat captured from coastal waters around Stewart Island. In order to be able to bring other sources of spat onto the island, oyster farmers agreed to the spat treatment protocol as a condition of their resource consent renewals. All oyster spat brought onto the island must be treated with 5% acetic acid for 60 seconds prior to transfer (M. Hoffman, Environment Southland, pers. comm.).

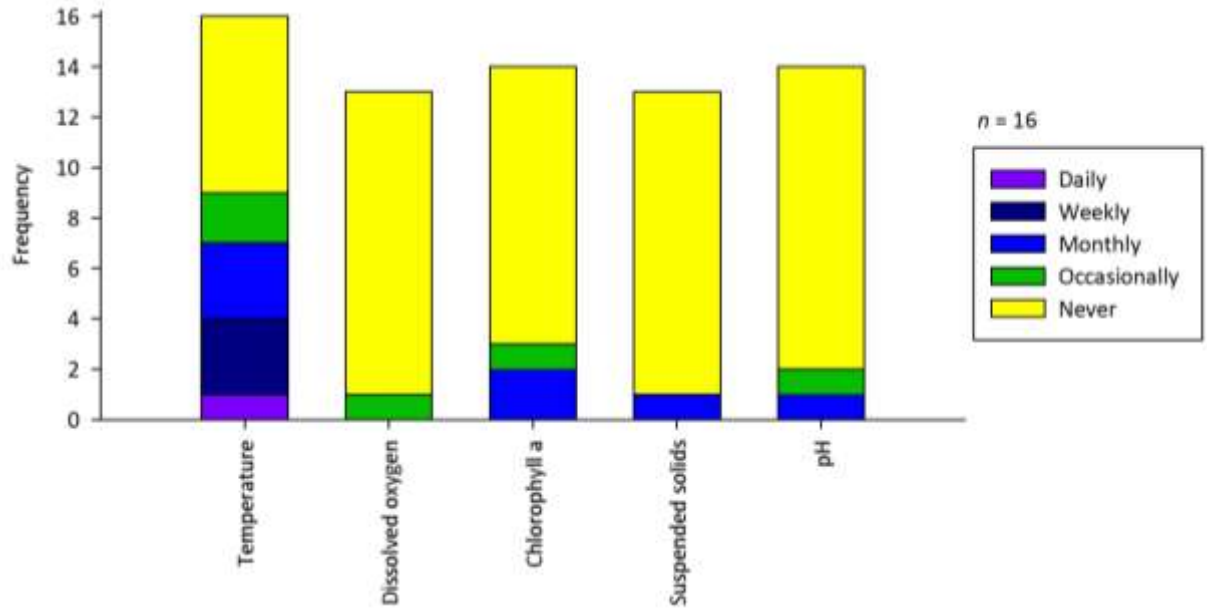

Figure 60: Monitoring frequency for various environmental parameters by mussel farmers reported in the on-line questionnaire. Note that the cumulative frequency of some parameters is less than *n* because some respondents did not provide answers for all parameters.

Figure 61: Mussels being harvested. Harvesting and reseeding are the only times that the majority of mussel farmers remove biofouling from their longlines (note recreational fishing vessels in background) (Image: S. Faire).

Current management methods for pests and diseases on mussel farms

The main methods used by questionnaire respondents to manage the risk of pest entry, exacerbation or transfer are: using antifouling paint on boats; washing and declumping seed; staff education; and, visual inspection (Figure 62). Other suggested methods of pest management are generally regarded as impractical, ineffective or haven't been considered by respondents (Table 13).

Most (16/19) questionnaire respondents routinely check for the presence of pest species on their farm, with the majority (15/18) of respondents checking during normal farm maintenance. However, it should be noted that many farmers do not have the boat facilities to lift their lines fully out of the water, and thus, they will only see what is growing on the surface of their lines, even if they visit the farms regularly (two interviewees). Most (13/19) respondents only remove biofouling from their farms at the point of harvest, with only 2/19 respondents removing biofouling from their farms at least quarterly (Figure 61). Biofouling material is typically cleaned on-site and disposed of in the sea (16/17) or disposed of in a landfill (4/17). The majority (16/18) of respondents don't use antifouling products on their farm structures.

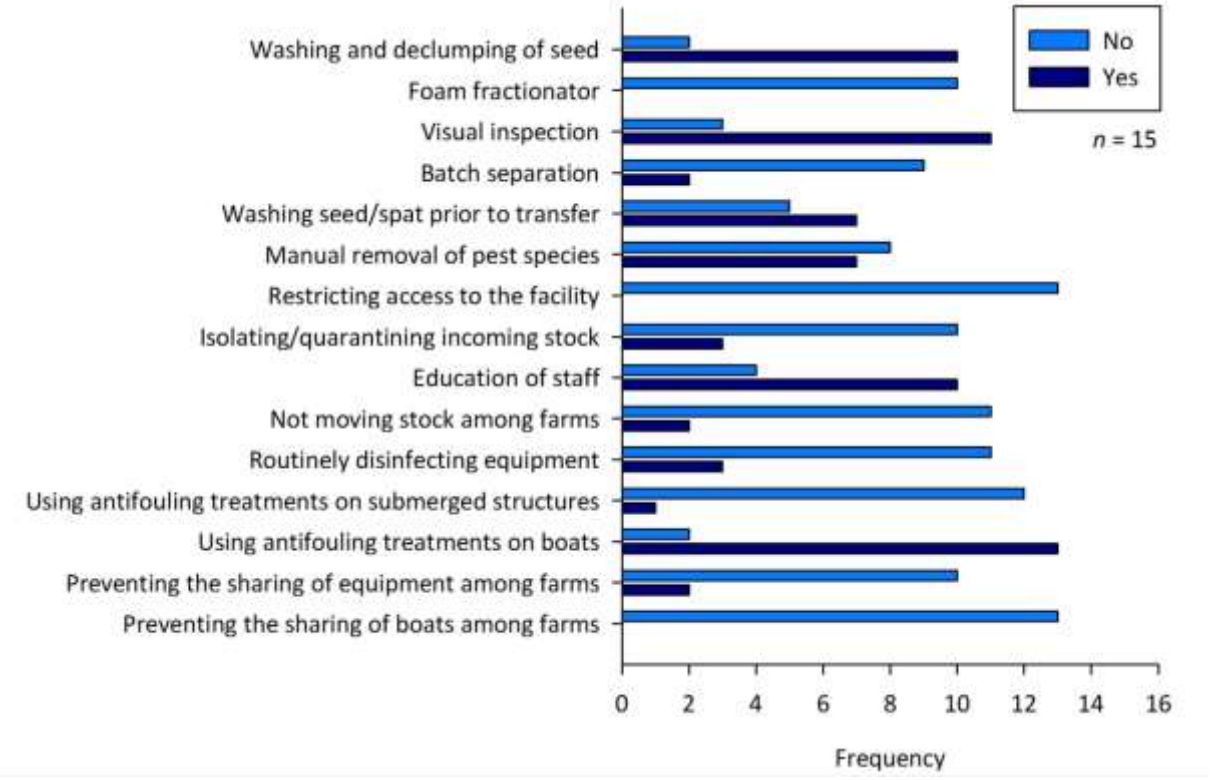

Figure 62: Methods used by mussel farmers to manage the risk of pest entry, exacerbation or transfer reported in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

Table 13: Reasons why mussel farmers (*n* = 15) don't use the following methods to manage the risk of pest entry, exacerbation, transfer.

Management methods	Options (Number of responses)					
	Impractical	Too expensive	Ineffective	Not necessary	Not possible	Not considered
Preventing the sharing of boats among farms	6		1	1	1	
Preventing the sharing of equipment among farms	4		2			1
Using antifouling treatments on boats			1			
Using antifouling treatments on submerged structures	2	1	1	1		2
Routinely disinfecting equipment	1	1	1	1		2
Not moving stock among farms	3		1		2	
Education of staff			1			
Isolating/quarantining incoming stock	3		1			1
Restricting access to the facility			1	1	1	3
Manual removal of pest species	1		2		1	1
Batch separation	1	1	1		1	
Visual inspection			1			
Washing seed/spat prior to transfer	1		1			
Foam fractionators			1			2
Washing and declumping of seed			1			

The most common pest species on mussel farms reported by interviewees are Japanese kelp and blue mussels, which were present in all four farming regions. The vase tunicate, Whangamata sea squirt, flatworms, mudworms and other crustaceans were only reported from the Marlborough/Tasman region, whereas, ribbed mussels (*Aulacomya maoriana*) and sea tulips (*Pyura pachydermatina*) were only reported from Southland (Figure 63 & Figure 64).

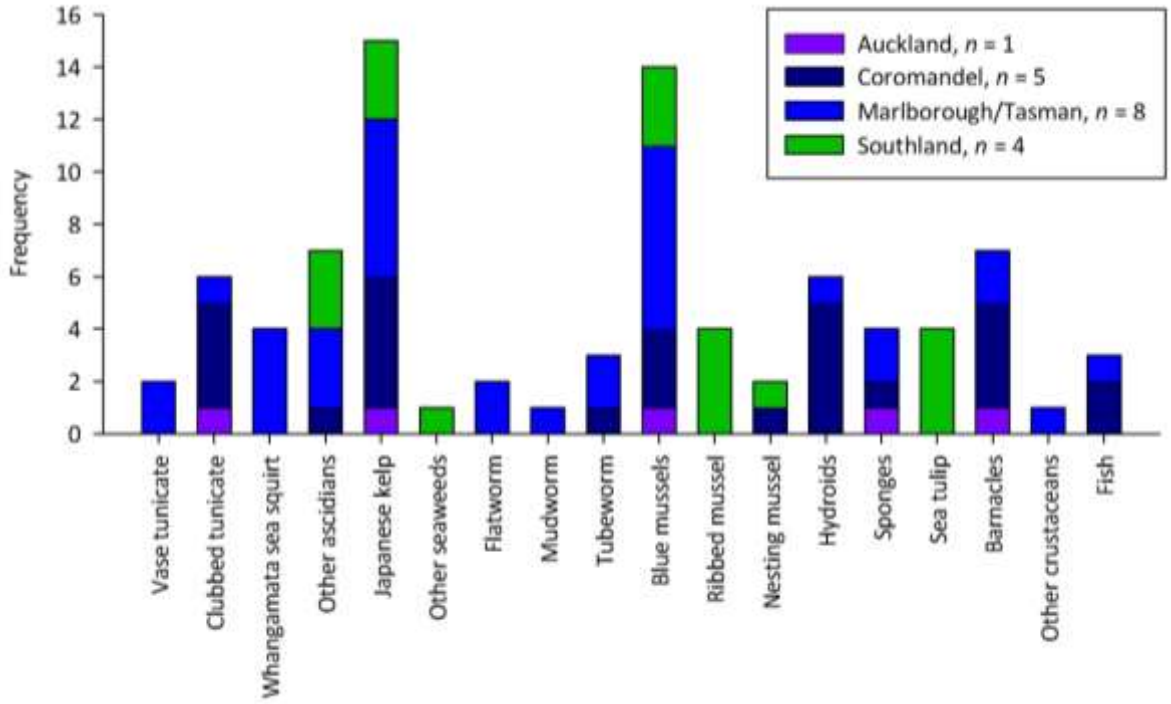

Figure 63: The most common pest species on mussel farms reported by interviewees.

Pests are currently managed as follows:

- all fouling species:
  - mussel seeding density is kept sufficiently dense to ensure a good coverage of the ropes with no gaps. Fouling organisms tend to settle more on the ropes than on the mussels (two interviewees).
- blue mussels:
  - longlines are submerged 4 metres below the surface for the first 6–8 months after seeding to reduce blue mussel settlement and give the green-lipped mussels a size advantage (seven interviewees);
  - mussel lines are checked every three months and the lines are stripped and reseeded if there are too many blue mussels on the lines[29] (one interviewee);
  - mussels are left out on the barge overnight before reseeding because blue mussels have a lower tolerance to desiccation than green-lipped mussels (one interviewees); and,
  - the abundance of blue mussel larvae in the water is monitored in Marlborough and Tasman and lines are not seeded when abundance of blue mussel late-stage larvae is highest (two interviewees).
- barnacles:
  - longlines are hung higher in the water column to reduce barnacle settlement (one interviewee); and,
  - lines are not seeded when barnacle settlement is highest (one interviewee).
- fish:
  - reseeding is delayed until mussels are around 15 mm in size when their shells are a bit thicker, which reduces the shell damage, fish attraction and predation during reseeding (one interviewee).

The main methods used by questionnaire respondents to manage the risk of disease entry, exacerbation or transfer are: staff education and applying BMP for shellfish welfare (Figure 65). Other suggested methods of disease management are generally regarded as impractical or ineffective (Table 14).

Only 1/19 respondents routinely test for diseases in their mussels, with testing occurring when animals are showing disease symptoms. None (16/16) of the respondents routinely use therapeutants on their mussels.

None of the interviewees reported any diseases or major mortality events in their juvenile or adult mussels, though some summer mortality is common (nine interviewees). One interviewee estimated that he sometimes lost 10–15% of his crop in summer. Note that many mussel farmers check their lines infrequently, and farmers don't generally associate empty shells or bare areas on the longlines with disease (two interviewees), and therefore, mortality events may be more common than reported. One interviewee reported that he noticed that sometimes summer die-offs moved through the farms from north to south and he suspected that something in the water currents was causing the mortalities.

Six interviewees reported that the performance of Kaitaia mussel spat has greatly declined in the past decade. Farmers now need to seed out double the amount of spat that they used to, in order to achieve the same production. Farmers are concerned that there will soon be insufficient Kaitaia spat quota because of the reduction in Kaitaia spat performance. It is unknown whether the high spat loss rate is because of: disease; sub-optimal transport or

[29] Colour graders are used to separate the blue mussels from the green-lipped mussels.

environmental conditions; predation; or poor retention (spat actively moving off the ropes) (see Section 4.5.1 on Kaitaia spat from more detail).

Figure 64: Examples of fouling species that grow on mussel longlines and buoys; a) *Undaria,* ascidians and red seaweeds, b) *Didemnum* and red seaweeds, c) sea tulips, and d) blue mussels (Images: C. Sim-Smith).

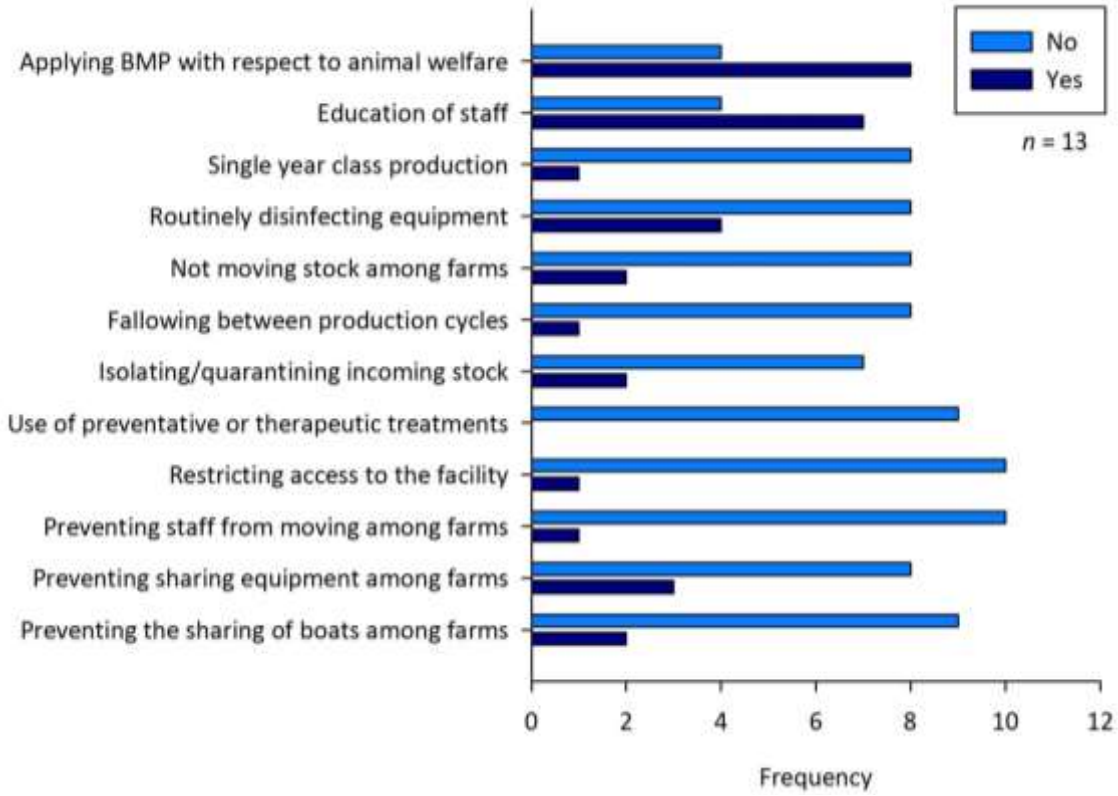

Figure 65: Methods used by mussel farmers to manage the risk of disease entry, exacerbation or transfer reported in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents did not provide answers for all categories.

Table 14: Reasons why mussel farmers (*n* = 13) don't use the following methods to manage the risk of disease entry, exacerbation and transfer.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Preventing the sharing of boats among farms	3		2		1	
Preventing sharing equipment among farms	3		2		1	
Preventing staff from moving among farms	3		1	1	1	
Restricting access to the facility	2		2	1	2	
Use of preventative therapeutic/chemical treatments on fish		1	1			
Isolating/quarantining incoming stock			1	1		
Fallowing between production cycles			1	1		
Not moving stock among farms	1		1	1		
Routinely disinfecting equipment			1	1		1
Single year class production			1	1		
Education of staff			1			
Applying best management practice with respect to animal welfare and animal husbandry			1			

Comparison of biosecurity practices among mussel farms

The majority of mussel farmers interviewed did little to intentionally manage the biosecurity risk on their farms. Stock transfers are believed to be a potential disease transfer vector by six interviewees, however, only two interviewees actually voluntarily prohibit stock movement to certain parts of the country. One interviewee does not move stock and equipment up from Coromandel to the far north because "*there are not pests up north*", while another interviewee doesn't move mussel seed from Coromandel to the South Island because there are too many pests in the Coromandel. Other interviewees believe that it's too late to prohibit stock transfers now because most of the pests have already been spread around the country (two interviewees).

Currently, there is a voluntary Code of Practice (COP) for mussel seed transfer between the North and South Island that involves declumping, washing and visually inspecting mussel seed for pest species before transfer. However, only three interviewees indicated that they follow the COP. One interviewee is concerned that nobody seems to adhere to the seed transfer COP.

Mussel farmers located in Stewart Island appear more proactive about biosecurity procedures. Resource consent conditions for marine farms on Stewart Island are more stringent than other areas around New Zealand, to protect the natural habitat of this high value area (M. Hoffman, Environment Southland, pers. comm.). Mussel farmers in Stewart Island are not permitted to bring mussel seed onto the island, other than Kaitaia spat; all equipment must be new or sterilised, and vessels must have been recently cleaned and antifouled:

- *"vessel cleaning costs us extra money but when you consider the costs of a pest incursion to the industry, its' worth it."*

4.4.7 Mussel spat harvesters

General monitoring & biosecurity practices

All (5/5) respondents kept records of stock transfers. None (4/4) of the respondents believe that it is important for a shellfish health specialist to visit their facility, and only one respondent has ever been visited by a health specialist or has a health specialist on-call.

Current management methods for pests and diseases by mussel spat harvesters

The main method used by questionnaire respondents to manage the risk of pest entry, exacerbation or transfer is not harvesting when there is a harmful algae bloom in the area (Figure 66). Visual inspection is also reportedly used by 4/5 respondents to manage pest transmission risk, however, it was reported in an earlier question that only 2/5 respondents routinely check for the presence of pest species (with these two respondents checking for pest species with every harvest). Pest species that are collected are typically returned back to the sea (4/5). Other suggested methods of pest management are generally regarded as ineffective (Table 15).

There are some discrepancies in the questionnaire answers and on-site interviews regarding the testing of mussel spat for the presence of harmful algae. One of five respondents reported that he routinely tests spat for the presence of harmful microalgae before transfer off-site. However, in a later question three respondents stated that they wash spat off the seaweed and test spat prior to transfer to manage pest transmission risk. Discussion regarding this issue during the on-site interviews revealed that washing and testing[30] of spat in accordance with

[30] The New Zealand Mussel Industry Council developed a voluntary national spat transfer programme to minimise the risk of transferring *Gymnodinium catenatum* from Ninety Mile Beach to areas where it is absent. Mussel spat collectors are required to test all batches of Kaitaia

the New Zealand Mussel Industry Council national spat transfer programme (NZMIC, 2002) only occurs when harmful algae blooms of *Gymnodinium catenatum* are in the area. The last time mussel spat harvesters were required to do this was in 2000–2001 (one interviewee).

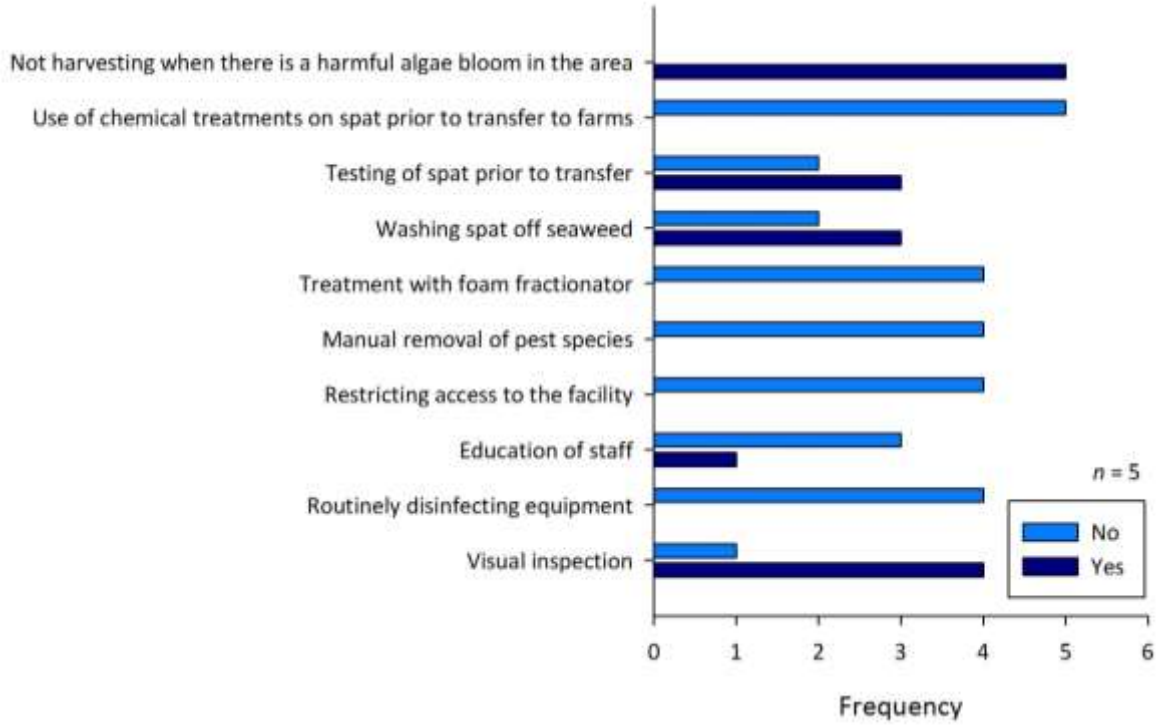

Figure 66: Methods used by mussel spat harvesters to manage the risk of pest entry, exacerbation or transfer reported in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

Table 15: Reasons why mussel spat harvesters (*n* = 5) don't use the following methods to manage the risk of pest entry, exacerbation and transfer.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Routinely disinfecting equipment			1			
Education of staff				1		
Restricting access to the facility			1			
Manual removal of pest species			1			
Treatment with foam fractionator		1				
Use of chemical treatments on spat prior to transfer to farms			1			

spat collected for *G. catenatum* when a bloom of the species is detected in the area. Kaitaia spat samples are sent to approved testing laboratories that count the concentration of *G. catenatum* cysts in the spat samples. If *G. catenatum* is present, the whole batch of Kaitaia spat must be treated (washed and the mussels separated from the seaweed) until there are no detectable cysts present, before the spat can be transferred to a *G. catenatum*-free area (NZMIC, 2002).

Mussel spat harvesters generally do not use any methods to manage the risk of disease entry, exacerbation or transfer (Figure 67). Three respondents reported that they test spat prior to transfer, but they were referring to testing for harmful algae rather than diseases. Suggested methods for managing disease transmission risk are generally regarded as unnecessary (Table 17). None (4/4) of the respondents routinely use therapeutants on their mussel spat.

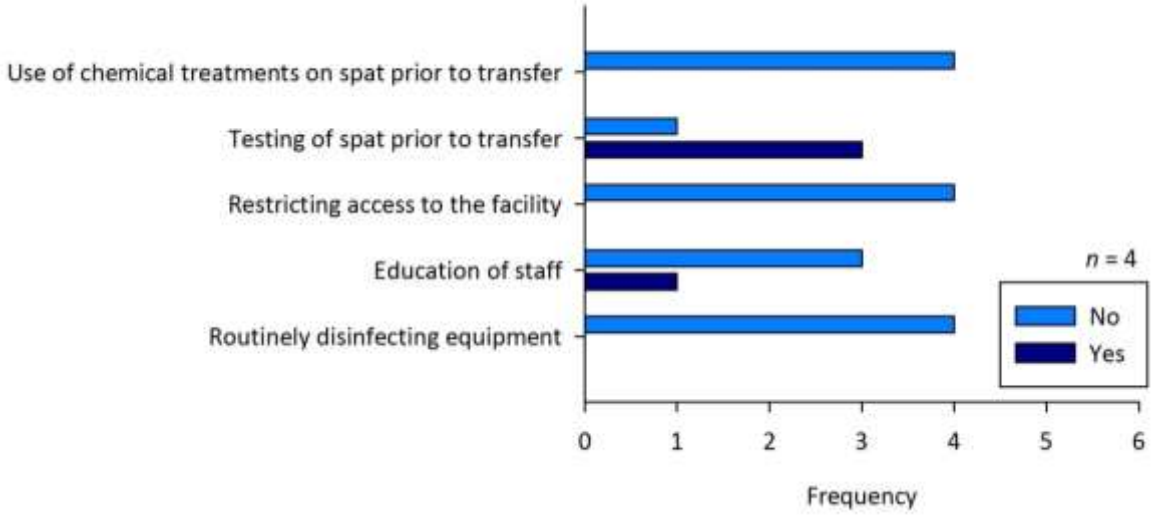

Figure 67: Methods used by mussel spat harvesters to manage the risk of disease entry, exacerbation or transfer reported in the on-line questionnaire.

Table 16: Reasons why mussel spat harvesters (*n* = 4) don't use the following methods to manage the risk of pest entry, exacerbation and transfer.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Routinely disinfecting equipment	1			1		
Education of staff				1		
Restricting access to the facility				1		
Use of chemical treatments on spat prior to transfer			1			

4.4.8 Aquaculture research facilities

General monitoring & biosecurity practices

Water temperature, dissolved oxygen and pH are measured at least weekly by most questionnaire respondents (Figure 68). Salinity and carbon dioxide are also measured at least weekly by two and one respondents, respectively. All respondents (5/5) keep records of stock transfers.

All (4/4) respondents remove mortalities from their culture units immediately when observed and store their mortalities in secured containers. Mortalities are disposed of in a landfill (3/5) or in an on-site mortality pit (2/5).

Feed is either stored in sealed, water-tight containers (3/5) or in bags (2/5).

Two (2/4) respondents have an aquatic health specialist on-site, 3/4 respondents regularly use the services of an external health specialist, and 4/5 respondents have a health specialist on-call if required.

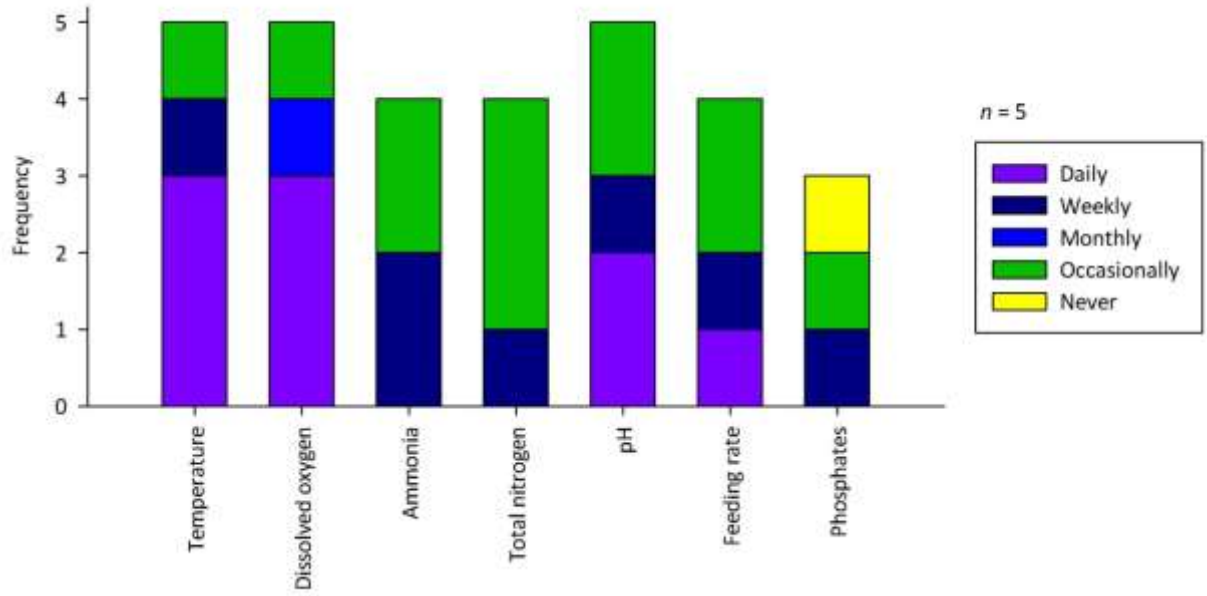

Figure 68: Monitoring frequency for various environmental parameters by aquaculture researchers reported in the on-line questionnaire. Note that the cumulative frequency of some parameters is less than *n* because some respondents didn't provide answers for all parameters.

Current management methods for pests and diseases on research facilities

Aquaculture research facilities use a wide range of methods to manage the risk of pest entry, exacerbation or transfer, including: staff education; isolating/quarantining incoming stock; restricting site access; manual removal of pests; batch separation; visual inspection; routinely disinfecting equipment; and not sharing equipment among sites (Figure 69). Other suggested methods of pest management are generally regarded as unnecessary (e.g., because they were a single site with no other sites to share equipment or boats among) or not possible (Table 17).

All (4/4) respondents routinely check for the presence of pest species on their facility, with 2/4 respondents checking at least every week. Biofouling is removed from culture units at least quarterly by 2/3 respondents, with biofouling material disposed of in a landfill (2/3) or cleaned on-site and left to disperse through the water (1/3). None (4/4) of the respondents use antifouling products on their culture units.

