Aquaculture Regulation in Canada:

A Case for Modernization, Standardization and Collaboration

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A major report submitted to the School of Graduate Studies

in Partial fulfilment of the requirements

for the degree of Master of Marine Studies

Fisheries Resource Management

December 2018

St. John's Newfoundland

ABSTRACT

As the global population is set to reach 9 billion by 2050, food production needs to be far more efficient in utilizing productive natural resources (World Bank, 2013). Aquaculture can address some of the difficult challenges that accompany global population growth.

Aquaculture regulation in Canada is shared between the provincial and federal governments. The Department of Fisheries and Oceans (DFO) is the lead regulatory authority that manages aquaculture in Canada. DFO manages aquaculture collaboratively with ten provincial governments and the Yukon Territory. There is significant potential for Canadian aquaculture to expand, with the Canadian government estimating that by 2020, domestic aquaculture production could exceed 308,000 tonnes with a processed value of USD 1.6 billion (FAO, 2018a). For future significant growth in Canada's aquaculture industry to occur, centralized policies and regulations, with DFO remaining the lead regulator, must be implemented to continue to protect the environment, and ensure the economic viability of the sector in an increasingly competitive global market.

Throughout this report, the discussion is centered around three themes: (1) the importance of aquaculture to the Canadian economy, (2) the need for aquaculture regulation and legislation to be standardized throughout the Canadian provinces and territories to promote the efficiency and growth of the industry, (3) recommendation of the standardization of aquaculture regulations be based on aspects of the British Columbian model –the largest aquaculture producing province in Canada (FAO, 2018a).

ACKNOWLEDGEMENTS

I would like to acknowledge and thank the following people who have supported me, not only during this report, but throughout my Master of Marine Science degree.

Firstly, I would like to thank my supervisor, Mr. Keith Rideout, Coordinating Instructor/Technical Liaison Regional Aquaculture Center, Coast of Bays, Newfoundland and Labrador, for his support, guidance and insight throughout this project.

I would like to thank my parents, my sister Dr. Jenni Sidey-Gibbons, and Dr. Chris Gibbons for their encouragement and support throughout the whole process. Without their guidance and support, this degree would not have been possible. Thank you for your support.

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LIST OF ACRONYMS

AAHD: Aquatic Animal Health Division

AAR: Aquaculture Activities Regulations

AAC: Aquaculture Association of Canada

AEMP: Aquaculture Environmental Monitoring Program

AMAC: Aquaculture Management Advisory Committee (British Columbia)

AMRL: Administrative Maximum Residue Limits

AMS: Aquaculture Monitoring Standard

BCARP: British Columbia Aquaculture Regulatory Program

BC-FLNRO: British Columbia Ministry of Forestry, Lands, Natural Resources Operations

BCSFA: British Columbia Salmon Farmers Association

BC-MA: British Columbia Ministry of Agriculture

CAIA: Canadian Aquaculture Industry Alliance

CGMP: Current Good Manufacturing Practices

CFIA: Canadian Food Inspection Agency

CCFAM: Canadian Council of Fisheries and Aquaculture Ministers

CVMA: Canadian Veterinary Medical Association

ECCC: Environment Climate Change Canada

EDR: Emergency Drug Release Program (Health Canada)

DFO: Department of Fisheries and Oceans

FAO: Food and Agricultural Organization of the United Nations

GDP: Gross Domestic Product

IMTA: Integrated Multi-Trophic Aquaculture

MOE: Ministry of Agriculture

MRL: Maximum Residue Limit

NAAHP: National Aquatic Animal Health Program

NDP: New Democratic Party

NHP: Natural Health Product

NWPP: Navigable Waters Protection Program

OIE: World Organisation for Animal Health

PAR: Pacific Aquaculture Regulations

PMA: *Pest Management Act*

PMRA: Pest Management Regulatory Agency

SAP: Sustainable Aquaculture Program

SOFIA: State of World Fisheries and Aquaculture (FAO Technical Reports)

TOC: Total Organic Carbon

TDS: Total Dissolved Solids

UN: United Nations

VDD: Veterinary Drugs Directorate

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1.0 Introduction

The global population is expected to reach 9 billion by 2050 and determining how the population will be fed will be a challenge (World Bank, 2013). The World Bank, an international financial institution working to reduce global poverty, estimates that fish represents 16% of global protein consumption and plays a major role in satisfying the global demand for protein (World Bank, 2013). Sustainable fish production can meet the increasing demand for protein for the middle class, while providing food security to developing countries. Based on the Food and Agricultural Organization's monitoring of marine fish stocks, marine fish stocks have continued to decline (FAO, 2018b). In 1974, 90.0% of fished stocks were harvested within biologically sustainable levels. In 2015, that number had decreased to 66.9% (FAO, 2018b).

Aquaculture has seen impressive growth over the past decades (World Bank, 2013). Aquaculture has helped the world produce more fish, kept the price of fish production low, and made fish and seafood more accessible to global consumers (World Bank, 2013). However, growing fish sustainably and without damage to the environment is challenging. Ensuring that a supply chain is environmentally sustainable and reliable is becoming increasingly important to seafood producers and consumers (World Bank, 2013). An increase in third-party certification schemes makes it easier for the consumer to choose seafood that is affordable, and from environmentally conscious sources.

With Canada having potential for aquaculture development in the coming decades, it is important to identify the factors that will promote the growth of the industry nationally (Canadian Aquaculture Industry Alliance, 2017a). The Canadian Aquaculture Industry Alliance (CAIA) argues that Canada's access to one of the longest coastlines in the world, its high biological seafood potential, along with an educated workforce, means that Canada should be able to improve its aquaculture potential and

production in the years to come (Canadian Aquaculture Industry Alliance, 2017a). In 2017, Canada was ranked 26th in global seafood production, and fourth in global salmon production behind Norway, Chile and Scotland (Canadian Aquaculture Industry Alliance, 2017a). Particularly important to note, is the number of Canadians which are employed by aquaculture activities, many of whom have entered the industry after the decline of global fisheries landings (Canadian Aquaculture Industry Alliance, 2017a).

Improving on these global rankings can help make up for production shortfalls associated with capture fisheries. Canada must be able to use the science and technological innovations that the aquaculture industry continues to develop, to increase Canadian farmed seafood output, and increase its global seafood production rankings. However, for the industry to continue to grow in Canada and continue to work to alleviate the pressure that captive fisheries are under, it needs to be environmentally sustainable – and having clear legislation that regulates what the industry can and cannot do. Long-term environmental sustainability should be the priority and the Canadian federal government has a responsibility, to all Canadians, to ensure that the industry is as sustainable as possible.

An important part of ensuring that Canadian aquaculture development is as sustainable as they can be is the approach of its regulators. Canadian aquaculture regulators need to take a clear approach to develop unbiased legislation that allows for the development of the industry, while also satisfying the concerns that many have regarding the overall long-term environmental sustainability of the industry.

To help ensure that aquaculture production remains as environmentally sustainable as possible, government intervention and regulations are necessary. Increased intergovernmental cooperation allows for greater oversight of aquaculture operations, so that global seafood demand is met in the most economically and environmentally sustainable way possible.

Aquaculture in Canada is highly regulated at both the federal and provincial levels under the regulatory authority that is set out in the *Fisheries Act* (British Columbia Fisheries Act, 1996). Continued regulatory reform is necessary to ensure that the Canadian aquaculture industry remains as environmentally responsible and sustainable as it can be. The Canadian Aquaculture Industry Alliance (CAIA) believes that Canada should have a national *Aquaculture Act*, and in their 2017 Annual report, argued that Canadian aquaculture was sustainable, diverse and growing rapidly (Canadian Aquaculture Industry Alliance, 2017c).

Regulation of the aquaculture industry in Canada involves multiple provincial and federal agencies, with Fisheries and Oceans (DFO) as the lead regulator (FAO, 2018). Intergovernmental regulation and cooperation in Canada have allowed the aquaculture industry to increase production, increase the labour force, and contribute to provincial and federal economies. In 2016, the province of British Columbia harvested 103,600 tons of farmed seafood, which contributed CAN $ 776.8 million to the provincial economy (Province of British Columbia, 2017).

Aquaculture regulation in Canada is different among provinces. For the industry to continue to grow, regulations must be standardized among provinces. In recent years, regulatory officials have been working towards creating new legislation for aquaculture that is more efficient, that protects fisheries and the environment and enables the Canadian aquaculture industry to grow (FAO, 2018a).

As of 2018, the federal *Fisheries Act (1985)* does not define aquaculture, rather the term is defined differently under different pieces of provincial legislation (Aquaculture in British Columbia, n.d.). In British Columbia, aquaculture is defined under the provincial *Fisheries Act (1996)*, [repealed in 2017], as: “growing and cultivation of aquatic plants, or fish for commercial purposes in any water environment of human made containers of water, and includes the growing and cultivation of shellfish on, in, or under the foreshore or in water” (Fisheries Act, 1996; FAO, 2018).

In Newfoundland, under the 1996 *Aquaculture Act,* aquaculture is defined as: "the farming of fish, molluscs, crustaceans, aquatic plants, and other aquatic organisms with an intervention in the rearing process to enhance production by regular stocking, feeding and protection from predation, and includes fallowing and processes to mitigate environmental degradation and placement of necessary gear and equipment" (FAO, 2018; Newfoundland and Labrador Fisheries and Land Resources, 2018).

In New Brunswick, aquaculture is defined, under the *New Brunswick Aquaculture Act* (2011) as: "the cultivation of aquatic plants and animals but does not include the cultivation of aquatic plants and animals in a laboratory for experimental purposes or in an aquarium" (FAO, 2018; New Brunswick Aquaculture Act, 2011).

As the Canadian aquaculture industry continues to grow, it becomes more important than ever to have science support the sustainable management, regulation, and cooperation among levels of government (Aquaculture Association of Canada, 2017). Sustainability reporting must remain at the forefront of aquaculture development in Canada if the industry is to grow, expand and help to alleviate pressure on global fisheries.

This report will investigate the evolution of aquaculture regulation in Canada with a focus on British Columbia, as this province has the largest share of aquaculture production in Canada (Aquaculture Association of Canada, 2017). This will include an overview of the socio-economic importance of aquaculture to the Canadian economy, a history of aquaculture legislation in British Columbia, and an overview of how aquaculture is regulated in Canada today. The report will conclude with an assessment of the legislation that governs aquaculture in Canada today, and make the argument for federal and provincial regulators to adopt a uniform policy for aquaculture regulation in Canada. Current legislation and aquaculture regulatory requirements are complex; each federal or provincial agency has multiple regulations that they use to monitor the industry.

