Fisheries and Oceans Canada | Pêches et Océans Canada
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Canadian Science Advisory Secretariat (CSAS)

Research Document 2017/072

National Capital Region

British Columbia farmed Atlantic Salmon health management practices

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December 2017

Canada

Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

ISSN 1919-5044

Correct citation for this publication:

Wade, J. 2017. British Columbia farmed Atlantic Salmon health management practices. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/072. vi + 55 p.

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ABSTRACT

Current farmed Atlantic Salmon (*Salmo salar*) fish health management practices, regulations and oversight in British Columbia (BC) are summarized with respect to the information pertinent to the transmission of pathogens between wild and farmed fish. Specific information regarding farming activities in the Discovery Islands area are provided in support of the environmental risk assessment to determine the risk to Fraser River Sockeye Salmon abundance and diversity due to pathogen transfer from Atlantic Salmon farms located in the Discovery Islands area of BC.

There are three Atlantic Salmon farming companies operating marine farms in the Discovery Islands: Cermaq Canada, Grieg Seafood and Marine Harvest Canada. Under the *Pacific Aquaculture Regulations,* as a condition of licence, each company has a Salmonid Health Management Plan (SHMP) and accompanying proprietary Standard Operating Procedures (SOPs). These SOPs along with other conditions of licence provide evidence of biosecurity measures in place to mitigate disease events and minimize spread of pathogens within and away from a farm should they occur. Compliance with these practices is audited by the Department of Fisheries and Oceans as a condition of licence. In addition to the mandatory audit program, all farms in the Discovery Islands are certified through Best Aquaculture Practices Certification (BAP).

Through DFO's audit program, tissue samples are taken for routine pathogen screening at accredited laboratories. These results are compared to the mandatory reporting requirements made by each company as a condition of licence. In addition, each of the three companies also monitor the health of their fish through the collection and analysis of syndromic information and take samples for pathogen screening.

Vaccination of Atlantic Salmon is not a requirement of licence; however, all companies do voluntarily vaccinate their fish for many pathogens including Infectious Hematopoietic Necrosis Virus (IHNV). The agreement to vaccinate fish and have a coordinated effort in mitigation of disease and response in an outbreak situation is formalized in a Memorandum of Understanding (MOU) termed the Salmon Farming Industry Viral Disease Management Plan. The use of vaccines was mentioned in the first version of the Viral Management Plan ratified in 2011 and indicated that vaccines were to be used in common areas. Since 2015, the IHNV vaccine has been used by all companies on all smolt before sea water entry.

Pratiques en matière de gestion de la santé du saumon de l’Atlantique d’élevage en Colombie-Britannique

RÉSUMÉ

Résumé des règlements, de la surveillance et des pratiques actuels en matière de gestion de la santé du saumon de l’Atlantique (*Salmo salar*) d'élevage en Colombie-Britannique (C.-B.) pour ce qui est des renseignements se rapportant à la transmission d'agents pathogènes entre les poissons sauvages et les poissons d'élevage. Des renseignements précis sur les activités d'élevage dans la région des îles Discovery sont fournis à l'appui de l'évaluation du risque environnemental afin de déterminer le risque pour l’abondance et la diversité du saumon rouge du fleuve Fraser que représente le transfert d’agents pathogènes à partir des fermes d'élevage de saumon de l’Atlantique situées dans la région des îles Discovery, en Colombie-Britannique.

Trois entreprises d'élevage de saumon de l'Atlantique exploitent des fermes marines dans la région des îles Discovery : Cermaq Canada, Grieg Seafood et Marine Harvest Canada. Conformément au *Règlement du Pacifique sur l’aquaculture*, à titre de condition de son permis, chaque entreprise dispose d'un Plan de gestion de la santé des salmonidés et de procédures opérationnelles normalisées (PON) exclusives et connexes. Ces PON et d'autres conditions de permis fournissent des preuves des mesures de biosécurité en place pour atténuer les cas de maladie et réduire au minimum la propagation d'agents pathogènes à l'intérieur et à l'extérieur d'une ferme au besoin. Le respect de ces pratiques est vérifié par Pêches et Océans Canada dans le cadre des conditions de permis. En plus du programme de vérification obligatoire, toutes les fermes situées dans les îles Discovery ont reçu la certification de pratiques exemplaires d'aquaculture (BAP).

Dans le cadre du Programme de vérification du MPO, des échantillons de tissus sont prélevés pour le dépistage de routine des agents pathogènes à des laboratoires agréés. Ces résultats sont comparés aux exigences obligatoires en matière de rapports produits par chaque entreprise en vertu des conditions de son permis. De plus, chacune des trois entreprises surveille également la santé de ses poissons en recueillant et en analysant des renseignements syndromiques, et prélève des échantillons pour le dépistage des agents pathogènes.

La vaccination des saumons de l'Atlantique n'est pas une exigence de permis; toutefois, toutes les entreprises vaccinent volontairement leurs poissons contre de nombreux agents pathogènes, y compris le virus de la nécrose hématopoïétique infectieuse (VNHI). L’entente concernant la vaccination des poissons et l'effort coordonné en vue d'atténuer les maladies et d'intervenir en cas d'éclosion est officialisée dans un protocole d'entente appelé le « plan de gestion virale de l'industrie salmonicole ». L'utilisation de vaccins était mentionnée dans la première version du plan de gestion virale ratifiée en 2011, laquelle indiquait que des vaccins devaient être utilisés dans les aires communes. Depuis 2015, le vaccin contre le VNHI est utilisé par l'ensemble des entreprises sur tous les saumoneaux avant leur entrée dans l'eau de mer.

INTRODUCTION

Fisheries and Oceans Canada (DFO) has a regulatory role to ensure the protection of the environment while creating the conditions for the development of an economically, socially and environmentally sustainable aquaculture sector. Restoring funding to support federal ocean science programs to protect the health of fish stocks, to monitor contaminants and pollution in the oceans, and to support responsible and sustainable aquaculture industries in Canada has been identified as a top priority of the Minister of Fisheries, Oceans and the Canadian Coast Guard.

It is recognized that there are interactions between aquaculture operations and the environment (Grant and Jones, 2010; Foreman et al., 2015). One interaction is the risk to wild salmon populations resulting from the potential spread of infectious diseases from Atlantic Salmon (*Salmo salar)* farms in British Columbia (BC) (Cohen, 2012). While several Atlantic Salmon farms are located within the migratory routes of Pacific salmon species, no risk assessment has been conducted to specifically determine the risk to wild fish populations associated with pathogens released from Atlantic Salmon farms.

DFO Aquaculture Management Directorate requested formal science advice on the risks of pathogen transfer from Atlantic Salmon farms to wild fish populations in BC. Given the complexity of interactions among pathogens, hosts and the environment, DFO will deliver the science advice through a series of pathogen-specific risk assessments followed by a synthesis.

PURPOSE OF THIS DOCUMENT

The information summarized in this document will assist in environmental assessments of the risk to Fraser River Sockeye Salmon due to pathogen transfer from Atlantic Salmon farms located in the Discovery Islands area of British Columbia. This document provides a summary of the legislative and regulatory requirements related to fish health management and describes the additional practices used by the Atlantic Salmon farming industry in the Discovery Islands area.

CONTEXT

FARMED ATLANTIC SALMON PRODUCTION

There are three Atlantic Salmon (*Salmo salar*) farming companies operating marine farms in the Discovery Islands in British Columbia: Cermaq Canada, Grieg Seafood and Marine Harvest Canada.

Cermaq Canada has 27 marine sites in British Columbia, three freshwater land-based hatchery sites and one land-based broodstock site. They employ approximately 250 people, and delivered 18,000 tonnes of salmon to the market in 2014 (Cermaq, 2014).

Grieg Seafood operates a total of 21 marine farm sites in British Columbia as well as a land-based hatchery in Gold River, BC (Grieg Seafood, 2014). In 2014 they employed 88 people and harvested 6,257 tonnes gutted weight equivalent (GWE) (Grieg Seafood, 2014).

Marine Harvest Canada harvested 26,697 tonnes GWE in 2014 (Marine Harvest, 2014). At any one time Marine Harvest Canada has between 30 and 35 operational farms. In addition they operate five land-based hatcheries, one lake smolt rearing facility and a processing plant in Port Hardy. Marine Harvest Canada employs approximately 500 people in British Columbia.

Most Atlantic Salmon farms in the Discovery Islands area consists of an array of 10 to 18, 24 m x 24 m, 30 m x 30 m or 36 m x 36 m cages. Maximum stocking density for Marine Harvest Canada is set at 16 kg/m^3, and 15 kg/m^3 for Grieg Seafood and Cermaq Canada. All farms in the Discovery Islands area are single year class sites.

Smolt size at stocking varies among companies and production strategy. On average, Marine Harvest Canada stock 100 g smolt; Grieg Seafood stock approximately 80 g smolt; and Cermaq Canada stock smolt ranging in size from 80 to 200 g (average 100 g).

Smolt are not stocked directly into the Discovery Islands area due to risk of infection from Kudoa. Consequently, fish are transferred to the Discovery Islands after being first stocked elsewhere.

LOCATION

This series of risk assessments is focused on the interaction between wild and farmed fish specifically located in the Discovery Islands area. This area refers to the islands located in Discovery Passage east of Vancouver Island near Campbell River and west of mainland British Columbia (Figure 1). The geographical location of the Discovery Islands is within Fish Health Zone 3-2 (Figure 2).

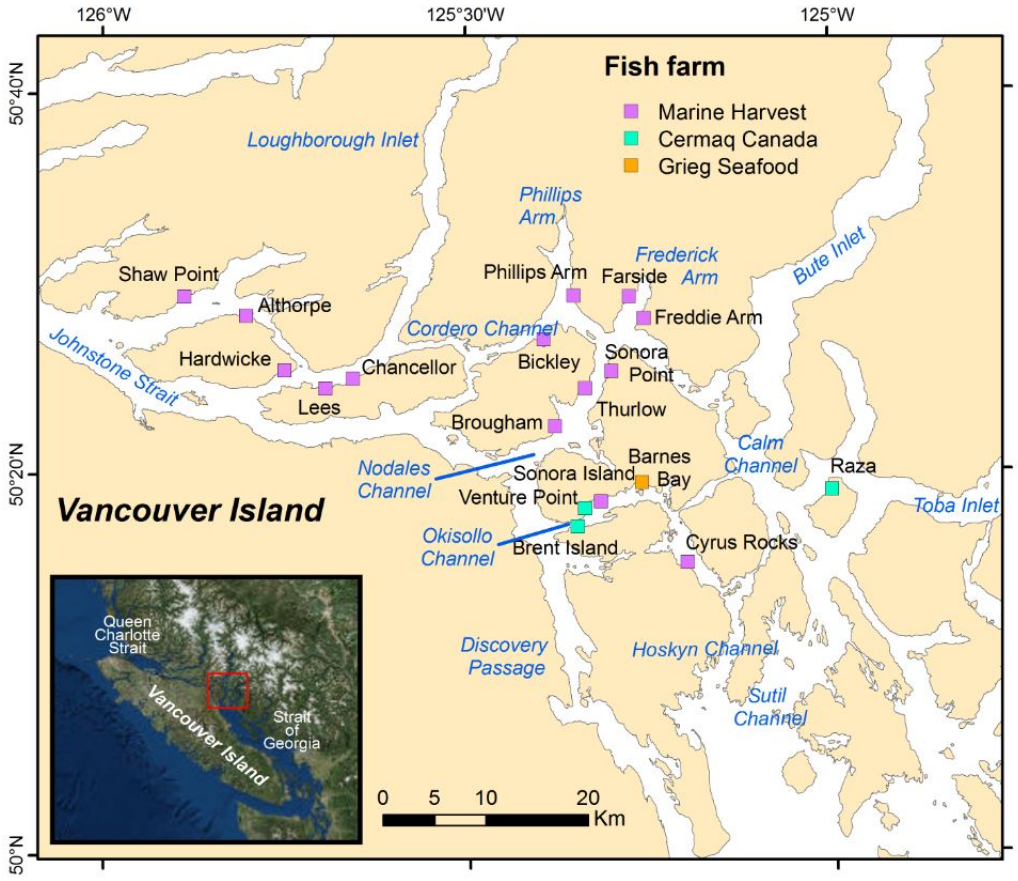

Figure 1: Map of the Discovery Islands in BC. The size of the symbol for fish farms are not to scale. Different colours represent different companies operating the farms as identified in the legend. The insert illustrates the location of the Discovery Islands in British Columbia.

Salmonid Fish Health Zones (Zone) are aggregated areas used by the Department in the management of marine salmonid fish production in British Columbia. Zones were originally delineated based on both watershed and DFO's Fisheries Management Areas. Because some sites remain licenced but have not produced Atlantic Salmon in many years, only those farms which held a valid marine aquaculture licence in 2015-2016 and had produced Atlantic Salmon since 2010 are included in the scope of the environmental risk assessment (Mimeault et al., 2017). Based on these criteria, as of January 2016 there were 15 licenced Atlantic Salmon farms in Zone 3-2 which are included in the analysis. There are three other farms which are adjacent to Zone 3-2 which are also included due to their proximity. These farms, Althorpe, Hardwicke and Shaw Point, are in Fish Health Zone 3-3. Therefore, for the purposes of this analysis, a total of 18 farms are considered in the Discovery Islands.

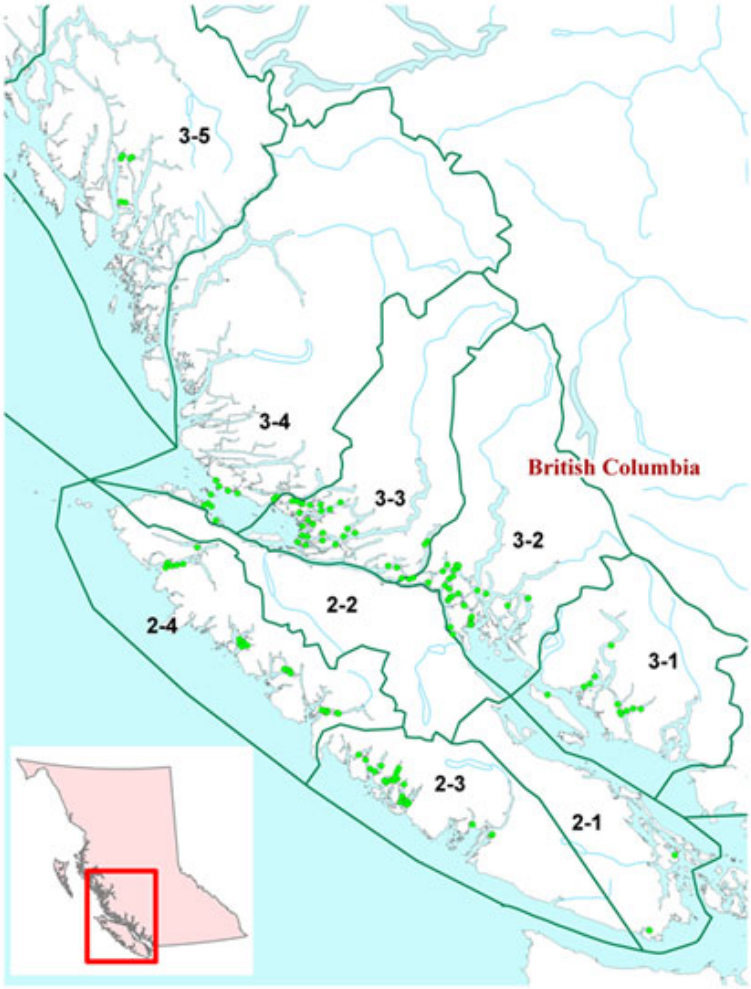

Figure 2: Map of Fish Health Zones (reproduced from Appendix I-A (iii) Marine Finfish Aquaculture Licence 2015-2016).

Of these 18 farms, Grieg Seafood operates one farm, Cermaq Canada operates three farms and Marine Harvest Canada operates fourteen farms. At any time the number of active salmon farms varies depending on harvest schedules and smolt stocking times.

LICENSING REQUIREMENTS

DFO is responsible for issuing aquaculture licenses for marine finfish, shellfish and freshwater operations in British Columbia. Licences are issued under the authority of the *Fisheries Act* and are subject to the provisions of the *Fisheries Act* and Regulations.

At the time of the writing of this document, the current licence conditions were for 2015-2016. As of September 29, 2016 new licence conditions were implemented. For the purposes of this document licence conditions for 2015-2016 will be utilized. There are no substantial changes to the licence conditions between these two versions.

Licence conditions (2015-2016) contain the following 14 categories:

- Production Plan
- Transfer of Fish
- Containment Array Requirements
- Fish Health
- Fish Health Record
- Sea Lice Monitoring
- Sea Lice, Health and Mortality Reporting
- Escape Prevention, Reporting and Response
- Management of Marine Mammal Interactions
- Protection of Fish Habitat
- Operation of Vessels
- Annual Aquaculture Statistical Report
- Use of Lights
- Administrative Matters

FISH HEALTH INFORMATION

Farmed fish health information is available in different formats from different sources and is collected for different purposes. Some information, such as Standard Operating Procedures (SOPs), is a requirement of licence conditions. Other information, such as viral management planning, is grower initiated for the best management of their business.

Marine aquaculture companies in British Columbia collect and utilize syndromic information in the production and health management of their stocks. This can include any pertinent data or information which aids in the early detection of illness or disease (fish health events). Syndromic information alerts farmers to potential changes in fish health and provides the opportunity to initiate mitigating measures.

Syndromic surveillance practices are applicable to animal health research, aquaculture, public health and clinical medicine (Mandl et al., 2004). Syndromic surveillance fulfills the central role of providing timely information to guide decisions and decision-making on management practices aimed at prevention, control and eradication of disease (Gustafson et al., 2010; OIE, 2010; Hasler et al., 2011; FAO, 2014) in a cost effective, scientifically defensible manner.

