Introduction

Fish farming, or sometimes referred to as aquaculture, is one of the major advances in the world of agriculture today. Although fish farming is growing in popularity across the globe, the focus of this report will just consider fish farming in Canada. The question we aim to answer asks, *Is fish farming sustainable in Canada?* According to the United Nations’ Food and Agriculture Organization (UNFAO), aquaculture has quickly become a billion dollar industry. The UNFAO also reports that the industry for fish farming is growing three times faster than any other animal being farmed (Meat Free Week 2013). Fish farming is very important in Canada for many reasons. The biggest reason is because the wild fish population is running being depleted by overfishing and poor environmental conditions. Secondly, along with awareness for living a healthy lifestyle in North America, many consumers are turning from red meats to fish because of its high protein content and healthy omega-3 fats. Fish that are farmed also contain less mercury than wild fish.

Aside from a small group of PETA supporters, fish farming in Canada is an important industry to nearly everyone. Specifically, it is very beneficial to people who enjoy eating fish or are concerned with living a healthy lifestyle because with more supply of fish comes lower prices and more selection. Therefore fish farming is also beneficial to consumers with low incomes, and it creates many different jobs for the unemployed.


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Background
Although fish farming is commonly unheard of in many land-locked provinces in Canada, it is actually not a new concept. Fish farming has a long tradition, beginning with fish hatcheries in 1800s with intentions to restock lakes and ponds with fish varieties such as catfish and salmon (FAO Fisheries & Aquaculture). According to a research paper written by Nick C. Parker, experimental fish farming in the United States dates back to 1812 at the Philadelphia Academy of Science (Parker). Since 1812, there have been significant efforts in developing sustainable and profitable methods of farming fish. Governments have passed many different laws and regulations for fish farmers that have both opened and closed doors into the industry. In Canada alone, there are 73 different rules and regulations for Canadian fish farmers, and a survey in 2011 found that 81% of Canadians want an official national Aquaculture Act (Canadian Aquaculture Industry Alliance 2011). The fish farming industry has a much longer history then many people realize, and clearly a very bright future.

The following image shows the growth rates in aquaculture in the United States. Similar growth patterns have occurred similarly in Canada.

### Major Species Farmed

**Salmon**

Salmon are the second most popular fish to farm. They are vaccinated to prevent outbreaks and the antibiotic use is very low compared to other agriculture sectors. There are different bay managements used to hold the fish. The different bays hold different years of the fish to prevent spread of disease and easily manage nutrition. Atlantic salmon is British Columbia’s largest agricultural export. New Brunswick, Nova Scotia and Newfoundland also farm salmon. Growth rate is around 18 months till maturity (Canadian Aquaculture Industry Alliance 2011).

The salmon’s diet consists of dense, dry pellets that are made from small bony fish. There are also vitamins and other sources of protein added to the pellets. All of the ingredients within the fish food are safe for human consumption. Farmers are working towards decreasing the amount of fish in the salmon diet to become more economical. Feed is controlled to prevent waste on the ocean floor. Salmon can turn their food into muscles and in turn require less food per kilogram of weight gained. They are much more efficient than cattle in this sense because cattle require approximately seven kilograms of food for each kilogram it gains whereas salmon only require one and a half kilograms (Canadian Aquaculture Industry Alliance 2011).

**Tilapia**

Tilapia is the third most popular farm fish. They contain high protein and are large in size. This tropical fish requires a warmer environment and therefore need to be raised in the indoor farming environment at a temperature of 28-30 degrees Celsius. Tilapia are primarily farmed in British Columbia, Alberta and Ontario. Tilapia can produce many broods per year unlike cold-water fish that grow at a slower pace. An advantage to raising tilapia is that they take less than 10 months to grow to market size (Canadian Aquaculture Industry Alliance 2011).

Tilapia are an omnivorous breed of fish with both a plant and animal based diet. For commercial farming, their diet is primarily plant based. Farmers are working on using grain from the Prairies to feed tilapia across Canada.

**Trout**

Trout are currently the only type of fish farmed in Saskatchewan, with Ontario being the largest producer of trout. The preferred type for raising on a farm is rainbow trout. They are raised indoors and then can be moved to outdoor tanks or lakes or ponds to continue their growth. It can take anywhere from 9-22 months to reach market size, depending on the use of the final product (Canadian Aquaculture Industry Alliance 2011).

The diet of trout is similar to salmon with dense nutrients and research is being done to reduce the amount of fishmeal within the diet. To reduce waste they use demand feeding and the tank only releases food when the fish are hungry.

**Cod**

Atlantic cod are cold-water fish that are primarily raised commercially in the Maritime region in Canada. Cod are also raised in large tanks until a certain age and then can be moved to cages in the ocean. Cod take about 24-36 months to grow to market weight (Canadian Aquaculture Industry Alliance 2011).

The diet of cod consists of nutrients with fishmeal, oil, minerals and vitamins. Cod require one kilogram of food for every one kilogram of weight gained.