The main methods used by questionnaire respondents to manage the risk of disease entry, exacerbation or transfer are: restricting access to the facility; isolating/quarantining incoming stock; staff education; applying BMP for animal welfare; treating incoming and effluent water; and division of the site into separate management units (Figure 70). Other suggested methods of disease and parasite management are generally regarded as unnecessary (Table 18).

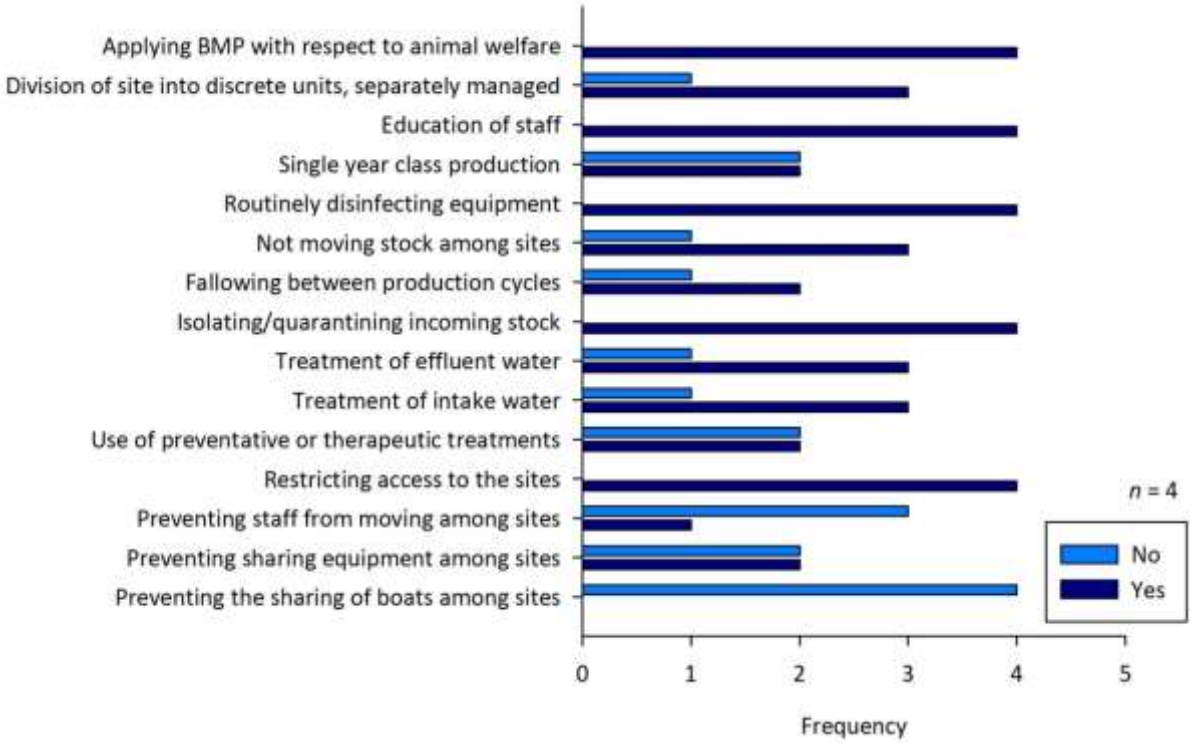

Figure 69: Methods used by aquaculture researchers to manage the risk of pest entry, exacerbation or transfer reported in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

Table 17: Reasons why research facilities (*n* = 4) don't use the following methods to manage the risk of pest entry/exacerbation/transfer.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Preventing the sharing of boats among farms				2	1	
Preventing the sharing of equipment among farms				1		
Using antifouling treatments on boats				2	1	
Using antifouling treatments on submerged structures				2	1	
Routinely disinfecting equipment				1		
Not moving stock among farms	2			1		
Visual inspection					1	
Division of site into discrete units, managed separately					1	

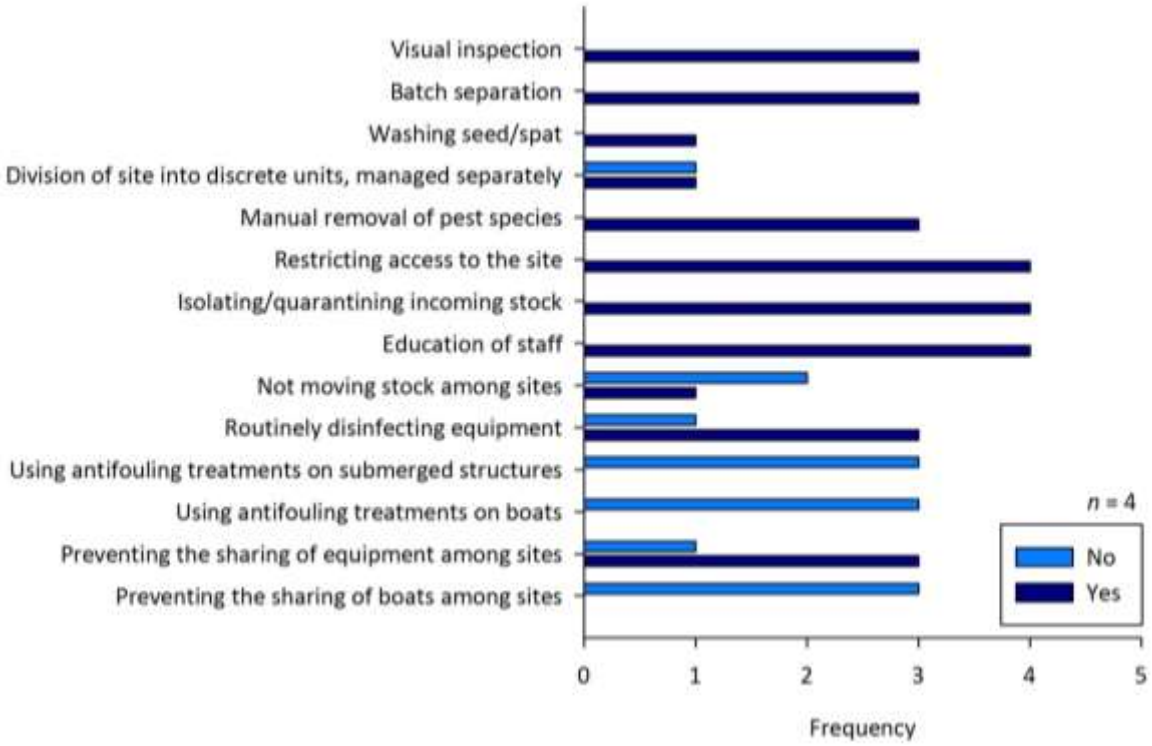

Figure 70: Methods used by aquaculture researchers to manage the risk of disease entry, exacerbation or transfer reported in the on-line questionnaire. Note that the cumulative frequency of some categories is less than *n* because some respondents didn't provide answers for all categories.

Table 18: Reasons why research facilities (*n* = 4) don't use the following methods to manage the risk of disease and parasite entry/exacerbation/transfer.

	Options (Number of responses)					
Management methods	**Impractical**	**Too expensive**	**Ineffective**	**Not necessary**	**Not possible**	**Not considered**
Preventing the sharing of boats among farms				2	1	
Preventing sharing equipment among farms				1		
Preventing staff from moving among farms	1			2		
Use of preventative therapeutic/chemical treatments on fish				1		
Fallowing between production cycles				1		
Not moving stock among farms				1		
Single year class production				1		
Division of farm into discrete units separately managed				1		

Intake seawater is treated by 3/5 respondents and effluent seawater is treated by 4/5 respondents using and range of methods (Figure 71). Of the three respondents that use live animal transporters, two respondents treat the water in the transporters (Figure 71). Treated transport water is either disposed of in the sea or in a municipal wastewater system[31].

[31] The respondent that did not treat their transport water did not give a response as to how transport water was disposed of.

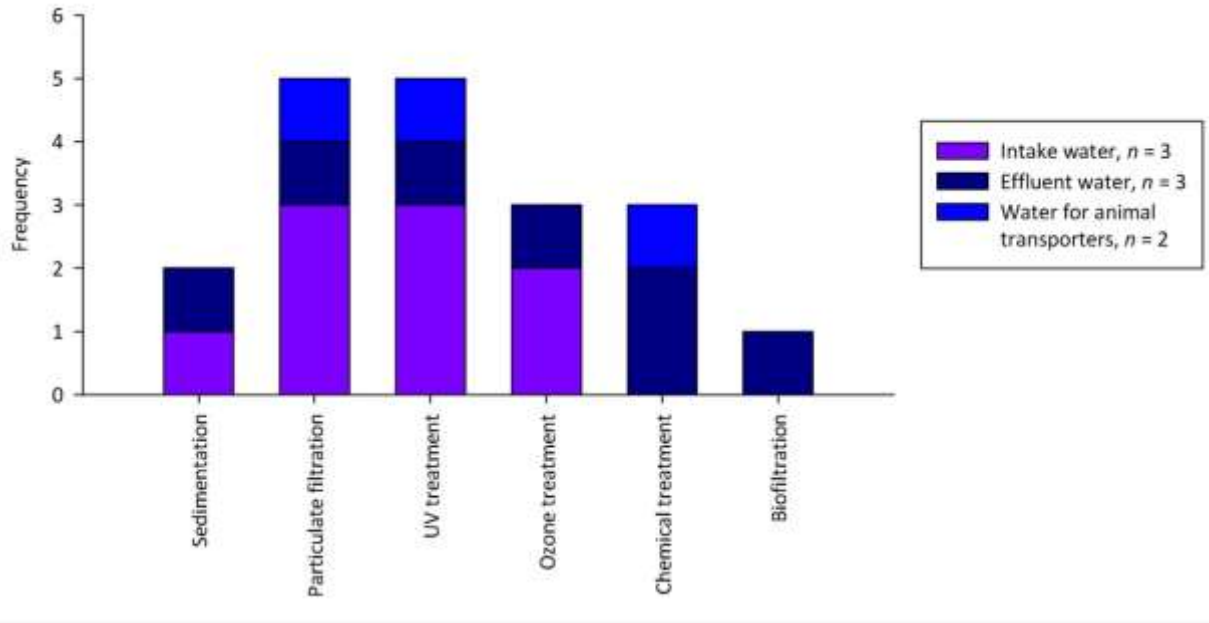

Figure 71: Water treatment methods used by aquaculture research facilities that were reported in the on-line questionnaire.

Most (3/5) respondents routinely test for diseases and parasites, with testing occurring: prior to transfer on- or off-site (3/3); periodically (2/3); or when animals are lethargic/sick (2/3). Therapeutants are routinely used by 2/5 respondents: as a preventative (2/2); when transferring animals on- or off-site (1/2); or to treat sick animals (2/2). Therapeutants are primarily used on finfish eggs, larvae and juveniles.

All (4/4) respondents quarantine new animals that are introduced to the site with quarantine periods depending on the species cultured.

None (4/4) of the respondents hold disease organisms at their facility for research purposes.

Pest and disease risks at both research facilities visited are minimised by:

- treating intake water (particulate filtration, UV (two sites), and ozone (one site). Note, however, that one research facility did not treat the water used for rearing feed microalgae, which was then fed to cultured shellfish. This untreated water and shellfish are kept separate from the rest of the facility;
- use of footbaths and handwash stations (two sites);
- regular testing of animal samples for diseases (two sites), in particular, all oysters are tested for OsHV-1 before they leave the hatchery (one site);
- regular cleaning and disinfecting of equipment and live animal transporters (two sites);
- separation of the site into separate zones with dedicated staff and equipment for each zone (two sites). Note, however, that at one site the 'separate' zones were only separated by about 1 m and water splashes could easily travel between the two zones;
- disinfection of fish eggs (one site);
- visual checks of stock prior to transport (two sites);
- isolation of new stock in a separate area (two sites);
- routinely treating new finfish for ecto- and endoparasites (one site);

- only feeding fish locally-caught frozen food[32] and compound feeds. Feed is stored in pest-proof containers (one site);
- staff education and implementation of SOPs regarding biosecurity (two sites); and,
- isolation of any infected areas. These areas are quarantined and restricted to one staff member, who is only allowed to work in the quarantine area just prior to leaving work for the day. All equipment and protective clothing must be left in the quarantine area (one site).

However, despite these measures, some pathogens are still introduced to the sites. Past infections include OsHV-1, marine *Vibrios*, flukes and ciliates. At one site, many of the current biosecurity procedures were only implemented after a serious disease outbreak.

4.5 BIOSECURITY NEEDS OF THE AQUACULTURE INDUSTRY

4.5.1 General biosecurity needs of the aquaculture industry

Industry-specific Codes of Practice regarding biosecurity

The majority of interviewees (38/51) felt that an industry-specific COP regarding biosecurity issues would be helpful. Interviewees were more divided as to whether a COP should be mandatory (8/29), voluntary (15/29) or a mixture of mandatory or voluntary sections (6/29) (Figure 72):

- *"yes it's (COP) voluntary but you would be a bloody idiot not to do it*"
- *"you shouldn't need to be forced to do these things"* (regarding a COP)
- *"it doesn't have teeth"* (regarding the voluntary COP)
- *"a voluntary COP wouldn't work, you can't have most people towing the line and some people not."*

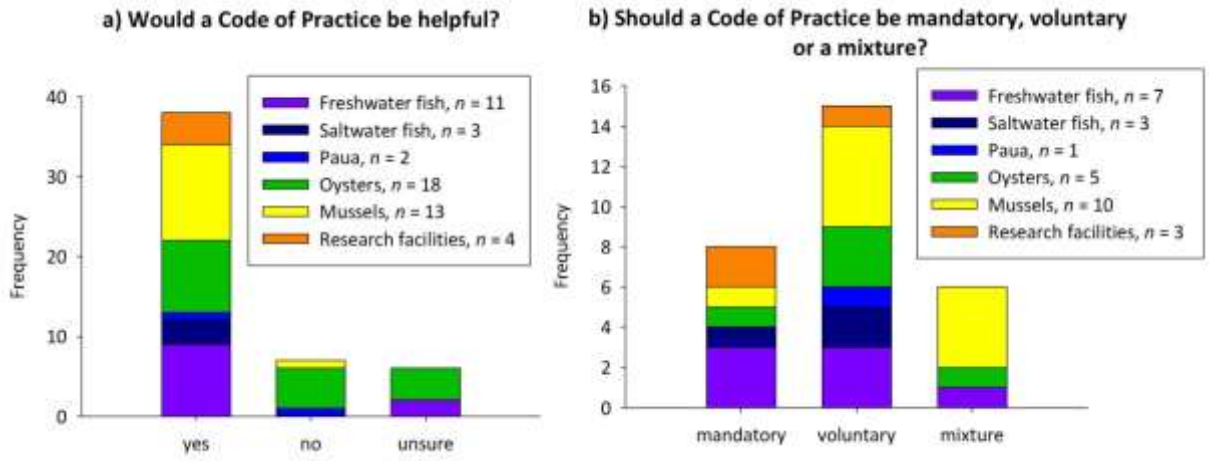

Figure 72: Interviewees opinions on a) whether a Code of Practice regarding biosecurity would be helpful, and b), whether the Code of Practice should be mandatory, voluntary or a mixture of mandatory and voluntary sections.

[32] Feeding fish locally-caught food minimises the risk of introducing pathogens that are not already present in the country. Note that viruses and some bacterial pathogens (e.g., *Aeromonas* spp. and *Edwardsiella* spp.) can survive being frozen, particularly if the freezing period is short and the temperatures are greater than -20 °C (Hine & MacDiarmid, 1997).

Six freshwater farmers and one oyster farmer commented that development of a relevant and practical COP for the whole industry would be difficult because of the wide variety of farming operations in the industry. Three farmers felt strongly that any COP needs to be industry-led:

- *"any COP needs to be written with local farmer knowledge, and not just the larger farmers or someone in MPI or Cawthron"*
- *"there needs to be a collaborative support for the COP for the good of New Zealand."*

Five salmonid farmers have already signed up to international certification programmes (e.g., GAA's Best Aquaculture Practices, and the disease-free programme for export to Australia), which require compliance with certain biosecurity protocols, e.g., all smolts must be certified free of diseases or parasites prior to transfer to the farms; routine testing for pathogens every six months; and disinfection or change of footwear before entering/leaving the site (GAA, 2011). Other farmers have developed their own biosecurity SOP (five interviewees):

- "*we wanted to lead by example and been seen as responsible users*"
- *"if something comes in we need to already be doing best management practices."*

The salmon, mussel and oyster industries currently have existing COPs that cover some biosecurity issues (AQNZ, 2007a; 2007b; NZ Salmon Farmers Association Inc, 2009). However, four farmers reported to us that while they were aware that COPs were available, they hadn't read them. Compliance with the salmon farmers COP is a requirement of all members of the New Zealand Salmon Farmers Association but is not currently externally audited[33]. Compliance with the mussel and oyster farmers COP is voluntary but participants are audited by Aquaculture New Zealand[34] and the list of complying participants is available to the public. All three COPs are currently in the process of being revised.

Development of practical methods of reducing the risk of pest and disease transmission associated with stock transfers

The mussel and oyster industry are currently highly reliant on the movement of stock around the country, and prohibition of stock movement would greatly reduce annual production. Currently, locally caught and hatchery reared spat are unable to meet industry demands, and it is likely to be a long time before this is the case. Practical methods for minimising the pest and disease transmission risks are needed. Some methods to be investigated include:

- Holding and purging facilities for bivalves. Land-based depuration (recirculation) facilities are used extensively by shellfish farmers in Europe, North America, Asia and Australia to clear bivalves of bacterial contaminants and harmful microalgae (Dijkema, 1995; McKindsey *et al.*, 2007; Lees *et al.*, 2010). The economic feasibility of developing depuration facilities in New Zealand should be investigated (two interviewees). This would remove the need for harvestable oysters to be relayed around the country and is also likely to improve the supply of oysters to processing factories. Depuration facilities could also be used for Kaitaia spat during toxic algal blooms; and,
- Development of remote setting[35] for Pacific oyster spat would allow small farmers to access disease-resistant family lines at a fraction of the cost of current hatchery reared spat and would also allow farmers to continue farming on sticks. Remote setting would remove the need for the transfer of spat from catching areas to farming areas (three interviewees).

[33] The revised salmon COP will have internal and external auditing.
[34] AQNZ aim to randomly audit 5% of the COP participants in every 2 year period.
[35] Remote setting is a technique where settlement-stage larvae that have been reared in a hatchery are sent to farmers, who then settle the larvae onto sticks/ropes in their own tanks on-site.

Research on the performance of Kaitaia spat

Research is needed on why the performance of Kaitaia mussel spat has greatly declined in the past decade (eight interviewees). It is unknown whether the high spat loss rate is because of: disease; sub-optimal transport or environmental conditions; predation; or poor retention (spat actively moving off the ropes).

One mussel farmer and one mussel spat harvester believe that sub-optional transport conditions are affecting Kaitaia spat survival. Packing methods vary among spat harvesters. Some harvesters pack their bags of spat in directly on top of one another, interspersed with blocks of ice to keep the temperature down, whereas other harvesters pack their spat in perforated fish bins so the spat is not crushed and they are not in direct contact with ice. Two interviewees reported that Kaitaia spat is now stored and transported at colder temperatures than previously (3–4 °C versus 12 °C); are sometimes kept for several days after harvesting prior to transport; and, are often crushed or frozen by direct contact with frozen blocks of ice that are used for chilling the spat.

Environmental conditions or predation may also be a factor in spat survival because two interviewees reported that spat survival is often poorer on the bottom half of the ropes (where there are high concentrations of suspended sediments or more fish), than the top half of the ropes.

Three interviewees believe that the spat might be affected by a virus.

Establishment of appropriate geographical zones for biosecurity management

Six interviewees commented that biosecurity in New Zealand should be managed in geographic zones that align with separate water bodies (e.g., Aquaculture Bay Management Areas (ABMA)) rather than by regional council boundaries or individual farm sites. Several farmers that shared the same water bodies with other farmers were concerned about inter-site biosecurity and how neighbouring farmers may compromise their farm's biosecurity.

Respondents also identified the need for more information and research on:

- pest and disease species that are a problem for aquaculture overseas so that the New Zealand industry is forewarned (five interviewees);
- pest and disease species that are present in New Zealand to assist with control (six interviewees);
- harmful algae blooms (one interviewee);
- on-growing techniques for oysters (one interviewee);
- blue skies projects 'science for science sake' (one interviewee); and,
- industry-led aquaculture projects (two interviewees).

More sharing of industry knowledge regarding biosecurity

Five interviewees commented that there should be more sharing of knowledge, biosecurity issues and management methods within the industry through internal working groups or something similar:

- *"it's good to share knowledge, many farmers have a lot of local knowledge in their head."*

Sharing of biosecurity knowledge within the industry is particularly important for the establishment of ABMAs. These internal working groups should have some clear rules of

engagement e.g., confidentiality and 'no-blame', and possibly employ the use of a neutral external facilitator.

4.5.2 How can the government assist with biosecurity management?

There is a need for better biosecurity information from MPI

Thirty two interviewees receive little or no information from MPI regarding biosecurity: *"we don't hear about a disease outbreak unless it gets into the media."* Seventeen interviewees would like to receive more information, particularly on:

- new or potential pest and disease species (eight interviewees);
- the spread of pest species to new areas (one interviewee);
- results of government-funded research projects (three interviewees);
- overseas aquaculture practices (one interviewee); and,
- food safety standards (one interviewee).

Email was the preferred form of contact by nine interviewees, and it was suggested that a quarterly biosecurity update would be good.

Three interviewees find that the current information from MPI is too lengthy or difficult to understand:

- "*some of it is pretty heavy reading*"
- *"lots of farm managers don't want to read screeds of stuff from MPI."*

Three interviewees find that much of the information they receive from MPI is not relevant to their business. Four interviewees often don't bother to read information sent to them by MPI, and three interviewees only read MPI information that came via the industry association.

MPI needs to work on building a good relationship with industry

MPI needs to have a better understanding of the industry in order to implement practical and effective biosecurity measures (six interviewees). It was suggested that a working group of MPI staff, industry and scientists would be beneficial for sharing biosecurity information, working through solutions and establishing trust between MPI and industry (seven interviewees). Any regulations that affect the aquaculture industry should be made in consultation with the industry (three interviewees):

- *"MPI needs to work on developing a better relationship with industry...not an authoritative relationship"*
- *"MPI need to engage with their communities; meet people face-to-face and don't send out lots of paper or emails"*
- *"MPI biosecurity need people on the ground to interface with the crew and get out on the boats"*
- *"the MPI person who does our site audits (around animal husbandry) admits that he doesn't know much about fish."*

One interviewee values the increased presence of MPI at industry meetings recently: *"they (MPI) are bringing us up to speed on potential future issues, it's really good."*

Some interviewees are reluctant to inform MPI about potential new pest species or biosecurity issues because they fear that they will be shut down, have new regulations imposed on them, lose control of their business, or have their international reputation damaged (three

interviewees). Currently, there is a culture amongst the aquaculture industry of dealing with biosecurity problems themselves without contacting MPI or regional authorities. For example:

- when OsHV-1 first appeared in 2010, the oyster industry did not want to notify MPI immediately, but instead paid a research institute $25,000 to identify the disease agent. Samples were only sent to MPI three months later, after the research institute couldn't identify the virus; and,
- the recent outbreak of the Mediterranean fanworm in Coromandel was discovered by mussel farmers who independently organised divers to examine a foreign barge. After the fanworm was discovered, farmers spent 2–3 weeks negotiating with the barge owner to get the barge cleaned (at the farmers' cost), before notifying the regional council. "*We (farmers) then watched to see how the system would work."*

Good industry-government relations depends on all MPI departments providing efficient, effective service and advice for the industry

Interviewees typically judge the whole of MPI together, and therefore, a bad experience with one MPI department makes interviewees reluctant to engage or co-operate with other MPI departments over different issues. Interviewees reported their frustration with dealing with MPI:

- *"I rang MPI several times over a bill but couldn't find a suitable person to talk to who knew what the bill was for"*
- *"MPI is now too complicated an organisation, a lot don't know what the other half are doing"*
- *"MPI seems to be struggling with structure and consistency; biosecurity contacts are no longer current"*
- *"I had to deal with three different people because of high staff turnover and had to explain myself every time...in the end I didn't bother with the application"*
- *"we were unable to export to certain countries because MPI made errors in the export registers and organic certification requirements"*
- *"the MPI aquaculture unit should have supported farmers' objections to occupation charges in the coastal plan...they (aquaculture unit) are money poorly spent"*
- *"MPI are hard work to deal with, are 'Nazi-like' when policing rules, particularly food-safety people"*
- *"MPI requirements for the transfer of smolts are not practical, they involve too much paperwork and MPI are slow to grant approval."*

A personal contact from MPI would be helpful

Twenty seven interviewees believe that a personal contact from MPI would probably be helpful; six interviewees are unsure; and 11 interviewees don't believe that a personal contact would be helpful. Three interviewees were concerned about the cost of the role and who would pay for it: *"wouldn't want a huge expense for nothing."* Any personal contact person needs to have a good knowledge of the industry and would have to understand all the issues concerning the farm, e.g., food safety, aquaculture, biosecurity (five interviewees). They would also have to be flexible with appointment timing and be available outside normal office hours (one interviewee). A personal MPI contact should be there to provide advice rather than policing regulations (two interviewees). Two interviewees suggested that MPI improve their contact information so that farmers know who to contact about different issues:

- *"I used to have a MAF officer who I used to ring all the time, he was my 'problem solver'"*

- *"It would be good to have a friendly go-to person like the old MAF officers who used to visit a few times a year and were on first-names basis"*
- *"I used to send MAF fisheries officers photos of unusual things but now I'm not sure who to send them to."*

MPI and regional councils need to sort out who is responsible for biosecurity

One interviewee commented that there needs to be some accountability between MPI and regional councils as to who is responsible for biosecurity. He commented that at present both authorities appear to be ducking responsibility.

Regional councils need to be more responsible for water quality issues

Seven interviewees believe that the regional councils need to do more to fix poor water quality issues, e.g., pollution from obsolete sewage treatment plants, septic tanks, recreational boats, terrestrial farm livestock and sedimentation. Three interviewees believe that regional councils need to do more enforcement of water quality regulations, e.g., boat sewage discharge regulations, and one respondent stated that central government should step in when regional councils are taking too long to rectify pollution problems. Poor water quality in farming regions compromises biosecurity, because farmers must relay stock to non-contaminated regions in order to be able to harvest them.

One interviewee would like regional councils to guarantee good water quality at farm sites if councils are going to be charging an abandonment bond for farms sites. Another interviewee stated that it was unfair that farmers were still expected to pay lease costs for Waikare Inlet farms that were closed for seven years because of sewage pollution.

One interviewee believes that there is no long-term future for oyster farming in the Mahurangi Harbour because water quality is going to deteriorate with the planned increase in housing. Four interviewees reported that they find regional councils inflexible and difficult to deal with.

Most farmers are aware that water quality problems are the responsibility of the regional council, however, they would like to see central government step in and take action when regional councils are taking too long to resolve poor water quality issues.

MPI needs to make boat owners more responsible for the risk that they pose to pest and disease transmission

Eleven interviewees believe that boat owners need to be more responsible for ensuring that: their hull is clean; they do not harbour pests and diseases in sea chests and ballast water; and, they are not discharging sewage near marine farms. Four interviewees believe that there needs to be more regulations with respect to keeping boat hulls clean[36], and three respondents believe that there needs to be more penalties and enforcement to ensure boat owners keep their boats clean:

- *"there needs to be increased accountability (regarding boat owners and pest/disease transmission)."*

[36] On 16 May 2014 the government released the Biofouling Craft Risk Management Standard, which will require all vessels arriving in New Zealand to be 'clean' below the waterline on arrival. The standard will be voluntary for the next four years and will become a legal requirement on 15 May 2018 (see www.biosecurity.govt.nz/enter/ships for more information).

Create more farming space for aquaculture

More farming space is required, which are sufficiently separated from other farms, so that the industry can implement single year class culture and fallowing (two interviewees). This is particularly important for finfish aquaculture with the move to culturing native New Zealand finfish species that have endemic diseases.

Better biosecurity education is needed for the general public

Four interviewees believe that there needs to be better biosecurity education for the general public so that they are aware of the risks that they pose to the environment. One interviewee thinks that the public education regarding Dydimo was good, however, another interviewee believes that it has now lost its effectiveness. One interviewee suggested that MPI provide wash stations near popular freshwater fishing spots to encourage fishers to wash their gear and minimise the chances of transmitting pests and diseases. Furthermore, two interviewees stated that MPI need to provide effective information to the media to counteract the 'scaremongering' that occurs in the media about pests and diseases in aquaculture: "*we (farmers) get hammered by the public in terms of our perceived impact.*"

5 Discussion

5.1 GENERAL RESPONSE RATE

The overall response rate for the on-line questionnaire is comparable to similar on-line questionnaires and to the typical response rate from the aquaculture industry, globally. For example, a meta-analysis of 45 published on-line questionnaires showed that the median response rate was 27%, with lower and upper quartiles of 19% and 43%, respectively (Manfreda *et al.*, 2008). New Zealand aquaculture industry representatives generally expect response rates of between 20% and 50% when they request information from their members (AQNZ, pers. comm.), and the average response rate for similar international surveys of the aquaculture industry is between 12% and 38% (Bergfjord, 2009; Chu *et al.*, 2010; Adams *et al.*, 2011).

In comparison, the response rate for the on-site interviews was much higher, with an overall response rate of 94% or a 'cold-calls' response rate of 90%. Personal, face-to-face contact with farmers appears to be the preferred method of contact for farmers for information sharing. Discussions with farmers during the on-site interviews revealed that many farmers couldn't be bothered with the 15 minute on-line survey because they were: too busy; didn't like computers; or just avoided 'paperwork' as much as possible. However, many farmers happily gave us 1–2 hours of their time for the on-site interviews and several farmers took us out to their farms for half a day or more. Similarly, many farmers commented that MPI needs to meet with farmers more in order to facilitate good government-industry relationships (see Section 4.5.2).

The response rate for the on-line questionnaire was highest for the mussel spat harvesters (67%), research facilities (56%), and freshwater finfish farmers (54%), and lowest for the paua industry (6%) (Table 1). It was expected that the highest response rates would come from the most concerned industries. However this was not the case, with the most concerned sectors being the paua and oyster industries (Table 4). Some of the mismatch between the response rate and the level of concern by respondents may have been caused by oyster farmers not wanting to participate in an on-line survey, rather than a disinterest in the survey topic, because the response rate of oyster and mussel farmers to the on-site interviews was very high. It should be noted that the reported response rates of the on-line questionnaire need to be interpreted with caution because many of the questionnaires may have been sent to obsolete contacts, particularly for the paua industry. Furthermore, the response rates in the oyster and mussel industry are likely to be under-estimated because it is common for single farmers/companies in these industries to manage numerous sites, both for themselves and for other farmers/companies.

