

# Aquaculture and Central West Newfoundland



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For further information on this report, or the larger research initiative, please visit [www.ruralresilience.ca/?page\\_id=109](http://www.ruralresilience.ca/?page_id=109).

# Preface

Communities and regions across Newfoundland and Labrador, and indeed the rest of Canada, are saddled with planning choices regarding development. These choices come in the form of both challenges and opportunities. How communities and regions respond, or not respond, to these choices shapes their collective future. Unfortunately, these planning and development issues are often unique from neighbouring communities and consume considerable time to discuss and plan.

In the fall 2012, students in the *Community and Regional Planning and Development* course in the Department of Geography at Memorial University of Newfoundland partnered with the Grand Falls-Windsor – Baie Verte – Harbour Breton Regional Council of the Rural Secretariat to explore and examine key land use planning issues. Based on regional priorities identified by the Regional Council, students examined land use planning in five key areas: aquaculture, access to crown lands, forestry, waterfront/cabin development, and tourism and recreation. Over the course of the fall term, students worked with Regional Council members to identify other jurisdictions in Canada dealing with similar opportunities and challenges. From these case studies, students have generated a series of recommendations. Over the past four months, the authors have shifted through academic, government, and community-based literature to generate this report. The concluding recommendations of the report serve as a catalyst for discussion among key stakeholders in the region; they are not to be viewed as prescriptive.

The opportunity for students to partner with the Regional Council is part of a larger community-based research initiative led by Dr. Kelly Vodden at the Environmental Policy Institute at Grenfell Campus, Memorial University (<http://www.grenfell.mun.ca/environmental-policy-institute>). This larger initiative received financial support from the Rural Secretariat, Government of Newfoundland and Labrador. For further information on the larger initiative visit [www.cwlanduse.ca](http://www.cwlanduse.ca).

This report represents a substantial contribution for land use planning in rural Newfoundland. The culmination of this work is a series of recommendations on the land use topic. Congratulations to the authors for building this important contribution and to the Regional Council for their partnership and support on this initiative.

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# Introduction

Within regional planning there are many themes, including animal health and welfare, social responsibility in public engagement, and ecosystem health. Aquaculture is an important part of the economy and is seen in areas across Canada and the world. When assessing the area of Central West in Newfoundland, it is of utmost importance to consider other areas that have experienced or are experiencing similar challenges. For the latter purpose we examine the following case studies; *Challenging the Aquaculture Industry Sustainability* and *Corporate social responsibility (CSR) Case Study Marine Harvest Canada Taking Leadership*. By examining other case studies one could try and find solutions to the challenges of the Central West area of Newfoundland.

A Scan of Land Use Issues (Mirza et al., 2012) describes the Central West area in Newfoundland as including Grand-Falls-Windsor, Baie-Verte, and Harbour Breton Region. It is the largest Rural Secretariat region on the island and covers over 30,000 square kilometers. There are 81 communities throughout the region, which is experiencing a decline in population. With the main economy focused on only three economic sectors, marine resources being one of them, it is vital to ensure proper attention is given to the aquaculture industry in the area. By combining the information from various resources, the Mirza report was able to highlight some issues surrounding the aquaculture industry. These issues include, but are not limited to: the need for infrastructure improvements, such as waste management; conflict between the aquaculture industry and other marine resource users; and aquaculture impacting traditional use areas.

The issues listed do not include references to other areas of study, or current local opinions. However, a community engagement initiative is being developed. The specific issues do carry merit within the overall themes mentioned previously, and considering other case studies would be an asset.

The Aquaculture from a Regional Perspective: Thinking of the Future report, published by the Grand Falls – Windsor – Harbour Breton – Baie Verte Regional Council of the Rural Secretariat, identifies the standing of aquaculture in the region. Aquaculture is seen as opportunity for rural areas to provide industrial growth, to increase provincial gross domestic product, and to create employment for both young and older citizens. In an attempt to develop a responsible and environmentally sustainable industry the region has developed short term (five to ten years) and long term (ten to twenty years) goals. They have recognized a need for the development and implementation of a management plan and expanded research into the future. It is noted many members feel the Department of Fisheries and Aquaculture need resources to implement a mandate, even though the government is a supporter and manager. Furthermore, there is seen to be a possibility of “an Integrated Multi-Trophic Aquaculture system as an innovative approach in increasing industrial economic gains and to [implement] friendlier environmental practices[...]” (Central West Regional Council for Rural Secretariat, 2008-2011). It is apparent Central West is trying to plan for the future.

It is not surprising that Central West has identified aquaculture as a priority considering that by the year 2030 aquaculture is expected to supply 50% of the world’s demand for seafood (Central West Regional Council for Rural Secretariat,

2008-2011). This would include species such as Steelhead Trout, Atlantic Cod, Atlantic salmon, and Blue Mussels; all a focus within Newfoundland and Labrador with 45 licensed salmon sites belonging to 5-6 companies and 50-60 licensed mussel sites. "The majority of finfish and mussel farm sites are located within Central West Region" (Central West Regional Council for Rural Secretariat, 2008-2011). It is priority for Central West to use the obvious opportunities in aquaculture to benefit rural areas, and that goals and objectives have to be in place.

