AN EVALUATION OF GRIEG SEAFOOD BC AND MARINE HARVEST CANADA'S MARINE NETPEN SALMON OPERATIONS IN BRITISH COLUMBIA, CANADA TO DETERMINE IF THEY ARE COMMITTED TO SUSTAINABLE OPERATIONS

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Executive Summary

The world population has passed 7 billion. Continued improvements in the aquaculture industry are enabling us to balance the growing demand for healthy seafood protein with the need to reduce pressure on wild fish stocks and the environment. Research has shown that escapes, benthic impacts, and chemical inputs at marine netpen salmon farm sites tend to be localized. Feed resources can be an issue, but the amount of wild fish required to feed farmed fish has been greatly reduced, with some companies looking to further minimize wild fish inputs and potentially eradicate them all together. Harmful interactions with marine mammals are also a point of concern, but companies have made measurable progress to minimize their interactions and are continuing to research and develop non-lethal control methods. Disease transmission is a major concern, but there is no definitive link between farmed salmon and disease events in wild salmon, and the presence of non-native pathogens has yet to be confirmed in BC.

Upon further investigation, Seafood for the Future (SFF) has found that Grieg Seafood BC and Marine Harvest Canada are operating responsibly and continue to make measurable progress towards reducing their impacts. This commitment to sustainable performance is validated in their certification by the Global Aquaculture Alliance's BAP—Best Aquaculture Practices. SFF will continue to work with these entities and their cohorts in the BC area to further reduce their environmental footprints.

In the past, SFF has recommended all BC farmed salmon on its "Gold List." Upon further review of the scientific data and information, SFF finds that there is a need for research to fill in the information gaps regarding the potential for disease transmission and to increase the level of transparency regarding this issue. SFF will move the overall recommendation for BC farmed salmon to the "Specific Stock" list until there are more data on the topic. This does not affect SFF's recommendations for Grieg Seafood BC and Marine Harvest as responsible producer partners.

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Preface

This report was written in response to concerns expressed by a number of environmental groups about the impacts that may result from farmed salmon operations in British Columbia, Canada. Specifically, the group inquired about Seafood for the Future's partnership with Grieg Seafood BC's Skuna Bay brand, which expanded to include the program's partnership with Marine Harvest Canada at a later meeting. Among their primary concerns were the spread of disease from farmed to wild salmon, marine mammal interactions, benthic and chemical impacts, and the lack of transparency from the industry and Canadian Government. The letter expressing their concerns is available in appendix I.

Introduction

The world population has passed 7 billion. Continued improvements in the aquaculture industry are enabling us to balance the growing demand for healthy seafood protein with the need to reduce pressure on wild fish stocks and the environment (FAO/NACA, 2012). According to the UN Food and Agriculture Organization (FAO), "Food fish has a nutrient profile superior to all terrestrial meats…In fact, if there is a single food that could be used to address all of the different aspects of world malnutrition, it is fish," (FAO, 2003a). Due to its high levels of heart-healthy Omega-3 fatty acids, salmon are among the healthiest of the fish proteins (Santerre, 2004 and AHA, 2013).

Global aquaculture is the fastest growing food production sector and now accounts for 50 percent of the world's fish consumption. The demand for farmed salmon is growing steadily and production has increased from 299,000 mt in 1990 to 1.9 million mt in 2010, of which 90 percent is Atlantic salmon (*Salmo salar)* (FAO, 2012, 2013a). Canada is the world's fourth largest producer of farmed salmon, with the majority produced in British Columbia, Canada (BC) (BCSFA, 2013).

Salmon farming in BC began with the cultivation of coho (*Oncorhynchus kisutch*) in the early 1970s followed by a shift to Atlantic salmon in the 1980s. In the latter decade there were 101 salmon farming companies operating in BC. As of 2011 only four main companies: Mainstream Canada, Marine Harvest Canada, Grieg Seafood BC, and the Creative Salmon Company, held 130 tenure licenses -- not all of which are active at any one time. According to a 2009 PricewaterhouseCoopers LLP report prepared for BC, the province's salmon aquaculture industry employed 6,000 people both directly and indirectly. The Aboriginal Aquaculture Association reports that First Nations people account for 14.1 percent of the labor force on farms and 36.6 percent at the processing plants (Cohen, 2012a).

As of December 2010 the Department of Fisheries and Oceans (DFO) became the lead agency charged by the Fisheries Act to regulate BC marine finfish aquaculture. The agency does so under the Pacific Aquaculture Regulations (PAR). Health Canada and the Canadian Food Inspection Agency (CFIA) also play critical roles in the regulation of fish health as it pertains to animal welfare on the farm and human consumption. Specific responsibilities are delegated to provincial government agencies where the BC Ministry of Agriculture and Lands (BCMAL) designated the lead agency (Cohen, 2012a).

Seafood for the Future

Seafood for the Future (SFF) is the Aquarium of the Pacific's nonprofit seafood advisory program. Our mission is to promote healthy and responsible seafood choices. SFF does not certify fisheries or aquaculture producers, rather we promote those who are harvesting and/or producing in a responsible manner. To be considered responsible by SFF, the product must be healthy and harvested from a sustainable wild or farmed fishery and also socially responsible. Our program follows strict scientific criteria to ensure that humans, the environment, and marine life are all part of the equation.

The Aquarium of the Pacific and SFF support responsible offshore aquaculture, both finfish and shellfish, by companies that are on, or that demonstrate a commitment to, a sustainable trajectory to producing seafood. Environmental sustainability, as defined by SFF, does not require zero measurable impact, so long as the impacts are small, not irreversible, and steps are being taken to further reduce impacts through best management practices (BMPs).

When evaluating potential aquaculture partners, SFF evaluates a facility's daily inputs/outputs, compliance with existing regulations, community/employee relations, and what steps the company is taking to go above industry standards to minimize its environmental impact and improve social welfare in its local community. While site visits are ideal, SFF is a nonprofit organization with a limited budget, so site visits are not always feasible. SFF did, however, conduct site visits to the two producers included in this report—Grieg Seafood BC and Marine Harvest Canada.

Grieg Seafood BC (Skuna Bay)

Skuna Bay is the premium brand of Grieg Seafood BC (Grieg Seafood) that represents only the top 6 percent of the company's production in BC. Grieg Seafood owns the tenures to 21 sites, at which it produces an average of 14,000mt annually (Skuna press release, appendix IV), making it the third largest producer in the region (DFO, 2012d). The company has its own hatchery and freshwater and saltwater facilities. Grieg Seafood employs 77 full-time BC residents and supports another 110 full-time jobs at the fish processing plant Walcan Seafood Ltd., with which it contracts to process its salmon (BCSFA, 2013b). Grieg Seafood BC was the first company globally to achieve multiple-site Best Aquaculture Practices (BAP) certification from the Global Aquaculture Alliance and in the past year all of its harvested fish were BAP certified.[1]

Grieg Seafood BC approached SFF about a potential partnership with their Skuna Bay product line in the fall of 2011. After evaluating and visiting their operations in BC, SFF determined that Grieg Seafood BC was operating on a responsible trajectory toward sustainability. Grieg has been transparent from the beginning and has cooperated with all SFF's requests for information, including its Best Management Practices, Fish Health

[1] Skuna Bay Salmon Earns BAP Certfication: http://www.seafoodsource.com/newsarticledetail.aspx?id=13613

Management Plan, and Best Aquaculture Practices Certification Audits for each site (see appendix II).[2]

In February 2012 Grieg Seafood BC became an approved partner of SFF after an evaluation and onsite inspection to determine if the company's operations met the sustainability criteria of the program. In June 2012 Grieg Seafood BC became a paid, one-year sponsor of the SFF program. In exchange, Grieg Seafood was provided standard sponsor benefits as well as a series of research papers to be undertaken by the Aquarium with formal outside peer review with the intent of improving their operations. The sponsor agreement states that sponsorship of SFF has no relation to Grieg Seafood's evaluation and partnership status in the program and that it must continue to meet the strict standards and criteria of the program. SFF is a nonprofit program that relies on fees charged to its partners and outside funding and sponsorships to maintain and further its efforts to promote healthy and responsible seafood. Any funds and/or sponsorships given to the program are clearly stated and enforced to have no bearing on the scientific decision-making process on issues of sustainability for SFF.

Marine Harvest Canada

Marine Harvest Canada is the largest producer of salmon in BC with 38 active sites and an annual production over 45,000mt. The company is vertically integrated with its own freshwater and saltwater production facilities and a processing plant. Marine Harvest Canada employs more than 500 people and is BAP certified (BCSFA, 2013b).

In 2010 the SFF team evaluated and conducted a site visit to a Marine Harvest Canada farm site in BC and found that its operations were responsible according to SFF criteria. Marine Harvest did cooperate with SFF's request for updated information (see appendix III).

Disease and Sea Lice

The transmission of disease from farmed salmon to wild salmon populations is a concern of scientists, environmental nonprofit groups, fishermen, First Nations groups, and the farmers (Kent, 2010, 2011; Côté et al., 2012; Kibenage et. al., 2012; and Cohen, 2012a,b,c). The aquatic environment poses unique challenges for controlling disease transmission (Kibenage et. al., 2012) and little is known about the transfer of pathogens and sea lice affecting wild salmon in the marine environment (Kent, 2011). According to Dr. Michael Kent, Professor at the College of Veterinary Medicine at Oregon State University, "The state of the science for understanding the impacts of pathogens on wild salmon in British Columbia is minimal, particularly compared to our understanding of diseases in salmon and trout in public or private aquaculture," (Kent, 2011).

In the three-year, $26 million Cohen Commission Inquiry into the Decline of Sockeye Salmon in the Fraser River, experts were asked to testify as to whether or not farmed salmon pose a direct threat to the Fraser River sockeye (*Oncorhynchus nerka*). Some

[2] SFF does have copies of Grieg Seafood BC's Best Management Practices, Fish Health Management Plan, Standard Operating procedures, and Best Aquaculture Practices Certification audits for reference, but these documents are confidential and will not be shared with the public.

experts found that salmon farms could pose a significant risk (Connors, 2011 and Dill, 2011), while others determined that the risk from salmon farms in BC is minimal (Noakes, 2011 and Korman, 2011). There was much disagreement on the issue, but there was also a consensus that there is no conclusive evidence to directly link farmed salmon to disease in wild salmon and that more research is necessary to definitively determine causality (Cohen, 2012a and Kent, 2012). The same holds true for the other research (Ford and Meyers, 2008; Connors et al., 2010, 2012; Kent, 2010; Marty et al., 2010; Saksida, 2006; Saksida et al., 2007, 2010, 2011; Johansen et al., 2011; Côté et al., 2012; and Kibenage et al., 2012).

In addition to the need for more research, many studies have suggested that improved husbandry, treatment, and siting regulations may be able to minimize the potential for marine netpen salmon aquaculture to spread disease in BC (Noakes et al., 2000; Hilaire et al., 2002; Saksida, 2006, 2007, 2010, 2011; Ford and Meyers, 2008; Johansen et al., 2011; and OIE, 2012a,b). Overall, there is a statistically significant declining trend in the number of high-risk diseases reported by the industry in BC (Korman, 2011).

A snapshot of BC salmon farm disease history

Diseases of major concern to wild salmon that have been confirmed in BC include: infectious hematopoietic necrosis virus (IHN), infectious pancreatic necrosis (IPN), furunculosis, and bacterial kidney disease (BKD). The latter two are high-risk bacterial pathogens that have not been found in wild salmon. IHN on the other hand, is lethal to sockeye fry and may present a risk to sockeye in the ocean (Kent, 2011).

The IHN virus has caused multiple outbreaks in BC marine netpen salmon farms (Hilaire et al., 2002; Saksida, 2006; and Kent, 2011). Outbreak events between farms in 1992-1996 were studied by Hilaire et al. (2002) and later compared to the 2001-2003 epidemic by Saksida (2006). Both studies indicated that farm-to-farm transmission due to poor biosecurity measures and mixing year classes were likely to blame for the spread. In her comparison of the two events, Saksida was able to show that the intensity, distance, and duration of the 2001-2003 outbreak was greatly reduced at affected farms from the 1992-1996 epidemic and concluded that the result was likely due to improved farming practices (Saksida, 2006).

Until recently, all of the virulent infections reported by BC salmon farms were endemic to Pacific salmon (Kent, 2011 and Côté et al., 2012). In the fall of 2011 a “positive” result for infectious salmon anemia (ISA) in samples from juvenile wild salmon in BC was detected by two non-governmental laboratories (Cohen, 2012a). Previously, the ISA virus had never been detected in the Pacific Northwest, but it has contributed to devastating losses on Atlantic salmon farms in Europe, Chile, Maine, and New Brunswick, Canada. The economic losses have been significant (Task Force, 2012). According to the world’s leading expert on ISA, Dr. Are Nylund, the virus can multiply on a farm for years, depending on husbandry practices (Cohen, 2012a). Unlike Atlantic salmon, laboratory research suggests that Pacific salmon may be resistant to the alien virus, although the potential for the virus to adapt to Pacific salmon should not be ignored (Dr. Kibenage testimony, Cohen, 2012a).

Confirmation of ISA is a complicated matter. A single "positive" result does not confirm the presence of the disease. Canadian protocol requires that the samples be tested in a CFIA-approved test facility to confirm the presence of ISA and other reportable diseases. These facilities and testing methodologies are internationally recognized by the Office International des Episooties, or the World Organization for Animal Health (OIE) and the US (Cohen, 2012a and Task Force, 2012). The CFIA was unable to confirm the presence of ISA in the samples from the wild salmon samples that initially tested positive at the non-governmental laboratories (Cohen, 2012a; Task Force, 2012; CFIA, 2012b; and OIE 2012c). There has been a lot of controversy surrounding both sets of results as well as the validity of the samples used and the tests performed by both parties (Cohen, 2012a; CFIA, 2012b; and OIE 2012c). US agencies in the Federal Aquatic Animal Health Task Force (Task Force) are working closely with Canada to understand what happened and how the CFIA handled the matter (Task Force, 2012).

Sea lice on BC salmon farms

Sea lice is a common parasite of adult Pacific salmon in the coastal ecosystem (Nagasawa, 2001 and Beamish et al., 2005, 2007). Studies have shown that these parasites can contribute to wild salmon mortality (Krokošek et at., 2012) and that salmon farms may increase the likelihood of juvenile salmon contracting unnaturally high numbers of the potentially deadly sea lice (Kent, 2000; Björn et al., 2001; Butler 2002; Heuch et al., 2005; Krokošek et at., 2012; Côté et al., 2012; and Cohen, 2012b). However, Marty et al. (2010) determined that farm sea lice levels are not a good predictor of wild salmon survival.

Research regarding the two most common sea lice in British Columbia, *Lepeophtheirus salmonis* and the less prevalent *Caligus clemensi* have shown that the abundance of sea lice on wild Pacific salmon in salmon farming areas in BC is similar to that in control areas away from the farms (Nagasawa, 2001 and Beamish et al., 2005; 2009). Saksida et al. (2007) also found that sea lice levels in BC are lower than those observed in other areas and the pathenogenic impact of *L. salmonis* in BC appears to be less.

An average of 30,000 farmed Atlantic salmon were examined per year between 2004 and 2010 to quantify lice abundance in BC. The average over all years and all seasons was 1.7 motiles/fish and there was a decline in abundance from 2004-2010 (Korman, 2011).

Aquaculture regulations in BC: Disease and sea lice

Disease

The primary legislation governing the health of farmed salmon in BC are the Health of Animals Act and the Fisheries Act, which charge the CFIA and DFO respectively as the lead agencies (Cohen, 2012b). The Health of Animals Act was amended to include aquatic animals in 2010. It addresses reportable diseases that are significant to Canadian trade, including ISA, IHN, IPN, and viral haemorrahagic septicaemia (VHS) (CFIA, 2013). As of December 2012 the Act also requires that shipments to the US are accompanied by an import permit issued by the CFIA as well as a health certificate from the US Animal Plant Health Inspection Service (Task Force, 2012). There have been no salmon egg imports to Canada since 2009 (DFO, 2012c).

The National Aquatic Animal Health Program (NAAHP) is co-administered by the CFIA and DFO to regulate aquatic animal health as per the Health of Animals Act. Its standards are consistent with those of the OIE to address aquatic animal diseases of finfish, mollusks and crustaceans (Cohen, 2012b). Canada is one of 28 member states of the OIE, (Cohen, 2012b). As a member, Canada is expected to:

- Publish standards on animal health, welfare, and food safety
- Collect, analyze, and disseminate animal health information
- Report outbreaks of OIE-listed diseases (Canada only reports "confirmed" cases)

Interprovincial transfers of aquatic animals, including farmed salmon and salmon eggs, are regulated by the DFO under the Fish Health Protection Regulations, which certify that the fish are free of listed diseases prior to transfer.

