

Something is Fishy: Salmon Farming on the B.C. Coast

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Introduction

Salmon farming in British Columbia (BC) is a wicked problem as it is dynamic, unique to the coast and has multiple stakeholders with cultural, economic, and environmental interests. BC salmon farming was first established in the 1970's and with tremendous growth, has evolved into an important industry and topic of debate. In 1995 a temporary six year moratorium was placed on farming, blocking the development of new sites in an attempt to understand the impact on the marine environment. During this period, production doubled as the intensity of existing farms failed to be regulated (Farmed and Dangerous, no date; Naylor, Eagle and Smith, 2003). Today, the industry in BC accounts for two-thirds of the total salmon aquaculture in Canada (Statistics Canada, 2013). Aquaculture however, is not without its drawbacks and as a result, many British Columbians and First Nations have expressed concern for the future of wild salmon stocks, health risks surrounding consumption, the economic future of the industry, and the threat to the aboriginal way of life. With a range of stakeholders expressing concerns, the complexities of salmon farming increase. While it appears to be the solution for depleted wild stocks, the environmental consequences associated with aquaculture produce a wicked problem, making the ongoing operations in need of change.



Figure 1: Map showing the salmon farming areas off the coast of BC (Galland and McDaniels, 2008).

Framing the Problem

What makes this seemingly simple problem a ‘wicked’ problem is down to a number of interconnected reasons with the basis of the problem lying with the difficulty of ‘balancing development and degradation’ (Leggart, 2001, p. 30). This is a complex issue which not only spreads across environmental spheres of interest, but economic and social, due to the large number of varying stakeholders involved in the salmon farming process. These wide ranging spheres of interest ultimately means there are wide ranging values and goals, and when coupled with subjective scientific knowledge, a ‘wicked’ problem with no foreseeable solution is created.

Conflicting scientific studies have come out, such as the Cohen Commission, stating the negative effects these farms are having on our environment. Evidence has been found that suggests a clear correlation between sea lice abundance and commercial salmon farms (Noakes et al, 2008), where the crowded pens provide ideal conditions for the parasites to thrive. As juvenile wild salmon migrate to the ocean from the surrounding rivers, these estuaries teeming with parasites infestations, become prime killing grounds for the young fish, ‘It takes only 15 lice to kill a juvenile’ (Salmon and Trout Conservation UK, 2013). If this scale of loss continues, due to the fragile nature of the ecosystem, there will be catastrophic effects to British Columbia’s wildlife (Noakes et al, 2000).

Despite this seemingly solid evidence, the problems and uncertainties remain. One of the major reasons for this is due to the lucrativeness of the industry, which in 2011 raised \$58.5 million GDP through the selling of BC salmon on world markets (BCstats, 2013). In addition, the creation of jobs directly and indirectly in remote communities has further boosted the profile of the industry in regard to the provincial economy. Consequently this has accentuated the gap between the values of the industry and government and that of remaining stakeholders. The mind map below breaks down the different components, highlighting the complex web of contrasting values and impacts of the ‘wicked problem’.

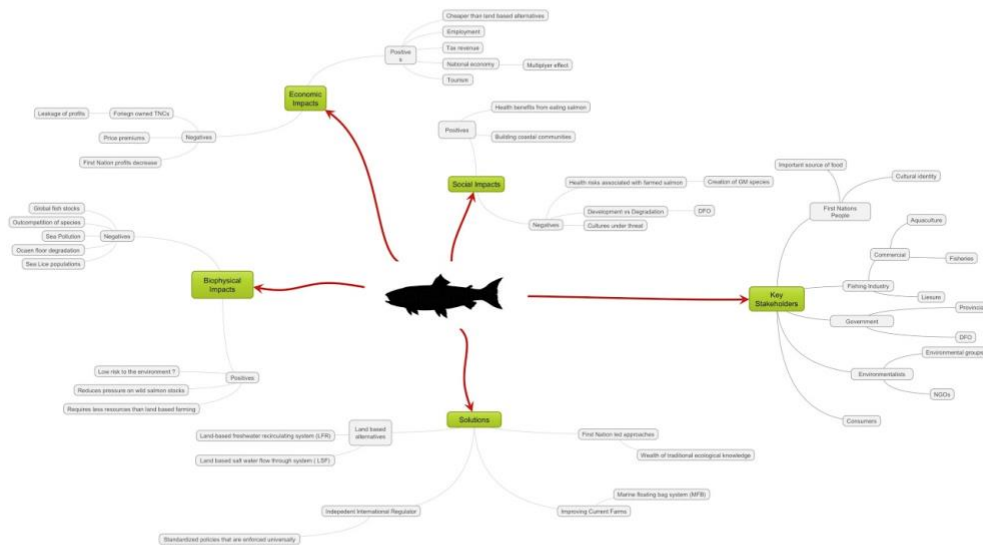


Figure 2: A mind map representing the case of salmon farming in BC.