One of the short term objectives that requires immediate action is biosecurity. Biosecurity is defined as "management practices that prevent healthy animal populations from being exposed to infectious or parasitic agents" (Central West regional Council for Rural Secretariat, 2008 -2011). This is essential since there have been examples of biosecurity failures, both within and outside of the province. One such example found in the Coaster News website is of an Infectious Salmon Anemia, or ISA, virus found at one of Gray Aqua Groups fish farms in Conne River on July 6, 2012. With 450,000 fish at the site it was important to try and prevent contamination to other fish in other netted areas (Coastal News, 2012). This would be one scenario Central West will try to avoid in the future as evident in the Aquaculture from a Regional Perspective: Thinking of the Future report where immediate action could include items such as "infrastructure, waste management, Bay Management Areas and a provincial sustainable management plan"(Central West regional Council for Rural Secretariat, 2008-2011).

Infrastructure is of concern as there is a lack of inflow and outflow wharves to be able to properly service each of the aquaculture sites. This lack of infrastructure expands to all the existing salmonid sites, and will be important for all upcoming sites that may be established as aquaculture opportunities are acted upon. This challenge is partially addressed as the provincial and federal governments will be funding part of the construction which is needed in communities such as Pool's Cove, Belleoram, St.Alban's, Conne River, Miltown, Hermitage, Gaultios, and Harbour Breton. The new wharves will reduce competition between fishermen and passenger service, and lowers the risks associated with potential contaminated wharves. A contaminated wharf could reduce growth, or aquaculture collapse resulting in financial lost, therefore it is essential that this infrastructure be address and continues to be monitored and addressed in the future (Central West Regional Council for Rural Secretariat, 2008-2011).

Another area requiring immediate action and will require continued monitoring is waste management. There is a stockpile of waste both organic and inorganic, including item such as "feed bags, ropes, nets, and plastic piping [with organic waste] consist[ing] mostly of fish offal" (Central West Regional Council for Rural Secretariat, 2008-2011, p.10). This organic waste collects on the sides of the nets, requiring it to be removed occasionally. It creates a risk of cross contamination between the cages as the cleaning of the collected waste releases some of it into the water. It is unknown what to do with this waste or if there may be other uses for it. The government's support is needed in order to implement any findings on how to manage this issue (Central West regional Council for Rural Secretariat, 2008-2011). It is important to note the issue of organic waste can have visible effects on the surrounding seabed and waters, as discussed later.

It is not enough to set up an aquaculture site and try to manage the impacts after, however, it is important to note the need for Bay Management Areas. Aquaculture from a Regional Perspective: Thinking of the Future identify how New Brunswick has implemented a plan with the intent of minimizing the risk of disease or

contaminations. The plan outlines a system which will determine where sites can be located, "which of these sites are in production and the transportation flow of boats and equipment within and across these areas. [...Some key issues that have been identified are] hydrodynamics and circulation, fish health, integration of alternative species, infrastructure, stakeholder interactions, fallow times, balancing production and supporting growth" (Central West Regional Council for Rural Secretariat, 2008-2011, p.10). It is evident the concerns in other aquaculture areas are similar to those in Central West and it is evident Central West has recognized this and begun to review other jurisdictions.

A Sustainable Management Plan also requires immediate action, and it is believed that an internal review of policies and regulations was vital in developing this plan. This should be implemented since 2011, by the Department of Fisheries and Aquaculture. It is important to note that a plan like this is necessary in order to maintain the mandate for long term sustainability by the Rural Secretariat. This is important both for fish health and for possible economic benefits for the province.

A second pressing issue for immediate action deals specifically with economics. Currently most of the salmon receives secondary processing outside of the province, due to policies which regulate minimum processing requirements. If more processing was required to happen within the province value would be added to the product, as well there would be further generation of jobs for rural communities. The latter is a key factor when planning for rural regional development. If the government increased the required processing this could not only benefit rural Newfoundlanders but the province as a whole, as revenues would increase (Central West regional Council for Rural Secretariat, 2008-2011).

Aside from the above immediate action needed, some with and without solutions; Central West also has objectives they would like to meet within the next five to ten years. One of these is the expansion of research and development. Within a growing industry there will continually be new challenges which will require research in order to be addressed. Also, there needs to be a Coastal Advisory Council to represent all of the marine stakeholders, who could then give advice to the government on how to develop a coastal management plan. The government could provide further support and resources, and one way of achieving this would be the creation of a Department of Aquaculture, to specifically deal with the growing industry. Central West realizes there has been an increased in support and funding from the government, while acknowledging some steps could be taken to help improve support to the development of aquaculture in Newfoundland.