Under the Fisheries Act, the DFO enforces the PAR to control, monitor, and report the presence of disease in aquaculture facilities. Among the licensing requirements listed in PAR are the creation and implementation of a Fish Health Management Plan (FHMP). The FHMP is reviewed annually by the DFO to ensure that it includes protocols to:

- Control and monitor the presence of pathogens and pests
- Give notice to the minister before a substance is used to treat the fish, fish are transferred (routine transfers w/in "salmonid transfer zone") or fish are harvested
- Keep records in relation to:
    - Any diagnosis or treatment of a fish pathogen or pest present in the facility
    - Any substance used to treat fish including quantity and date and method of administration
    - Number and species of fish that die prior to harvest and the cause of death
    - Data collected in the monitoring of the environmental impact of the facilities operations

All farms must monitor and report the health status of their fish to the DFO and CFIA on a monthly basis (Korman testimony, Cohen, 2012b). In the event that a positive result is found for a reportable disease, the CFIA will require a quarantine and additional testing at a DFO or CFIA-approved laboratory. If the outbreak in question is ISA, then the sample will have to go to an OIE National Aquatic Animal Health Laboratory System laboratory to confirm the positive (CFIA, 2012a). If the positive result is replicated, salmon farms in BC are required to humanely cull their entire cohort to minimize the risk of spreading it to wild populations and/or neighboring farms (CFIA, 2012a and Cohen, 2012a).

Sea lice

Since 2003 all marine netpen finfish producers in BC are required to sample and report sea lice abundances monthly. As per the PAR, reports go to and are made public by the DFO. Prior to the PAR, reports were made to the BCMAL (DFO, 2011a). The PAR requires that farms conduct sea lice sampling at the following intervals:

- 1x/month from July 1st – February 28th

    - In the event that the abundance levels reach three or more motiles (free-moving life stages of *Lepeophtheirus salmonis)* per salmon, the frequency is to increase to 1x/2 week period.
- 1x/2 weeks from March 1st – June 31st , during the wild smolt outmigration
    - If the sampling results in three or more motiles during this period, management measures must be taken to reduce levels within 15 calendar days of the results and the results must be reported to the DFO within five days of discovery.

All of this information is reported to the Fish Health Database as a requirement of the FHMPs under the PAR. In the event that the trigger level of three or more motiles is reached, the facility is required to take one of the following actions:

- Monitor more frequently
- Harvest the most affected fish
- Therapeutic management
- Apply other farm husbandry techniques to reduce the abundance of sea lice

During the period of smolt outmigration, however, quick mitigation is necessary and therefore only therapeutic or harvest options are available (BCMAL, 2008).

In addition to the monthly and sometimes bimonthly sea lice audits conducted and reported by the industry, the DFO conducts random statistical samples. As of 2012, the DFO has stated that it plans to target 50 percent of the active Atlantic salmon farms in BC for audits during the outmigration months in which juvenile wild salmon are most vulnerable to transfer (DFO, 2012). According to Saksida et al. (2007), the majority of estimates provided by industry are actually higher than levels determined by the government audits, providing strong evidence that the sea lice levels reported by the industry are a valid reflection of sea lice levels.

In the event that treatment is deemed necessary, SLICE® (emamectic benzoate) is the only in-feed therapeutant approved to treat fish for sea lice in BC. The treatment can only be administered by a registered veterinarian to ensure proper dosage. Research shows that the dosages currently administered in BC have limited impacts (Waddy et al., 2007 and Kuo et al., 2010) and that levels retained in the flesh and skin are well below Health Canada guidelines (Whyte et al., 2011). Emamectin benzoate can impact invertebrates in the benthic community, but studies have failed to detect toxic effects on invertebrates near farms using the treatment in BC (Willis et al., 2005 and Tefler et al., 2006). There are concerns that sea lice will develop a tolerance for the treatment (Cohen, 2012b), but Saksida et al. (2010) found that SLICE® is still an effective treatment in BC.

According to Dr. Sonja Saksida, BC salmon farms treat much less than other jurisdictions, usually no more than two times a production cycle, and some never have to treat because they never reach the trigger point (Saksida testimony, Cohen, 2012a). Further, many experts agree that improved husbandry practices such as fallowing and keeping single-year classes at each site will help if there is cooperation among all the farms in the area (Cohen 2012a and Saksida 2010,2011).

Transparency in BC salmon farm disease reporting

Among the major concerns regarding disease transfer from farmed salmon to wild salmon is the lack of transparency by the industry and the government. There is limited information on disease events as they occur in the BC area. The BCSFA Fish Health Database includes information on the fish health subzone, species, year class, disease, and count of new, recurring, and relapsing events. The information is available through the BCMAL, but only through 2010 (BCMAL, 2012).

While current information is not readily available to the public, the PAR and FHMPs require the farms to report required data to the database on a monthly basis (DFO, 2011a). It should also be noted that when Dr. Saksida asked for sensitive information about the IHN outbreaks from 1992-1996 and 2001-2003, she received 100 percent compliance from the infected farms (Saksida, 2006). For the purposes of this report, SFF received all of the information requested, including highly sensitive proprietary information, from Grieg Seafood BC and also the majority of requested information from Marine Harvest Canada.

The power of today's media, internet, and social media cannot be discounted when discussing the issue of transparency. Most of the incidents listed below can be found by a Google search. They are also available, albeit to a limited extent, in each of their parent company's quarterly reports (Grieg Seafood, 2012 and Marine Harvest, 2012).

Grieg Seafood: Disease history and management

Disease

In compliance with the PAR, Grieg Seafood's fish health is regularly monitored by a licensed veterinarian as per the FHMP. The fish are monitored daily by trained on-site staff and inconsistencies are reported to Fish Health Staff. To maintain fish health, the company keeps single year classes at it sites, fallows sites between harvest and restocking, keeps densities low, regularly removes dead fish, and coordinates with neighboring farms under an area-based management plan to minimize any potential cross-contamination.

In 2012 a sample from a Grieg Seafood BC farm tested positive for IHN. The company immediately took action, putting the facility in quarantine until the positive was confirmed on August 7th and the cohort was humanely culled on August 9th and properly disposed of to destroy the virus (Stewart Hawthorn, Grieg Seafood BC, personal communication, 2012).[3] After the outbreaks, Grieg Seafood was among the farmers in the area that agreed to up their use of the IHN vaccine, APEX IHN.[4] The company previously chose not to use the vaccine due to the fact that there had not been any outbreaks for nine years and they wanted to minimize chemical inputs in its fish (Stewart Hawthorn, Grieg Seafood BC, personal communication, 2012).

[3]Grieg Confirms IHN Virus at Canada Site: http://www.intrafish.com/global/news/article1353944.ece
[4] BC Salmon Farmers Agree to 100% IHN Vaccination: http://www.intrafish.com/global/news/article1360421.ece

Later in 2012 there was a furunculosis outbreak in its hatchery. The infected fish were immediately culled and properly disposed of and the hatchery was disinfected (Stewart Hawthorn, Grieg Seafood BC, personal communication, 2013).[5]

In December 2012 Alexandra Morton, BC biologist and anti-salmon farming activist submitted Grieg Seafood BC samples for testing to an OIE reference lab, presumably from a grocery store (Welch, 2012). The preliminary results indicate that the sample tested positive for the ISA virus. The CFIA advised Grieg Seafood that they are not going to pursue further testing because they have determined that the chain of custody for the initial samples was unverifiable and the farm origin cannot be proven (Stewart Hawthorn, Grieg Seafood, personal communication, 2013).

Sea lice

In addition to the above requirements, Grieg Seafood BC requires sampling of treated pens two and five weeks post treatment to ensure efficacy.

Upon review of the DFO's Sea Lice Counts from Jan 2011-June 2012, Grieg's motile abundance breached the trigger only once and at only one location. The breach was included in the July-September 2011 report, after the peak juvenile outmigration. Management action was reported (DFO, 2012).

Coordinated farm management

In locations where Grieg Seafood shares coastline with other companies, the sites are in close communication regarding fish health management and to coordinate sea lice treatments. Elsewhere, Grieg Seafood farms carefully coordinate stocking, lice treatments, health management, plankton monitoring, harvest, and fallowing.

Marine Harvest: Disease history and management

Disease

In addition to regular fish health monitoring by a licensed veterinarian as per the FHMP and biosecurity requirements under the PAR, Marine Harvest keeps single-year classes at its sites; fallows between harvest and restocking at each site; and coordinates treatments, fallowing, and restocking with neighboring farms under an area-based management plan. In addition, they are participating in a study to monitor pathogen and parasite interactions between wild and farmed salmon in the Broughton Archipelago. Marine Harvest was the first BC production company to vaccinate its fish using all available, efficacious vaccines (vibriosis, furunculosis, and IHN). The vaccines are administered at the hatchery when the fish are a minimum of 20 grams in size and at least four to six weeks prior to transfer to a saltwater net-pen site. No diseases were reported.

Sea lice

[5] Disease Problems in UK, Canada force Grieg to $15.7 million write-down: http://www.intrafish.com/global/news/article1362301.ece

Marine Harvest samples and reports sea lice abundance as per the PAR. The company has also partnered with the DFO and other parties in multi-year research projects to monitor sea lice levels on wild salmon in their Klemtu and Broughton Archipelago production areas.

Upon review of the DFO's Sea Lice Counts from Jan 2011-June 2012, Marine Harvest had 51 reports of counts above the trigger level of three motiles. Ten of these incidents were recorded during the outmigration period for wild smolts and appropriate management actions were carried out (DFO, 2012).

Coordinated farm management

In locations where Marine Harvest shares coastline with other companies, the sites are in close communication regarding fish health management and to coordinate sea lice treatments. Elsewhere, Marine Harvest farms carefully coordinate stocking, lice treatments, health management, plankton monitoring, harvest, and fallowing.

Discussion

The many unknowns surrounding the potential for salmon farms to transmit disease and increase the likelihood of accelerating the decline in wild stocks is a real concern that cannot be underestimated. However, there are many unknowns associated with disease transmission in the marine environment and there is no conclusive evidence to make a definitive link between farmed salmon and disease in wild salmon. What is fairly certain is that improved husbandry and biosecurity measures currently practiced by the industry in BC have minimized the occurrences of sea lice and infectious disease in the farmed stocks (Noakes et al., 2000; Hilaire et al., 2002; Saksida, 2006, 2007, 2010, 2011; Ford and Meyers, 2008; Johansen et al., 2011; and OIE, 2012a,b). All of the researchers of Technical Report 5 of the Cohen Commission Inquiry (Dill, 2011; Noakes, 2011; Connors, 2011; and Korman, 2011) agreed that, if fish farms are the point source, then the pathogens should be detectable on farms and therefore record keeping and fish health management procedures can minimize the transfer of pathogens to wild fish. They also agreed that proper management could enable farmed and wild salmon to coexist. They did, however disagree on what constitutes "proper management" (Cohen, 2012a).

Recent "positive" results for ISA are a concern, but they have not been confirmed (CFIA, 2012b). The OIE Reference Laboratory for ISA at the Atlantic Veterinary College that conducted the 2011 tests is under investigation by the OIE for misconduct. A decision as to whether or not the laboratory will retain its credentials will be determined in May 2013 (OIE, 2012c). Meanwhile, testimonies by the world's leading experts at the Cohen Commission Hearings (Cohen, 2012a) and the OIE (2012a) confirm that the results are difficult to replicate and there are many variables that can lead to false positives or negatives in association with the current testing methods.

According to Alexandra Morton, the CFIA did not report initial "positives" discovered in 2009 (Welch, 2012). While they should have been reported, Canadian policy is to run the mandatory secondary testing via OIE and US-approved testing methods to confirm the positive before notifying the public (CFIA, 2012a). This policy is sanctioned by the OIE (Task Force, 2012). Given that there have been no signs of the disease in the highly

susceptible farmed Atlantic salmon since 2002, it is likely that the government laboratory did not reproduce the positive.

The ISA virus has lethal effects on Atlantic salmon and has devastated billions of dollars worth of fish elsewhere in the world. In 2007 the ISA virus was reported in Chile and cost the industry more than $2 billion in losses and 26,000 workers were laid off. Imported eggs from Norway were likely the culprit (Barrionueve, 2011). Based on this information, it does not benefit the farmers to not act upon learning of a preliminary "positive" result if it should occur in regular testing. It is also likely they would not want to make the information public, but the law states that upon confirmation from secondary testing, they would have to do so. There is no proof of whether or not this has happened and been covered up, however there have been no signs of the ISA virus in BC farmed salmon (Kent, 2012 and Stewart Hawthorn, Grieg Seafood BC, personal communication, 2013).

Further, there have been no salmon egg imports since 2009 (DFO, 2012c). According to Waknitz et al. (2003), Atlantic salmon cannot be a vector of exotic disease without the importation of eggs with an eggs-only policy in place. This was recently reaffirmed by Dr. Kent who also stated that prior to 2009 the DFO's egg importation was a "very rigorous program" (Cohen, 2012a).

Grieg Seafood

There have been two conclusive positive results at Grieg Seafood facilities in recent years, but their response was quick and transparent. In both cases, SFF received emails and media statements explaining the issue and what steps were being taken to resolve it. In the event that the initial "positive" was confirmed, Grieg Seafood took appropriate steps to minimize the risk of spreading the disease to the neighboring ecosystem. SFF was also made aware of the potential "positive" for the ISA virus from the Morton samples. Grieg Seafood implements BMPs to minimize impacts from such events.

Marine Harvest

SFF has no record of disease outbreaks in recent years at Marine Harvest farms. The company was the first to use all available vaccines to prevent such incidents and implements BMPs to minimize the occurrence of disease events.

SFF Conclusion: Grieg Seafood has experienced outbreaks and in every case reported, taken timely and responsible action to minimize the spread to neighboring farms and wild fish. It has also informed SFF of confirmed and potential "positive" cases. Both Grieg Seafood and Marine Harvest have taken appropriate steps to minimize the occurrence and/or transmission of harmful pathogens and parasites. SFF will work with Marine Harvest to improve the level of transparency and continue to work with Grieg Seafood so long as they remain transparent and continue to show responsible actions to minimize the spread and occurrence of disease at their facilities.

Marine Mammal Interactions

Marine netpen salmon production has increased in BC over the last few decades. At the same time, harbor seal (*Phoca vitulina*) and California sea lion (*Zalophus californianus*) populations have also increased (DFO,2012b and Caretta et al., 2011). These animals are smart and opportunistic predators that likely look at the captive salmon as a ready food source (DFO, 2012b and Nash et al., 2000). Despite the increased probability of interaction between salmon farms and the opportunistic predators, marine mammal conflicts at BC salmon farms have significantly decreased over the past decade (DFO, 2012b).

Aquaculture regulations in BC: Marine mammal interactions

In BC, marine mammal interactions with marine finfish netpen aquaculture are regulated by the DFO under the Fisheries Act, Marine Mammal Regulations, and the PAR. These regulations are designed to minimize conflict with marine mammals in the industry by encouraging passive deterrent methods (DFO, 2012b). As of March 15, 2012 the DFO requires that all BC marine netpen farms submit a Marine Mammal Conflict Mitigation Plan, which is intended to describe the policies, procedures, and infrastructure improvements implemented at each facility to minimize harmful interactions with marine mammals (DFO, 2011a). To ensure compliance, DFO biologists conduct site visits. Due to the potentially detrimental effects on the local cetaceans, acoustic deterrent devices are prohibited (DFO, 2012b).

Among the deterrent methods required by the DFO are:

- Regular removal of dead fish and proper storage of food and garbage to minimize predator attraction
- Secondary predator exclusion nets used from October to May (peak seal and sea lion presence in BC)
- Mesh size that is selected to deter predators, but avoid entanglement
- Nets must be continually monitored to ensure that they remain taut to provide the most effective barrier

In the event that all of these efforts fail to deter a habor seal or California sea lion that presents an "imminent danger to an aquaculture facility or to human life," the animal can be lethally removed by a licensed employee or contractor (DFO, 2012b). California sea lions and seals throughout the Pacific have become less frightened of humans and tend to exhibit bolder behavior (Nash et al., 2000). Some pinnipeds have exhibited territorial behaviors over a preferred food source and can create dangerous working conditions for divers (Nash et al., 2000 and Stewart Hawthorn, Grieg Seafood, personal communication). If lethal removal is deemed necessary, a full report must be submitted to the DFO within seven calendar days. For species other than harbor seals and California sea lions, facilities must obtain a special permit for lethal removal (DFO, 2012b). There have been no recorded stellar sea lions put down by means of lethal control since they were listed as a Species of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2003 (DFO, 2012b). New and improved regulations with a focus on passive deterrent methods have greatly reduced the number of lethal conflicts over the past decade (Fig 1).