Going forward, the current regulatory approach in British Columbia could be used as a template; however, there are also inefficiencies associated with this model, particularly when it comes to siting, wastewater discharge and benthic monitoring requirements. The current method of aquaculture regulation in Canada is effective; the involvement of multiple agencies places a series of checks and balances at the federal and provincial levels and ensures that aquaculture is managed appropriately. However, management of the industry differs regionally; e.g. management of aquaculture in British Columbia differs from Newfoundland and Labrador. Adoption of standardized methods for aquaculture management in Canada would lead to greater transparency, increased efficiency and ultimately greater growth of sustainable aquaculture production in Canada.

2.0 Global and Canadian Aquaculture

2.1 Global and Canadian Seafood Production from Fisheries and Aquaculture

Global aquaculture continues to increase production annually. Aquaculture supplies more than 50 percent of all seafood produced for human consumption – and that percentage should continue to rise, hopefully alleviating some of the global pressure on wild capture fisheries. Table 1 illustrates the global fisheries and aquaculture production from 2011 to 2016. In 2014, capture fisheries produced 91.2 million tonnes of fisheries product, with aquaculture producing 73.7 million tonnes of fish (Food and Agricultural Organization, 2018). Total global marine catch in 2016 was 79.3 million tonnes, down from 81.2 million tonnes in 2015 (FAO, 2018b). Total world fisheries and aquaculture production peaked at approximately 171 million tonnes in 2016, with aquaculture representing 47 percent of the total. As the aquaculture industry

continues to expand its production capabilities, it is anticipated that the world global fisheries production will decrease.

Table 1: Global capture fisheries and aquaculture production for 2011-2016 (million tonnes), (FAO, 2018).

WORLD FISHERIES AND AQUACULTURE PRODUCTION AND UTILIZATION (MILLION TONNES)[a]

Category	2011	2012	2013	2014	2015	2016
Production						
Capture						
Inland	10.7	11.2	11.2	11.3	11.4	11.6
Marine	81.5	78.4	79.4	79.9	81.2	79.3
Total capture	**92.2**	**89.5**	**90.6**	**91.2**	**92.7**	**90.9**
Aquaculture						
Inland	38.6	42.0	44.8	46.9	48.6	51.4
Marine	23.2	24.4	25.4	26.8	27.5	28.7
Total aquaculture	**61.8**	**66.4**	**70.2**	**73.7**	**76.1**	**80.0**
Total world fisheries and aquaculture	**154.0**	**156.0**	**160.7**	**164.9**	**168.7**	**170.9**
Utilization[b]						
Human consumption	130.0	136.4	140.1	144.8	148.4	151.2
Non-food uses	24.0	19.6	20.6	20.0	20.3	19.7
Population (*billions*)[c]	7.0	7.1	7.2	7.3	7.3	7.4
Per capita apparent consumption (*kg*)	18.5	19.2	19.5	19.9	20.2	20.3

[a] Excludes aquatic mammals, crocodiles, alligators and caimans, seaweeds and other aquatic plants.
[b] Utilization data for 2014–2016 are provisional estimates.
[c] Source of population figures: UN, 2015e.

In 2016, Canada produced over 200,000 metric tons of shellfish and finfish through aquaculture, with the highest producing provinces being British Columbia, Newfoundland and Labrador and New Brunswick, with 102,325 MT, 28,622 MT and 28,082 MT, respectively (DFO, 2018). Table 2 illustrates the final product value of Canadian aquaculture in 2010.

Table 2: Canadian Aquaculture Farm, Process Value, and Final Product Values ($000s) in 2010, separated by province (DFO, 2013; Socio-Economic Impact of Aquaculture in Canada, 2013 Edition). Non-numerical values indicate no data available.

Province	*Farm-gate values*		*Process value-added*		*Final Product value*		*Total Value*
	Finfish	Shellfish	Finfish	Shellfish	Finfish	Shellfish	
British Columbia	511,500	22,300	41 080	19 030	552 580	41 330	593 910
Ontario	17,100	-	2 300	-	19 400	-	19 400
Quebec	8,579	829	4 046	545	12 625	1 374	14 000
New Brunswick	162,700	2,038	98 145	3 462	260 845	5 500	266 345
Nova Scotia	32,932	8,100	1 448	3 260	34 380	11 360	45 740
PEI	-	30,254	-	27 592	-	57 846	57 846
NFLD & Labrador	81,270	2,953	29 031	3 056	110 301	6 009	116 310
Total	814,081	66,474	176 050	56 945	990 131	123 419	1 113 551

The overexploitation of global capture fisheries and poor aquaculture practices are two of the major ways that the human population is harming the oceans, to which we are inextricably linked, and upon which the global population depends (Ocean Wise Seafood Program, 2018). While there are environmental issues with both industries, aquaculture represents a potential solution to the global overfishing crisis. According to the United Nations, the global output of fish from commercial fishing activities has stagnated, and currently, there is no additional output of fish available – there is not enough fish in the ocean to meet the global demand (FAO, 2016). The additional demand for seafood created by 7 billion people can be alleviated by sustainable aquaculture– and the industry also represents a livelihood for individuals that may have decreased employment opportunities attributed to the decline in commercial fishing opportunities.

2.2 Socio-Economic Perspectives of Aquaculture in Canada

Aquaculture production in Canada has positive socio-economic impacts. Annual Canadian production increased more than four-fold between 1990 and 2002, with increases in the number of approved leases and the total production area (Fisheries and Oceans, 2012). In 2003, there were decreases in the production output of Canadian aquaculture due to price weakness in international markets (Figure 1). After 2004, the annual production output of cultivated species in Canada increased due to strong prices in the international markets, and a decrease in Atlantic salmon availability in the Chilean market (Fisheries and Oceans, 2012).

The Canadian aquaculture industry contributes significantly to the Canadian economy. Annually, the industry generates $5.1 billion in economic activity in Canada, and contributes over $2 billion to the Canadian gross domestic product (GDP) every year (Canadian Aquaculture Industry Alliance, 2017b). The aquaculture sector employs over 25,000 employees and generates over $1.16 billion in labour income annually. As a country, Canadian aquaculture seafood exports total 200,565 tonnes and have a production value of over $1.37 billion dollars (Canadian Aquaculture Industry Alliance, 2017b). Over 97 percent of Canadian cultivated seafood is exported to the United States, with the remainder allocated for China (including Hong Kong), Japan, Singapore and South Korea (Canadian Aquaculture Industry Alliance, 2017b).

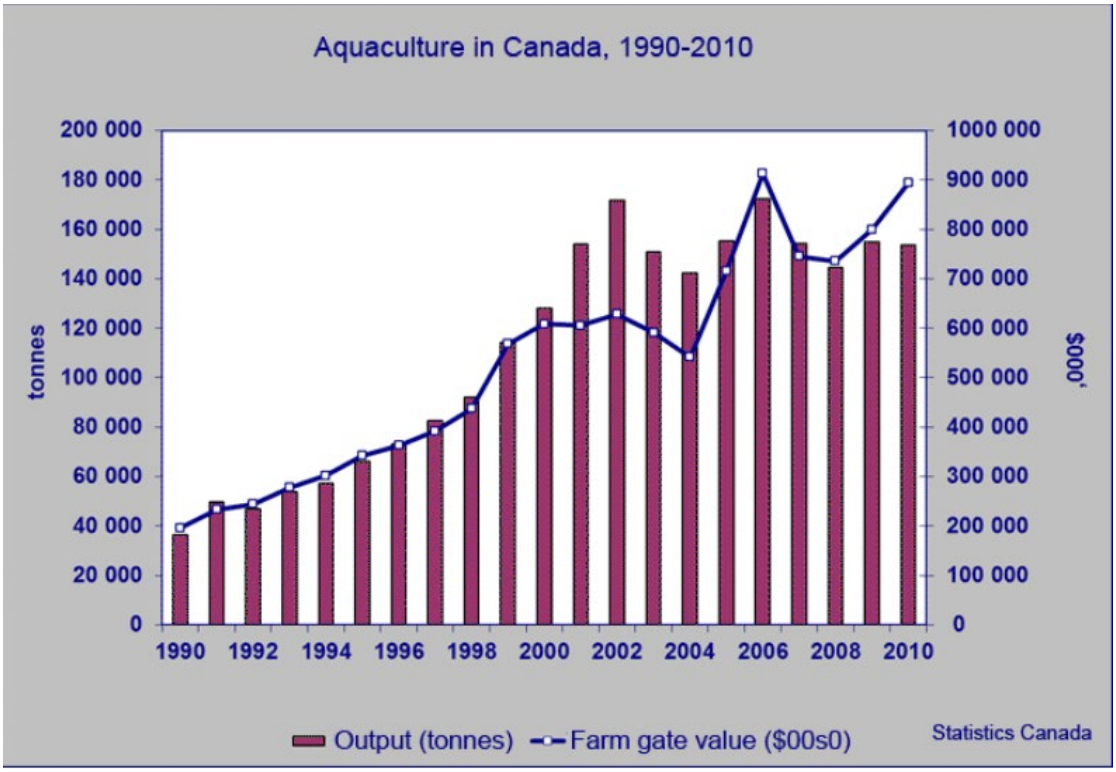

Figure 1: Total annual Canadian aquaculture output, from 1990- 2010, plotted against both annual production (tonnes), and millions of dollars ($USD). There was an increase in the annual production output in Canada for most of the time frame, aside from the 2002-2004 and 2006-2008 periods (DFO, 2012; Pinfold, 2013).

The annual production output of Canadian aquaculture comprises production from the Atlantic provinces and British Columbia, although British Columbia accounted for half of the total production output and increase in site licenses from 1990-2010 (Pinfold, 2013). According to Pinfold (2013), in 2010, the Canadian aquaculture industry generated just over one billion in total GDP, with over $355 million in direct GDP, and approximately $710 million in "spin-off" impact. Pinfold describes "spin-off" impact as:

> "Industry [creating] just over 5,800 full-time equivalent jobs, with an overall employment impact of just over 14,000 FTE [full-time equivalent], generating labor income of $193 million with an overall impact of $618 million" (Pinfold, 2013).

As of 2015, the total value of the seafood industry in Canada highlights the need for the development of a sustainable seafood and aquaculture program in Canada that emphasized industry sustainability and maintained federal commitment to the industry's development in Canada.

The economic impacts of aquaculture are particularly important when examining the Canadian provinces that have been affected by commercial fishing losses in recent years. In provinces like Newfoundland and Labrador, the expanding aquaculture industry is an important economic contributor to the provincial economy and is of importance to the rural regions of the province. Managed primarily by the Department of Fisheries and Land Resources (DFLR), the expansion of aquaculture has led to positive economic and social impacts for residents, businesses and communities (Newfoundland and Labrador Fisheries and Aquaculture, 2014).