In addition to the immediate actions and short term objectives, there is a need for long term objectives. This includes alternative species and integrated multi-trophic aquaculture. Expanding research into the aquaculture industry could give direction for how the industry can expand; this includes the raising of other species, specifically in an environment where they can live together, with species using the waste of other species. A way of replicating the natural process found in the wild. Central West is already watching a pilot study in British Columbia, and if success is had then this could be a potential for Newfoundland and Labrador (Central West regional Council for Rural Secretariat, Year).

It is clear in the latter overview of Central West there has been some initiatives taken to improve aquaculture, and there has been challenges identified that requires further examination. Some areas which seem to be less developed or without solutions in aquaculture would be in relation to biosecurity, or more specifically

waste management. Other areas such as infrastructure, Bay Management Areas, Sustainable Management plan, secondary processing, further research and government support, may not be fully implemented or implemented at all, however it appears that Central West is aware of a possible solution and is watching key areas such as British Columbia and New Brunswick for their progress.

"Greenpeace is an independent global campaigning organization that acts to change attitudes and behaviour, to protect and conserve the environment and to promote peace" (Greenpeace, 2008, p#). It is for this reason the article Challenging the Aquaculture Industry Sustainability was chosen. It is a report on collections of case studies around the world. Greenpeace examined practice which may lead to degradation of the environment or impact areas socially. They provide examples of how some aquaculture areas, such as in Israel or the Netherlands, have adopted practices to try and make aquaculture sustainable through the use of aquaponics and multi-trophic integration systems. This information could potentially be valuable to Central West, as it can provide information on what to avoid and possible pursuit areas.

## Challenging the Aquaculture Industry Sustainability

There has been a steady increase in aquaculture around the world. Because of this Green Peace has compiled several case studies on several species including shrimp, tuna, tilapia, and most importantly salmon. These case studies represent regions around the world, including but not limited to Bangladesh, Honduras, Ecuador, Chile, and Canada. Although the specific regions are not indicated in all cases, the report gives a combined overview of areas in an attempt to highlight the challenges faced by many aquaculture industries. The report also gives recommendations in how to achieve a sustainable aquaculture industry which may be relevant to other areas involved in aquaculture.

"Against a continuing background of diminishing and over-exploited marine resources, aquaculture has been widely held up as a panacea to the problem of providing a growing world population with ever increasing amounts of fish for consumption" (Greenpeace, 2008). The fishing industry is growing so vastly that the methods of production has intensified, especially in the production of carnivorous species, which has resulted in many serious impacts on the environment and human rights abuses. In southern Chile, salmon farming industry has grown quickly since the 1980's. The levels of foreign investment have also grown during this period. The main importers of salmon are Japan as well as America. In 2005, Chile produced nearly 40% of the world production of farmed salmon. The main themes in case study were nutrition pollution, disease and parasitic infestations, threats to wild fish from escaped farmed salmon, impacts on marine mammals and birds, and social or human rights issues. Some of the abuses reviewed can stem from the producers and processor desire to offer low prices to consumers in a highly competitive market. Practices outlined below can cause serious doubts on how sustainable the aquaculture is.

Nutrient pollution tends to happen in almost all areas of aquaculture, including but not limited to shrimp, tuna, cod, and salmon. Organic wastes from fish or crustacean



farming include uneaten food, body wastes, and dead fish are entering the surrounding waters around the aquaculture farms (Greenpeace, 2008). Salmon fishing industry has greatly grown in the past few years. With the process of salmon fishing, the waters that contain these organic wastes are entering the area where the cages are located. In some instances a large number of fish in one area can create enough waste to substantially reduce the amount of oxygen in the water, leading to the suffocation of both wild and farmed fish and decreased the biodiversity. The most visible effects on nutrient pollution at salmon farms are those which impact the seabed. When this organic waste hits the sea floor the oxygen can become diminished from the activities of bacteria. Biodiversity then decreases in such areas because only a small number of species can survive in these conditions. For example, in Canada where there is an area of salmon cages, about 200 meters away there was an extremely high decrease of biodiversity (reference?). In Chile, in an area of 8 different salmon cages there was a reduction of biodiversity by almost 50% (reference?). It is clear that too much organic waste affects the immediate surrounding areas. It is important to note the more cages in an area or the higher the stocking densities of fish will increase the organic waste present in the surrounding waters.

These waters are not only a threat to wild salmon and decrease biodiversity, but they act as plant nutrients in locations where the circulation of water is restricted. As a result, this may lead to algal blooms of phytoplankton and filamentous algae, which can be very harmful. They could not only result in the death of marine animals such as lobster, and clams, but also cause shellfish poisoning in humans. Shellfish poisoning occurs when humans consume bivalve shellfish such as clams, oysters, scallops, mussels, cockles; as well as molluscan shellfish such as whelks and periwinkles; and lobster or crab. The problem is that the latter marine life is sensitive to the quality of their marine environment. "Because they feed themselves by filtering microscopic organisms from the water, harmful bacteria, viruses and biotoxins from their surroundings can build up in their tissues and cause illness in people who consume them" (Canadian Food Inspection Agency, 2012, p#). The three forms of shellfish poisoning, paralytic, amnesic, and diarrhetic, are all caused by toxins which cannot be destroyed by cooking. This is particularly worrisome as, unless producers take measures to ensure the latter marine animals are protected, there is not anything a consumer can do further protect oneself. Just like the consumers mentioned above, the wild populations of marine species are at the mercy of the sustainable actions or lack of in aquaculture practices.