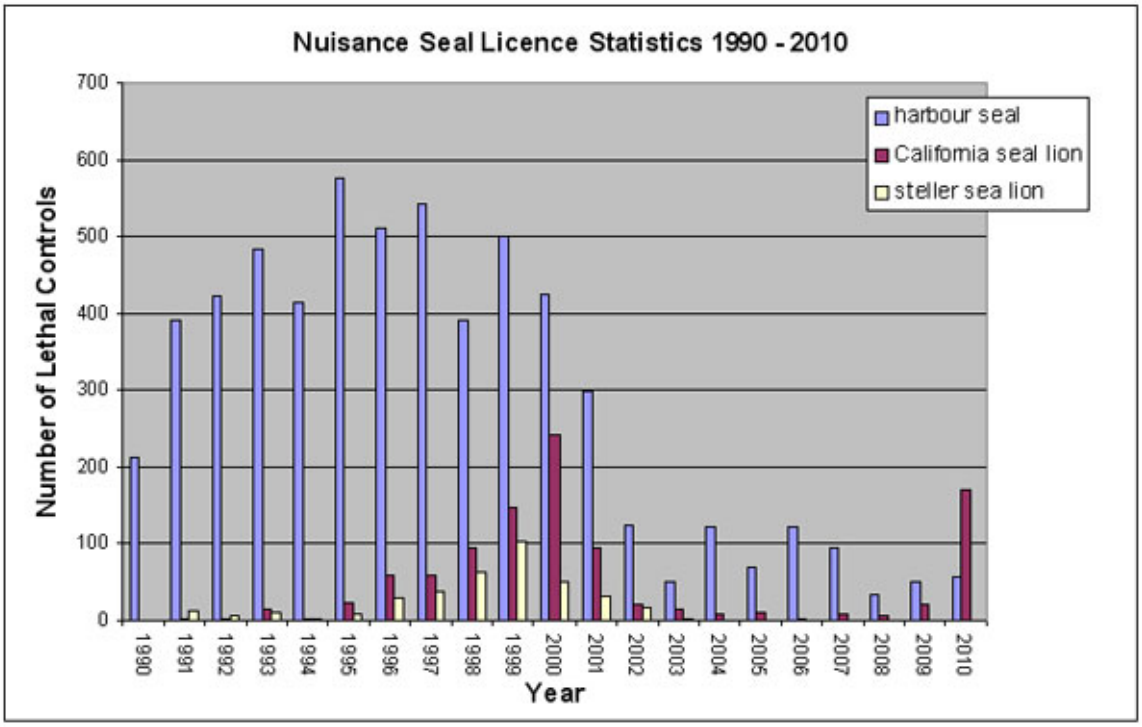

Fig. 1 DFO Licenses for lethal removal of seals and sea lions (DFO, 2012b). Note: production was 12,946mt in 1990 (Noakes, 2002) and 74,880mt in 2010 (DFO, 2011b).

Not all marine mammal mortalities at marine finfish facilities are intentional. Seals and sea lions are strong, intelligent, and persistent animals. Occasionally those traits combine with the determination to feast on a seemingly easy target and they make their way through the predator nets designed to keep them out. As a result, some get trapped and do not make it out and they drown. The DFO requires that these accidental drownings be reported upon discovery of the mortality followed by a written report within seven days of the initial notification (DFO, 2011a).

Grieg Seafood: Marine mammal interactions and management

Marine mammal interactions

In 2010 65 California sea lions and four harbor seals were reported as accidental drowning mortalities at three Grieg Seafood BC salmon farm sites. According to Stewart Hawthorn, managing director of Grieg Seafood, the 2010 incidents were the result of an increase in sea lion populations in the BC area and miscommunication with the contractors in charge of installing the nets (Stewart Hawthorn, Grieg Seafood, personal communication).

As per Canadian law, the drownings were reported to the DFO within 24 hours followed by written reports within seven days. The reports were made public in the DFO's quarterly reports on marine mammal accidental drownings. Grieg was later charged by the DFO under Section 32 of the Fisheries Act for these incidents. On January 21, 2013 Grieg announced that the charges had officially been dropped. In exchange for its participation in a community-based restorative justice process involving multiple

stakeholders including representatives from the First Nations, academic, and nonprofit communities, the DFO and the Crown deemed the charges unnecessary and dropped them (Skuna press release, appendix IV).

Prior to these events, Grieg had never experienced a drowning at any of its sites in its 10 years of operations (Skuna press release, appendix IV), and there were no incidents in 2011 (DFO, 2012b). In 2012 there were four accidental drowning incidents, two harbor seals, one California sea lion, and one unidentified species (the specimen was too decomposed to determine the species).

In 2011 Mr. Hawthorn authorized the removal of four seals and four sea lions by means of lethal control. He explained his decision in the following statement:

> "After many months of employing contract divers to adjust and re-set fish nets and predator nets to prevent the seals and sea lions from killing our stock we resorted to culling of these animals. This was only done after several months of attempting to exclude them passively and only after the divers reported that they were being targeted with aggressive behavior by the animals concerned." (Stewart Hawthorn, Grieg Seafood BC, personal communication).

Marine mammal management

Grieg Seafood's BMPs for Predation Management state that:
"Predation management will be conducted in such a manner as to ensure human safety, to minimize the attraction of animals to farm stock, and to minimize the need for lethal control." Grieg has ensured the restorative justice committee that they will continue to modify and adapt new and improved netting and designs and share its experiences to establish marine mammal BMPs with other farms and facilities (Skuna press release, appendix IV).

Marine Harvest: Marine mammal interactions and management

Marine mammal interactions

In 2011 Marine Harvest authorized the control of 173 California sea lions and 56 harbor seals. There were no accidental drownings in 2011. According to Marine Harvest, the numbers of seal and sea lion presence in 2010/2011 were higher than normal and in order to protect the structural integrity of their facilities, they authorized the control of the animals. The lethal control authorizations for 2012 were much lower at four California sea lions and one harbor seal. There was one California sea lion and six harbor seals that accidentally drowned at Marine Harvest sites in 2012 (DFO, 2012b).

Marine Mammal management

Marine Harvest is in compliance with regulations under the PAR and since September 2011 has made it company policy that lethal control is a last resort after all passive methods have failed and the animal continues to be a threat to human safety and/or the structural integrity of the containment structure. Also, in response to increased interactions in 2011, the company has successfully employed a variety of new

containment and barrier technologies to minimize predator interactions at their sites (Marine Harvest, appendix III).

Discussion

Any marine mammal mortality due to human-related activities is significant and SFF does not take this issue lightly. The rapid expansion of aquaculture to meet the needs of the growing human population and the increase in marine mammal populations will lead to an increase in interactions. Some of the best managed fisheries in the US and arguably the world that are ranked as a "Green Best Choice" option by some of the top seafood advisory programs[6] are listed as Category II fisheries under the NOAA Fisheries Service's List of Fisheries. Category II fisheries result in the mortality or serious injury of between 1 percent and 50 percent of the species' potential biological removal rate (PBR), or the number of individuals that could be removed from the population and allow the species to remain at sustainable levels. In the event that there are multiple marine mammals affected, the fishery will be ranked according to the stock from which it takes the highest percentage of the PBR (NOAA Fisheries, 2012a).

The primary species of concern regarding harmful interaction with BC salmon farms are the harbor seal and California sea lion. The BC harbor seal stock PBR estimate is 6,300[7] and the California sea lion PBR estimate is 9,200 (Pacific coast from Baja Calfornia to BC)[8] (Olesiuk, 2010 and Carretta et al., 2011). In 2011 the total harbor seal and California sea lion interactions with the BC marine finfish netpens would have put the industry into a Category II fishery at 1.13 percent of the harbor seal and 2.47 percent of the California sea lion PBRs. If listed as a fishery in the US, Grieg Seafood and Marine Harvests data from 2008-2012 indicate that both companies would fall into the low end of a Category II fishery for harbor seal and California sea lion interactions. Just as US fisheries managers are working to minimize interactions in wild-capture fisheries, Grieg Seafood BC and Marine Harvest Canada are on the trajectory to fall into a Category III fishery, meaning they will interact with less than one percent of the PBR for harbor seals and California sea lions in a year (see appendix V).[9]

Interactions with the endangered stellar sea lion have also been reported in the past, but there have been no recorded incidents by means of lethal control since stellar sea lions were listed as a Species of Special Concern by COSEWIC in 2003. There are no recorded lethal controls or drowning incidents involving stellar sea lions at Grieg Seafood or Marine Harvest sites. In the Q2 2012 Accidental Drowning report, there was a specimen

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[6]Sea Choice: http://www.seachoice.org/search-fish/5/?q&r%5B0%5D=1
Seafood Watch: http://www.montereybayaquarium.org//cr/SeafoodWatch/web/sfw_factsheet.aspx?gid=49
Blue Ocean Institute: http://blueocean.org/seafoods/?seafood-search=salmon&x=-831&y=-697
SFF Gold List: http://seafoodforthefuture.org/recommendations/

[7] Rough estimate based on NOAA Fisheries' data for calculating PBR (Wade, 1998) and the 2009 BC harbor seal stock assessment (Olesiuk, 2010).

[8] The BC harbor seal population is considered a separate stock from others in the Pacific Northwest, while the California sea lion population is considered one stock throughout the Pacific coast (Carretta et al., 2011).

[9] Calculations based on data from the DFO's Quarterly Reports on Marine Mammal Interactions (DFO, 2012b) and information provided by Grieg Seafood and Marine Harvest.

that was reported by Grieg Seafood as unidentifiable due to decomposition and therefore cannot be ruled out as a potential stellar (DFO, 2012b).

Grieg Seafood

Aside from the incidents in 2010, Grieg Seafood had no reported accidental drownings and the numbers show that the company has taken effective steps to minimize lethal control interactions. Grieg Seafood BC has handled marine mammal interactions responsibly.

Marine Harvest

Marine Harvest is in compliance with local regulations and has no record that they have had interaction by means of lethal control or accidental drowning with the stellar sea lion. The company recognized the increase in interactions in 2010/2011 as "unacceptable" and has taken steps to minimize future interactions, including the addition of more internal authorization protocols for lethal control (Marine Harvest, appendix III).

SFF Conclusion: Grieg Seafood and Marine Harvest have taken responsible action to minimize their interactions with marine mammals. SFF will continue to work with both companies to further avoid these incidents.

Benthic and Chemical Impacts

Salmon farms can create effluents in the form of feed, feces, and dead fish as well as residue from pesticides, antibiotics, and other chemicals that can negatively impact the benthic communities below them (Brooks and Mahnken, 2003a; Nash, 2003; Burridge et al., 2010; Torrissen et al., 2011; and Dill, 2012). In BC, these impacts tend to be localized (Brooks et al., 2003; Brooks and Mahnken, 2003; and Côté et al., 2012). Chemical and biological remediation has been shown to occur naturally during fallow periods (Brooks and Mahnken, 2003a). Fallowing, coupled with improved farming, and siting practices have minimized the impacts in the BC area (Brooks and Mahnken, 2003b; Carroll et al., 2003; and Nash, 2003). Feeding methods and technologies have also advanced in recent years to minimize waste (Torrissen et al., 2011). Many of the farms use computerized systems to drive automated feeding systems, with feedback mechanisms to detect when fish have finished feeding. This allows fish to be fed to satiation without overfeeding and consequent feed wastage (FAO, 2013).

Chemicals used on BC salmon farms

Therapeutants

Antibiotic use in salmon aquaculture is regulated by Health Canada under the Veterinary Drugs Directorate (VDD), which regulates most of the therapeutants used in the industry and prescribes withdrawal periods for each drug (Health Canada, 2010). Products registered for use in Canada are: Oxytetracycline, trimethoprim80%/sulphadizine20%, sulfadimethoxine80%/ormetoprim20%, and florfenicol (Burridge et al, 2010 and Health Canada, 2010). The use of any of the aforementioned antibiotics requires a veterinary prescription (DFO, 2011a and DFO, 2011c).

Though low in toxicity, antibiotics remain in the environment long after they are excreted from the fish being treated. This can increase the likelihood of treatment-resistant strains of target bacteria. As a result, regulations have been enacted to minimize the use of antibiotics in animal husbandry in many countries, including Canada. The need for antibiotics can be minimized with proper husbandry (Burridge et al., 2010). In recent years, there has been a significant decrease in the use of antibiotics in BC salmon aquaculture (BMAL, 2009; Burridge et al., 2010; and DFO, 2011c) and there is concern that the limited number of available compounds could result in resistance development, but there is not enough data publicly available to properly assess the risk (Burridge et al, 2010).

Pesticides

Emamectin benzoate (SLICE®) is the only sea lice treatment approved for use in Canada (Saksida et al., 2010 and Burridge et al., 2010). Canada limits the number of sea lice treatments within a grow-out cycle to three (Burridge et al., 2010). There is concern over the impacts this treatment could have on non-target organisms. Waddy et al. (2002) found that emamectin benzoate may be causing American lobsters on Canada's east coast to molt prematurely. Further studies by Waddy et al. (2007) suggest that these impacts are limited to a small number of individuals and that widespread effects are unlikely. Recent studies in BC have failed to detect toxic effects on invertebrates near farms using emamectin benzoate (Willis et al., 2005 and Tefler et al., 2006).

The emamectin benzoate treatment can only be administered by a registered veterinarian to ensure proper dosage. Recent research shows that the dosages currently administered in BC have limited impacts (Waddy et al., 2007 and Kuo et al., 2010) and that levels retained in the flesh and skin are well below Health Canada guidelines (Whyte et al., 2011). There are concerns that the sea lice will develop a tolerance for the treatment, but Saksida et al. (2010) found that SLICE® is still an effective treatment in BC.

Metals

Zinc is added to farmed salmon feed as a mineral supplement and concentrations of the element are typically increased in the water and sediment near salmon farms (Brooks and Mahnken, 2003b and Burridge et al., 2010). In BC, some farms have reached levels that exceed Washington State's sediment quality criteria (Brooks and Mahnken, 2003). Zinc is generally biologically unavailable because the fish waste that accumulates in the farm vicinity elevates organic carbon and sulfides that bind it to the sediment (Burridge et al., 2010). Feed producers in British Columbia have reduced the amount of zinc in their feed to the minimum necessary to maintain salmon health and have changed the form of zinc used (Brooks and Mahnken, 2003b). A study by Brooks (2001) suggested that the use of methionine analog instead of zinc sulfate could minimize the accumulation of zinc in sediments near salmon pens. Continued monitoring continues to test this theory (Nash, 2003).

Chemical remediation during fallow periods decreases zinc levels (Brooks et al., 2003). It is possible that zinc released during the chemical remediation process makes its way into

the water column and becomes biologically available to pelagic organisms. This hypothesis is in need of research (Burridge et al., 2010).

Copper is found in the antifouling agents used to prevent the accumulation of fouling organisms that can reduce water flow, oxygen levels, and compromise the structural integrity of the nets, which could lead to escapes (Brooks and Mahnken, 2003b). The rate of release of harmful chemicals from the antifoulants is affected by water temperature, current speed, physical location of the netpens, salinity, and pH as well as the nature of the toxic agent (Brooks and Mahnken, 2003b and Burridge et al., 2010). Like zinc, the fish waste accumulated at farm sites elevates the organic carbon and sulfides that bind the copper, greatly reducing its bioavailability. However, disturbance of the sediments can redistribute the copper into the water column (Burridge et al., 2010).

In BC, the amounts of copper found in the agents used in the area are not toxic and biologically insignificant except to organisms attempting to settle on the nets (Brooks and Mahnken, 2003b) and the copper concentrations do not affect the quality of the seafood produced (Solberg et al., 2002). Brooks (2000) determined that remediation for copper at fallowed farm sites was successful in short time spans. Based on his findings, he recommended fallowing and BMPs to allow for the use of antifoulants with minimal impacts. Among his suggestions were upland washing of copper treated nets and disposal of all material at an appropriate landfill along with annual sediment monitoring programs at sites using copper treated nets (Brooks and Mahnken, 2003). That approach has been adopted by the DFO under the PAR (DFO, 2011a).

Disinfectants

Disinfectants are used for biosecurity measures to limit the transfer of disease. They are applied to nets, boats, containers, boots, raingear, diving equipment, platforms, and decking. Little is known about the effects of disinfectants, but all of the compounds are water-soluble and should be low in toxicity. This is heavily dependant on how much is being used and where it is being released (Burridge et al., 2010). In BC, disinfectants must be included in the farm's Fish Health and Chemical and Other Substances Management Plans, which are audited annually by the DFO (DFO, 2010).

Anesthetics

Anesthetics in salmon aquaculture are used when fish are handled or transported. They are used infrequently and in low doses and therefore have a minimal environmental impact (Burridge et al., 2010). In BC, they are regulated by Health Canada under the VDD (Health Canada, 2010).

Aquaculture regulations in BC: Benthic and chemical management

Benthic Monitoring

Benthic monitoring and reporting for all farm sites has taken place since the BC Ministry of Agriculture and Lands instituted interim measures in 2000 and 2001, which led to the Finfish Aquaculture Waste Control Regulation (FAWCR)(Backman et al., 2009). Since the adoption of the PAR in 2010, the DFO has taken over authority for the monitoring of

benthic impacts. Marine netpen producers are required to conduct benthic monitoring at peak biomass and report on:

1. Soft bottom substrates (these tests are conducted at 0m, 30m, and 125m from the farm site and vary based on distance):
    - Free Sulfides
    - Redox potential
    - Metals
    - Total volatile solids (TVS)
    - Sediment grain size
2. Hard bottom substrates
    - Calculations for time segment classifications from the containment structure array
    - Percent cover of *Beggiatoa sp.* and/or opportunistic polychaete complexes (OPC) in each time unit
    - Other abiotic and biotic parameters

These peak biomass surveys must be conducted within 30 days (before or after peak biomass) or every 24 months if cycle is longer or fish continuously remain onsite. In the event that the free sulfides at the 30m and/or 125m mark for soft bottom or the *Beggiatoa sp*. and OPC exceed the acceptable threshold set by the DFO, the site must be fallowed until further testing confirms that these counts have once again fallen below the threshold. These indicators were selected based on the Brooks (2001) study that demonstrated that they could act as physicochemical surrogates, providing sensitive indicators of the response of macrobenthic communities to associated organic enrichment (Backman et al., 2009). The sediment sampling protocols were based on Washington State Surveys (Backman et al., 2009). Surveys yielding results above the accepted threshold must be reported to the DFO within 14 days (DFO, 2011a). In addition to industry-generated reports, DFO biologists conduct field audits (DFO, 2012d).