Information such as biosecurity protocols, facility inspections, animal import requirements and disease monitoring programs are types of syndromic information (Gustafson et al., 2010).

The benefits of using syndromic surveillance include, but are not exclusive to, detecting expected or unexpected events, detecting symptoms of known or emerging diseases with or without a specific surveillance system present. If the design is suitable, syndromic surveillance is a cost effective approach to maintaining low prevalence of diseases (OIE, 2010; Oidtmann et al., 2013; Triple-S, 2013). Under best case scenarios these systems can provide real-time or near real-time disease surveillance (Reis and Mandl, 2003; Mandl et al., 2004; Triple-S, 2013), as well as serving as an ongoing monitoring tool for disease outbreaks (Hasler et al., 2011).

This section describes the types of data and information being collected and used within the context of fish health management on a marine Atlantic Salmon farm in British Columbia. Some information is collected in fulfillment of the conditions of licence (2015-2016), other as a part of each company's best management practices.

SALMONID HEALTH MANAGEMENT PLAN

A Salmonid Health Management Plan (SHMP) and accompanying proprietary SOPs are required as a condition of a Marine Finfish Aquaculture Licence under the *Pacific Aquaculture Regulations*. Appendix IV of the Marine Finfish Aquaculture Licence application is a Salmonid Health Management Plan (Template). The following description corresponds to the SHMP for 2015-2016 finfish aquaculture licences. For the purposes of this review, this template will be referred to with the date 2015-2016. There is also a Manual of Fish Health Practices (DFO, 2016) which is a supplement to the template to aid companies in writing a SHMP as well as provide guidance for the evaluation of SHMPs by DFO. DFO auditors assess whether the elements of the SHMP are consistent with the outcome based performance as described in the template and manual. The Manual is the guide which is used by government regulators as a comparative standards document against which industry SOPs are assessed.

The Salmonid Health Management Plan Template (2015-2016) outlines the health concepts and required elements associated with a finfish aquaculture licence (Table 1); these are performance or outcome-based activities. Salmonid Health Management Plan (SHMP) SOPs may be applied to a specific site or to all of a licence holder's facilities if they are the same. Because they are company specific, the names and contents of the SOPs vary among companies. In many cases, there is more than one SOP listed to address a concept or element required in the Template (2015-2016) because it is left to each company to determine how they will address the requirements.

It is stated in the SHMP Template (2015-2016) that all required SOPs are to be submitted to DFO Aquaculture Management Division for review and response upon submission of a licence application. These SOPs are approved by DFO as a part of the initial licence application. After licence approval, the licence holder must submit annually to the Department for its "considered response", all amendments to the SOPs or indicate no changes (Section 4.2 Conditions of Licence 2015-2016). In addition to addressing these required concepts, companies have other best practices and SOPs which they are not required to submit to the Department as a condition of licence.

Table 1: Summary of the concepts and elements in the Salmonid Health Management Plan Template (2015-2016) and requirement for Standard Operating Procedures.

Concept	Elements	Sub-elements	SOP required
Personnel Duties and Responsibilities			
1.1 Personnel Duties and Responsibilities	1.1.1 Veterinarian	-	No
	1.1.2 Fish health manager / technicians / team	-	No
	1.1.3 Facility staff play a role	-	No
	1.1.4 Contact names and number	-	No
Health Concepts and Required Elements			
2.1 Biosecurity	-	-	No
2.2 Keeping Fish Healthy	2.2.1 Single year-class farms	-	No
	2.2.2 Suitable rearing environment and security	-	Yes
	2.2.3 Normal fish behaviour is observed	-	No
	2.2.4 Predator control	-	Yes
	2.2.5 Feed and nutrition	-	Yes
2.3 Fish Handling Techniques	2.3.1 Routine handling techniques	-	Yes
	2.3.2 Harvesting	-	Yes
2.4 Monitoring Water Quality	2.4.1 Contingency plans	-	Yes
2.5 Keeping Pathogens Out	2.5.1 Personnel / Visitor / Diver / Supplier movement	-	Yes
	2.5.2 Equipment / Vehicle movement	-	Yes
	2.5.3 Moving fish between facilities	-	Yes
2.6 Monitoring Fish Health and Disease	2.6.1 Carcass collection	-	Yes
	2.6.2 Carcass classification	-	Yes
	2.6.3 Specific fish health procedures	2.6.3.1 Anesthetizing and sedating fish	Yes
		2.6.3.2 Sea lice monitoring	Yes
		2.6.3.3 Vaccinating fish	Yes
		2.6.3.4 Euthanasia	Yes
2.7 Fish Health Records	-	-	No
2.8 Fish Disease Outbreaks / Emergency	-	-	Yes
2.9 Escaped Medicated Fish	-	-	Yes

Concept	Elements	Sub-elements	SOP required
2.10 Handling Drugs and Chemicals	2.10.1 Medicated feed storage, administration and inventory	-	Yes
	2.10.2 Treatment records	-	Yes
	2.10.3 Chemicals and Biologicals	2.10.3.1 Disinfectants, chemicals and biologicals	Yes
Broodstock-Special Considerations			
3.1 Suitable Rearing Environment	-	-	No
3.2 Feed and Nutrition	-	-	No
3.3 Biosecurity	-	-	Yes
3.4 Selection and Handling	-	-	Yes
3.5 Medications	-	-	Yes
3.6 Egg and Milt Collection	-	-	Yes
3.7 Disease Screening	-	-	No
3.8 Egg Disinfection	-	-	Yes
3.9 Egg (and/or Milt) Transportation	-	-	Yes
3.10 Identifying Progeny	-	-	No
3.11 Records	-	-	No

FISH HEALTH SOPS

Section 2 of the SHMP Template (2015-2016), *Health Concepts and Required Elements*, is pertinent to pathogen transfer environmental risk assessments; specifically Sections 2.2 to 2.6 and 2.8 (Table 1). Section 1 provides standard information such as names and contact information and will not be discussed further. Section 3, *Broodstock,* is out of the scope of this series of risk assessments as it is assumed that fish entering the marine environment are free of notifiable diseases. The following is a summary of the SOPs and best management practices associated with fulfillment of these sections as they apply to marine farms.

All SOPs include a description of the actions to be taken as well as records which must be kept and the responsible person or persons. Because the guidelines provided by DFO for SOP content are high level addressing key concepts, not specifics, it is not possible to differentiate between what the Department considers minimum SOP requirements and what each company has in place. For example, Section 2.5 of the SHMP Template (2015-2016) is *Keeping Pathogens Out.* There are three sub-sections which address how to keep pathogens out (see Table 1). Requirements for Section 2.5.1 *Personnel/ visitor/ diver/ supplier movement* are:

> "Where possible, personnel and visitors avoid travel between [corporate entity name]'s containment arrays. If such travel is unavoidable, personnel and visitors adhere to all biosecurity procedures at each facility. Procedures are posted or explained to all visitors as part of the visitor log-in event. Suppliers are advised of containment array procedures and delivery-order in advance. Suppliers attending multiple facilities may be denied access. Staff will notify suppliers [and divers] if any specific disease of concern arises."

The Department provides no additional direction on how this should be achieved; it is up to the company submitting the licence application to address this concept to the satisfaction of the

Department's fish health veterinarian. Therefore it is assumed that for all companies with a valid finfish aquaculture licence, the SOPs submitted are in compliance with the conditions of licence and approved by the DFO veterinarian. All companies with valid licences therefore meet the requirements of the SOPs. Whether they exceed the requirements cannot be determined as there is no indication of what would require a re-submission of an SOP after review by the Department.

For the purposes of this document, SOP content has been summarized in relation to licence requirements according to the following categories: biosecurity; fish transfer; environmental monitoring; mortality management; and harvesting. These categories are the key areas which will be addressed in the risk assessments. Salmonid Health Management Plans and SOPs (valid 2015-2016) were provided by the Department for each of the three Atlantic Salmon farming companies. The SOPs are considered proprietary to the companies; therefore, individual companies will not be identified. Rather, when possible, a summary of the contents of the SOPs has been provided which describes how the companies met or exceeded Departmental "concept" requirements as indicated in the Marine Finfish Aquaculture Licence and SHMP (2015-2016). This will be done by explaining what the "concept" is and providing what companies have put in their SOPs to address the concepts. Unless otherwise indicated, the description of what is in the SOPs applies to all companies.

Determining if the elements of the SOPs exceed requirements is not necessarily straightforward because, as was indicated previously, what would constitute a failure to comply and require a revision of an SOP is not documented by DFO.

Biosecurity

The concept of biosecurity (Section 2 SHMP (2015-2016)) states that "disease-causing agents" (pathogens) may be spread by sick fish (wild or cultured) through the water, on shared equipment, other animals, or inadvertently by personnel, visitors or their personal gear. Entrance of potential pathogens is minimized by supporting an effective biosecurity "barrier" at each facility. Barriers may be physical, chemical or biological. Biosecurity measures apply to all personnel, visitors, divers, suppliers, regulators, vessels, and all equipment. Biosecurity has three main goals: keeping fish healthy, keeping pathogens out, and keeping disease from spreading. Barriers may be physical or functional (i.e., protocols).

Biosecurity SOPs have been organized and summarized based on three categories, people, other animals and equipment. These categories were selected as they are key control points for effective biosecurity. When possible, element and sub-elements of the SHMP Template (2015-2016) summarized in Table 1 will be referenced.

People

SOPs are in place for biosecurity control related to the movement of people onto a farm and between farms. Each company has biosecurity related SOPs for such events as: fish health visits; diver disinfection; visitors and suppliers; and staff disinfection and biosecurity. These correspond to Sections 2.5.1, 2.6.1 and some elements of 2.3.1 and 2.6.3 described in Table 3. Each company has their own versions of these SOPs or protocols. These SOPs include a description of the actions to be taken as well as records which must be kept and the responsible person or persons.

Site and staff disinfection protocols are important SOPs related to biosecurity and the movement of people on and between farm sites. They contribute to the fulfillment of Section 2.5.1 of the SHMP Template (2015-2016) (Table 1). These protocols or SOPs are in place in order to minimize the opportunity for cross contamination from one farm site to another, or

within a site. It is standard practice of all three companies that no personnel will travel between sites; in the event that this is unavoidable, employees must clean and disinfect all personal protective equipment prior to leaving one site and again once arriving at the new site. The movement of personnel between sites must be approved in advance by the site manager. Without exception, sites with the youngest fish must be visited first (i.e., most vulnerable or susceptible), the oldest last. In the event that a site may have a fish health issue, that site is visited last.

One important control point is the admittance of visitors on farm sites. The SOPs indicate that visitors are to be transported to the site via a designated area vessel or site vessel; the use of signage such as: no trespassing; reporting to staff upon arrival; and the use of footbaths. All companies have restrictions about visitor access. Visitors must ask permission prior to arriving on site and will be asked about where they have been within 24 hours (some companies require 48 hours). These questions serve to determine the level of risk of pathogen transfer from another facility to their farm. Visitors are asked to use footbaths and are not permitted to bring or use their personal protective clothing or equipment on site unless it has been washed and disinfected to the satisfaction of the site manager. There is nothing in the SHMP (2015-2016) which requires these details; without any further guidance by the Department, it is assumed that they meet the minimum requirements.

All companies use Virkon® Aquatic, a broad spectrum disinfectant. How it is to be used is described in SOPs depending on the application. In general, it is applied in diluted form to equipment and in footbaths and for general equipment disinfection at farm sites. The SOPs stipulate that in order for Virkon® Aquatic to be most efficacious, the surface must be cleaned first and free of as much organic material as possible. A 1% solution of Virkon® Aquatic is standard for everyday applications, it is refreshed when it is either soiled or has lost its purple/pink colour. The contact time is ten minutes. The use of Virkon® Aquatic is recorded for each site. Once Virkon® Aquatic is deactivated it is stored in buckets for transfer to the mort float. A mort float is a designated float which holds only dead fish containment vessels. It is normally located at the edge of a lease as far away from the farm as possible. Staff are required to wear designated mort-specific gear and personal floatation devices when handling morts (Section 2.6.1 of the Salmonid Health Management Plan). This gear is cleaned and disinfected after use and remains on-site, stored away from other non-mort related gear.

There is nothing in the SHMP Template (2015-2016) which requires the details described above such as: type of disinfection product to use, contact time, changing of gear between sites or the use of dedicated mort handling personal gear. These are company-driven procedures which have been put in place, but are approved by the Department.

Other Animals

SOPs are in place to minimize the contact of farmed salmon with wild animals. These measures may include the use of predator nets outside the fish containment nets as well as bird nets affixed to the top of the cages.

Equipment

The SHMP Template (2015-2016) states that when possible, equipment is not to be shared, that it is kept as clean as possible at all times, is cleaned and disinfected after use and stored dry in its proper location. In addition, items which must be used at more than one facility are subject to biosecurity and disinfection measures. No other details are required in the Template with respect to Section 2.5.2 *Equipment and Vehicle Movement*.

Equipment biosecurity as summarized here applies to Section 2.5.2 as well as elements of Sections 2.3.1, 2.3.2, and 2.6.1. The SOPs developed by each company include significantly

greater detail than the minimum requirements defined in the SHMP Template (2015-2016), in order to fulfill what is necessary for both their own operational requirements as well as licencing requirements.

The SOPs indicate that in order to control the potential spread of pathogens from one site to another, most equipment is not to be shared between sites. Most equipment used on a daily basis such as dip nets, personal protective gear, catch nets, seine nets, plankton nets, dive suits, etc., are site specific. These are cleaned and disinfected after use and stored dry in a clean area.

Some specialized equipment is shared between farms and companies, and there are biosecurity protocols in place that are defined in the SOPs for all shared equipment. This is a standard guideline described in the SHMP Template. Any equipment being shared is cleaned and disinfected with Virkon® Aquatic for the appropriate contact time on-site before transfer. It is disinfected again on the vessel which is transferring the equipment. One company required it to be disinfected again upon arrival at the new site.

If large, partially submerged equipment such as housing barges, feed storage barges, etc., need to be moved from one site to another they must first be scraped free of any marine life, scrubbed, pressure washed and debris moved prior to disinfection and transfer to another site. There are specific protocols in place for large items such as site barges or houses. As they often contain Styrofoam floats and cannot be scraped or pressure washed, they are tarped and water pumped out from inside the tarp. Some companies prescribe that tarps are to be kept in place for seven days after the water has been pumped out to allow for sufficient drying, but the duration of tarping is defined with each company's SOP, and not a standardized requirement of the SHMP Template (2015-2016). If it is not feasible to tarp, the barge must be cleaned and fallowed for a minimum of two weeks before moving to the new location.

Vessels

The only mention of vessels in the SHMP Template is in the description of biosecurity (Section 2.1) which states that biosecurity measures apply to "…all personnel, visitors, divers, suppliers, regulators, vessels, and all equipment." The companies fulfill this requirement with several SOPs mostly categorized under SHMP Section 2.5.2 *Equipment/Vehicle Movement*. How this is to be achieved is up to the individual companies.

The SOPs dictate that all vessels are required to dock in designated locations. Site-specific boats do not move between sites. All site boats must contain a footbath or sprayer with Virkon® Aquatic; these equipment are used by all new crew travelling to the site. All equipment being transported on the vessel must be cleaned and disinfected before leading into the boat. In the event that debris or other contaminants are transported on the boat deck, all surfaces must be disinfected with Virkon® Aquatic.

For Grieg Seafood sites vessel SOPS are slightly different. All vessels must be cleaned and disinfected with Virkon® Aquatic above the waterline when moving between fish groups. Vessels are required to dock in designated locations. Vessels may be designated to a site or an area.

Fish Transfer

Fish transfer can and does occur between land-based hatcheries and marine grow-out sites as well as between grow-out sites themselves. In either case, until September 8, 2015, under the Pacific Aquaculture Regulations, the licence holder was required to meet certain conditions including:

- The fish are live Atlantic or Pacific salmonids
- The species are the same as those listed on the licence
- Transfers occur within the same Salmonid Transfer Zone (Figure 3)
- The licence holder has written, signed confirmation from the source facility's veterinarian, fish health staff or facility manager that:
    - Mortalities, excluding eggs, in any stock reared at the source facility have not exceeded 1% per day due to any infectious diseases, for any four consecutive day period during the rearing period;
    - The stock to be moved from the source facility shows no signs of clinical disease; and
    - No stock at the source facility is known to have had any disease listed in Appendix III of the conditions of licence.