In Newfoundland and Labrador, aquaculture expansion occurred rapidly in 2000 due to the government's release of a publicized strategy aimed at the development of the province's aquaculture sector, the identification of three priority species for commercial development, including Atlantic salmon (*Salmo salar)*, steelhead trout (*Oncorhynchus mykiss)* and the blue mussel (*Mytilus edulis)*, and focused on the research and development of Atlantic cod cultivation (Newfoundland and Labrador Fisheries and Aquaculture, 2014).

The research and development focus on the cultivation of these commercially important species contributed to the positive impacts the aquaculture industry had on the provincial GDP from 2003-2013. In 2013, the total GDP from the aquaculture industry, including direct, indirect or induced activities was estimated at approximately $104.1 million, up from less than $10.5 million in 2003 (Newfoundland and Labrador Fisheries and Aquaculture, 2014). Annual increases in salmonid production output (over 19,000 MT of growth between 2003 and 2013) allowed for direct GDP growth

(Newfoundland and Labrador Fisheries and Aquaculture, 2014). The monetary benefits of provincial aquaculture development can vary annually, but the employment benefits that the industry can provide, particularly in rural or economically depressed areas, is positive.

In 2017, it was estimated that the Canadian aquaculture industry contributed significant economic benefits to rural and coastal communities in Canada. The Canadian Aquaculture Industry Alliance (CAIA) estimates that farming and fish processing activities from aquaculture generated CAN $5.16 billion in economic activities, CAN $2 billion in GDP, and over 25,000 full time paying jobs for Canadians, which was estimated to have generated CAN $ 1.16 billion in wages in 2016 alone (Canadian Aquaculture Industry Alliance, 2017a). This economic activity has created solid production, revenue and exports for the country and while global seafood production from capture fisheries has been stagnant since the late 1980's (FAO, 2016), aquaculture revenue in Canada continues to increase (Canadian Aquaculture Industry Alliance, 2017a). In 2016, Canadian cultivated seafood exports rose to over CAN $1 billion (Canadian Aquaculture Industry Alliance, 2017a).

One of the most important benefits that aquaculture brings to rural communities in Canada is the involvement of indigenous communities in the generation of economic benefit. The Canadian Aquaculture Industry Alliance estimates that from 2012-2017, there were over forty indigenous commercial partnerships in the Canadian aquaculture industry – and these partnerships generated 3,480 additional jobs and over CAN $170 million for members of indigenous communities. Within the next decade it is estimated that 8,230 additional jobs, and CAN $410 million in additional revenue potential will be realized (Canadian Aquaculture Industry Alliance, 2017a).

3.0 Regulatory Jurisdiction of Aquaculture in Canada and British Columbia

3.1 Canada

In Canada, the provincial and federal governments share regulatory authority and enforcement responsibility over aquaculture – from original applications, siting, operation and through to the site(s) being decommissioned (Standing Senate Committee on Fisheries and Oceans, 2016). The Department of Fisheries and Oceans is the lead regulatory agency that helps to unite and encourage collaboration over aquaculture regulation and responsibility in Canada – and the ultimate power to regulate aquaculture was assigned to the department and to the Minister of Fisheries and Oceans by the Prime Minister's Office in 1984 (Standing Senate Committee on Fisheries and Oceans, 2016).

While there are challenges regarding the regulation of aquaculture in Canada, the industry is committed to sustainability. While aquaculture legislation and reform in Canada is currently complicated, the country still has some of the most stringent laws and regulations for the aquaculture industry compared to other countries.

Aquaculture has the potential to replace commercial fishing activities, but only if the stringent regulatory review of the industry is continued. Management decisions need to be based on sound science – while ensuring the industry has room to grow in a sustainable fashion.

Individual provinces regulate their aquaculture operations differently. The Prince Edward Island (P.E.I) and British Columbia governments are heavily involved in the management of provincial aquaculture. Additionally, the Department of Fisheries and Oceans manages the federal government's Sustainable Aquaculture Program (SAP), whose primary objective is to foster the development of the aquaculture industry in

Canada in the most sustainable and responsible way (Standing Senate Committee on Fisheries and Oceans, 2016).

In Canada there are multiple federal departments that are responsible for aquaculture industry enforcement, compliance, and advancement through research and development. Environment and Climate Change Canada (ECCC), Health Canada, the Canadian Food Inspection Agency (CFIA), and Transport Canada all play roles in the management of aquaculture in British Columbia, and in Canada. Environment and Climate Change Canada's primary responsibility is to minimize the threats of pollution to the environment, through mandating environmental assessments for the aquaculture industry. These occur at several points of a production cycle, including in the initial siting application, before stocking, through peak biomass times, and in fallowing times. Environment and Climate Change Canada's regulatory authority is managed through the *Canadian Environmental Protection Act*, (Government of Canada, 1999) certain provisions that are defined in the *Fisheries Act*, (British Columbia Fisheries Act, 1996) and in the New Substances Notification Regulations (Standing Senate Committee on Fisheries and Oceans, 2016).

With regards to both aquaculture development and regulation in Canada, Health Canada's role is the management of all drugs that are used on species that are cultivated in Canada. This includes the management of aquaculture feed, aquaculture vaccines, and aquaculture drugs such as those that can be required to mitigate disease and improve fish health throughout the species' production cycle. The lead regulatory authority within Health Canada, the Veterinary Drugs Directorate (VDD), is the office responsible for the approval of all new aquaculture drugs, vaccines, or medicated feed.

CFIA is responsible for the management and control of animal diseases through the *Health of Animals Act*. One salmonid aquaculture producer located in British Columbia was required to depopulate their sites between 2012-2013 due to an immediately notifiable disease outbreak at their farm operations – the decision to

depopulate was required by the CFIA, because those fish presented a disease risk to other companies located in the area, other local sites, and the environment (Government of Canada, 2013).

Within the authority granted to the Canadian Food Inspection Agency through the *Feeds Act*, the *Safe Foods for Canadians Act*, and under the Fish Inspection Regulations, the CFIA can regulate the manufacturing and approval of animal feeds for all species in Canada (Canadian Food Inspection Agency, 2015). CFIA can inspect processing plants and issue export certificates for animals under the *Safe Foods for Canadians Act* (Canadian Food Inspection Agency, 2017a). Under the Fish Inspection Regulations, the CFIA ensures that all fish, whether they are of wild or cultivated origins, are processed in approved, inspected and safe processing facilities – and that the products themselves meet federal requirements for food safety and identity (Standing Senate Committee on Fisheries and Oceans, 2016). All federal agencies regulate aspects of aquaculture in Canada under their mandate; for the industry to grow further, increased regulatory collaboration will be necessary.

3.2 British Columbia

In 1988, the British Columbia and federal governments signed a Memorandum of Understanding on Aquaculture Development, which was replaced by an Agreement signed in 2010. The Agreement applied to the management of all forms of aquaculture in British Columbia, and included aquaculture activities such as stock enhancement programs, government research programs, and other non-commercial (or commercial) aquaculture-related activities taking place in British Columbia (Government of Canada, 2010a).

The purpose of the 2010 Agreement was to define the responsibilities of both the federal and the provincial governments, with respect to both the management and regulation (or enforcement) of the aquaculture sector in British Columbia. The

Agreement sets out a way for both governments to collaborate on the management and regulation of the industry in British Columbia, and it defines instances where both levels of government should coordinate efforts and which levels of government should take the regulatory lead in aquaculture management (Government of Canada, 2010a). The end goal of the Agreement was to facilitate effective consultation between the federal and provincial governments, effective decision making and data sharing mechanisms that allow for the aquaculture industry to develop and grow in the most environmentally sustainable way possible, and allow for the industry to be as well managed and transparent as possible (Government of Canada, 2010b).

The 2010 Agreement between the two levels of government remains effective, primarily because it outlines the responsibility that each party has with respect to responsibly managing British Columbia's aquaculture industry. The Agreement stipulates that the federal government is responsible for the protection and conservation of fish and fish habitat, the proper management and control of fisheries, including aquaculture, and the management of pollution measures (Government of Canada, 2010b). By 2013, these definitions were modified with the changes implemented by Rt. Hon Stephen Harper's Conservative government, however, most of these defined responsibilities are still valid. Developing a future agreement that outlines provincial and federal regulatory responsibilities with regards to Canadian aquaculture would benefit the industry and allow for growth. Using the 2010 Agreement as a model for a national agreement could be successful, partly because it clearly outlines responsibilities.

The federal government maintains responsibility of all crown lands in BC and issues the tenures and operating licenses with respect to proposed or existing aquaculture facilities that are located on crown lands (Government of Canada, 2010a). Sections 5.2.4 through 5.2.8 of the Canada – British Columbia Agreement on Aquaculture Management (2010) (Government of Canada, 2010a), define the responsibilities that the government has with respect to aquaculture activities in British

Columbia, including the management of the Navigable Waters Protection Program (NWPP), the maintenance of aquatic animal health matters through further inter-agency cooperation, and the maintenance of healthy aquatic ecosystems through the management of aquatic diseases and veterinary drugs that are used within the aquaculture industry (Government of Canada, 2010a).

The British Columbia provincial government assigns its aquaculture responsibilities to different provincial agencies. The Ministry of Agriculture is the lead regulatory agency for aquaculture activities in British Columbia – and serves as the primary communicator with the federal government on aquaculture affairs. The Ministry of Natural Resource Operations is the primary regulator responsible for the issuance of tenures and aquaculture site licensing in British Columbia. The Ministry of Environment is responsible for waste and disposal from aquaculture facilities unless there are deleterious substance(s) that are deposited into a fishery – in which case, the Department of Fisheries and Oceans and Environment and Climate Change Canada are responsible. The Department of Fisheries and Oceans defines deleterious substances as: "any substance that, if added to any water would degrade or alter or form part of a process of degradation or alternation of the quality of that water so that it is rendered, or likely to be rendered deleterious to fish or fish habitat" (Government of Canada , 2018).

Within British Columbia, the Pacific Aquaculture Regulations (PAR), with authority from the federal *Fisheries Act*, regulate the aquaculture industry provincially. Regulating and monitoring British Columbia's marine finfish aquaculture facilities is the shared responsibility of the Department of Fisheries and Oceans (DFO), and the provincial government (Fisheries Act , 1985). In 2010, when the new regulations were first proposed, the PAR established a licensing regime in British Columbia like other fisheries managed by DFO (Aquaculture in British Columbia, n.d.)

The PAR apply to any aquaculture facility, or prescribed aquaculture activities that are in: “the territorial sea of Canada off the coast of British Columbia, the internal waters of Canada off the coast of British Columbia that are not in that province, any internal waters of Canada in British Columbia, and/or any facility in British Columbia from which fish may escape into Canadian fisheries waters” (Pacific Aquaculture Regulations SOR/2010-270, 2015). The Minister of Fisheries and Oceans maintains ministerial control, but the province of British Columbia controls some important aspects of aquaculture development provincially, particularly when it comes to site licensing, access, and therapeutant use. If the license is in good standing, aquaculture facilities are responsible for recording all matters related to stocking, therapeutant use, or the aquaculture site’s facility.