If the license holder wants to make production or infrastructure changes that will increase or alter the existing benthic footprint, the license holder must produce a baseline survey that indicates where the majority of the waste will fall. The surveys help the DFO properly site new and existing sites to ensure that there are no impacts to sensitive habitats and minimal impacts to other benthic communities (DFO, 2012).

Therapeutants

The use of therapeutants in BC is regulated by Health Canada under the VDD and the Pest Management Regulatory Agency. The PAR requires that the use and the dosage/amount of therapeutants, pesticides, copper and zinc, and chemicals are recorded and reported to the DFO under the Fish Health and Chemical and Other Substances Management Plans (DFO, 2010).

Chemicals

As per the PAR, license holders are required to have a Chemical and Other Substances Management Plan including the management and control of therapeutants, disfectants, pesticides, antifouling agents, hydrocarbons, and blood. Chemicals and other hazardous

materials must be clearly identified and properly contained and staff must be trained to properly respond to a spill of any size. In addition, the following have to be reported to the DFO annually:

- The active component of therapeutants, pigments, pesticides, and zinc and copper formulations
- The names of all materials that are directly or indirectly released into the water during the reporting period including anesthetics, anti-fouling agents, and/or other substances
- The monthly weight of carcasses and disposal method

If using copper treated nets, the license holder must wash its nets at authorized land-based facilities (DFO, 2011a). Those facilities house containers in which nets are cleaned and the water is filtered to minimize the amount of copper that reaches the ocean. Disposal of antifouling materials deemed as hazardous or contaminated waste is regulated by the Province of BC, Ministry of Environment (MOE). Waste at the net-cleaning facilities has a specific processing procedure approved by the MOE, which generates a registration number and which the waste treatment contractor must follow in order to ensure that there are no leachates. All shipments from the facility must have a specific manifest and number that must be registered with the MOE within 72 hours. The facility keeps a copy of the manifest, as does the hazardous waste treatment facility. For those who chose not to use copper anti-foulants, *in-situ* removal of biofouling must be recorded (DFO, 2011a).

Grieg Seafood: Benthic and chemical management

Where applicable, Grieg Seafood farm sites coordinate stocking, lice treatments, health management, plankton monitoring, harvest, and fallowing with neighboring farms (Grieg BAP Audit, 2011 and SFF site visit, 2012).

Benthic

As per PAR, benthic surveys are conducted and reported to the DFO at peak biomass by a third-party auditor that is recognized by the department, reported to the DFO by Grieg Seafood, and sites are fallowed until free sulfides or *Beggiatoa sp*. and OPC are below the DFO's threshold. Benthic surveys are kept for four years post-harvest (unless newly acquired by the company) and are held at Grieg Seafood BC's head office (Grieg BAP Audits, 2011).

In order to further minimize their impacts, Grieg Seafood farm sites use cameras to monitor feeding and minimize excess feed released into the environment (SFF site visit, 2012). Water quality is monitored daily (Grieg FHMP, 2012) and data are available to calculate carbon and nitrogen discharge to the environment (Grieg BAP audit, 2011).

Therapeutants

Grieg Seafood uses improved husbandry and biosecurity to minimize the need for therapeutant treatments such as antibiotics and emamectin benzoate, the latter which may be reported monthly during sea lice reporting. All therapeutant use is administered and

recorded under veterinary approval. Records of treatments are available at each site and reported to the DFO on a quarterly basis.

Metals

Grieg Seafood uses the *in-situ* net cleaning method as well as copper-based antifoulants. Nets are cleaned off-site at MOE approved facilities where the resulting runoff can be contained and filtered before entering the environment.

Disinfectants

Grieg Seafood uses just enough disinfectants to be effective for the purposes of biosecurity. They are stored and disposed of in sealed containers that are collected by contractors for proper disposal.

Marine Harvest: Benthic and chemical management

Marine Harvest sites coordinate stocking, lice treatments, health management, plankton monitoring, harvest, and fallowing with neighboring farms (Marine Harvest, appendix III).

Benthic

To alleviate nutrient build-up in the benthic community, Marine Harvest Canada implements the following mitigations:

- Reduction in maximum fish production levels at low capacity sites
- Repositioning of production cages with respect to available currents and depth
- Closure of non-economical, non-environmentally sustainable site
- Improved fish feeding strategies
- Increased production at high capacity sites

As per PAR, benthic surveys are conducted and reported to the DFO at peak biomass by a third-party auditor that is recognized by the department and sites are fallowed until free sulfides or *Beggiatoa sp*. and OPC are below the DFO's threshold. Benthic surveys for at least three years (unless newly acquired by the company) are available at all sites (Marine Harvest, appendix III).

Marine Harvest sites also use camera technology to monitor feeding and minimize excess feed released into the environment (SFF site visit, 2010). Water quality is monitored daily and data are available to calculate carbon and nitrogen discharge to the environment (BAP cert requirements).

Therapeutants

Marine Harvest minimizes the need for therapeutant treatments such as antibiotics and emamectin benzoate by implementing improved husbandry and biosecurity practices. All therapeutant use is administered and recorded under veterinary approval. Records of treatments are available at each site and reported to the DFO on a monthly basis.

Metals

Marine Harvest no longer uses antifoulants on any of its nets. Instead, nets are cleaned *in-situ* as needed.

Disinfectants

Disinfectants are limited to small amounts for biosecurity purposes. They are stored and disposed of in sealed containers that are collected by contractors for proper disposal.

Discussion

Regulations requiring regular monitoring, reporting, and fallowing in addition to improved siting and farming practices implemented by the farmers have improved benthic conditions in the province (Backman et al., 2009). There is evidence of linkages between chemical inputs and effects and it is possible that some of the chemicals thought to be bound to the sediment could be redistributed into the water column and available to marine life. These are valid concerns which merit more research (Burridge et al., 2010), but SFF recognizes that these farms have and continue to make efforts to minimize their impact.

Grieg Seafood

Grieg Seafood complies with BC regulations by hiring an approved third party to sample the benthic conditions at peak biomass production and report results to the DFO. The use of therapeutants is prescribed and monitored by a licensed veterinarian and reported to the DFO on a monthly basis. Other hazardous materials are properly marked and stored, recorded, and reported to the DFO. All records are available on-site. Grieg Seafood also participates in area-based management where applicable to minimize its impacts.

It still uses copper-based antifoulants, but cleans them responsibly in an approved offshore facility where the runoff can be contained and filtered.

Marine Harvest

Marine Harvest also complies with BC regulations by hiring an approved third party to sample the benthic conditions at peak biomass production and reports results to the DFO. The use of therapeutants is prescribed and monitored by a licensed veterinarian and reported to the DFO on a monthly basis. Other hazardous materials are properly marked and stored, recorded, and reported to the DFO. All records are available on-site. Marine Harvest participates in area-based management as well.

Marine Harvest does not use copper-based antifoulants. Instead, it uses *in-situ* cleaning as needed and as per the PAR, maintains record of any *in-situ* cleaning that takes place on its nets.

SFF Conclusion: Grieg Seafood and Marine Harvest have taken responsible actions to minimize organic and chemical inputs at their farm sites. SFF will work with Grieg Seafood to minimize their use of copper-based antifoulants.

Feed

The largest environmental footprint created by salmon farms is feed (Pelletier et al., 2009). Salmon are carnivorous and in order to maintain the high levels of Omega-3 fatty acids that make salmon so attractive as a food source, fish meal and fish oil are required to produce the increased level of those lipids in salmon. Much of those ingredients are now provided by fishery byproducts rather than wild fish (Torrissen et al., 2011). Over the years the amount of wild fish required to produce farmed fish has been greatly reduced (See table 1).

	FFDR Fish Oil	FFDR Fishmeal
2004	4.28	1.24
2011	2.05	0.56

Table 1-Feed Fish Dependency Ratio (FFDR) is the quantity of wild fish used per quantity of culture fish product. These numbers are averages based on Skretting feed composition and average commercial economic feed conversion ratios (eFCR).

The two primary feed producers in Canada are EWOS and Skretting.

EWOS

EWOS is a subsidiary of Cermaq based in Norway that supplies aquaculture feed via operations in Canada, Chile, Norway, Scotland, and Vietnam. The total inclusion rate for fishmeal feed in 2011 was 23 percent (EWOS, 2012). In order for suppliers to sell product to EWOS, they must:

- Comply w/regulations in countries they operate (no fish caught by means of illegal, unregulated and unreported fishing)
- Demonstrate the practice of corporate social responsibility and follow UN Global Compact Principles
- Manage environmental impacts from daily operations
- Demonstrate employee welfare

EWOS also supports the International Fishmeal and Fish Oil Organization's Standard for Responsible Supply (IFFO RS). The company is also researching alternatives that could eliminate the need for marine ingredients all together (EWOS, 2012).

Skretting

Skretting is owned by Nutreco and produces feed for more than 60 species in the US, Canada, Norway, Chile, the UK, and more. The total inclusion level, or amount of marine products used in Skretting feed is 24 percent (Skretting, 2012).

As of 2011 Skretting buyers must follow the Sustainable Procurement Strategy to purchase only demonstrably sustainable raw materials for its feeds. Suppliers that wish to sell product to Skretting must meet the following criteria:

- Comply w/regulations in countries they operate (no fish caught by means of illegal, unregulated and unreported fishing)
    - Management controls must be based on scientific monitoring and assessment
    - Documentation stating species used in the manufacturing of the product must be provided
- Demonstrate the practice of corporate social responsibility and follow UN Global Compact Principles
- Manage environmental impacts from daily operations
- Demonstrate employee welfare
- Species cannot be endangered

Skretting conducts audits on suppliers to ensure compliance, but strongly recommends that suppliers obtain certification from accredited bodies such as the Marine Stewardship Council (MSC) or the IFFO RS as well. The company's feed plants were the first in North America to obtain the Global Aquaculture Alliance's BAP certification. Skretting was also represented in the World Wildlife Fund (WWF)'s Salmon Aquaculture Dialogues and the company's COO Knut Nesse is a member of the Supervisory Board of the Aquaculture Stewardship Council (ASC) (Skretting, 2012).

Grieg Seafood: Feed sourcing

Grieg Seafood BC sources feed from Skretting and EWOS. For the second successive year, Grieg Seafood BC and its counterparts in Norway have had the best feed conversion ratio (eFCR), or amount of wild fish required to produce one pound of farmed fish, ever recorded (Grieg Seafood, 2012). According to staff veterinarian, Barry Milligan (personal communication), Grieg Seafood BC's feed statistics are as follows:

FCR: 1.25
FIFO[10]: 1.5-1.1
Fish Meal: ≤20%
Fish oil: ≤15%

Marine Harvest: Feed sourcing

Marine Harvest sources feed from Skretting. According to Marine Harvest, its current feed statistics are as follows:

FCR: 1.35
FIFO: 1.19
Fish Meal: 12%
Fish oil: 12%

[10] FIFO is the fish in:fish out ratio, or the amount of wild fish to produce 1 pound of the final product produced.

SFF Conclusion: Grieg Seafood and Marine Harvest are sourcing their feed responsibly and working to minimize their use of wild feed ingredients.

Community Relations and Environmental Stewardship

Grieg Seafood

Grieg Seafood has signed cooperation agreements with two First Nation groups in whose territories its farms are operating. In addition, it is working toward cooperation agreements with four other First Nation groups. The company has a community support plan in which they donate to numerous organizations, including fish donations for fund raising events at schools and hospitals (Grieg BAP Audit, 2011).

Grieg Seafood has also commissioned several studies on wild salmon populations, including:

- Sakinaw Lake Eelgrass Planting Project
- Lingcod Egg Mass Survey
- Abalone Survey
- Canuma River Channel Restoration Project (including 5 yr post-project monitoring)
- Cambell River Estuary Restoration Project (including 5 yr post-project monitoring)
- Burman River Restoration Project (including 5 yr post-project monitoring)
- Best Practices Workshop – Seal and Sea Lion Interactions

In addition, Grieg Seafood contributes annually to the wild hatchery activities of the following salmon enhancement organizations:

- Nootka Sound Watershed Society
- Campbell River Salmon Foundation
- Powell River Salmonid Society
- Sunshine Coast Enhancement Society
- Pacific Salmon Foundation

Grieg Seafood's Skuna Bay brand is also working to reduce its carbon footprint by not flying its product and has recently announced that it will participate in a carbon offset program. The packaging in which Skuna Bay ships its salmon is also completely recyclable (Skuna Bay, 2013).

Marine Harvest

Marine Harvest Canada won the Campbell River Chamber award for Family Friendly business of the year in 2011 (Marine Harvest, 2011). The company also engages the community through events, beach cleanups, enhancement program support, contribution to charities, and staff-led initiatives. In 2006 the company started an extensive dialogue process with the Coastal Alliance for Aquaculture Reform to develop mutually beneficial communication efforts. The program ended in 2012. Marine Harvest has also signed agreements with the WWF Canada and Ducks Unlimited.

The company has contributed to a number of research and development projects in areas including fish husbandry, fish health and safety, and closed containment technologies. See appendix III for a complete list of Marine Harvest Canada research projects.

Certifications

Both Grieg Seafood BC and Marine Harvest Canada have received BAP certification from the Global Aquaculture Alliance. A 2011 study conducted by the University of Victoria's Seafood Ecology Research Group compared the environmental performance for 20 marine finfish aquaculture standards. These standards were given numerical values based on methodology from the Global Aquaculture Performance Index (GAPI) and ranked based on absolute and value-added performance as well as the Monterey Bay Aquarium's Seafood Watch (MBA) and Blue Ocean Institute's (BOI) criteria for sustainable aquaculture. For the MBA and BOI comparisons, BAP certification fell into the "Yellow Good Alternative" category. When weighted for value-added performance, the assessment produced values from -10 to +21. BAP certification was awarded a +1, which indicates that BAP certified farms are performing above the industry standards for environmental sustainability. According to Dr. Michael Tlusty of the New England Aquarium, BAP certification has limited impact on single control points, but the combined impact is significant (Tlusty, 2012).

Discussion

The top value-added score went to the US National Organic Standards, but those standards have yet to be finalized for aquaculture. The much anticipated Aquaculture Stewardship Council (ASC) scored a +7, however no salmon farms have achieved ASC certification and according to the ASC's website, there are none pending certification at this time. According to Tlusty, most companies research the requirements and attempt to meet them prior to the expensive ISO 65 accredited audits to ensure that they will pass (Tlusty, 2012). It is likely that some companies are in the process of making the necessary improvements to meet the ASC's stringent criteria, but whether or not they will remains to be seen.

SFF Conclusion: The Global Aquaculture Alliance's BAP certification criteria are higher than industry standards and SFF recognizes it as a reliable indicator of responsible aquaculture producers.

Conclusion

It is argued that, while there is a need to feed our growing population healthy fish protein, most of the people in need will not benefit from salmon production. This is true in a direct sense, but developed countries tend to exploit the fish protein resources of developing countries by importing to meet shortfalls in their own countries (Pauly et al., 2005). According to the latest Fisheries of the United States report, the US imported 90% percent of its seafood in 2011 (NOAA Fisheries, 2012b). Salmon is a staple in North America, but the wild catch, which supplies only 30% of the world's supply (FAO, 2012), cannot meet the overwhelming demand on its own. It is imperative that we find a balance between wild and farmed salmon to meet these demands without compromising the health and viability of wild stocks or the environment. While closed containment may

be an important component to achieve this balance in the future, current operations are not able to meet the demand in an economically efficient manner (Boulet et al., 2010).

The industry has grown and improved over the last four decades. Research has shown that escapes, benthic impacts, and chemical inputs tend to be localized and are of minimal concern. Feed resources can be an issue, but the FCRs have greatly improved, with some companies, including those in BC, looking to further minimize wild fish inputs and potentially eradicate them all together (EWOS, 2012 and Skretting, 2012). Harmful interactions with marine mammals are also a point of concern, but companies have made measurable progress to minimize their interactions and are continuing to research and develop non-lethal control methods. There have been unfortunate incidents involving higher than normal interactions in recent years, but the companies in question immediately took responsibility for their actions and have since taken actions to make sure these incidents are not repeated.

Disease is the most concerning of the issues of marine netpen salmon aquaculture in BC. The study of viral transmission in the marine environment is minimal and there is no conclusive evidence that directly links salmon farms to the occurrence of disease in wild salmon populations (Dill, 2011; Noakes, 2011; Connors, 2011; Korman, 2011; and Cohen, 2012a,c). The majority of the research on salmon aquaculture states the need for more research and that improved regulation, husbandry, siting, and farming practices have minimized impacts in some capacity. Further, the leading researchers involved in the Cohen Commission Inquiry agreed that, if disease is present, it should be detectable at the farm level (Cohen, 2012a). In the event that conclusive evidence is found after years of research, it could be too late to mitigate the effect and this is a serious concern. However, if salmon farms are not directly linked to pathogen transfer in the Pacific Northwest, the proven statistical improvements made and 6,000 people employed by the industry cannot be discounted.