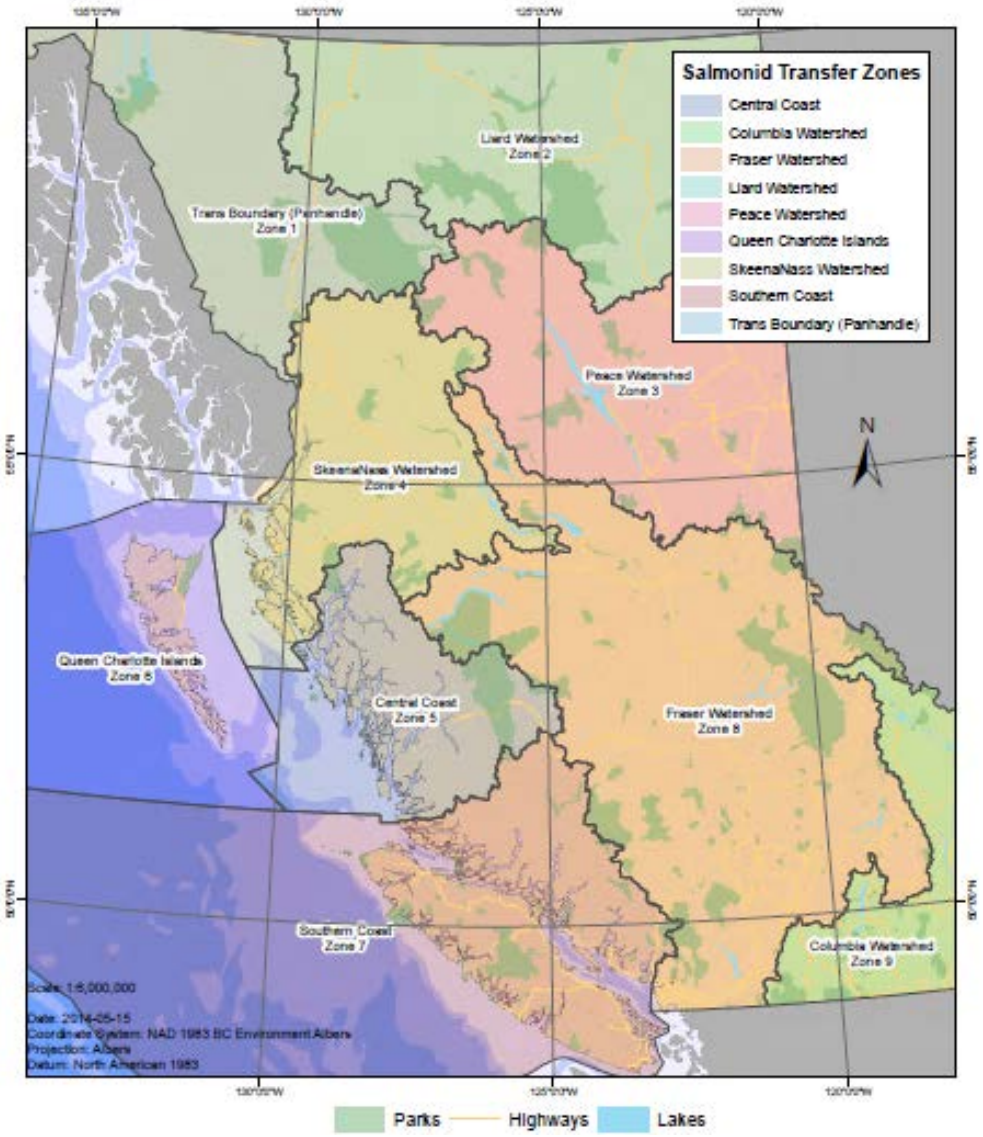

Figure 3: Map of Salmonid Transfer Zones (reproduced from Appendix II Marine Finfish Aquaculture Licence 2015-2016).

Appendix III of a Marine Finfish Aquaculture Licence (2015-2016) includes fish diseases and pathogens of regional, national and international concern, namely: IHNV, infectious pancreatic necrosis virus (IPNV), viral hemorrhagic septicemia (VHSV), infectious salmon anemia (ISA), *Oncorhynchus masou* virus disease (OMV), whirling disease and cold water vibrio. In addition, the list also includes any other filterable replication agent causing cytopathic effects (CPE) in cell lines specified by the Minister or is causative of identifiable clinical disease in fish.

Beginning September 8, 2015 (Section 2.3 Marine Finfish Aquaculture Licence 2015-2016) licence holders are required to apply to the BC Introductions and Transfers Committee for authorization to transfer fish within a zone as well as between zones. Historically, cross zone transfer required testing of diseases or agents listed in Schedule II of the Fish Health Protection Regulations namely: IHN, IPN, VHS, whirling disease, ceratomyxosis, furunculosis, enteric redmouth disease, and any filterable replicating agent capable of causing cytopathic effects in the cell lines of fish as specified by the Minister. This was achieved through general bacteriology screening, cell culture screening and risk based parasite screening. These testing protocols have continued for cross zone transfer despite the repealing of the Fish Health Protection Regulations and with it, the authority of the Local Fish Health Officer who would execute the Regulations. Testing now occurs for diseases listed in Appendix III of the marine finfish licence as Diseases of Regional, National and International Concern as mentioned above.

As a component of the SHMP Template (2015-2016), growers are required to have an SOP which addresses the movement of fish between facilities (Table 1, Element 2.5.3). The requirements of the SOP are to have the appropriate permits in place before transfer and to minimize stress, transmission of pathogens or possibility of escape. If well boats are used, water quality is to be monitored and maintained. Companies have SOPs which address these concepts including the delivery of smolts from hatcheries to marine sites; movement or towing of containment structures and; escape prevention. It is indicated in their SHMPs that all permits will be in place before movement as per the conditions of licence.

Environmental Monitoring

Each company collects environmental data at each farm in production. Some measurements may be seasonal, others are collected daily. These data are recorded electronically and communicated to the Fish Health Management Team. The Fish Health Management Team is a term in the Salmonid Health Management Plan Template (2015-2016) which refers to those persons, including the company veterinarian, who are responsible for the major fish health decisions. Environmental data which are collected include but are not limited to: dissolved oxygen levels at various depths; surface temperature; harmful algal monitoring; storms; entrapment and; nutrition. The monitoring of many of these environmental parameters is required as a condition of licence according to Appendix 6B (temperature, dissolved oxygen and salinity) and must be available for examination during an audit. Water chemistry is monitored whenever fish are crowded for treatment, transfer or harvest.

There are SOPs for environmental monitoring as well as mitigation measures should they be feasible. These SOPs include elements of Section 2.2 *Keeping Fish Healthy* as well as Section 2.4 *Monitoring Water Quality* of the SHMP Template (2015-2016). Section 2.2.2 *Suitable Rearing Environment and Security* requires SOPs which ensure:

> "[Corporate entity name] is responsible for ensuring a suitable rearing environment for the fish so they remain healthy. Requirements related to materials used in the construction and maintenance of rearing units provide security and minimize risk of

potential escape or harm to fish. Facilities are staffed 24-hours daily or are locked, alarmed, secured or otherwise monitored to control entry and deter vandalism."

Section 2.2.5 *Feed and Nutrition* requires SOPs which demonstrate the following:

> "The objective of good nutrition is to optimize fish health and growth so fish receive sufficient quantity and quality of feed. [Corporate entity name] has procedures in place for healthy, hygienic delivery of feed to fish. Proper storage of feed is essential to maintaining its nutritional quality. Feed is stored in structures designed to minimize spillage, spoilage, and wildlife's access to feed. Feed is also protected from extremes of heat, sunlight and moisture."

Details in the SOPs include the storage of feed indoors; away from wild animals and that doors should be shut when not in use. Used feedbags are to be stored securely indoors; walkways kept free of feed and feed debris. Feed is to be stored away from extreme heat, light and humidity. Feed records are to be kept onsite for the duration of the grow-out cycle. Companies have additional SOPs for the storage and use of medicated feed.

Mortality Management

Removal

Dead fish, otherwise referred to as mortalities or morts, are regularly removed from marine cages. The methods and frequency of mort removal have changed with time as well as between different culture systems depending on the feasibility of technology, e.g., steel-cage systems vs. polar circles. Pre-2011, morts were primarily collected through the use of SCUBA divers and mort rings (ring placed in the bottom of a cage to collect dead fish). Since 2011, most Atlantic Salmon farms in British Columbia have used uplifts to remove dead fish from the bottom of cages. A typical uplift consists of a conical pen bottom which collects large solids and morts at a centralized point. There is a flexible tube at the centre into which air is injected creating the uplift of morts to the surface to be emptied. Uplifts allow farms to remove morts on a daily basis as required. For those sites which cannot use mort rings or uplifts, but continue to use SCUBA divers, SOPs are in place for mortality collection and diver disinfection and movement within a farm.

Each company ensures that all equipment being used to handle morts is in good working order and not broken or damaged. Mort specific equipment is labelled and stored cleaned and disinfected, away from other equipment. All equipment, including boats, walking surfaces, personal protective gear (boots, rain gear, etc.) are disinfected with Virkon® Aquatic as per manufacturer's recommendations. Whenever handling morts, gloves are worn. Each company has SOPs for these activities.

Classification

Dead fish are removed from each cage and placed in a designated mort tub with a lid. All mortalities are assessed by farm personnel and a suspected cause of death is recorded, when possible. The Fish Health Management Team or veterinarian (as appropriate) from the company is notified if an elevated mortality count occurs or when classification of a mortality is of concern. Elevated mortality can be defined as a mortality as low as 0.02%/day but may vary depending on the circumstance such as smolt transfer. The Fish Health Management Team or company veterinarian regularly reviews the causes of mortality and investigates as required. Mortality classification is the responsibility of those personnel who have received fish health training.

As per each SHMP, companies are required to classify, record, and report mortalities on a monthly and quarterly basis to the BC Salmon Farmers' Association (BCSFA) database based on the following mort classification categories:

- Environmental (oxygen, water quality, storms, entrapment, nutritional)
- Fresh "silvers"
- Handling and transport damage (trauma)
- Maturation
- Old (decomposed)
- Poor performers
- Predator attack
- Dead wild finfish carcasses (number and type, e.g., herring-like, rockfish-like, etc.)

Licence conditions require reporting of these reports on a quarterly basis to the Department.

In addition to this minimum requirement, some companies have more specific categories or classifications for morts. These categories aid in farm management practices and inform fish health personnel. These categories and associated descriptions are included in the SOPs for each farm/company. For example, mortalities due to environmental causes may be further classified as caused by algal blooms, from exposure to harmful plankton; or gill damage caused by jellyfish; or low dissolved oxygen. Predator attacks may be further classified by the type of predator (e.g., birds, sea lions or seals). If farm personnel identify signs of a particular pathogen or disease such as bacterial kidney disease (BKD), viral hemorrhagic septicemia (VHS), infectious hematopoietic necrosis virus (IHNV) or vibriosis, for example, these will be recorded by farm staff and the company's fish health management team will be alerted.

Holding and Removal from Site

After the mort classification is complete and any required diagnostic samples have been taken, a lid is placed on the mort tote to prevent spillage and deter predators. The outside of the container is disinfected with Virkon® Aquatic and transported via farm boat to the mort float; in cases where there is single location collection of carcasses, carcasses are transferred directly to Xactics® containers on a float that is attached to the containment array. Farm boats with cranes of sufficient lift to move a metric tonne are uncommon and these array-associated floats are large so storage is also on this float. It is standard for a farm to have a small float containing an Xactics® container located away from the farm but within the confines of the lease. Nothing else is stored on this float but the two mort containers, one 1000-L container and one 100-L container. Dead fish are placed in the container and the lid secured. These details are all outlined in each company's SOPs.

The frequency of the removal of the container from the farm varies. Typically, a container remains on-site until it is sufficiently full to require removal but not overfilled thus preventing spillage and seepage. Containers are removed by barge for on-land disposal. Disposal sites are provincially regulated by the Province of BC. The barge is used only for mort removal on that day. There is no set schedule for mort removal; morts are removed when containers are nearly full.

Harvesting

The Salmonid Fish Health Management Plan requirements for the harvesting (Section 2.3.2) of fish from a marine cage site are focused on ensuring that blood water and sea lice are contained and fish stress is minimized. These practices are not audited by DFO during fish health audits but are observed by Aquaculture Management during incidental catch auditing.

The discharge of bloodwater is not permitted under the Aquaculture Activity Regulations and would be a violation under the Fisheries Act.

The only other requirement is that the company must detail the harvest method, taking into account these first two points. All three companies have SOPs for harvesting which address these requirements.

Harvest methods are similar for all three companies; as required in the SHMP, methods are employed to reduce stress to the greatest degree possible and contain blood water as much as possible as described below.

In preparation for harvesting, pipes and hoses are carefully inspected for any holes, and the totes which will hold the harvested fish are checked to ensure they are in good working order. A catch net is installed in order to prevent any inadvertent fish escapes. Fish are then pumped from the cage onto the harvest boat, gills are slit and fish are placed in the hold of the boat on slush. Blood water is contained in a spill tank and transported with the fish to the processing plant for disinfection and disposal. The crew that conducts the stun and bleed is the harvest crew, which stay with the boat, they are not site personnel.

It is the responsibility of the captain of the boat to ensure that proper cleaning and disinfection of the well boat and all equipment has occurred prior to and after moving fish. Both the fish and the slush quality are monitored while on-route. Because well boats could be used for multiple purposes, for example, sea lice treatments, harvest, and fish transport, stringent biosecurity measurements are in place and outlined in the SOPs. Marine Harvest Canada have separate vessels for live haul and dead haul. Marine Harvest Canada have biosecurity measures in place for all vessels when they change task or operate in a different area or transport fish of different ages (Diane Morrison, Marine Harvest Canada, 124-1334 Island Highway, Campbell River, British Columbia, Canada V9W 8C9, pers. comm.).

There are many biosecurity measures outlined in these SOPs, not all measures apply to all companies, some measures of note include:

- Not pumping bilge water in close proximity to aquaculture sites.
- All transport should aim to be a closed transport system with no water exchange with the environment. If this is not possible, no boat will open the transport system within five kilometers of another company's site or a processing plant. All actions are documented in the ship's log.
- Adherence to cleaning and disinfection protocols.
- A seven day downtime is in effect if a vessel is returning to work at a site after working at a site of another company or a wild fishery. The vessel must then undergo a biosecurity audit by the company.
- A seven day downtime is in effect if a vessel is returning to work to move fry after transporting grow out fish. The vessel must then undergo a biosecurity audit by the company.

HEALTH MANAGEMENT PROGRAMS

Company Training

Each salmon farming company has its own Fish Health Management Team. Generally speaking, each Fish Health Management Team consists of a minimum of one fish health veterinarian, laboratory and field technicians/ biologists as well as trained fish health staff

working on each marine cage site. Each shift at each cage site has staff who are trained in various aspects of fish health including, mortality classification and sea lice counting. It is the on-site staff who maintain the fish health records for the site and communicate with the site manager and fish health veterinarian as necessary. Staff are trained by the company fish health veterinarian or other knowledgeable sources on an on-going basis. Staff also participate in third party training sessions on various aspects of fish health.

There are several references to "training" in the SHMP (2015-2016) none of which provide details on what specific training is required just that training is required. Training in vaccination is required as indicated in Section 2.6.3.3 of the SHMP; system training with regards to fish health records is required as stated in Section 2.7; safe handling of any medications is mentioned in Sections 2.10.1 and 3.5 and safe handling of chemicals is mentioned in Section 2.10.3.1. These are the only references to training in either the SHMP or the licence conditions. Documentation of this training for all employees must be kept at the company's head office or at the fish health professional's office. As such, fish health training records are maintained for all employees. For some companies advancement and/or increases in wages are contingent on various levels of training including training in fish health. All three companies have fish health training programs, all maintain records of staff training.

Company Diagnostics and Testing

Should it be required, diagnostic testing is conducted according to each company's SOPs and/or upon instruction by the company veterinarian or Fish Health Management Team. Companies are not required by the Department to sample fish for any pathogens outside of their participation in the fish health audit program (See section Provincial/Federal Fish Health Audit Systems). All industry driven diagnostic testing is voluntary and informs management decisions within the company. Consequently, the level of testing varies by company and is beyond DFO requirements.

For example, in 2014 (a typical year) Marine Harvest Canada sampled over 4800 fish for histology; approximately 19% of which were tested for bacteriology and virology (by polymerase chain reaction (PCR), not cell culture). This equates to over 900 fish tested for IHNV, VHSV and ISAV in addition to the Department's fish health audit program. These numbers do not include any broodstock or pre-transfer smolt testing. All were found IHNV and ISAV negative, two fish tested positive for VHSV.

Grieg Seafood has a similar program. In a typical production cycle, approximately 80 fresh "silver" fish are routinely screened for pathogens. Testing includes histology, bacteriology and virology. Any sample submitted for tissue culture is tested for virology. In 2014, a total of 1,161 fish were tested for virology. All virology samples for 2014 tested negative for any agents that produce cytopathic effects. Prior to transport to saltwater in 2014, each group of smolt was screened for pathogenic bacteria as well as virology. All tests were negative.

In 2014, Cermaq Canada tested 3,158 fish for various pathogens of concern. In addition, more than 500 tests for IHNV, VHS and ISAV were performed before smolt stocking; all were found negative. Also not included in this total are the number of broodstock tested for virology and BKD. All virology tests were negative. BKD was detected in low levels with all positive fish discarded.

A summary of IHNV testing conducted by Grieg Seafood, Cermaq Canada and Marine Harvest Canada has been provided in Table 2 for 2011 to 2015. Broodstock screening and pre-transfer smolt testing are not included in these data.

All companies sample only fresh mortalities (silvers) or moribund fish. All companies utilize a combination of in-house diagnostic capabilities as well as third party diagnostic services from certified labs. All companies participate in various special projects which may include research and development that would require additional testing of fish above that described above. All companies utilize histology, bacteriology and virology as diagnostic tools in fish health and disease management. The types of tests used by companies change over time and with the pathogen of concern. All companies use tests as recommended or verified by third party laboratories. For example, Cermaq Canada has recently moved from quantitative fluorescent antibody technique (QFAT) screening for BKD to quantitative PCR (qPCR) based on external advice and technological advance. Similarly, PCR and now qPCR as a screening test is increasingly replacing virology and in some cases histology.

When appropriate, companies may take actions to promote fish health and mitigate the spread of disease before test results are confirmed. This may include for example enhancing biosecurity or limiting vessel traffic to and from the site.

Table 2: Summary of IHNV testing undertaken by companies in British Columbia from fish on marine cage sites between 2011-2015, broodstock and smolt testing pre-transfer not included. Data provided by each company.

Company	Year	Max # active farms	# IHNV tests		# Confirmed positive tests
			Cell culture	PCR	
Grieg Seafood	2011	14	875	0	0
	2012	14	265	1085	60
	2013	11	525	120	0
	2014	11	1116	45	0
	2015	15	730	30	0
Marine Harvest Canada	2011	30	64	1135	0
	2012	30	104	2365	0
	2013	24	4	957	0
	2014	29	14	2130	0
	2015	27	8	2076	0
Cermaq Canada	2011	20	295	10	0
	2012	16	8	914	75*
	2013	17	0	84	0
	2014	19	0	15	0
	2015	19	52	118	0

* In 2012, Cermaq Canada had two IHNV cases confirmed by cell culture and 73 cases confirmed using PCR; none occurred in the Discovery Islands.