5.2 BIOSECURITY AWARENESS, PERCEPTIONS & CONCERNS OF THE AQUACULTURE INDUSTRY

An understanding of biosecurity awareness, perceptions and concern in the aquaculture industry is important in order to assess how supportive the industry will be for the implementation of biosecurity best management practices. Furthermore, it is important to understand any misconceptions that the industry may have regarding biosecurity, because any misconceptions may be barriers to the implementation of biosecurity best management practices.

The vast majority (88–89%) of questionnaire respondents were moderately to very concerned about the potential effects of aquatic pests and diseases on their business. Overall,

respondents expressed similar levels of concern for pests (56% very concerned) and diseases (54% very concerned). The most concerned industries were the paua, oyster and research industries (Figure 11 & Table 4 in Section 4.3.1). All these industries have experienced disease or pest outbreaks in New Zealand (e.g., OsHV-1 outbreaks) and have also read about the devastating effects that diseases and pests can cause in other countries (e.g., high mortalities from abalone ganglioneuritis in Australia in the late 2000s (Hooper *et al.*, 2007)).

Disease outbreaks within the history of New Zealand aquaculture have been rare, and with the exception of the recent OsHV-1 outbreak, no other widespread, serious disease outbreaks were reported by interviewees. This lack of disease experience in some sectors is reflected in their level of concern about disease. For example, in the on-line questionnaire 15/20 oyster farmers were very concerned about preventing or managing diseases on their farms, whereas only 4/13 freshwater farmers and 7/19 mussel farmers were very concerned about preventing or managing diseases on their farms (Table 4 in Section 4.3.1). The lack of disease awareness and experience makes the New Zealand aquaculture industry vulnerable to disease outbreaks, both from incursions of new pathogens and pathogens already present in the country, because appropriate preventative management practices are not in place (Castinel *et al.*, 2014).

The lower level of concern about diseases from freshwater salmonid farmers is surprising given that there are several commercially significant diseases overseas that can cause high mortalities in farmed freshwater salmonids (e.g., infectious haematopoietic necrosis, viral haemorrhagic septicaemia and bacterial kidney disease: Meyer, 1991; Toranzo *et al.*, 2005; Saksida, 2006). Some farmers perceive that the risk of future disease outbreaks in New Zealand is low given the current lack of salmonid diseases in the country, while other farmers perceive that the risk of pest and disease introduction to their site is low given the close proximity of their farm to the spring head. While this is true to a certain extent (Wester, 1983), most farms do not draw their water directly from the spring head, and thus, there is a possibility that diseases can be introduced to the farm via wild fish that inhabit the surrounding waters. Other farmers are aware that a disease-free history does not guarantee a disease-free future: *"it's not if, it's when"* (regarding a disease outbreak).

To date, the New Zealand mussel industry has also been free of any serious disease outbreaks (Diggles *et al.*, 2002; Tubbs *et al.*, 2007). Mussel farmers are more concerned about managing pest species rather than diseases on their farms (Table 4 in Section 4.3.1). While the majority (17/21) of mussel farmers are moderately or very concerned about managing pest species on their farms, they believe that MPI needs to 'weigh up' the risk an introduced species poses to the industry versus the cost of control measures before implementing any control measures. While this opinion is understandable given the cost and ineffectiveness of past biosecurity measures required of farmers, e.g., attempts to control *Didemnum*, it can be very difficult to determine whether a species will become a pest in a new environment, and eradication of an introduced aquatic pest species is realistically only feasible during the early stages of incursion. Once an aquatic pest species becomes established, eradication is extremely difficult or impossible, and very expensive (Bell *et al.*, 2011). Thus, immediate action is required for there to be any chance of successful eradication. Better communication of these issues to the industry would increase industry understanding and engagement for early eradication attempts.

Several marine farmers (six interviewees) are concerned about the cost of biosecurity measures to their business. While 10 interviewees acknowledged that managing pest species is a cost to their business in terms of the loss of productivity, reduced market value of products, and increased labour time required for cleaning and processing, very few farmers appear to have quantified this cost to their business. Only one mussel farmer reported that he

had some estimation of the cost of pests to his business: "*it's too expensive not to check (for pests). Pests can change the productivity of a line from $20 k to $5 k."* Communication of these 'hidden' costs of pests to industry is likely to increase the willingness of farmers to implement biosecurity measures. For example, a survey of around 500 shellfish growers in the United States found that managing biofouling costs farmers, on average, 15% of their total operating costs (excluding any loss in productivity) (Adams *et al.*, 2011). Loss of productivity is much harder to estimate, but fouling of mussel lines by *Didemnum* alone is estimated to result in a 10% loss in productivity in mussel farms in the Marlborough Sounds (Coutts & Sinner, 2004).

Natural water movement was identified as the most likely method that pests and diseases are transported to farms, however only two interviewees believe that the risk of pest and disease transmission via water can be managed for open farms. The majority of farmers appear unaware of biosecurity methods successfully used overseas to reduce pest and disease transmission among open farms e.g., Aquaculture Management Area Agreements, single year class production and fallowing (Wheatley *et al.*, 1995; Stewart, 1998; Chang *et al.*, 2007; Scott, 2010). Again, better communication of these 'success stories' to industry would increase industry support and engagement for the implementation of these biosecurity methods.

International shipping and degradation of water quality were identified as the next largest biosecurity risks for the aquaculture industry and many farmers (36 interviewees) believe that the government is not doing enough to mitigate these risks. Mussel (15 interviewees) and oyster (5 interviewees) farmers are the most concerned about the risk that international shipping poses to their businesses. Oyster farmers were less concerned that mussel farmers, which may be because oyster farmers are affected by fewer fouling species than mussel farmers (because most oyster farms are intertidal).

Prior to 1998, around 93% of the 148 introduced marine species in New Zealand are likely to have arrived via hull fouling or ballast water (Cranfield *et al.*, 1998). New Zealand has had an international shipping ballast water standard in place since 2000, however, this standard is not completely effective at eliminating introduced species introductions via ballast water (Inglis *et al.*, 2013; Castinel *et al.*, 2014). Most farmers are either unaware of the standard or they believe that better enforcement of the standard is required. Farmers were also very concerned about pest species that arrive on the hulls of international ships, oil rigs and barges. Many of these farmers have seen or heard about heavily-fouled international vessels that have arrived in New Zealand (e.g., see Top of the South Marine Biosecurity Partnership, 2013). The recent introduction of the Biofouling Craft Risk Management Standard, which will become a legal requirement in 2018, will help reduce the risk of accidental incursions of introduced marine species via hull fouling (MPI, 2013). Communication to the industry of the existence of the ballast water and biofouling standards, and what MPI does to enforce these standards, will reassure farmers that MPI are working to minimise the risk of marine incursions.

Degradation of water quality is a major concern for 12 interviewees. While farmers acknowledge that water quality is the responsibility of the regional council, they are often frustrated by the lack of action by regional councils and think that central government should be providing some assistance to councils to improve water quality in farming areas. Poor water quality in farming regions also leads to food safety and biosecurity problems because: 1) animals reared in sub-optimal conditions are more susceptible to disease; 2) there is an increased risk of harvested products being contaminated by human pathogens; and, 3) it increases the number of stock transfers that occur because farmers must relay shellfish to areas of good water quality in order to harvest them.

The risk of pests and disease transmission via stock transfers is a controversial topic, particularly for the mussel and oyster industries. Both of these industries are currently heavily reliant on moving stock around the country because spat/seed is only available from localised areas. In addition, the oyster industry frequently relays harvestable-sized oysters to avoid harvest closures caused by poor water quality. While many mussel (seven interviewees) and oyster farmers (10 interviewees) believe that stock transfers are a likely pest and disease transmission vector (Figure 29, Figure 30, Figure 33 & Figure 34), fewer farmers believe that stock movement should be ceased (seven interviewees). Prohibition of stock movement as a method of preventing pest and disease transmission is viewed as futile by many farmers because farmers believe that pests and diseases have already been spread throughout the country (two interviewees), or they will be eventually transferred around the country by other vectors (four interviewees). This in contrary to biosecurity best practice, which has shown that stocking disease-free animals, isolating the farm, ceasing stock transfers of untested stock, culling of infected animals and disinfection of equipment can all help to contain the spread of pests and diseases (Mohan *et al.*, 2008; Corbeil & Berthe, 2009).

Farmers believe that many biosecurity risks are outside the aquaculture industry's control, however, all the onus of biosecurity management is being put on the aquaculture industry. While farmers are not responsible for bringing pests and diseases into the country, they are likely to facilitate the spread of pests and diseases around the country via stock and equipment transfers, boat movements and the provision of a large area of suitable habitat for fouling organisms (Dodgshun *et al.*, 2007). Furthermore, aquatic farmers are likely to be a major beneficiary of the aquatic biosecurity system (compared to other human-mediated transport vectors), and therefore, it may be argued that aquatic farmers should pay for a larger proportion of biosecurity costs.

MPI is perceived by some farmers (four interviewees) as being unprepared for a disease outbreak. Farmers believe that MPI needs to have: the ability to identify diseases quickly; a clearly defined action plan for potential disease outbreaks; and, readily available vaccines for fish. However, MPI's ability to deal with biosecurity issues is not well understood by industry, with 34–45% of questionnaire respondents admitting that they don't know much about MPI's expertise in various biosecurity areas (Figure 14). Better communication to industry would reassure the industry about MPI's capabilities and is likely to increase the probability of industry contacting MPI when they have a biosecurity issue.

5.3 BIOSECURITY PRACTICES OF THE AQUACULTURE INDUSTRY

5.3.1 Comparison of biosecurity practices among farms producing different species

It is important to consider aquaculture biosecurity practices across sectors, as well as within each aquaculture sector because farming practices in one sector may affect the biosecurity of other sectors, and some farmers cultivate more than one species on the same site. The most obvious example of this is the link between the freshwater and saltwater salmonid industries, where smolts are transferred from freshwater hatcheries to saltwater farms. There is also evidence that certain disease agents (e.g., infectious pancreatic necrosis virus, *Vibrio anguillarum*, *Loma salmonae*) can be transferred between shellfish and finfish (Pietrak *et al.*, 2012; McConnachie *et al.*, 2013; Molloy *et al.*, 2013).

There was a large variation in the biosecurity practices among the farms surveyed, and the moderate to high level of industry concern regarding pests and diseases is not always reflected in their biosecurity practices. Overall, research facilities and the land-based paua facility

visited implemented the most rigorous biosecurity measures, which were generally consistent with recommended international best practices (Table 19 & Wester, 1983; Mohan *et al.*, 2008). These facilities:

1) minimise the risk of pest and disease entry by: treating their intake water; deterring animal pests; disinfecting all equipment, hands, footwear and clothing; restricting access to the facility and, quarantining all incoming stock;
2) minimise the risk of disease proliferation onsite by: checking stock daily; regularly testing for disease (research facilities); managing culture units in separate zones; culling infecting animals and, isolating infected culture units; and,
3) minimise the risk of spread of disease to other facilities by: testing all oysters for OsHV-1 prior to transfer off-site; and, treating all effluent water that was in contact with oysters.

These facilities are also very proactive in staff education regarding biosecurity, which is critical to ensure that biosecurity SOPs are properly adhered to. While biosecurity measures at these facilities are now fairly rigorous, a number of biosecurity measures in two of the three facilities visited were only instigated after a disease outbreak occurred on-site, and there is still room for improvement. The land-based paua facility currently does not routinely test for diseases, although it is regularly visited by a shellfish health specialist. One research facility currently has an untreated water system that also flows on-site. This system is kept separate from the treated water system, but there is a risk of disease transfer between the two systems. All land-based facilities could also improve their methods for minimising the risk of pest and disease transfers off-site through the treatment of all effluent water[37] and disease testing of all stock leaving the site.

Biosecurity practices on salmonid farms (both freshwater and saltwater) are generally moderate, though commercial farms have stricter biosecurity practices than non-commercial farms (see Section 4.4.2). Two commercial salmonid farmers were concerned that stock transfers by non-commercial farmers were poorly regulated and may jeopardise commercial farming operations.

Two commercial freshwater farms and one commercial saltwater farm have GAA's Best Aquaculture Practices certification (GAA, 2011), and three commercial freshwater farms and one commercial saltwater farm belong to Australia's disease-free export programme. The biosecurity requirements of GAA's Best Aquaculture Practices certification are not overly onerous (Table 20), and it should be possible for all New Zealand salmonid farms to reach this standard. Note that, as an increasing number of farms become GAA certified, there is likely to be a requirement for the formation of ABMA between neighbouring farms located within 5 km of other certified farms.

None of the salmonid farms interviewed currently meet the biosecurity criteria of the more stringent Aquaculture Stewardship Council's salmon standard (Table 20). The major requirements that New Zealand farms currently do not meet are: single-year class production; quarterly site visits by a veterinarian, post-mortem analysis of 100% of unexplained mortality events; and, publicly available mortality records.

Water treatment is not possible for many open salmonid farms, which leaves them vulnerable to waterborne pest and disease transmission. However, none of these farms currently utilise other biosecurity methods e.g., single year class production, fallowing and ABMA agreements, that have been shown to reduce disease transmission and mortalities in open farms overseas (e.g., Wheatley *et al.*, 1995; Stewart, 1998; Chang & Page, 2010).

[37] The land-based paua facility is currently installing a water treatment system for its effluent water.

Furthermore, while water treatment is possible for land-based hatcheries, none of the freshwater hatcheries that we visited currently treat their incoming water[38]. The majority of salmonid farms had SOPs that reduced the risk of pest and disease transmission via equipment or staff, but several interviewees admitted that adherence to these SOPs by staff could be improved (see Section 5.6 for more details).

Biosecurity practices to prevent the transmission of pests and diseases on mussel and oyster farms and mussel spat harvesting facilities are typically minimal, despite their moderate to high level of concern about pests and diseases, and the recent OsHV-1 outbreak in the oyster industry. There are currently no therapeutic treatments for mussel and oyster diseases, and introduced pest species are extremely difficult to eradicate once established. Thus, prevention rather than treatment is the primary driver for successful bivalve health management (GAA, 2013). Many farmers actively look out for new pest species, manually remove pests from their farms and educate their staff about pests. However, with the exception of Stewart Island farmers, stock is freely moved around the country without testing or treatment for pests and diseases, equipment shared among farms is rarely disinfected, and pest species and mortalities are frequently discarded back into the sea in close proximity to the farms.

While highly concerned about the impacts of pests and disease on their farms, mussel and oyster farmers generally believe that there is no feasible way of stopping pests and diseases being introduced to their farms, and thus, implementation of biosecurity management methods such as prohibiting stock movement, disinfecting equipment and fallowing are perceived as futile. For example, the current New Zealand oyster farmers COP states that: *"While oyster farming may be a potential vector re biosecurity threats this should be seen in context, including other vectors, for example; equipment, vessels, biota, currents, also that the key NZ Biosecurity measures against undesirable aquatic organisms are to keep them out of NZ and for early detection (most probably at ports)"* (AQNZ, 2007b). Shellfish diseases in open farms are very difficult to prevent and control, however, a number of methods have been shown to reduce the incidence of disease in cultured shellfish, including: isolating the farm; ceasing stock transfers of untested stock; culling of infected animals (and disposal off-site); disinfection of equipment; reductions in stocking density; fallowing; and, stocking disease-resistant strains that originate from a disease-free hatchery (Mohan *et al.*, 2008; Corbeil & Berthe, 2009).

International GAA and ASC biosecurity BMP criteria for bivalves currently do not address the risks of pest and disease transfers via stock and equipment transfers. GAA's Best Aquaculture Practice standard primarily focuses on staff training and recording of mortality events, while the ASC bivalve standard is more focused on preventing adverse impacts on the environment from the use of chemicals, explosives or lethal pest control methods (Table 21). Many New Zealand mussel and oyster farms meet ASC's biosecurity criteria, though a small number of farms use antifouling products on their farming structures. New Zealand mussel and oyster farms do not currently meet GAA's biosecurity criteria because they do not use a shellfish health specialist to train their staff or liaise with authorities. Only two oyster farms and one mussel farm surveyed were regularly visited by a shellfish health specialist.

[38] One site is in the process of installing water treatment for their hatchery.

Table 19: Comparison of how well New Zealand land-based abalone farms surveyed meet the biosecurity and disease management criteria of international best management practices certification for abalone produced by the Aquaculture Stewardship Council (ASC, 2010). Criteria have been slightly abbreviated here for brevity, for a full explanation of criteria see the appropriate standards. ✓ = all farms meet the criteria; s = some farms meet the criteria; × = no farms meet the criteria;? = unknown whether farms meet the criteria; na = not applicable.

Criteria	Farms that comply with criteria
All biological waste must be properly disposed of	✓
Stock must be certified free of diseases and pests of concern prior to transfer among farms, followed by an eight week isolation	na
Compliance with a documented protocol for health surveillance that must include:	
• stock inspections of all culture units at least once every 10 days;	✓
• routine disease testing every 6 months;	×
• disease testing of all batches of wild abalone introduced to the farm; and,	na
• any mortality event (>1% of stock and >50 abalone) must be recorded and the cause of death investigated. If mortality is not due to a non-infectious cause then the affected units must be isolated, disease testing must be conducted, a veterinarian and regulatory authorities must be notified, and animals culled (where no treatment is available).	?[39]
All equipment and clothing from other abalone farms must be disinfected before being brought onto the farm	na
Access to farmed abalone by birds and other animals is minimised (e.g., indoor culture units, netting, deterrents)	✓
No prophylactic use of antibiotics	✓
Where farms use fresh seaweed, it must be locally sourced	?

[39] Farms met these criteria for a recent mortality event. It is unknown whether all mortality events are investigated.

Table 20: Comparison of how well New Zealand salmonid farms surveyed meet the biosecurity and disease management criteria of international best management practices certifications for salmon produced by the Global Aquaculture Alliance (GAA, 2011) and the Aquaculture Stewardship Council (ASC, 2012). Criteria have been slightly abbreviated here for brevity, for a full explanation of criteria see the appropriate standards. ✓ = all farms meet the criteria; s = some farms meet the criteria; ✗ = no farms meet the criteria;? = unknown whether farms meet the criteria; na = not applicable.

Criteria	Farms that comply with criteria	
	Saltwater finfish	Freshwater finfish
Global Aquaculture Alliance Best Aquaculture Practices salmon standard		
A qualified fish health specialist must oversee a fish health management plan for the farm, direct the diagnosis and treatment of fish diseases, and co-ordinate activities with other farms in their ABMA (where ABMAs are in place)	s	s
A biosecurity and health management plan must be in place that includes:		
• cleaning and disinfecting of all equipment and footwear before it enters/leaves the farm;	s	s
• sanitary disposal of dead fish; and	✓	✓
• an altered status that requires extra vigilance if disease is suspected	s	s
The farm must comply with all legal requirements for disease testing, fish movement, disease treatment and reporting of notifiable diseases	✓	✓
Written procedures for the diagnosis and treatment of disease are required	✓	s
Farm staff shall be trained in biosecurity and health management procedures	s	s
All smolts shall be free of diseases and parasites, and vaccinated (where vaccines are available), prior to transfer to farms	s	s
Observations by farm staff of disease indicators and resulting actions concerning disease diagnosis and treatment shall be recorded	s	s
If used, medication must be prescribed by the fish health professional and used in accordance with product instructions and national regulations	na	✓
Records shall be kept of all therapeutants used	na	s
All disease outbreaks and actions shall be recorded	s	s
If the farm is a member of an ABMA, the farm shall comply with all fish health requirements of the ABMA. If no ABMA is in place, the farm shall coordinate fish health management with other BAP-certified farms within a 5 km radius	na	na
The farm shall comply with national or regional regulations on disease and parasite management	✓	✓
Aquaculture Stewardship Council salmon standard		
Farms must have a fish health management plan for the identification and monitoring of diseases	s	s
Site visits by a veterinarian at least four times per year	s	s
Site visits by a fish health manager at least once per month	s	s
100% of dead fish must be removed and disposed of in a responsible manner	✓	✓
100% of mortalities must be recorded, all mortality events shall receive a post-mortem analysis	?	?
Less than 10% of viral disease related mortality per production cycle	?	?
Less than 40% of total mortalities shall be unexplained from the last two production cycles for farms with total mortality of more than 6%	?	?
A mortalities reduction program is required that includes defined annual targets for reductions in mortalities and unexplained mortalities	?	?
Documentation of all chemicals and therapeutants used	na	?
No therapeutants that are banned in any of the primary salmon producing or importing countries are to be used	✓	✓

Criteria	Farms that comply with criteria	
	Saltwater finfish	Freshwater finfish
100% of medication events are to be prescribed by a veterinarian	na	✓
Compliance with all withholding periods	na	✓
Farm level cumulative parasiticide treatment index must be ≤13 for the most recent cycle	na	na
For farms with a PIT ≥6, it must be demonstrated that the parasiticide load of the most recent cycle is at least 15% less than the average of the two previous production cycles	na	na
No prophylactic use of antimicrobial treatments	✓	✓
No use of antibiotics that are listed as critically important for human medicine by the World Health Organization	✓	✓
≤4 antibiotic treatments in the most recent production cycle	✓	✓
If more than one antibiotic treatment is used in the most recent production cycle, it must be demonstrated that this is at least 15% less than the average of the two previous cycles	✓	✓
Farmers must demonstrate that all buyers have been provided a list of all therapeutants used in production	?	?
Bioassay analysis must be conducted to determine resistance when two applications of a treatment have not produced the expected effect	na	na
When bioassays are being conducted, an alternative treatment must be used on fish	na	na
All salmon on site must be a single year class (≤6 months between smolts are allowed as long as the site is fully fallowed between cycles)	×	×
When disease is suspected or there is an increase in unexplained mortality farms must: report the issue to the appropriate regulatory authority; increase monitoring and surveillance; and, promptly make findings publicly available	?	?
Evidence of compliance with the OIE Aquatic Animal Health Code	?	?
If an OIE-notifiable disease is confirmed on the farm, evidence that: the farms has immediately culled the pen(s) in which the disease was detected; immediately notified other farms in the ABMA; increase monitoring and conduct rigorous disease testing; and, promptly make findings publicly available	na	na

Table 21: Comparison of how well New Zealand mussel and oyster farms surveyed meet the biosecurity and disease management criteria of international best management practices certifications for mussels produced by the Global Aquaculture Alliance (GAA, 2013) and for bivalves produced by the Aquaculture Stewardship Council (ACS, 2012). Criteria have been slightly abbreviated here for brevity, for a full explanation of criteria see the appropriate standards. ✓ = all farms meet the criteria; s = some farms meet the criteria; ✗ = no farms meet the criteria;? = unknown whether farms meet the criteria; na = not applicable.

Criteria	Farms that comply with criteria	
	Mussels	Oysters
Global Aquaculture Alliance Best Aquaculture Practices Mussel Standard		
A person with relevant experience in mollusc health must liaise with authorities regarding shellfish health management and report any notifiable diseases	✗	✗
Staff shall be appropriately trained and kept up-to-date on mollusc health management by the mollusc health specialist	✗	✗
Observations by farm staff on abnormal mortalities and disease indicators, and resulting actions shall be reported and recorded	s	s
Any disease outbreaks shall be recorded	s	s
Aquaculture Stewardship Council Bivalve Standard		
No mutagenic, carcinogenic or teratogenic pesticides to be used on the farm	✓	✓
No chemicals that persist as toxins in the marine environment are to be used on the farm (including copper antifouling products)	s	s
Only non-lethal management of critical species that are pests or predators is to be used	✓	✓
Leadline or lead sinkers are permitted on predator netting	na	na
No use of explosives	✓	✓

5.3.2 Comparison of biosecurity practices among staff at different managerial levels

An understanding of the biosecurity concerns and practices among staff at different managerial levels is important, particularly for large companies where farm workers that are responsible for most of the daily jobs meet infrequently with the farm owner or manager. Creation and maintenance of biosecurity best practices within a company takes time and effort, but these can be quickly undermined by lack of staff training and support, lack of adherence to biosecurity SOPs, and a failure of staff to recognise the importance of biosecurity (Wester, 1983; Hardy-Smith, 2006).

Interviews with farm workers at several sites revealed that there is sometimes a lack of concern about biosecurity issues in farm workers, particularly for workers that haven't been in the aquaculture industry for long, or had little vested interest in the farms (four interviewees):

- *"pests are only a problem because they slow your job down"*
- *"I leave biosecurity to the boss"*
- *"contract labourers at other farms are not interested in how the farm runs, they just do their job. They won't say anything about unusual things that they notice"*

Many owners/managers are proactive in training their staff regarding biosecurity practices through staff meetings, running training courses, and encouraging them to attain formal qualifications in biosecurity and animal health (eight interviewees):

- *"it takes a lot of training to install the importance of biosecurity into them (staff)"*
- *"staff meetings are good, they make a connection between management and farm staff, and allows them to understand why certain practices are in place."*

However, two owners/managers don't believe that workers are reliable enough to notice new pest species or do not believe that biosecurity should be part of their job, and consequently do not give them any biosecurity training:

- *"it takes the workers 1–2 years before they can even look up enough from their jobs to notice what farm they are working on...they are unlikely to notice any pests before them unless they (the pests) are preventing them from doing their job"*
- *"they (farm workers) should be getting on with doing their job efficiently, not looking for pest species."*

The beliefs of farm owners/managers are influential on staff, and often staff members expressed similar opinions about biosecurity issues to their bosses (three sites), though this was not always the case (one site).

5.4 BIOSECURITY NEEDS OF THE AQUACULTURE INDUSTRY

The major biosecurity needs that were identified by the aquaculture industry are:

- industry specific Codes of Practice regarding biosecurity that have been developed with industry input and consider all types of farming operations;
- more sharing of industry knowledge regarding biosecurity;
- development of practical methods to minimise the transmission risk associated with stock transfers, e.g., depuration facilities and remote setting;
- research on the poor performance of Kaitaia spat, and whether this is disease-related;
- establishment of appropriate geographical zones (ABMAs) for biosecurity management;
- better biosecurity information from MPI (i.e., frequency, relevance, format);
- a better MPI-industry relationship across all MPI departments;
- proactive government leadership over biosecurity;
- remediation of poor water quality issues in farming areas to reduce the relaying of stock;
- addressing biosecurity issues in other marine users, e.g., recreational boating; and,
- better biosecurity information for the general public.

All of the needs identified by industry have merit. As aquaculture research specialists, we believe that the major biosecurity needs of New Zealand's aquaculture industry are: better education of the aquaculture industry; a better MPI-industry relationship; establishment of ABMAs; establishment of a national pest and disease testing and reporting system; improvement of water quality in farming areas; and, development of practical methods to minimise the transmission risk associated with stock transfers. These issues are discussed in more detail below.

Better education of the industry

The aquaculture industry in New Zealand is relatively young and the majority of aquatic farmers in New Zealand are self-taught. These self-taught farmers have no formal education in aquaculture, but have learned about their business through practical 'hands on' experience, discussions with other farmers, and self-directed reading. Given the geographic isolation of New Zealand and the historical lack of aquaculture diseases in the country, New Zealand aquatic farmers have had little experience with disease (until the 2010 OsHV-1 outbreak). Furthermore, because New Zealand aquatic farmers mainly learn through their own experiences, farming practices are generally reactive (practices change because of an identified problem), and there is little implementation of preventative biosecurity measures.

This learning approach is particularly problematic for shellfish farmers that have open farms that are vulnerable to waterborne pests and diseases, for which, there are often no effective treatments or eradication methods. Thus, there is a need for better education of the industry regarding:

- the importance of biosecurity, in particular, the implementation of preventative measures prior to pest and disease outbreaks. Given that treatment or eradication of disease and pests is usually not feasible for shellfish farms, prevention is the best option;
- the main methods of pest and disease transmission among farms;
- the need to act immediately when non-native aquatic incursions are detected. If MPI were to 'wait-and-see' whether new incursions were to become a problem, the chance of a successful eradication is almost nil;
- biosecurity measures that have been successfully used overseas to reduce the incidence of pests and diseases in open farms;
- effective on-farm biosecurity methods that farmers can implement; and,
- the business cost of 'doing nothing' regarding biosecurity (in terms of increased labour, loss of production and decreases in the market value of products);

Communication of these issues to the aquaculture industry would increase industry uptake of preventative biosecurity measures.

A better MPI-industry relationship

Currently, there is a breakdown in communication between MPI and industry. Communication from MPI to industry is currently ineffective in terms of frequency, relevance, format and audience reached. Furthermore, there is a lack of trust and confidence within the aquaculture industry for MPI, which results in industry withholding important information from MPI and using other expert sources for biosecurity advice. Establishment of trust and a good working relationship between MPI and industry is essential for effective biosecurity management and facilitating a high level of industry engagement and co-operation for any biosecurity protocols. MPI need to build up industry's trust and confidence in them by:

- better communication with respect to MPI's biosecurity capabilities;
- better communication regarding biosecurity measures that are currently in place e.g., current legislation and enforcement measures regarding international shipping (e.g., ballast water and hull fouling control), pest surveillance surveys, and pest and disease diagnostic services;
- working with regional councils to improve water quality in farming areas;
- working with industry on a face-to-face level, e.g., through industry conferences, industry working groups and meetings;
- giving serious consideration to concerns raised by industry and responding to concerns in a prompt and courteous manner. For example, industry has recently contacted MPI regarding their concerns about the potential disease risk associated with the importation of chilled salmon from the Northern Hemisphere. One farmer reported to us that: *"the first response from MPI was confrontational and has not dealt with industry concerns. The industry is very concerned with this issue and is doubtful that MPI will be favourable"*; and,
- establishing a 'no blame'[40] culture to encourage industry to share information with MPI.

[40] It is acknowledged that in certain circumstances enforcement action may be required from MPI to protect the rest of the industry or the environment.

Establishment of Aquaculture Bay Management Areas

Many of the recommended pest and disease BMP used in open farms overseas depend on the establishment of ABMAs to standardise husbandry practices and synchronise production cycles, fallowing and medication regimes. The use of ABMAs in Ireland, Scotland, Canada (New Brunswick) and USA (Maine) have been found to significantly reduce the incidence of pests and disease in open fish farms (Scottish Executive, 2000; MAA, 2002; Chang *et al.*, 2007).

ABMAs are effective because many pathogens of aquaculture species do not survive long without a host (Thomson & Side, 2002), and therefore, the temporary removal of all stock from an area is an effective method of pest and disease control. ABMAs also provide a mechanism for isolating farms from other ABMAs because the transfer of stock, equipment or vessels between ABMAs is typically prohibited. For effective isolation of ABMAs, each ABMA needs to be sufficiently separated from one another to prevent waterborne transfer of pathogens among areas, and ideally, ABMAs should be consistent with hydrographically defined boundaries (Chang *et al.*, 2014). Creation of ABMAs that were too small, too close to one another, and inconsistent with hydrographic boundaries was found to be ineffective at limiting disease transmission (Chang & Page, 2010; Chang *et al.*, 2014).