According to the FAO:

> "An important component of human well-being is employment…However, these benefits induced by employment in aquaculture are often overlooked. The sector has developed at a time of growing scrutiny from the public, improved communications and vociferous opposition groups. Although opposition groups can act as environmental and social watchdogs and as lobby groups, putting pressure on aquaculture businesses to increase transparency and improve working conditions, it is also important to consider the benefits accruing from the sector, including employment," (FAO, 2012).

Among the concerns voiced by salmon farming opponents, the Cohen Commission, researchers, and the FAO is the need for transparency from the industry. Farm-related information such as the results from benthic, sea lice, marine mammal interactions, and incidental catch surveys are available to the public. What is still lacking is detailed information on fish health events such as viral and bacterial outbreaks. SFF agrees that this is an issue and must be resolved if real progress is to be made with valuable research. SFF also recognizes the intense scrutiny and attempts to discredit farms by the activist community and that building trust must be mutual. While information on viral and bacterial incidents is not readily available to the public, it should be noted that SFF was able to obtain highly sensitive information regarding fish health from Grieg Seafood BC

and from Marine Harvest, although the latter was somewhat limited. In addition, Grieg Seafood has notified SFF and other stakeholders as these events unfolded. For the purposes of her research on the IHN virus, Saksida (2006) noted that she received 100 percent compliance when she asked the farms for information.

SFF and responsible salmon aquaculture in BC

Upon further investigation of Grieg Seafood BC and Marine Harvests Canada operations, SFF has found that these companies are operating responsibly and continue to make measurable progress towards reducing their impacts. This commitment to sustainable performance is validated in their certification by Global Aquaculture Alliance's BAP. SFF will continue to work with these entities and their cohorts in the BC area to further reduce their footprint.

In the past, SFF has also recommended BC farmed salmon on its "Gold List." Upon further review of the scientific data and information, SFF finds that there is a need for research to fill in the information gaps regarding the potential for disease transmission and to increase the level of transparency regarding this issue. While the aforementioned companies and many of their counterparts are producing responsibly in the region, SFF will move the overall recommendation for BC farmed salmon to the "Specific Stock" list until there is more data on the topic. In the meantime, SFF will work with the farmers and concerned groups to try to find solutions to improve transparency regarding fish health events at farm sites.

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Appendix I: Group Letter Expressing Concern Over Salmon Farming in BC

December 12, 2012

Dr. Jerry R. Schubel
President and CEO
Aquarium of the Pacific
100 Aquarium Way
Long Beach, California 90802

Cc: Board and Senior Staff

Dear Dr. Schubel, Esteemed Board Members, and Senior Staff:

We, the undersigned, are writing to express serious concerns about the partnership between your Seafood For The Future (SFTF) program and Grieg Seafood, known to SFTF under the banner of their "Skuna Bay Craft-Raised Salmon" branding initiative.

Among our concerns is that operators of Grieg's net-pen salmon farms are party to the killing of seals and sea lions, benthic pollution, and the spread of disease and parasitic sea-lice into wild salmon stocks.

It is our conviction that the net-pen Atlantic salmon farmed and exported to the U.S. by Grieg Seafood under their Skuna Bay banner do not in fact meet any reasonable standard of sustainability— and that Grieg is using an affiliation with your program to "greenwash" an ecologically dangerous and irresponsible product that has already been red-listed by the Monterey Bay Aquarium's Seafood Watch, SeaChoice and Ocean Wise, among other organizations.

We are also concerned that in the past year, SFTF staff have ignored substantive questions about ecological sustainability, apparently setting aside SFTF's stated mission as a third-party advisor to consumers on healthy and responsible seafood choices. In particular, in December of 2011, an SFTF staff member brushed off important questions posed by Kelly Roebuck, Sustainable Seafood Campaign Manager for the Living Oceans Society, about the basis and rationale for the Skuna Bay/SFTF partnership.[1] Two months after this email correspondence, the former SFTF staffer was hired as Grieg's Southern California brand representative for Skuna Bay salmon.

[1] Email excerpt from SFTF staff: "Thanks so much for reaching out to us! It is wonderful to be introduced to you via email! ... We understand your position, particularly being based in Vancouver. It is our position that responsible aquaculture is an important facet of a sustainable sourcing strategy. We understand that we will not see eye-to-eye on our recommendations and partnerships and to us that is OK because our end goals are one in the same – to promote the consumption of healthy and responsibly sourced seafood..."

Background on Grieg Seafood

Atlantic salmon raised in net pens — in what the Skuna Bay website calls British Columbia's "natural, pristine ocean"—may impute some form of "natural" quality to unsuspecting consumers, but it by no means equates to sustainability. Rather, it means inflicting unjustifiable and potentially irreversible ecological harm to the formerly pristine locations where these operations are sited.

There is no farm in Skuna Bay; the nearest Grieg operation is at Concepcion Point in the Nootka Sound area about 18 miles away. The Skuna Bay name has been affixed by Grieg Seafood onto non-native Atlantic salmon reared in several of their net-pen operations on the BC coast, none of which employ a pathogen barrier to deter viral, bacterial or parasitic contamination of wild fish.

By locating their farms along wild salmon migration routes, Grieg is disrupting the natural balance that protects young wild salmon from sea lice.

Grieg claims that their net-pens constitute a "craft" endeavour, but their three net-pen operations in the Nootka Sound area (Williamson Passage and Muchalat Inlet North and South) are licensed for 3900 - 4100 metric tonnes of salmon. The average of all 123 net-pen sites in BC is 2,344 metric tonnes. At more than 1550 metric tonnes over the provincial average, Grieg facilities do not appear to be an improvement over other industrial-scale salmon mariculture facilities; rather, they run up to 66% higher than the average farm.

Grieg is a large Norwegian corporation with considerable resources. Globally it sells 90,000 tonnes of farmed salmon per year; in 2010 alone pre-tax profits were approximately USD $28M. For the past decade a host of conservation groups, biologists and concerned citizens have urged Grieg to use their profits to relocate their farms to closed-containment. Closed-containment facilities such as the successful Aquaseed "SweetSpring" facility in Washington are proving the technology viable and sustainable. (SweetSpring, unlike Grieg, has received a SuperGreen rating from the Monterey Bay Aquarium.) Grieg has refused.

Because Grieg has not used its significant resources to invest in the closed-containment facilities that would make it truly sustainable, and instead has chosen to externalize ecological costs on surrounding habitat, the following consequences have resulted.

I am incredulous that the Aquarium of the Pacific's Seafood for the Future program, claiming to support sustainable use of the oceans, would partner with Grieg Seafood's Skuna Bay branding exercise. Like any open net-pen salmon farm, Grieg's operations have negative effects on local benthic communities and marine mammal populations.

Worse, such farms pose significant risks to populations of wild salmon and other species by acting as incubators for viral diseases and other pathogens. Their advertising represents a particularly disingenuous example of greenwashing. The Aquarium should terminate this partnership immediately, in the interests of a healthy ocean and their own reputation.

— Lawrence M. Dill, PhD, FRSC
Professor of Biological Sciences,
Simon Fraser University

Marine Mammal Deaths

Part of the month-to-month operation of salmon farms is the killing of "nuisance" marine mammals, as well as the drowning of mammals by entanglement in the net-pens. Attached is a copy of January 2012 charges laid against Grieg Seafood by a federal conservation officer for the wrongful death of seven sea lions and two seals at their farms over a 20-week period.

Fisheries and Oceans Canada reports that between 1999 and 2010, salmon farmers in BC legally shot or otherwise killed 1935 harbour seals, 738 California sea lions and 202 Steller sea lions. (The latter is now a species of special concern under Canada's federal Species at Risk Act.) In the first

three months of 2011 alone, 141 California sea lions, 37 seals and two Steller sea lions were reported killed at BC fish farms.

Grieg Seafood operates approximately 13 per cent of the net-pen operations currently sited in BC coastal waters. If Grieg was responsible for their proportional number of these deaths, that means their "craft-raised" salmon includes, at minimum, the deaths of 256 harbour seals, 114 California sea lions and 26 Steller sea lions.

Note that these numbers only reflect deaths recorded under BC's "honour system" of reporting, and do not include the significant but untracked number of pinnipeds and cetaceans that died unseen, caught in nets below the surface.

Viral and bacterial diseases

Skuna's website statement[2] that they are sustainable because they are relieving human consumption pressure on wild salmon stocks is misleading at best. At worst, it is willfully deceptive. Research by Ransom Myers and Jenn Ford in 2007 shows a global correlation between the regional existence of net-pen salmon farms and the decline of wild salmon, a claim that has been supported by numerous other studies[3].

Net-pens not only create an ecologically novel niche for vast blooms of parasitic sea lice that can harm or kill out-migrating salmon smolts, they also provide concentrated biomass that can amplify endemic or imported viral and bacterial pathogen loads in coastal waters.

The recent *Cohen Commission Inquiry into the Collapse of Fraser River Sockeye* revealed disease outbreaks—*Aeromonas salmonicida* infection (linked to furunculosis) and *Renibacterium salmoninarum* infection (linked to BKD, bacterial kidney disease)— at a number of Grieg net-pen operations. These pathogens were identified by Dr. Michael Kent, Professor of Microbiology & Biomedical Sciences at Oregon State University, as potentially high risks for causing disease in sockeye salmon.

Outbreaks of the above-named pathogens, as well as Infectious Hematopoietic Necrosis Virus (IHNV), are not uncommon at salmon farms. In 2012 alone, documented outbreaks of IHNV swept through net-pen operations in BC and Washington State, with unknown effects on wild fish. According to their own documents, a major outbreak of furunculosis in Grieg's BC operations resulted in significant losses for the company in 2011; again, however, the effect of these outbreaks on BC's wild salmon and other species remain unknown, because—despite urging from many concerned groups— neither industry nor government has undertaken to research them.

Recent positive tests for previously unidentified viruses in BC, such as Infectious Salmon Anemia Virus (ISAV) and Piscine Reovirus (PRV) are more troubling, given their risk to wild salmon is not yet completely understood. Both these viruses are linked to the industry in other parts of the world.

The matter of net-pen Atlantic salmon farms as unnatural ecological niches that can breed devastating pathogen blooms is a very serious one, and was one of the central subjects at the $26.4

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[2] http://www.skunasalmon.com/our-environment/salmon-protection

[3] Ford JS, Myers RA (2008) A global assessment of salmon aquaculture impacts on wild salmonids. PLoS Biol 6(2): e33. doi:10.1371/journal.pbio.0060033. See also L. Neil Frazer. Sea-Cage Aquaculture, Sea Lice, and Declines of Wild Fish. Conservation Biology, 2008; DOI: 10.1111/j.1523-1739.2008.01128.x. See also Hutchinson P, editor (2006) Interactions between aquaculture and wild stocks of Atlantic salmon and other diadromous fish species. Proceedings of an ICES/NASCO Symposium held in Bergen, Norway, 18–21 October 2005. ICES J Mar Sci 63:(7).

million Cohen Commission sockeye-survival inquiry that closed last December. "Salmon farms along the sockeye migration route in the Discovery Islands have the potential to introduce exotic diseases," wrote Justice Bruce Cohen in his final report issued October 31, 2012. "I therefore conclude that the potential harm posed by salmon farms to Fraser River sockeye salmon is serious or irreversible."

Chemical feeds

Farmed salmon in BC are fed astaxanthin, a synthetic petrochemical dye delivered to the salmon via their pellet feed. This is not the only chemical additive they ingest, nor the most harmful. In the densely packed, static net-pens—restraining a fish that is migratory by nature—in order to rid their salmon of the sea-lice that mass on them, their feed also contains "Slice," emamectin benzoate. This is a crustacean-killing chemical that diffuses into the bloodstream and flesh of the fish, to be ingested by the sea-lice on their scales. It is toxic to crustaceans such as shrimp, crabs and lobster. Studies of farmed salmon in Europe and eastern Canada show that sea-lice are developing a resistance to this product, provoking use of more toxic substances including azamethiphos and deltamethrin (classified as "super-toxic"). Eastern Canada's largest salmon farming company, Cooke Aquaculture, is facing 19 counts under the Fisheries Act for alleged illegal use of cypermethrin.

Sea-floor pollution

The ocean is vast, but does not render pollutants harmless by dilution. Fish farms produce an astounding quantity of waste, which has similar impacts to those of municipal sewage. In a single year, one B.C. fish farm can dump wastes equivalent to between 2,250 and 5,580 people[4]. In 2003 alone, the B.C. salmon farming industry discharged approximately 1435 mt to 2100 mt of nitrogen—equal to that of three million people— contributing greatly to ocean eutrophication and subsequent ecological impacts[5].

Fish farm waste consists of fish feces, uneaten food pellets, drugs and drug residues, pesticides, fungicides, and feed additives, including toxic metals. This untreated waste spills through the cages and smothers the ocean floor. As this layer breaks down, it consumes oxygen vital to shellfish and other bottom-dwelling sea creatures, rendering the sea-bed unlivable and creating a niche for bacterial pathogens.

Despite its carefully constructed image, "Skuna Bay" is not a craft-farm operation run by rugged mariculturists with a passion for protecting wild salmon stocks. Rather, it is a marketing fiction created by a large corporation whose motive is not protecting wild salmon but maximizing shareholder profit—and whose operations harm marine wildlife and violate the precautionary principle.

Endorsements of sustainability by Aquarium of the Pacific are perceived by the public, as they ought to be, as founded in science, sound data and significant depth of knowledge on the programs and products promoted. To operate a program like SFTF in any other manner is a violation of the public trust.

We urge you to reconsider your relationship with Grieg Seafood in favour of aquaculture operations that meet higher standards of sustainability— and we would welcome a dialogue with you about the bases for your SFTF partnerships.

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[4] Folke, C., Kautsky, N., and Trell, M. 1994. The costs of eutrophication from salmon farming: Implications for policy. Journal of Environmental Management 40: 173-82.)

[5] Goldburg, R., Naylor, R. 2005. Future seascapes, fishing, and fish farming. Front Ecol Environ; 3(1): 21-28.

The appendix below provides additional citations for the facts noted above, and we would be happy to answer any questions you may have regarding our concerns.

We look forward to your timely response.

Sincerely,

Fraser Riverkeeper Society
Tyee Bridge
Riverkeeper and Campaign Director

Living Oceans Society
Kelly Roebuck
Sustainable Seafood Campaign Manager

Rick Routledge, PhD.
Professor of Statistics and Actuarial Sciences
Simon Fraser University

Orange County Coastkeeper
Inland Empire Waterkeeper
Garry Brown
Executive Director

Marvin Rosenau
Instructor, Fish, Wildlife and Recreation Program
British Columbia Institute of Technology

David Suzuki Foundation
John Werring
Senior Science and Policy Advisor

Conservation Council of New Brunswick/
Fundy Baykeeper
Matthew Abbott
Coordinator

Sierra Club BC
Colin Campbell
Marine Campaign Coordinator

Wilderness Committee
Torrance Coste
Pacific Coast Campaigner

LA Waterkeeper
Liz Crosson
Executive Director

Canadian Parks and Wilderness Society,
BC Chapter
Nikki Hill
Executive Director

Watershed Watch Salmon Society
Stan Proboszcz
Fisheries Biologist

Lawrence M. Dill, PhD FRSC
Professor of Biological Sciences
Simon Fraser University

Daniel Pauly, PhD
Professor of Fisheries Science
Fisheries Centre, University of British Columbia

Waterkeeper Alliance
Lesley Adams
Western Regional Coordinator

Alexandra Morton
Salmon Biologist
Pacific Coast Wild Salmon Society

Greenpeace Canada
Sarah King
Oceans Campaign Coordinator

California Coastkeeper Alliance
Sara Aminzadeh
Executive Director

Ecology Action Centre
Rob Johnson
Coordinator

Georgia Strait Alliance
Ruby Berry
Program Manager

T. Buck Suzuki Environmental Foundation
David Lane
Executive Director

APPENDIX

This section provides citations for the facts and assertions in this letter. Several are footnoted above, but we have gathered the rest here to avoid lengthy footnoting.