Governance Framework

Decision Makers

The governance of BC salmon farming involves a variety of interconnected yet conflicting interests. The industry itself is comprised of 11 companies, mainly Marine Harvest, Cermaq, and Grieg Seafood which produce 88% of all farmed finfish, with locations at Campbell River, Port Hardy and Tofino (Manning and Hubley, 2015). In BC, the governance of aquaculture falls into the jurisdiction of the federal government, which has several departments and agencies influencing different aspects of policy. To further the complexity, First Nations, environmental groups, and the industry strive for influence (Noakes et al. 2003, p. 125). Therefore, while the framework that influences governance is concentrated primarily in the federal branch, policy is swayed by the provincial government, First Nations, environmental groups, the industry and the public who operate through the legislation in place.

Legislation, Regulation, and Policies

Despite the growth in salmon aquaculture worldwide at an international level, legislation for salmon farms remains surprisingly absent. Many groups, namely the critics of the practice, would be in support of an international agenda creating legislation that farms worldwide would be obligated to conform to (Naylor, Eagle and Smith, 2003).

In the 1990s, global influence over increasing environmental concerns associated with commercial open net farming led to a licensing ban by the BC provincial government to prevent industry expansion in 1995 (Noakes et al, 2003). Meanwhile, research was carried out to create a definitive stance on the dangers of the farming. This resulted in the first major and controversial piece of legislation, which stated damage to the natural environment at current levels of farming was of 'low overall risk' (Noakes et al, 2003, p. 365). This has summed up the governmental stance towards policies since. The leading federal agency in the industry is the Department of Fisheries and Oceans (DFO). The DFO works under the *Fisheries Act* and the *Aquaculture Activities Regulations* to implement and regulate policy (Noakes et al, 2003, p. 365). The federal branch also utilizes legislation from Environment Canada under the *Canadian Environmental Protection Act*, Health Canada under the *Food and Drugs Act*, and the Canadian Food Inspection Agency under the *Health of Animals Act*. The provincial branch, which despite having limited power in decision-making, has an active day to day involvement in the business side of the industry. The Ministry of Agriculture (BC-MA) is the lead agency in their 'strategic development of the industry' (Manning and Hubley, 2015, p. 6).

The final stakeholders influencing the governance of BC salmon farms are the non-statutory institutions, including industry workers and First Nations. It is the industry workers who provide scientific information to the DFO on which policies are created, possibly limiting the credibility of the data collection, as industry workers refrain from choosing research that would badly frame their farms (Noakes et al, 2003). The First Nations population are deemed highly knowledgeable on salmon farm environments as the operations 'fall within their traditional territories' (Heaslip, 2008, p. 988). However, due to the complexity and capitalist nature of the industry, the extent to which each of these stakeholders' opinions are incorporated in decision-making varies considerably. With disproportionate levels of self-determinacy given

to the industry itself (Noakes et al, 2003), it is clear that future governance needs a greater degree of stakeholder incorporation.

Moving Forward

Moving forward, there are several policy recommendations. However, as various stakeholders hold different views and values, inevitably, these policies are conflicting. Outlined below are some recommendations, with a brief analysis of each.



Figure 3: Photograph of the current salmon farms (Farmed Salmon Boycott, 2014).

Proposed Alternative Farming Techniques

As technology develops, issues around salmon farming can be approached in new ways. Three ways currently under research are: marine floating bag system (MFB), land-based saltwater flow-through system (LSF), land-based freshwater recirculating system (LFR). All proposed systems have succeeded in making fish escapes, predator interaction and disease transmission non-existent, while also lowering feed input, allowing for higher stock densities (Ayer and Tyedmers, 2009). One issue not met by all systems is waste management, which can be seen in the table below alongside other inputs and outputs resulting from these systems.