At first, it was thought that escaped salmon, an estimated three million per year, would not be able to survive and cope with the conditions which they would face in the wild (reference?). In actuality, the number of salmon that have escaped have been breeding with wild salmon all over the world; including areas such as Ireland, Norway, and North America (reference?). This is problematic and can cause issues because of their genetic differences. The challenge lies when the offspring of farmed and wild salmon are less fit and even less able to survive in the wild than either of parents. This means the original genetic profile of wild salmon may not be able to reassert itself and could potentially be on their way to extinction.

Also where stocking densities are high disease and parasites are problematic. Some wild populations can also be affected by this of the pass near and infected farmed salmon.

One example of a disease that affects these farmed salmon would be parasitic sea lice. These parasites feed off of the skin of the salmon, blood as well as mucous; this

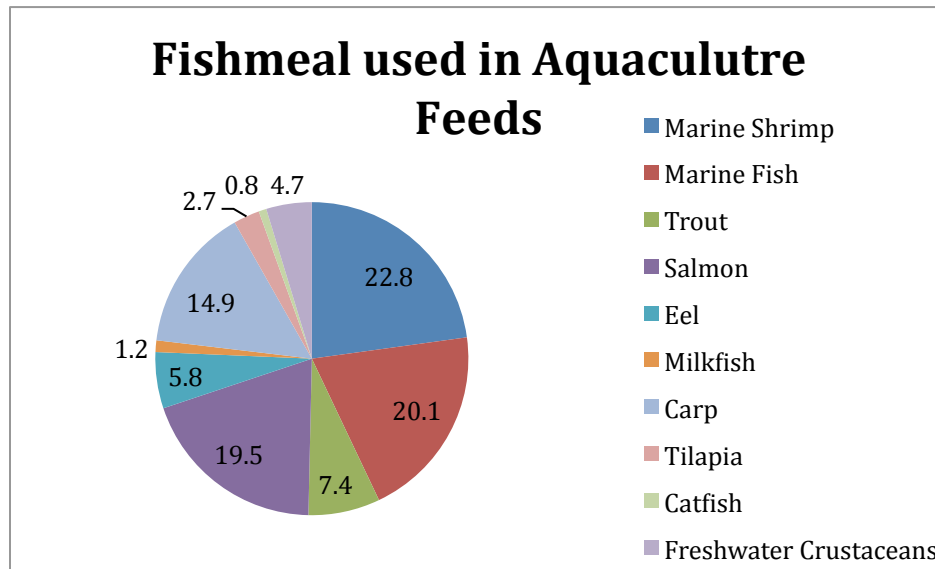
can cause death to the fish. In the province of British Columbia, as well as in Norway, there is evidence that wild salmon populations have been affected by sea lice spread. This epidemic is said by researchers, to result in the pink salmon populations to fall by 99% in the next four years (reference?). If these lice outbreaks in salmon continue in years to come, then there will definitely be an extinction of salmon (Greenpeace, 2008).

In addition to high stocking causing decreases in biodiversity and diseases and parasites, another threat that is present deals with the way in which some farmed fish are obtained. Salmon are raised from eggs and are then transferred to nets; however, other species such as tuna are caught from wild populations and then put in aquaculture nets to be fattened up for processing and selling. This affects the number of wild tuna available, especially since it is suspected that the catch is over exceeding sustainable levels and is often done illegally. This can have negative impacts on the number of fish available for other commercial fishermen who are not involved in aquaculture (Greenpeace, 2008). Although the latter issue is different than the methods of salmon aquaculture in Central West of Newfoundland, it highlights potential impacts. If this method of harvesting were to happen with salmon or other species, it is safe to assume that similar issue may arise in this area.

Aside from harvesting of fish to further raise in nets, other species are being harvested for fishmeal and fish oil. The feed which salmon depends upon can be made from small oily species such as anchovies, herrings, and sardines. The catch of these species can have by-catch further depleting other species which may already be in decline. Because of aquaculture the demand of fishmeal and fish oils are increasing (reference?). These products are also used by the agriculture industry as feed for some of the farm animals. However, with the product now being used for both industries, it is debatable whether aquaculture is increasing the net protein available for human consumption. "In fact, in the case of carnivorous fish and shrimp the input of wild caught fish exceeds the output of farmed fish by a considerable margin, since conversion efficiencies are not high" (Greenpeace, 2008, p#). It is important then to consider the practice of obtaining fish meal, in order to develop a sustainable plan in agriculture.