The PAR manages three major types of aquaculture in British Columbia. Marine finfish comprise the majority (almost exclusively Atlantic salmon), through approximately 130 sites province-wide. Clams, oysters, mussels, scallops and geoducks are managed alongside other shellfish species through 500 provincial sites. Freshwater finfish facilities that raise rainbow trout, private non-commercial hatcheries for sturgeon, Coho salmon and sockeye salmon, are managed alongside enhancement facilities (Aquaculture in British Columbia, n.d.).

By placing the Pacific Aquaculture Regulations as a subsection under the broader *Fisheries Act*, the Department of Fisheries and Oceans has the responsibility to minimize any potential negative effects of aquaculture in British Columbia. The federal government issues the licenses for marine and freshwater facilities, including all hatcheries in British Columbia, enforces new aquaculture regulations, assesses all modifications to existing aquaculture sites, and conducts aquaculture research programs (Aquaculture in British Columbia, n.d.). The provincial government is responsible for issuing the tenures for marine or freshwater environments, regulates

the business aspects of aquaculture (such as workplace health and safety), and reports on provincial seafood exports (Aquaculture in British Columbia, n.d.).

Aquaculture license holders are required to comply with all other forms of authorization from federal or provincial agencies that have jurisdiction for marine finfish aquaculture facilities in British Columbia. Under the 2010 *Pacific Aquaculture Regulations*, all aquaculture operators have a responsibility to report back, to the provincial and federal governments, information on their operations and environmental data. While the provincial government's regulatory roles and responsibilities are limited in comparison to the federal government over aquaculture licenses, they are still responsible for issuing aquaculture sites with tenures. These tenures may be multi-year, or issued for a single year, like in the Discovery Islands, British Columbia (Fisheries and Oceans Canada, 2012).

4.0 Aquaculture Regulation in British Columbia

4.1 History of Aquaculture Regulation in British Columbia

In 1986, after the British Columbia government issued a moratorium on the establishment of new salmon farming leases in the province, the Minister of Forests and Lands tasked Commissioner David Gillespie ("The Gillespie Report") with first looking at the potential impacts of salmonid aquaculture on the marine ecosystems of British Columbia. Gillespie, the Chairman of the B.C. Finfish Aquaculture Inquiry, made several recommendations regarding how the industry could reduce its environmental impact and increase its sustainability after the report's December 1986 publication (Ministry of Forests and Lands, 1986). The report discussed the level of support that the British Columbia aquaculture industry had from the government, the level of First Nations involvement in the industry, fish marketing and processing, the marine environment,

aquaculture siting and production plans, land tenure, and the provincial lease system (Government of Canada, 2011).

After publication of the 1986 Gillespie Report, the Canadian federal government and the Province of British Columbia issued a Memorandum of Understanding on Aquaculture Development in the province of British Columbia (Government of Canada, 2011). The Memorandum set out that the federal government and the province of British Columbia would cooperate on research and development for aquaculture, and both regulatory agencies would divide responsibilities when it came to education and training for the aquaculture industry. British Columbia would issue licenses that would allow for aquaculture operations to continue in the province, however, the license applications would be issued to the federal government for review and comment before they were approved (Government of Canada, 2011). The province and the federal government would continue to share the responsibility of ensuring compliance and regulatory inspection activities and would participate equally in information sharing between both agencies. For any species that are regulated by the federal government, the federal government would be responsible for issuing all permits for wild broodstock fish – or any part of them, such as eggs, milt, spawn, or larvae (Government of Canada, 2011).

This initial 1988 contract between regulatory agencies continued and allowed for cooperation and co-management of the industry until 1999, when the provincial Government announced its Salmon Aquaculture Policy Framework initiative, which also established a Fish Farm Review Committee, containing both federal government and provincial government representatives. This Committee developed out of the government of BC asking its Environmental Assessment Office, in 1997, to perform an assessment of the regulatory framework that was currently governing the industry in the province (Government of Canada, 2011).

Governed by the provincial *Environmental Assessment Act*, the 1997 review identified problems with the aquaculture regulatory framework in British Columbia. The responses to the review were mixed, because at the time salmon aquaculture opponents had been raising concerns about the environmental impact and sustainability of the industry – but there were no simple ways to fix the issues that had been identified. The review produced by the Environmental Assessment Office struggled with developing a non-biased review of the industry with little baseline data upon which to support its review (Government of Canada, 2011).

The 1997 review offered forty-nine recommendations in the final Salmon Aquaculture Review document that the Environmental Assessment Office presented to the Ministry of Agriculture (Government of Canada, 2010a). Most of the recommendations dealt with the environmental sustainability of the industry, however there were also concerns over First Nations involvement over licenses and the potential effects on marine benthos and shellfish harvesting areas. The review concluded that:

> "salmon farming, as presently practiced and at current production levels, presents a low overall risk to the environment. However, … [there are] continuing concerns about localized impacts on benthic organisms, shellfish populations, and marine mammals suggests the need for additional resources to protect them. Additional monitoring [is required] and areas such as the potential impacts of interactions of escaped farmed salmon with wild populations, identification [and control] of disease pathogens, potential for disease transfer between farmed and wild salmon species and impacts from antibiotic residues [should be studied further]" (Government of Canada, 2011).

The 1997 review helped establish the baseline for how aquaculture regulation should evolve in British Columbia and helped to increase the research and development of new technologies for the industry, many of which have allowed the industry to increase production volumes in the twenty years since the Environmental Assessment Office published its review of salmonid aquaculture in British Columbia. It encouraged the public to get involved in the industry by encouraging the industry to be as

sustainable as it can be, while also contributing significantly to the economies of British Columbia and Canada. Reviews like the one published by the BC government encouraged regulatory change for many aspects of aquaculture, like licensure, aquaculture siting, fish transport, fish health management, harvesting, and benthic monitoring techniques.

In 1999, British Columbia continued its work with the Canadian federal government towards collaborative aquaculture regulation and monitoring. A new Salmon Aquaculture Policy Framework was announced the same year, and established a new Fish Farm Review Committee, a joint panel between the Province of British Columbia and the Department of Fisheries and Oceans. The panel concluded that the number of fish farm licenses in the province should remain at 121. The moratorium on new fish farm licenses and applications would be continued, and further, the province would explore the possibility that all current tenures in the province would be reviewed, and potentially relocated (Government of Canada, 2011).

4.2 Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River

The 2009 Cohen Commission, formally named the *Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River* was established in 2009 following three consecutive years of closure of the Sockeye salmon fishery in the Fraser River, British Columbia. An important commercial, recreational and food fish, the poor years of Sockeye salmon returns into the Fraser led to the establishment of an independent scientific commission, led by Justice Bruce Cohen, a British Columbia Supreme Court Judge appointed in 1987 (Cohen, 2012).

While the 2012 Commission focused primarily on the reasons for the declining Sockeye salmon stocks in the Fraser River, it looked at provincial aquaculture development as a potential cause of declining wild salmon stocks. Environmental

activists have pointed to open-net salmon farming in British Columbia as being a non-sustainable, environmentally damaging industry to wild salmon populations (Living Oceans, 2018). However, there is no scientific consensus on whether open-pen salmon farming is the sole cause of declining salmon populations in British Columbia (Aquaculture Association of Canada, 2017).

The aquaculture industry was examined during the Cohen Commission and over the course of the Commission, 179 witnesses were questioned over 139 days of testimony (Cohen, 2012). The Cohen Commission was tasked with examining the management of the Fraser River Sockeye fishery, which included an examination of the Department of Fisheries and Oceans management activities of fish and fish habitat. Further, the Commission examined the management of salmon farms, along with an overview of the fish health management principles employed by the Department of Fisheries and Oceans, a potential link to the declining Sockeye salmon populations (Cohen, 2012).

The mandate of the 2009 Cohen Commission was fourfold: first, Cohen was instructed to "conduct the inquiry without seeking to find fault on the part of any individual, community or organization, and with the overall aim of respecting conservation of the sockeye salmon stock and encouraging broad cooperation among stakeholders" (Cohen, 2012). Second, the Commission was to audit the policies and practices of the Department of Fisheries and Oceans, including their management policies of the Fraser River Sockeye salmon fishery, the Department's risk management strategies, its application of Department resources and staff, and its stock assessment practices, including the monitoring, counting of stocks, stock forecasting and enforcement priorities (Cohen, 2012). Third, Cohen was to investigate and make independent findings of fact regarding (a) the causes for the decline of the Fraser River Sockeye salmon stocks and examine the potential precipitating factors that would prevent mature fish from successfully spawning, and (b) determine the current state of

Fraser River sockeye salmon stocks and the long-term projections of those stocks (Cohen, 2012). Finally, the Commission was to develop recommendations aimed at improving future stocks of the Fraser River Sockeye salmon fishery, including implementing stock and fisheries management changes at the Department of Fisheries and Oceans.

A part of the discussion surrounding the decline in the number of returning Sockeye salmon in the Fraser River was the role, and potential influence (either positive or negative), aquaculture played in the low recruitment years. Within the Commission, there was evidence presented by both those that opposed salmon farming and open-net pen aquaculture, and those from industry that pointed out that the existence of salmon aquaculture reduces fishing pressure on wild stocks. The potential positives and negatives of the industry and the current debates regarding its sustainability from non-governmental activists or independent scientists are beyond the scope of this report.

It is important to note that the province of British Columbia regulated and licensed all salmon farm operational permits before 2010. In 2009, the BC Supreme Court determined that aquaculture, particularly open net pen salmon farming, fell under the definition of a "fishery", and thus, should be included in the regulatory purview of the Department of Fisheries and Oceans (Cohen, 2012). The BC Supreme Court struck down the provincial legislation that was responsible for the regulation of salmon aquaculture, although the decision was delayed for a year until the Department of Fisheries and Oceans could determine the regulatory requirements that the industry would have to undergo. However, the BC Supreme Court recognized that the land beneath open-pen salmon farms was the property of the provincial government and all future aquaculture site applications and tenure decisions would be the responsibility of the provincial, not federal government (Cohen, 2012).

In the conclusion of the Commission, Cohen argued that the amendments made to the *Fisheries Act* (1985), potentially could impact the procedures and policies

examined by the 2009 Commission. Despite this, he argued that fisheries management in Canada should continue to be managed by the federal government as the central authority (Justice Bruce I. Cohen, 2012). Cohen argued that fisheries management in Canada is a complex and demanding task that cannot be shared among all the parties that seek to participate in Canadian fisheries management (Justice Bruce I. Cohen, 2012).