	Marine net pen	Marine floating bag	Land-based flow-through	Land-based recirculating
General system parameters				
Geographic setting	British Columbia	British Columbia	British Columbia	New Scotia
Culture medium	Saltwater	Saltwater	Saltwater	Freshwater
Total culture volume (m ³)	180,000	12,000	2,200	900
Average stocking density (kg/m ³)	29	76	86	73
Inputs - infrastructure (kg)				
Coverage	6.3	26.7	190	690
Steel	2.9	10	1.0	13.8
Zinc	6.2	-	-	-
Polyethylene	6.4	0.1	-	-
Polypropylene	0.2	0.04	-	-
Nylon	5.7	5.3	0.1	-
Plastic	6.2	0.9	-	-
PVC pipe	-	2.3	-	4.2
Polyester acetate	-	-	-	-
Total	61.1	38.3	381	637
Inputs - operational (t)				
Smolt (kg)	20.6	199	14.6	238
Feed (kg)	1300	1170	185	1448
Protein (t)	8.5	-	-	-
Oilseed (t)	28.8	15.6	-	-
Gasoline (t)	36.3	-	-	-
Heating oil (t)	-	-	15,400	275
Electricity (kWh)	-	1400	908	22,600
Primary source	90% Hydro	90% Hydro	90% Hydro	77% Coal
Liquid oxygen (m ³)	-	370	1001	-
Calcium chloride (kg)	-	-	-	481
Solid ash (kg)	-	-	-	804
Outputs - operational (kg)				
Species	Atlantic salmon	Atlantic salmon	Atlantic salmon	Arctic char
Harvest weight (kg)	2.0-5.0	4.0-5.0	4.0-5.0	1.5
Mortality	95.0	13.6	84.4	305
O ₂ emissions to water	0.5	-	26.0	0
N emissions to water	31.3	26.4	4.1	0
P emissions to water	4.9	4.4	-	0
Suspended N	-	-	-	4.8
Suspended P	-	-	-	3.2
Total live-weight fish produced during grow-out cycle (t)	3600	400	96.2	46.2

Notes: For specific details on data sources and calculations consult (93).

Table 1: Shows the amount of inputs required of the varying potential systems, as well as the outputs that result from producing one tonne of live-weight fish (Ayer and Tyedmers, 2008, p. 366). [click to expand]

The MFB system utilizes impermeable bags requiring the pumping of supplemental oxygen to procure the salmon. Next, the LSF system located on land while still anchored to BC's coast requires the pumping of nearby fresh saltwater through the system. The final possible

system, LFR has the ability to be located across the country in warehouses as it runs on freshwater, 99% of which is processed and returned for additional uses (Ayer and Tyedmers, 2009). Also in this system, fish wastes can be harvested and repurposed as fertilizer. The downsides are the very large amount of energy consumption, the extensive use of non-renewables to make the water livable, and global warming potential due to operational demands.

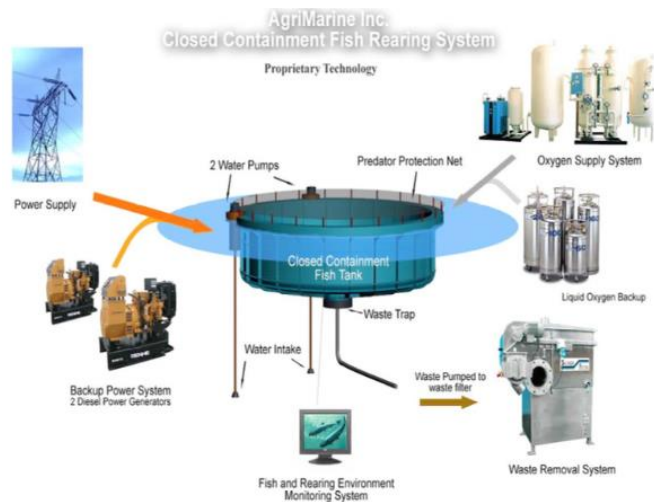


Figure 4: The diagram shows the process of the proposed LFR system (Simon Fraser University, 2008, p.6).

Advertisements state closed containment salmon is the 'best choice' for consumers, but according to studies in the Ayer and Tyedmers (2009, p. 363) article, this is not the case due to the astronomical economic costs of establishing any new systems technologies. Currently, it appears that although MFB is desirable, the switchover cost for a system that is not significantly better than the current cannot be justified. Ayer and Tyedmers (2009) conclude by ranking the most environmentally and economically suitable for future salmon farming to the least: MFB, net-pen (current system), LSF, and lastly the LFR system.