**Halibut**
The halibut is also a cold-water fish farmed in the Maritimes and are in high demand. They are raised in cages until maturity and then moved to sea cages. Halibut require 24-36 months of growth to market weight (Canadian Aquaculture Industry Alliance 2011).

The diet of the halibut fish also contains fishmeal, oils and added nutrients.


### Methods of Fish Farming

#### Cage Farming

Cage farming in Canada typically occurs in the ocean off the coast of British Columbia and the Maritimes. Cage farming is also known as off shore cultivation. A main concern with this type of farming is that the farmed fish can come in contact with wild fish. This can create an issue because they can transfer diseases. The dimensions range from 8-10 meters deep and 70-100 meters in circumference for salmon. The sizes of cages can vary from species to species. These cages can hold between 15,000 and 30,000 young fish. There can be concerns with diseases as well with this method (Farms 2015).

#### Indoor

Indoor farming is the alternative to cage farming. Raising fish in large indoor tanks allows for species in high demand such as tilapia to be raised away from the sea. The fish can be protected from predators and environmental issues such as pollution and oil spills. The following table lists advantages and disadvantages to indoor fish farming (Farms 2015).

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected</td>
<td>Large Electricity Input Costs</td>
</tr>
<tr>
<td>Produce Faster</td>
<td>Start Up Costs</td>
</tr>
<tr>
<td>Environmentally Friendly</td>
<td>Finding Fish for Carnivorous Diets</td>
</tr>
<tr>
<td>Reduces mixing of farm and wild fish</td>
<td>Lower Input Costs</td>
</tr>
<tr>
<td></td>
<td>Flexibility</td>
</tr>
</tbody>
</table>

#### Irrigation Ditch

Irrigation fish farms are environmentally sustainable. The water from the fish tanks is recycled and used as fertilizer for agriculture. This method is self-sustaining because it grows plants and algae for fish food. The pond is typically lined with clay. Main types of fish grown in this environment include tilapia, catfish and other fresh water fish. Resources for irrigation can include rivers and underground water or reservoirs (Farms 2015).
**Integrated Recycling Systems**

Integrated recycling fish farms are the purest type of fish farm. Large plastic tanks are placed in a greenhouse and with proper fertilization the tilapia eat the algae in the tank that will grow naturally. Hydroponic beds are placed near the tank and the wastewater from the tank is cycled through to the crops. The crops are able to convert the ammonia to nitrates for fertilization. An aerated pebble-bed filter strains other wastes out of the tank. The most common crops grown in the hydroponic beds are herbs (Aquaculture Irrigation Technology 2006).

**Environment**

Although fish farming creates an enormous opportunity, there are both environmental benefits and non-sustainable practices. Within the four main forms of fish farming, the caging system has many negative environmental impacts, but the ocean caging systems that have the worst reputation. However, the other three forms of farming (Indoor, Irrigation, and Integrated) are associated with more positive environmental breakthroughs.

**Unsustainable Practices**
Cage farms have been known to be very environmentally unfriendly, but all these negative effects depend on the species and the location. Most of the concerns with cage farms are with the ocean cages. These ocean cages can have some negative effects depending on the location and the regulations of these areas. Some of these issues are disease/parasite transfers, introduction/spread of exotic species, chemical pollution, habitat destruction, and the killing of predators in the area that prey on the farmed species. These dangers can cause serious issues to the wildlife whose habitat the farm has invaded. Since most of these ocean farms are in sensitive habitats (mangroves, coves, etc.), the habitat is easily damaged and can be hard to reverse. However the bigger issue is caused when exotics are introduced to the environment. An exotic being introduced either won’t survive due to predators, or if they have no predators, can thrive and take over the environment. Needless to say these are major concerns and leads to the conclusion that open cage might not be completely environmentally sustainable due to the effects it could have. (DSF 2014)


The above picture displays a diagram of the concerns that are associated with open net fish farming in the ocean, lakes, and rivers. This is further explained in the above paragraph.

**Sustainable Practices**
Aquaculture in Canada is closely monitored to ensure that the strict environmental policies, regulation and guidelines are being followed. These are in place to ensure minimum damages to the environment and safety for the fish and the workers. These farms are also helping to repopulate deflated populations of many fish species, such as salmon and trout. The industry are also seeing benefits to some aquatic environments through some form of aquaculture, such as an increase in water quality through the farming of filter feeding shellfish. By farming seaweed, and shellfish, as well as fish there is natural waste recycling taking place, creating a natural habitat with minimum environmental impact. Some farms are also developing waste into fertilizers and soil aid, as well as natural products for enhancing shellfish beds. Another worry for carnivorous fish species is that their food source is unsustainable, but they are looking for natural feed sources that do not require external supply (oil seeds, and fishery byproducts) (ACOA 2012).

Social Sustainability

Aquaculture is an established and growing industry in Canada, and globally is the fastest growing food production activity (ASRI 2010). Aquaculture comprised 50% of global seafood production in 2008 and in 2009 total global production was valued at over $86 billion USD. That same year Canadian aquaculture produced $800 million of farmed seafood (ASRI 2010). With the demands for seafood increasing and a growing global population, rapid growth is expected to continue within the aquaculture industry. With rapid growth comes the responsibility to ensure sustainability by carefully balancing economic, environmental and social factors.