This decision by the Commission is important for several reasons. First, it recommends that the Minister of Fisheries and Oceans and the Department of Fisheries and Oceans continue to be the central authority and regulator of fisheries management in Canada. This recommendation is significant. By recommending this, it validated the authority that Fisheries and Oceans had on Canadian fisheries management. In recent years, DFO has faced external pressure from fisheries stakeholders, the New Democrat (NDP) and Green Parties, and non-government activist groups to step away from managing both fisheries and aquaculture in Canada, citing conflicting mandates. These stakeholders argued that Fisheries and Oceans was unable to sustainably manage both aquaculture and fisheries in Canada (The Vancouver Star, 2018). The external review by the 2009 Cohen Commission ruled this was not the case. Second, it argues that the amendments made to the *Fisheries Act* in 2012, and in 2013, could potentially affect the Department of Fisheries and Oceans' ability to effectively manage fisheries. While the cause of the sockeye salmon population decline in the Fraser River was most likely due to several different stressors in the environment, it is likely salmon farming and fish farm management did play a role (Cohen, 2012).

5.0 Aquaculture Regulatory Reform

5.1 Clarification of Regulatory Responsibilities

Aquaculture regulatory responsibility is shared between the provincial and federal governments in Canada. In some provinces, the primary regulatory responsibilities fall to the provincial government. In British Columbia and Prince Edward Island, it is the federal government whose primary responsibility is to enforce two pieces of legislation that allow aquaculturists to operate, the *Fisheries Act* (1985), and the *Health of Animals Act* (1990) (Department of Fisheries and Oceans, 2017; Fisheries Act , 1985; Health of Animals Act, 1990). In BC and in PEI, the provincial government plays a secondary role when managing aquaculture. The federal government is the lead regulatory authority.

The federal government's responsibility lies predominately with international trade, disease mitigation, and ensuring that the environment remains protected, all while permitting the aquaculture industry to operate. In 2013, however, amendments were made to Section 35 of the *Fisheries Act*, and a provision was added that prohibited the deposition of deleterious substances, or any activity that threatened the productivity of a recreational, commercial, or Aboriginal fishery (Fisheries and Oceans Canada, 2016).

In 2014, after these changes were adopted, the federal government sought to clarify the roles of Environment and Climate Change Canada and the Department of Fisheries and Oceans with regards to fisheries habitat protection and the deposition of any deleterious substances (Department of Fisheries and Oceans, 2017). It was determined that Environment and Climate Change Canada would be the lead regulatory authority on all issues that dealt with the deposition of deleterious substances into the environment, whether it be a result of industrial or commercial use except when it came

to aquaculture. Aquaculture was exempted from this requirement. The Minister of Fisheries and Oceans remained the lead minister, and the Department of Fisheries and Oceans remained the lead regulatory authority on aquaculture management in Canada.

Despite the modifications made by regulatory agencies within the federal government, by 2014 aquaculture management in Canada remained confusing and rather complicated. However, the introduction of the *Aquaculture Activities Regulations* (AAR), in 2015, found within sections 35 and 36 of the *Fisheries Act* (1985) attempted to clarify aquaculture management in Canada. The AAR is described further in sections 5.4 and 6.

5.2 Sustainable Aquaculture Program

In 2008, the Sustainable Aquaculture Program (SAP) was created by the Government of Canada to help streamline the aquaculture regulatory environment; through the enhancement of the aquaculture industry and with increased science-based decision making, and greater transparency through enhanced industry reporting requirements. A CAN $54 million commitment by the government of Canada, regardless of which political party had majority governing power in the country, was committed through three main initiatives.

First, CAN $6.5 million would be made available annually; over half of this would be available for regulatory aquaculture science and used for the support of science and research activities undertaken by the federal government. An additional three million dollars per year would be earmarked for improvements to regulatory reform and governance, and CAN $1-4 million would be committed to ensuring that public reporting in aquaculture would continue.

Initiated by the Harper minority government in 2015, the Sustainable Aquaculture Program ensures that policy objectives and regulatory activities that surround the aquaculture industry evolve with the industry. The Conservative government felt that regulatory modernization had to occur simultaneously with the growth of the industry in Canada.

A 2014 press release by the Honorable Gail Shea, Minister of Fisheries and Oceans (2013-2015), announced over CAN $54 million over five years to ensure that Canada's SAP improved reporting requirements for the industry and modernized the regulatory framework within which the aquaculture industry is governed in Canada.

Minister Shea expressed the desire of the Conservative government to modernize the aquaculture industry development and regulatory reporting, saying that:

> "aquaculture is the fastest growing feed production sector worldwide, and [the industry] creates much needed jobs in rural areas, and in Aboriginal communities. Our government's investment of CAN $54-million will help to address aquaculture sector challenges to growth by reducing red tape and improving regulatory management and transparency; as well as increasing scientific knowledge and supporting science-based decision making".

Further, through the renewal of the SAP, and together with the Conservative government's partnerships, the government would be able to continue its commitment to a sustainable and prosperous Canadian aquaculture sector. As of 2017, the federal government remains committed to the conservation of marine ecosystems and wild fish stocks; ensuring that all active aquaculture facilities are inspected, and it audits industry-submitted reports to ensure that industry shows high levels of compliance required as conditions of license (Fisheries and Oceans Canada, 2018a).

The SAP aims to achieve regulatory reform in the Canadian aquaculture industry. The 2013-19 program objectives seek to harmonize industry prosperity and

development with continued regulatory oversight and sound management decisions that are based on peer-reviewed scientific sources.

5.3 2018 Reform of the Fisheries Act

Federal Fisheries Minister Dominic LeBlanc unveiled plans for *Fisheries Act* reform in February 2018. Proposed changes would help to protect Canada's fish and fish habitat and safeguard local economies that depend on fisheries. The proposed changes would reverse changes implemented by the previous federal government, which weakened the protections available for Canada's fisheries and fish habitats, which weakened habitat protection, increased economic uncertainty related to fisheries, and weakened the federal government's ability to protect Canadian fisheries. The proposed bill, if passed, would strengthen the federal government's ability to ensure compliance with Canadian fisheries law, dissuade non-compliance and strengthen the *Fisheries Act* (Government of Canada, 2018b).

Modernizing the *Fisheries Act* initially began in 2007, with the federal Conservative government recognizing that Canada's oceans and inland waters contain a multitude of some of the most productive fish ecosystems in the world (House of Commons Canada, 2017). The 2012 amendments to the *Fisheries Act* came into force in November 2013 (Bill C-32) and clarified the federal government's responsibilities with respect to protecting wild fish. While the enforcement abilities of the *Fisheries Act* lied in the conservation and protection of fish, the protection of fish habitat and the prevention of aquatic pollution, the provincial, federal and territorial responsibilities were not initially well-defined.

In 1867, under the *Constitution Act* (1867), the federal government was assigned regulatory purview and responsibility over the marine and inland fisheries, while the provincial governments were "assigned responsibility for matters of property and civil rights and the management of public lands" (House of Commons Canada, 2017). The

federal government's responsibilities under the *Fisheries Act* also satisfies several international obligations relating to fisheries habitat protection, including the United Nations Fish Stocks Agreement (1982), and the United Nations Convention on Biological Diversity (1993) (United Nations, 1993).

The passing of Bill C-32, the bill that proposed the changes to the *Fisheries Act*, was controversial. In 2012, one of the notable changes to the *Fisheries Act* was that fish habitat protections were only applied if the fish and/ or habitats were part of commercial, recreational, or Aboriginal fisheries (House of Commons Canada, 2017). Equally critical among stakeholders was the removal of two *Fisheries Act* provisions, in Section 32 [1] of the Act. Before 2012, the Section prohibited "killing any fish by any means other than fishing", and in Section 35[1] prohibited individuals, or groups from undertaking any "work or undertaking that results in harmful alteration, disruption or destruction of fish habitat" (House of Commons Canada, 2017). These two important provisions were replaced in 2012 by a single provision which prevented "any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery, or to fish that support such a fishery". Serious harm was defined as: "the death of any fish, or any permanent alteration to, or destruction of fish habitat (spawning grounds and any other areas including nursery, rearing food supply and migration areas", which fish depend on to carry out their life processes" (House of Commons Canada, 2017; Government of Canada, 2007).

The federal government's goals for the 2012/2013 *Fisheries Act* amendments were fourfold. First, the regulatory regime focused on managing potential threats to the sustainability and productivity of all commercial, recreational, or Aboriginal fisheries within Canada's waters. Second, the amendments were aimed at providing Canada's fisheries enforcement agencies with increased protection tools to ensure compliance. The third goal was to provide clarity, certainty and consistency through enhanced regulatory standards and regulations, and finally, the 2012/2013 *Fisheries Act*

amendments sought to identify which organizations were the best suited to provide fisheries protection services to Canadians (Fisheries and Oceans Canada, 2016).

In June 2018, the amendments made to the *Fisheries Act* passed the Senate, reversing some of the deleterious changes made by the Harper majority government in 2012/2013. Bill C-68, the bill that contained the proposed amendments to the *Fisheries Act*, was tabled by the Minister of Fisheries and Oceans, Dominic LeBlanc in February 2018, and he implemented the changes promised by the Liberal government led by Prime Minister Justin Trudeau. The June 2018 change removed the amendments made by the previous government that reduced the scope of the *Fisheries Act*. Bill C-68 proposed to broaden the definition of fish habitat by replacing "serious harm", which was introduced in 2012, with the previous "harmful alteration, disruption or destruction of fish habitat" (Norton Rose Fulbright, 2018).

5.4 Aquaculture Activities Regulations

The Aquaculture Activities Regulations (AAR) receive their authority from the *Fisheries Act* (1985). The AARs regulate aspects of aquaculture including the regulation of drugs, pest control products, fish morbidity or mortality, the specified substances a licensed facility may use, and substrate sampling or restocking after every production cycle.

Section 15 of the AAR defines the prescribed works, undertakings, activities and conditions. The aquaculture facility must submit an annual report to the Minister of Fisheries that contain the details for each drug or pest control product used per facility per year. This information must include the deposit (type), date, quantity, and geographic coordinates of the use. Further, the owner of the facility should undertake all measures to prevent the accidental release or deposit of a drug. An annual report must be submitted to the Minister before April 1st of the year following the drug or pesticide use.