Increase Aboriginal Rights

Despite the DFO claiming to acknowledge First Nation rights, their power has remained limited during the growth of the lucrative BC salmon farming industry. Consequently, First Nations are increasingly under threat in terms of their diet, economic and political position and cultural traditions (Page, 2007). Whilst Hamouda *et al.* (2005) discuss the lack of First Nations integration due to established inferiority by other prominent stakeholders, Heaslip (2008) claims existing aquaculture management far from integrates First Nation values and knowledge. For example, farms within the traditional territories of First Nations have been established without consultation with the groups (Naylor et al., 2005). Such claims highlight the undemocratic process of BC salmon farming governance and the continued lack of First Nation involvement.



Figure 5: Aboriginal peoples in protest against the salmon aquaculture industry (First Nations, 2003).

There is certainly a case to be made for the incorporation of First Nation knowledge in BC salmon farming. For centuries, First Nations have been dependent on wild salmon stocks and operations 'fall within their traditional territories' (Heaslip, 2008, p. 988). As a result, First Nation peoples have a wealth of knowledge, deserving of recognition. Within the heated debate of salmon farming governance, academics have supported broader management schemes, acknowledging and respecting First Nation practices and traditional ecological knowledge (Heaslip, 2008). Furthermore, BC Salmon Farmers Association (2015) is committed to building coastal communities, creating lasting partnerships with the First Nations as they recognize it is their territory the industry seeks to operate in. Combining First Nations expertise with scientific research would create a broader monitoring approach which has the ability to reduce environmental damage and promote sustainability.

Arguably, under the new Liberal government, First Nations knowledge has an increased chance than ever before to be incorporated in salmon farming legislation. Trudeau has promised a review of governance in consultation with First Nation peoples, recognizing the relationship between the groups and their traditional territories and restoring their power (CBC News, 2015; Liberal, 2015). Whether these promises will be realized is up for debate.

Creation of an International Agenda

As previously mentioned, there is no international legislative body for the global salmon farming industry. In a movement away from political and economical limitations preventing nations from enforcing more stringent regulations, international agreements can be successfully achieved. Therefore, this perspective calls for greater coordination between the major salmon producing regions and countries, regulating environmental degradation to ensure that sustainable approaches are enforced. Of the total farmed salmon sold worldwide, 90% of production is limited to a small number of countries, enabling this to become a feasible objective (Naylor, Eagle and Smith, 2003).

However, the key obstacle to greater regulatory controls from individual countries is the transnational nature of the industry and its ability to move production away if the restrictions become too damaging to profits. An international standardizing body would make sure this is no longer the case, as restrictions would be enforced globally (Naylor, Eagle and Smith, 2003). By standardizing practices worldwide, it would become easier to make the industry accountable for their own actions, whilst bypassing the potentially mono-sided views of national authority. It is important to make sure these regulations are not so high as to

discourage participation, but not so low as to make the international body insignificant (Naylor, Eagle and Smith, 2003). The failures of the existing voluntary regulating bodies, the North Atlantic Salmon Conservation Organization (NASCO), since 1994 has highlighted the need for compulsory co-ordinated action (Cullis-Suzuki and Pauly, 2010).

By looking at the successes of current national legislation, such as those from Scotland, we can see the kinds of regulations that an international body should be standardizing on a global scale. The key to Scottish regulation is the definitive approach to sustainability, one that ensures minimal impacts to both marine and freshwater ecosystems (ASF, 2015). The Scottish environmental protection agency (SEPA), has specific guidelines in relation to the water quality in areas surrounding salmon farms. When pollutants from faeces and chemicals used to kill sea lice go above acceptable levels, SEPA will step in and take actions against the company (Henderson and Davies, 2000). It is this style of action that should be used on an international scale. This would ultimately be incentivized with the use of a universal labeling scheme to reflect environmentally sound practices, targeting the corporations who do not cooperate (Naylor, Eagle and Smith, 2003).

Changing the Siting Policy

A final proposed solution to salmon aquaculture of salmon could lie in changes in the siting policy. In BC, the location of farms is determined by established and compiled criteria, which describes the conditions needed to build a new farm. The following will describe three out of fifteen criteria examples used to evaluate farms, as well as the correlated problems.