Company Mortality Rates

Both Cermaq Canada and Grieg Seafood track fish production using a rolling mortality rate. This calculation includes mortalities from sea water entry on a 12 month rolling basis and takes into account harvested fish, culled fish and mortalities. A rolling mortality calculation eliminates seasonal variation. Marine Harvest Canada does not routinely calculate mortalities in such a

way; they keep a monthly inventory for each farm, from which they can calculate mortality to date. Weekly reports include year-to-date mortality rates.

Cermaq Canada reported a 12 month rolling mortality rate of 7.1 % for Canadian operations (Cermaq, 2014). For Grieg Seafood, the 12 month rolling mortality in 2014 was 5.9% (Grieg Seafood, 2014). Both of these calculations are based on the number of fish and do not exclude any exceptional mortality events. In 2014, Marine Harvest Canada reported 11.5% annual mortality (by biomass) (Diane Morrison, Marine Harvest Canada, 124-1334 Island Highway, Campbell River, British Columbia, Canada V9W 8C9, pers. comm.).

Company Fish Health Oversight

"Mortality by cause" is recorded electronically by farm staff and sent to the respective company's Fish Health Management Team on a weekly basis. The company veterinarian and/or members of the Fish Health Management Team review the percent (%) mortality and cause of mortality to determine if actions must be taken such as a site visit or sample event. When they examine the % mortality and mortality by cause, environmental information such as water temperature, salinity and plankton blooms is taken into consideration. Additional information such as time of year; age of fish; time since sea water entry; and disturbances or treatment of fish is also considered.

Each company has their own mortality threshold level for an automatic site visit by either the company veterinarian or a member of the Fish Health Management Team. These levels vary from 0.02% mortality/day to 0.05% mortality/day depending on life stage and environmental conditions. A visit may also be warranted if the cause of mortality is deemed suspicious or unusual, including abnormal behaviour. Outside of an unusual event which may trigger a site visit, all companies have regular scheduled visits of their respective Fish Health Management Team and/or veterinarian. The frequency of these regular visits varies by company. One company estimates they make over 500 fish health site visits/year. The other two aim to visit all farms at least once per quarter with the frequency increasing with newly stocked fish, an increase in mortality or other concern.

Treatments

It is a licence requirement to maintain the appropriate records for the use of all prescription therapeutants. Additional to this, is the requirement of a licenced veterinarian to maintain a veterinarian-client-patient relationship which includes overseeing the proper handling, storage and application of all prescription therapeutants they have prescribed.

In British Columbia it is not a requirement of licence to vaccinate Atlantic Salmon; all vaccinations are voluntary. All companies vaccinate their fish for furunculosis, vibriosis, and IHNV. In addition, Marine Harvest Canada vaccinates for BKD; Cermaq Canada vaccinates against enteric redmouth disease and mouth rot and; Grieg Seafood vaccinates for enteric redmouth disease and winter ulcer.

In order to be able to harvest fish year round, smolt are stocked into seawater up to nine months of the year, typically between September and May. This is achieved by controlling water temperatures to both delay incubation and hatch time of eggs and; accelerating or reducing growth of fry. Therefore, vaccination occurs as batches of fish reach minimum size requirements for the particular vaccine. Consequently, vaccination can occur over a six to seven month period. Vaccine is ordered in small batches with multiple orders made during a season. This practice therefore decreases the likelihood that an entire year class would be affected if a vaccine failure occurred.

Certification Programs

There are two certification programs in which the three companies participate, Best Aquaculture Practices Certification (BAP) and Aquaculture Stewardship Council (ASC). A detailed description of their certification process and salmon standards can be found on their respective websites. A brief description of selected sections of the standards has been summarized.

The Global Aquaculture Alliance coordinates the development of Best Aquaculture Practices (BAP) certification standards for farms, feed mills, hatcheries and processing facilities (bap.gaalliance.org).

Table 3: Standard requirements for BAP certification (BAP, 2015).

Standard requirements
1. Community: Property rights and regulatory compliance
2. Community: Community relations
3. Community: Worker safety and employee relations
4. Environment: Sediment and water quality
5. Environment: Fishmeal and fish oil conservation
6. Environment: Control of escapes
7. Environment: Predator and wildlife interactions
8. Environment: Storage and disposal of farm supplies
9. Animal health and welfare: Health and welfare
10. Animal health and welfare: Biosecurity and disease management
11. Food safety: Control of potential food safety hazards
12. Traceability: Record-keeping requirement

Section 10, “animal health and animal welfare” is the most directly pertinent section to this risk assessment. The standards are in place as it is recognized that precautions should be taken in salmon farming to reduce the likelihood of infection and clinical disease, and limit their impacts by appropriate treatment if they occur (BAP standards, 2015). The standards encompass farm management measures such as the requirement for a Fish Health Management Plan; they include stipulations regarding diagnosis and treatment as well as sea lice. Many of the specific requirements of BAP certification are also requirements of licence in British Columbia. For a detailed description of the BAP standards see the BAP standards and guidelines for salmon (BAP, 2015).

Of note, standard 10.7 indicates that “all smolts brought into the farm shall be free from diseases and parasites specified in applicable national health regulations and shall be vaccinated against diseases for which effective vaccines are available prior to stocking” (BAP, 2015).

Other relevant standards include 2.6, the participation in an Area Management Agreement and the demonstration of compliance with the terms. This is demonstrated through the participation in the Viral Management Plan (see below).

The ASC came about as a result of the World Wildlife Fund Aquaculture Dialogues held between 2004 and 2015 with the aim to reduce the environmental and social impacts of aquaculture worldwide. The certification is made up of three parts: the aquaculture farm standards; independent 3rd party audits; and Marine Stewardship Council (MSC) chain of custody certification and the ASC logo. There are seven principles and many criteria which form the basis of the certification (Table 4).

Table 4: Principles and criteria of ASC salmon standard (Version 1.0 June 2012).

Principle	Criterion
1. Comply with all applicable national laws and local regulations	1.1 Compliance with all applicable local and national legal requirements and regulations
2. Conserve natural habitat, local biodiversity and ecosystem function	2.1 Benthic biodiversity and benthic effects
	2.2 Water quality in and near the site of operation
	2.3 Nutrient release from production
	2.4 Interaction with critical or sensitive habitats and species
	2.5 Interaction with wildlife, including predators
3. Protect the health and genetic integrity of wild populations	3.1 Introduced or amplified parasites and pathogens
	3.2 Introduction of non-native species
	3.3 Introduction of transgenic species
	3.4 Escapes
4. Use resources in an environmentally efficient and responsible manner	4.1 Traceability of raw materials in feed
	4.2 Use of wild fish for feed
	4.3 Source of marine raw materials
	4.4 Source of non-marine raw materials in feed
	4.5 Non-biological waste from production
	4.6 Energy consumption and greenhouse gas emissions on farms
	4.7 Non-therapeutic chemical inputs
5. Manage disease and parasites in an environmentally responsible manner	5.1 Survival and health of farmed fish
	5.2 Therapeutic treatments
	5.3 Resistance of parasites, viruses and bacteria to medicinal treatments
	5.4 Biosecurity management
6. Develop and operate farms in a socially responsible manner	6.1 Freedom of association and collective bargaining
	6.2 Child labour
	6.3 Forced, bonded or compulsory labour
	6.4 Discrimination
	6.5 Work environment health and safety
	6.6 Wages
	6.7 Contracts (labour) including subcontracting
	6.8 Conflict resolution
	6.9 Disciplinary practices
	6.10 Working hours and overtime
	6.11 Education and training
	6.12 Corporate policies for social responsibility
7. Be a good neighbour and conscientious citizen	7.1 Community engagement
	7.2 Respect for indigenous and aboriginal cultures and traditional territories
	7.3 Access to resources

Requirements related to Principal 5, “manage disease and parasites in an environmentally responsible manner” indicate that it is a requirement that “percentage [100%] of fish that are vaccinated for selected diseases that are known to present a significant risk in the region and for which an effective vaccine exists” (ASC, 2012). However, the farm’s veterinarian is responsible for undertaking and providing written documentation of the “analysis of the diseases that pose a risk in the region and the vaccines that are effective.” The veterinarian must

determine which vaccinations are to be used and demonstrate to the auditor that the decision is consistent with the analysis (ASC, 2012).

Another requirement of note includes “evidence of a fish health management plan, approved by the designated veterinarian, for the identification and monitoring of fish diseases and parasites” (ASC, 2012).

Currently, all Marine Harvest Canada sites, with the exception of three smolt nursery sites (Bell, Upper Retreat and Port Elizabeth) are BAP certified. In addition, four sites, Marsh Bay, Doyle, Duncan and Monday Rock are both BAP and ASC certified. All of Cermaq Canada’s marine sites are BAP certified. In addition, Bare Bluff, Mussel and McIntyre farms are ASC certified; Brent and Venture farms are pending ASC approval. All of Grieg Seafood’s marine farm sites are BAP certified.

RECORDING AND REPORTING

Recording

Under the Pacific Aquaculture Regulations, companies are required to maintain fish health records for the production cycle, and an additional four years at a minimum for marine aquaculture (Section 15.1 (a), 2015-2016 Finfish Aquaculture Licence), and a minimum of six years for freshwater/land-based aquaculture (Section 9.5, 2015-2024 Freshwater/Land-based Aquaculture Licence).

As a condition of licence and in accordance with the Pacific Aquaculture Regulations, the licence holder must maintain certain records. For example, the licence holder is required to keep complete, up-to-date and accurate written or electronic records of fish stocking and fish health activities on-site. These records must include both the stocking and fish health activity for the facility as well as the use of all therapeutants, pest control products and anesthetics. Fish health training and familiarity with relevant activities in the SHMP for all employees is an expectation of the Department, which was a licence condition historically but which will be removed from the licence and instead be part of the PAR Guidance Document in 2016. The Department of Justice directed this amendment.

Licence holders are required, as a condition of licence, to ensure that fish health events and carcass assessments are reviewed by the company’s veterinarian or the fish health staff to assess patterns in fish health and facilitate quarterly reporting. A fish health event, as defined in Part A of the Marine Finfish Aquaculture Licence (2015-2016) is an active disease occurrence on an aquaculture facility that triggers an action, where such action is intended to reduce or mitigate impact and risk associated with that occurrence or event. Fish health events do not include routine activities such as sea lice monitoring, fish health sampling or surveillance.

The SHMP (2015-2016) stipulates the minimum requirements for record keeping including:

- Routine handling techniques (SHMP Section 2.3.1)
- Monitoring water quality (dissolved oxygen, water clarity, temperature) (SHMP Section 2.4)
- Records of poor water quality events and actions taken (SHMP Section 2.4.1)
- Visitor logs (SHMP Section 2.5.1)
- Carcass numbers and classification (SHMP Sections 2.6.1 and 2.6.2)
- Diagnostic sampling is recorded and reported as per licence (SHMP Section 2.6.2)
- Sea lice monitoring (SHMP Section 2.6.3.2)
- Recording the euthanasia of numerous fish (SHMP Section 2.6.3.4)
- Fish health records (SHMP Section 2.7)
- Fish disease outbreaks/emergency (SHMP Section 2.8)

- Daily inventory and records of medicated feed (SHMP Section 2.10.1)
- Detailed records of the administration of medicated feed (kept on-site) (SHMP Section 2.10.2)
- Broodstock specific records (*out of scope for this review)
- Daily inventory and record of medications (SHMP Section 3.5)
- Egg take and pathogen screening (SHMP Section 3.11) (*out of scope for this review)

Fish Health Event Results

As a condition of licence, farms are required to report Fish Health Events as described previously. A summary of the Fish Health Events for Zone 3-2 and the three farms within the scope of this assessment in Zone 3-3 are provided (Table 5). Fish Health Event reporting began in the autumn of 2002; they were not required to be reported in 2013 and 2014, but was once again a condition of licence as of 2015.

From the last quarter of 2002 to December 2010, IHN would have been reported as a Fish Health Event. After December 2010, IHN would have been reported under Appendix III as an Urgent Notification. The IHN incident in 2002 does not appear in Table 5 because confirmation of the incidence happened before the last quarter and reporting was only required to occur once for a single incident.

Table 5: Summary of Fish Health Events for Zone 3-2 and three farms in Zone 3-3 from 2002 to 2012. Data provided by DFO Aquaculture Management.

Year	# Fish Health Events	No diagnosis	Number of events by disease					
			Kudoa infection	*Aeromonas salmonicida* infection	Myxobacterial infection	Viral Haemorrhagic Septicemia Virus infection	Netpen liver disease	*Renibacterium salmoninarum* infection
2002	4	-	-	3	1	-	-	-
2003	6	-	-	3	2	1	-	-
2004	2	-	-	-	1	-	1	-
2005	20	-	-	-	18	-	-	2
2006	2	-	-	1	1	-	-	-
2007	9	-	-	-	9	-	-	-
2008	2	-	-	-	2	-	-	-
2009	9	-	-	-	8	-	-	1
2010	19	1	2	1	12	-	-	3
2011	7	-	-	-	5	-	-	2
2012	2	-	-	-	2	-	-	-
Total	**82**	**1**	**2**	**8**	**61**	**1**	**1**	**8**

Urgent Notification Results

From December 2010 to December 2015, if a pathogen listed in Appendix III Urgent Notification of the Marine Finfish Aquaculture License (2015-2016) was confirmed, it would be categorized under that Appendix as an Urgent Notification and not as a Fish Health Event. As of December 2015 these pathogens were once again reported as Fish Health Events.

Three notifications of IHN occurred in 2012, one notification of VHS in 2012 and another in 2014 (Table 6). Case definitions have been defined for each of these diseases/pathogens; only results which meet the case definitions are considered Urgent Notifications.

Table 6: Summary of Urgent Notification reporting by disease/pathogen from 2011-2015 for all marine Atlantic Salmon aquaculture in BC. "Other" may include "any other filterable replicating agent causing cytopathic effects in cell lines specified by the Minister or is causative of identifiable clinical disease in fish". Data provided by DFO Aquaculture Management.

Year	Number of events by disease							
	IHN	**IPN**	**VHS**	**ISA**	**OMV**	**Whirling**	**Hitra**	**Other**
2011	0	0	0	0	0	0	0	0
2012	3	0	1	0	0	0	0	0
2013	0	0	0	0	0	0	0	0
2014	0	0	1	0	0	0	0	0
2015	0	0	0	0	0	0	0	0
Total	**3**	**0**	2	**0**	**0**	**0**	**0**	**0**

Reporting

As stipulated in Part B Section 1.3a of the Marine Finfish Aquaculture Licence (2015-2016), a licence holder must submit monthly, a seven month rolling inventory plan for all licenced species. Data are provided for the current month; projections are provided for six upcoming months. This includes number of fish, biomass, age class and harvest activities. This report also includes any transfers to and from the facility for the previous month as indicated in Part B Section 1.3b of the licence. When fish are harvested, Part B Section 1.4 of the licence indicates that a Population Harvest Declaration Form must accompany the fish and be provided to the processor.

In the case of a mortality event, licence conditions (Section 4.4b) stipulate that the Department must be notified no later than 24 hours after discovery with as much detail as possible. A mortality event is defined in Part A of the Marine Finfish Aquaculture Licence (2015-2016) as:

- Fish mortalities equivalent to 4,000 kg or more, or losses reaching 2% of the current facility inventory within a 24 hour period, or
- Fish mortalities equivalent to 10,000 kg or more, or losses reaching 5% within a five day period.

No later than ten days after the initial mortality notification, a summary report is to be sent to the Department which includes cumulative carcass biomass (kg), the number of fish that died, the proportion of the inventory that this represents and probable cause of the mortality event. These reports are required to be provided to the Department every ten days thereafter if the mortality continues. In addition to these reports, the licence holder is required to indicate what actions are to take place to handle the additional biomass associated with mortality as well as what vessels will be used to transport them to land-based disposal facilities, if required. The disposal (or composting) is regulated by the Organic Matter Recycling Regulation (OMRR), under the *Environmental Management Act* and the *Public Health Act*. The regulation does not authorize leachate and is designed to protect ground water and soil. During the 2012 outbreak of IHNV, DFO informed the Provincial Ministry of Environment that there would be traffic to the composting facility and that biosecurity provisions were necessary. The BCSFA kept the composting facilities appraised of developments in interest of preparation should additional farms test positive for IHN and require eradication. They also reported to the CFIA Incident

Command System with operational updates regarding ongoing carcass disposal such as estimates of capacity and how the facility was isolating the area receiving the culled fish.

As a condition of the Marine Finfish Aquaculture Licence (2015-2016), the licence holder must submit a quarterly report to the Department which includes:

- Mortality by category (including nil reports) (Section 7.4 Marine Finfish Aquaculture Licence)
- Use of therapeutants, pest control agents and anesthetics (Section 7.4 Marine Finfish Aquaculture Licence)
- Records of all wild finfish mortalities collected during routine carcass recovery (Section 7.5 Marine Finfish Aquaculture Licence)

It is a requirement to record as well as fill in a form for any wild finfish mortalities and incidental catches. The form is meant to track dead incidental catch, estimates of live incidental catch during transfer and harvest as well as herring spawn observed on infrastructure. Daily mortalities of non-licenced fish (incidental) are not included in this report but are required to be reported to DFO quarterly. A template is provided for each of the three quarterly report requirements in the conditions of licence. DFO publicly reports on these and other fish health related requirements on their website (see Appendix I for a list of reports).

As a condition of licence (Section 8), any escape or evidence of escape of cultivated fish from a facility must be reported to the Department upon discovery. The licence holder must provide as much detail as possible including any treatments administered if still within the withdrawal time after a medicated treatment A follow-up report must be submitted to DFO no later than seven days after the event or suspected event.