6.0 Regulation of Environmental Protection and Public Safety in Canadian Aquaculture

6.1 Finfish Aquaculture Waste Control Regulations (BC)

Under the Finfish Aquaculture Waste Control Regulations (BC), introduction of waste into the environment is not prohibited, and an operator can cause waste to be introduced into the environment within the tenure and occupied by the operator's facility, [only] if the operator and the facility satisfy the requirements of this regulation (Environmental Management Act, 2018). However, this does not remove all responsibility from the holder of the site lease. Biological baseline and physical data, including free sulphides, redox potential, total organic carbon (TOC), sediment grain size, total zinc, copper and other any other contaminants must be gathered before fish and containment structures are placed, to ensure that a comparison is possible after aquaculture activities take place (Province of British Columbia, 2018c). This is the minimum amount of data that must be provided to the federal and provincial regulators. The aquaculture site and license number are assigned under the *Fisheries Act* and the land tenure file number is assigned under the *Land Act*. Additionally, details regarding how the aquaculture site will be stocked during the entire production cycle and the number and species of finfish that are to be cultivated must also be outlined to regulators.

The planned monthly feeding summary over the course of the production cycle and stocking densities, including the total dry weight of feed usage in tonnes for the production cycle is expected to be submitted with the site licensure application. If this application is for a new site, site applicants will have to provide an estimate supporting their application. If any of the feed parameters change or are over/under estimated values by more than 20% at any point in time in the production cycle, a notice to the regulators (both provincial and federal) must be received from the site owners and

operators within 30 days of the change having taken place. DFO is predominately responsible for monitoring benthic conditions of stocked sites throughout the production cycle, and producers track feed usage daily, as part of their internal monitoring programs (DFO, 2018a).

Once these conditions are outlined in the application, it is submitted to the Integrated Management Land Bureau, a division of the Ministry of Agriculture. The Department of Fisheries and Oceans coordinates the review of the application and maintains the responsibility of being the lead regulatory authority in charge of the entire process. Environment and Climate Change Canada reviews the application under the *Canadian Environmental Assessment Act*. Transport Canada ensures the application under the *Navigation Protection Act* to ensure that the proposed site application does not impose any navigational hazards under the Act (Robson, 2006).

From the input of all federal agencies, the Department of Fisheries and Oceans determines whether to issue the permit to the interested party. All federal and provincial agencies are required to agree before a site application will be approved. The Ministry of Agriculture must issue the provincial aquaculture license, and the Integrated Land Management Bureau must issue the Crown Land Tenure (Robson, 2006).

To ensure that sites maintain compliance, operators must implement a best management plan for the operation and maintenance of the aquaculture site. The site must have the following objectives: continually work to reduce their total discharge, or potential amount of discharge; reduce the quantity and quality of discharged pollutants and wastes and must work to meet eleven other conditions set forth by provincial regulators – conditions which must be met annually for the license to remain valid for any aquaculture operations (Robson, 2006).

In British Columbia, land-based facilities are not exempted from implementing a best management strategy to control the release of potentially deleterious substances

into the environment. However, applications for land-based facilities in British Columbia are managed under a different Act. The federal *Canadian Environmental Assessment Act* assesses the environmental footprint of all land-based aquaculture facilities in British Columbia, and for the rest of Canada (Government of Canada, 2018a).

Regardless of whether the operation is for commercial, private or enhancement activities, any facility or hatchery that uses more than 75 liters or 20 gallons of groundwater per minute is designated a land-based operation under the *Water Act* in British Columbia. Land-based aquaculture finfish operations in British Columbia must also comply with the Land-based Finfish Waste Control Regulation– in addition to the requirement for waste water permit(s) (Environmental Management Act, 2018).

In principal, and in most sites presently operating in Canada, finfish hatcheries are designed to ensure that wastewater discharge is spread out over a large area, and that most, if not all, hatchery discharge is diluted by the time that it reaches any source of open water. Hatchery designs often facilitate these principals. However, to ensure that all facilities remain compliant under federal and provincial regulations, land-based facilities are required to submit influent and effluent water samples to the Ministry of Environment for times when their biomass is considered the highest (Province of British Columbia, 2018a).

6.2 Aquaculture Environmental Monitoring

In Canada, aquaculture environmental monitoring programs (AEMPs) have been implemented in British Columbia, New Brunswick, Nova Scotia and Newfoundland and Labrador, and are federally regulated (Aquaculture Canada , 2014). Often, AEMPPs are run by individual provincial agencies for the federal government in Canada and are designed to enhance the environmental sustainability of the industry. All AEMPPs in Canada, while often managed by different levels of governments, are run similarly (Aquaculture Canada , 2014; (Aquaculture Canada , 2014; Day, Cooper, & Chopin, 2015)

AEMP programs require video monitoring of the benthos and benthic environments or communities surrounding an aquaculture operation, sediment sampling (which often occurs around aquaculture "events", such as stocking, or harvesting of the cultivated species), and often, subsequent genomic or taxonomic analyses (Aquaculture Canada , 2014). In Southern Newfoundland, only video monitoring is required in sites with primarily rocky bottoms. What does vary between provinces is the extent to which sites are monitored by their regulatory bodies. Differences include the number of samples collected in a lease, or the number of parameters that are monitored. Overall, monitoring results from benthic analyses allow regulators to quantify the impact that aquaculture leases are having on the natural environment.

Country-wide, it remains important for the aquaculture industry to implement in-house management strategies that allow for the growth of the industry while also ensuring long-term sustainability. One important indicator of success is the environmental monitoring system that must be in place internally, and the one that is regulated by the government. It is common for aquaculture companies operating in British Columbia to have in-house environmental monitoring systems, including plankton monitoring systems. Marine aquaculture facilities can be challenged by difficult environmental conditions, depending on the location of the facility. Low levels of dissolved oxygen and harmful plankton species challenge producers year-round. An in-house environmental monitoring system helps to reduce the negative effects that the environment can have on fish. Buying fish and fish products that are raised in the most environmentally sustainable way possible is increasingly important to processors and consumers. It is in the best interest of the aquaculture producer to make sure that their product has as small an environmental footprint as possible.

Further, through the Finfish Aquaculture Waste Control Regulations (BC), regulators have developed protocols for the environmental monitoring of marine

aquaculture sites. Environmental monitoring is required for all sites that produce over 2.5 tonnes of fish annually, and the site's results are submitted to DFO's Aquaculture Management team, who complement those results with their own samples. Samples taken by DFO are obtained within 30 days of the site's samples, and in the same location, to corroborate the site's results (Department of Fisheries and Oceans, 2018b).

When it comes to aquaculture environmental management, each province (other than in NL), maintains their own environmental programs. However, it is generally agreed, among industry participants, that a network between the industry and the regulatory bodies should be established to identify the optimal methodologies that should be used for environmental monitoring during active aquaculture operations (Marine Harvest, 2017). One of the most important discussions that needs to take place between regulators and the industry is regarding the standards and expectations that regulators have for the industry when it comes to sustainability and environmental management. Management objectives, regulations, aquaculture environmental monitoring, sampling designs, parameters and/or sampling thresholds (Aquaculture Canada , 2014) are important factors to consider when designing an environmental plan.

Aquaculture environmental monitoring remains important for Canadian regulators because it helps to quantitatively assess the impact of aquaculture operations and leases in Canadian waters. However, it is important to determine the overall effect(s) that a lease may have, and to not automatically assume that all aquaculture sites have negative effects on the flora and the fauna of the local ecosystems.

Under the Aquaculture Activities Regulations, the Pacific aquaculture industry is required to conduct seafloor environmental monitoring of all active finfish aquaculture sites (Aquaculture Association of Canada, 2017). Depending on substrate type, different types of environmental monitoring are appropriate. If an aquaculture site is located over a soft bottom and cultivates finfish in tidal waters in, or adjacent to Quebec, Nova

Scotia, New Brunswick, British Columbia, Prince Edward Island, or Newfoundland and Labrador, the owner or operator of the facility must satisfy several conditions. First, the benthic substrate samples must satisfy the federal monitoring standard, and the concentration of free sulfide must be determined in accordance with the monitoring standard. Second, additional samples of the benthic substrate must be taken if the aquaculture site is located adjacent to Quebec, Nova Scotia, New Brunswick, PEI or Newfoundland and Labrador if the mean concentration of free sulfide exceeds 3000 µM. Additional monitoring is required for facility operators in British Columbia if the mean concentration of free sulfide exceeds 1300 µM, at stations 30 m and 125 m from the site structure (AAR Regulations, 2017a). Aquaculture Monitoring Standards (AMS) are available for owners or operators of an aquaculture facility from Fisheries and Oceans and are updated regularly to reflect any changes in the marine environment (AAR Regulations, 2017a).

If an aquaculture operation is located over a hard-bottom substrate, different benthic monitoring activities are required. According to the AAR, sites that are in areas where soft-bottom, benthic grabs are not possible, can satisfy environmental monitoring requirements with visual monitoring. In visual monitoring, monitors are primarily looking for the presence or absence of *Beggiatoa sp*. or the presence or absence of *Polychaeta sp.* (Aquaculture Management , 2015) They must first confirm that they inspected the benthic substrate in the manner and at the times and locations specified in the Aquaculture Monitoring Standards.

Sites located in tidal waters in or adjacent to Quebec, Nova Scotia, New Brunswick, Prince Edward Island or Newfoundland and Labrador are not permitted to restock the facility if *Beggiatoa* sp., or other similar bacteria, marine worms or barren substrate is found in more than 70% of the locations outlined in the AMSs. *Beggiatoa sp.* form bacterial mats and are often found where anoxic conditions are present, and the presence of marine worms (class *polychaeta* or annelids) on hard or soft-bottom

sediment often represents high sulfide conditions (AAR Regulations, 2017a). In British Columbia, restocking of an aquaculture facility is not permitted if *Beggiatoa sp*., covers more than 10% of any four monitoring segments, or 10% or more of two contiguous segments of substrate specified in the ASM, that are within 116 and 124 m from the aquaculture net-pen containment structure. If two or more contiguous segments of impacted substrate are within 124 m to 140 m from the fish containment structure, restocking is also not permitted in any British Columbia aquaculture site (AAR Regulations, 2017a). Testing for additional parameters such as biological oxygen demand (BOD) is not currently required by aquaculture operators to satisfy their environmental monitoring requirements. This is currently being discussed by federal regulators (AAR Regulations, 2017a).

6.3 Aquaculture Siting Considerations in Canada

The selection of aquaculture sites in Canada is of utmost importance and can determine the feasibility of successful operations. One of the most important aspects of site selection is determining if the site is appropriate for aquaculture activities. Arguably, the species selected, what type of technology to be applied and the site chosen all affect each other, however it is important to also consider the scale of the aquaculture operation(s). When selecting an aquaculture site, what type of technology will be employed, and the species that will be cultured is important. In Canada, the predominant farmed finfish species is Atlantic salmon (*Salmo salar)*.

When considering potential sites, it is necessary to consider climatic conditions, access to markets, regulatory limitations, suitable communications, availability of labor, availability of power or public utilities and protection from the elements. In small-scale operations, it will be necessary for investors to consider proximity to markets, consumers and resources – all aspects that could ensure business viability (Delgado, 2003).