Firstly, buffers 'divide a region into acceptable and unacceptable areas' and can thus include or exclude locations from consideration (Galland and Daniels, 2008, p. 525). Criteria for buffers, which have a set number of meters that a farm has to be away from a stream, states that once a farm falls short of the distance, it is automatically disqualified, even if fulfilling other criteria. Secondly, a salmon-bearing stream is defined differently. The DFO acknowledges any stream having the capacity to sustain salmon, while the Ministry of Agriculture, Fisheries and Food (MAFF) only regards large waterways that have a determined number of fish (Galland and Daniels, 2008, p. 526). Consequently, different groups such as the First Nations and transnational corporations will use different standards to assess what waterway is protected. Thirdly, criteria are 'site-specific', whereby they identify exact spots in a region where farms can operate (Galland and Daniels, 2008, p. 526). However, these areas are seen as independent from a wider, more dynamic system. This also contributes to disputes with Aboriginals in the area who often advocate for the interconnectedness of the ecosystems, rather than the break down into small, self-sustaining areas. Limiting potential sites to a list of separated areas results in a lack of understanding of these regions as whole and sustainable.

Siting policy can be changed to better understand and incorporate operating farms into complex ecosystems. Most importantly, there need to be discussions and negotiations, rather than simply checking criteria boxes when new farms are proposed. A body that does this is the Facility Siting Credo and has been beneficial for decisions on sites, as it inspires conversation between stakeholders (Galland and Daniels, 2008, p. 527). Another potential for improvement is consulting public values and building trust between developers and communities which can help mediate conflicts (Galland and Daniels, 2008, p. 527). The people living in the area potentially have great insight into how to build sustainably and should be consulted. Incorporating research and opinions of scientists and economists would result in better, more informed consensus. Siting policy must be transformed from a static, set list

of criteria into a dynamic process that mimics the complexities of the ecosystems where the farms are being constructed.

Conclusion

The environmentalists, aboriginals, and other stakeholders claim change needs to occur. However, the level of investment in the changes suggested to infrastructure is currently not seen as feasible even in the face of adversity. While switching to new farming techniques seems desirable, the monetary and ecological costs that result quickly defame these possible solutions. The idea of altering the siting policy of these farms to locations elsewhere provides a possibility for positive progression. Nonetheless, there are issues around this proposal in the defining of what is and isn't a salmon bearing stream, and as a result what regulations hold greater importance when locating farms. The idea of changing policy also falls into the creation of an international agenda that would establish a set of rules and regulations needed to tackle the decreasing wild salmon populations together as people of the world. This possibility, however, has problems rooted in enforcement worldwide, especially if some countries ignore the legislation. This has given rise to other ideas for BC farms such as a temporary moratorium to allocate time for development of technologies, a ban on regions of coasts known to be a wild salmon migratory route, and to move the industry into deeper waters away from the coastal regions.

In conclusion, salmon farming in BC is a complex and multidimensional issue with a number of important stakeholders with varying perspectives over the future of the industry. Consequently, there is no single flawless solution that keeps every stakeholder happy. Instead the future of the industry should look to adopt a number of possible solutions, whilst preparing to accept that trade-offs will have to be incurred. Ultimately a more sustainable industry is of paramount importance before damages to the environment become irreversible. The sooner stakeholders begin to universally co-operate, the sooner sustainable salmon farming can become a reality.

References

Peer Reviewed Articles

Ayer, N. W. and Tyedmers, P. H. (2009). 'Assessing alternative aquaculture technologies: Life cycle assessment of salmonid culture systems in Canada', *Journal of Cleaner Production*, 17(3), pp. 362-373. doi:10.1016/j.jclepro.2008.08.002

Cullis-Suzuki, S. and Pauly, D. (2010). 'Failing the high seas: A global evaluation of regional fisheries management organizations', *Marine Policy*, 34(5), pp. 1036–1042. doi:10.1016/j.marpol.2010.03.002

Galland, D. and McDaniels, T. (2008). 'Are New Industry Policies Precautionary? The Case of Salmon Aquaculture Siting Policy in British Columbia', *Environmental Science and Policy*, 11(6) p. 527.

Hamouda, L., Hipel, K. W., Marc Kilgour, D., Noakes, D. J., Fang, L. and McDaniels, T. (2005) 'The salmon aquaculture conflict in British Columbia: A graph model analysis', *Ocean & Coastal Management*, 48(7-8), pp. 571–587. doi: 10.1016/j.ocecoaman.2005.02.001.

Published in an international journal, issued 12 times a year, this article can be deemed a credible source for my theme. The article provides information on the stakeholders and

various conflicts, which subsequently emerge in the practice of salmon farming in BC. From prior research and knowledge, I am aware the First Nations' have struggled economically, socially and environmentally due to the development of salmon aquaculture with concerns for their traditional land, culture, resources and economy; this article helps in my understanding as to why by explaining some of the conflicts between opposing groups. Using the graph model for conflict resolution, BC salmon farming conflicts are explained. Hamouda *et al.* (2005) conclude that no policy available to the BC government would please all groups. As the article was published 10 years ago, this could be viewed as a weakness. Conflicts may have now changed due to the implementation of various policies during the published period and present day. Nevertheless, the article is successful in presenting an in depth understanding of conflicts. This is useful to my theme as it explains the values of the First Nation communities and their interactions or lack of with the industry.