Recently some aquaculture industries have been replacing fishmeal with plant-based proteins for their feeds. The trend is not growing as fast as the aquaculture industry, leaving a demand for fishmeal quite high. Some plants which have been used are barley, soybean, canola, corn, cottonseed, and pea. If these plants are to be used for plant-based protein in a sustainable aquaculture industry it is important that they are sourced from sustainable agriculture practices as well. There are some challenges with this because some species of fish require fish meal and cannot be sustained by plant based protein alone (Greenpeace, 2008). In this situation a combination of fishmeal and plant based proteins are possible, but the amount of plant based protein potentially used will largely depend upon the species being farmed, particularly if they are carnivorous species (see Figure 1).

Figure 1: Fishmeal Used in Aquaculture Feeds, 2003



Source: Greenpeace (2008)

It is also important to note that when fish are caught for feed in aquaculture they may impact local use of the product. And if they are to be caught it is vital that they are caught in such a way to not impact other fisheries, or species. The "UN Food and Agriculture Organization (FAO) has recommended that governments of major aquaculture- producing countries prohibit the use of 'trash fish' as feed for the culture of high value fish" (Greenpeace, 2008, p#).

From all of the above environmental and social issues around aquaculture, it clear that there is a need for sustainable practices to be developed, especially within the context of rural areas. In 2005, 40% of farmed salmon from around the world was supplied from the producers and processors in Chile (Greenpeace, 2008). The salmon industry in Chile has a terrible safety record. Non-existent safety regulations have been reported on farms in Chile and as well as in processing plants. More reports tell that there have been more than 50 accidental deaths of divers in the past three years (reference to "more reports"). Reports also show the levels of wages, which are very low; as well as long working hours, and lack of respect for workers who deserve maternity rights. It is vital that these trends do not occur in Canada, and within Newfoundland and Labrador. Thus taking lesson from other regions of aquaculture can be beneficial for Central West moving forward with development issues.

## Corporate Social Responsibility (CSR) Case Study: Marine Harvest Canada Taking Leadership

Nutreco is a Norwegian owned, global food company that operates aquaculture and agriculture businesses throughout the world. The company was established in 1994 and currently operates in over twenty countries including Canada, USA, Spain,

Germany, France, Australia, Chile, Poland and the Netherlands. Within Nutreco Aquaculture is a salmon farming company called Marine Harvest, which operates in Canada, Scotland, Ireland, Norway and Chile. Marine Harvest is the world's largest producer of farmed salmon, and produced nearly 152,000 tonnes of fish in 2000. In addition to being the largest global producer of farmed salmon, the company is one of the largest fish feed producers in the world. In 2001, their sales were approximately €3,825 million and the company had almost 11,000 employees worldwide. Marine Harvest Canada has about 300 employees, owns small processing plants in Ontario and New Brunswick and larger operations in British Columbia. This case study outlines Nutreco's Corporate Social Responsibility (CSR) programs and policies and describes how they are implemented in Marine Harvest Canada, and more specifically deals with the functioning in Campbell River, British Columbia. Nutreco's vision is "to combine transparency with continuing vigour through participation in food value chains. Nutreco aims to provide consumers with food that is clearly safe, healthy and nutritious that comes from sustainable resources, while maintaining an enlightened attitude towards employees, society and the communities in which it operates, to the environment and animal welfare" (reference, p#).

The case study takes place in Campbell River, which is located in the Vancouver Island region of British Columbia. Campbell River is a city located on the coast of British Columbia, on the east coast of Vancouver Island, on the south end of Discovery Passage which is an important shipping route. Having a population of approximately 32,000 people, Campbell River is the third largest city on Vancouver Island (The Province of British Columbia, year). The Vancouver Island region is a large, sparsely populated area which consists of Vancouver Island, the Gulf Islands, and a section of the mainland. Not only is Campbell River known as "the salmon capital of the world", but it is also a great area for whale watching, bird watching, and fishing. The gross domestic product of British Columbia in 2011 was 217,749, the fourth highest in Canada behind Ontario, Quebec and Alberta. As of 2011, the population in British Columbia was 4,400,057 people (Statistics Canada, year). Marine Harvest operates a total of 16 fish farms in British Columbia. This province faces some problems for aquaculture since it is the home of a traditional wild salmon fishery and the commercial fishing sector. However, Campbell River is a great location for it, given its close proximity to the USA which is currently the fastest growing salmon market in the world.

Marine Harvest is not only the biggest fish farmer in British Columbia but it also produces one fifth of the world's farm-raised salmon. They supply to places such as Norway, Scotland, Chile and Ireland, this amount of world distribution means the company must act under strict regulations to ensure their products are properly produced. The salmon are raised in freshwater hatcheries; they are then transferred to the Pacific waters in their marine freshwater sites, after they are harvested and processed for shipment all around the world.