In January of each year, an annual Aquaculture Statistical Report must be completed and submitted to the Department as indicated in Section 13 of the Marine Finfish Aquaculture Licence (2015-2016). This form includes information such as species, weight, unit of measure (quantity), value and product type as well as processing information. This must be completed for each licenced facility.

As of January 2016, all three companies are in compliance with all of these requirements. Should they be found out of compliance, a notification would be sent to the company by DFO outlining the non-compliance and actions to be taken in the event that the non-compliance is not rectified.

FISH HEALTH DATABASE

Beginning in October 2002, the BC Salmon Farmers' Association (BCSFA) began submitting quarterly aggregate fish health information from their members to, what was then, the BC Ministry of Agriculture, Food and Fisheries (BC MAFF). These quarterly reports were generated from the BCSFA Fish Health Database, a private-public partnership initiative (Karreman, 2004). The database was and remains privately operated by the BCSFA. Originally, the database managed the health information submitted by the companies (Karreman, 2004):

- Privately owned freshwater and marine finfish aquaculture sites
- Publicly owned freshwater and, where applicable, federal marine Salmon Enhancement facilitates operated by Fisheries and Oceans Canada
- Public freshwater and net pen facilities operated by Freshwater Fisheries Society of British Columbia

As a condition of licence, operators were and are still required to report fish health data (see previous section). Aggregated fish health information was initially provided to BC MAFF on a quarterly basis and posted on the provincial website. After the Department of Fisheries and Oceans became the legislative authority for aquaculture in British Columbia with the Pacific Aquaculture Regulations in 2010, these data were and continue to be posted on the DFO website. The changes in structure and responsibility will be described in brief as it is important to understand the conditions under which the data, which are to be used in the risk assessment, were collected. For the most part, there have been few changes pre and post Pacific Aquaculture Regulations with respect to the database function.

One important change after 2010 was direct, licence by licence reporting to DFO, making licence holders the source of records and DFO the holders of the reported data. Previous to 2010, non-BCSFA members were compelled to report to BCSFA because the regulator required reporting as a licence condition and this reporting came through BCSFA database. The three Atlantic Salmon producers and the one major Chinook salmon producer continue to provide the data sets for the BCSFA database.

All results in the database are reported based on fish group. A fish group is defined as a species or genetic grouping of a particular species of fish cultured in a private or public facility. It is further defined by species, date of egg take and saltwater entry date (Karreman, 2004). Fish health events are also reported in the database. Fish health information is provided to the BCSFA for entry into the Fish Health Database on a monthly basis. The information is aggregated by fish health zones (Figure 2) and provided to the Department (previously to BC MAFF) each quarter. If there are less than three participants operating sites in a subzone with one of the species-water type groupings then that subzone's information is aggregated with the next contiguous subzone to maintain confidentiality (Karreman, 2004). Each quarterly report submitted to the Department contains three sub reports (Karreman, 2004).

- Average mortality rate for each species in each sub zone
- Proportional mortality rate by cause
- Fish Health Events

In 2013, the Department no longer required the reporting of "fish health events" in the quarterly report, instead they required quarterly reporting of "mortality by cause". It was, however, still a requirement to record fish health events in order that they may be audited (See section Provincial/Federal Fish Health Audit Systems).

This change in reporting, trading fish health event for mortality rate reports, had two motivations. A policy at the time, "red tape reduction" meant that requesting a new report required eliminating a reporting requirement of another; the second was that data that were reported had to be used by DFO in their business. Mortality rate and its causes provide health and performance information and are amenable to statistical treatment such as trends analysis, important to the regulator's business. Fish health event data, as reported, provide distribution information, that is disease presence/absence in time (season) and place (zone). Changes in distribution over time can be identified but the data are not amenable to statistical treatment such as trends analysis. The sampling through the audit program (see section Provincial/Federal Fish Health Audit Systems) allowed the Department to ensure compliance with the recording and reporting of presence of disease, and allowed detection of emergence of histopathology diagnosed disease, but the objective of validated industry-reported diagnoses included statistical analysis that was not possible with the fish health events data collected.

Concurrent with this change in reporting of mortality by cause was a change in diagnostic services. Traditionally, complete diagnostic services were provided by the Provincial Ministry of Agriculture's Animal Health Centre. Molecular diagnostic screening and bacteriology services

continued, but from the autumn of 2011 to December 2013 histopathology services were no longer available and a third party histologist and veterinary histopathologist were used. Aquatic Diagnostic Service, Atlantic Veterinary College accommodated DFO after clinical services for existing clientele were provided for. Fish Diagnostic Services (a private company operated by Dr. Hugh Ferguson), accommodated DFO for 2013 audit samples. As a consequence, 2011 and 2012 histopathology results were obtained as early as four months and as late as 14 months, and 2013 histopathology results were obtained as early as five months and as late as 15 months after the sample was taken (Ian Keith, DFO, 103-2435 Mansfield Drive, Courtenay, BC, Canada V9N 2M2, pers. comm.). Although molecular diagnostic (qPCR) screening for viruses of reportable diseases continued, the foundation of surveillance for reportable disease (due to the lag time of histopathology results) through the auditing program could not serve as a fulsome surveillance program but rather a monitoring program (Ian Keith, DFO, 103-2435 Mansfield Drive, Courtenay, BC, Canada V9N 2M2, pers. comm.). This is an important difference in function. Surveillance is the systematic, ongoing collection, analysis and dissemination of information in time for actions to be taken; monitoring, is the intermittent performance and analysis of routine measurements, aimed at detecting trends but with no requirements or thresholds for action (Last, 2001).

In the past year, a contract veterinarian with statistical experience has been analyzing all the farm-level data submitted to calculate incidence rate and other metrics. Because of this work, and because of a relaxing of the “red tape reduction” policy, there is rationale for re-instating fish health event reporting. As of January 2016, the requirement to report of Fish Health Events on a quarterly basis to the Department will be restored and the functioning of the audit/surveillance program can resume (see next section) (Ian Keith, DFO, 103-2435 Mansfield Drive, Courtenay, BC, Canada V9N 2M2, pers. comm.). Ongoing epidemiological expertise will, however, still be required to support the fish health program moving forward.

Provincial/Federal Fish Health Audit Systems

In 1997, the BC Salmon Aquaculture Review was conducted. The recommendations of that review were accepted by the BC Ministry of Agriculture and Lands (BCMAL) in 1999. One of the outcomes was the development of a new Salmon Aquaculture Policy and the staged implementation of a new regulatory and management framework with the major objective to improve fish health. Implementation of the program began in 2001 (BCMAL, 2006).

Among other changes, the provincial government began requiring industry to develop and follow a fish health management plan and to monitor and report as dictated in the conditions of licence. In turn, the government audited the reporting and published the findings. These activities together, provided a measure of health on the farms. The objectives of this program were:

> “Ensuring a comprehensive approach to aquaculture health management is a key objective of the Provincial Fish Health program. The cornerstone of the Provincial Fish Health program is the Fish Health Management Plan. These plans encompass all aspects of farming that can affect the health of the animals being farmed. As of 2003 all private companies and public fish culture facilities are required to develop and maintain a current Fish Health Management Plan (FHMP) specific to their facilities. For private companies and the provincially licensed public facilities, the FHMP is enforceable as a Term & Condition of an aquaculture licence. Another objective of the Fish Health Program is to ensure access to accurate and verifiable data on the health and disease status of cultured fish stocks. For salmon aquaculture, all facilities in freshwater and saltwater are required to report site-specific information to an industry database monthly; companies must report all mortality, causes of mortality and fish health/ disease events.

> In addition quarterly reports of the health status are provided to government and posted for public viewing on the BC Ministry of Agriculture and Lands website. Health monitoring and reporting of disease status is a requirement under the FHMP and compliance monitoring is built-in to the system. This report provides a detailed synopsis of the findings from the Fish Health Audit and Surveillance Program since 2003." (BCMAL, 2006).

In 2003, Fish Health Management Plans (FHMP) became a condition of licence. By 2005 all but two facilities had approved FHMPs and 100% of all marine salmonid producers had approved plans by 2006 (BCMAL, 2006). FHMPs were and currently are reviewed annually by what was then BCMAL and is now DFO. As a part of the FHMP, all companies were required to monitor and report the health status of their fish on a monthly basis to the industry database (BCMAL, 2006); the three Atlantic Salmon producers and major Chinook salmon producer continue to report to the industry database. The specifics of this reporting were described in the previous section. The industry database is operated by a third party professional computer company and verified by an independent contract veterinarian (BCMAL, 2006). If a company does not comply with the monthly deadlines, they are given a notification. Depending on the reason for non-compliance, actions by what was then the Province of BC and now DFO, will vary. In addition to this verification, an on-farm audit and records review is in place.

The original audit program under the BC MAFF was termed the Fish Health Auditing and Surveillance Program (Karreman, 2004). Currently, it is similarly termed Fish Health Audit and Surveillance (FHAS) under the Department's Fish Health Program, a component of the BC Aquaculture Regulatory Program (BCARP).

DFO's BC Aquaculture Regulatory Program (BCARP) undertakes the auditing program in addition to providing timely information and data on the environmental and operational performance of the aquaculture industry in British Columbia to the general public and stakeholders. Aquaculture Management staff conducting fish health audits are trained by the senior biologist and overseen by the field operations veterinarian.

The fish health audit and surveillance system consists of three main activities:

- DFO fish health veterinarians and bio-technicians monitor activities and review health-related records at marine salmon farms, as outlined in Health Management Plans and verified using a compliance inspection checklist;
- DFO fish health bio-technicians collect samples from recently dead fish (silvers) to verify, or audit, the farm veterinarians' routine monitoring and reporting of natural diseases that are common to BC's wild and farmed fisheries; and
- DFO audit results are compared to reports submitted directly to DFO by the farming companies each quarter (or available to DFO upon request for years 2013-2015).

Audit Methodology

Current audit methods are designed to address the three activities of the audit and surveillance program as outlined above. A maximum of 30 active farms are audited each quarter. A farm is considered active once three cages have been stocked for a minimum of 30 days following the populating of the first cage at the farm. Each active farm is assigned a number and a computer program randomly selects which farms are to be audited for each quarter. The program is weighted in that a minimum of 1 farm in each Fish Health Zone is sampled each quarter and that the number of farms in a Zone is representative of the percentage of the total number of active farms in the province. For example, if a Zone contains 20 percent of the farms in the province, approximately 20% of the 30 farms selected for the audit in that quarter will be from

that Zone. The goal is to sample 120 farms per year. However, just because a farm was selected for auditing in one quarter does not preclude it from being selected in subsequent quarters in a given year.

During a fish health audit inspection, Aquaculture Management staff will review the following activities, protocols, procedures and plans:

- Biosecurity
- Feed, nutrition and medication
- Monitoring water quality
- Fish health-carcass retrieval protocols
- Fish health/husbandry records
- Sea lice-handling procedures
- Fish handling, euthanasia, welfare
- Disease outbreak/kill contingency plan

The DFO audit checklist has been provided for reference in Appendix II.

A maximum of 30 fresh fish are selected for histopathology, bacteriology and molecular diagnostics/virology, in most circumstances eight fresh fish are sampled. This sample size is used for several reasons; most significantly there are often too few suitably fresh fish (silvers) to sample. Financial and time constraints also dictate small sample sizes.

Sampling is aimed at achieving 95% confidence of detection of 2% disease prevalence at the farm level (BCMAL, 2006). Sampling targets the "dead from unknown cause" portion of the population thus increasing the likelihood of reportable disease detection should it occur (BCMAL, 2006). Samples are normally sent to the provincial Animal Health Centre in Abbotsford for diagnostic testing as described in the previous section. The centre is an American Association of Veterinary Laboratory Diagnosticians (AAVLD) accredited full service diagnostic lab. All test methods conform to international standards.

For bacteriology, kidney tissue is swabbed from each fish individually. Biochemical analysis and/or gene sequencing are the confirmatory tests used. Histopathology samples are examined for disease lesions and cause of mortality.

For virology/molecular diagnostics, anterior and posterior kidney, liver, spleen, gill, and pyloric cecae tissues are taken from each fish (BCMAL, 2006). Heart tissue has always been included in histology but was added to the virology testing in 2011.

Samples are pooled to a maximum of five fish/sample and screened using PCR at the Animal Health Center for federally and internationally recognized diseases and pathogens that may affect fish movement and trade. These pathogens include: Infectious Hematopoietic Necrosis Virus (IHNV), Infectious Pancreatic Necrosis Virus (IPNV), Infectious Salmon Anaemia Virus (ISAV), Viral Hemorrhagic Septicemia Virus (VHSV), *Piscirickettsia salmonis* and Salmonid Alpha Virus (SAV).

In the event of a PCR positive finding of a reportable virus, the pathologist reports to CFIA and the client and copies the email to the DFO veterinarian. For IHNV and VHSV, laboratory confirmation is conducted at the Animal Health Centre. Confirmatory tests for ISAV and IPNV are performed at the designated National Aquatic Animal Health Laboratory System (NAAHLS) reference laboratory (see National Aquatic Animal Health Program section).

Audit Evaluation

In 2006, an evaluation was performed to critically assess both the surveillance and auditing functions of the program (Centre for Coastal Health, 2006). At the time of the evaluation, it was

determined that the data collected as a part of the Fish Health Audit and Surveillance Program "…exceed international standards to demonstrate freedom of disease and the level of fish health monitoring in BC is more comprehensive than in other parts of Canada and other salmon production regions of the world." (Centre for Coastal Health, 2006).

Keeping in mind that surveillance is defined as a systematic, ongoing collection, analysis and dissemination of information in time for actions to be taken (Last, 2001), it was determined that as a surveillance program, there were two critical aspects missing (Centre for Coastal Health, 2006):

- "Specific and measurable objectives for the program, including specific thresholds for action; and
- A plan for routine and ongoing analysis, interpretation and communication of the results to those who need to know in time to act."

Aspects of these shortfalls have subsequently been addressed. With respect to the first bullet, specific and measurable objectives for the program have been achieved and are outlined in BCMAL 2003-2005 (completed in 2006). These bullets have only been partially fulfilled. There has been a focus on routine and on-going analysis, on preserving the continuity of the dataset and standardizing analyses. This allows for the ability to recognize change. What is missing, however, is the interpretation of the information and data. As indicated previously, epidemiological support is required (see Fish Health Database section).

Audit Testing and Results

From the beginning of the audit program in quarter four of 2002 to quarter one 2016, there have been 1382 Atlantic Salmon tested from a total of 240 farm visits in the Discovery Islands and the three farms included in the assessment in Fish Health Zone 3-2 (Table 7). Appendix III provides the fish health audit results for IHNV for all farmed salmon in BC, as well as Atlantic Salmon from all Fish Health Zones.

Table 7: Summary of Provincial/Federal audit results for IHNV testing conducted from quarter four 2002 to quarter one 2016 on Atlantic Salmon in the Discovery Island area (Zone 3-2 plus 3 farms in Zone 3-3). Data provided by DFO Aquaculture Management.

		Atlantic Salmon				
Year	**Quarter**	**# Fish tested**	**# Farms tested**	**# Pools/ agent**	**# Positive pools**	**# Positive farms**
2002	4	32	3	7	4	1
2003	1	6	2	2	0	0
2003	2	16	2	4	0	0
2003	3	20	4	7	0	0
2003	4	7	2	2	0	0
2004	1	11	2	11	0	0
2004	2	20	2	11	0	0
2004	3	31	4	8	0	0
2004	4	24	5	10	0	0
2005	1	13	4	6	0	0
2005	2	35	6	13	0	0
2005	3	26	5	10	0	0
2005	4	21	4	8	0	0
2006	1	25	5	8	0	0
2006	2	27	3	7	0	0
2006	3	36	5	11	0	0
2006	4	65	6	16	0	0
2007	1	45	5	12	0	0
2007	2	42	5	11	0	0
2007	3	50	7	14	0	0
2007	4	48	7	13	0	0
2008	1	26	6	7	0	0
2008	2	24	7	8	0	0
2008	3	33	7	10	0	0
2008	4	40	8	12	0	0
2009	1	44	7	12	0	0
2009	2	43	7	11	0	0
2009	3	40	5	9	0	0
2009	4	27	4	7	0	0
2010	1	18	4	5	0	0
2010	2	0	0	-	0	0
2010	3	11	3	-	0	0
2010	4	19	4	-	0	0
2011	1	14	3	-	0	0
2011	2	17	3	5	0	0
2011	3	12	4	4	0	0

		Atlantic Salmon				
Year	**Quarter**	**# Fish tested**	**# Farms tested**	**# Pools/ agent**	**# Positive pools**	**# Positive farms**
2011	4	23	6	8	0	0
2012	1	29	6	8	0	0
2012	2	19	5	7	0	0
2012	3	36	6	9	0	0
2012	4	33	6	9	0	0
2013	1	13	4	4	0	0
2013	2	9	3	3	0	0
2013	3	16	3	4	0	0
2013	4	15	2	3	0	0
2014	1	16	3	4	0	0
2014	2	17	4	5	0	0
2014	3	34	5	8	0	0
2014	4	18	4	5	0	0
2015	1	28	5	7	0	0
2015	2	27	4	6	0	0
2015	3	27	5	8	0	0
2015	4	21	4	5	0	0
2016	1	33	5	8	0	0
Total	**-**	**1382**	**240**	**-**	**4**	**1**

In October 2002, there was one case of IHNV diagnosed at the Frederick Arm farm in the Discovery Islands. Twenty Atlantic Salmon were sampled for bacteriology, histology and virology. Four pools were PCR-positive for IHNV; two of the four pools of fish were culture-positive for IHNV. The diagnosis was IHN and bacterial kidney disease.