Research is needed in New Zealand on the appropriate boundaries for ABMAs that are consistent with hydrographic boundaries. In some areas, marine farms may need to be shifted to provide sufficient separation between ABMAs, and farm resource consent conditions may need to be standardised among farms. ABMAs should also be across species groups, e.g., shellfish and finfish, because some pests and diseases affect multiple species.

In order to be effective, all farms within an ABMA need to be part of the agreement. Farmers may be reluctant to participate in ABMA agreements if they are only seen as an extra suite of regulations to comply with: *"I don't want too many regulations...don't let it get out of control"*. Currently, biosecurity and husbandry practices of the aquaculture industry are very company-orientated and there is little sharing of biosecurity information among companies. Some farmers report that: *"it is difficult to collaborate with other commercial operators"*. Discussions with industry will be required to demonstrate that ABMAs are beneficial to all participants, and to collectively agree upon shared biosecurity and husbandry practices. Farmers report that discussions between farmers can often convince non-compliant farmers to change their practices:

- *"the odd farmer will rebel against common sense but they get told off by the other farmers. Industry rat bags are generally weeded out like natural selection"*
- *"farmers have a vested interest in preventing pests and diseases from entering their farms, they would put peer-pressure on farmers that are not complying."*

Establishment of a national pest and disease testing and surveillance system

Early detection of pests and diseases through good stock monitoring and routine disease testing greatly improves the probability that a pest or disease can be controlled (Subasinghe *et al.*, 2001). Routine disease testing of animals is currently conducted by 7/12 freshwater farms, 2/2 saltwater farms, 8/20 oyster farms, 3/5 research facilities, 1/19 mussel farms and 0/2 paua farms. Disease testing within the industry is currently an *ad hoc* process; finfish farmers generally conduct disease testing to comply with international certifications, while other farmers test for a variety of reasons and use various diagnostic service providers.

There is a need for improvement in the linkages between farmers, diagnosticians, researchers and authorities so that there is a simple process whereby:

1. farmers send samples for testing routinely or when they identify potential new pest or disease occurrences;
2. diagnosticians identify the pest or disease and report back to farmers and the authorities;
3. authorities inform farmers as to the best methods of control. If no control methods are available, funds are directed towards research in this area; and,
4. researchers report back their results to authorities and farmers in a concise and easily interpretable format.

Establishment of a national pest and disease testing and surveillance system such as described above, is likely to increase the percentage of farmers that routinely conduct disease testing, will assist in the early detection of pests and disease, and will improve the chances of successful control. Routine disease testing could also be required prior to the transfer of stock among ABMAs.

Improvement of water quality in farming areas

Poor water quality in farming regions compromises biosecurity and food safety because:

1. animals reared in sub-optimal conditions are more susceptible to disease;
2. farmers must relay stock to non-contaminated regions in order to be able to harvest them; and,
3. there is an increased risk of products being contaminated with human pathogens.

Water quality is affected by numerous land-users. Integrated Catchment Management Groups that involve various land users and stakeholders, e.g., land farmers, marine farmers, forestry, regional councils, iwi and central government, can provide an effective means of raising awareness of the impact of various activities on water quality, and collectively working towards solutions. Most aquatic farmers are aware that water quality problems are the responsibility of the regional council, however, they would like to see central government step in and take action when regional councils are taking too long to resolve poor water quality issues. In areas where poor water quality is an on-going, long-term problem, consideration should be given to the reallocation of marine farms.

Development of practical methods of reducing the risk of pest and disease transmission associated with stock transfers

Development and implementation of practical methods for reducing the risk of pest and disease transmission are urgently needed, particularly for the shellfish industry. Immediate prohibition of stock transfers would cripple the mussel and oyster industries because:

1. the current supply of locally caught and hatchery-reared mussel and oyster spat are insufficient to meet industry requirements;
2. the oyster industry relies on relaying stock to avoid harvest closures from poor water quality;
3. mussel farmers use a mixture of spat from Northland and Golden Bay to ensure they have a harvestable product for 10–11 months of the year (because Kaitaia spat and Golden Bay spat ripen at different times). The use of only one of these spat sources would greatly reduce the harvestable window for farmers.

Recommended methods for reducing the pest and disease transmission risk associated with stock transfers are given in Section 5.6.2.

5.5 BARRIERS TO IMPLEMENTATION OF BIOSECURITY BEST PRACTICES

Currently, there is a major discordance between the concern with the aquaculture industry for biosecurity issues and their actual biosecurity practices. Whilst 88–89% of the industry are moderately to highly concerned about pests and diseases, biosecurity practices for the majority of New Zealand farms do not meet current international standards for best practice. This section describes what we believe to be the major barriers to the implementation of biosecurity best practices in the New Zealand aquaculture industry. Recommendations to overcoming these barriers are discussed in Section 5.6.

The belief that 'nothing can be done' to stop pest and disease transmission

There is a widespread belief within the aquaculture industry that 'nothing can be done' to stop the transmission of pests and diseases around the country. Many farmers believe that water currents and other transmission vectors, e.g., boats and wild animals, will eventually transfer pests and diseases throughout the country. They have also witnessed the failed attempts to eradicate introduced pests such as *Undaria*, *Didemnum* and *Styela*. Thus, many farmers believe that biosecurity measures are pointless because *"you can't stop the tide."*

A lack of engagement by farmers for biosecurity measures

Past biosecurity measures that have been required of farmers by MPI, such as the *Didemnum* plastic wrapping trial and the washing of Kaitaia spat during *Gymnodinium catenatum* blooms, are viewed as ineffective and a waste of time and money:

- *"there was no real risk to the public, farmers were only transferring spat, not harvest-sized mussels....there were still rigorous FSA standards in place around harvest"* (regarding the *Gymnodinium* cysts in Kaitaia spat).
- "*it was a waste of money and ineffective*" (regarding the trials to control *Didemnum* with plastic wrap).

Ineffective, expensive methods encourage non-compliance and create resentment in the industry, particularly if the cost of biosecurity procedures are too high relative to the perceived risk. For example, during the 2000–2001 *Gymnodinium* bloom, mussel farmers were required to test and wash Kaitaia spat until it was clear of cysts. However, farmers believed that there was little risk to consumers from transferring the harmful algae with the spat, and it was reported that some farmers only washed the spat sample that they sent for testing, rather than the whole batch of spat. These past experiences have made farmers sceptical of biosecurity and reluctant to implement other methods.

There is also a proportion of the aquaculture industry that does not see the importance of biosecurity and are unlikely to comply with any biosecurity measures. The size of this group is uncertain because they are unlikely to have participated in this project:

- *"there is still a cowboy element to the oyster industry and they would just move stock at night"*
- *"about 30% of the oyster industry are cowboys who won't comply with any regulations"*
- *"other farmers won't have anything to do with the oyster industry, there's some bad history there"*
- *"they (farm workers) should be getting on with doing their job efficiently, not looking for pest species."*

The cost of biosecurity measures

The cost of biosecurity measures is a barrier to biosecurity best practice. Farmers won't implement biosecurity measures if they are viewed as uneconomic for their business:

- *"I wouldn't like to see too many industry/government programmes. The costs are too high and I fear that farmers will have to pay for them"*
- *"if you put heaps of criteria on, people won't do it, it costs too much money"*
- *"compliance and monitoring costs are killing the industry"*
- *"the Didemnum eradication programme cost small farmers $100–200 k, it almost closed down the individual farmers"*
- *"biosecurity measures are expensive, it's hard to justify spending money on 'low-risk' issues when there are more urgent, essential items that are required for operations."*

However, many farmers do not appear to have a good estimation of the cost of 'doing nothing' regarding biosecurity (in terms of increased labour, loss of production and decreases in the market value of products). Thus, many farmers are likely to perceive that the cost of implementing biosecurity measures is higher than it actually is.

A lack of engagement and adherence by farm workers for biosecurity protocols

Larger aquaculture companies often have fairly comprehensive SOPs regarding biosecurity, e.g., staff are required to use footbaths, equipment must be regularly cleaned and disinfected, and the movement of equipment between sites without disinfection is prohibited. However, a number of farmers admitted to us that adherence to these SOPs did not occur 100% of the time:

- *"when we are busy, staff move sites, and in practice, so does their gear"*
- *"the company has a SOP in place but there is not much of an emphasis of biosecurity on-site as there's not much of a perceived risk, e.g., footbaths are often left to dry out."*

Some farm workers do not recognise the importance of biosecurity management on their sites:

- *"I need to constantly remind staff about the importance of biosecurity, otherwise some get slack"*
- *"It would be good to have a MPI staff member come and visit staff. This would highlight the importance of biosecurity and would tell staff members that it's not just about their manager being pedantic."*

The widespread movement of stock around the country is a biosecurity risk

All of the aquaculture sectors surveyed move stock around the country, with the mussel, oyster and salmonid industries particularly reliant on stock movement. Currently, stock are rarely treated or tested for pests and diseases prior to transfer, though there are a few exceptions:

- one research facility tests all oysters for OsHV-1 before they leave the hatchery;
- one oyster hatchery treats and tests oysters for *Bonamia* regularly, and all oysters are treated with 5% acetic acid before leaving the hatchery; and,
- all salmonid eggs from Didymo-positive areas are treated before transfer to Dydimo-negative areas.

Movement of untreated/untested stock carries a high pest and disease transmission risk, however, prohibiting stock movement would have major economic consequences for many farmers because insufficient locally-caught or hatchery-reared spat are currently available.

An additional barrier to the implementation of any biosecurity measures regarding stock movement is that many farmers do not believe that stock movement carries a high transmission risk, even though this has been repeatedly demonstrated (for reviews see McKindsey *et al.*, 2007; Brenner *et al.*, 2014). For example, some oyster farmers continued to move stock around the country during the OsHV-1 outbreak:

- *"when the virus first hit, their response was to rush oysters down to the Kaipara"*
- *"some oyster farmers were bringing up untested spat from Nelson in the middle of the virus."*

Furthermore, other farmers believe that it is beneficial to spread a disease around the country to allow wild stock to develop resistance to it:

- *"let Mother Nature build up a resistant strain."*
- "*I think that it's a good idea to spread the virus around the country to allow wild stocks to develop resistance. I would encourage stock movement for that reason."*

For example, oysters from Kawhia Harbour are OsHV-1 free, but oyster farmers do not want to buy Kawhia spat because they believe that Kawhia spat has no resistance to the virus and dies as soon as it is moved out of Kawhia Harbour.

The use of wild broodstock carries a disease risk

Some freshwater salmonid farms regularly bring wild broodstock onto their sites for breeding, which carries a disease risk. Wild broodstock for freshwater salmonid farms are visually examined but are not tested or treated for diseases. Some farmers quarantine their wild broodstock downstream of the hatchery. Eggs from wild broodstock are not always disinfected unless they are being transferred from a Dydimo-positive to a Dydimo-negative area.

Research facilities also occasionally bring wild broodstock onto their site. Researchers acknowledge that this does carry a risk of introducing disease on-site. Research facilities currently manage this risk by:

- treating wild fish for endo- and ectoparasites and keeping the fish in an isolated area for around three months (one site); and,
- keeping all wild oyster broodstock in permanent isolation, prohibiting the sharing of gear, and treating all effluent water with bleach and UV.

Identification and collection of biofouling species are difficult for many farmers

Many farmers are interested in identifying what is growing on their farms and 30 interviewees stated that they would contact someone (other farmers, research institutes, MPI or council) about unusual organisms growing on their farm. However, seven interviewees reported that they don't know what most biofouling species that they see on the farm are, and don't know whether the species are native, introduced or a pest:

- *"it would be useful to know what is a pest and what isn't"*
- *"it's hard for Joe average to identify pest species"*
- *"farmers are encouraged to identify species, but unless you have a guy who can do this it is difficult."*

Farmers also report that they don't have the time to look at biofouling species or collect them while working:

- *"farm workers not looking for pests on the farm, they are just doing their work and probably wouldn't notice anything unless it was very obvious"*

- *"the guy cutting the ropes is most likely to see biofouling but he's got a dangerous job...he probably wouldn't have time to look at fouling species as he's concentrating on his job"*
- *"collecting specimens and finding bottles is a pain, and then it is difficult to remember where it was collected from."*

The inability of farmers to identify the species on their farms, and the hassle of having to collect, preserve and dispatch an unusual organism to MPI are barriers to rapid pest detection, because many farmers opt for a 'wait and see' approach rather than contacting the authorities about an unusual species:

- "*I didn't know what it was. I was meaning to check up on it"* (referring to the presence of the droplet tunicate on his farm).

Fifteen interviewees have seen the MPI pest cards; eight find them useful and one doesn't. It was suggested that industry-specific pest cards would be more useful. One interviewee thinks that more species should be included in the pest cards. Five interviewees had not seen the pest cards.

A lack of treatment of intake/effluent water in land-based facilities

Several of the land-based facilities surveyed do not have any water treatment systems in place, which allows any pests or diseases present in the waterways to enter their farms. Only two facilities treated their effluent water for pests and diseases before discharge. The large capital cost required to install water treatment systems, and the belief among farmers that water treatment is not required (because of the proximity to spring heads or the lack of disease history) are barriers to the installation of water treatment systems.

A lack of farm space to allow fallowing and single year-class culture

Single-year class production followed by a short fallow period has been shown to be very effective in reducing mortality rates in farmed salmon overseas (Wheatley *et al.*, 1995; Chang & Page, 2010; Scott, 2010). However, if current production levels are to be maintained, additional water space for farming is required in order to implement these biosecurity measures. The difficulty in obtaining resource consents for new farm space is a current barrier to the implementation of single-year class production and fallowing (Sim-Smith & Forsythe, 2013).

A lack of use of aquatic health specialists in the shellfish sectors

The majority of mussel and oyster farmers, and mussel spat harvesters don't believe that it's important that a shellfish health specialist visits their farm, and very few have a health specialist on-call if required. This lack of willingness to use health specialists is a barrier to biosecurity best practice. For early disease detection and control, it is important that farmers have access to health specialists trained in shellfish disease management and surveillance (Corbeil & Berthe, 2009), and are willing to use them. Demonstration of the importance of regular disease surveillance is required to change the current attitude of farmers.

5.6 RECOMMENDATIONS TO FACILITATE BIOSECURITY BEST PRACTICE IN THE NEW ZEALAND AQUACULTURE INDUSTRY

Based on the results of this project and our knowledge of the aquaculture industry, the following recommendations are made to facilitate biosecurity best practice in the New Zealand aquaculture industry.

5.6.1 Engagement of the aquaculture industry is critical

Engagement of the aquaculture industry is critical to ensuring widespread, effective uptake of any proposed biosecurity measures, regardless of whether they are mandatory or voluntary. The following recommendations are made to facilitate industry engagement with biosecurity measures:

Biosecurity measures must have some demonstrable benefit to farmers

On-farm biosecurity measures must have some demonstrable 'business benefit' to farmers in order to maximise farmers' engagement and compliance with biosecurity measures. That is, biosecurity procedures must be profitable or at least cost-neutral to the farmer when assessed in terms of potential increases in production, reduction in labour costs or increased market potential. For example, several salmonid farmers have signed up to a disease-free programme to increase their markets:

- *"we signed up (to the disease-free programme) practically for exporting...it costs a lot of money but it's worth it"*
- *"the disease testing costs $4–5k. It's a big expense for a small company but its good practice and keeps up with the customer's standards."*

Biosecurity procedures that are expensive to implement with little perceived benefit will not result in high industry engagement (Mohan *et al.*, 2008). Currently, many farmers only see the cost of implementing biosecurity measures, and do not have an accurate estimation of the business costs of 'doing nothing' regarding biosecurity (in terms of increased labour, loss of production and decreases in the market value of products). An understanding of the economic consequences of 'doing nothing' e.g., lack of water treatment, not using health professionals, or the transfer of untested stock, will increase the uptake of biosecurity protocols and the number of farmers that comply with regulations or COPs. We recommend that a cost-benefit analysis of biosecurity practices is conducted for the aquaculture industry, and these results are communicated to farmers to increase farmers' engagement for biosecurity measures.

Biosecurity measures need to be shown to be effective

MPI and research institutes need to provide easily interpretable and accessible information to the aquaculture industry that demonstrates that proposed biosecurity methods are effective. There needs to be a fundamental change in belief in the aquaculture industry from 'nothing can be done' to the realisation that on-farm biosecurity measures can prevent or minimise pest and disease entry into farms. Education of the industry in the following areas is needed to change industry's attitudes and to increase engagement for biosecurity measures:

- the importance of biosecurity, in particular, the importance of implementing preventative measures prior to pest and disease outbreaks;
- the need for early detection and rapid action against pest and disease incursions/outbreaks;
- the main methods of pest and disease transmission among farms;

- biosecurity measures that have been successfully used overseas to reduce the incidence of pests and diseases in open farms; and,
- effective on-farm biosecurity methods that farmers can implement.

We recommend that this information is conveyed to industry using real-life examples, and in a format that industry prefers, e.g., conference presentations or industry magazine articles. Ideally, it would be very effective to have an overseas farmer or researcher give a presentation to industry who has personally: experienced a disease outbreak; implemented new biosecurity methods; and, seen the benefits of the implemented methods.

Internationally, aquatic biosecurity is still a developing research field and currently there are no known feasible control methods for many aquatic pests and diseases. Thus, on-going research trials will be required for the development of on-farm biosecurity methods in New Zealand. We recommend that MPI and researchers work with industry in the development and trial of any on-farm biosecurity measures. This will give industry a sense of ownership of the methods, an understanding of the difficulties in developing control methods, and will demonstrate the effectiveness of any implemented measures.

Better education of farm staff to encourage engagement and adherence to biosecurity measures

An improvement in biosecurity education is needed for all farm staff, not just the farm owners/managers. A lack of engagement by some farm staff was identified as a barrier to biosecurity best practice. Improvement in staff engagement with respect to on-site biosecurity can be made through:

1. sending staff on formal education courses to increase their understanding of the importance of biosecurity:
   - *"I encourage them to go on courses...ones that have unit standards on fish behaviour and health"*
   - *"it takes a lot of training to install the importance of biosecurity in them (staff)";*
2. staff meetings and in-house training to emphasise the importance of biosecurity on-site and to maintain biosecurity practices: *"staff meetings are good, they make a connection between management and farm staff, and allows them to understand why certain practices are in place";* and,
3. creating a positive workplace attitude regarding biosecurity practices. The attitudes of the farm owner/manager and positive peer-pressure from colleagues has been shown to be influential in the biosecurity practices and attitudes of farm staff (Delabbio, 2006). A positive workplace attitude is also critical to maintaining biosecurity awareness within a company.

Biosecurity education courses run by MPI, in collaboration with industry, or the provision of funding to subsidise the costs of biosecurity courses may encourage more farm owners/managers to send their staff on courses.

MPI needs to improve on their relationship with industry

MPI needs to work on improving their relationship with the aquaculture industry to earn industry's trust and maximise industry engagement for biosecurity protocols. In order to achieve this we recommend that MPI:

- update their contact database of marine and freshwater farmers, to ensure that their communications to industry are reaching all relevant parties;

- provide better quality biosecurity information to the industry. Current information provided to the industry was identified as insufficient in frequency and is often ignored by industry because it is too difficult or time-consuming to read. Industry would like to receive more regular information from MPI regarding biosecurity that is easy to read, relevant to their sector, concise and up-to-date. Industry do not like reading long emails or reports. Recommended forms of communication include brief direct emails, information sent via industry associations, the use of industry magazines and presentations at conferences/workshops. Use of multiple forms of communication will also improve information distribution. For example, it is recommended that the results of this project are communicated to industry via a short email flyer, an article in the AQNZ magazine and through presentations to industry groups. Biosecurity issues identified in this project that need to be communicated to the industry include:
  - MPI's biosecurity capabilities;
  - biosecurity measures that are currently in place in New Zealand, e.g., current legislation and enforcement measures regarding international shipping (e.g., ballast water and hull fouling control), pest surveillance surveys, and pest and disease diagnostic services;
  - points of contact and responsibilities of various MPI departments and regional councils regarding biosecurity, food safety and water quality; and,
  - biosecurity measures that are used overseas to successfully reduce the incidence of pests and diseases in open farms;
- spend more time 'on the ground' with industry through industry working groups, conferences and personal contacts;
- provide effective, coordinated and helpful service across all MPI departments because MPI is viewed as one organisation by farmers, and establish points of contact for the various departments that famers use e.g., aquaculture, biosecurity, food safety and exports;
- take responsibility for biosecurity issues and demonstrate that MPI are working on biosecurity risk management across all aquatic users e.g., boat owners, ports, commercial fishing companies;
- give serious consideration to concerns raised by industry and responding to concerns in a prompt and courteous manner;
- work with regional councils, land and water users, and stakeholders to improve water quality issues so that farmers do not need to relay stock;
- establish a 'no-blame' culture to encourage industry to share information with MPI. However, in certain circumstances, enforcement action may be required from MPI to protect the rest of the industry or the environment; and,
- provide effective media coverage to counteract the 'scaremongering' that occurs in the media about pests and diseases in aquaculture.

Industry-specific Codes of Practice should include biosecurity

The majority of the aquaculture industry thought that industry-specific COP regarding biosecurity would be useful. About half the respondents thought that COPs should be voluntary, with the other half believing that they should be mandatory or part mandatory. We suggest that COP are made voluntary but are linked to quality accreditation schemes that provide a market advantage to farmers e.g., similar to organic certification, to encourage compliance. We recommend that as part of the current revision of the COPs, AQNZ work at developing and promoting a market advantage for those farmers than comply with the COPs. Furthermore, to encourage compliance, any COP needs to be developed with industry

involvement and should consider all types of farming operations within the sector, not just the largest or most common operations.

5.6.2 Implementation of biosecurity measures at a national or regional level

While much of this project has focused on on-farm biosecurity practices within the aquaculture industry, biosecurity measures must also be implemented at a national or regional level for effective pest and disease management.

Biosecurity should be managed in geographic zones (Aquaculture Bay Management Areas)

Biosecurity should be managed in geographic zones (ABMAs) that correspond to different water bodies rather than by regional authority boundaries or farm sites. A number of farms are located in close proximity of one another, and several farmers are concerned about inter-site biosecurity. Farmers suggested that the development of shared biosecurity plans with neighbouring farms would be beneficial. A current example of biosecurity management by geographic zone is the establishment of the Top of the South Biosecurity Partnership. This partnership aims to protect the top of the South Island from damaging marine pests and diseases, and involves representatives from the Tasman District Council, Nelson City Council, Marlborough District Council, MPI, DOC, the aquaculture industry, port companies, tangata whenua and other stakeholders (www.marinebiosecurity.co.nz).

MPI, regional councils, researchers and industry need to work together to establish ABMAs within New Zealand. Work is needed on:

- appropriate ABMA boundaries that are consistent with hydrographic boundaries and are sufficiently separated from one another. In some areas, marine farms may need to be shifted to provide sufficient separation between ABMAs;
- standardisation of farm resource consents if they contradict ABMA agreements; and,
- facilitation of industry-government discussions regarding the formation of ABMAs, their effectiveness, and farming practices that will be covered by the ABMA agreement.

Single-year class management and fallowing for finfish

ABMA agreements combined with single-year class production and a short fallow period (1-3 months) after each production cycle have proven to be very effective in reducing mortality rates in farmed salmon overseas (Wheatley *et al.*, 1995; Chang & Page, 2010; Scott, 2010) and reducing the use of antibiotics and antiparasitic chemicals in aquaculture (Midtlyng *et al.*, 2011). We recommend that single-year class production should be carried out at all finfish sites, with a short fallow period between production cycles to limit disease transmission. All farmers within the same ABMA should stock the same year-class, and stock, vessels and equipment should not be transferred among different ABMAs to limited disease transmission.

It should be noted that additional farming space will be required in order to implement single-year class management and fallowing without a decrease in annual production. In order to encourage the uptake of these biosecurity methods in New Zealand, we suggest that regulatory authorities make additional farming space available to finfish farmers, with the proviso that the additional farming space will be used to implement single-year class management and fallowing practices.

Establishment of a national pest and disease testing and surveillance system

Early detection of pests and diseases through good stock monitoring and routine disease testing greatly improves the probability that a pest or disease can be controlled (Subasinghe *et al.*, 2001). While MPI already have a free 0800 pest and disease identification service and a user-pays routine disease testing service, these services are not widely known about or used by industry. Currently, disease testing within the industry occurs infrequently and on an *ad hoc* basis, particularly in some sectors.

We recommend that a national pest and disease testing and surveillance system is established where farmers are informed as to how that can (and should) routinely send animals for testing. Any routine disease testing service should be inexpensive to encourage widespread participation. For example, the Fish Health Inspectorate of Scotland provides a free disease testing service for fish farmers and conducts annual site inspections and disease testing of fish farms and wild fish populations (The Scottish Government, 2010).

Establishment of a national pest and disease testing and surveillance system is likely to increase the percentage of farmers that routinely conduct disease testing, will assist in the early detection of pests and disease, and will improve the chances of successful control.

Practical methods are needed to reduce the risk of pest and disease transmission with stock transfers

The New Zealand aquaculture industry is currently highly reliant on stock transfers, and prohibition of stock movement is not a feasible short-term solution for reducing the risk of pest and disease transmission. Research is needed on practical methods to reduce the dependence of the industry on stock transfers, and for testing or treating stock to minimise the transmission risk. Some recommended methods to be investigated include:

1. *continued research on disease-resistant oysters*—the breeding of disease resistant animals for aquaculture have greatly improved survival and productivity of cultured animals overseas (Cheney *et al.*, 2004; Lightner, 2011; Dove *et al.*, 2013). However, the ability to utilise single seed stock will require a capital investment for many New Zealand oyster farmers who currently farm on sticks or ropes. Some farmers also report that they cannot afford to purchase single seed spat;
2. *the development of remote setting technology for oysters*—remote setting would allow small farming operations to: access disease-resistant family lines at a fraction of the cost of single seed spat; continue farming on sticks; and remove the need for wild spat transfers;
3. *the installation of holding and purging facilities for shellfish*—shellfish growers overseas use depuration facilities to purge shellfish of any bacterial contaminants or toxic microalgae (McKindsey *et al.*, 2007). The economic feasibility of using depuration facilities in New Zealand should be investigated. These facilities would remove the need for relaying oysters to different harbours prior to harvest and is likely to improve product supply to the factories. It may also be possible to use these facilities for Kaitaia spat during toxic algae blooms;
4. *use of freshwater, hot water or air exposure to reduce shellfish pests*—use of freshwater baths, hot water dips and/or long periods of air-exposure prior to stock transfers are recommended by the Australia Government to minimise the transmission risk of fouling pests. Tolerances of both the host and the pest to the various treatments vary with species (Commonwealth of Australia, 2013).
5. *biosecurity certification of hatcheries*—biosecurity certification and auditing of hatcheries to ensure that hatcheries are distributing pest and disease-free stock (Sinner *et al.*, 2013).

6. *routine disease testing prior to stock transfers*—routine disease testing of stock should be required prior to the transfer of stock among ABMAs (once established).
7. *quarantining and routine disease testing for wild broodstock*—quarantining and routine disease testing for wild broodstock should be required;
8. *routine egg disinfection*—all finfish eggs should be routinely disinfected prior to transfer to minimise disease transmission from parents to offspring. This is particularly important prior to transfer; and,
9. *preventing stock transfers from pest and disease positive sites to negative sites*—stock transfers or releases should be prohibited from areas where certain pests and diseases have been confirmed to areas where pests and diseases are absent. This biosecurity practice is already used in New Zealand to minimise the spread of Dydimo, and is used overseas to prevent the spread of other diseases e.g., whirling disease (Wagner, 2002; Colorado Parks and Wildlife, 2014).

Research on the poor performance of Kaitaia spat

Research is needed on why the performance of Kaitaia mussel spat has greatly declined in the past decade, and whether it is a biosecurity-related issue. The poor performance of Kaitaia spat may be caused by:

1. disease—there are few known diseases of green-lipped mussels, however, this does not mean that diseases are not present (Castinel *et al.*, 2014). An RNA virus was associated with high mortalities of recently reseeded mussel spat from the Marlborough Sounds and in hatchery-reared spat. It appears that the virus is a common shellfish pathogen in the wild, but only causes severe mortalities when the mussels are stressed or vulnerable (e.g., after transport and/or reseeding) (Hay & Hooker, 1994; Jones *et al.*, 1996). Pathogenic species of *Vibrio* bacteria have been identified from hatchery-reared mussel larvae, but not from wild animals (Kesarcodi-Watson *et al.*, 2009);
2. sub-optimal transport conditions—packing and transport conditions for spat vary among harvesters and some conditions appear to be sub-optimal. Hayden *et al.* (2001) found that survival of Kaitaia spat was the highest if the spat are kept below 5 °C, are not in direct contact with ice or ice melt water and are out of the water for less than 7 days.
3. predation—fish predation of recently seeded mussel spat can be up to 100% within 24 hours at some sites, with survival of spat being significantly lower at 15 m depth than at 5 m depth (Hayden, 1995). Spat losses from predation are supported by reports from interviewees that spat survival is often lower on the bottom half of the ropes, and that snapper numbers around mussel farms in the Coromandel have noticeably increased over time; and/or,
4. poor retention—mussel spat have the ability to move away if they are located in unfavourable conditions, and therefore, the environmental conditions of the farm site will affect spat retention (Sim-Smith, 2006). Spat retention has been shown to be significantly higher in areas of high turbulence and current speeds (Buchanan, 1994; Hayden & Woods, 1997), and when spat are in good nutritional condition (Foote, 2003). Some interviewees reported that they maximise their spat retention by seeding their spat out on their farms that have the best growing conditions, however, it appears that not all farmers follow this practice.

Routine record keeping of stock mortalities is often recommended as a useful tool for early disease detection (e.g., Castinel *et al.*, 2014). However, without a better understanding of the factors that affect spat retention and mortality, record keeping is likely to have limited use as a disease indicator for mussel farmers. It is unlikely that the poor spat performance is simply a

result of a lower proportion of mussels in the Kaitaia spat[41]. The mussel spat harvesters COP requires mussel spat harvesters to provide estimations of the average size of spat and the spat count per kg of seaweed for each shipment of spat sent to farmers (MFA, 2012). Although the COP is voluntary, spat harvesters that send down shipments with low concentrations of mussel spat/kg are unlikely to remain in business for long.

Farmers need more assistance with pest identification

Many farmers find identification and collection of biofouling species difficult, which makes them reluctant to collect and send unusual specimens to MPI. Simple identification tools, such as an industry-specific biosecurity mobile phone application (app), could assist with rapid pest detection. It is suggested that an app is developed that allows farmers to take a photo of any unusual species that they see on the farm and email it directly to MPI for identification. This would save farmers the hassle of collecting, preserving and dispatching any unusual specimens. The app could also record the GPS location of the photo if subsequent collection was required to confirm the identity of the specimen. It could also be a portal for regular updates on new pest species to look out for.