The Campbell River facility is the newest fish processing plant in British Columbia and it processes more than 35,000 tonnes of salmon per year. Since this company produces so much fish per year and distributes to so many places the testing of the fish must be well documented to ensure that they are selling a high quality product. All of the fish are tested for therapeutic residues, pathogens and naturally occurring environmental contaminants such as dioxins PCBs and heavy metals (Marine Harvest Canada, year). The amount of testing shows that the fish go through the proper safety testing protocols and the results show that any residue found is far below the

levels specified by the Canadian Food Inspection Agency (CFIA). CFIA audits every fish plant annually to ensure the public that what they are buying is top quality fish that the company guarantees. Not only does Marine Harvest have these audits performed every year they also do their own audits throughout the year to validate that their plants are performing up their own standards.

According to Marine Harvest there are no hormones or steroids added to their products or what they feed to their products. Not adding growth enhancing hormones to their products is something many people are looking for which will increase sales. Marine Harvest also strive to add as little antibiotics to their salmon as possible, they have a proactive approach to healthy fish which helps keep the amount of medication needed at a minimum. The amount of antibiotics in the fish is less than 0.002%, which is much less than the average pork or beef bought at the grocery store. Any salmon that requires antibiotics is treated by a veterinarian and cannot be harvested until the regulated waiting period is over (Marine Harvest Canada, year).

Salmon harvested at Marine Harvest are not allowed to breed with Pacific salmon, due to the fact that the farmed fish cannot produce proper offspring that can survive in the wild. This causes the Pacific fish to create many offspring that will inevitably die before they can reproduce resulting in a decline in their species. The breeding of farmed fish and wild fish is a concern for Marine Harvest since it can negatively affect the environment which they ensure they do not do. Not only can it affect the environment but the lost fish is a financial loss to the company as well. Since the fish farms are located on the coastal areas of British Columbia concerns of escaped fish have been voiced since the effects on the environment is unsure. Marine Harvest believes that farmed fish would quickly die in the ocean which is beneficial to the wild fish since it does not create competition for food. They also state that any attempts of breeding fish in the lab have been unsuccessful so the farmed fish could not mate anyways. As it states on their site "Atlantic salmon, the preferred species for farming in British Columbia, cannot breed with Pacific salmon. Attempts to cross breed Atlantic and Pacific salmon in controlled laboratory experiments have not been successful. Additionally, there have been no observations of successful inter breeding in the wild" (Marine Harvest Canada, p#). Even though they believe escaped fish to not be a thing of concern they are always striving to improve management and use of technology to reduce the likelihood of escapes. They also publically report and document escapes to ensure it won't be a common occurrence, the response to their loss of fish is also reported to the public. By keeping the details of the company public it gives people piece of mind that they are buying a quality product. This is important since the demands of fish are increasing and people only want top quality of the product.

In the past ten years, the majority of wild fish stocks have been decreasing while the global demand for fish still increases. The aquaculture sector has been growing to supply the increasing global demand for seafood; however, there are multiple concerns for the effects it has on marine environment as well as sustainability. Whereas land-based farming occurs mostly on private land, aquaculture uses and directly affects the world's fresh water and oceans, which is a public resource. Therefore, this industry must engage in CRS activities such as communications with a variety of different stakeholders. Stakeholders such as governments, fisherman, scientists, environmental non-government organizations, as well as First Nation communities have expressed different concerns regarding possible threats to marine resources as a result of poorly managed aquaculture operations. Such concerns

include: the impact of waste on the ocean floor which can result in the eutrophication of coastal waters (as that discussed in the previous section), the mixing of escaped farmed fish with wild fish, the use of pesticides and antibiotics, as well as the use of fish oil and fish meal which are prepared from the wild fisheries. Not only are there environmental concerns, but also concerns regarding the health and safety of the global food industry. There are concerns regarding the large amount of dioxins and PCBS in the fish meal that companies feed the salmon.

Unilever, one of the largest global buyers of frozen fish and the World Wildlife Fund (WWF), an international conservation organization collaborated to establish the Marine Stewardship Council (MSC) in 1997. Unilever, the owner of many valuable seafood brands, came to the realization they had to make an attempt to inhibit threats posed as a result of overfishing. WWF was worried about the impacts of poorly managed aquaculture operations. MSC established an environmental standard for sustainable fisheries, and if the standard is met the fishery can place a MSC sustainability logo label on the products to reward environmentally friendly and responsible fishery practices. The MSC is approved and supported by multiple organizations, non-governmental organizations, and industries. It is an example of an international multi-stakeholder group striving to ensure that aquaculture operations are carried out in a sustainable development manner, which ultimately gains the respect and trust of consumers at a global level.