Heaslip, R. (2008). 'Monitoring salmon aquaculture waste: The contribution of First Nations' rights, knowledge, and practices in British Columbia, Canada', *Marine Policy*, 32(6), pp. 988–996. doi: 10.1016/j.marpol.2008.02.002.

This article focuses directly on the importance of the First Nations' people in BC salmon farming. Through discussing salmon aquaculture waste, with particular focus on the Kwakwaka'wakw people, the article states the great importance and the interaction of First Nations' as the operations 'fall within their traditional territories' (Heaslip, 2008, p. 988). This could be of use as my research could also focus on the interaction of one particular native group. Though Heaslip (2008) herself recognises the importance, the article discusses the lack of integration of the First Nations' values and experiences in marine monitoring, suggesting they should be incorporated. After comparing the monitoring approaches, she argues if native knowledge was taken into account it could broaden the approach to environmental monitoring; rather than only using scientific technologies, the native 'holistic understanding of the environment' should also be considered (Heaslip, 2008, p. 995). This article shares a point of view, supported by interview data. As it is published in a credited journal, *Marine Policy*, I consider the article reliable. Both a strength and weakness of the article is its focus on First Nations' and waste. Whilst an in depth discussion, it fails to consider other forms of knowledge First Nations' have with BC salmon farming and therefore I will find this information elsewhere.

Henderson, A. R. and Davies, I. M. (2000). 'Review of aquaculture, its regulation and monitoring in Scotland', *Journal of Applied Ichthyology*, 16(4-5), pp. 200–208. doi: 10.1046/j.1439-0426.2000.00260.x.

McDaniels. T. L., Hadi, D. and Stevens, S. (2005). 'Multiple Scales and Regulatory Gaps in Environmental Change: The Case of Salmon Aquaculture', *Global Environmental Change*, 15(1), pp. 9-21.

This theoretical essay goes some way into looking at the differing scale of perspectives from federal and provincial points of view. Looking how despite day to day running of BCs commercial salmon farming industry residing with the hands of local governmental decisions, real power over decision making, and potential to neglect environmental concerns, comes the federal level of centralized power. The author comments on how environmental issues such as this one requires multiple levels of response, suggesting that they need the help from regulatory processes to provide more effective jurisdiction. Controls are needed outside the sphere of governmental interest, where economical concerns are not the only driving force behind decision making.

Including a critique of the major power and decision making bodies in their ability to make effective decisions when environment decision are at stake, will be an effective counter argument that does not focus on the neglect of environmental issues. By looking at the centralized nature of policy making, it becomes obvious that it might not be necessarily the best form of governance over issues concerning the environment. Local external levels should take a larger role, where opinions and decisions are not distorted by economic gains. This is however, merely a convincing opinion of the author and should be treated critically. The article provides a lack of reference towards the role that science has played in raising awareness in the public and how that has influenced the decisions we have seen regarding this issue.

Naylor, R. L., Eagle, J. and Smith, W. L., (2003), 'Salmon aquaculture in the Pacific Northwest: A global industry with local impacts', *Environment*, 45(8), pp. 18 – 39.

The article provides a useful and realistic critique of current structure of power, although some of the figures and statistics are dated, it does show how the balances of power have been formed regarding the issue. By looking at how industry provided employment in a period where the province was experiencing economic decline in these marginalized rural regions and how it was greatly received by governmental powers, provides support to statements regarding the sidelining of environmental issues. The authors are highly critical of the MAFF, suggesting that their reaction to the heavily emphasized environmental damages, has not been sufficient, whilst he does not mention any counter evidence that suggest that the links between farming and sea lice is not significant.

Noakes, D. J., Beamish, R. J. and Kent, M. L. (2000). 'On the decline of pacific salmon and speculative links to salmon farming in British Columbia', *Aquaculture*, 183(3), pp. 363-386. doi:10.1016/S0044-8486(99)00294-X

The authors of this article raise the points that Salmon farms are not the only reason for the decline of Wild Salmon, and instead they relate it more of the change in climates, the loss of freshwater habitats, and multiple other reasons. The article even goes to the point of saying that, "although farmed salmon are also a potential source for these disease pathogens, surveys of pathogens in wild and hatchery fish show no patterns that could be attributed to salmon farming." They state that, "the same antibiotics used in the salmon farming industry are also used in salmon enhancement projects, making it difficult to identify the source of some pathogens." These are points that are not often raised in what some call the "war on fish farmers" that has been declared by many British Columbians in the past couple decades. This article is noteworthy for my research as it presents views that many people tend to ignore, as they want to find a scapegoat, and not blame themselves for how they are changing the environment enough to affect the Salmon population.