Skuna's "Natural, Pristine Ocean"

<www.skunasalmon.com/our-water>

Grieg Production Capacity in Nootka Sound

http://www.pac.dfo-mpo.gc.ca/aquaculture/licence-permis/docs/finfish-pisciculture-eng.htm

Grieg Annual Production and 2010 Profits

http://www.nyhetstjenester.no/grieg-seafood-annual-report-2011/board-of-directors-report/

Marine Mammal Deaths

"Nuisance Kills 1990-2010" <www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/docs/mar_mamm/seal-phoque/licence-stat-permis-eng.htm>

"Authorized Marine Mammal Control Activities, January-March, 2011" <www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/docs/mar_mamm/control-lutte/2011-Q1-T1-eng.htm>

Dr. Michael Kent on Salmon Pathogens

Cohen Commission Technical Report 1: Infectious Diseases and Potential Impacts on Survival of Fraser River Sockeye Salmon. February, 2011. Executive Summary, p. i. <www.cohencommission.ca/en/pdf/TR/Project1-Report.pdfFebruary 2011>

IHN Outbreaks "Not Uncommon" in Salmon Farms

"Investigation of the 2001-2003 IHN epizootic in farmed Atlantic salmon in British Columbia" by Sonja Saksida, BSc DVM MSc. <www.agf.gov.bc.ca/ahc/fish_health/IHNV_report_2003.pdf>

IHN Outbreaks in Washington in 2012

<www.kitsapsun.com/news/2012/may/25/states-first-appearance-of-fish-killing-virus-at/>

IHN Outbreaks in BC in 2012

<www.cbc.ca/news/canada/british-columbia/story/2012/06/02/bc-salmon-farm-virus.html>

Grieg 2011 Furunculosis Outbreak

Grieg 2011 Board of Director's Report. <www.nyhetstjenester.no/grieg-seafood-annual-report-2011/board-of-directors-report/>

Piscine Reovirus and ISAV in BC Waters

Cohen Inquiry Highlights Report, Watershed Watch Salmon Society, p. 63-64. <www.watershed-watch.org/wordpress/wp-content/uploads/2012/07/CohenInquiryHighlightsReport.pdf>

Dr. Miller also reported that her lab found 25% of Creative Salmon's Chinook tested positive for ISAV (page 112, line 39) and that 25% of migrating wild sockeye also tested positive for ISAV. Mr. McDade also inquired about other viral testing, Dr. Miller replied: "We did find fish positive for the… [piscine reovirus], which is thought to be causing HSMI [Heart and Skeletal Muscle Inflammation]…We see positives for that in our [wild] sockeye salmon, as well."

Justice Cohen's "serious and Irreversible"

Cohen Commission Final Report, "The Uncertain Future of Fraser River Sockeye," Volume 3, p. 92.
<http://www.cohencommission.ca/en/pdf/FinalReport/CohenCommissionFinalReport_Vol03_04.pdf#zoom=100>

Astaxanthin use by Industry

<www.farmedanddangerous.org/salmon-farming-problems/health-concerns-chemical-use/dependence/>
<www.bellona.org/aquaculture/artikler/Dyes_in_salmon>

Use of Deltamethrin by Salmon Farmers to Control Sea-Lice Outbreaks

<www.dfo-mpo.gc.ca/aquaculture/sustainable-durable/rapports-reports/2009-M17-eng.htm>

Cooke Aquaculture and Cypermethrin Charges

<www.cbc.ca/news/canada/new-brunswick/story/2011/11/02/nb-company-charged-in-lobster-death.html>

Appendix II: Updated Information Provided by Grieg Seafood BC (Skuna Bay)

February 6, 2013

Long Beach Aquarium of the Pacific
320 Golden Shore, Suite 100
Long Beach, CA 90802 USA
Attention: Kim Thompson, Program Manager
Seafood for the Future Program Via email: kthompson@lbaop.org
Dear Kim;

Re: Request for Information January 22, 2013

In reply to your January 22, 2013 email regarding Grieg Seafood BC's practices, I would advise the following.

Query Activity	Grieg Information
List of all marine mammal interactions over the past 5 years (2008-2012)	See attached. Lethal control is employed only after all other efforts to corral a marine mammal and redirect it to the natural environment have failed. Only certified professional marksmen are employed for lethal control, which decision can only be made by the Managing Director of Grieg Seafood after full investigation of all efforts made in an instance. Acoustical deterrents are not allowed for use in BC.
List of all viral/bacterial positives at Grieg facilities from 2008-2012	See attached.
Copy of the Fish Health Management Plan	See attached.
Percentage of Imported Eggs	No eggs are imported.
Use of Lights	See attached.
A list of all of Grieg BC's affiliations with the First Nations and local communities	Grieg Seafood has signed cooperation agreements with two First Nation groups in whose territories their farms are operating. Grieg is also engaged either in relationship-building activities or formal negotiations with four other First Nations toward cooperation agreements. To respect the independent governing authority of each First Nation's Chief or their negotiating representative,

	Grieg Seafood does not make public the names of First Nations with whom it is negotiating, until a mutually-agreed upon media release is drafted announcing the formal signing of a cooperation agreement. Only the Mowachaht Muchalaht First Nation has agreed to the publication of their name in a media release. Grieg BC has contributed annually to fundraising, social and community events in numerous Vancouver Island communities. In 2012 Grieg contributed both cash, donations of fresh and smoked salmon and volunteer time to more than 60 organizations related to sports, arts & culture, national holiday events, First Nations, education and health (hospice, hospital foundation, disease research, food banks, charitable organizations). In addition Grieg contributes annually to the wild hatchery activities of five salmon enhancement organizations. They are the Nootka Sound Watershed Society, Campbell River Salmon Foundation, Powell River Salmonid Society, Sunshine Coast Salmon Enhancement Society and Pacific Salmon Foundation.
The Skuna Bay name	The name 'Skuna Bay' is the geographical location of a bay on Nootka Island on the west coast of Vancouver Island. It is not an aboriginal name and there is no royalty arrangement with a First Nation. This name was selected in consultation with the First Nation in the whose traditional territory Nootka Island is located. To respect the cultural values and importance to First Nations groups of protecting their traditional languages, Grieg Seafood does not use aboriginal words for its branded seafood.
A list of studies commissioned by Grieg on wild salmon, the BC marine ecosystems, and/or improving farming practices to mitigate the industry's environmental impacts	• Sakinaw Lake Eelgrass Planting Project • Lingcod Egg Mass Survey • Abalone Survey • Conuma River Channel Restoration Project (incl. 5 year post-project monitoring) • Campbell River Estuary Restoration Project (incl. 5 year post-project monitoring) • Burman River Restoration Project (incl. 5 year post-project monitoring; 2013) • Best Practices Workshop – Seal & Sea Lion Interactions (2013) In addition, Grieg Seafood contributes annually to the wild hatchery activities of the following salmon

	enhancement organizations: • Nootka Sound Watershed Society • Campbell River Salmon Foundation • Powell River Salmonid Society • Sunshine Coast Enhancement Society • Pacific Salmon Foundation

We have provided all of our internal control documents for your review. These encompass more than 70 individual Best Management Practices and Standard Operating Procedures that are used to direct our day-to-day operations. All of these documents that have been provided are the basis of our farming intellectual property and as such are to be kept confidential. They were provided to your organization specifically for the purpose of completing your due diligence related to an inquiry with respect to verifying that we are doing what we say.

I have enjoyed working through this process to you – this process demonstrates that we are committed to farming the oceans responsibly and respectfully.

Yours truly,

Marilyn Hutchinson

Marilyn Hutchinson
Director Sustainability & Growth
Grieg Seafood BC Ltd.
Tel. (250) 286-0838, ext. 112
Email: marilyn.hutchinson@griegseafood.com

Copy:
Stewart Hawthorn, Managing Director
Dave Mergle, Director

Attachments:
Grieg Seafood 2008-2012 Marine Mammal Interactions
Grieg Seafood Positive Diagnostic Results 2008-2012
Grieg Seafood FHMP rev 2011 apr 5 sa (currently 120 individual policies)
Grieg Seafood Annual Light Use 2011
Grieg Seafood Annual light Use 2012
Grieg Seafood Best Management Practices BMPs (currently 14 individual policies)
Grieg Seafood Brood Standard Operating Procedures SOPs (currently 8 individual policies)
Grieg Seafood Freshwater Standard Operating Procedures SOPs (currently 26 individual policies)
Grieg Seafood Marine Standard Operating Procedures SOPs (currently 26 individual policies)

Appendix III: Updated Information Provided by Marine Harvest Canada

Contents

Environmental Leadership by Marine Harvest Canada

The following initiatives differentiate Marine Harvest Canada operations and demonstrate our commitment to environmental sustainability:

- **Vaccination with all available vaccine products** – MHC was the first BC producer to vaccinate all fish stock for infectious hematopoetic necrosis virus (IHNv) as well as the bacterial diseases furunculosis and vibriosis. As a result, while other companies had IHNv disease episodes in 2012, no MHC site detected the disease. All Atlantic salmon producers have now committed to IHNv vaccine use.

  This year, MHC is trialing the use of the Renogen vaccine for bacterial kidney disease (BKD). This bacterium is common in the environment and is routinely detected in Pacific salmon species. In Atlantic salmon, the disease is generally controlled with good husbandry – antibiotic treatment is rare. Even so, the only antibiotic treatment choice is Oxytetracycline which requires larger amounts of active ingredient to control disease. If the vaccine is effective, long term antibiotic use will be further reduced.
- **SLICE resistance studies** – contracted third-party organization to study efficacy of SLICE treatments and to conduct bioassays. This work has confirmed that reduced susceptibility (or increased resistance) of sea lice to SLICE is not occurring or likely to occur on MHC farms.
- **Wild salmon monitoring** – 5 year program with DFO and interested parties for sea lice (and some disease) monitoring of wild salmon species in two operational areas.
- **Harvest boats for sea lice control** – modified harvest boats to ensure the filtering of discharge waters during harvest thereby reducing the opportunity for sea lice transmission into the environment.
- **Certification goals** – plans to apply Global Aquaculture Alliance Best Aquaculture Practice 4-star certification to operations by December 31, 2013, which includes certification for the following:
  - ★ BAP Salmon Farms standard – all marine farms prior to harvest, 14 certified in 2012 and 10 audits planned in 2013.
  - ★ BAP seafood processing standard

- ★ BAP hatchery standard – not currently available.
- ★ BAP feed mill standard – MHC's feed manufacturer, Skretting Canada, was certified to this standard in October 2012.
- **Antifoulant use** – antifoulant compounds are no longer applied to MHC nets. Frequent in-situ cleaning ensures minimal impact of biological material on the benthic community.
- **Storm-resistant containment systems** – many sites have transitioned from square net pen cage structures to independent circular pens that better resist damage due to storms.
- **Moorings and net standards** – moorings and nets meet the stringent Norwegian (NS9415) standard.
- **Containment technology research** – trialing new semi-rigid containment net technologies 1) to study best predator avoidance 2) cleaning ease to support best water quality and oxygen levels for fish growth and welfare. It is hoped that these new containment technologies will virtually eliminate negative predator interactions.
- **Beach cleanups** – MHC farm site personnel conduct monthly beach cleanups of shores near the farm.
- **Dialogue with eNGO groups** – extensive dialogue process with CAAR (Coastal Alliance for Aquaculture Reform) to develop mutually-beneficial communications and research efforts. While this six year dialogue ended in 2012, initiatives like the Broughton Archipelago sea lice management plan (www.bamp.ca) continue. Additionally, MHC has signed agreements and ongoing dialogue with WWF Canada and Ducks Unlimited Canada.
- **Corporate sustainability reporting** – 4 year program for corporate sustainability reporting, this data: assesses status regarding various social and environmental parameters; identifies areas requiring improvement; and ensures transparency in environmental and social practice.
- **Habitat compensation projects** – habitat compensation through eel grass transplantings in the Klemtu area as well as artificial reef construction in the Kyoquot and Broughton Archipelago areas.
- **Benthic assimilation capacity** – farm site production is matched to the capability of the ocean environment at that location with adjustments made on a site by site basis to achieve minimum impact and maximum sustainability.
- **Cage array alignment / environmental impact** – continual improvements to cage array position to access greater tidal energies or depth that help to reduce measurable sediment impacts.
- **Hard bottom environmental monitoring** – Marine Harvest Canada (MHC) initiated and lead collaborative project with other BC companies and scientific experts to develop regulations to monitor hard-substrate benthic floors.
- **Processing plant effluent** – initiated industry-leading waste water treatment at MHC's Port Hardy Processing Plant.

References

Ruggerone G.T., Peterman R.M., Dorner B. and Myers K.W. (2010) "Magnitude and Trends in Abundance of Hatchery and Wild Pink Salmon, Chum Salmon and Sockeye Salmon in the North Pacific Ocean" *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science* 2:306-328.

Wildlife and Predator Interactions

- What kind of control measures are taken against predators?

Marine Harvest Canada has specific policy (Environmental and Biodiversity Policy) and Standard Operating Procedures that minimize interaction with wildlife. The philosophy and daily required activities of these documents are fully integrated into farming operations and all farm staff receive training and reinforcement of their importance. Below are some of the passive measures which help reduce opportunities for negative wildlife interactions. Pacific Aquaculture Regulation (PAR) requirements (the complete PAR regulations are available at http://www.pac.dfo-mpo.gc.ca/aquaculture/licence-permis/docs/licence-cond-permis-mar-eng.pdf) do not allow the use of acoustic deterrents for seals or sea lions and state specific requirements for the use of lethal interference.

Risk	Control Measure
Fish mortalities as an attractant	*Routine mort checks and retrieval *Appropriate mort disposal and containment *Mortalities stored in separate area away from main production *Surfaces exposed to mortalities are cleaned
Fish feed as an attractant	*Feed storage in specific area with limited access (doors close off feed shed) *Partially used feed bags closed *Feed spills cleaned up *Feed stored so that oldest is used first *large one tonne bags of feed have liners and are shrink wrapped *Grates over feed holds *Endeavour to feed below bird exclusion nets
Access via farm structures or unsecured areas	*Nets installed correctly (appropriate anchoring for bottom topography, net type, current, tides, depth) *Nets inspected on routine basis *Nets extend 1m out of water and are affixed to handrails *All farm buildings/structures can be closed off and locked *Predator nets (full secondary net wall) as required *Shark guards (bottom secondary net) as required *Bird (surface enclosing) nets *Separate staff living quarters with closure, designated areas for eating *Sites separated from shore (no walkways)
Random predator attacks	*Staff surveillance above water structures *In-pen cameras *Routine diver inspections *Daily site inspection report *Garbage stored in secured containers

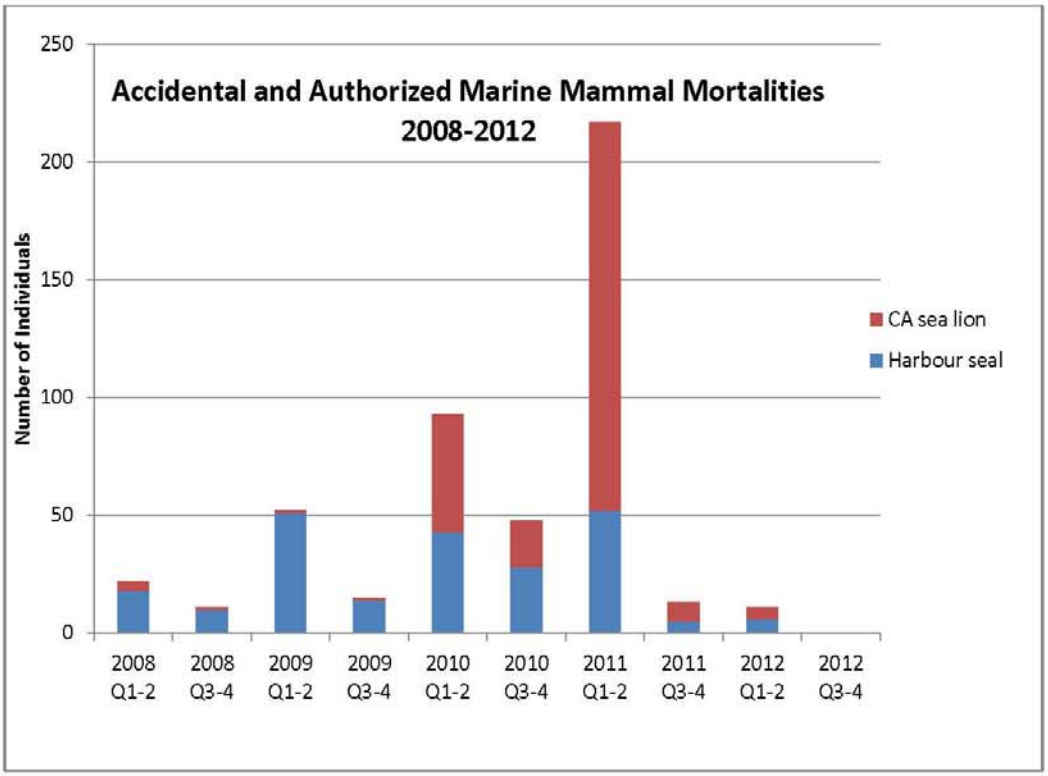
Even with good practices and passive control measures in place, in some Marine Harvest Canada production areas, sea lion populations have increased exponentially compared to historical numbers and damage to nets from such large numbers is a threat to the integrity of the containment system increasing the likelihood of fish escape. As a result, in 2011 Marine Harvest Canada dispatched a relatively large number of sea lions. Recognizing the unacceptable nature of this response and the need to find an alternative way to deter predators, Marine Harvest Canada has adopted a non-lethal control policy and is currently conducting a study with various new and robust containment net technologies to determine the best options for predator exclusion.

Additionally, since September of 2011, Marine Harvest Canada has intensified its internal authorization requirements for lethal interactions (see press release "Marine Harvest Canada takes immediate action to reduce seal and sea lion kills"). Predator mortality is only allowed where multiple efforts to deter the animal have been ineffective and all options exhausted and where the animal is deemed to be an immediate threat to 1) human health and safety and/or 2) the integrity of the containment system.