Better collaboration and education on biosecurity issues is needed

Better collaboration and education on biosecurity issues is needed, both within industry and between industry and the general public. We recommend that this is achieved through:

- the creation of internal industry working groups to discuss biosecurity practices, particularly in regard to the shared biosecurity practices and the establishment of ABMAs; and,
- industry participation in external stakeholder groups, e.g., integrated catchment management groups and community events, so that all aquatic users have an understanding of how their actions affect biosecurity and what they can do to improve biosecurity.

Working with external stakeholders would increase the public's understanding of aquaculture in New Zealand, provide transparency about farmers' operations, and ensure that the aquaculture industry are included in collaborative decision making processes regarding issues that affect their operations.

[41] Analysis of the composition of Kaitaia spat shows that it comprises, on average, 50% seaweed, 26% green-lipped mussels and 19% sediment, and 5% 'other'(by wet weight). There were no other mussel species present in the samples (Jeffs *et al*., 2005).

6 Conclusion

The diverse range of farming activities and opinions of aquatic farmers in New Zealand makes it a challenge to develop effective biosecurity measures that are embraced by all the aquaculture industry. Compared to international biosecurity practices in Europe and North America, New Zealand's current biosecurity practices are relatively basic in most aquatic farms (Sim-Smith & Forsythe, 2013). New Zealand's geographic isolation has offered the country some protection from pests and diseases in the past. However, with increasing globalisation, New Zealand cannot continue to rely on our isolation to protect us from pest and disease incursions. As one interviewee concluded, *"if something comes in we need to already be doing best management practices."*

The majority of the aquaculture industry is highly concerned about preventing and managing pests and diseases on their farm. However, many farmers currently think that the only feasible method of biosecurity management is the prevention of pests and diseases from entering the country. While this is the most preferable solution because control of aquatic pests and diseases is extremely difficult, there are a number of biosecurity practices that can mitigate the effects of pests and diseases on aquaculture operations.

There needs to be a fundamental change in belief in the aquaculture industry from its current view of 'nothing can be done' to the recognition that on-farm biosecurity measures can prevent or minimise pest and disease entry into farms. This change in belief can be achieved through good scientific advice, examples of overseas farmers' disease experiences and control methods, effective communication of this information, development of practical, effective biosecurity methods, providing farmers assistance with pest and disease identification and testing, and the establishment of a good government-industry relationship.

Engagement of the aquaculture industry is critical to the implementation of biosecurity best practice in New Zealand. Without effective industry engagement, compliance with biosecurity measures, regardless of whether they are mandatory or voluntary, is likely to be low. Effective engagement of the aquaculture industry can be promoted by good communication of biosecurity information to the industry, educating farm staff on the importance of biosecurity, involving industry in the development of biosecurity measures, ensuring biosecurity measures are effective and beneficial to farmers, promoting the benefits of biosecurity to farmers in terms of increased production, decreased labour costs and better trade access, and by improving government-industry relations. Good biosecurity management is a common goal for the aquaculture industry and government, and one that they should work towards together.

7 References

ACS (2012). ASC bivalve standard, ver. 1.0. Aquaculture Stewardship Council, The Netherlands. 57 pp. Available from http://www.asc-aqua.org/upload/ASC%20Bivalve%20Standard_v1.0.pdf (Accessed June 2014).

Adams, C.M.; Shumway, S.E.; Whitlatch, R.B.; Getchis, T. (2011). Biofouling in marine molluscan shellfish aquaculture: a survey assessing the business and economic implications of mitigation. *Journal of the World Aquaculture Society 42(2)*: 242–252.

AQNZ (2007a). Greenshell mussel industry environmental code of practice. Aquaculture New Zealand, Nelson. Available from http://musselfarmnz.com/downloads/Mussel_industry_code_of_practice.pdf (Accessed May 2014).

AQNZ (2007b). New Zealand oyster industry code of practice. Aquaculture New Zealand, Nelson. 52 pp.

Aquaculture NZ (2012). A sustainable growth story. Nelson. 8 pp. Available from http://aquaculture.org.nz/wp-content/uploads/2012/12/A-sustaianble-growth-story.pdf (Accessed May 2014).

ASC (2010). ASC abalone standard, ver. 1.0. Aquaculture Stewardship Council, Utrecht, The Netherlands. 42 pp. Available from http://www.asc-aqua.org/upload/ASC%20Abalone%20Standard_v1.0.pdf (Accessed June 2014).

ASC (2012). ASC salmon standard. ver. 1.0. Aquaculture Stewardship Council, The Netherlands. 103 pp. Available from http://www.asc-aqua.org/upload/ASC%20Salmon%20Standard_v1.0.pdf (Accessed April 2013).

Bell, A.; Phillips, S.; Georgiades, E.; Kluza, D. (2011). Risk analysis: vessel biofouling. Ministry of Agriculture and Forestry, Wellington. 145 pp.

Bergfjord, O.J. (2009). Risk perception and risk management in Norwegian aquaculture. *Journal of Risk Research 12(1)*: 91–104.

Brenner, M.; Fraser, D.; Van Nieuwenhove, K.; O'Beirn, F.; Buck, B.H.; Mazurié, J.; Thorarinsdottir, G.; Dolmer, P.; Sanchez-Mata, A.; Strand, O.; Flimlin, G.; Miossec, L.; Kamermans, P. (2014). Bivalve aquaculture transfers in Atlantic Europe. Part B: Environmental impacts of transfer activities. *Ocean & Coastal Management 89*: 139–146.

Buchanan, S. (1994). The settlement behaviour and recruitment of *Perna canaliculus*. MSc thesis. University of Auckland, Auckland, New Zealand. 112 pp.

Burgess, T.F. (2001). A general introduction to the design of questionnaires for survey research. University of Leeds, UK. Available from http://www.cavehill.uwi.edu/cermes/SocMonPub/Workshop_trainin_%20resources/Recommended_reading/Questionnaire%20design%20and%20analysis/Burgess_2001_Survey_design.pdf (Accessed September 2013).

Castinel, A.; Forrest, B.M.; Hopkins, G. (2014). Review of disease risks for New Zealand shellfish aquaculture: perspectives for management. *Cawthron Report No. 2297 for the Ministry for Business, Innovation and Employment*. Nelson. 31 pp.

Chang, B.; Page, F.H. (2010). The development of the salmon aquaculture industry in southwestern New Brunswick, Bay of Fundy. *In*: Cooper, L.L.; Stephenson, R.L.; Annala, J.H. (Eds). *Gulf of Maine Symposium–Advancing ecosystem research for the future of the Gulf: proceedings of a symposium held at St Andrews, NB, October 5–9, 2009. Canadian Technical Report of Fisheries and Aquatic Sciences no. 2904*, St Andrews, New Brunswick. p. 69.

Chang, B.; Page, F.H.; Losier, R.J.; Lawton, P.; Singh, R.; Greenberg, D.A. (2007). Evaluation of bay management area scenarios for the southwestern New Brunswick salmon aquaculture industry: Aquaculture Collaborative Research and Development Program final project report. *Canadian Technical Report for Fisheries and Aquatic Sciences no. 2722*. St Andrews, New Brunswick. 69 pp.

Chang, B.D.; Coombs, K.A.; Page, F.H. (2014). The development of the salmon aquaculture industry in southwestern New Brunswick, Bay of Fundy, including steps toward integrated coastal zone management. *Aquaculture Economics and Management 18(1)*: 1–27.

Chang, F.H.; Anderson, C.; Boustead, N.C. (1990). First record of a *Heterosigma* (Raphidophyceae) bloom with associated mortality of cage-reared salmon in Big Glory Bay, New Zealand. *New Zealand Journal of Marine and Freshwater Research 24(4)*: 461–469.

Cheney, D.; Burnett, L.; Christy, A.; Davis, J.; Elston, R.; Friedman, C.; Griffin, F.; Langdon, C.; Suhrbier, A. (2004). Improvement of disease resistance and understanding of summer mortality in Pacific oysters *Crassostrea gigas*. *Journal of Shellfish Research 23(1)*: 284–285.

Chu, J.; Anderson, J.L.; Asche, F.; Tudur, L. (2010). Stakeholders' perceptions of aquaculture and implications for its future: a comparison of the U.S.A. and Norway. *Marine Resource Economics 25(1)*: 61–76.

Colorado Parks and Wildlife (2014). Whirling disease and Colorado's trout. http://cpw.state.co.us/learn/Pages/WhirlingDiseaseCOTrout.aspx (Accessed June 2014).

Commonwealth of Australia (2013). National biofouling management guidelines for the aquaculture industry. Canberra. 26 pp. Available from http://www.marinepests.gov.au/marine_pests/publications/Documents/Aquaculture_guidelines.pdf (Accessed June 2014).

Corbeil, S.; Berthe, F.C.J. (2009). Disease and mollusc quality. *In*: Shumway, S.E.; Rodrick, G.E. (Eds). *Shellfish Safety and Quality*, Woodhead Publishing Ltd, Cambridge, UK. pp. 270–294.

Coutts, A.D.M.; Sinner, J. (2004). An updated benefit-cost analysis of management options for *Didemnum vexillum* in Queen Charlotte Sound. *Cawthron report no. 925 for the Marlborough District Council*. Nelson. 14 pp.

Cranfield, H.J.; Gordon, D.P.; Willan, R.C.; Marshall, B.A.; Battershill, C.N.; Francis, M.P.; Nelson, W., A; Glasby, C.J.; Read, G.B. (1998). Adventive marine species in New Zealand. *NIWA Technical Report no. 34*. Wellington. 48 pp.

Delabbio, J. (2006). How farm workers learn to use and practice biosecurity. *Journal of Extension 44(6)*: http://www.joe.org/joe/2006december/a2001.php.

Diggles, B.D.; Hine, P.M.; Handley, S.; Boustead, N.C. (2002). A handbook of diseases of importance to aquaculture in New Zealand. *NIWA Science and Technology Series no. 49*. Wellington. 200 pp.

Dijkema, R. (1995). Large-scale recirculation systems for storage of imported bivalves as a means to counteract introduction of cysts of toxic dinoflagellates in the coastal waters of the Netherlands. *In*: Poggi, R.; Le Gall, J.Y. (eds). 2nd Conference Internationale sur la Purification des Coquillages. Rennes, France, 6–8 April 1992. IFREMER, pp. 355–367.

Dodgshun, T.; Taylor, M.; Forrest, B.M. (2007). Human-mediated pathways of spread for non-indigenous marine species in New Zealand. *DOC Research and Development Series 266*. Department of Conservation, Wellington. 44 pp.

Dove, M.C.; Nell, J.A.; O'Connor, W.A. (2013). Evaluation of the progeny of the fourth-generation Sydney rock oyster *Saccostrea glomerata* (Gould, 1850) breeding lines for resistance to QX disease (*Marteilia sydneyi*) and winter mortality (*Bonamia roughleyi*). *Aquaculture Research 44(11)*: 1791–1800.

Foote, G. (2003). Characterisation of the viability of Greenshell™ mussel spat, *Perna canaliculus* with respect to hatchery production and growout retention. MSc thesis. University of Auckland, Auckland, New Zealand. 52 pp.

GAA (2011). Salmon farm best aquaculture practices standards. Global Aquaculture Alliance, St Louis, Missouri. 22 pp. Available from http://www.gaalliance.org/cmsAdmin/uploads/BAP-SalmonF-611S.pdf (Accessed June 2014).

GAA (2013). Mussel farms best aquaculture practices standards. Global Aquaculture Alliance, St Louis, Missouri. 16 pp. Available from http://www.gaalliance.org/cmsAdmin/uploads/bap-musself-813.pdf (Accessed June 2014).

Hardy-Smith, P. (2006). Biosecurity at the farm level – how to create a state of mind. *In*: Scarfe, A.D.; Lee, C.-S.; O'Bryen, P.J. (Eds). *Aquaculture Biosecurity: Prevention, Control, and Eradication of Aquatic Animal Disease*, Blackwell Publishing, Iowa. pp. 149–154.

Hay, B.; Hooker, S. (1994). An investigation into the feasibility of producing Greenshell™ mussel spat (*Perna canaliculus*) in a hatchery. *A report for the NZ Mussel Industry Council*. Auckland Uniservices and AquaBio Consultants Ltd, 27 pp.

Hayden, B. (1995). Factors affecting recruitment of farmed Greenshell™ mussels, *Perna canaliculus* (Gmelin) 1791, in Marlborough Sounds. PhD thesis. University of Otago, Dunedin, New Zealand. 274 pp.

Hayden, B.; Woods, C. (1997). Current speed has an effect on mussel spat retention. *Aquaculture Update 19*: 9.

Hayden, B.; Woods, C.; Hatton, S. (2001). Handling and storage conditions to optimise survival of mussel spat. *NIWA client report for the NZ Mussel Industry Council*. 9 pp.

Hine, P.M.; MacDiarmid, S.C. (1997). Contamination of fish products: risks and prevention. *OIE Revue Scientifique et Technique 16(1)*: 135–145.

Hooper, C.; Hardy-Smith, P.; Handlinger, J. (2007). Ganglioneuritis causing high mortalities in farmed Australian abalone (*Haliotis laevigata* and *Haliotis rubra*). *Australian Veterinary Journal 85(5)*: 188–193.

Inglis, G.; Morrisey, D.; Woods, C.; Sinner, J.; Newton, M. (2013). Managing the domestic spread of harmful marine organisms. Part A – operational tools for management. *NIWA client report CHC2013-150 for the Ministry for Primary Industries, Preparedness and Partnerships Directorate*. Christchurch. 166 pp.

Jeffs, A.G.; Sim-Smith, C.; Alfaro, A.C. (2005). Development of the green-lipped mussel spat resource in northern New Zealand. *NIWA Client report AKL2005-06 for the NZ Mussel Industry Council*. 55 pp.

Jones, J.B.; Scotti, P.D.; C, D.S.; Wesney, B. (1996). Virus-like particles associated with marine mussel mortalities in New Zealand. *Diseases of Aquatic Organisms 25*: 143–149.

Kesarcodi-Watson, A.; Kaspar, H.; Lategan, M.J.; Gibson, L. (2009). Two pathogens of Greenshell™ mussel larvae, *Perna canaliculus: Vibrio splendidus* and a *V. coralliilyticus*-neptunius-like isolate. *Journal of Fish Diseases 32(6)*: 499–507.

Lees, D.; Younger, A.; Doré, B. (2010). Depuration and relaying. *In*: Rees, G.; Pond, K.; Kay, D.; Bartram, J.; Santo Domingo, J. (Eds). *Safe Management of Shellfish and Harvest Waters*, IWA Publishing, London. pp. 145–181.

Lightner, D.V. (2011). Virus diseases of farmed shrimp in the western hemisphere (the Americas): a review. *Journal of Invertebrate Pathology 106(1)*: 110–130.

MAA (2002). Cooperative Bay Management Agreement. Maine Aquaculture Association, Hallowell, Maine.

MacKenzie, L.A.; Smith, K.F.; Rhodes, L.L.; Brown, A.; Langi, V.; Edgar, M.; Lovell, G.; Preece, M. (2011). Mortalities of sea-cage salmon (*Oncorhynchus tshawytscha*) due to a bloom of *Pseudochattonella verruculosa* (Dictyochophyceae) in Queen Charlotte Sound, New Zealand. *Harmful Algae 11*: 45–53.

Manfreda, K.L.; Bosnjak, M.; Berzelak, J.; Haas, I.; Vehovar, V. (2008). Web surveys versus other survey modes: a meta-analysis comparing response rates. *International Journal of Market Research 50(1)*: 79–104.

McConnachie, S.H.; Guselle, N.J.; Speare, D.J. (2013). Retention of viable microsporidial (*Loma salmonae*) spores within the blue mussel (*Mytilus edulis*): use of an experimental laboratory model probing pathogen transfer within a multi-trophic aquaculture setting. *Aquaculture 376–379*: 1–5.

McKindsey, C.W.; Landry, T.; O'Beirn, F.X.; Davies, I.M. (2007). Bivalve aquaculture and exotic species: a review of ecological considerations and management issues. *Journal of Shellfish Research 26(2)*: 281–294.

Meyer, F.P. (1991). Aquaculture disease and health management. *Journal of Animal Science 69(10)*: 4201–4208.

MFA (2012). Code of Practice: Ninety Mile Beach (Te Oneroa A Tohe) weed/mussel spat collecting, storage, transport and seeding. Marine Farming Association, Nelson. 8 pp.

Midtlyng, P.J.; Grave, K.; Horsberg, T.E. (2011). What has been done to minimize the use of antibacterial and antiparasitic drugs in Norwegian aquaculture? *Aquaculture Research 42(Suppl. 1)*: 28–34.

Mohan, C.V.; Phillips, M.J.; Bhat, B.V.; Umesh, N.R.; Padiyar, P.A. (2008). Farm-level plans and husbandry measures for aquatic animal disease emergencies. *OIE Revue Scientifique et Technique 27(1)*: 161–173.

Molloy, S.D.; Pietrak, M.R.; Bricknell, I.; Bouchard, D.A. (2013). Experimental transmission of infectious pancreatic necrosis virus from the blue mussel, *Mytilus edulis*, to cohabitating Atlantic salmon (*Salmo salar*) smolts. *Applied and Environmental Microbiology 79(19)*: 5882–5890.

MPI (2013). Ships and vessels. Ministry for Primary Industries. www.biosecurity.govt.nz/enter/ships (Accessed Feb 2014).

NZ Salmon Farmers Association Inc (2009). Finfish Aquaculture Environmental Code of Practice. NZ Salmon Farmers Association Inc, Nelson. 26 pp.

NZMIC (2002). New Zealand mussel industry national spat transfer programme. New Zealand Mussel Industry Council, Nelson. 15 pp.

Pietrak, M.R.; Molloy, S.D.; Bouchard, D.A.; Singer, J.T.; Bricknell, I. (2012). Potential role of *Mytilus edulis* in modulating the infectious pressure of *Vibrio anguillarum* 02β on an integrated multi-trophic aquaculture farm. *Aquaculture 326–329*: 36–39.

Saksida, S.M. (2006). Infectious haematopoietic necrosis epidemic (2001 to 2003) in farmed Atlantic salmon *Salmo salar* in British Columbia. *Diseases of Aquatic Organisms 72(3)*: 213–223.

Schonlau, M.; Fricker, R.D.; Elliot, M.N. (2006). *Conducting Research Surveys via E-mail and the Web*. RAND Corporation, 142 pp.

Scott, D. (2010). A review of the regulation of salmon farming in Scotland. Stirling Aquaculture, Stirling. 20 pp. Available from http://cmsdevelopment.sustainablefish.org.s3.amazonaws.com/2011/05/23/salmon%20report%20-%20Stirling-ba59deb5.pdf (Accessed May 2013).

Scottish Executive (2000). Final report of the joint government/industry working group on infectious salmon anaemia (ISA). Aberdeen. 142 pp. Available from http://www.scotland.gov.uk/Uploads/Documents/JGIWGReport.pdf (Accessed May 2013).

Sim-Smith, C. (2006). Greenshell™ mussels: solving the case of the disappearing spat. *Water & Atmosphere 14(3)*: 15–17.

Sim-Smith, C.; Forsythe, A. (2013). Comparison of the international regulations and best management practices for marine finfish farming. *NIWA client report AKL2013-13 prepared for the Ministry for Primary Industries*. Auckland. 85 pp.

Sinner, J.; Forrest, B.M.; Newton, M.; Hopkins, G.; Inglis, G.; Woods, C.; Morrisey, D. (2013). Managing the domestic spread of harmful marine organisms, part B: statutory framework and analysis of options. *Cawthron report no. 2442 for the Ministry for Primary Industries Preparedness and Partnerships Directorate*. Nelson. 72 pp.

Stewart, J.E. (1998). Sharing the waters: an evaluation of site fallowing, year class separation and distances between sites for fish health purposes on Atlantic salmon farms. *Canadian Technical Report of Fisheries and Aquatic Sciences no. 2218*. Dartmouth, Nova Scotia. 56 pp.

Subasinghe, R.P.; Bondad-Reantaso, M.G.; McGladdery, S. (2001). Aquaculture development, health and wealth. *In*: Subasinghe, R.P.; Bueno, P.; Phillips, M.J.; Hough, C.; McGladdery, S.; Arthur, J.R. (Eds). *Aquaculture in the Third Millennium. Technical Proceedings of the Conference on Aquaculture in the Third Millennium, Bangkok, Thailand, 20–25 February 2000*, Food and Agriculture Organization of the United Nations, Rome. pp. 167–191.

The Scottish Government (2010). Fish health inspectorate service charter. 15 pp. Available from http://www.scotland.gov.uk/Resource/Doc/295194/0101169.pdf (Accessed June 2014).

Thomson, M.; Side, J. (2002). Environmental considerations and legislative control of marine salmon farming. *In*: Stead, S.M.; Laird, L. (Eds). *Handbook of Salmon Farming*, Praxis Publishing Ltd, Chichester, UK. pp. 331–372.

Top of the South Marine Biosecurity Partnership (2013). Biosecurity Top of the South. Nelson. 17 pp. Available from http://www.marinebiosecurity.co.nz/downloads/2216281/TOS+Annual+report.pdf (Accessed June 2014).

Toranzo, A.E.; Magariños, B.; Romalde, J.L. (2005). A review of the main bacterial fish diseases in mariculture systems. *Aquaculture 246(1–4)*: 37–61.

Tubbs, L.; Lee, P.; Diggles, B.D.; Sheppard, M.; Jones, J.B.; Sim-Smith, C. (2007). A review of aquatic diseases of significance to New Zealand. *NIWA client report for Biosecurity New Zealand*. Wellington. 455 pp.

Vicente, P.; Reis, E. (2010). Using questionnaire design to fight non-response bias in web surveys. *Social Science Computer Review 28(2)*: 251–267.

Wagner, E.J. (2002). Whirling disease prevention, control and managment: a review. *American Fisheries Society Symposium 29*: 217–225.

Wester, H. (1983). Considerations in hatchery design for the prevention of diseases. *In*: Meyer, F.P.; Warren, J.W.; Carey, T.G. (Eds). *A Guide to Integrated Fish Health Management in the Great Lakes Basin*, Special Publication 83-2, Great Lakes Fishery Commission, Michigan. pp. 29–36.

Wheatley, S.B.; McLoughlin, M.F.; Menzies, F.D.; Goodall, E.A. (1995). Site management factors influencing mortality rates in Atlantic salmon (*Salmo salar* L.) during marine production. *Aquaculture 136(3–4)*: 195–207.

Whittington, R.; Paul-Pont, I.; Stubbs, J.; Jones, S. (2012). Pacific oyster mortality syndrome – OsHV-1. University of Sydney technical visit to New Zealand 27–29 March 2012. *University of Sydney*. 5 pp. Available from http://oysterhealthsydney.files.wordpress.com/2012/05/new-zealand-poms-visit-final-report-summary-15-5-12.pdf (Accessed June 2014).

8 Appendix

8.1 FRESHWATER FINFISH QUESTIONNAIRE

Instructions

Thank you for your participation in this questionnaire.

It should take around 15 minutes of your time. Please click on a button to select your answer. When you are finished with each question, click "Next". The questionnaire is divided into four sections:

1. Your facility;
2. Pests;
3. Diseases and Parasites; and
4. General Biosecurity Feedback.

This questionnaire covers all freshwater facilities under your management. If you farm other species you may be asked to help with the other species questionnaires.

There is a bar on the top of the questionnaire showing your progress.

Your Facility

This section is on your facility.

There is a wide variety of aquatic operations. To get an understanding of your specific operation, we need some background information about your facility.

Q1. What is the main purpose of your facility? (*Please check only one)*

- Food production
- Hatchery production for re-stocking natural waters
- On growing
- Fishout ponds
- Hatchery production to supply farmers
- Other, please specify_____

Q2. Please identify the geographic area that your facility(s) are located in:

- Auckland
- Coromandel
- Northland
- Bay of Plenty
- Central North Island
- Canterbury
- Marlborough
- Southland/Stewart Island
- Other, please specify_____

Q3. Please indicate what is the primary species that you grow, and also any other species that you grow.

	Primary species (*Check one only)*	Secondary species *(Check all that apply)*
Chinook salmon	□	□
Brook trout	□	□
Rainbow trout	□	□
Brown trout	□	□
Tiger trout	□	□
Grass carp	□	□
White carp	□	□
Silver carp	□	□
Ornamental fish	□	□
Koura	□	□
Other	□	□

Please specify_____

Q4. How many freshwater farms/hatcheries do you manage? _____

Q5. What stages of the fish's life cycle do you hold on-site? *Please check **all** that apply.*

- □ Eggs
- □ Fry (larvae)
- □ Smolt
- □ Juveniles
- □ Adults
- □ Broodstock

Q6. What is the source of broodstock on your site?

- □ Wild-caught
- □ Other farms
- □ Self-supplied broodstock
- □ Not applicable
- □ Other, please specify_____

Q7. What is your annual production?

- □ 0–1000 MT
- □ 1000–5000 MT
- □ 5000+ MT

Q8. Which of the following parameters do you monitor at your site?

	At least once a day	At least once a week	At least once a month	Occasionally	Never
Water temperature	□	□	□	□	□
Dissolved oxygen levels	□	□	□	□	□
Ammonia	□	□	□	□	□
Total nitrogen (nitrates and nitrites)	□	□	□	□	□
pH	□	□	□	□	□
Feeding rates	□	□	□	□	□
Feed wastage	□	□	□	□	□
Other	□	□	□	□	□

Please specify:_____

Q9. Do you keep records of stock coming onto and off your farm?

- □ Yes
- □ No

Pest Species

This section is on pest species.

In this section, we would like to get an understanding about your thoughts and concerns about pest species, and your current methods of dealing with pest species.

Q10. For your site, how concerned are you about preventing/managing pest species?

- □ Not concerned
- □ Low
- □ Medium
- □ Very concerned

Q11. For your site, please indicate the types of pest species you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Crustaceans	□	□	□	□
Bivalves	□	□	□	□
Gastropods/snails	□	□	□	□
Other fish species	□	□	□	□
Dydimosphena	□	□	□	□
Other microalgae	□	□	□	□
Aquatic plants	□	□	□	□
Other	□	□	□	□

Please specify:_____

Q12. What aquatic pest species are you specifically concerned about?_____

Q13. Do you routinely check for the presence of pest species on your facility?

- □ Yes
- □ No

Q14. How often do you check your facility for the presence of pest species?[42]

- Daily
- Weekly
- Monthly
- Quarterly
- More than quarterly

Q15. How often do you remove biofouling species from your farm?

- Daily
- Weekly
- Monthly
- Every 3 months
- Every 6 months
- Yearly
- Never

Q16. How do you dispose of biofouling species?

- Cleaned on site and left to disperse through water
- Removed from site and disposed of in a landfill
- Other, please specify_____

Q17. How often do you treat your facility structures with antifouling products? (excluding vessels)

- Never
- About once every 6 months
- About once every year
- More than once per year

Q18. What do you think are the most likely ways pest species would enter your facility? *Please check all that apply*

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water	☐	☐	☐	☐
Recreational boats	☐	☐	☐	☐
Slow moving vessels(barges, dredgers)	☐	☐	☐	☐
Farm working boats/contractor boats	☐	☐	☐	☐
Visitors (service people, technicians etc.)	☐	☐	☐	☐
Stock transfers	☐	☐	☐	☐
Equipment (containers, nets, etc)	☐	☐	☐	☐
Other wild animals (fish, birds, shellfish etc)	☐	☐	☐	☐
Staff	☐	☐	☐	☐
Other please specify:_____	☐	☐	☐	☐

[42] Question skipped if answer to previous question was 'No'.

Q19. Which of the following methods do you use to manage the risk of pest entry/exacerbation/transfer? If not, please indicate reasons (*Check all that apply*)

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing the sharing of equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on boats	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on submerged structures	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among farms	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Manual removal of pest species	☐	☐	☐	☐	☐	☐	☐	☐
Division of facilities into discrete units separately managed	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of incoming water	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of effluent water	☐	☐	☐	☐	☐	☐	☐	☐

Diseases & Parasites

This section is on diseases and parasites.

In this section, we would like to get an understanding about your thoughts and concerns about diseases and parasites, and your current methods of dealing with them.

Q20. For your business, how concerned are you about preventing/managing diseases and parasites?

- ☐ Not concerned
- ☐ Low
- ☐ Moderate
- ☐ Very concerned

Q21. On your facility, please indicate the type of diseases you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Bacterial diseases	□	□	□	□
Viral diseases	□	□	□	□
Fungal diseases	□	□	□	□
Parasitic diseases	□	□	□	□

Q22. What disease or parasite species are you specifically concerned about?_____

Q23. Do you think it is important that a fish health specialist visits your facility?
- □ Yes
- □ No

Q24. Has a fish health specialist ever visited your facility?
- □ Yes
- □ No

Q25. How often does a fish health specialist visit your facility?[43]
- □ Monthly
- □ Quarterly
- □ Half-yearly
- □ Annually

Q26. Do you have a fish health specialist on call?
- □ Yes
- □ No

Q27. Do you routinely test fish for diseases and parasites?
- □ Yes
- □ No

Q28. When do you test for diseases and parasites?[43]
- □ Prior to transfer on site
- □ Prior to transfer off site
- □ Periodically
- □ When animals are lethargic/sick/dying/show disease signs
- □ Other, please specify_____

Q29. Do you routinely use therapeutants/medicines/saltwater treatments on your fish?
- □ Yes
- □ No

Q30. When do you use therapeutants on your fish?[43]
- □ As a preventative
- □ To treat a disease outbreak
- □ When transferring stock
- □ Other, please specify_____

[43] Question skipped if answer to the previous question was 'No'.

Q31. How often do you remove mortalities from your culture units?

- Immediately when observed
- Daily
- Every 3–4 days
- Weekly
- More than weekly
- Never

Q32. How do you store your mortalities before disposal?[44]

- Sealed, water-tight containers
- Open containers
- Rubbish bags
- Other, please specify_____

Q33. How do you store your feed on-site?

- Sealed, water-tight containers
- Open containers
- Bags
- Fridge/freezer
- Other, please specify_____

Q34. Do you use predator nets on your site to exclude birds?

- Yes
- No

Q35. What is the main source of water for your facility?

- Surface water (lake, river, stream)
- Spring water
- Well/bore water (freshwater)
- Chlorinated municipal water
- Other, please specify_____

Q36. Do you treat your intake water prior to use for animal production?

- Yes
- No

Q37. How do you treat your intake water prior to use in animal production? (*Please check all that apply).*[44]

- UV treatment
- Sedimentation
- Chemical treatment
- Ozone treatment
- Filtration
- Other, please specify_____

Q38. Do you treat your effluent water after being used for animal production?

- Yes
- No

[44] Question skipped if answer to the previous question was 'Never' or 'No'.

Q39. How do you treat your effluent water after being used for animal production? (*Please check all that apply).*[45]

- UV treatment
- Sedimentation
- Chemical treatment
- Filtration
- Ozone treatment
- Biofiltration
- Other, please specify:_____

Q40. Do you treat the water used in fish-transporters?