Any business, as well as the overall industry must consider the interconnected relationship between social well-being, economic prosperity and environmental protection with respect to sustainability. A business in the aquaculture sector must operate in a manner that is respectful of local communities and the environment. It must consider work place safety, job creation, labour rights, employee demographics, workplace satisfaction, and community development and have product available at the local level (ASRI 2010). For a firm operating in the aquaculture industry to be classified as socially sustainable they must have strong community relations, focus on worker safety and have good relations with all of their employees (AC 2012). Canadian aquaculture is striving to address all areas of sustainability. The aquaculture industry employs many people, therefore making is sustainable to the community. It provides an estimated 14,500 full-time jobs in Canada; many these jobs are in rural and coastal communities. Most workers are under the age of thirty five. These communities are often in isolated areas with few economic opportunities. Aquaculture generates thousands of jobs, both directly and in indirectly through related industries. Small communities are realizing that aquaculture can benefit their economy in times of decline of other natural resources. This industry supports community service projects such as salmon conservation, beach clean up and other community events.

A collaborative effort between the DFO, federal and provincial government, industry and other stakeholders has helped to produce the Agriculture Sustainability Reporting Initiative to address six themes to address sustainability. The Canadian aquaculture industry has certificate programs that certify producers as sustainable under Canadian Government and the Aboriginal Aquaculture Association’s criteria. The picture below shows the First Nations group Kuterra selling their first farmed fish.

http://www.namgis.bc.ca/CCP/Pages/default.aspx

Economic

Fish Farms have had a positive impact on the Canadian economy through increased employment, increased fish sales, and low cost of production. However there is some belief it could be harmful to wild fish populations. Fish farms are very economical as they provide thousands of jobs in rural, coastal and aboriginal communities. Young people are starting to stay around their local communities because of the opportunities fish farms have provided for them. Fish farms are helping the First Nations lower their unemployment by supplying them with jobs. Table 1 shows the employment of fish farms throughout the provinces of Canada.

| Table 1 - Canadian Aquaculture Sector Employment, 2007 The first column shows the annual employment (2010) Columns 2-9 shows employment values for all provinces (excluding MN, AB and SK). Column 11 shows employment values for Canada. |
The farmed salmon industry supplies more than 10,000 jobs in Canada.

Fish farms can produce more fish at a faster rate than natural reproduction of fish within the ocean. Without fish farms society could not keep up with the high demand for fish products including meat and other supplements. The demand for fish products is soaring because it is one of the healthiest proteins. Farmed fish has high omega-3 fatty acids and very low mercury content. Fish farms have shown that it has healthier benefits than wild fish, making the demand for farmed fish greater. Health experts recommend having fish at least two times a week to maintain a healthy diet.

Another benefit of fish farming is the increased supply of fish. Since fish farming can produce fish at a higher rate then fisherman can catch them, there is a larger supply of fish being sold in the market. With this increase in supply, we are seeing a lower demand which is reducing the cost of fish, making it both more available and affordable.

Canadian farmed products are exported to more than 60 countries. The majority of our exports go to the United States. Farmed salmon is Canada’s largest export.


The Canadian Government supports open net-cage farming. The government continues their support by assisting with the growth of the industry. An incentive for fish farmers is that they will decrease taxes on closed tanks investments, while increasing permit fees on open net-cages.

Based on the stats provided fish farming is a sustainable economy

Trade-offs
As seen in the above diagram there are some trade-offs when it comes to fish farming in Canada. The main trade-offs seen are that while supplying fresh fish to Canada and creating jobs to the general public, there is some damage occurring to the environment. This is mostly due to open net fish farms as they have been causing some damage to habitats and the escapes of non-indigenous species into lakes, rivers, and oceans. One of the social trade-offs is that even though farmers are switching to indoor systems to reduce environmental impact, and decrease costs, people are not happy about the fact that the fish are in an artificial habitat. These indoor facilities are usually trying to mimic the natural environment as close as possible, but they are still not in the wild and this concerns groups like PETA and other animal welfare awareness sects. Another issue is the fact that even though fish farms are helping to repopulate endangered species which is both socially and environmentally beneficial, there is a trade-off off economically. Since the cost of repopulating is high, there is a lower economic profit.

Conclusion

Yes, fish farming in Canada is sustainable. Fish farms have many positive outcomes. They provide thousands of jobs, help communities, reproduce endangered fish, trade with 60 different countries, plus many more. Of course fish farms have a few problems but they are trying to fix them to make fish farming more sustainable. Atlantic Canada’s objective of sustainable aquaculture is practiced through improved innovation, technology, and responsible environmental management practices, which comply with strict Canadian and U.S. regulations (Atlantic Canada Exports 2015).

With out fish farms we could not keep up with the high demand for fish. Farmed fish help improve nutrition as well as food security all over the world. Fish farms allow people to be able to enjoy fish with out the worry of extinction, provides many jobs, which allows smaller communities to keep running.

We conclude that fish farming in Canada is sustainable.

See also


References