Audit Compliance Summary

From 2011 to 2015, there were 465 audits of Atlantic Salmon farms in British Columbia. Many audits resulted in no deficiencies, the highest number of deficiencies was 83 in 2012 and lowest, 52 in 2013; the average number of deficiencies per audit ranged from a high of 1.43 in 2011 to a low of 0.51 in 2012 (Table 8). The average number of deficiencies per audit over five years is 0.77. The greatest number of deficiencies (90) is recorded for the sea lice category. In discussion with DFO Aquaculture Management, this deficiency is most often a transcriptional error between paper copies of records and electronic files. The next most frequent deficiency "carcass retrieval protocol or record keeping needs improvement" is most often a failure to create an adequate barrier between morts and equipment or adequate disinfection. Equipment may be as simple as notebooks, pencils and gloves used when retrieving morts or the retrieval equipment itself. For a detailed description of what elements of the deficiency categories are audited, see the inspection checklist reproduced in Appendix II.

At the time of an audit, the results, including deficiencies, are communicated to the site manager or staff in charge. A follow up letter is sent documenting the audit results normally within the first month of the following quarter (may be up to four months post inspection). If the deficiency requires immediate attention, a phone call from the DFO veterinarian to the company veterinarian would take place. During the subsequent site visit, auditors record whether the

deficiency had been rectified. Because sites are randomly selected for audits there is no specified time period, it could be as soon as the following quarter. If by the third visit the deficiency is not addressed a phone call is placed to the company.

Depending on the deficiency, communication may be made with Conservation and Protection to intervene. Conservation and Protection will perform their own inspection as a follow up to determine if a violation has been committed. The framework describing this response is currently under review.

Table 8: Summary of DFO audit deficiencies for Atlantic Salmon farms 2011-2015. Data provided by DFO Aquaculture Management.

DFO audit deficiency categories	Number of deficiencies					Total
	2011	2012	2013	2014	2015	
Carcass retrieval protocol or record keeping needs improvement	2	8	4	23	23	60
Disease contingency or mass mortality information or records needs improvement	2	1	0	0	0	3
Fish handling, euthanasia protocol or records	3	1	0	0	0	4
Footbaths or sanitizers needs improvement	0	1	3	11	3	18
Husbandry or record keeping as per COL Appendix VII-A or VII-B needs improvement	2	5	4	3	6	20
Lice protocol or lice records as per COL Appendix VI or VI-A needs improvement	21	17	15	18	19	90
Mooring signage needs improvement	21	6	7	6	9	49
Mortality assessment or classification needs improvement	0	0	0	0	0	0
Nutritional or medicated feed protocol concerns	0	0	2	1	3	6
Training documentation is not up-to-date	0	4	0	3	5	12
Transfer records are not complete or up-to-date	25	9	9	3	3	49
Visitor protocol communication needs improvement	7	2	4	2	0	15
Water quality monitoring, equipment or record keeping needs improvement	0	0	1	0	0	1
Wild fish mortality records need clarification	0	1	1	0	0	2
Current finfish licence is not posted at facility	0	0	2	0	1	3
Total # deficiencies	83	55	52	70	72	332
# audits	58	102	96	99	110	465
# farms with deficiencies	40	35	31	41	45	192
Average # deficiencies/audit	1.43	0.51	0.54	0.7	0.65	0.77

NATIONAL AQUATIC ANIMAL HEALTH PROGRAM

The National Aquatic Animal Health Program (NAAHP) falls within the jurisdiction of the Canadian Food Inspection Agency (CFIA), under the *Health of Animals Act*. The goal of the NAAHP is to prevent the introduction and spread of aquatic animal diseases and the program operates under a disease risk framework based on internationally-accepted standards of the World Organisation for Animal Health (OIE). The NAAHP is co-delivered by DFO which provides diagnostic/laboratory support to the CFIA through the National Aquatic Animal Health Laboratory System (NAAHLS) and conducts research on test method validation, and other fish health topics and disease interactions for the NAAHP.

The *Health of Animals Act* authorizes the CFIA to take actions pertaining to any animal that may be affected by any disease. However, the CFIA has refined its programs through the implementation of the *Health of Animals Regulations*, the *Reportable Disease Regulations*, and published policy documents.

The CFIA utilises a risk-based disease management approach, which includes defined lists of federally reportable, immediately notifiable and annually notifiable diseases, and the species of finfish, molluscs, and crustaceans susceptible to these diseases. Infectious haematopoietic necrosis (IHN) is a reportable disease.

The disease lists contained in the *Reportable Disease Regulations* and the susceptible species list contained in the *Health of Animals Regulations* can be amended based on an assessment of emerging risks. Action can be taken at any time, if necessary, for diseases not appearing on these lists.

Notification of Disease

Notification by people in Canada of suspicion or detection of listed reportable and immediately notifiable diseases to the CFIA and CFIA's disease response to those notifications has been in effect since December 2010, including IHN:

- Notification of reportable diseases by aquaculturists
- Notification of reportable diseases by veterinarians and aquatic animal health specialists
- Notification of reportable and immediately notifiable diseases by researchers
- Directive on notification of reportable and immediately notifiable diseases by diagnostic laboratories.

Disease Response

Animal health management in Canada is a collaboration among federal, provincial and municipal governments, aboriginal groups, and industry. In some cases, the CFIA may not be the lead for management of diseases that exist in Canada. The lead may be either the Province of BC or industry who manages the disease according to their goals. The CFIA, however, ensures that the disease remains contained within the infected area.

Should a reportable or immediately notifiable disease or significant emerging disease be detected or suspected, the CFIA has a range of tools to manage the potential outbreak.

Although disease investigation and response situations vary, the steps involved normally include:

- **Initial inspection** by a CFIA veterinarian, who may decide to initiate biosecurity measures such as **movement controls** of animals and things by ordering a quarantine and/or declaring the premises an infected place.
- **Sample collection and submission** following a rigorous process to ensure that test results are reliable and valid. The CFIA will only accept samples that have been collected by or under the oversight of a CFIA veterinary inspector and submitted to the NAAHLS.
- **Investigation** of the health of the animals and the biosecurity management practices used at the facility, including movements of the animals and things into and out of the facility.
- **Surveillance and monitoring** for potential spread of the disease between aquaculture sites and to wild aquatic animals.
- **Disease testing** conducted at a DFO NAAHLS laboratory using testing protocols that are validated according to international standards.
- **Destruction and disposal,** if necessary, following humane, internationally recognized methods.
- **Cleaning and disinfection** of infected facilities and things (e.g., nets, equipment, boats, vehicles, etc.) after all destruction and disposal activities have been completed.
- **Removal of movement controls** once the CFIA evaluates and determines that the quarantine order or infected place declaration may be removed.

Movement Controls

Authorizations to move aquatic animals under the NAAHP are subject to relevant import or domestic program requirements. The import component of the NAAHP has been in effect since December 2012 and domestic movement controls were implemented in December 2015.

A CFIA-issued import permit is required under the NAAHP to import susceptible species of aquatic animal imports into Canada. More information on the import program is available on the CFIA Aquatic Animal Import webpage.

For domestic movements, the CFIA has assigned, through declarations, a specific disease status to each applicable province/territory or part of a province/territory, as well as the territorial sea and contiguous zone of Canada, for reportable diseases that occur in Canada. Movements between declared areas of lower to higher health status require a CFIA domestic movement permit. In addition, the CFIA will allow facilities whose management and biosecurity practices are amenable to the maintenance of a distinct disease status to apply to the CFIA for recognition as a compartment. The CFIA will inspect such facilities and, if they meet the national standards for compartment recognition and other necessary requirements, will issue a free area declaration that recognizes the elevated health status of the compartment. More information on the domestic movement program is available on the CFIA Aquatic Animal Domestic Movements webpage.

Disease Response for IHN in Enzootic Areas

The CFIA has a specific response plan for IHN. The CFIA has zoned Canada for the presence and absence of IHN in susceptible species of finfish. The declarations and maps can be found on the CFIA webpage listing declarations by provinces and marine area of finfish reportable

diseases. The zones identified as Pacific Ocean, Pacific Ocean Watershed of British Columbia and Pacific Ocean Watershed of Yukon are declared as infected areas for IHN; the rest of the zones in Canada are declared as free areas for IHN.

The goal of CFIA's disease response policy for responding to IHN notifications in the Pacific Ocean and Pacific Ocean Watershed of BC is to contain the disease to these zones; eradication of the disease will be considered under certain circumstances. The CFIA will:

- Confirm the disease, and publish the confirmation on the CFIA web site and report to the World Organization for Animal Health (OIE).
- Identify if the epidemiology of the disease has changed, for example, infection in a new species or a change in the expected clinical picture. Changes in epidemiology are published on the CFIA web site and reported to the OIE.
- Identify if any movements of infected animals or contaminated things occurred out of the infected area during the period when disease was likely introduced into the affected facility.
- Identify and control any planned movements of animals or things from the affected facility that are not covered by the domestic movement control program.
- Identify if surveillance for potential spread of IHN is required outside of the infected area because the notification was from a wild finfish population or because of a high risk movement of affected cultured finfish.
- Determine if eradication of a cultured population is required, for example, because of a vaccine failure occurring at the manufacturing level or identification of a significant impact on wild fisheries.
- Provide advice on disease containment or elimination on any disease response procedures that may be undertaken by industry or government finfish hatcheries, such as disposal of affected finfish and cleaning and disinfection.

INDUSTRY VIRAL DISEASE MANAGEMENT PLAN

In addition to the Salmonid Health Management Plans, their accompanying SOPs and conditions of licence, the three companies in conjunction with the BC Salmon Farmers' Association have developed and agreed upon a Salmon Farming Industry Viral Disease Management Plan (Viral Management Plan). The first version of the Viral Management Plan was agreed upon in 2011; the MOU has been reviewed and updated regularly since.

This plan is not a requirement of licence but it was developed voluntarily by the industry in order to quickly and effectively respond to an incidence or suspected incidence of viral outbreak in a farm as well as to ensure common practices in disease mitigation. This plan is not reviewed with government agencies or departments including DFO as it is industry driven and outside the requirements of licence. It was, however, shared with the Canadian Food Inspection Agency. It builds on the minimum Departmental requirements for disease outbreak response indicated in Section 2.8 *Fish Disease Outbreaks/Emergency* of the SHMP (2015-2016) which states:

In order to address these requirements, all three companies have SOPs in place which have been reviewed and approved by the Department.

Purpose

The VMP serves as a Memorandum of Understanding (MOU) among all parties. It is significant for many reasons, most importantly, it outlines the procedures and cooperation among farms and companies necessary in the event of an outbreak in order to minimize the spread of

disease and mitigate future infection. The VMP is reviewed, updated and approved by all participating members each year. The 2015 version of the VMP was used in the formulation of this summary.

Content

Included in the Viral Management Plan are a series of Annexes including:

- Biosecurity Standards to Minimize the Risk of Disease Transmission;
- Biosecurity Standards, Procedures and Protocols for Transport of Smolts and Harvest and Transport of Market Size Fish;
- Minimum Biosecurity Standards for Fish Processing and Handling Water and Wastewater from Fish Processing (out of scope of this review);
- Viral Disease Outbreak Management Plan; Standards for Increased Biosecurity for Harvesting, Transporting and Processing of Viral Diseased Fish;
- Protocol for Sharing Resources for Harvesting, Processing and Distribution of Fish from a Disease Outbreak;
- Minimum Biosecurity and Environmental Standards and Required Capacity for Mass Mortality Removal; and
- Auditing System.

A summary of these standards and protocols identifying clauses pertinent to this discussion is provided in the next section. When possible, activities undertaken by industry above those required as a condition of licence will be identified. The VMP builds on some elements of the SOPs required in the SHMP and conditions of licence but many of the coordinated activities outlined in the Viral Management Plan are above these requirements and industry led.

Organization

In order to successfully develop, revise and carry out the Viral Management Plan a number of committees have been created including: Industry Practice Management Committee; Outbreak Management Team; Fish Health and Biosecurity Standards Committee; Biosecurity Standards for Fish Processing and Handling Wastes and Wastewater from Fish Processing Committee; and Mass Mortality Disposal Committee. Each of these committees has representatives from all companies, some with technical expertise such as veterinarians and biologists, others with logistical expertise such as transportation and harvest, and management expertise such as the managing directors of the companies or members of the BCSFA. The specific details of the makeup of these committees will not be discussed here.

None of these committees are a requirement by the Department in fulfillment of any aspect of licence.

The Industry Practice Management Committee is responsible for activities such as development of the industry practice, approving standards and protocols, identifying compliance actions and management of a viral disease outbreak. The committee is required to meet in person or via teleconference within 24 hours of being notified of a suspicious finding to discuss the Disease Management Outbreak Plan as well as participate as members of the Outbreak Management Team. This collaboration and cooperation is not a requirement of licence.

The Outbreak Management Team provides a coordinated industry response to a viral disease outbreak to limit the effects of the confirmed positive case on all companies. The team consists

of Managing Directors of the companies as well as veterinarians and the BC Salmon Farmers' Association. The Managing Directors are responsible for the management and implementation of resources for harvesting, processing and distribution of fish from a disease outbreak as well as the management and organization of team meetings. Company veterinarians provide fish health and biosecurity information to management; are responsible for coordinating any regulatory sampling, index site management, implementing enhanced site surveillance; or other activities as described in the Outbreak Management Plan. The company veterinarians ensure that at a minimum, the standards and protocols of the Viral Disease Outbreak Management Plan are upheld.

The BC Salmon Farmers' Association is responsible for setting up a Communications Committee to manage communications during an outbreak situation.

The Fish Health and Biosecurity Standards Committee is responsible for the development of standards and protocols for the following documents: Biosecurity Standards to Minimize the Risk of Disease Transmission; Biosecurity Standards, Procedures and Protocols for Transport of Smolts and Harvest and Transport of Market Size Fish; Viral Disease Outbreak Management Plan; and Standards for Increased Biosecurity for Harvesting, Transporting and Processing of Viral Diseased Fish. In addition, they provide information for the development of the following standards: Minimum Biosecurity Standards for Fish Processing and Handling Wastes and Wastewater from Fish Processing; Minimum Biosecurity and Environmental Standard and Required Capacity for Mass Mortality Removal; and Auditing System. This committee reviews and approves protocols and standard operating procedures used by the companies to meet the standards outlined in their Memorandum of Understanding.

Annexes

Biosecurity Standards to Minimize the Risk of Disease Transmission

The purpose of these standards is to support protocols and procedures that minimize the risk of disease transmission on the production site or between production sites. These standards apply to protocols and procedures during normal operations. In this summary, only protocols and procedures which exceed the requirements of the Department will be described.

These standards include procedures relevant to vertical transmission such as adherence with importation guidelines, disinfection of hardened eggs and the agreement that gametes will not be used from broodstock populations that have viruses present that adversely affect fish. The SHMP (Section 3.8) requires that eggs are disinfected, however, it does not stipulate how or with what product(s) and that they cannot be used if they are derived from broodstock that have viruses present which adversely affect fish.

Also included is an agreement that all companies will vaccinate for IHNV in all production areas and, in shared areas, vaccines against other viral diseases will be used as they become commercially available. Currently, all companies are vaccinating all Atlantic Salmon against IHNV (Diane Morrison, Marine Harvest Canada, 124-1334 Island Highway, Campbell River, BC, Canada V9W 8C9 and Barry Milligan, Cermaq Canada, 203-919 Island Highway, Campbell River, BC, Canada V9W 2C2, pers. comm.). The conditions of licence and SHMP (2015-2016) do not require any vaccination of Atlantic Salmon; their use is industry driven. The use of an IHNV vaccine was mentioned in the first version of the Viral Management Plan ratified in 2011 and indicated that "Biosecurity standards should include, amongst others, recommendations for low stress husbandry practices, vaccination of smolts in common areas which are by definition high risks areas, and minimum fallow periods between cycles as indicated by the site."

The Salmonid Health Management Plan (Section 2.2.1) does state that efforts should be made to stock sites as single year class. It is not a requirement to do so however. Through the VMP, companies have agreed that sites will be single year class with the exception of broodstock sites.

Biosecurity standards are also outlined for the transport and disposal of mortalities, offal and blood water during normal operations. These are consistent with the requirements of the SHMP (2015-2016) and conditions of licence (2015-2016). Included in this section are protocols for cleaning and disinfection, and isolation and control of transport routes to limit the chances of cross contamination. A disposal site checklist is provided as well as details of the mortality disposal biosecurity plan. The latter includes contact information, route schematics, cleaning and disinfecting procedures, record keeping and confirmation of staff knowledge and training. All of which exceed the requirements of the Department.

Biosecurity Standards, Procedures and Protocols for Transport of Smolts and Harvest and Transport of Market Size Fish

The purpose of this section is to identify biosecurity standards, procedures and solutions for the transport of live fish to marine grow out sites, as well as harvest and transport of market size fish from marine sites to processing plants. Some companies have included many of the measures described below in the SOPs submitted in fulfillment of the SHMP requirements. It is difficult to determine if the SOPs would have been approved had these details not been included or been different, thus making it even more difficult to determine what a minimum standard would be for the Department to approve SOPs and the Salmonid Health Management Plan.

Elements of this section which illustrate the cooperation among companies and would be considered above the requirements of the SHMP are:

- All companies will endeavour to use UV filtration on transport vessels (or run a closed system).
- If for some reason a closed system cannot be maintained, a company will not flush water within five kilometers of another company's site.
- Sea lice filters will be used during all harvests, and all equipment will undergo cleaning and disinfecting before re-use.
- Transport of live fish for harvest will be with a closed system or using stun and bleed on site and chilled transport.
- When unloading at the processing plant, 100% of residual blood water in the boat will be removed and contained at the processing plant where it will be disinfected through the plant disinfection system.
- An annual, internal company audit will be conducted to ensure all activities and equipment used in the harvest and transport of fish to the processing plant conform to the MOU standards.