- Yes
- No
- Not applicable

Q41. How do you treat the water used in fish-transporters? (*Please check all that apply).*[46]

- UV treatment
- Sedimentation
- Chemical treatment
- Filtration
- Ozone treatment
- Other, please specify:_____ _____

Q42. How do you dispose of the water used in fish-transporters?[46]

- In natural waterways
- In the sea
- A municipal wastewater treatment system
- **N**ot applicable
- Other, please specify_____

Q43. What do you think are the most likely ways diseases & parasites would enter your facility? (*Please check all that apply*)

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water	□	□	□	□
Recreational boats	□	□	□	□
Boats that service the farm	□	□	□	□
Slow moving vessels (barges, dredgers)	□	□	□	□
Visitors (service people, technicians etc.)	□	□	□	□
Stock transfers	□	□	□	□
Equipment (containers, nets, etc)	□	□	□	□
Other wild animals (fish, birds, shellfish, etc)	□	□	□	□
Staff	□	□	□	□
Feed	□	□	□	□
Other	□	□	□	□

Please specify_____

[45] Question skipped if answer to the previous question was 'No'.
[46] Question skipped if answer to question 40 was 'No' or 'Not applicable'.

Q44. Which of the following methods do you use to manage the risk of disease and parasite entry/exacerbation/transfer? If not, please indicate reasons (*check all that apply*)

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing the sharing of equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing staff from moving among farms	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Use of preventative therapeutic/ chemical treatments on fish	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of incoming water	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of effluent water	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Fallowing between production cycles	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among farms	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Single year class production	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Division of facilities into discrete units separately managed	☐	☐	☐	☐	☐	☐	☐	☐
Applying best management practice with respect to animal welfare and animal husbandry (exacerbation)	☐	☐	☐	☐	☐	☐	☐	☐
Other,	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

General Biosecurity Feedback

This section is on general biosecurity. This section is an opportunity to share your issues or concerns on general biosecurity matters.

Q45. Where do you find the most useful information with respect to on-farm biosecurity practices? *(Please check all that apply)*

- ☐ MPI – Aquaculture Unit
- ☐ MPI – Biosecurity Response Team
- ☐ Fish health specialists/veterinarians
- ☐ Other farmers
- ☐ Industry Association Representatives
- ☐ NIWA
- ☐ Cawthron
- ☐ Universities
- ☐ Training courses
- ☐ Workshop material
- ☐ Books
- ☐ Reports
- ☐ Scientific papers
- ☐ Former work colleagues
- ☐ Internet
- ☐ TV
- ☐ Newspapers
- ☐ Regional Councils
- ☐ Department of Conservation
- ☐ Other, please specify_____

Q46. Are you aware that MPI has a contact number (0800 80 99 66) to report any farm mortality events or suspect exotic pest species?

- ☐ Yes
- ☐ No

Q47. Would you use the MPI 0800 number to report in the occurrence of any of the above instances at your facility?

- ☐ Yes
- ☐ No

Q48. Which box captures your concerns about using the MPI number?

- ☐ Potential for exclusion from decision/solution making process
- ☐ Unaware of the 0800 process, i.e., what happens after I call the number?
- ☐ Other, please specify_____

Q49. How effective do you think MPI's aquatic biosecurity functions are? *Please provide an answer for each line.*

	Ineffective	Low	Moderate	Effective	Don't know
Communications to industry	☐	☐	☐	☐	☐
Aquatic health expertise	☐	☐	☐	☐	☐
Pest expertise	☐	☐	☐	☐	☐
Diagnostic services	☐	☐	☐	☐	☐
Biosecurity response preparedness	☐	☐	☐	☐	☐
Aquatic disease response action(s)	☐	☐	☐	☐	☐
Pest response action(s)	☐	☐	☐	☐	☐
Organism movement controls	☐	☐	☐	☐	☐
Aquatic surveillance	☐	☐	☐	☐	☐
Controls on imports	☐	☐	☐	☐	☐
Controls on exports	☐	☐	☐	☐	☐

We value your experience and practical working knowledge of freshwater fish farming.

Q50. Do you have any additional comments that will help assist us with this research?

_____

Q51. Are you interested in receiving updates about this research project and other MPI biosecurity projects in the future?

- ☐ Yes
- ☐ No

Q52. If yes, please provide your contact details below:[47]
Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Mobile phone number:

On-site interviews

For the next stage of our research we will be conducting on-site interviews with selected farms in early 2014. Site visits will help researchers understand the real world of farming and will give us the chance to have face to face discussion with you and your staff about your issues and concerns on biosecurity. As independent researchers we are able to keep your information confidential. The final report will be made available to participants.

MPI, in collaboration with industry representatives, will then use the results of this project to inform a wider project investigating the management of biosecurity risks to New Zealand aquaculture. This project aims to benefit New Zealand, your industry and your business.

[47] Question skipped if answer to the previous question was 'No'.

Q53. Are you able to assist with the next stage of our research?

- Yes
- No

Q54. If yes and you have not already provided your details above, please provide your contact details below.[48]

Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Phone number:
Mobile phone number:

Thank you for supporting the growth of New Zealand's aquaculture industry.

[48] Question skipped if answer to the previous question was 'No'.

8.2 SALTWATER FINFISH QUESTIONNAIRE

Instructions

Thank you for your participation in this questionnaire.

It should take around 15 minutes of your time. Please click on a button to select your answer. When you are finished with each question, click "Next". The questionnaire is divided into four sections:

1. Your facility;
2. Pests;
3. Diseases and Parasites; and
4. General Biosecurity Feedback.

This questionnaire covers all saltwater facilities under your management. If you farm other species you may be asked to help with the other species questionnaires.

There is a bar on the top of the questionnaire showing your progress.

Your Facility

This section is on your facility.

There is a wide variety of aquatic operations. To get an understanding of your specific operation, we need some background information about your facility.

Q1. What is your annual production?

- 0–1000 MT
- 1000–5000 MT
- 5000+ MT

Q2. Please identify the geographic area that your facility(s) are located in:

- Auckland
- Coromandel
- Northland
- Bay of Plenty
- Canterbury
- Marlborough
- Southland/Stewart Island
- Other, please specify_____

Q3. How many saltwater fish farms do you manage? _____

Q4. Do you culture any other species apart from salmon?

- Yes
- No

Q5. If yes, what species?[49]_____

[49] Question skipped if answer to the previous question was 'No'.

Q6. Which of the following parameters do you monitor at your site?

	At least once a day	At least once a week	At least once a month	Occasionally	Never
Water temperature	□	□	□	□	□
Dissolved oxygen levels	□	□	□	□	□
Ammonia	□	□	□	□	□
Total nitrogen (nitrates and nitrites)	□	□	□	□	□
pH	□	□	□	□	□
Feeding rates	□	□	□	□	□
Feed wastage	□	□	□	□	□
Other	□	□	□	□	□

Please specify:_____

Q7. Do you keep records of stock coming onto and off your farm?

- □ Yes
- □ No

Pest Species

This section is on pest species.

In this section, we would like to get an understanding about your thoughts and concerns about pest species, and your current methods of dealing with pest species.

Q8. For your site, how concerned are you about preventing/managing pest species?

- □ Not concerned
- □ Low
- □ Medium
- □ Very concerned

Q9. For your site, please indicate the types of marine pest species you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Sponges	□	□	□	□
Harmful/toxic algae (phytoplankton)	□	□	□	□
Bryozoans	□	□	□	□
Hydroids	□	□	□	□
Crabs	□	□	□	□
Bivalves	□	□	□	□
Gastropods/marine snails	□	□	□	□
Bristleworms/fan worms	□	□	□	□
Barnacles	□	□	□	□
Starfish, sea urchins, sea cucumbers	□	□	□	□
Seaweeds	□	□	□	□
Sea squirts/ascidians	□	□	□	□
Amphipods/isopods	□	□	□	□
Other	□	□	□	□

Please specify_____

Q10. What aquatic pest species are you specifically concerned about?_____

Q11. Do you routinely check for the presence of marine pest species on your facility?

- □ Yes
- □ No

Q12. How often do you check your facility for the presence of pest species?[50]

- □ Daily
- □ Weekly
- □ Monthly
- □ Quarterly
- □ More than quarterly
- □ Other, please specify_____

Q13. How often do you remove biofouling species from your culture units?

- □ Daily
- □ Weekly
- □ Monthly
- □ Every 3 months
- □ Every 6 months
- □ Yearly
- □ Never

Q14. How do you dispose of biofouling species?

- □ Cleaned on site and left to disperse through water
- □ Removed from site and disposed of in a landfill
- □ Removed from site and disposed of in sea outside of resource consent boundaries
- □ Other, please specify_____.

[50] Question skipped if answer to the previous question was 'No'.

Q15. How often do you treat your facility structures with antifouling products? (excluding vessels)

- Never
- About once every 6 months
- About once every year
- More than once per year

Q16. What do you think are the most likely ways marine pest species would enter your facility? (*Please check all that apply).*

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water				
Recreational boats				
Slow moving vessels(barges, dredgers)				
Farm working boats/contractor boats				
Shipping vessels				
Slow moving vessels (tugs, barges, oil rigs, dredgers)				
Visitors (service people, technicians etc.)				
Stock transfers				
Equipment (containers, nets, etc)				
Other wild animals (fish, birds, shellfish etc)				
Staff				
Other				

Please specify_____

Q17. Which of the following methods do you use to manage the risk of pest entry/exacerbation/transfer? If not, please indicate reasons (check all that apply)

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing the sharing of equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on boats	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on submerged structures	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among farms	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Manual removal of pest species	☐	☐	☐	☐	☐	☐	☐	☐
Division of facilities into discrete units separately managed	☐	☐	☐	☐	☐	☐	☐	☐
Applying best management practice with respect to animal welfare and animal husbandry	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

Diseases & Parasites

This section is on diseases and parasites.

In this section, we would like to get an understanding about your thoughts and concerns about diseases and parasites, and your current methods of dealing with them.

Q18. For your business, how concerned are you about preventing/managing diseases and parasites?

- ☐ Not concerned
- ☐ Low
- ☐ Moderate
- ☐ Very concerned

Q19. On your facility, please indicate the type of diseases you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Bacterial diseases	☐	☐	☐	☐
Viral diseases	☐	☐	☐	☐
Fungal diseases	☐	☐	☐	☐
Parasitic diseases	☐	☐	☐	☐

Q20. What disease or parasite species are you specifically concerned about?_____

Q21. Do you think it is important that a fish health specialist visits your facility?

- ☐ Yes
- ☐ No

Q22. Has a fish health specialist ever visited your facility?

- ☐ Yes
- ☐ No

Q23. How often does a fish health specialist visit your facility?[51]

- ☐ Monthly
- ☐ Quarterly
- ☐ Half-yearly
- ☐ Annually

Q24. Do you have a fish health specialist on call?

- ☐ Yes
- ☐ No

Q25. Do you routinely test fish for diseases and parasites?

- ☐ Yes
- ☐ No

[51] Question skipped if answer to the previous question was 'No'.

Q26. When do you test for diseases and parasites?[52]

- Prior to transfer on site
- Prior to transfer off site
- Periodically
- When animals are lethargic/sick/dying/show disease signs
- Other, please specify_____

Q27. Do you routinely use therapeutants/medicines/freshwater treatments on your fish?

- Yes
- No

Q28. When do you use therapeutants on your fish?[52]

- As a preventative
- To treat a disease outbreak
- When transferring stock
- Other, please specify_____

Q29. How often do you remove mortalities from your culture units?

- Immediately when observed
- Daily
- Every 3–4 days
- Weekly
- More than weekly
- Never
- Other, please specify_____

Q30. How do you store your mortalities before disposal?[52]

- Sealed, water-tight containers
- Open containers
- Bulk bags
- Other, please specify_____

Q31. How do you store your feed on-site?

- Sealed, water-tight containers
- Open containers
- Bags
- Fridge/freezer
- Other, please specify_____

Q32. Please indicate whether you use predator nets on your site to exclude the following animals? (*Please check all that apply*)

- Seals
- Sharks
- Birds
- Other, please specify_____

[52] Question skipped if answer to the previous question was 'No'. or 'Never'.

Q33. What do you think are the most likely ways diseases & parasites would enter your farm? (*Please check all that apply*)

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water	□	□	□	□
Recreational boats	□	□	□	□
Boats that service the farm	□	□	□	□
Slow moving vessels (barges, dredgers)	□	□	□	□
Shipping vessels				
Visitors (service people, technicians etc.)	□	□	□	□
Stock transfers	□	□	□	□
Equipment (containers, nets, etc)	□	□	□	□
Other wild animals (fish, birds, shellfish, etc)	□	□	□	□
Staff	□	□	□	□
Feed	□	□	□	□
Other	□	□	□	□

Please specify_____

Q34. Which of the following methods do you use to manage the risk of disease and parasite entry/exacerbation/transfer? If not, please indicate reasons (*check all that apply*)

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing the sharing of equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing staff from moving among farms	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Use of preventative therapeutic/ chemical treatments on fish	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Fallowing between production cycles	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among farms	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Single year class production	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Division of facilities into discrete units separately managed	☐	☐	☐	☐	☐	☐	☐	☐
Applying best management practice with respect to animal welfare and animal husbandry (exacerbation)	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

General Biosecurity Feedback

This section is on general biosecurity. This section is an opportunity to share your issues or concerns on general biosecurity matters.

Q35. Where do you find the most useful information with respect to on-farm biosecurity practices? *(Please check all that apply)*

- ☐ MPI – Aquaculture Unit
- ☐ MPI – Biosecurity Response Team
- ☐ Fish health specialists/veterinarians
- ☐ Other farmers
- ☐ Industry Association Representatives
- ☐ NIWA
- ☐ Cawthron
- ☐ Universities
- ☐ Training courses
- ☐ Workshop material
- ☐ Books
- ☐ Reports
- ☐ Scientific papers
- ☐ Former work colleagues
- ☐ Internet
- ☐ TV
- ☐ Newspapers
- ☐ Regional Councils
- ☐ Department of Conservation
- ☐ Other, *please specify*_____

Q36. Are you aware that MPI has a contact number (0800 80 99 66) to report any farm mortality events or suspect exotic marine pest species?

- ☐ Yes
- ☐ No

Q37. Would you use the MPI 0800 number to report in the occurrence of any of the above instances at your facility?

- ☐ Yes
- ☐ No

Q38. Which box captures your concerns about using the MPI number?

- ☐ Potential for exclusion from decision/solution making process
- ☐ Unaware of the 0800 process, i.e., what happens after I call the number?
- ☐ Other, please specify_____

Q39. How effective do you think MPI's aquatic biosecurity functions are? (*Please provide an answer for each line).*

	Ineffective	Low	Moderate	Effective	Don't know
Communications to industry	☐	☐	☐	☐	☐
Aquatic health expertise	☐	☐	☐	☐	☐
Pest expertise	☐	☐	☐	☐	☐
Diagnostic services	☐	☐	☐	☐	☐
Biosecurity response preparedness	☐	☐	☐	☐	☐
Aquatic disease response action(s)	☐	☐	☐	☐	☐
Pest response action(s)	☐	☐	☐	☐	☐
Organism movement controls	☐	☐	☐	☐	☐
Aquatic surveillance	☐	☐	☐	☐	☐
Controls on imports	☐	☐	☐	☐	☐
Controls on exports	☐	☐	☐	☐	☐

We value your experience and practical working knowledge of saltwater fish farming.

Q40. Do you have any additional comments that will help assist us with this research?

_____

Q41. Are you interested in receiving updates about this research project and other MPI biosecurity projects in the future?

- ☐ Yes
- ☐ No

Q42. If yes, please provide your contact details below:[53]
Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Mobile phone number:

On-site interviews

For the next stage of our research we will be conducting on-site interviews with selected farms in early 2014. Site visits will help researchers understand the real world of farming and will give us the chance to have face to face discussion with you and your staff about your issues and concerns on biosecurity. As independent researchers we are able to keep your information confidential. The final report will be made available to participants.

MPI, in collaboration with industry representatives, will then use the results of this project to inform a wider project investigating the management of biosecurity risks to New Zealand aquaculture. This project aims to benefit New Zealand, your industry and your business.

[53] Question skipped if answer to the previous question was 'No'.

Q43. Are you able to assist with the next stage of our research?

- Yes
- No

Q44. If yes and you have not already provided your details above, please provide your contact details below.[54]

Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Phone number:
Mobile phone number:

Thank you for supporting the growth of New Zealand's aquaculture industry.

[54] Question skipped if answer to the previous question was 'No'.

8.3 PAUA QUESTIONNAIRE

Instructions

Thank you for your participation in this questionnaire.

It should take around 15 minutes of your time. Please click on a button to select your answer. When you are finished with each question, click "Next". The questionnaire is divided into four sections:

1. Your facility;
2. Pests;
3. Diseases and Parasites; and
4. General Biosecurity Feedback.

This questionnaire covers all paua farms under your management. If you farm other species you may be asked to help with the other species questionnaires.

There is a bar on the top of the questionnaire showing your progress.

Your Facility

This section is on your facility.

There is a wide variety of aquatic operations. To get an understanding of your specific operation, we need some background information about your facility.

Q1. What is the main purpose of your facility? (*Please check only one)*

- Food production
- Spat/seed production
- Pearl production
- Other, please specify_____

Q2. What is your annual production?

- 0–250 MT
- 250–500 MT
- 500–1000 MT
- 1000+ MT

Q3. Please identify the geographic area that your facility(s) are located in:

- Auckland
- Coromandel
- Northland
- Bay of Plenty
- Canterbury
- Marlborough
- Southland/Stewart Island
- Other, please specify_____

Q4. Please indicate what is the primary species that you grow, and any other species that you grow.

	Primary species (*Check one only)*	Secondary species *(Check all that apply)*
Paua	□	□
Macroalgae/seaweeds	□	□
Other	□	□

Please specify_____

Q5. What is the source of broodstock on your site?

- □ Wild-caught
- □ Other farms
- □ Self-supplied broodstock
- □ Not applicable
- □ Other, please specify_____

Q6. Which of the following parameters do you record for your business?

	At least once a day	At least once a week	At least once a month	Occasionally	Never
Water temperature	□	□	□	□	□
Dissolved oxygen levels	□	□	□	□	□
Ammonia	□	□	□	□	□
Total nitrogen (nitrates and nitrites)	□	□	□	□	□
pH	□	□	□	□	□
Carbon dioxide	□	□	□	□	□
Other	□	□	□	□	□

Please specify_____

Q7. Do you keep records of stock coming onto and off your farm?

- □ Yes
- □ No

Q8. Do you transport paua around the country?

- □ Yes
- □ No

Q9. Do you transport paua in seawater?[55]

- □ Yes
- □ No

Q10. Do you treat the water used in shellfish transporters?[55]

- □ Yes
- □ No
- □ Not applicable

[55] Question skipped if answer to the question 8 was 'No'.

Q11. How do you treat the water used in shellfish transporters? (*Please check all that apply)*[55]

- UV treatment
- Sedimentation
- Chemical treatment
- Filtration
- Ozone treatment
- Other, please specify:_____ _____

Pest Species

This section is on pest species.

In this section, we would like to get an understanding about your thoughts and concerns about pest species, and your current methods of dealing with pest species.

Q12. For your site, how concerned are you about preventing/managing pest species?

- Not concerned
- Low
- Medium
- Very concerned

Q13. For your site, please indicate the types of pest species you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Sponges	□	□	□	□
Harmful/toxic algae (phytoplankton)	□	□	□	□
Bryozoans	□	□	□	□
Hydroids	□	□	□	□
Crabs	□	□	□	□
Bivalves	□	□	□	□
Gastropods/marine snails	□	□	□	□
Bristleworms/fan worms	□	□	□	□
Barnacles	□	□	□	□
Starfish, sea urchins, sea cucumbers	□	□	□	□
Seaweeds	□	□	□	□
Sea squirts/ascidians	□	□	□	□
Amphipods/isopods	□	□	□	□
Other	□	□	□	□

Please specify_____

Q14. What is the one aquatic pest species you are most concerned about?

_____

Q15. Do you routinely check for the presence of marine pest species on your facility?

- Yes
- No

Q16. How often do you check your facility for the presence of pest species?[56]

- Daily
- Weekly
- Monthly
- Quarterly
- More than quarterly

Q17. How often do you use antifouling treatments on your farm structures? (excluding vessels)

- Never
- About once every 6 months
- About once every year
- More than once per year

Q18. How often do you remove biofouling species from your farm?

- Daily
- Weekly
- Monthly
- Every 3 months
- Every 6 months
- Yearly
- Never

Q19. What do you think are the most likely ways pest species would enter your facility? (*Please check all that apply).*

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water	□	□	□	□
Recreational boats	□	□	□	□
Boats that service the site	□	□	□	□
Shipping vessels	□	□	□	□
Visitors (service people, technicians etc.)	□	□	□	□
Stock transfers	□	□	□	□
Equipment (containers, nets, etc)	□	□	□	□
Other wild animals (fish, birds, shellfish etc)	□	□	□	□
Staff	□	□	□	□
Other	□	□	□	□

Please specify_____

[56]Question skipped if answer to the previous question was 'No'.

Q20. Which of the following methods do you use to manage the risk of pest entry/exacerbation/transfer? If not, please indicate reasons (*check all that apply*)

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing the sharing of equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on boats	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on submerged structures	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among farms	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Manual removal of pest species	☐	☐	☐	☐	☐	☐	☐	☐
Division of facilities into discrete units separately managed	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of incoming water	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of effluent water	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

Q21. How do you dispose of biofouling species?

- ☐ Cleaned on site and left to disperse through water
- ☐ Removed from site and disposed of in a landfill
- ☐ Removed from site and disposed of in sea outside of resource consent boundaries
- ☐ Other, please specify_____.

Diseases & Parasites

This section is on diseases and parasites.

In this section, we would like to get an understanding about your thoughts and concerns about diseases and parasites, and your current methods of dealing with them.

Q22. For your business, how concerned are you about preventing/managing diseases and parasites?

- Not concerned
- Low
- Moderate
- Very concerned

Q23. On your farm, please indicate the type of diseases you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Bacterial diseases	□	□	□	□
Viral diseases	□	□	□	□
Fungal diseases	□	□	□	□
Parasitic diseases	□	□	□	□

Q24. What is the one disease or parasite you are most concerned about?_____

Q25. Has a shellfish health specialist ever visited your facility?

- Yes
- No

Q26. How often does a shellfish health specialist visit your facility?[57]

- Monthly
- Quarterly
- Half-yearly
- Annually

Q27. Do you have a shellfish health specialist on call?

- Yes
- No

Q28. Do you routinely test shellfish for diseases and parasites?

- Yes
- No

Q29. When do you test for diseases and parasites?[57]

- Prior to transfer on site
- Prior to transfer off site
- Periodically
- When animals are lethargic/sick/dying/show disease signs
- Other, please specify_____

[57] Question skipped if answer to the previous question was 'No'.

30. Do you routinely use therapeutants/medicines/freshwater treatments on your shellfish?

- Yes
- No

Q31. When do you use therapeutants on your shellfish?[58]

- As a preventative
- To treat a disease outbreak
- When transferring stock
- Other, please specify_____

Q32. How often do you remove mortalities from your culture units?

- Immediately when observed
- Daily
- Every 3–4 days
- Weekly
- More than weekly
- Never

Q33. How do you store your mortalities before disposal?[58]

- Sealed, water-tight containers
- Open containers
- Garbage bags
- Other, please specify_____

Q34. How do you dispose of mortalities?

- Disposed of in sea within resource consent boundaries
- Removed from site and disposed of in a landfill
- Removed from site and disposed of in sea outside of resource consent boundaries
- Other, please specify_____.

Q35. Do you farm paua on land or in the sea?

- Land
- Sea

Q36. Do you treat your intake water prior to use for animal production?[59]

- Yes
- No

Q37. How do you treat your intake water prior to use in animal production? (*Please check all that apply).*[59]

- UV treatment
- Sedimentation
- Chemical treatment
- Ozone treatment
- Filtration
- Other, please specify_____

Q38. Do you treat your effluent water after being used for animal production? [59]

- Yes
- No

[58] Question skipped if answer to the previous question was 'No' or 'Never'.
[59] Question skipped if answer to question 35 was 'Sea'.

Q39. How do you treat your effluent water after being used for animal production? (*Please check all that apply).* [59]

- UV treatment
- Sedimentation
- Chemical treatment
- Filtration
- Ozone treatment
- Biofiltration
- Other, please specify:_____

Q40. What do you think are the most likely ways diseases & parasites would enter your facility? (*Please check all that apply*).

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water	□	□	□	□
Recreational boats	□	□	□	□
Boats that service the site	□	□	□	□
Shipping vessels				
Slow moving vessels (barges, dredgers)	□	□	□	□
Visitors (service people, technicians etc.)	□	□	□	□
Stock transfers	□	□	□	□
Equipment (containers, nets, etc)	□	□	□	□
Other wild animals (fish, birds, shellfish, etc)	□	□	□	□
Staff	□	□	□	□
Feed	□	□	□	□
Other	□	□	□	□

Please specify_____

Q41. Which of the following methods do you use to manage the risk of disease and parasite entry/exacerbation/transfer? If not, please indicate reasons (*check all that apply*)

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing the sharing of equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing staff from moving among farms	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Use of preventative therapeutic/ chemical treatments on shellfish	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Fallowing between production cycles	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among farms	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Single year class production	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of incoming water	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of effluent water	☐	☐	☐	☐	☐	☐	☐	☐
Division of facilities into discrete units separately managed	☐	☐	☐	☐	☐	☐	☐	☐
Applying best management practice with respect to animal welfare and animal husbandry (exacerbation)	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

General Biosecurity Feedback

This section is on general biosecurity. This section is an opportunity to share your issues or concerns on general biosecurity matters.

Q42. Where do you find the most useful information when you have a problem with disease or pests? *(please check all that apply)*

- MPI – Aquaculture Unit
- MPI – Biosecurity Response Team
- Shellfish health specialists/veterinarians
- Other farmers
- Industry Association Representatives
- NIWA
- Cawthron
- Universities
- Training courses
- Workshop material
- Books
- Reports
- Scientific papers
- Former work colleagues
- Internet
- TV
- Newspapers
- Regional Councils
- Department of Conservation
- Other, please specify_____

Q43. Are you aware that MPI has a contact number (0800 80 99 66) to report any farm mortality events or suspect exotic marine pest species?

- Yes
- No

Q44. Would you use the MPI 0800 number to report in the occurrence of any of the above instances at your facility?

- Yes
- No

Q45. Which box captures your concerns about using the MPI number?

- Potential for exclusion from decision/solution making process
- Unaware of the 0800 process, i.e., what happens after I call the number?
- Other, please specify_____

Q46. How effective do you think MPI's aquatic biosecurity functions are? (*Please provide an answer for each line).*

	Ineffective	Low	Moderate	Effective	Don't know
Communications to industry	☐	☐	☐	☐	☐
Aquatic health expertise	☐	☐	☐	☐	☐
Pest expertise	☐	☐	☐	☐	☐
Diagnostic services	☐	☐	☐	☐	☐
Biosecurity response preparedness	☐	☐	☐	☐	☐
Aquatic disease response action(s)	☐	☐	☐	☐	☐
Pest response action(s)	☐	☐	☐	☐	☐
Organism movement controls	☐	☐	☐	☐	☐
Aquatic surveillance	☐	☐	☐	☐	☐
Controls on imports	☐	☐	☐	☐	☐
Controls on exports	☐	☐	☐	☐	☐

We value your experience and practical working knowledge of paua farming.

Q47. Do you have any additional comments that will help assist us with this research?

_____

Q48. Are you interested in receiving updates about this research project and other MPI biosecurity projects in the future?

- ☐ Yes
- ☐ No

Q49. If yes, please provide your contact details below.[60]

Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Mobile phone number:

On-site interviews

For the next stage of our research we will be conducting on-site interviews with selected farms in early 2014. Site visits will help researchers understand the real world of farming and will give us the chance to have face to face discussion with you and your staff about your issues and concerns on biosecurity. As independent researchers we are able to keep your information confidential. The final report will be made available to participants.

MPI, in collaboration with industry representatives, will then use the results of this project to inform a wider project investigating the management of biosecurity risks to New Zealand aquaculture. This project aims to benefit New Zealand, your industry and your business.

[60] Question skipped if answer to the previous question was 'No'.

Q50. Are you able to assist with the next stage of our research?

- Yes
- No

Q51. If yes and you have not already provided your details above, please provide your contact details below.[61]

Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Phone number:
Mobile phone number:

Thank you for supporting the growth of New Zealand's aquaculture industry.

[61] Question skipped if answer to the previous question was 'No'.

8.4 OYSTER QUESTIONNAIRE

Instructions

Thank you for your participation in this questionnaire.

It should take around 15 minutes of your time. Please click on a button to select your answer. When you are finished with each question, click "Next". The questionnaire is divided into four sections:

1. Your facility;
2. Pests;
3. Diseases and Parasites; and
4. General Biosecurity Feedback.

This questionnaire covers all oyster farms under your management. If you farm other species you may be asked to help with the other species questionnaires.

There is a bar on the top of the questionnaire showing your progress.

Your Facility

This section is on your facility.

There is a wide variety of aquatic operations. To get an understanding of your specific operation, we need some background information about your facility.

Q1. What is the main purpose of your facility?

- Food production
- Spat/seed supply
- Other, please specify_____

Q2. Please identify the geographic area that your facility(s) are located in:

- Auckland
- Coromandel
- Northland
- Bay of Plenty
- Canterbury
- Marlborough
- Southland/Stewart Island
- Other, please specify_____

Q3. Please indicate what is the primary species that you grow, and also any other species that you grow.

	Primary species (*Check one only)*	Secondary species *(Check all that apply)*
Pacific oysters	□	□
Dredge/Bluff/flat oysters	□	□
Paua	□	□
Green-lipped mussels	□	□
Blue mussels	□	□
Seaweeds	□	□
Other	□	□

Please specify_____

Q4. How do you farm you oysters? (*Please check all that apply*).

- □ On sticks
- □ In trays
- □ In netting bags
- □ In baskets
- □ On longlines
- □ In a land-based hatchery
- □ Other, please specify_____

Q5. What is the source of your seed?

- □ Wild-caught
- □ Other farms
- □ Other hatcheries
- □ Own hatchery
- □ Other, please specify_____

Q6. What geographic area does your seed come from?_____

Q7. Please list any areas that you transfer oysters to for on-growing_____

Q8. How many oyster farms do you manage? _____

Q9. What is your annual production?

- □ 0–10,000 dz
- □ 10,000–100,000 dz
- □ 100,000–300,000 dz
- □ 300,000+ dz

Q10. For your business, which of the following parameters do you record?

	At least once a day	At least once a week	At least once a month	Occasionally	Never
Water temperature	□	□	□	□	□
Dissolved oxygen levels	□	□	□	□	□
Ammonia	□	□	□	□	□
Total nitrogen (nitrates and nitrites)	□	□	□	□	□
pH	□	□	□	□	□
Chlorophyll *a*	□	□	□	□	□
Suspended solids	□	□	□	□	□
Other	□	□	□	□	□

Please specify_____

Q11. Do you keep records of stock coming onto and off your farm?