Due to environmental and conservation concerns about the aquaculture sector, there has been a lot of controversy between the government, First Nations, environmental groups, and the aquaculture sector in British Columbia. In 1995, the provincial and federal governments implemented a moratorium to ban new fish farms in the province. It stayed in effect until September 2002, when the provincial government lifted the moratorium and allowed companies to apply for permission for new aquaculture sites. In addition to the lift of the moratorium, the government initiated a new *Waste Management Act* by which companies would be responsible for the effect of farming salmon on the ocean floor underneath and near by the salmon farm. The Minister for Food, Agriculture and Fisheries implied that British Columbia's recent regulations "will be the toughest and most comprehensive regulations in the world" (reference, p#). The Ministry of Water, Land, and Air Protection has implemented new aquaculture waste control regulations that includes provisions for management practices, registration, waste discharge, requirements for domestic sewage, monitoring and reporting, fees, offences as well as penalties (reference?).

Various First Nations participate in treaty negotiations with the provincial and federal governments. However, there is suspicion that some aquaculture companies are receiving permits to construct fish farms in areas where disputes over territorial areas have not been resolved by the treaty. Last year, the Heiltsuk First Nation of Bella Bella sued the provincial government due to the issuing of salmon farm licences within their territory (reference). This ongoing issue complicates accessibility to water resources for many companies, as well as Marine Harvest Canada. Developing strong, trusting relationships with First Nations is very important to the aquaculture sector because the majority of fish farms are located on the traditional territory of First Nations. One example of a successful relationship is the connection between Marine Harvest Canada and Kitsoo/Xai'xaix First Nation. Before the partnership was established, the Kitsoo/Xai'xaix Nation economy was connected to the wild salmon fishery with the people of Klemtu working within the commercial fishery. As a result of debates about conservation of the wild salmon fishery, declines in commercial fishing have had considerable impacts on the economy. During the late 1980's the

Kitasoo/Xai'xais started farming salmon. In the early 1990's, the Kitasoo/Xai'xais started seeking for business partners to help construct and sustain fishing aquaculture infrastructure within their territory, and in 1998 Marine Harvest Canada signed a business agreement. The agreement between the Kitasoo/Xai'xais Council says that the "aquaculture operations cannot do damage to wild species that are traditionally used by the Kitasoo" (reference, p#). Such wild species include wild salmon, sea urchins, sea cucumbers, prawns, clams, and more. The First Nation has their own environmental monitoring program, which is carried out by the Kitasoo people and consists of dive teams to make sure wild species are protected and not damaged in any way. Although it has not been done yet, the Kitasoo also have the authority to demand aquaculture operations to be terminated if damage to wild species is taking place. Marine Harvest Canada has supplied funding to assist local hatcheries and projects as well as conducting research to become more educated about diseases that are targeting stocks of local wild salmon. This partnership has provided the Kitasoo with many economic opportunities. Each year, approximately six million pounds of salmon are processed, which generates \$1 million to the local economy and many community members receive employment at Marine Harvest fish farms in the region (reference).

Nutreco has outlined various areas of interest and priority for their CSR strategy. Such areas include: guaranteeing safe quality food for global customers, operating with respect for the environment and animals, maintaining safe working conditions for employees, and committing to well-being of local communities where the company operates. Another main priority for the company is the reporting and communications aspect of CSR. In order to achieve success as a company, communications between various stakeholders and the company must be emphasized. Nutreco has established a series of initiatives to engage in dialogue with its stakeholders. Four years ago, Nutreco started an annual conference termed Aqua Vision, providing a chance for the company to meet with key stakeholders such as farmers, processors, retailers, decision makers and the media, allow critics of the aquaculture sector to voice concerns and to increase the transparency of the company as a whole. These yearly conferences are committed to discussing the sector's challenges such as the value chain, the environment, consumer perception and innovation through sharing knowledge.

## Integration of Other Resources

Since the above cases do not address all of the issues regarding Central West, this section is meant to integrate a variety of resources to better address the concerns, specifically with hydrodynamics and circulation and Conne River issues. Having proper water circulation is one of the main ways to minimize environmental degradation. In order to determine where there is adequate water flow the flow needs to be measure for at least one lunar cycle. This can be done through the use of current meters, which are now relatively inexpensive. Acoustic doppler current profiling, or ADCP, can be used for a more accurate measure of flow, especially when used in conjunction with GPS positioning. "The seabed maps provide bathymetric contours and a characterisation of benthic habits. [...] These maps are generally ground – truthed using underwater video, which also provides information on distributions of significant species and/or communities" (Allan and Burnell, 2009, p. 685). The maps can then be used to determine if an area is suitable for aquaculture. It is important to note that the carrying capacity can refer to the production or

ecological aspects. The production carrying capacity, simply put, is the number of fish that can be raised in an area in order to achieve maximum production. Ecological carrying capacity refers to the amount of aquaculture and area can support without significantly damaging the ecology or bio-diversity. When using the current mapping techniques, it is important to note which carrying capacity is being sought, as the ecological capacity will be much lower than the production capacity (Allan and Burnell, p.685, 2009). The way that aquaculture is approached can affect how local people will react to the industry.