Viral Disease Outbreak Management Plan

These standards will take effect in the event of an outbreak of a viral disease. They provide a framework for structured and controlled actions in an outbreak situation. This plan is enacted whenever a suspicious finding of concern occurs. This may include an unexpected increase in mortality in one or more cages on a site or a substantial increase in the number of moribund fish causing specific concern. It may also include the presentation of clinical signs consistent with

viral infection of concern in moribund or fresh mortalities or, when receiving preliminary positive results of a virus of concern from the laboratory.

In the event of one of these situations, a series of actions are set into place which includes but is not limited to the notification of company veterinarians, sampling, site isolation and notification of other company veterinarians and authorities. Any sampling and testing is conducted in accordance with the National Aquatic Animal Health Program instructions (CFIA/DFO). The focus of sampling is determined by the Outbreak Management Team.

Roles and responsibilities of teams including those of the Outbreak Management Team are identified in the plan including agreed upon procedures. Specifics regarding index case management, ongoing management for areas with multiple positive findings and repopulation are provided in the Viral Management Plan. Of significance to the potential immediate spread of disease is the rapid depopulation and secure disposal of fish after receiving CFIA approval to do so. Positive sites will remain fallow for a minimum of three months or one month after release from quarantine, whichever is longer. Depending on the restrictions put in place by CFIA many of these actions are in addition to the minimum required by licence.

Elements of the Viral Disease Outbreak Management Plan encompass requirements of SOPs in the Salmonid Health Management Plan including: Section 2.8 *Fish Disease Outbreak/Emergency,* Section 2.6.1 *Carcass Collection* (Table 3), as well as in the conditions of licence (2015-2016).

The SHMP Template (2015-2016) provides only the following guidelines in the development of SOPs which address Section 2.8 *Fish Disease Outbreak/Emergency*:

> "A fish health emergency is any situation where the health of a fish population is suddenly at risk. This may be due to disease-causing agents (such as pathogenic virus) or to abrupt water quality changes (such as plankton blooms, a toxin, or a sudden, severe decline in dissolved oxygen). Vigilant monitoring, recording and early detection is key to good management of health emergencies.
>
> An outbreak is defined as an unexpected occurrence of mortality or disease. Not all outbreaks are infectious or fish health emergencies. Infectious diseases may differ in how contagious they are and therefore how easy or difficult they are to control. Rapid response is essential but will be determined on a case-by-case basis in conjunction with the Veterinarian, the Fish Health Management Team, and/or by regulatory authority. Once an outbreak/emergency has been recognized, specific steps are followed. The objective is to keep the pathogen concentration (or load) as low as possible and to prevent spread of the problem within or off the facility. Biosecurity is enhanced."

Additional procedures regarding management of an outbreak can be found in SOPs which address mass mortality in Section 2.6.1 *Carcass Collection* (Table 1). Again, the guidelines only require an SOP which addresses mass mortality and adhere to licence conditions.

Salmonid Health Management Plan Section 2.6.1 *Carcass Collection* pertaining to a mass mortality states:

> "…If mass mortality arises, it is managed according to licence conditions and its specific SOP."

According to the conditions of licence (2015-2016) companies must submit a procedure which adequately fulfills the following criteria with respect to a mortality event:

- "Notification to the Department of a mortality event defined in Part A "Mortality Event" not later than 24 hours after discovery, providing as much detail as outlined in Appendix V-A;

- Not later than 10 calendar days after the mortality notification, submission to the Department a completed Appendix V-A, with subsequent update reports every 10 days thereafter if the specific mortality continues;
- Actions to handle the additional biomass on site associated with the mortality event of the magnitude defined in Part A of the licence; and
- Identification of vessels that will be used to collect and transport mortalities to on-land facilities in the case of elevated mortality events." Section 4.4b Licence conditions (2015-2016)."

There is one other section of the conditions of licence which is relevant to a disease outbreak situation and that is a *fish health event*. Section 4.5 of the conditions of licence (2015-2016) pertaining to a fish health event stipulates that:

"Should a Fish Health Event occur, the licence holder must:

- Take immediate action to manage the event by implementing a response procedure to minimise the potential spread of pathogens if an infectious disease is diagnosed;
- Undertake follow up measures to evaluate the Fish Health Event and the efficacy of the mitigation measures taken;
- Submit a completed Appendix V-B [Fish Health Event Report] to the Department, not later than seven calendar days after the event; and retain a copy on site to be made available for review by a Fishery Officer or Fishery Guardian upon request; and
- Submit to the Department a therapeutic management measures as set out in Appendix V-C [Mortalities by Category Report]."

All of these items are addressed in SOPs submitted with the SHMPs for each company. What is in the Viral Management Plan, but is not included in the SOPs, are the details on communication among companies (see list below); the agreement to adhere to common practices in the best interest of all companies both in a viral outbreak situation and everyday practices.

When a positive confirmation has been received or index case confirmed, the VMP requires that a series of procedures are enacted including:

- Initiation of the industry communication strategy
- Isolation procedures
- No movement of live fish out of the risk area
- No boat traffic to and from the farm without CFIA approval
- No personnel movement between sites
- Equipment from affected area to be kept separate from equipment from other areas
- Increased mortality retrieval and monitoring for disease of fresh mortalities from all cages
- Mortalities are to be contained on-site until a biosecure location for mortality disposal is identified
- Complete a trace-back to determine when/how the disease agent could have been introduced or spread in order to identify additional at risk areas

Standards for Increased Biosecurity for Harvesting Transporting and Processing of Viral Diseased Fish

The purpose of this standard is to provide for increased biosecurity for the harvesting, transport and processing of fish found positive for viral disease. These are enhanced biosecurity standards over and above those outlined for harvesting, transporting and processing of fish under non-outbreak situations. It is important to note that all of these activities, in the case of a positive viral disease situation, will be conducted under the approval of CFIA.

At the infected site, fish will be harvested and transported whole to the processing plant for bleeding and processing. All blood water and blood will be contained and treated in the processing plant. All production, harvest and transport equipment used for diseased fish will be used only for diseased fish. Dedicated vessels, equipment and docks will be used for harvest and transport of diseased fish. All boats and equipment used in the harvest and transport of diseased fish will be steam pressure washed and disinfected. They will remain either in dry dock for three days or have a 14 day down-time before working with non-infected fish or farms.

All suspicious sites that are placed under quarantine by CFIA will require license approvals for all processing plants which will handle infected fish. Standards for processing include but are not exclusive to: communication plan with processing plant managers; isolation of docks and processing plants used for handling diseased fish; appropriate equipment to be used to transfer fish to the processing plant; record keeping; and compliance with CFIA requirements.

Much of these efforts have been outlined in SOPs submitted to the Department in fulfillment of Salmonid Health Management Plans. The requirements by the Department, however, are general. See previous section describing the Departmental requirements of Section 2.8 *Fish Disease Outbreak/Emergency*, Section *2.6.1 Carcass Collection* of the SHMP (2015-2016) and the conditions of licence pertaining to a fish health event.

Protocol for Sharing Resources for Harvesting, Processing and Distribution of Fish from a Disease Outbreak

This protocol outlines the standards for cooperation and allocation of shared resources for the harvesting, processing and distribution of fish from a disease outbreak in an efficient, timely and biosecure manner. During an outbreak all proposed sharing must be approved by CFIA. Standards include information on communication and cooperation between companies and with CFIA; documentation requirements; personnel management; and harvest timeline agreements. It is explicitly stated that all fish from the index case site are to be killed or harvested within 14 days of positive confirmation of the index case.

All of the elements of this protocol are industry driven, with the exception of the requirement to work with CFIA. None of these actions are specified in the SHMP or conditions of licence (2015-2016).

Minimum Biosecurity and Environmental Standards and Required Capacity for Mass Mortality Removal

This protocol defines the standards for the transport and disposal of mortalities in the event of a mass mortality event. The implementation of the standards requires approval from CFIA. Although some of the details outlined in these standards are included in SOPs submitted to the Department in fulfillment of the requirements of the SHMP (2015-2016), in the event of an outbreak (as described in previous sections), a plan for mass mortality disposal is not a requirement.

With respect to a mass mortality event, it has been agreed upon by all signatories of the VMP MOU that:

- All companies will have available the resources, equipment, staff, etc., to remove a mass mortality within 14 days of a positive confirmation of the index case and have an approved disposal site.
- All resources will be documented and communicated to all companies as a part of the mass mortality disposal plan.
- Mortalities will be removed at least once per day.
- All movement of people and equipment will be controlled and documented.
- Additional transportation requirements come into effect to contain and mitigate the spread of pathogen.
- The mortality disposal site standard includes the transport and disposal of mortalities; and processing offal and blood water during a mass mortality event. These standards include heightened disinfection requirements; personnel and equipment movement restrictions; and the implementation of 24 hour security at the disposal site.
- Enhanced biosecurity standards at cage sites are described.
- Annually, the company veterinarians review the disposal standards and disposal company methods, and all available resources and logistics.
- The transportation plans, processing of offal and blood and enhanced biosecurity standards must all be approved by CFIA (also a CFIA requirement).

Auditing System

The company veterinarians are responsible for ensuring that the SOPs and protocols of their respective companies meet the standards outlined in the VMP. A third party common external auditor will audit all companies. The BCSFA audit team will audit service provider standards. All results are reviewed by the company veterinarians. The audit guidance document and procedures are approved by the Fish Health and Biosecurity Standards Committee. The external audit includes comparing actual performance of the companies against the standards and protocols defined in the VMP. The external audit is conducted at a minimum annually.

There is no requirement by the Department to undertake any of these actions or have an audit system.

SUMMARY

Fish health is managed on a BC Atlantic Salmon farm in various ways, some are mandatory licence conditions, others are voluntary and industry led.

Under the *Pacific Aquaculture Regulations,* as a condition of licence, each company must have a Salmonid Health Management Plan (SHMP) and accompanying proprietary Standard Operating Procedures (SOPs). These SOPs along with other conditions of licence provide evidence of the biosecurity measures in place to mitigate disease events and minimize the spread of pathogens within and away from a farm should they occur. Other licence conditions which aid in the maintenance of healthy fish are production plans, fish transfer requirements and fish health record keeping. Elements of these SOPs and other licence conditions are regularly audited by the Department of Fisheries and Oceans. Farms are notified of any deficiencies and steps to rectify the deficiencies must be taken. From 2011 to 2015, there were 465 audits of Atlantic Salmon farms in British Columbia. Many audits resulted in no deficiencies, the highest number of deficiencies was 83 in 2012 and lowest, 52 in 2013; the average number of

deficiencies per audit ranged from a high of 1.43 in 2011 to a low of 0.51 in 2012; the average number of deficiencies per audit over five years is 0.77.

Through DFO's audit program, tissue samples are taken for routine pathogen screening at accredited laboratories. These results are compared to the mandatory reporting requirements made by each company as a condition of licence. From quarter four 2002 to quarter one 2016, of what was the provincial audit program and is now the DFO audit program, 6,881 Atlantic Salmon were tested for IHNV from 1,152 farms, ten farms tested positive for IHNV, the same farm may have been tested more than once. In the Discovery Islands over the same time period, 1,382 fish were tested for IHNV from 240 farms and one farm tested positive.

All three companies monitor the health of their fish through the collection and analysis of syndromic information and pathogen screening of mortalities. Examples of syndromic information they collect are environmental data, feeding information, abnormal behaviour and types of mortalities. To some degree all of these are elements of licence conditions but the companies require more detailed information in many cases and then utilize that information in site management. For example, samples are taken for disease screening during an audit but the companies also sample fresh mortalities on a routine basis for their own disease screening. From marine cage sites alone, Marine Harvest Canada typically samples over 4,800 fish per year for histology and approximately 900 for virology; Grieg Seafood typically tests over 1,000 fish per year for virology; and Cermaq Canada typically tests over 3,000 fish per year for various pathogens of concern. These estimates do not include broodstock or pre-transfer smolt testing.

The companies participate in certification programs which provide evidence of biosecurity oversight and fish health monitoring. All farms in the Discovery Islands are certified through Best Aquaculture Practices Certification (BAP); some farms are in the process of being certified through Aquaculture Stewardship Council (ASC) as well. Both certifications require standards be met regarding fish health and welfare. Some of these standards are similar to those required as a condition of licence. BAP certification requires that all smolts brought into a farm are vaccinated against diseases for which effective vaccines are available prior to stocking. ASC certification requires that all fish are vaccinated for diseases known to present a significant risk in the region and for which an effective vaccine exists.

Although vaccination of Atlantic Salmon is not a requirement of licence, all companies do voluntarily vaccinate their fish for pathogens including IHNV. The agreement to vaccinate fish and have a coordinated effort in mitigation of disease and response in an outbreak situation is formalized in the industry's Viral Management Plan. The Viral Management Plan is an MOU among the three companies in conjunction with the BC Salmon Farmers' Association. This plan is not a requirement of licence. The use of vaccines was mentioned in the first version of the Viral Management Plan ratified in 2011 and indicated that vaccines were to be used in common areas. Since 2015, the IHNV vaccine has been used by all companies on all smolt before sea water entry.

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APPENDIX I PUBLIC REPORTING BY DFO

Table 9: Public reporting by DFO in British Columbia related to fish health management.

Mortality Rates and Carcass Classification by Category	
Report A	Average monthly mortality of cultured salmon by fish health zone (2013 onwards)
Report B	Carcass classification by category by fish health zone (2013 onwards)
Report C	Carcass classification by category (monthly average) by facility (2013 onwards)
Fish Health Monitoring Activities and Farm Audits	
Report D	Summary of DFO's fish health monitoring activities
Fish Health Audit and Surveillance Summary by Facility	
Report E	Fish health audit and surveillance summary by facility
Monitoring of Compliance with Health Management Plans	
Report F	Fish health inspection compliance summary
Report G	Fish health inspection results by facility

APPENDIX II DFO AUDIT INSPECTION CHECKLIST (October 2015 version)

Health & Mortality Management Plan (HMP) Inspection

(with reference to requirements of HMP and C.o.L. 2013 - 2014)

NB. Section16.1: *"Unless otherwise noted under specific conditions of this licence, the licence holder shall keep all records required by these conditions… at this facility for the duration of the production cycle"*

Operation Description and Information Reported to DFO

Inspection Date and Time: _____

AQ Licence #: _____ Company Name:_____

Facility Name: _____ Facility Reference #:_____FHAS Code:_____

Fish transfer inventory (s.3.1 - s.3.4; App I-Aii): _____ & approx. date of last transfer: _____

Elevated mortality reports (App VII-D; s5.4c): YES☐ NO☐ Date: _____

Average lice abundance (as per latest report, (s8.1, App. VI-A)): N/A☐

Fem: _____ Mot:_____ Chal: _____ Calig: _____ Sample Date: _____

Counts: _____ _____ _____ _____

Any dates where ">3 trigger" was reached in past 3 months? YES☐ Date:_____ NO☐

Pens reported as last assessed for lice: N/A☐ Ref Pen: _____; Pen _____; Pen _____.

Therapeutant Use (s.5.5c; s.6.1b 8.4; App VII-B & C):

Date (MM-YY)	-	-	-	-	-
Therapeutant	-	-	-	-	-

Has this facility had previous DFO inspection(s) for this cycle of fish: YES☐ NO☐

If YES, complete the following:

Date of Previous Inspection	FHAS Code	SL Code	Deficiency (Indicate Section Number)	Have Deficiencies Been Resolved (Also indicate whether deficiency resolved next to the appropriate section in this form)	Any outstanding or previously unchecked elements (e.g. 6.8) that should be assessed or revisited?
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

Note: If this facility has had a previous inspection for this cycle of fish, then only complete the sections of the checklist highlighted in grey, depending on whether a fish health and/or sea lice audit was conducted this visit, yellow, or those sections where a deficiency from a previous visit was indicated.

***Please don't forget to write the inspection date and time on the first page**

Farm personnel interviewed: _____

HMP inspection conducted by DFO staff:_____

Additional activities on this inspection date: Fish Health☐ Sea Lice☐ Other: ☐ _____

Current: Fish Inventory: _____ Average Weight: _____ Biomass: _____

Biomass recorded on Facility's Aquaculture Licence: _____

Does licence number onsite match the current valid licence number in AQUIIS? YES☐

_____

Items highlighted in yellow are important and require immediate on-site discussion or attention, if deemed inadequate by DFO staff.