Proper siting of aquaculture is important for the site's overall productivity, and British Columbia has some of the best conditions for aquaculture production in the world; the British Columbia coastline stretches more than 27,000 km along the Pacific Ocean and is flushed by a mixed diurnal tidal system (FAO, 2018a). The province's optimal environmental conditions are protected by siting regulations that are some of the strictest for aquaculture operators in Canada. The conditions a site must satisfy, to have a tenure in British Columbia, are rigorous and the application process is lengthy to ensure the natural ecosystem is protected, and the socio-economic concerns of the province and the public are considered (Robson, 2006).

Salinity and temperature conditions are important to consider when selecting sites for hatcheries, as is the likelihood of the water source being polluted as result of the land-based aquaculture system. The regulatory guidance is clear regarding what aquaculture operators can do legally with respect to site selection (Environmental Management Act, 2018).

Appropriate site selection for aquaculture is important because salmon farming structures must be adequately protected from excessive currents (greater than three knots) (Robson, 2006). In addition, sites that are too shallow do not encourage salmon to feed in the most productive way (Robson, 2006). Sites that are too shallow may lead to difficulties with anchoring, adequate mixing - to ensure adequate oxygen is delivered - and waste/sediment is dispersed (Robson, 2006)

According to the Department of Fisheries and Oceans Canada, aquaculture site selection is an important tool to limit any potential negative effects that aquaculture may have on the natural environment. Through proper site selection by aquaculture lease holders and regulatory oversight, the Department of Fisheries and Oceans ensures that disease and parasite transfer between farm sites and the deposition of organic waste between or beneath cage sites is minimized (AAR Regulations, 2017a)

Aquaculture siting considerations, along with lease limitations, are defined within the federal Aquaculture Activities Regulations, a subset of the federal *Fisheries Act*, along with several other pieces of legislation that govern the issuance of site tenures provincially and federally (AAR Regulations, 2017a).

Except for Prince Edward Island, Canadian provinces are responsible for issuing aquaculture site tenures, and provincial government's act as the leasing authorities. The province of British Columbia issues aquaculture site tenure licenses where the activity would take place in either the marine or freshwater environment. The province also issues marine plant cultivation licenses and regulates business aspects of aquaculture such as workplace health and safety. The Department of Fisheries and Oceans issues the licenses that allow the site to operate (Department of Fisheries and Oceans, 2016).

One of the most significant decisions that the provincial government can make with regards to the aquaculture industry in British Columbia is the issuance of site licenses that include crown lands, under the *Land Act* (Government of British Columbia, 2018). It is important to note that the Department of Fisheries and Oceans is still the primary regulator responsible for issuing licenses for marine finfish, shellfish and land-based operations, including freshwater hatcheries in Canada, Aboriginal groups, or government enhancement activities (Department of Fisheries and Oceans, 2018).

In Canada, aquaculture siting and lease applications can be complex, and the siting process and policy in British Columbia have undergone several revisions since the 1980's. In 2010, the federal government and the Department of Fisheries and Oceans assumed primary control of licensure applications for aquaculture operations in Canada. However, as mentioned previously, the British Columbia provincial government maintains a key role in issuing tenures under the provincial *Land Act* for marine and freshwater, or land-based sites (Department of Fisheries and Oceans, 2016).

In 2015 there were 116 fish farm licenses present in British Columbian waters (Figure 2), with an additional three applications approved by the Department of Fisheries and Oceans for a total of 119 active sites province-wide (Department of Fisheries and Oceans, 2016).

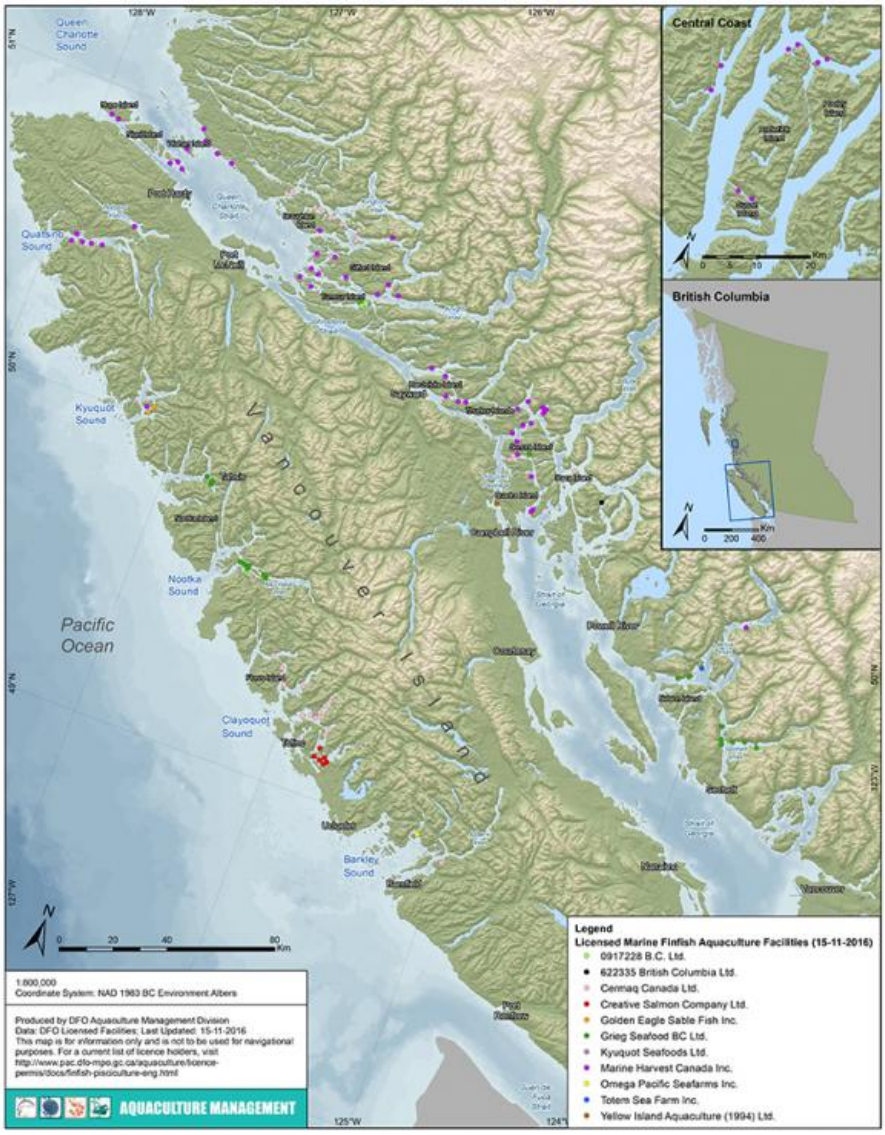

Figure 2: Aquaculture finfish tenures in British Columbia – as of 2015, there were 116 site licenses present in the province – although not all operate at the same time. Specific fallowing and bottom benthos parameters are required before a site can begin stocking activities and the new production cycle ((Aquaculture Management , 2015).

Licenses in British Columbia are usually issued for more than one year – apart from the Discovery Islands, off the East coast of Vancouver Island, where they are still issued for one year only due to fish health concerns that arose out of the Cohen Commission (Justice Bruce I. Cohen, 2012). Licenses for shellfish farms and land-based finfish facilities are issued for up to nine years, and marine finfish facility licenses are issued for up to six years (Department of Fisheries and Oceans, 2018).

All sites, regardless of species stocked, have the responsibility to uphold their conditions of license, issued by the Department of Fisheries and Oceans when their application is approved. An aquaculture facility's condition of license may stipulate that more than one species may be cultivated in it, or it may be for commercial or non-commercial use, but the responsibility for reporting and for managing fish health appropriately is the same (Department of Fisheries and Oceans, 2018). There are no differences in reporting requirements between species, or if the facility is for non-commercial use, such as for enhancement.

Applying for a tenure to the province of British Columbia and for a license to the Department of Fisheries and Oceans is a multi-year process and is often an expensive one for interested parties (Robson, 2006). The British Columbia Salmon Farmers Association (BCSFA), estimates that modern site applications can often run hundreds of pages, and cost upwards of CDN $200,000 dollars, with no guarantee of approval (Robson, 2006). This cost does not include the complex site environmental assessment that is required under the *Canadian Environmental Assessment Act* before an application can proceed.

Fisheries and Oceans Canada, Transport Canada, and the British Columbia Ministry of Forests, Lands and Natural Resource Operations and Rural Development are the regulatory leads that approve or deny aquaculture site tenures in British Columbia.

If the aquaculture license application is for a food product, or used for commercial applications, then the Ministry of Agriculture will also require a company to apply for a Seafood Industry License – which regulates the provincial food safety standards that are required of businesses and individuals that conduct certain activities in the seafood industry (Province of British Columbia, 2017b).

The overlapping of regulatory responsibilities between the federal government and the provincial government is evident when looking at the environmental regulatory requirements that aquaculture operators must traverse before being approved for a license in British Columbia. Whether a processing facility is owned by an aquaculture producer is irrelevant, because, in Canada, if processing of any fish occurs at all, regardless if it is cultivated or wild, the facility is required to be licensed (Province of British Columbia, 2017b).

To successfully qualify for a new aquaculture lease in British Columbia, a potential leaseholder must satisfy fifteen separate conditions set by the province. First, unless permission is received by First Nations government, all potential aquaculture leaseholders must be one kilometer away, in all directions from First Nations Territory. Potential sites must be at least one kilometer away from all herring spawning areas that are designated to be of high importance. In addition, potential sites must be at least three hundred meters away from shellfish beds that are of commercial or recreational importance to First Nations Territory (Department of Fisheries and Oceans, 2018).

Leases must be 125 meters from commercial and all other wild shellfish beds, and an appropriate distance from areas deemed as sensitive fish habitat as determined by the province of British Columbia (Robson, 2006). Sites must be an appropriate distance from any areas used extensively by marine mammals, as determined by provincial authorities or Fisheries and Oceans. Aquaculture leases are also not permitted to be in culturally significant areas and must be at least three kilometers away from any

existing aquaculture site in accordance with a local area plan (Robson, 2006; Government of British Columbia, 2018).

Siting requirements in British Columbia require potential aquaculture operators to deal with a minimum of three regulators, and multiple pieces of legislation. All salt water to the high tide mark is designated as Crown land and, as a result can only be leased from the provincial government if potential leases meet the requirements set out by both the federal and provincial governments (Province of British Columbia, 2018b). The first step to successfully achieving a site licensure in British Columbia is to apply for a tenure from the Ministry of Forests, Lands and Natural Resources (Department of Fisheries and Oceans, 2018a). British Columbia is largely responsible for the approval of the tenure application, however both the federal and provincial governments share regulatory authority and compliance responsibility over aquaculture tenures and licenses in British Columbia (Robson, 2006).