Page, J. (2007) 'Salmon Farming in First Nations' Territories: A Case of Environmental Injustice on Canada's West Coast', *Local Environment*, 12(6), pp. 613–626. doi: 10.1080/13549830701657349.

In this peer reviewed article, Justin Page addresses the environmental injustice that is currently has been taking place for the majority of the second half of the 20th century. He addresses the reasons for concern that the local First Nations peoples have over Salmon farming off of the coast that they have ethically survived alongside for thousands of years. The concerns revolve around the pollution of aquatic environment, risk to wild salmon populations, food safety issues, and how all of these cause environmental injustice for

coastal BC First Nations. The article provides a unique insight into the topic as it addresses the concerns that are shared by the general public, but then channels them into a First Nations focus.

Government Documentation

BC Stats. (2013). *Fisheries, Aquaculture, hunting and trapping*. Retrieved from <http://www.bcstats.gov.bc.ca/StatisticsBySubject/BusinessIndustry/FisheriesAquacultureHuntingTrapping.aspx>

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Canada. Department of Fisheries and Oceans and Québec Ministère des Ressources naturelles et de la Faune. (2009). *Conservation Status Report, Atlantic Salmon in Atlantic Canada and Québec: Part II–Anthropogenic Considerations*. Ottawa, Ontario: Canadian Advisory Secretariat (CSAS) National Capital Region Fisheries and Oceans Canada.

Canada. Department of Fisheries and Oceans and Québec Ministère des Ressources naturelles et de la Faune. (2009). *Conservation Status Report, Atlantic Salmon in Atlantic Canada and Québec: Part II–Anthropogenic Considerations*. Ottawa, Ontario: Canadian Advisory Secretariat (CSAS) National Capital Region Fisheries and Oceans Canada.

Canada. Department of Fisheries and Oceans. Maritimes Region, Canadian Government EBook Collection, & Canadian Science Advisory Secretariat. (2014). *Recovery potential assessment for outer bay of fundy atlantic salmon*. Ottawa: Canadian Science Advisory Secretariat.

Canada. Department of Fisheries and Oceans (2014) Maritimes Region, Canadian Government EBook Collection, & Canadian Science Advisory Secretariat. (2014). *Recovery potential assessment for outer bay of fundy atlantic salmon*. Ottawa: Canadian Science Advisory Secretariat.

This report was made in compilation with the department of Fish and Oceans, Québec Provincial Atlantic salmon fisheries and habitat managers, economists and personnel in Aboriginal fisheries to represent the discussing: the threats to wild Salmon populations, the evidence, recovery efforts already under way, proposals of possible solutions, and the threat of decreased salmon population has on over 40, 000 First Nations peoples. In the report they supply raw data on the output of farms, the rough number of wild salmon harvested, and other relative information. The article highlights and discusses many differing elements that are vital in the discussion of fish farming. Being a government document it is reliable and is able to provide me with trustworthy numbers and explanation of them.

Canada. Department of Fisheries and Oceans. Maritimes Region, Canadian Government EBook Collection, & Canadian Science Advisory Secretariat. (2014). *Recovery potential assessment for outer bay of fundy atlantic salmon*. Ottawa: Canadian Science Advisory Secretariat.

This article examines the potential the Bay of Fundy has for recovering its Atlantic Salmon population. The article is backed by the Department of Fisheries and Oceans, and provides

a case study that gives raw data on the effects Salmon farming has had on the local environment. The article provides the information for the number of returning Salmon to the Bay, the number of freshwater habitats that have been affected by human interference, and other numbers surrounding the effects and harvest of the local farms. The article allows for me to present a case study where the problem is identified, solutions have been attempted, and future solutions are being planned to be put in place.