- Are data available on predator or other wildlife mortalities?

Predator and wildlife mortality numbers for the BC industry are updated quarterly on DFO's website.

The following bar graph indicates total number of accidental and authorized marine mammal mortalities at all Marine Harvest sites for the years 2008-2012. Each year is shown in two parts: Q1-2 represents January to June and Q3-4 represents July to December. The large increase in mortalities in early 2010 and especially in early 2011 was due to substantial increases in sea lion populations in two production areas. Reduced marine mammal mortalities since late 2011 correspond with the introduction of intensified internal authorization requirements. No accidental or authorized kills were recorded in Q3-4 2012. It should be noted that accidental mortalities are infrequent and represent a small fraction of overall mortalities.



- Are mortalities sufficient to negatively impact their populations?

While the loss of any individual animal is unfortunate, mortality numbers are small compared to population sizes and; therefore, these interactions are likely to have no impact at the population level. Lethal deterrence is only considered as a final course of action when all other efforts have failed; in cases where deliberate mortalities

have increased, this has always been in response to the threat of net damage due to an exceptional increase in the predator population in an area.

- Are any protected or endangered species affected?

PAR requirements only allow lethal deterrence authorization for California sea lions and harbor seals. Neither of these is a protected or endangered species. Special authorization is required for other species (e.g. Stellar sea lions). MHC has had no accidental or authorized mortality of any other marine mammals, including Stellar sea lions.

References

Read A.J., Drinker P., and Northridge S. 2011 "Bycatch of Marine Mammals in U.S. and Global Fisheries" *Conservation Biology* Vol. 20, No. 1, 163-169.

Chemical Use

- Are reliable records available of chemical use on farms?

Records are maintained of all treatments given during the production cycle. These records include both written (e.g. prescriptions, population harvest declaration forms) and production software records. Copies of paper records are maintained on site (with the fish receiving treatment) and with the company Veterinarian. Treatment information is provided to both DFO and the Canadian Food Inspection Agency (CFIA). DFO receives this information in quarterly reports as well as a population harvest declaration form which accompanies harvested fish to the processing facility.

Marine Harvest Canada no longer applies antifoulants on any of its nets. Nets are now cleaned in-situ with a frequency commensurate with the amount of biological growth on the net (temperature and daylight dependent). As nets are replaced, new nets will not have any antifoulant treatment.

- Which chemicals are used during the production cycle, how often? (e.g. antibiotics, piscidides, herbicides, pesticides, antifoulants etc)

Chemical use during production generally falls into two categories: disinfectants and therapeutants. Marine Harvest Canada no longer uses antifoulant treatment on any of its production nets.

Disinfectant use is limited to small amounts used to surface disinfect footwear as well as equipment which is brought to the site. This use ensures biosecurity and food safety are safeguarded by eliminating growth and transmission of pathogens.

Therapeutant usage during marine production include antibiotics, anesthetics (MS222 for anesthetizing fish during handling events such as routine sea lice counts), and SLICE (emamectin benzoate). MS222 is used monthly on small groups of fish (3 groups of 20 each) that are physically handled during sea lice monitoring. The use of anesthetic reduces stress and safeguards fish welfare. On infrequent occasions when lethal sampling is required for health screening, weight sampling etc., fish will be anesthetized with MS222 as well.

In BC, SLICE is the only treatment option for sea lice. Prophylactic SLICE treatment for smolt entries is not done in BC (numerous sea lice treatment options and prophylactic use are common practice in other salmon farming jurisdictions). SLICE treatment is prescribed to conform to government regulated thresholds, not to address

farm fish morbidity. While some sites never receive a treatment, on average, BC salmon farms receive 1.2 treatments during the marine production cycle (approximately 20-22 months).

Antibiotic treatments are milled into the feed and require a veterinarian prescription. Only four antibiotics are authorized for use in BC: florfenicol, oxytetracycline, Romet-30, and tribrissen. As well, brood fish receive erythromycin injections prior to spawning to control transmission of bacterial infection from one generation to the next. As all fish receive vaccines for common pathogens prior to saltwater entry, antibiotic treatment is rarely needed and the amount used is minimal.

- To what extent are active chemicals or by-products released to the environment?

By only utilizing in-feed treatments, reducing feeding rates and monitoring feeding behaviour, the maximum uptake of the therapeutant is achieved and the amount of waste medicated feed entering the environment is minimized.

Regarding sea lice therapeutant use, salmon farming in BC differs greatly from other salmon farming jurisdictions as 1) only one therapeutant, SLICE, is used to treat sea lice infections (other treatments used worldwide include teflubenzuron as an in-feed treatment and azamethiphos, cypermethrin, deltamethrin, hydrogen peroxide, dichlorvos and pyrethrins as bath treatments) 2) relative to other salmon farming jurisdictions, BC farmed salmon receive very few therapeutant treatments (and consequently, the amount of therapeutant used is less). As well, it should be noted that these sea louse treatments are the result of government mandated interim wild salmon conservation objective, they are not due to fish health and welfare concerns. This differs from the experiences of salmon farming jurisdictions in the Atlantic Ocean (i.e. Canada's East Coast, Norway, Scotland, Ireland) where, if unchecked, the aggressive nature of *L. salmonis* can and does cause farm fish health problems –thus requiring treatment to prevent or treat morbidity. It has now been determined that the reason *L. salmonis* infestations do not cause the same health concerns in BC and BC does not experience the ever-increasing numbers of sea lice on its farmed fish is that the Pacific *L. salmonis* is a separate species from the organism of the same name in the Atlantic Ocean (Yazawa 2008).

A final source of chemicals on salmon farms is disinfectants. Disinfectants are used for footbaths, equipment, staff gear etc. to promote biosecurity and reduce/eliminate transmission of pathogens. Footbaths represent the biggest use on site and once the disinfectant is no longer active, the spent solution is disposed of in totes that hold site mortalities stored for disposal (mortalities from these totes are collected by contractors and transported to land-based composting facilities).

- Is there any evidence of impacts to non-target organisms?

There is still much debate about the impacts of chemical use:

"The key issue regarding aquaculture activities and their potential to have environment impacts is: What are the cumulative impacts/effects? This question can be asked strictly in the context of chemicals i.e., are there cumulative effects associated with repeated exposure to one compound, to chronic exposure to one compound, to exposure to mixtures of chemicals, etc. The question can also be asked in the context of multiple environmental stressors: are chemicals likely to have a greater effect at high temperatures, under hypoxic conditions, under varying pH conditions? These are very complex questions with no easy answers. But they are also extremely relevant in an overall assessment of effects and pathways of effects. Reviewers of this document have correctly pointed out that while it is true that firm linkages have not been established between certain

chemical inputs and effects, the weight of evidence suggests that linkages exist. The authors agree with this assessment and while promoting increased research to address the uncertainty, also promote application of the precautionary principle to ensure environmental sustainability of the aquaculture industry in Canada." (Burridge et al. 2010)

While chemicals associated with medicated feed or antifoulant use may accumulate in sediments and be potentially released via resuspension, there is evidence that chemicals in the benthos are bound in the sediments and this decreases toxicity (Brooks 2003).

SLICE demonstrates low water solubility and high adsorption to particulate matter (such as feces and waste feed) (Scottish Executive Central Research Unit 2002). Some argue that there is the potential for SLICE® to accumulate in sediments (through repeated application) and enter the food chain through organisms like crabs, mussels and oysters. However, one study reported that SLICE® was not detected in sediment samples collected near a fish farm for 10 weeks after treatment and no positive results were measured in mussels after 4 months (Burridge et al. 2008). Additional studies conducted at active sites did not find a relationship between levels of SLICE® in sediments and benthic community changes (Black et al. 2008).

A Scottish Executive Central Research Unit report (2002) states that antimicrobial compounds readily associate with particulate matter, and that measurable residues in sediments is generally localized beneath the farm. This report considers that environmental risk of antimicrobial compounds in aquaculture is very low and states that use is insignificant compared to agricultural use.

Regarding research specific to British Columbia, "There are very few published data regarding the presence of antibiotics (in sediments and biota) of aquaculture origin in Canada. Cross et al. (1997) reported that fauna adjacent to a small salmon farm in the Strait of Georgia showed no evidence of OTC in their tissues except for one crab sampled from directly under a cage. Hargrave et al. (2008) studied growth inhibition in *Aeromonas salmonicida* exposed to a range of OTC concentrations. They collected sediments samples near aquaculture sites, near sewage outfalls and at reference sites. Evidence of antibiotic resistant strains of bacteria was found in samples from all sites. Of particular interest is the finding that there are antibiotic resistant bacteria in fish food. This supports an assertion by Kerry et al. (1995) that fish food may be a source of resistant bacteria." (Burridge et al. 2010)

In areas of high aquaculture activity risk associated with persistence of residues will be completely different than in British Columbia where farms are sited further apart or in the freshwater context (Burridge et al. 2010).

- Is there any evidence of resistance to chemical treatments?

In BC, there is no indication of resistance to chemical treatments. To reduce the development of SLICE resistant sea lice, the number of SLICE treatments per fish grow out cycle is limited to three in Canada. In BC, actual use never exceeds two treatments per cycle and on average a farm will receive 1.2 treatments per production cycle. PAR requires licence holder to report the use and amount of any medicated feed administrated.

To promote ongoing monitoring of chemical resistance a number of mechanisms are in place:

- Where antibiotic treatment is required and the bacterial pathogen is readily cultured, a drug susceptibility assay is always conducted.
- In the area of highest salmon farm density (five active farm sites) in BC (Okisollo Channel) an agreement between the three companies with farm sites in the channel requires communication and coordination

(when possible) of medicated feed treatments. As well, the three companies have agreed to collaborate on annual bioassay testing for SLICE use in this shared area.

Marine Harvest Canada has additionally contracted a third party organization to 1) study the efficacy of SLICE treatments on its farms 2) conduct bioassays on sea lice from a variety of Marine Harvest farm sites. Both assessments have shown no pattern of resistance i.e. SLICE treatments have been efficacious and sea lice are susceptible to SLICE treatment.

How antibiotic use in BC Salmon Farming differs from other food animal production

- The volumes of antibiotics used in salmon farming are very small in comparison to other food animal or human use.
- Farmed salmon health is overseen by a veterinarian throughout the production group's life cycle. There is generally no requirement for other food animals to have this, or any, veterinary oversight of animals or stock.
- All antibiotic (Ab) treatment requires a veterinary prescription. Other food animal production does not require a prescription – Ab use is at the farmer's discretion and medicated feed can be purchased at the local feed supply store. As no veterinary prescription is required, there is no follow-up that a treatment was conducted appropriately. Multiple treatments with the same antibiotic are possible and follow-up regarding the drug efficacy or resistance development may or may not occur.
- Antibiotics are never used prophylactically or as growth promoters in farmed salmon. In other food animal production, some statistics suggest that the largest antibiotic use is in the absence of disease.
- Antibiotic use in farmed salmon is only short term (no more than 14 days) whereas Ab use in other food production animals can be continuous throughout long periods of the life cycle.
- In farmed salmon all medicated feed treatments have a withdrawal period and this is based on degree days (to account for the slower metabolism of a cold-blooded species in cooler water temp). In food production animals, not all antibiotics require a withdrawal period prior to slaughter. Thus, it is possible for an animal to receive an antibiotic treatment up until the day it goes to market.
- All information on any drug treatment in farmed salmon must accompany the production group through to harvest and processing and is provided to the Canadian Food Inspection Agency and the USFDA (if marketed in US). As use is not controlled in other farm animals, there are no checks on usage.
- Farmed salmon are cold-blooded, other major food production animals are warm-blooded: the pathogens that infect farmed salmon are not pathogens that cause disease in humans or other warm-blooded animals. Thus the transfer of disease or Ab resistant disease from farmed salmon to humans does not occur and the risk of transfer of Ab-resistant genes to land-animal pathogens is very small.
- More context - consider the implications of other large and sometimes unnecessary use of Ab – in make-up, hand creams, soaps for humans and as sprays for vegetable/fruit crops

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Fishmeal and Fish Oil

Are the fisheries certified, or is any evidence available regarding their sustainability status?
Skretting, Marine Harvest Canada's only supplier of fish feed, provided the following information (Nesse 2008) about the sustainability of their marine product sourcing:

As an industry leader, Skretting feels obliged to guide the development of the fish feed sector towards responsible behaviours and increasing sustainability, characteristics that are essential for the long-term future. This commitment is brought into practice through sourcing marine products from responsibly managed stocks.

This means that suppliers of marine products to Skretting must document that fish used to produce meal and oil have been responsibly sourced, without depleting fish stocks or damaging the wider marine environment.

To be an approved supplier of marine products to Skretting, the supplier will be evaluated, and at certain intervals audited, by Skretting. We require our suppliers provide adequate information to demonstrate marine products delivered to Skretting originate from:

1. Fisheries regulated by official management controls and total catch limits
All fisheries that supply of marine products to the Skretting must be subject to government controls to conserve stocks and prevent over-fishing.

2. Official management controls must be based on scientific monitoring and assessment
Controls on the fisheries used for marine products shall be based on regular monitoring and assessment of the status of individual stocks, conducted by independent or Government-based scientific organisations.

3. Each delivery of marine products must be accompanied by documentation stating the fish species used in the manufacturing of the product.
In order for Skretting to control and verify points 1 and 2 have been fulfilled, the supplier must provide documentation about the species from which marine products have been produced.

4. Marine products have not been produced from endangered fish species.

The supplier guarantees that the species used for production of marine products (with reference to point 3) are not classified as Critically Endangered or Endangered in the IUCN Red List (The International Union for the Conservation of Nature and Natural Resources).

Economic FCR (eFCR)

- Economic FCR (i.e. total feed provided divided by total harvest weight)

For Marine Harvest Canada fish harvested in 2012, the average eFCR is 1.35. Based on fishmeal and fish oil inclusion levels in diets, this eFCR equates to a FIFO (fish in, fish out) ratio of 1.19.

References

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Disease

- Are data available from pathogen and parasite monitoring on the farms?

Fish health reports for farms are reported to DFO on a monthly basis and stored in a central database. This database is not publicly available. Farm fish health data collection is audited by DFO and reported publicly at http://www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/health-sante-eng.htm. Similar to fish health monitoring, sea lice on farm sites is monitored monthly and reported to DFO. This information is audited and data is available at http://www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/lice-pou-eng.htm.

- What are the key characteristics of the production system or management that would prevent or allow the transfer of pathogens or parasites from the farm into the wild?

All production fish receive vaccination at the hatchery when 1) the fish are a minimum of 20 grams in size and 2) at least four to six weeks prior to transfer to a saltwater net pen site. These vaccines are for diseases whose microbial agents are commonly observed in the marine environment, including two bacterial diseases (vibriosis and furunculosis) and a viral disease (infectious hematopoetic necrosis). Marine Harvest Canada was the first BC production company to vaccinate all of its fish with all available vaccines and is currently trialing a vaccine for another common disease, bacterial kidney disease (BKD).

All sites are subject to continuous monitoring in the form of routine and unscheduled visits by fish health professionals. Fish behavior, appetite, site hygiene controls and mortality are monitored and reported. Mortalities are collected and examined routinely. Examination includes cause of death classification –most often death is not a result of disease. Farmed fish mortalities can result from environmental causes (for example, toxicity or gill damage from plankton blooms), from mechanical damage (for example, rubbing against net pen structures and equipment during storms) and can occur when individual fish adapt poorly to the marine environment (called 'poor performers'). If disease is suspected and/or there is increased mortality, a health professional will examine the fish to confirm diagnosis.

Sea lice monitoring occurs at least once per month at British Columbia farm sites. During periods of outmigration of juvenile wild Pacific salmon this monitoring increases to twice per month as required by PAR.

Additionally, the entire fish health and sea lice monitoring program is audited by Fisheries and Oceans Canada. These audits include onsite documentation audits – records of monitoring and reporting – as well as hands-on sea lice counts and mortality screening by government auditors.

Wild fish monitoring is the responsibility and mandate of Fisheries and Oceans Canada. Marine Harvest Canada has partnered with Fisheries and Oceans Canada and other parties for specific monitoring initiatives in several of our production areas – Klemtu and the Broughton Archipelago.

- Is evidence available of interactions with and/or impacts on wild species resulting from pathogen and parasite transfer from the farm? Are impacts on wild species sufficient to significantly impact their population size?

In BC, discussion and study of pathogen or parasite impacts have centered on two debates: sea lice transmission from farmed salmon to outmigrating pink salmon juveniles in the Broughton Archipelago and pathogen transmission from farmed salmon to outmigrating Fraser River sockeye.

Regarding sea lice transmission, the most comprehensive study to date (Marty et al. 2010) utilized historical farm data and 60 years of pink salmon data to determine that while farm fish are the main source of sea lice on the Broughton Archipelago's outmigrating wild pink salmon, there is no statistical correlation between lice levels on the salmon farms and survival of wild pink salmon populations. That is, while individuals may be affected, there is no population-level effect.