- □ Yes
- □ No

Pest Species

This section is on pest species.

In this section, we would like to get an understanding about your thoughts and concerns about pest species, and your current methods of dealing with pest species.

Q12. For your business, how concerned are you about preventing/managing pest species?

- □ Not concerned
- □ Low
- □ Medium
- □ Very concerned

Q13. On your site, please indicate the types of pest species you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Sponges	□	□	□	□
Harmful/toxic algae (phytoplankton)	□	□	□	□
Bryozoans	□	□	□	□
Hydroids	□	□	□	□
Crabs	□	□	□	□
Bivalves	□	□	□	□
Gastropods/marine snails	□	□	□	□
Bristleworms/fan worms	□	□	□	□
Barnacles	□	□	□	□
Starfish, sea urchins, sea cucumbers	□	□	□	□
Seaweeds	□	□	□	□
Sea squirts/ascidians	□	□	□	□
Amphipods/isopods	□	□	□	□
Flatworms	□	□	□	□
Other	□	□	□	□

Please specify_____

Q14. What pest species are you specifically concerned about?_____

Q15. Do you routinely check for the presence of marine pest species on your farm?

- □ Yes
- □ No

Q16. How often do you check your farm for the presence of pest species?[62]

- □ Daily
- □ Weekly
- □ Monthly
- □ Quarterly
- □ More than quarterly

Q17. How often do you use antifouling treatments on your culture units?

- □ Never
- □ About once every 6 months
- □ About once every year
- □ More than once per year

Q18. How often do you remove biofouling species from your farm?

- □ Daily
- □ Weekly
- □ Monthly
- □ Every 3 months
- □ Every 6 months
- □ Yearly
- □ Never

[62] Question skipped if answer to the previous question was 'No'.

Q19. How do you dispose of biofouling species?[63]

- Cleaned on site and left to disperse through water
- Removed from site and disposed of in a landfill
- Removed from site and disposed of in sea outside resource consent boundaries
- Other, please specify_____.

Q20. What do you think are the most likely ways pest species would enter your facility? (*Please check all that apply).*

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water	□	□	□	□
Recreational boats	□	□	□	□
Shipping vessels				
Slow moving vessels (barges, dredgers)	□	□	□	□
Farm working boats/contractor boats	□	□	□	□
Visitors (service people, technicians etc.)	□	□	□	□
Stock transfers	□	□	□	□
Equipment (containers, nets, etc)	□	□	□	□
Other wild animals (fish, birds, shellfish etc)	□	□	□	□
Staff	□	□	□	□
Other	□	□	□	□

Please specify_____

[63] Question skipped if answer to the previous question was 'Never'.

Q21. Which of the following methods do you use to manage the risk of pest entry/exacerbation/transfer? If not, please indicate reasons (*check all that apply*)

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing the sharing of equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on boats	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on submerged structures	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among farms	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Manual removal of pest species	☐	☐	☐	☐	☐	☐	☐	☐
Washing seed prior to transfer	☐	☐	☐	☐	☐	☐	☐	☐
Testing for algal blooms	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

Diseases & Parasites

This section is on diseases and parasites.

In this section, we would like to get an understanding about your thoughts and concerns about diseases and parasites, and your current methods of dealing with them.

Q22. For your business, how concerned are you about preventing/managing diseases and parasites?

- ☐ Not concerned
- ☐ Low
- ☐ Moderate
- ☐ Very concerned

Q23. On your farm, please indicate the type of diseases you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Bacterial diseases	□	□	□	□
Viral diseases	□	□	□	□
Fungal diseases	□	□	□	□
Parasitic diseases	□	□	□	□

Q24. What disease or parasite species are you specifically concerned about?_____

Q25. Do you think it is important that a shellfish health specialist visits your facility?
- □ Yes
- □ No

Q26. Has a shellfish health specialist ever visited your facility?
- □ Yes
- □ No

Q27. How often does a shellfish health specialist visit your facility?[64]
- □ Monthly
- □ Quarterly
- □ Half-yearly
- □ Annually

Q28. Do you have a shellfish health specialist on call?
- □ Yes
- □ No

Q29. Do you routinely test shellfish for diseases and parasites?
- □ Yes
- □ No

Q30. When do you test for diseases and parasites?[64]
- □ Prior to transfer on site
- □ Prior to transfer off site
- □ Periodically
- □ When animals are lethargic/sick/dying/show disease signs
- □ Other, please specify_____

Q31. Do you routinely use therapeutants/medicines/freshwater treatments on your shellfish?
- □ Yes
- □ No

Q32. When do you use therapeutants on your shellfish?[64]
- □ As a preventative
- □ To treat a disease outbreak
- □ When transferring stock
- □ Other, please specify_____

[64] Question skipped if answer to the previous question was 'No'.

Q33. How often do you remove mortalities from your farm?

- Immediately when observed
- Daily
- Every 3–4 days
- Weekly
- More than weekly
- Never
- Other, please specify_____

Q34. How do you store your mortalities before disposal?[65]

- Sealed, water-tight containers
- Open containers
- Rubbish bags
- Other, please specify_____

Q35. How do you dispose of mortalities? *(Check all that apply)*[65]

- In the sea within farm resource consent boundaries
- Removed from site and disposed of in a landfill
- Removed from site and disposed of in sea outside of resource consent boundaries
- Other, please specify_____

Q36. Do you farm oysters in the sea or on land?

- Land
- Sea

Q37. Do you treat your intake water prior to use for animal production?[66]

- Yes
- No

Q38. How do you treat your intake water prior to use in animal production? (*Please check all that apply).*[66]

- UV treatment
- Sedimentation
- Chemical treatment
- Ozone treatment
- Filtration
- *Other, please specify*_____

Q39. Do you treat your effluent water after being used for animal production?[66]

- Yes
- No

[65] Question skipped if answer to question 33 was 'Never'.
[66] Question skipped if answer to previous 36 was 'Sea'.

Q40. How do you treat your effluent water after being used for animal production? (*Please check all that apply).*[66]

- UV treatment
- Sedimentation
- Chemical treatment
- Filtration
- Ozone treatment
- Biofiltration
- Other, please specify_____

Q41. What do you think are the most likely ways diseases & parasites would enter your facility? (*Please check all that apply*).

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water				
Recreational boats				
Shipping vessels				
Boats that service the farm				
Slow moving vessels (barges, dredgers)				
Visitors (service people, technicians etc.)				
Stock transfers				
Equipment (containers, nets, etc)				
Other wild animals (fish, birds, shellfish, etc)				
Staff				
Feed				
Other				

Please specify_____

Q42. Which of the following methods do you use to manage the risk of disease and parasite entry/exacerbation/transfer? If not, please indicate reasons (*check all that apply*).

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing sharing equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing staff from moving among farms	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Use of preventative therapeutic/ chemical treatments on shellfish	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of incoming water	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of effluent water	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Fallowing between production cycles	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among farms	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Single year class production	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Division of facilities into discrete units separately managed	☐	☐	☐	☐	☐	☐	☐	☐
Applying best management practice with respect to animal welfare and animal husbandry (exacerbation)	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

General Biosecurity Feedback

This section is on general biosecurity. This section is an opportunity to share your issues or concerns on general biosecurity matters.

Q43. Where do you find the most useful information with respect to on-farm biosecurity practices? *(Please check all that apply)*

- ☐ MPI – Aquaculture Unit
- ☐ MPI – Biosecurity Response Team
- ☐ Shellfish health specialists/veterinarians
- ☐ Other farmers
- ☐ Industry Association Representatives
- ☐ NIWA
- ☐ Cawthron
- ☐ Universities
- ☐ Training courses
- ☐ Workshop material
- ☐ Books
- ☐ Reports
- ☐ Scientific papers
- ☐ Former work colleagues
- ☐ Internet
- ☐ TV
- ☐ Newspapers
- ☐ Regional Councils
- ☐ Department of Conservation
- ☐ Other, please specify_____

Q44. Are you aware that MPI has a contact number (0800 80 99 66) to report any farm mortality events or suspect exotic marine pest species?

- ☐ Yes
- ☐ No

Q45. Would you use the MPI 0800 number to report in the occurrence of any of the above instances at your facility?

- ☐ Yes
- ☐ No

Q46. Which box captures your concerns about using the MPI number?

- ☐ Potential for exclusion from decision/solution making process
- ☐ Unaware of the 0800 process, i.e., what happens after I call the number?
- ☐ Other, please specify_____

Q47. How effective do you think MPI's aquatic biosecurity functions are? (*Please provide an answer for each line).*

	Ineffective	Low	Moderate	Effective	Don't know
Communications to industry	☐	☐	☐	☐	☐
Aquatic health expertise	☐	☐	☐	☐	☐
Pest expertise	☐	☐	☐	☐	☐
Diagnostic services	☐	☐	☐	☐	☐
Biosecurity response preparedness	☐	☐	☐	☐	☐
Aquatic disease response action(s)	☐	☐	☐	☐	☐
Pest response action(s)	☐	☐	☐	☐	☐
Organism movement controls	☐	☐	☐	☐	☐
Aquatic surveillance	☐	☐	☐	☐	☐
Controls on imports	☐	☐	☐	☐	☐
Controls on exports	☐	☐	☐	☐	☐

We value your experience and practical working knowledge of oyster farming.

Q48. Do you have any additional comments that will help assist us with this research?

_____

Q49. Are you interested in receiving updates about this research project and other MPI biosecurity projects in the future?

- ☐ Yes
- ☐ No

Q50. If yes, please provide your contact details below.[67]

Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Mobile phone number:

On-site interviews

For the next stage of our research we will be conducting on-site interviews with selected farms in early 2014. Site visits will help researchers understand the real world of farming and will give us the chance to have face to face discussion with you and your staff about your issues and concerns on biosecurity. As independent researchers we are able to keep your information confidential. The final report will be made available to participants.

MPI, in collaboration with industry representatives, will then use the results of this project to inform a wider project investigating the management of biosecurity risks to New Zealand aquaculture. This project aims to benefit New Zealand, your industry and your business.

[67] Question skipped if answer to the previous question was 'No'.

Q51. Are you able to assist with the next stage of our research?

- Yes
- No

Q52. If yes and you have not already provided your details above, please provide your contact details below.[68]

Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Phone number:
Mobile phone number:

Thank you for supporting the growth of New Zealand's aquaculture industry.

[68] Question skipped if answer to the previous question was 'No'.

8.5 MUSSEL QUESTIONNAIRE

Instructions

Thank you for your participation in this questionnaire.

It should take around 15 minutes of your time. Please click on a button to select your answer. When you are finished with each question, click "Next". The questionnaire is divided into four sections:

1. Your facility;
2. Pests;
3. Diseases and Parasites; and
4. General Biosecurity Feedback.

This questionnaire covers all mussel farms under your management. If you farm other species you may be asked to help with the other species questionnaires.

There is a bar on the top of the questionnaire showing your progress.

Your Facility

This section is on your facility.

There is a wide variety of aquatic operations. To get an understanding of your specific operation, we need some background information about your facility.

Q1. What is the main purpose of your facility? (*Please check only one).*

- Food production
- Spat/seed supply
- Other, please specify_____

Q2. Please identify the geographic area that your facility(s) are located in.

- Auckland
- Coromandel
- Northland
- Bay of Plenty
- Canterbury
- Marlborough
- Southland/Stewart Island
- Other, please specify_____

Q3. Do you culture any other species apart from Greenshell mussels?

- Yes
- No

Q4. What other species do you culture?[69]_____

Q5. How many mussel farms do you manage? _____

[69] Question skipped if answer to the previous question was 'No'.

Q6. What is your annual production?

- 0–500 MT
- 500–1000 MT
- 1000–5000 MT
- 5000+ MT

Q7. Where do you get your mussel spat from? (*Check all that apply*).

- Kaitaia
- Coromandel/Hauraki Gulf
- Marlborough
- Other, please specify_____

Q8. Do you keep records of stock coming onto and off your farm?

- Yes
- No

Q9. Which of the following parameters do you record for your business?

	At least once a day	At least once a week	At least once a month	Occasionally	Never
Water temperature	□	□	□	□	□
Dissolved oxygen levels	□	□	□	□	□
Chlorophyll *a*	□	□	□	□	□
Suspended solids	□	□	□	□	□
pH	□	□	□	□	□
Other	□	□	□	□	□

Please specify_____

Pest Species

This section is on pest species.

In this section, we would like to get an understanding about your thoughts and concerns about pest species, and your current methods of dealing with pest species.

Q10. For your business, how concerned are you about preventing/managing pest species?

- Not concerned
- Low
- Medium
- Very concerned

Q11. On your farm, please indicate the types of pest species you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Sea squirts/ascidians	□	□	□	□
Sponges	□	□	□	□
Harmful/toxic algae (phytoplankton)	□	□	□	□
Bryozoans	□	□	□	□
Hydroids	□	□	□	□
Crabs	□	□	□	□
Bivalves	□	□	□	□
Gastropods/marine snails	□	□	□	□
Bristleworms/fan worms	□	□	□	□
Barnacles	□	□	□	□
Starfish, sea urchins, sea cucumbers	□	□	□	□
Seaweeds	□	□	□	□
Amphipods/isopods	□	□	□	□
Flatworms	□	□	□	□
Other	□	□	□	□

Please specify_____

Q12. What aquatic pest species are you specifically concerned about?_____

Q13. Do you routinely check for the presence of pest species on your farm?

- □ Yes
- □ No

Q14. How often do you check your farm for the presence of pest species?[70]

- □ Daily
- □ Weekly
- □ Monthly
- □ Quarterly
- □ More than quarterly

[70] Question skipped if answer to the previous question was 'No'.

Q15. What do you think are the most likely ways pest species would enter your facility? (*Please check all that apply).*

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water	□	□	□	□
Recreational boats	□	□	□	□
Shipping vessels	□	□	□	□
Slow moving vessels (barges, dredgers)	□	□	□	□
Farm working boats/contractor boats	□	□	□	□
Visitors (service people, technicians etc.)	□	□	□	□
Stock transfers	□	□	□	□
Equipment (containers, nets, etc)	□	□	□	□
Other wild animals (fish, birds, shellfish etc)	□	□	□	□
Staff	□	□	□	□
Other	□	□	□	□

Please specify_____

Q16. Do you use antifouling treatments on your farm structures? (excluding vessels)

- □ Yes
- □ No

Q17. How often do you remove biofouling species from your farm?

- □ At the point of harvest
- □ Daily
- □ Weekly
- □ Monthly
- □ Every 3 months
- □ Every 6 months
- □ Yearly
- □ Never

Q18. How do you dispose of biofouling species?[71]

- □ Cleaned on site and left to disperse through water
- □ Removed from site and disposed of in a landfill
- □ Removed from site and disposed of in sea outside of resource consent boundaries
- □ Other, please specify_____.

[71] Question skipped if answer to the previous question was 'Never'.

Q19. Which of the following methods do you use to manage the risk of pest entry/exacerbation/transfer? If not, please indicate reasons (*check all that apply*).

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing the sharing of equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on boats	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on submerged structures	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among farms	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Manual removal of pest species	☐	☐	☐	☐	☐	☐	☐	☐
Batch separation	☐	☐	☐	☐	☐	☐	☐	☐
Visual inspection	☐	☐	☐	☐	☐	☐	☐	☐
Washing seed/spat prior to transfer	☐	☐	☐	☐	☐	☐	☐	☐
Foam fractionator	☐	☐	☐	☐	☐	☐	☐	☐
Washing and declumping of seed	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

Diseases & Parasites

This section is on diseases and parasites.

In this section, we would like to get an understanding about your thoughts and concerns about diseases and parasites, and your current methods of dealing with them.

Q20. For your business, how concerned are you about preventing/managing diseases and parasites?

- ☐ Not concerned
- ☐ Low
- ☐ Moderate
- ☐ Very concerned

Q21. On your farm, please indicate the type of diseases you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Bacterial diseases	□	□	□	□
Viral diseases	□	□	□	□
Fungal diseases	□	□	□	□
Parasitic diseases	□	□	□	□

Q22. What disease or parasite species are you specifically concerned about?_____

Q23. What do you think are the most likely ways diseases & parasites would enter your facility? (*Please check all that apply*).

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water	□	□	□	□
Recreational boats	□	□	□	□
Shipping vessels				
Boats that service the farm	□	□	□	□
Visitors (service people, technicians etc.)	□	□	□	□
Stock transfers	□	□	□	□
Equipment (containers, nets, etc)	□	□	□	□
Other wild animals (fish, birds, shellfish, etc)	□	□	□	□
Staff	□	□	□	□
Feed	□	□	□	□
Other	□	□	□	□

Please specify_____

Q24. Do you think it is important that a shellfish health specialist visits your farm?

- □ Yes
- □ No

Q25. Has a shellfish health specialist ever visited your farm?

- □ Yes
- □ No

Q26. How often does a shellfish health specialist visit your farm?[72]

- □ Monthly
- □ Quarterly
- □ Half-yearly
- □ Annually

Q27. Do you have a shellfish health specialist on call?

- □ Yes
- □ No

[72] Question skipped if answer to the previous question was 'No'.

Q28. Do you routinely test shellfish for diseases and parasites?

- Yes
- No

Q29. When do you test for diseases and parasites?[73]

- Prior to transfer on site
- Prior to transfer off site
- Periodically
- When animals are lethargic/sick/dying/show disease signs
- Other, please specify_____

Q30. Do you routinely use therapeutants/medicines/freshwater treatments on your shellfish?

- Yes
- No

Q31. When do you use therapeutants on your shellfish?[73]

- As a preventative
- To treat a disease outbreak
- When transferring stock
- Other, please specify_____

Q32. How often do you remove mortalities from your farm?

- At the point of harvest
- Immediately when observed
- Daily
- Every 3–4 days
- Weekly
- More than weekly
- Don't remove mortalities
- Other, please specify_____

Q33. How do you store your mortalities before disposal?[73]

- Sealed, water-tight containers
- Open containers
- Rubbish bags
- Never
- Other, please specify_____

Q34. How do you dispose of material post-processing? *(Check all that apply).*

- In the sea within farm resource consent boundaries
- Removed from site and disposed of in a landfill
- Removed from site and disposed of in sea outside of resource consent boundaries
- Other, please specify_____

[73] Question skipped if answer to the previous question was 'No'.

Q35. Which of the following methods do you use to manage the risk of disease and parasite entry/exacerbation/transfer? If not, please indicate reasons (*check all that apply*).

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing the sharing of equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing staff from moving among farms	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Use of preventative therapeutic/ chemical treatments on shellfish	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Fallowing between production cycles	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among farms	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Single year class production	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Applying best management practice with respect to animal welfare and animal husbandry (exacerbation)	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

General Biosecurity Feedback

This section is on general biosecurity. This section is an opportunity to share your issues or concerns on general biosecurity matters.

Q36. Where do you find the most useful information with respect to on-farm biosecurity practices? *(please check all that apply).*

- MPI – Aquaculture Unit
- MPI – Biosecurity Response Team
- Shellfish health specialists/veterinarians
- Other farmers
- Industry Association Representatives
- NIWA
- Cawthron
- Universities
- Training courses
- Workshop material
- Books
- Reports
- Scientific papers
- Former work colleagues
- Internet
- TV
- Newspapers
- Regional Councils
- Department of Conservation
- Other, please specify_____

Q37. Are you aware that MPI has a contact number (0800 80 99 66) to report any farm mortality events or suspect exotic marine pest species?

- Yes
- No

Q38. Would you use the MPI 0800 number to report in the occurrence of any of the above instances at your facility?

- Yes
- No

Q39. Which box captures your concerns about using the MPI number?

- Potential for exclusion from decision/solution making process
- Unaware of the 0800 process, i.e., what happens after I call the number?
- Other, please specify_____

Q40. How effective do you think MPI's aquatic biosecurity functions are? (*Please provide an answer for each line).*

	Ineffective	Low	Moderate	Effective	Don't know
Communications to industry	☐	☐	☐	☐	☐
Aquatic health expertise	☐	☐	☐	☐	☐
Pest expertise	☐	☐	☐	☐	☐
Diagnostic services	☐	☐	☐	☐	☐
Biosecurity response preparedness	☐	☐	☐	☐	☐
Aquatic disease response action(s)	☐	☐	☐	☐	☐
Pest response action(s)	☐	☐	☐	☐	☐
Organism movement controls	☐	☐	☐	☐	☐
Aquatic surveillance	☐	☐	☐	☐	☐
Controls on imports	☐	☐	☐	☐	☐
Controls on exports	☐	☐	☐	☐	☐

We value your experience and practical working knowledge of mussel farming.

Q41. Do you have any additional comments that will help assist us with this research?

_____

Q42. Are you interested in receiving updates about this research project and other MPI biosecurity projects in the future?

- ☐ Yes
- ☐ No

Q43. If yes, please provide your contact details below.[74]
Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Mobile phone number:

On-site interviews

For the next stage of our research we will be conducting on-site interviews with selected farms in early 2014. Site visits will help researchers understand the real world of farming and will give us the chance to have face to face discussion with you and your staff about your issues and concerns on biosecurity. As independent researchers we are able to keep your information confidential. The final report will be made available to participants.

MPI, in collaboration with industry representatives, will then use the results of this project to inform a wider project investigating the management of biosecurity risks to New Zealand aquaculture. This project aims to benefit New Zealand, your industry and your business.

[74] Question skipped if answer to the previous question was 'No'.

Q44. Are you able to assist with the next stage of our research?

- Yes
- No

Q45. If yes and you have not already provided your details above, please provide your contact details below.[75]

Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Phone number:
Mobile phone number:

Thank you for supporting the growth of New Zealand's aquaculture industry.

[75] Question skipped if answer to the previous question was 'No'.

8.6 MUSSEL SPAT HARVESTERS QUESTIONNAIRE

Instructions

Thank you for your participation in this questionnaire.

It should take around 15 minutes of your time. Please click on a button to select your answer. When you are finished with each question, click "Next". The questionnaire is divided into four sections:

1. Your facility;
2. Pests;
3. Diseases and Parasites; and
4. General Biosecurity Feedback.

This questionnaire covers all spat collection sites under your management. If you farm other species you may be asked to help with the other species questionnaires.

There is a bar on the top of the questionnaire showing your progress.

Your Facility

This section is on your site.

To get an understanding of your specific operation, we need some background information about your facility.

Q1. What is your annual harvest volumes for all your sites?

- 0–10 MT
- 10–50 MT
- 50–100 MT
- 100–200 MT
- 200+ MT

Q2. Do you keep records of stock coming onto and off your site?

- Yes
- No

Q3. What areas around the country do you transfer mussel spat to?_____

Q4. Do you temporarily hold live spat in seawater prior to transfer off site?

- Yes
- No

Pest Species

This section is on pest species.

In this section, we would like to get an understanding about your thoughts and concerns about pest species, and your current methods of dealing with pest species.

Q5. For your business, how concerned are you about preventing/managing pest species?

- Not concerned
- Low
- Medium
- Very concerned

Q6. On your site, please indicate the types of marine pest species you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Sea squirts/ascidians	□	□	□	□
Sponges	□	□	□	□
Harmful/toxic algae (phytoplankton)	□	□	□	□
Bryozoans	□	□	□	□
Hydroids	□	□	□	□
Crabs	□	□	□	□
Bivalves	□	□	□	□
Gastropods/marine snails	□	□	□	□
Bristleworms/fan worms	□	□	□	□
Barnacles	□	□	□	□
Starfish, sea urchins, sea cucumbers	□	□	□	□
Seaweeds	□	□	□	□
Amphipods/isopods	□	□	□	□
Flatworms	□	□	□	□
Other	□	□	□	□

Please specify_____

Q7. What aquatic pest species are you specifically concerned about?_____

Q8. Do you routinely visually check for the presence of pest species on your site?

- □ Yes
- □ No

Q9. How often do you check your site for the presence of pest species?[76]

- □ Daily
- □ Weekly
- □ Monthly
- □ Quarterly
- □ More than quarterly

Q10. Do you routinely test spat for harmful marine algae?

- □ Yes
- □ No

Q11. When do you test spat for harmful marine algae? (*Check all that apply*)[76]

- □ Presence of sick or dead mussels
- □ Before transfer off-site
- □ When there is a harmful algal bloom in the area
- □ When required to by government agencies
- □ Other, please specify_____

[76] Question skipped if answer to the previous question was 'No'.

Q12. How do you dispose of any pest species that are collected?

- Returned to sea
- In a landfill
- Other, please specify_____.

Q13. What do you think are the most likely ways pest species would enter your site? (*Please check all that apply).*

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water				
Recreational boats				
Shipping vessels				
Slow moving vessels(barges, dredgers)				
Farm working boats/contractor boats				
Visitors (service people, technicians etc.)				
Stock transfers				
Equipment (containers, nets, etc)				
Other wild animals (fish, birds, shellfish etc)				
Staff				
Other				

Please specify_____

Q14. Which of the following methods do you use to manage the risk of pest entry/exacerbation/transfer? If not, please indicate reasons (*check all that apply*).

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Visual inspection	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Manual removal of pest species	☐	☐	☐	☐	☐	☐	☐	☐
Treatment with foam fractionator	☐	☐	☐	☐	☐	☐	☐	☐
Washing spat off seaweed	☐	☐	☐	☐	☐	☐	☐	☐
Testing of spat prior to transfer	☐	☐	☐	☐	☐	☐	☐	☐
Use of chemical treatments on spat prior to transfer	☐	☐	☐	☐	☐	☐	☐	☐
Not harvesting when there is a harmful algae bloom in the area	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

Diseases & Parasites

This section is on diseases and parasites.

In this section, we would like to get an understanding about your thoughts and concerns about diseases and parasites, and your current methods of dealing with them.

Q15. For your business, how concerned are you about preventing/managing diseases and parasites?

- ☐ Not concerned
- ☐ Low
- ☐ Moderate
- ☐ Very concerned

Q16. On your facility, please indicate the type of diseases you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Bacterial diseases	☐	☐	☐	☐
Viral diseases	☐	☐	☐	☐
Fungal diseases	☐	☐	☐	☐
Parasitic diseases	☐	☐	☐	☐

Q17. What disease or parasite species are you specifically concerned about?_____

Q18. Do you think it is important that a shellfish health specialist visits your site?

- Yes
- No

Q19. Has a shellfish health specialist ever visited your site?

- Yes
- No

Q20. How often does a shellfish health specialist visit your facility?[77]

- Monthly
- Quarterly
- Half-yearly
- Annually

Q21. Do you have a shellfish health specialist on call?

- Yes
- No

Q22. Do you routinely use therapeutants/medicines/freshwater treatments on your shellfish?

- Yes
- No

Q23. When do you use therapeutants on your shellfish?[77]

- As a preventative
- To treat a disease outbreak
- When transferring stock
- Other, please specify_____

Q24. What do you think are the most likely ways diseases & parasites would enter your site? (*Please check all that apply*).

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water	☐	☐	☐	☐
Recreational boats	☐	☐	☐	☐
Shipping vessels	☐	☐	☐	☐
Boats that service the farm	☐	☐	☐	☐
Visitors (service people, technicians etc.)	☐	☐	☐	☐
Stock transfers	☐	☐	☐	☐
Equipment (containers, nets, etc)	☐	☐	☐	☐
Other wild animals (fish, birds, shellfish, etc)	☐	☐	☐	☐
Staff	☐	☐	☐	☐
Feed	☐	☐	☐	☐
Other	☐	☐	☐	☐

Please specify_____

[77] Question skipped if answer to the previous question was 'No'.

Q25. Which of the following methods do you use to manage the risk of disease and parasite entry/exacerbation/transfer? If not, please indicate reasons (*check all that apply*)

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Test of spat prior to transfer	☐	☐	☐	☐	☐	☐	☐	☐
Use of chemical treatments on spat prior to transfer	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

General Biosecurity Feedback

This section is on general biosecurity. This section is an opportunity to share your issues or concerns on general biosecurity matters.

Q26. Where do you find the most useful information with respect to on-farm biosecurity practices? *(please check all that apply)*

- ☐ MPI – Aquaculture Unit
- ☐ MPI – Biosecurity Response Team
- ☐ Shellfish health specialists/veterinarians
- ☐ Other farmers
- ☐ Industry Association Representatives
- ☐ NIWA
- ☐ Cawthron
- ☐ Universities
- ☐ Training courses
- ☐ Workshop material
- ☐ Books
- ☐ Reports
- ☐ Scientific papers
- ☐ Former work colleagues
- ☐ Internet
- ☐ TV
- ☐ Newspapers
- ☐ Regional Councils
- ☐ Department of Conservation
- ☐ Other, please specify_____

Q27. Are you aware that MPI has a contact number (0800 80 99 66) to report any farm mortality events or suspect exotic marine pest species?

- ☐ Yes
- ☐ No

Q28. Would you use the MPI 0800 number to report in the occurrence of any of the above instances at your facility?

- ☐ Yes
- ☐ No

Q29. Which box captures your concerns about using the MPI number?

- ☐ Potential for exclusion from decision/solution making process
- ☐ Unaware of the 0800 process, i.e., what happens after I call the number?
- ☐ Other, please specify_____

Q30. How effective do you think MPI's aquatic biosecurity functions are? (*Please provide an answer for each line).*

	Ineffective	Low	Moderate	Effective	Don't know
Communications to industry	☐	☐	☐	☐	☐
Aquatic health expertise	☐	☐	☐	☐	☐
Pest expertise	☐	☐	☐	☐	☐
Diagnostic services	☐	☐	☐	☐	☐
Biosecurity response preparedness	☐	☐	☐	☐	☐
Aquatic disease response action(s)	☐	☐	☐	☐	☐
Pest response action(s)	☐	☐	☐	☐	☐
Organism movement controls	☐	☐	☐	☐	☐
Aquatic surveillance	☐	☐	☐	☐	☐
Controls on imports	☐	☐	☐	☐	☐
Controls on exports	☐	☐	☐	☐	☐

We value your experience and practical working knowledge of the mussel industry.

Q31. Do you have any additional comments that will help assist us with this research?

_____

Q32. Are you interested in receiving updates about this research project and other MPI biosecurity projects in the future?

- ☐ Yes
- ☐ No

Q33. If yes, please provide your contact details below.[78]

Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Mobile phone number:

[78] Question skipped if answer to the previous question was 'No'.

On-site interviews

For the next stage of our research we will be conducting on-site interviews with selected farms in early 2014. Site visits will help researchers understand the real world of farming and will give us the chance to have face to face discussion with you and your staff about your issues and concerns on biosecurity. As independent researchers we are able to keep your information confidential. The final report will be made available to participants.

MPI, in collaboration with industry representatives, will then use the results of this project to inform a wider project investigating the management of biosecurity risks to New Zealand aquaculture. This project aims to benefit New Zealand, your industry and your business.

Q34. Are you able to assist with the next stage of our research?

- Yes
- No

Q35. If yes and you have not already provided your details above, please provide your contact details below.[79]

Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Phone number:
Mobile phone number:

Thank you for supporting the growth of New Zealand's aquaculture industry.