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Grey Literature

British Columbia Salmon Farmers Association. (2015). *About Us*. Retrieved from <http://bcsalmonfarmers.ca>

This is an online source, described as a forum for the various stakeholders involved in the salmon farming sector. Though a useful source of information, it is certainly a bias website, arguably expected of online sources. The British Columbia Salmon Farmers Association

(BCSFA) support and promote salmon farming in BC, providing it is of a sustainable and responsible nature. I believe this source to be of use to my theme as it provides background knowledge into salmon farming in BC; without knowledge of the wider picture, it is difficult to understand the issue of my focused theme. Also, the website has links to various up to date press releases and articles, some of which may be of use to me in the future. Though the credibility and/or accuracy of websites can often be questioned, I view BCSFA as a reliable source of information. The website provides contact details, various links to support their point of view and concurs with views of other websites, for example Positive Aquaculture Awareness (2010), thus suggesting it is a recognized site in the salmon farming industry. Despite this, there are certainly drawbacks. It does not mention the negative issues currently related to salmon farming in BC, which other sources document. Therefore, my research should seek to include an alternative point of view to remain balanced.

BC Farmers Association. (2015). *Growing the World's Best Fish*. Retrieved from <http://bcsalmonfarmers.ca/growing-worlds-best-fish/>.

The BC Salmon Farmers Association provides an informational article of their work. They argue that the salmon they farm are of top quality and that the farm sites themselves are well taken care of. They advocate for the improvements that their organization has made to raise knowledge about farming, improve quality of product, and cause little environmental damage. The reference is noteworthy because of its strong advocacy for salmon farming, making it useful for research, as it vividly illustrates the opinion of the farmer's association in continuing on with salmon farming. There is a variety of sections that address concerns like sea lice, and then addresses them, offering the lens of a strong stakeholder in the issue.

The data comes from the organization itself and its confidence in self monitoring. The Association does have credibility to it, holding itself open for criticism, yet it's very heavily bias towards the benefits of salmon farming. Unlike environmental organization that criticize farming, this organization heavily favours it and will defend itself against criticism. The information given about its efforts to minimize things like disease and effects on wildlife is quite compelling, yet it can only be trusted to a degree given the nature of the organization. The information provided lacks support from other sources, rather the farmers are monitored by their collective association, perhaps causing the article to lose some credibility.

Farmed and Dangerous, (No Date). *History in BC*. Retrieved from:

<http://www.farmedanddangerous.org/solutions/industry-reform/history-in-bc/>

Morton. A (2015). *Salmon Confidential: The Ugly Truth About Canada's Open-net Salmon Farms*. Retrieved from <http://www.alexandramorton.ca/salmon-confidential-booklet/>

Liberal. (2015). *Environmental Assessments*. Retrieved from

<http://www.liberal.ca/realchange/environmental-assessments/>

Data Sources

Statistics Canada, (2013), *Aquaculture, production and value, by province and Canada – 2007*. Retrieved from <http://www.statcan.gc.ca/pub/23-222-x/2011000/t039-eng.htm>

I believe it is important to discover and include statistics on the value of salmon aquaculture and to gain an understanding of the broader issue in order to understand the relationship

between salmon farming and First Nations' in BC. This data can be deemed a reliable source as I retrieved it from the Canadian government website. Firstly the statistics demonstrate that salmon aquaculture in BC accounts for over two-thirds of total salmon aquaculture in Canada (measured in tonnes). In addition, it shows that the value of aquaculture salmon in BC accounts for over half of the total value in Canada. This indicates the importance of the industry within the province. I view this data to be useful as it gives me an understanding as to the scope of the aquaculture industry in Canada, but in particular BC. A weakness of this data is that it does not focus on the salmon aquaculture; it provides broad information on all forms of aquaculture in Canada. I therefore believe it is vital to include some data specific to salmon farming in BC.

Multimedia

ASF. (2015). *Atlantic salmon federation*. Available at: <http://www.asf.ca/main.html> (Accessed: 30 November 2015).

First Nations. (2003). *Fisheries: Heiltsuk*. [Photograph]. Retrieved from <http://www.firstnations.de/fisheries/heiltsuk.htm>

Farmed Salmon Boycott. (2014). *A brief look at the industrial, mega operations that salmon farms are*. [Photograph]. Retrieved from <http://farmed-salmon-boycott.com/industrial-fish-farming/>

Macdonald, N. (2009). *Something fishy in BC*. [Photograph]. Retrieved from <http://www.macleans.ca/society/life/something-fishy-in-bc/>

Simon Fraser University. (2008). *Speaking for the Salmon Proceedings Encouraging Innovative Solutions for Sustainable Salmon Aquaculture Workshop*. [Photograph]. Retrieved from <https://www.sfu.ca/cstudies/science/resources/1274123844.pdf>

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