With regards to pathogen transmission to Fraser River sockeye stocks, Noakes (2011) found that incidence of farmed salmon disease which is high risk to sockeye salmon is very low and does not pose a significant risk. Additionally, Noakes found no significant correlation between the number of sea lice on farmed salmon and the Fraser River sockeye returns. As such, he found no correlation between farmed salmon production and Fraser River sockeye salmon returns.

References

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Source of Stock

- What is the source of the stock on the farm? (e.g. source of ova, smolts etc)

Marine Harvest Canada is self-sufficient for its production needs. That is, eggs for the next generation are taken from MHC broodstock raised in BC.

Both Atlantic salmon strains used in BC were originally sourced from Europe. All imports were originally purchased as Schedule II screened eggs based on the "Fish Health Protection Regulations Manual of Compliance" (DFO 1984) and later from certified disease-free sources. Upon arrival in Canada, these eggs and resulting young were quarantined. Since 2004, all eggs imported into BC were sourced from Iceland and there have been no imports since 2009. The Iceland company providing these eggs is unique as it is land-based and draws water from deep saltwater wells which do not support any fish life and; therefore, are not contaminated

with fish pathogens. Even so, all imports require disease-free certification prior to shipment as well as quarantine at the receiving facility.

References

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Lights

Lights are used on farm sites to prevent early maturation or grilsing of the salmon. Grilsing is a natural process that has negative outcomes –loss of fish growth and reduced product quality- for commercial production. In the past few years, the increased availability and performance of LED lights has allowed our facilities to move to these lights. Additionally, the lumens used are much less. Light use is controlled by Standard Operating Procedures that dictate type, luminosity, number and depth of lights based on cage size.

The concern with light use stems from attraction of smaller fish which then enter the net pen and become food. Several studies (Clarke 2004, Hay et al. 1996, Black 1992) have looked at the stomach contents of farmed salmon from lit cages and found that this is not the case. The most recent of these studies concluded "caged Atlantic salmon in this study consumed very few wild food organisms. The most common wild organisms were caprellids, which live on the side of netpen cages. We found no larval fish in the guts but there were a few fish larvae among the wild plankton in the vicinity of the farms."

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First Nation Communities

Marine Harvest Canada currently operates within the Traditional Territories of 20 Canadian First Nations. The company has formal agreements with ten of these Nations and five First Nation owned businesses. MHC's *First Nations Relations Policy* recognizes the governing rights of each Nation and fosters relationships based on: respect for cultural traditions; engagement and communication on issues related to the rights and interests of the aboriginal community; mutually beneficial relations based on alignment of common interests and aspirations; and cooperation to protect rights and interests and to address environmental, social and economic concerns associated with MHC operations.

The relationship between the Kitasoo First Nation and MHC is an excellent example of the partnership required in the development of these agreements and the long term economic and social benefits.

Kitasoo/Xai'xais First Nation

Having relied for decades on an economy based on the commercial salmon fishery, the Kitasoo First Nation faced extreme economic hardship when the industry collapsed. The Kitasoo dealt with their changing economic circumstance by developing an economic revitalization plan focusing on aquaculture, forestry and tourism. The leadership of the community has always believed in community decision-making based on consensus. Therefore, the movement to these new sectors involved considerable community discussion and debate. The positive and negative aspects of every development, every proposed logging cutblock, and every significant tenure application was examined - and granted or revoked by the people based on factual information and case study. This inclusive process reviewed developments from an economic, cultural, environmental and social perspective. The community's review of salmon aquaculture took over 1 ½ years to reach consensus and an agreement was signed with Marine Harvest Canada in 1998.

While the Kitasoo/Xai'xais people's involvement in finfish aquaculture may be viewed as controversial, the benefits to the Kitasoo/Xai'xais First Nation have been considerable. The increase in jobs, (a total of 55 people working full time) has brought not only increased wealth into the village but it has increased self-esteem and self-confidence in the young workers. For the first time in a long time, they feel that they have some options for the future, as many of the skills that they acquire will be transferable to other jobs.

A video describing this unique partnership and history of salmon farming in Klemtu can be viewed here http://www.youtube.com/watch?v=lkjl8IUwiEE&list=PLAWxOSIXRS68TLeOPAVt1JdHniFwXMmRM&index=1.

Kwakiutl First Nation

A collaborative agreement was signed in 2000.

Gwa'sala/'Nakwaxda'xw First Nation

A collaborative agreement was signed in 2000.

Quatsino First Nation

A collaborative agreement was signed in 2006.

MHC has similar agreements with Homalco, We Wai Kai, Wei Wai Kum and K'omoks First Nations.
MHC also maintains business to business agreements with First Nation owned businesses that provide services to MHC for harvesting, fish processing, freight transport and crew transport.

Community Involvement

MHC recognizes the importance of supporting the communities near our operations. This involvement comes in the form of community engagement through events, beach cleanups, enhancement program support, MHC BBQ trailer support for charities and employee-led initiatives. Information on community support can be found at:
http://www.marineharvestcanada.com/people_donations.php
http://www.youtube.com/playlist?list=PLA75A1C9BEE36158F

Community engagement also means working with groups concerned about salmon farming. In 2006, MHC started an extensive dialogue process with CAAR (Coastal Alliance for Aquaculture Reform) a coalition of seven environmental groups, to develop mutually-beneficial communications efforts. While this six year dialogue ended in 2012, initiatives like the Broughton Archipelago sea lice management plan continue. Additionally, MHC has signed agreements with WWF Canada and Ducks Unlimited.

Research Projects

Marine Harvest Canada supports and engages in research with various partners and agencies on a continuous basis. Areas of research include fish husbandry, fish health and safety, feeding and containment equipment design as well as environmental impact and pathways of effects. The following list is not exhaustive but indicates the wide variety of projects supported or undertaken directly by the company both in BC and in Europe.

Marine Harvest Canada R&D Projects		
Project	***Area of Interest / Benefit***	***Status***
Assessing role of sea lice in transmission of pathogens in farmed salmon	Farmed salmon health and welfare, wild population interactions	C
Alternative fish cage nets – measures of biofouling, durability and fish growth	Fish health and welfare, escape prevention, wildlife interactions, passive predator control	C
Production impacts with yeast cell derivatives	Fish health and welfare, natural feed ingredients	C
Effectiveness of ozonated water as an antimicrobial agent in primary processing	Food safety	C
Traditional clam garden rejuvenation project	Community relations, wildlife interactions, environmental sustainability	C
Processing plant and harvest vessel hygiene	Food safety	C
Harvest excellence	Food safety, product quality	C
Net trial	Fish health and welfare, escape prevention, wildlife interactions, passive predator control, alternative production systems	O
Fungus research project	Fish health and welfare including enhancement projects	O
Infectious Hematopoietic Necrosis virus (IHNv) – study of viral shedding, infective dose, and viral dispersion	Farmed salmon health and welfare, wild population interactions	O
Land-based Atlantic salmon grow-out using recirculation aquaculture system technology	Alternative production systems	D
Integrated multi-trophic aquaculture research network	Alternative production systems	O
Characterization of benthic impacts to hard bottom substrate from open net salmon farming	Environmental sustainability	O
Environmental effects of emamectin benzoate at BC marine cage farms	Environmental sustainability, wildlife interactions	O
Coastal and nearshore habitat classification for the Broughton Archipelago	Environmental sustainability	O
Assessment of impacts to natural beaches and culturally modified clam gardens in the Broughton Archipelago	Environmental sustainability, wildlife interactions, community relations	O
Monitoring and modeling of sea lice interaction with wild and farm salmon in the Broughton Archipelago	Wild population interactions, environmental sustainability, farmed salmon health	O
Modeling sea lice population dynamics and SLICE efficacy on farmed salmon in the Broughton Archipelago	Wild population interactions, environmental sustainability, farmed salmon health	C
Historical analysis of wild salmon in the Broughton Archipelago	Wild population interactions, environmental sustainability	O
Assessing control of Kudoa thyrsites in farmed Atlantic salmon	Product quality	O
Marine Harvest Group Technical Services R&D Projects		
Project	***Area of Interest / Benefit***	***Status***
Sea lice vaccine testing	Fish health and welfare, wild population interactions, farmed salmon health, non-medicinal sea lice control	C

Comparison of grower diets: diet composition, effect on performance, product quality, fish health, sustainability	Fish health and welfare, environmental sustainability	C
Temperature and salinity treatments for sea lice	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	C
Physical barrier technology for sea lice (1)	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	C
Light technology for sea lice (1)	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	C
Seawater functional diets review and recommendations	Fish health and welfare, environmental sustainability	C
Comparison of MH Canada and MH Europe breeding stocks using genetic markers	Fish health and welfare	C
Effectiveness of anti-lice diets	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	C
Sea lice management	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	C
Salmon louse genome sequencing	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	C
Caligus vaccine development	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	C
Securing health benefits of MH salmon through fatty acid profiling	Product quality	C
Vaccination and vaccination technique – impact on fish growth and melanin deposition	Fish health and welfare, product quality, wild population interactions	C
Algae derivative as in feed sea lice treatment	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	O
Physical barrier technology for sea lice (2)	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	O
Test audits for ASC standard	Environmental sustainability, community relations	O
Escape prevention project	Wild population interactions, environmental sustainability	O
Tarping option for sea lice treatment	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	O
Quantifying effects of fish densities in large scale fish farming – survival and fish performance	Fish health and welfare, product quality	O
Light technology for sea lice (2)	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	O
Vaccine benchmarking 2012	Fish health and welfare, wild population interactions	O
Cleaning fish oils used in salmon feeds – feasibility study	Product quality, fish health and welfare	O

Sea lice repellants	Wild population interactions, environmental sustainability, farmed salmon health	O
Wrasse farming	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	O
Wrasse health	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	O
Topilouse – a multi-disciplinary study of sea lice topical treatment	Wild population interactions, environmental sustainability, farmed salmon health	O
Salmon Louse Research Center	Wild population interactions, environmental sustainability, farmed salmon health	O
Plant extracts to treat sea lice	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	O
Sea lice removal technology	Wild population interactions, environmental sustainability, farmed salmon health, non-medicinal sea lice control	O
Salmon Aquaculture Dialogue	Environmental sustainability, community relations	O
International collaborative project to sequence Atlantic salmon genome	Farm and wild fish health and welfare	O

C – complete

O – ongoing

D – delayed

Appendix IV: Grieg Seafood BC Media Statement on the 2010 Marine Mammal Interactions

MEDIA STATEMENT: Grieg Seafood BC Ltd.

Grieg Seafood BC and Department of Fisheries and Oceans Reach Agreement through Environmental Restorative Justice Process at Gold River

Grieg Formally Accepts Responsibility for the Accidental Drownings of Sea Lions and Develops Best Practices for Marine Mammal Management

January 21, 2013

Campbell River, BC – Grieg Seafood BC, the Department of Fisheries Oceans and the community have reached an agreement regarding charges filed last year by DFO relating to sea lion and seal deaths in early 2010 at Grieg's farms located near Gold River on Vancouver Island's west coast.

Both organizations acknowledged that a prosecution process was unnecessary and less certain to result in a productive outcome. Grieg Seafood BC and DFO mutually agreed to address the drownings, a contravention of the Fisheries Act, through a Restorative Justice process involving the local community. Representing the affected community and the animals were local community members including elected officials, leaders from the local First Nations community, local tourism representatives and marine mammal experts from the Vancouver Aquarium and SMRU Canada, a marine mammal research company based in Vancouver. (A complete list of participants appears on page 2.)

During the resulting meeting, Grieg explained the events that led to the animal losses and also what they had done subsequently to prevent a similar occurrence. The community and forum members applauded Grieg's openness, willingness to explain what had happened and their commitment to non-harmful management practices. They were impressed by Grieg's responsible approach and appreciated Grieg's commitment to developing passive sea lion and seal management practices. It was acknowledged by all that Grieg's efforts to improve their practices have been very successful.

"We were very saddened by these accidental drownings. The number of animals around our farms that year was unprecedented and their behaviour changed. This is what led to some animals becoming trapped in our nets. As soon as the first incidents were discovered we reported the losses and moved to prevent further occurrences by installing and reconfiguring additional predator exclusions nets. Since then we have continued to invest in newly developed equipment and adapt our predator management program to prevent such incidents at our farms," said Stewart Hawthorn, Managing Director of Grieg Seafood B.C. Ltd.

"We appreciated the meeting and the opportunity to explain the situation and our vigorous response. The loss of these 65 sea lions and 4 seals is unacceptable and, as we shared previously, we are very sorry for what happened. We are committed to farming in a way that is respectful and responsible to the environment and local communities and we appreciated the community member's acknowledgement of our good efforts in this regard."

Grieg Seafood and others in this area observed an unprecedented rise in the number of California sea lions in the region beginning in the fall of 2009. We observed changes in the behaviour as the sea lions attempted to penetrate the fish nets and prey on the farm's salmon. Once Grieg had installed the additional anti-predator netting it was then adjusted to optimize its safety and effectiveness for marine life on both sides of the barrier with the aid of contract divers and other expert consultants.

It was acknowledged at the forum that prior to this time Grieg had never experienced a single sea lion or seal drowning at any of its farms in 10 years of operations.

Grieg continues to consider, modify and adapt new and improved netting and designs. The company is also sharing its experiences and learning to establish a set of best practices in marine mammal management with other similar farms and facilities.

As a result of the joint agreement and Grieg's acknowledgement of responsibility and comprehensive response, charges have been dropped and Grieg is pleased to support the following projects:

$5,000 towards the running of a passive sea lion and seal management workshop and publication of a best practices summary

$5,000 contribution to the Great Canadian Shoreline Clean-up with a request to target west coast Vancouver Island beaches

$90,000 contribution to the Nootka Sound Watershed Society for the purposes of community education (Aqua Van visits to the local communities and development of Marine Ecosystem information/education packages) and salmon enhancement projects in the Tahsis, Sucwoa, Leiner, Canton and Tsowwin Rivers

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About Grieg Seafood BC Ltd:
Grieg Seafood BC Ltd. is a salmon farming company established in 2000, with offices in Campbell River, a hatchery in Gold River and farms located on the east and west coasts of Vancouver Island. It farms approximately 14,000 metric tonnes of salmon per year and directly employs more than 120 people from communities on Vancouver Island and the Sunshine Coast of BC. Grieg's commercial activities support a wide range of rural communities and supplier companies on Vancouver Island and beyond.

Community Forum Participants:
Larry Andrews – Elder Advisor to the Chief Councillor of the Mowachaht Muchalaht Band
Jude Schooner – Mayor, Village of Tahsis, Dive Charter Operator
Kirsty Begon – Councillor Village of Gold River
Kent O'Neill – General Manager, The Lodge at Gold River
Dr. Dominic Tollit – Senior Research Scientist, SMRU Canada, (Sea Mammal Research Unit Ltd a joint venture with St. Andrews University)
Dr. Lance Barrett-Lennard – Senior Marine Mammal Scientist Vancouver Aquarium
Jason Knight – DFO Field Supervisor for Gold River Field Unit
Stewart Hawthorn – Managing Director, Grieg Seafood BC Ltd.
Blair Billard – Production Manager, Grieg Seafood BC Ltd.

Appendix V: Marine Mammal Interactions at Grieg Seafood and Marine Harvest Farm Sites from 2008-2012 Including Estimated Potential Biological Removal Rate Percentages

Marine Mammal Interactions at Grieg Seafood and Marine Harvest BC Salmon Farms 2008 - 2012

Harbor Seal Interactions						
	Grieg Seafood (produces approximately 13,500mt/yr)		**Marine Harvest** (produces approximately 45,000mt /yr)		**Total Interactions at BC Salmon Farms***	
	Interactions	%PBR	Interactions	%PBR	Interactions	%PBR
2008	7	**0.11**	28	**0.44**		
2009	5	**0.08**	64	**1.02**		
2010	7	**0.11**	70	**1.11**		
2011	4	**0.06**	56	**0.89**	71	**1.13**
2012	2	**0.03**	7	**0.11**	12	**0.2**
2008-2012 Total	25	**0.04**	225	**3.57**	83	**3.51**

California Sea Lion Interactions						
	Grieg Seafood (produces approximately 13,500mt/yr)		**Marine Harvest** (produces approximately 45,000mt /yr)		**Total Interactions at BC Salmon Farms***	
	Interactions	%PBR	Interactions	%PBR	Interactions	%PBR
2008	2	**0.02**	32	**0.35**		
2009	6	**0.07**	66	**0.72**		
2010	90	**0.98**	135	**1.47**		
2011	4	**0.04**	173	**1.88**	227	**2.47**
2012	3	**0.03**	5	**0.05**	8	**0.09**
2008-2012 Total	102	**1.11**	411	**4.47**	235	**4.7**

Note: Categories in the List of Fisheries are based on annual interactions within an entire fishery. Category II fisheries interact with 1-50 percent of the potential biological removal rate (PBR), or the number of individuals that could be removed from the population and allow the species to remain at sustainable levels. Category III fisheries interact with less than 1 percent of the PBR. Farm data is based on the numbers provided by Grieg Seafood, Marine Harvest, and the DFO Marine Mammal Interaction quarterly reports.

*Only lethal interactions for Total Interactions at BC Salmon Farms are publicly available from 2008 - 2010 so we did not include it in the data. The 2011 and 2012 data includes lethal control and accidental drowning incidents.

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