Miakpukek First Nation has already experienced an Infectious Salmon Anemia, or ISA, virus found at one of Gray Aqua Groups fish farms on July 6, 2012 (reference). Prior to this the relation with the Mi'qmaq in Newfoundland was as follows. They did not "explicitly disallow fish farming on their territory, but are experiencing decreases in the wild salmon stocks of two rivers. The representative from Conne River, Ross Hinks, believed that the industry is probably going to be operating in his community's waters for some time to come, and that it therefore needed to be held accountable for escaped fish and for impacts on the wild stocks" (Brattland, and Schreiber, 2012, p#). Also Paul Robinson (Ahousesht) comments that "What I hear all the time is sea lice being studied—this issue has everyone's attention. There should be a global ban on the use of night lights on cages. Fish are attracted to the lights, it's been observed in our area by our people for a couple of decades. This should get a lot more attention than it has. Everything goes to the light in the water. That could be a reason why the fish stocks are so low" (Brattland, and Schreiber, 2012, p#). It appears that certain methods can inevitably affect the wild fish populations, not only with breeding, but with contamination like mentioned several times in this paper. If industries are using lights on the nets, and fish are more attracted to these areas, then there will be an increase in the possibility of farmed salmon spreading diseases, such as sea lice, to the wild population. And like mentioned before, this can kill the fish, causing a depletion in both farmed and wild salmon. It is of utmost importance for aquaculture industries to consider all potential actions which may cause impacts on local wild species. It is not clear if this could be one potential problem that is causing salmon population around Conne River to decrease, but it is an issue they should be aware of, considering the recent sea lice episode. Maintaining the local relationships in any industry is vital for success.

## Key Lessons and Recommendations

It is a known fact that aquaculture is having a hard time keeping up with the demands of fish. The result has been to produce more fish farms but this makes many communities concerned about the affects we are having on the marine environment. There are only so many fish in the sea and even personally growing them is not enough for the demand today. Since the farming of fish can affect the already delicate marine environment government officials and the people of the First Nations demand to see effort being made to prevent any lasting effects. Since the majority of fish farming does take place on First Nations territory it is important to have a strong positive relationship with them to ensure their land is not negatively impacted by fish farming. This was seen in the case involving Marine Harvest who had a strong relationship with the First Nation people and their quality of fish farming met and exceeded most standards. This is a good goal to set for all fish farms to hopefully reduce the negative impact we have on many environments.



The CSR activities are very important for a company to undertake since it gives them feedback on what the public likes and dislikes on their way of harvesting. This can greatly affect sales; if the people are concerned with the quality of the fish they buy they simply won't buy it. Even no knowledge on how the fish is farmed can be very negative to a company, the public wants to know each step of the process to ensure the company isn't hiding how their fish is really made. Marine Harvest decided to make every step available to the public and they also record the number of fish escapes and how they handled it online. This helps them gain trust from the communities which is the foundation of a successful company. Their activities in the CSR are strong since they have a very good connection to the First Nation people who agree with the way they manage their fish farms. There is minimal to no damage to the environment or the wild fish still caught by the First Nation people. It is also important to have secure fish farming facilities to ensure the farmed fish cannot be released into the wild. This could have negative impacts on the wild fish that would try and mate with them. Farmed fish contain antibiotics which could affect their offspring if they were to reproduce. There is also evidence their offspring would not survive long putting a strain on the population of salmon in the ocean.

It is recommended by many fish farming companies to feed their fish plant based protein meals. Fish are typically fed anchovies, herrings, and sardines; this is further depleting other species which may already be at risk. The protein meals are a good supplement since it is made out of barley, soybean, canola, corn, cottonseed, and pea. These plants are more available and easier to access than catching more species in the ocean to feed the fish farms. Not all fish can be sustained by this option since many are carnivorous but if some are switched to the plant based feed then it leaves the herring and sardines to fish that need them. Another option to feed the fish is to use the fish trimmings from the filleting and processing of fish. This would help reuse what would normally be thrown away and the company would not have to pay for extra fish feed. Another way to reduce the waste of fish trimmings is to use them in integrated multi-trophic aquaculture; this means the trimmings will be used as a nutrient filled fertilizer which can be used to grow seaweed. Not only do the trimmings not go to waste it helps grow another species that is then consumed by the public.

Aquaponics is a fast growing idea on how to reduce the effects of fish farming on the ocean and also to reduce disease such as sea lice affecting the farmed fish. Aquaponics are land based fish farms that have no connection to the ocean; this is seen as a positive solution to the issue of escaped farmed fish affecting the wild species in the ocean. It also protects the fish in the farms since they are not exposed to sea lice or other diseases that could require them to be filled with more antibiotics. This can be a great solution to the issue of every company following strict guidelines on how to produce their fish. Even though safety is still very important in fish growing it will help companies spend their time and money on the production of fish instead of trying not to impact the marine environment.

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