1. Biosecurity (s.5.1; App IV HMP s.2; s.12.23)

1.1 Is a functional footbath present at all arrival locations? YES☐ NO☐

1.2 Type of disinfectant used in bath:
Virkon☐ Bleach☐ Ovadine☐ Pucks☐ Other ☐

1.3 Is there a footbath at other critical traffic points on-site (i.e. ramps)? YES☐ NO☐ NA☐

1.4 While on-site, was the footbath used by site staff? YES☐ NO☐ Not Observed☐

1.5 Is there evidence, other than footbaths, of minimizing potential pathogen transfer (i.e. sanitizers, sprayers, net dips, other)? YES☐ NO☐

1.6 Are footbaths and disinfection liquid(s) disposed of in mort totes? YES☐ NO☐ Other: _____

Visitor protocol (s.13.1 & 2; s.5.1; App IV HMP s.2.5):

1.7 Are there signs directing visitors to a well-marked moorage areas / dock? YES☐ NO☐

1.8 Are there signs indicating restricted moorage areas? (E.g. at mort float) YES☐ NO☐

1.9 Are visitor protocols posted or explained at designated docking stations? YES☐ NO☐

1.10 Are biosecurity procedures communicated? YES☐ NO☐

2. Feed, Nutrition & Medication (s.5.1; App IV. HMP s.2.2.5 & s.2.10.1)

2.1 Is feed stored in a contained, protected location (not in weather elements)? YES☐ NO☐

2.2 Are feeds on site within 'best before' date? YES☐ NO☐ NA☐

2.3 Is feed, observed as being fed to fish, free of visible mould or contaminants? YES☐ NO☐ Not Observed☐

If medicated feed is on-site (s.5.1; s.6.1b; App VII-B and C; HMP s.2.10.2):

2.4 If yes, is it recorded in the Rx file on-site? YES☐ NO☐ NA☐

2.5 If yes, is medicated feed stored in clearly marked bags, easily distinguishable from non-medicated feed? YES☐ NO☐ NA☐

3. Monitoring Water Quality (s.5.1; s.6.1a; HMP s.2.4; App VII-A)

3.1 Are microscopes and other plankton monitoring equipment available? YES☐ NO☐

3.2 Is equipment available for measuring water quality? YES☐ NO☐

3.3 Is equipment on-site to respond to blooms or low D.O. (e.g. tarps, bubble curtains, air compressors, etc.)? YES☐ NO☐ NA☐

3.4 Are records of water quality on-site? YES☐ NO☐

3.4.1 If yes, are they up-to-date? YES☐ NO☐ NA☐

3.4.2 If yes, is there evidence of increased monitoring during poor water quality events (e.g. plankton bloom or low oxygen)? YES☐ NO☐ NA☐

-	Score	From Total
Page 2 Totals:	-	-

4. Fish Health - Carcass Retrieval Protocols (s.5.3; s.5.4; s.8.4; s.10.2; App VII-C & D; HMP s.2.6)

If carcass retrieval occurred during this assessment: NA ☐

☐ Check this box if DFO was **not** present to observe the carcass collection

4.1 If divers, are they following basic HMP biosecurity protocols? YES☐ NO☐ NA ☐
4.2 Does staff wear raingear, gloves and rubber boots during collection? YES☐ NO☐ NA ☐
4.3 Is the staff handling the carcasses using disinfectant between pens, on gear, or on areas where potential contamination may have occurred? YES☐ NO☐ NA ☐
4.4 Is carcass collection equipment (dive rings, dip nets, uplift boxes) disinfected between pens? YES☐ NO☐ NA ☐
4.5 Is there evidence of designated carcass containers? YES☐ NO☐ NA ☐

4.6 Are the carcasses properly covered & contained to facilitate biosecurity? YES☐ NO☐ NA ☐

4.7 If dead wild finfish exist in the carcass collection, is that documented? YES☐ NO☐ NA ☐
☐Observed ☐Discussed

4.8 If any live wild finfish are caught during carcass collection, are they released outside the aquaculture facility in the least harmful manner? YES☐ NO☐ NA☐
☐Observed ☐Discussed

From records/observation: (s.5.1; s.5.4a; HMP s.2.6.2)

4.9 Do staff categorize carcasses? YES☐ NO☐
4.10 Is carcass collection performed by a known and effective method? YES☐ NO☐
4.11 Method used: Divers ☐ Pump ☐ Bottom rings☐ Other: _____
4.12 Is there a routine schedule for carcass collection from pens? YES☐ NO☐
4.13 Does the frequency facilitate early detection of disease (i.e.fresh silvers)? YES☐ NO☐
4.14 Is a mort float located away from the production fish? YES☐ NO☐ NA ☐:_____
4.15 If yes, does the mort float meet biosecurity principles (safe, secure, etc)? YES☐ NO☐ NA ☐:_____
4.16 If no mort float, where are carcasses stored? _____ & for how long?_____

5. Fish Health Husbandry Records (s.1.1; s.1.2; s.3.1d, s.3.2; s.3.3; s.5.1; s.5.4; s.6.1; s.6.2; s.6.3; s.8.4; App IV; App VII-A, B & C; s.16.1; HMP s.1.1.3; HMP s.2.7)

Do written/computer records address:

5.1 Mortality number or rate? YES☐ NO☐ NA ☐
5.2 Carcass classifications? YES☐ NO☐ NA ☐
5.3 Sampling events (if any)? YES☐ NO☐ NA ☐
5.4 Is this a single year class production unit? YES☐ NO☐ NA ☐ Brood
If No, list mitigative actions to minimize this risk: _____
5.5 Is this a single species production unit? YES☐ NO☐
5.6 Fish movements: is species on-site listed on the licence (s.1.1; s.1.2; s.3.1b)? YES☐ NO☐ NA ☐
5.7 Is there written confirmation of in/out fish transfers? YES☐ NO☐ NA ☐
5.7.1 If yes, are health attestation(s) attached? (s.3.1d; s.3.2; s.3.3) YES☐ NO☐ NA ☐
5.7.2 If yes are treatment records from the previous facility accessible encompassing 90 days (therapeutants), 21 days (anaesthetics) prior to the first transfer date to the current facility? (s.6.1b; App VII-B) YES☐ NO☐ NA ☐in hatchery
5.8 Prescription records are current (eg. TMS, antibiotics, SLICE)? (if any)? YES☐ NO☐ NA ☐
5.9 Is daily administration of med feed recorded (i.e. pens & feed amounts)? YES☐ NO☐ NA ☐
5.10 Other types of mitigative actions logged (i.e. net changes, split fish, etc.)? YES☐ NO☐ NA ☐
5.11 Are carcass evaluations, sampling by fish health staff and corresponding dates recorded? (s.6.1; App VII-A(g)) YES☐ NO☐ NA ☐in Town

5.12 Indications that fish health and mortality records can be, or are reviewed by the company veterinarians or fish health staff? (s.6.3; s.8.4; s.16.1) YES☐ NO☐ NA ☐in Town

5.13 Are there training records indicating all facility staff have read and abide by the HMP and relevant SOPs? (App IV; HMP s.1.1.3) YES☐ NO☐ NA ☐

Name of record checked:_____ Last date:_____

5.14 Are relevant and current SOPs of the HMP on-site? YES☐ NO☐

-	Score	From Total
Page 3 Totals:	-	-

6. SEA LICE

If Pacific salmon: Do records indicate intermittent opportunistic monitoring of lice? (s.7.7) YES☐ NO☐ NA☐

If Atlantics(Atlantics, s.5.1; s.7; App.VI)
Sea lice sampling occurred during this inspection ☐

Check NO if an action made by staff resulted in a forfeit or postponement of the sampling event or a loss of integrity in the sampling data (e.g.: fish were recently handled etc.) NO☐
Note, It may be possible in this instance to check both Yes and No, particularly if the observations or awareness of a practice that could cause loss of data integrity was observed mid-way in the sampling event.

Check NA if sampling was not scheduled to occur. GOTO section 6.8. NA☐

Handling Procedures

If lice counts occurred during this HMP assessment:

6.1 Are staff following fish-gathering protocols (s.7.3; App VI; App IV HMP) (i.e. crowding first then random selection)? YES☐ NO☐ NA☐

6.2 Method of capture was:
Large seine ☐ Box seine ☐ Shallowed net ☐ Chum/dip☐ Other_____

6.3 Are staff using anaesthetic properly (i.e. able to handle fish in 1 - 2 minutes)? YES☐ NO☐ NA☐

6.4 Are fish adequately contained (catch nets, low stress, adequate tote size) (s.9.1)? YES☐ NO☐ NA☐

6.5 Are staff handling fish to ensure accurate lice enumeration? YES☐ NO☐ NA☐

6.6 Are staff handling fish in a manner that minimizes fish stress and trauma? YES☐ NO☐ NA☐

6.7 Are staff categorizing the lice into required life-stages and species? YES☐ NO☐ NA☐

From records: (s.16.1(i); s.8.1; App.VI-A)

6.8 Do counts, last reported by farm to DFO, agree with the facility records? (s.16.1(i); s.8.1; App.VI-A) YES☐ NO☐ NA☐

6.8.1 Is the SW entry date, in the above record (last reported SL, App.VI-A) reported correctly (i.e. is a direct entry date from the hatchery to SW)? YES☐ NO☐ NA☐

6.9 If an average of >3 motiles/fish has been experienced by this farm in the past 3 months, has monitoring increased to at least biweekly? (s.8.3) YES☐ NO☐ NA☐

Do sea lice records address:

6.10 All sea lice assessment dates and count results? (s.6.1) YES☐ NO☐
Last date:_____

6.11 3 groups of 20 fish within a monthly, or semi-monthly, assessment? YES☐ NO☐

6.12Is there a designated reference population identified in records? YES☐ NO☐ NA☐

6.13 Is that reference pop. known and sampled by staff each count? YES☐ NO☐

7. Fish Handling, Euthanasia, Welfare(s.5.1; s.5.4c; s.16.1; HMP s.2.3, s.2.6.3)

If major culls/euthanasia events occurred, have they been recorded? YES☐ NO☐ NA☐

7.1.1 Do the records indicate the method of euthanasia or anaesthesia? YES☐ NO☐ NA☐

8. Disease Outbreak / Kill Contingency Plan (s.5.1; s.5.4c; s.5.5; App IV HMP s.2.8; s.16.1)

Is the contact list for the fish health expertise/ team readily available?	YES☐	NO☐
Is the Manager/staff aware of company procedures to deal with fish disease outbreaks / emergencies?	YES☐	NO☐
Does a Mass Mortality plan or procedure exist on-site (s.5.4c; s.16.1)?	YES☐	NO☐

-	Score	From Total
Page 4 Totals:	-	-

The on-site inspection conducted on this day is not intended to be inclusive of all licence conditions. Any "NO" or "NA" items identified and noted below by DFO staff may be considered deficient, inadequate or items of concern on this day and may require further explanation or action by the Licence Holder. These noted items will specifically be revisited by DFO staff. Once completed, this document is considered sensitive and protected pursuant to Section 20 of the Access to Information Act.

HMP INSPECTION RESULT:

This facility had _____ inspection items checked **YES** from a total of _____* applicable inspection items (maximum number = 67 yes). *If an inspection item is not applicable (NA) then that line item is subtracted from the maximum total (eg. 67 – 14 NA's = 53).

Page	Score	From Total
1	-	-
2	-	-
3	-	-
TOTALS	-	-

Comments:

DFO staff observations concerning other COLs or the Fisheries Act may require C&P attention. YES☐ NO☐
Photos taken? YES☐ By whom:_____ NO☐

Photo Details
Name [format: Facility Reference # - FHAS Code – Fish (if applicable) & sequence (a, b, c…).jpg] and Description
Example: *1082-2014-007-1a.jpg* Description: *Necropsy Fish #1*
Photo 1: _____ Description: _____
Photo 2: _____ Description: _____
Photo 3: _____ Description: _____
Photo 4: _____ Description: _____
Photo 5: _____ Description: _____

Fisheries and Oceans (DFO) staff signature: _____ Date: _____

Print name: _____

To be completed by Fisheries and Oceans (DFO):

Date reviewed by Field Supervisor: _____ Signature: _____
Print Name: _____

If photos taken, they have been titled, dated & filed according to Facility Reference #? YES☐ NO☐ NA☐

C&P staff was contacted to follow-up concerns noted during this audit. YES☐ Date: _____ NO☐ NA☐

A copy of this HMP Inspection summary was provided to the Licence Holder: YES☐ NO☐
A copy of this HMP Inspection summary was provided to DFO C&P: YES☐ NO☐
The Licence Holder's Fish Health Rep was subsequently contacted by DFO: YES☐ NO☐ NA☐

DFO Veterinarian signature:_____ Date: _____

Print name: _____

Additional Veterinary comments:

Sea Lice Calculator

Index	Pen #	Female:	Female Gravid:	Male:	Immature:	Chalimus:	Caligus:
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
Sub totals:		-	-	-	-	-	-
-		-		-		-	-
-		FEMALE		NON-FEMALE			
		-					
TOTAL:		MOTILE				CHALIMUS	CALIGUS

APPENDIX III FISH HEALTH AUDIT IHNV RESULTS

Table 10: Summary of Provincial/Federal audit results for IHNV testing conducted from quarter four 2002 to quarter one 2016 for: all farmed salmon in all Zones; all Atlantic Salmon in all Zones and; Atlantic Salmon in Zone 3-2 and three farms in Zone 3-3. Data provided by DFO Aquaculture Management (Q=quarter).

		All farmed salmon, all regions					Atlantic Salmon, all regions					Atlantic Salmon, Discovery Islands area				
Year	Q	# Fish Tested	# Farms Tested	# Pools/ Agent	# Positive Pools	# Positive Farms	# Fish Tested	# Farms Tested	# Pools/ Agent	# Positive Pools	# Positive Farms	# Fish Tested	# Farms Tested	# Pools/ Agent	# Positive Pools	# Positive Farms
2002	4	209	27	52	15	5	160	20	40	15	5	32	3	7	4	1
2003	1	163	23	45	8	3	125	17	34	8	3	6	2	2	0	0
2003	2	193	27	49	4	2	122	18	32	4	2	16	2	4	0	0
2003	3	155	28	51	0	0	97	19	33	0	0	20	4	7	0	0
2003	4	137	27	45	0	0	79	15	25	0	0	7	2	2	0	0
2004	1	188	29	60	0	0	116	18	40	0	0	11	2	11	0	0
2004	2	190	30	82	0	0	125	20	56	0	0	20	2	11	0	0
2004	3	150	28	47	0	0	124	20	36	0	0	31	4	8	0	0
2004	4	147	29	48	0	0	102	21	33	0	0	24	5	10	0	0
2005	1	152	29	48	0	0	94	21	31	0	0	13	4	6	0	0
2005	2	165	29	53	0	0	134	24	44	0	0	35	6	13	0	0
2005	3	153	28	55	0	0	129	22	47	0	0	26	5	10	0	0
2005	4	116	21	41	0	0	96	17	33	0	0	21	4	8	0	0
2006	1	135	27	47	0	0	115	23	40	0	0	25	5	8	0	0
2006	2	145	28	51	0	0	116	22	41	0	0	27	3	7	0	0
2006	3	141	23	46	0	0	125	20	40	0	0	36	5	11	0	0
2006	4	223	24	57	0	0	154	18	39	0	0	65	6	16	0	0
2007	1	209	30	57	0	0	168	25	45	0	0	45	5	12	0	0
2007	2	202	28	52	0	0	172	25	45	0	0	42	5	11	0	0
2007	3	181	28	49	0	0	157	25	43	0	0	50	7	14	0	0
2007	4	171	29	45	0	0	146	24	38	0	0	48	7	13	0	0

Year	Q	All farmed salmon, all regions					Atlantic Salmon, all regions					Atlantic Salmon, Discovery Islands area				
		# Fish Tested	# Farms Tested	# Pools/ Agent	# Positive Pools	# Positive Farms	# Fish Tested	# Farms Tested	# Pools/ Agent	# Positive Pools	# Positive Farms	# Fish Tested	# Farms Tested	# Pools/ Agent	# Positive Pools	# Positive Farms
2008	1	132	27	38	0	0	107	23	32	0	0	26	6	7	0	0
2008	2	155	30	44	0	0	122	24	35	0	0	24	7	8	0	0
2008	3	143	29	42	0	0	113	24	34	0	0	33	7	10	0	0
2008	4	158	29	43	0	0	128	24	35	0	0	40	8	12	0	0
2009	1	155	26	40	0	0	134	21	34	0	0	44	7	12	0	0
2009	2	146	29	40	0	0	122	24	32	0	0	43	7	11	0	0
2009	3	141	27	40	0	0	120	23	34	0	0	40	5	9	0	0
2009	4	143	27	38	0	0	137	25	36	0	0	27	4	7	0	0
2010	1	121	25	34	0	0	118	24	33	0	0	18	4	5	0	0
2010	2	0	0	-	-	-	0	0	-	-	-	0	0	-	-	-
2010	3	54	15	-	-	-	54	15	-	-	-	11	3	-	-	-
2010	4	63	13	-	-	-	63	13	-	-	-	19	4	-	-	-
2011	1	69	15	-	-	-	69	15	-	-	-	14	3	-	-	-
2011	2	98	15	26	0	0	83	13	23	0	0	17	3	5	0	0
2011	3	65	17	22	0	0	59	16	20	0	0	12	4	4	0	0
2011	4	126	28	39	0	0	106	25	33	0	0	23	6	8	0	0
2012	1	141	26	39	0	0	131	24	36	0	0	29	6	8	0	0
2012	2	171	29	45	0	0	141	25	38	0	0	19	5	7	0	0
2012	3	170	27	43	0	0	153	23	38	0	0	36	6	9	0	0
2012	4	162	28	44	0	0	137	24	37	0	0	33	6	9	0	0
2013	1	154	28	40	0	0	131	23	33	0	0	13	4	4	0	0
2013	2	165	27	42	0	0	131	22	33	0	0	9	3	3	0	0
2013	3	178	27	46	0	0	146	21	37	0	0	16	3	4	0	0
2013	4	192	27	48	0	0	171	22	42	0	0	15	2	3	0	0
2014	1	181	27	44	0	0	149	21	35	0	0	16	3	4	0	0
2014	2	198	29	51	0	0	180	25	45	0	0	17	4	5	0	0

Year	Q	All farmed salmon, all regions					Atlantic Salmon, all regions					Atlantic Salmon, Discovery Islands area				
		# Fish Tested	# Farms Tested	# Pools/ Agent	# Positive Pools	# Positive Farms	# Fish Tested	# Farms Tested	# Pools/ Agent	# Positive Pools	# Positive Farms	# Fish Tested	# Farms Tested	# Pools/ Agent	# Positive Pools	# Positive Farms
2014	3	232	30	58	0	0	219	27	54	0	0	34	5	8	0	0
2014	4	110	21	30	0	0	103	20	28	0	0	18	4	5	0	0
2015	1	187	29	42	0	0	175	27	39	0	0	28	5	7	0	0
2015	2	223	29	51	0	0	205	26	46	0	0	27	4	6	0	0
2015	3	213	28	51	0	0	203	27	49	0	0	27	5	8	0	0
2015	4	196	28	46	0	0	184	26	43	0	0	21	4	5	0	0
2016	1	151	29	47	0	0	131	26	42	0	0	33	5	8	0	0
Total	**-**	**8318**	**1393**	**-**	**27**	**10**	**6881**	**1152**	**-**	**27**	**10**	**1382**	**240**	**-**	**4**	**1**