[79] Question skipped if answer to the previous question was 'No'.

8.7 RESEARCH FACILITY QUESTIONNAIRE

Instructions

Thank you for your participation in this questionnaire.

It should take around 15 minutes of your time. Please click on a button to select your answer. When you are finished with each question, click "Next". The questionnaire is divided into four sections:

1. Your facility;
2. Pests;
3. Diseases and Parasites; and
4. General Biosecurity Feedback.

There is a bar on the top of the questionnaire showing your progress.

Your Facility

This section is on your facility.

There is a wide variety of aquaculture research facilities. To get an understanding of your specific operation, we need some background information about your facility.

Q1. What species (and life stages) have you had on site over the past year? *(Check all that apply).*

	Adults/ broodstock	Juveniles	Larvae	Eggs
Chinook salmon	☐	☐	☐	☐
Hapuku	☐	☐	☐	☐
Kingfish	☐	☐	☐	☐
Green-lipped mussels	☐	☐	☐	☐
Blue mussels	☐	☐	☐	☐
Pacific oysters	☐	☐	☐	☐
Flat oysters	☐	☐	☐	☐
Eels	☐	☐	☐	☐
Flatfish	☐	☐	☐	☐
Trout	☐	☐	☐	☐
Snapper	☐	☐	☐	☐
Butterfish	☐	☐	☐	☐
Paua	☐	☐	☐	☐
Sea cucumbers	☐	☐	☐	☐
Sea urchins	☐	☐	☐	☐
Macroalgae	☐	☐	☐	☐
Microalgae for feed	☐	☐	☐	☐
Harmful/toxic microalgae species	☐	☐	☐	☐
Other	☐	☐	☐	☐

Please specify_____

Q2. For each species, please indicate whether they are reared on land, in the aquatic environment or are distributed to other growers for on-growing (*Please check all that apply).*

	Reared on land using pumped water	Reared in the aquatic environment in pens/cages	Distributed to other growers for on-growing	Not applicable
Chinook salmon	□	□	□	□
Hapuku	□	□	□	□
Kingfish	□	□	□	□
Green-lipped mussels	□	□	□	□
Blue mussels	□	□	□	□
Pacific oysters	□	□	□	□
Flat oysters	□	□	□	□
Eels	□	□	□	□
Flatfish	□	□	□	□
Trout	□	□	□	□
Snapper	□	□	□	□
Butterfish	□	□	□	□
Paua	□	□	□	□
Sea cucumbers	□	□	□	□
Sea urchins	□	□	□	□
Macroalgae	□	□	□	□
Microalgae for feed	□	□	□	□
Harmful/toxic microalgae species	□	□	□	□
Other	□	□	□	□

Please specify_____

Q3. Do you keep records of stock coming onto and off your facility?

- □ Yes
- □ No

Q4. What sources of water do you use for holding animals? (*Check all that apply*)

- □ Sea water (*in situ*)
- □ Pumped sea water
- □ Surface water (lake, river, stream)
- □ Spring water
- □ Well/bore water (freshwater)
- □ Chlorinated municipal water
- □ Other, please specify_____

Q5. Do you treat your intake water prior to use for animal production?

- □ Yes
- □ No

Q6. How do you treat your intake water prior to use in animal production? (*Please check all that apply).*[80]

- UV treatment
- Sedimentation
- Chemical treatment
- Ozone treatment
- Filtration
- Other, please specify_____

Q7. Do you treat your effluent water after being used for animal production?

- Yes
- No

Q8. How do you treat your effluent water after being used for animal production? (*Please check all that apply).*[80]

- UV treatment
- Sedimentation
- Chemical treatment
- Ozone treatment
- Filtration
- Biofiltration
- Other, please specify_____

Q9. Do you treat the water used in live-animal transporters?

- Yes
- No
- Not applicable

Q10. How do you treat the water used in live-animal transporters? (*Please check all that apply).*[81]

- UV treatment
- Sedimentation
- Chemical treatment
- Filtration
- Ozone treatment
- Other, please specify:_____ _____

Q11. How do you dispose of the water used in live-animal transporters?[81]

- In natural waterways
- In the sea
- A municipal wastewater treatment system
- **N**ot applicable
- Other, please specify_____

[80] Question skipped if answer to the previous question was 'No'.
[81] Question skipped if answer to question 9 was 'No' or 'Not applicable'.

Q12. Which of the following parameters do you monitor at your site?

	At least once a day	At least once a week	At least once a month	Occasionally	Never
Water temperature	□	□	□	□	□
Dissolved oxygen levels	□	□	□	□	□
Ammonia	□	□	□	□	□
Total nitrogen (nitrates and nitrites)	□	□	□	□	□
pH	□	□	□	□	□
Animal feeding rates	□	□	□	□	□
Total phosphates	□	□	□	□	□
Other	□	□	□	□	□

Please specify_____

Diseases & Parasites

This section is on diseases and parasites.

In this section, we would like to get an understanding about your thoughts and concerns about diseases and parasites, and your current methods of dealing with them.

Q13. For your site, how concerned are you about preventing/managing diseases and parasites?

- □ Not concerned
- □ Low
- □ Moderate
- □ Very concerned

Q14. For your site, please indicate the type of diseases you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Bacterial diseases	□	□	□	□
Viral diseases	□	□	□	□
Fungal diseases	□	□	□	□
Parasitic diseases	□	□	□	□

Q15. What is the one disease or parasite you are most concerned about?_____

Q16. Do you hold cultures of disease organisms on site for research purposes?

- □ Yes
- □ No

Q17. Can you please list which cultures of disease organisms that you hold on site for research purposes?[82]_____

Q18. Do you have an aquatic disease specialist(s) on site?

- □ Yes
- □ No

[82] Question skipped if answer to the previous question was 'No'.

Q19. Do you use the services of external aquatic disease specialist(s)?

- Yes
- No

Q20. How often do aquatic disease specialist(s) visit your facility?[83]

- Monthly
- Quarterly
- Half-yearly
- Annually

Q21. Do you have an aquatic disease specialist on call?

- Yes
- No

Q22. Do you quarantine new animals that are introduced on-site in an isolated holding area?

- Yes
- No

Q23. How long are new animals held in quarantine in an isolated holding area?[83]

_____

Q24. Do you routinely test animals for diseases and parasites?

- Yes
- No

Q25. When do you test animals for diseases and parasites? (*Check all that apply*).[83]

- Prior to transfer on site
- Prior to transfer off site
- Periodically
- When animals are lethargic/sick/dying/show disease signs
- Other, please specify_____

Q26. Do you routinely use therapeutants/medicines/salinity treatments on your animals?

- Yes
- No

Q27. When do you use therapeutants on your animals?[83]

- As a preventative
- To treat a disease outbreak
- When new stock are introduced to the site
- When transferring stock off site
- Other, please specify_____

[83] Question skipped if answer to the previous question was 'No'.

Q28. How often do you use therapeutants/medicines/disinfectants/salinity treatments on each of these life-stages?

	Never	At least once a week	About once a month	About once every 3 months	About once every 6 months	>6 months
Finfish eggs	☐	☐	☐	☐	☐	☐
Finfish larvae	☐	☐	☐	☐	☐	☐
Finfish juveniles	☐	☐	☐	☐	☐	☐
Finfish adults	☐	☐	☐	☐	☐	☐
Shellfish eggs	☐	☐	☐	☐	☐	☐
Shellfish larvae	☐	☐	☐	☐	☐	☐
Shellfish juveniles	☐	☐	☐	☐	☐	☐
Shellfish adults	☐	☐	☐	☐	☐	☐

Q29. How often do you remove mortalities from your culture units?

- ☐ Immediately when observed
- ☐ Daily
- ☐ Every 3–4 days
- ☐ Weekly
- ☐ More than weekly
- ☐ Never

Q30. How do you store your mortalities before disposal?[84]

- ☐ Sealed, water-tight containers
- ☐ Open containers
- ☐ Rubbish bags
- ☐ Other, please specify_____

Q31. How do you dispose of mortalities? (*Check all that apply*)[84]

- ☐ In the sea within farm resource consent boundaries
- ☐ Removed from site and disposed of in a landfill
- ☐ Removed from site and disposed of in sea outside of resource consent boundaries
- ☐ Other, please specify_____

Q32. How do you store your feed on-site?

- ☐ Sealed, water-tight containers
- ☐ Open containers
- ☐ Bags
- ☐ Fridge/freezer
- ☐ Other, please specify_____

[84] Question skipped if answer question 29 was 'Never'.

Q33. What do you think are the most likely ways diseases & parasites would enter your facility? (*Please check all that apply*).

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water	□	□	□	□
Recreational boats	□	□	□	□
Shipping vessels	□	□	□	□
Boats that service the farm	□	□	□	□
Visitors (service people, technicians etc.)	□	□	□	□
Stock transfers	□	□	□	□
Equipment (containers, nets, etc)	□	□	□	□
Other wild animals (fish, birds, shellfish, etc)	□	□	□	□
Staff	□	□	□	□
Feed	□	□	□	□
Other	□	□	□	□

Please specify_____

Q34. Which of the following methods do you use to manage the risk of disease and parasite entry/exacerbation/transfer? If not, please indicate why (*check all that apply*).

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing the sharing of equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing staff from moving among farms	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Use of preventative therapeutic/ chemical treatments on animals	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of incoming water	☐	☐	☐	☐	☐	☐	☐	☐
Treatment of effluent water	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Fallowing between production cycles	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among sites	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Single year class production	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Division of facilities into discrete units separately managed	☐	☐	☐	☐	☐	☐	☐	☐
Applying best management practice with respect to animal welfare and animal husbandry (exacerbation)	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

Please specify_____

Pest Species

This section is on pest species.

In this section, we would like to get an understanding about your thoughts and concerns about pest species, and your current methods of dealing with pest species.

Q35. For your site, how concerned are you about preventing/managing pest species?

- ☐ Not concerned
- ☐ Low
- ☐ Medium
- ☐ Very concerned

Q36. For your site, please indicate the types of pest species you are most concerned about?

	Not concerned	Low	Medium	Very concerned
Fish	☐	☐	☐	☐
Amphipods/isopods	☐	☐	☐	☐
Barnacles	☐	☐	☐	☐
Bivalves	☐	☐	☐	☐
Bristleworms/fan worms	☐	☐	☐	☐
Bryozoans	☐	☐	☐	☐
Crabs	☐	☐	☐	☐
Echinoderms	☐	☐	☐	☐
Flatworms	☐	☐	☐	☐
Gastropods	☐	☐	☐	☐
Aquatic plants	☐	☐	☐	☐
Hydroids	☐	☐	☐	☐
Ascidians	☐	☐	☐	☐
Sponges	☐	☐	☐	☐
Harmful/toxic algae	☐	☐	☐	☐
Macroalgae	☐	☐	☐	☐
Other	☐	☐	☐	☐

Please specify_____

Q37. What is the one aquatic pest species you are most concerned about?_____

Q38. Do you routinely monitor for the presence of pest species on your facility?

- ☐ Yes
- ☐ No

Q39. How often do you monitor your facility for the presence of pest species?[85]

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Quarterly
- ☐ More than quarterly

[85] Question skipped if answer to the previous question was 'No'.

Q40. What do you think are the most likely ways pest species would enter your facility? (*Please check all that apply).*

	Unlikely	Moderately likely	Very likely	Don't know
Naturally via water	□	□	□	□
Recreational boats	□	□	□	□
Slow moving vessels(barges, dredgers)	□	□	□	□
Farm working boats/contractor boats	□	□	□	□
Visitors (service people, technicians etc.)	□	□	□	□
Stock transfers	□	□	□	□
Equipment (containers, nets, etc)	□	□	□	□
Other wild animals (fish, birds, shellfish etc)	□	□	□	□
Staff	□	□	□	□
Other	□	□	□	□

Please specify_____

Q41. Which of the following methods do you use to manage the risk of pest entry/exacerbation/transfer? If not, please indicate reasons (*check all that apply*).

	Yes	No	Too expensive	Impractical	Ineffective as a control measure	Not necessary	Not possible	Haven't considered using this method
Preventing the sharing of boats among farms	☐	☐	☐	☐	☐	☐	☐	☐
Preventing the sharing of equipment among farms	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on boats	☐	☐	☐	☐	☐	☐	☐	☐
Using antifouling treatments on submerged structures	☐	☐	☐	☐	☐	☐	☐	☐
Routinely disinfecting equipment	☐	☐	☐	☐	☐	☐	☐	☐
Not moving stock among farms	☐	☐	☐	☐	☐	☐	☐	☐
Education of staff	☐	☐	☐	☐	☐	☐	☐	☐
Isolating/ quarantining incoming stock	☐	☐	☐	☐	☐	☐	☐	☐
Restricting access to the facility	☐	☐	☐	☐	☐	☐	☐	☐
Manual removal of pest species	☐	☐	☐	☐	☐	☐	☐	☐
Batch separation	☐	☐	☐	☐	☐	☐	☐	☐
Visual inspection	☐	☐	☐	☐	☐	☐	☐	☐
Division of site into discrete units managed separately	☐	☐	☐	☐	☐	☐	☐	☐
Washing seed/spat prior to transfer	☐	☐	☐	☐	☐	☐	☐	☐

Q42. How often do you use antifouling products on your culture units?

- ☐ Never
- ☐ About once every 6 months
- ☐ About once every year
- ☐ More than once per year

Q43. How often do you remove biofouling species from your culture units?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Every 3 months
- ☐ Every 6 months
- ☐ Yearly
- ☐ Never

Q44. How do you dispose of biofouling species?[86]

- Cleaned on site and left to disperse through water
- Removed from site and disposed of in a landfill
- Other, please specify_____.

General Biosecurity Feedback

This section is on general biosecurity. This section is an opportunity to share your issues or concerns on general biosecurity matters.

Q45. Where do you find the most useful information with respect to on-farm biosecurity practices? *(Please check all that apply).*

- MPI – Aquaculture Unit
- MPI – Biosecurity Response Team
- Fish health specialists/veterinarians
- Other farmers
- Industry Association Representatives
- NIWA
- Cawthron
- Universities
- Training courses
- Workshop material
- Books
- Reports
- Scientific papers
- Former work colleagues
- Internet
- TV
- Newspapers
- Regional Councils
- Department of Conservation
- Other, please specify_____

Q46. Are you aware that MPI has a contact number (0800 80 99 66) to report any farm mortality events or suspect exotic marine pest species?

- Yes
- No

Q47. Would you use the MPI 0800 number to report in the occurrence of any of the above instances at your facility?

- Yes
- No

Q48. Which box captures your concerns about using the MPI number?

- Potential for exclusion from decision/solution making process
- Unaware of the 0800 process, i.e., what happens after I call the number?
- Other, please specify_____

[86] Question skipped if answer to the previous question was 'Never'.

Q49. How effective do you think MPI's aquatic biosecurity functions are? (*Please provide an answer for each line).*

	Ineffective	Low	Moderate	Effective	Don't know
Communications to industry	☐	☐	☐	☐	☐
Aquatic health expertise	☐	☐	☐	☐	☐
Pest expertise	☐	☐	☐	☐	☐
Diagnostic services	☐	☐	☐	☐	☐
Biosecurity response preparedness	☐	☐	☐	☐	☐
Aquatic disease response action(s)	☐	☐	☐	☐	☐
Pest response action(s)	☐	☐	☐	☐	☐
Organism movement controls	☐	☐	☐	☐	☐
Aquatic surveillance	☐	☐	☐	☐	☐
Controls on imports	☐	☐	☐	☐	☐
Controls on exports	☐	☐	☐	☐	☐

Q50. Do you have any additional comments that will help assist us with this research?

_____

Q51. Are you interested in receiving updates about this research project and other MPI biosecurity projects in the future?

- ☐ Yes
- ☐ No

Q52. If yes, please provide your contact details below.[87]

Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Mobile phone number:

On-site interviews

For the next stage of our research we will be conducting on-site interviews with selected farms in early 2014. Site visits will help researchers understand the real world of farming and will give us the chance to have face to face discussion with you and your staff about your issues and concerns on biosecurity. As independent researchers we are able to keep your information confidential. The final report will be made available to participants.

MPI, in collaboration with industry representatives, will then use the results of this project to inform a wider project investigating the management of biosecurity risks to New Zealand aquaculture. This project aims to benefit New Zealand, your industry and your business.

[87] Question skipped if answer to the previous question was 'No'.

Q53. Are you able to assist with the next stage of our research?

- Yes
- No

Q54. If yes and you have not already provided your details above, please provide your contact details below.[88]

Name:
Company:
Address 1:
Address 2:
City/Town:
Region:
Postal code:
Email address:
Phone number:
Mobile phone number:

Thank you for filling in the questionnaire!

[88] Question skipped if answer to the previous question was 'No'.

8.8 INTERVIEW QUESTIONS FOR THE ON-SITE VISITS

1. Can you show me around your site and give me a brief overview of your farming process?
2. Can you give me a brief description about your regular day, your responsibilities and how many sites you manage?
3. How long have you been working in the aquaculture industry?
4. Do you have any pest species growing on your farm? Which species in particular? How long have you had them, where do they grow and how does it affect your farm?
5. Do you do anything to control the introduction, growth and spread of these pests?
6. What would you do if you noticed something new or unusual growing on your farm?
7. Is there anything that the government or industry could do to help control pests?
8. What about diseases or parasites? Any particular species? What about unexplained die-offs? How does it affect your farm?
9. Do you do anything to control the introduction, growth and spread of these diseases?
10. Is there anything that the government or industry could do to help control diseases?
11. Do have a staff education programme? What does it involve?
12. Water was identified as a major source of pest and disease transmission. Do you think there are any ways to reduce the risk of waterborne transmission?
13. Do you think that pests and diseases can be transferred around with stock or wild animals? Do you use any methods to reduce the risk of stock or other animals transmitting pests/diseases?
14. Do you think that pests and diseases can be transferred around with equipment? Do you use any methods to reduce the risk of equipment transferring pests/diseases?
15. Does your industry currently have any Codes of Practices/Best Management Practices around biosecurity? Would you find this useful if industry were to develop some? Do you think that Codes of Practices should be voluntary or mandatory?
16. Do you receive any information from MPI around biosecurity? Would you like to receive more information? In what form? Would it help to have a personal contact from MPI that you can discuss your operations and receive specific assistance?
17. Is there anything else you think would aid biosecurity of the aquaculture industry?

8.9 ADVANCE NOTICE OF QUESTIONNAIRE

Advance notice email for nationwide questionnaire: Managing Biosecurity Risk for Business Benefit.

This email is to give you advance notice of some important forthcoming research concerning your business and the economy of New Zealand.
The Ministry for Primary Industries (MPI) and Aquaculture NZ (AQNZ) are collaborating on a project to inform recommendations and guidelines on farm biosecurity tools & biosecurity plans to ensure they truly add value to the industry. There are three phases to the project:

1. Understanding practices, priorities and perceptions;
2. Risk profiling (organism and pathway risk); and
3. Developing tools to manage biological risk.

This research project is the first phase of the overall project and aims to create a snapshot of current biosecurity practices, perceptions, needs and awareness in the major aquaculture sectors.

We would value your participation in this research.
The research comprises two parts:

- a short on-line survey that is being sent to all aquaculture farms in New Zealand; and,
- follow-up site visits to a selected number of farmers who are interested to participate further.

In a few days we will be sending you the on-line link to our short survey.
The survey should only take about 15 minutes of your time. It is voluntary to participate, but we would greatly value your views. Your input will help New Zealand, your industry and your own business. Further information is supplied in the attachment.

You may be asked later if you would agree to a site visit. This too is voluntary.

Further information please contact:
Stacey Faire, Coast and Catchment Ltd (phone number)
Richard Fraser, Ministry for Primary Industries (phone number)
Colin Johnston, Aquaculture NZ (phone number)

8.10 BACKGROUND INFORMATION FOR AQUACULTURE INDUSTRY AND FLYER FOR THE CONFERENCE.

MANAGING BIOSECURITY RISK FOR BUSINESS BENEFIT

Background

Aquaculture is one of the fastest growing primary sectors in the world. In New Zealand, it generates an estimated $380 million for our economy. In the area of biological risk there is potential for significant impacts to New Zealand's aquaculture businesses due to losses in production or restricted trade caused by introduced or emerging pests and diseases. Recent events, such as the Pacific oyster mortalities, indicate that appropriate strengthening of aquaculture biosecurity practices could be a useful business risk management measure.
The Ministry for Primary Industries (MPI) and Aquaculture NZ (AQNZ) are collaborating on a project to inform recommendations and guidelines on farm biosecurity tools & biosecurity plans to ensure they truly add value to the industry. There are three phases to the project:

1. Understanding practices, priorities and perceptions;
2. Risk profiling (organism and pathway risk); and
3. Developing tools to manage biological risk.

In addition, information from this whole process will support discussions on Government Industry Agreements (GIA), pest management planning and pathway management plans with the aim of making them fit-for-purpose and least restrictive to ongoing business.

MPI, as the funding agency, have commissioned Coast and Catchment Ltd, a New Zealand owned environmental consultancy, to complete the first phase of the project. The aim of the first phase is to create a snapshot of current biosecurity practices, perceptions, needs and awareness in the major aquaculture sectors.

How can farmers and producers be involved?

You can help this process by sharing information about your own current farming practices including on-farm biosecurity management, your issues with the current biosecurity system and your views on risk priorities. To find this out we will be asking you to fill in an on-line questionnaire and allow us to visit your farm to talk to you and your staff. All raw data collected will be treated confidentially by Coast and Catchment Ltd and will ultimately be destroyed after six months. Information generated will be aggregated data for confidentially.

Farmers and producers can be involved by:

- **Completing an on-line Questionnaire**: we will shortly send each farmer in New Zealand an on-line questionnaire. The questionnaires cover items including current farming practices but also enables you to provide your priorities, concerns, risks and needs on aquaculture biosecurity; and
- **Supporting site visits**: we will contact a representative number of farmers, across the industry seeking to visit their facilities. These site visits will enable us to explore in greater detail some of the issues raised in the questionnaire. Gaining the perspective

across a farm's workforce is important as it helps build a picture of the realities of aquaculture in NZ.

What will the information be used for?
To create a snapshot of current biosecurity practices, perceptions, needs and awareness in the major aquaculture sectors. The final report will be provided to farmers and producers. MPI and Aquaculture NZ will then combine the results of this project with the second phase, an assessment of the known pests and diseases and pathways. As part of the wider project, recommendations will be developed in collaboration with industry representatives either through a working group or a discussion forum.

Rules of engagement
There are several special points to note regarding the whole project:

- *No blame:* aquaculture is just one user of the aquatic environment. Biosecurity management should consider all aquatic users;
- *Public good*: the aquaculture industry is helping New Zealand and themselves by addressing biosecurity concerns and improving the social perspective of aquaculture in New Zealand;
- *Voluntary*: this research is aimed at improved risk management for industry & government. There will be no new regulations as a result of this research;
- *Confidential*: information from individual farmers will be aggregated by independent consultants to keep it confidential. Coast and Catchment Ltd will not pass on specific farm related information to MPI;
- *Sharing information*: findings will inform any discussions between Aquaculture NZ and MPI regarding Government Industry Agreements, pest management policy and domestic pathway management plans;
- *Responsive*: MPI will provide participants with the final report. Participants will be kept informed of the next phase of the project and industry representatives will be invited to be part of the collaborative process to develop recommendations; and,
- *Trust:* an important outcome of this work is to strengthen the relationship between MPI and the industry.

In a few days we will be sending you the online link to our short survey.
The survey should only take about 15 minutes of your time. It is voluntary to participate, but we would greatly value your views. Your input will help New Zealand, your industry and your own business.

Thank you for your time and support. Further information please contact:

Stacey Faire, Coast and Catchment Ltd (phone number)

Richard Fraser, Ministry for Primary Industries (phone number)

Colin Johnston, Aquaculture NZ (phone number)

8.11 BACKGROUND INFORMATION SENT TO FISH AND GAME

MANAGING BIOSECURITY RISK FOR BUSINESS BENEFIT

Background

Aquaculture is one of the fastest growing primary sectors in the world. In New Zealand, it generates an estimated $380 million for our economy, not including the significant contribution that trout fisheries make to the tourism sector. In the area of biological risk there is potential for significant impacts to New Zealand's aquaculture businesses due to losses in production or restricted trade caused by introduced or emerging pests and diseases. Recent events, such as the Pacific oyster mortalities, indicate that appropriate strengthening of aquaculture biosecurity practices could be a useful business risk management measure.

The Ministry for Primary Industries (MPI), Aquaculture NZ (AQNZ), and Fish and Game NZ are collaborating on a project to inform recommendations and guidelines on farm biosecurity tools & biosecurity plans to ensure they truly add value to the industry. There are three phases to the project:

1. Understanding practices, priorities and perceptions;
2. Risk profiling (organism and pathway risk); and
3. Developing tools to manage biological risk.

MPI, as the funding agency, have commissioned Coast and Catchment Ltd, a New Zealand owned environmental consultancy, to complete the first phase of the project. The aim of the first phase is to create a snapshot of current biosecurity practices, perceptions, needs and awareness in the major aquaculture sectors.

How can farm managers be involved?

You can help this process by sharing information about your own current farming practices including on-farm biosecurity management, your issues with the current biosecurity system and your views on risk priorities. To find this out we will be asking you to fill in an on-line questionnaire and allow us to visit your farm to talk to you and your staff. All raw data collected will be treated confidentially by Coast and Catchment Ltd and will ultimately be destroyed after six months. Information generated will be aggregated data for confidentially.

Farmers and producers can be involved by:

- **Completing an online Questionnaire**: we will shortly send each farmer in New Zealand an online questionnaire. The questionnaires cover items including current farming practices but also enables you to provide your priorities, concerns, risks and needs on aquaculture biosecurity; and,
- **Supporting site visits**: we will contact a representative number of farmers, across the industry seeking to visit their facilities. These site visits will enable us to explore in greater detail some of the issues raised in the questionnaire. Gaining the perspective across a farms workforce is important as it helps build a picture of the realities of aquaculture in NZ.

What will the information be used for?

To create a snapshot of current biosecurity practices, perceptions, needs and awareness in the major aquaculture sectors. The final report will be provided to farmers and producers. MPI will then combine the results of this project with the second phase, an assessment of the known pests and diseases and pathways. As part of the wider project, recommendations will be developed in collaboration with Fish and Game representatives either through a working group or a discussion forum.

Project Outcomes

The outcomes sought for the overall project are to:

- identify and understand the biological risks to Fish and Game;
- understand current farming practices including on-farm biosecurity management;
- appreciate Fish and Game's priorities, concerns, risks and needs to better inform appropriate and useful biosecurity plans for the sector;
- enable voluntary implementation of the on-farm biosecurity management options;
- enable Fish and Game and MPI to be better informed and prepared to respond to incursions or emerging risks; and,
- continue to build good relations between Fish and Game and MPI.

Approach to Project

To achieve the outcomes listed above, this research project must engage with aquaculture farmers, managers and workers to gain an accurate understanding of:

- the real world of farm-based activities;
- the concerns, perceptions and needs of farmers regarding biosecurity;
- farmers' own priorities for biosecurity;
- practical problems in implementing biosecurity measures;
- current biosecurity management practices in New Zealand's major aquatic animal production facilities;
- how information is gained and disseminated by the industry to link this research into this network; and,
- how the research can further a productive partnership between the Aquaculture Unit of MPI and Fish and Game.

Rules of engagement

There are several special points to note regarding the whole project:

- *No blame:* Fish and Game is just one user of the aquatic environment. Biosecurity management should consider all aquatic users;
- *Public good*: Fish and Game are helping New Zealand and themselves by addressing biosecurity concerns and improving the social perspective of aquaculture in New Zealand;
- *Voluntary*: this research is aimed at improved risk management for Fish and Game & government. There will be no new regulations as a result of this research;
- *Confidential*: information from individual sites will be aggregated by independent consultants to keep it confidential. Coast and Catchment Ltd will not pass on specific farm related information to MPI;
- *Sharing Information*: findings will inform any discussions between Fish and Game and MPI regarding wider biosecurity planning;
- *Responsive*: MPI will provide participants with the final report. Participants will be kept informed of the next phase of the project and industry representatives will be invited to be part of the collaborative process to develop recommendations;

- *Trust:* an important outcome of this work is to strengthen the relationship between MPI and Fish and Game; and,
- *Value of sports fisheries:* the work Fish and Game do to maintain and enhance sports fisheries is important. Fish and Game, and MPI can together help improve biosecurity management for your operations into the future.

In a few days we will be sending you the online link to our short survey.

The survey should only take about 15 minutes of your time. It is voluntary to participate, but we would greatly value your views. Your input will help New Zealand, your industry and your own business.

Thank you for your time and support. Further information please contact:

Stacey Faire, Coast and Catchment Ltd (phone number);

Richard Fraser, Ministry for Primary Industries (phone number).

8.12 TEXT TO LAUNCH ON-LINE SURVEY

Last week, we emailed you advance notice of an on-line survey being conducted by Coast and Catchment on behalf of MPI and in collaboration with the Aquaculture Industry. The aim of the research is to create a snapshot of current biosecurity practices, perceptions, needs and awareness in the major aquaculture sectors.

We are now ready to launch the survey which is being sent to every aquaculture business in New Zealand.

We are anticipating a very high return rate for the survey as it has attracted a lot of interest. The better the participation the more informed the recommendations will be towards better enabling on-farm biosecurity management options for your industry.

Thank you for your participation in this important research. It will take only 15 minutes of your time. It is easy to do. Your input will help New Zealand, your industry and your own business. It is confidential. It will not result in compulsory new regulations, but rather it aims to reduce everyone's aquaculture business from vulnerability to pests, diseases and parasites. We will get back to you with our national findings.

Please click on the following link to begin.

https://www.surveymonkey.com/s/oyster

For further information please contact:

Stacey Faire, Coast and Catchment Ltd (phone number)

Richard Fraser, Ministry for Primary Industries (phone number)

Colin Johnston, Aquaculture NZ (phone number)

8.13 EXAMPLE OF TEXT FOR EMAIL REMINDERS

PROJECT UPDATE – Managing Biosecurity Risk for Business Benefit.

Last week you received an email requesting your input into an online questionnaire. We are pleased to announce that we have received a high response rate from:

- Paua farmers;
- Finfish farmers (marine & freshwater); and,
- Spat harvesters

We also have received support from mussel and oyster farmers, however, we need more responses to build a better picture and improve protection of your industry.

Everyone has a story to tell and our role is to gather all the stories together, to build an overall picture of the concerns, issues and current practices of marine farmers. Biosecurity is an item that can affect all farmers, nobody is in isolation. Working together helps New Zealand, your industry and your business. Click on the link to tell your story.

Oyster farming – https://www.surveymonkey.com/s/oyster

or

Mussel farming – https://www.surveymonkey.com/s/mussel_farming

All information will be kept confidential. If you have filled your questionnaire in (thank you!), can you please encourage a colleague to fill in theirs? Forward this email to them. Their input will make a difference.