To obtain the government's approval, the application must outline all proposed locations of the farm structure, proposed sea cage layout and proposed maximum production targets. If the proposed facility is adjacent to First Nation's territory, then, by law, the First Nations must be consulted. Appropriate biological studies must be completed by qualified professionals (Robson, 2006).

Interestingly, the criticism over salmon farming is often due to the perceived negative effects that net pen salmon farming has on the environment, and the industry's ecological footprint. However, to be able to accurately estimate the ecological footprint of the industry, it is important to consider the total active sites holding fish at any given time on the British Columbia coast. At any one time there are approximately 80 actively operating sites on the BC coast, which is significantly less than the number of site applications that were approved by the government (Marine Harvest, 2018). Due to fallow site requirements, and considering production cycles within aquaculture

companies, it would be exceedingly rare for all approved saltwater sites to be operating at the same time in British Columbia (Marine Harvest, 2018).

Individually each farm is comprised of between 8-12 individual net pens, with each pen having an average surface area of 1,082 m^2. Each farm would, on average, occupy 13,068 m^2 and multiplying by 80 active sites means that approximately 1.035 square kilometers of area of the British Columbian coastline is actively farming salmon at any one time. This, of course, only considers the area occupied by the cages. Technically, additional area between and outside the cages (within the farming lease) is also utilized for salmon farming. Taking this into account, according to the British Columbia Ministry of Agriculture, the total area occupied due to salmon farming in 2006 (128 leases) was 6000 hectares (60 square kilometers) – a small area compared to the estimated 162,000 square kilometers that are dedicated to terrestrial farming in Canada (Robson, 2006).

6.3.1 Effluent Standards of Land-Based Aquaculture Facilities

There are two types of conventional aquaculture systems that are most commonly used in Canadian aquaculture operations; land-based and open-water farms. The regulations that govern each type of aquaculture operation are somewhat different, however both types of operations report primarily to the Department of Fisheries and Oceans (in British Columbia, and PEI), and various provincial departments in other Canadian provinces as their lead regulatory authority.

In land-based aquaculture, the most common operations include pond sites and hatcheries. Depending on the species raised, most pond sites are made of earthen materials. When constructed out of these types of materials, aquaculture operators must consider factors like soil composition and alkalinity when raising their species to the appropriate size. Some of the most important factors that must be considered when looking at hatchery construction (especially in Canada), are the source, quality, and

availability of water. The quantity and quality of water available is important for all aquaculture systems but is particularly important for land-based systems (The Conservation Fund, 2016).

In the past, to ensure that these land-based facilities were compliant with federal and provincial regulations, water samples were required to be submitted to the BC Ministry of Environment (MOE) for times when their biomass was the highest, where the MOE tested them for nitrogen, ammonia, TDS (total dissolved solids), and phosphorus. Eventually, water sampling was determined to be the hatchery's responsibility.

The Land-Based Finfish Waste Control Regulations (Province of British Columbia, 2018a), a subsection of the *Environmental Management Act*, state that: "subject to subsection [2] the owner of a land-based finfish facility must submit a receiving water quality report before construction begins, or if the current facility expands its annual production by 20%" (Province of British Columbia, 2018b). The annual report must contain an analysis of the proposed discharge, the existing beneficial uses of receiving water, and predicted effects the proposed discharge will have on the receiving water, including the effects of both nitrogen and phosphorus compounds. The concerns relate to the potential for eutrophication or changes in the temperature and/or dissolved oxygen concentrations of the receiving waters (Province of British Columbia, 2018b). Facilities are to adhere to these regulations year-round, unless an exemption report is produced by the facility, and water testing must begin by the proposed facility before construction begins (Province of British Columbia, 2018a).

A land-based aquaculture facility is considered non-compliant from the perspective of the Department of Fisheries and Oceans and the Ministry of Environment if the non-filterable residue concentration of the effluent exceeds 10 mg/L, (dilution ratio is less than 20 to 1), or 20 mg/L (dilution ratio is greater than 20 to 1) (Province of British Columbia, 2018b).

Total phosphorus discharge must not exceed 0.1-0.2 mg/L, depending on a facility's dilution ratio, and no detectable limits of chlorine are to be discharged from any aquaculture facility. Further, the facility is considered non-compliant if it releases untreated cleaning wastes, solids from ponds or raceways, detergents, disinfection agents, cleaning agents or chemicals (Province of British Columbia, 2018b).

The only instance in which these substances can be released from a land-based aquaculture facility (in limited amounts) is if the effluent is able to pass a 96-hour bioassay test, as defined by the Environment and Climate Change Canada Biological Test Method; reference method for determining acute lethality of effluents to rainbow trout (Province of British Columbia, 2018b).

The wastewater and effluent management for land based, and marine aquaculture facilities in British Columbia are cumbersome. Individual permit holders have regulatory reporting responsibilities under four separate provincial acts and have responsibility to report to both the Province of British Columbia, and to three separate federal agencies. No one jurisdiction has complete regulatory control over marine or land-based aquaculture discharge – and this is a limiting factor for the industry's growth in the province. Safeguarding the environment could still occur alongside industry growth even with aquaculture regulatory reform to reduce redundant regulation.

6. 4 Aquaculture Food Safety

The provincial regulatory authority on British Columbian food safety, the Ministry of Agriculture, enforces the British Columbia *Fish and Seafood Act*, which came into effect in 2015 (Legislative Assembly of British Columbia, 2015), and makes references to the federal *Fish Inspection Act* that was brought into law in 1985 (British Columbia, 2017). Regulations changed in 2017, when the BC government announced that the Ministry of Agriculture placed a new emphasis on food safety and the

development of food safety plans. As of January 1, 2017, all seafood processors and fish receivers or vendors are required to develop, maintain and follow a written food safety and sanitation plan that addresses any potential food safety concerns (Province of British Columbia, 2017b).

A summary document produced by the Ministry in response to the amendments that occurred in January 2017 provided a fourfold rationale for the update of the legislation. First, the amendments incorporated greater food safety standards into the Act, sought to enhance British Columbia food safety standards and brought fish processor and vendor operations into alignment with modern food safety standards. Due to these amendments to the Act, seafood processors and vendors are now responsible for implementing a full food safety plan and HACCP (Hazard Analysis Critical Control Point) based food-safety plan (Legislative Assembly of British Columbia, 2015). Second, the British Columbia Ministry of Agriculture recognizes that with the amendments to the Act, there is less regulatory burden placed on fish and seafood processors – the new amendments to the Act eliminate the need for fish and seafood vendors and processors to have multiple licenses. If a fish and seafood processing facility (wild or captive fish processing), or a fish vendor is a federally-registered fish processor, or if the facility is already registered and licensed for food safety, no additional licensing requirements will be placed on those facilities (Province of British Columbia, 2017b).

The principal aquaculture fish processing plants in British Columbia are regulated by the Canadian Food Inspection Agency (CFIA), and their food safety programs are not required to be audited routinely by the Ministry of Environment under the *Fish and Seafood Act.* However, their wastewater discharge does fall under the jurisdiction of the Ministry of Environment and is thus regulated by the provincial government.

6.4.1 Chemical Residue Monitoring in Aquaculture

The *Fisheries Act* (1985) continues to be the federal act that governs aquaculture in Canada. However, there are subsections of the *Fisheries Act* that allow for provinces to individually control certain aspects of aquaculture regulation, such as biosecurity, pest control or site selection. Disease mitigation and management are controlled and enforced under the *Fisheries Act*, and enforcement is shared among the Department of Fisheries and Oceans, Environment and Climate Change Canada, and the Canadian Food Inspection Agency.

When an aquaculture facility is readying their product(s) for sale, they must test them for chemical residues. According to the Canadian Food Inspection Agency, they must test them with an accredited analytical laboratory that uses a validated method of analysis that can provide a measurable result, to determine whether the food product meets the applicable human food safety guidelines (Canadian Food Inspection Agency, 2017a).

The maximum allowable chemical residues in aquaculture food products are not set by the Canadian Food Inspection Agency, nor the Department of Fisheries and Oceans. Health Canada is the lead regulatory authority for determining the safe level of chemical residues in cultured products intended for human consumption, and the Veterinary Drugs Directorate branch is responsible for the approval and safe distribution of approved aquaculture drugs in the country (Canadian Food Inspection Agency, 2017a).

Ultimately, CFIA and Health Canada define therapeutants as: “chemical substances that are used on fish farms or in aquaculture operations when necessary to keep animals (i.e. fish or crustaceans) healthy while they are being raised. Therapeutants can be drugs or pesticides” (Canadian Food Inspection Agency, 2017c).

As fish and shellfish are considered food products, the Canadian Food Inspection Agency is responsible for the measurement of therapeutant use in aquaculture activities, bacteriological guidelines for both fresh and frozen fish and shellfish products, and arguably most importantly, measurement of therapeutant residues in cultivated products before they are marketed for human consumption (Canadian Food Inspection Agency, 2017a).

The Canadian Food Inspection Agency internal Appendix 1(A) contains the Aquaculture Therapeutant Residue Monitoring List (CFIA, 2017c). These are guidelines for therapeutant residues in aquaculture products and they identify the approved therapeutants currently being used and monitored in domestically produced and imported fish and shellfish products. Having a therapeutant drug fully approved in Canada can take years – and while there are exemption programs available for drug sponsors to use products during experimental studies or use drugs under the federally mandated Emergency Drug Release (EDR) system – regardless, all cultivated aquaculture products must be tested for residues before the animals are slaughtered for human or animal food use. There are no exceptions.

There are instances where drugs can be deemed “accepted to be used” in Canadian aquaculture activities, however these are limited, and how these drugs enter the country, and the instances in which they are used, are tightly controlled by the Canadian Border Services Agency, and the Veterinary Drugs Directorate, respectively. Within the Aquaculture Activities Regulations, there are strict conditions under which a facility can use an aquaculture drug at a facility. The drug must be approved for use in Canada; and must be sold under prescription by a licensed veterinarian. The veterinarian must be authorized (board-certified) to practice veterinary medicine under the laws of the province in which the aquaculture facility is located (AAR Regulations: Drugs, 2017b).

When using an aquaculture drug in Canada, the drug must be used conservatively by an owner or operator of an aquaculture site. Within the Aquaculture Activities Regulations (AAR Regulations: Drugs, 2017b), owners or operators must consider the implications of using the drug, whether there are alternatives, and record all site usage patterns. Within the AAR Reporting Requirements 1 and 2 (sections 5.b and c), operators are required to fill out a pesticide deposit form, which outlines the DFO region of deposit, and their federal and provincial aquaculture license information. In the same form, operators are required to fill out a treatment start and end date, the name of product used, active ingredients, reason for treatment, and number of species treated. Operators must specify the amount of pesticide product used in liters (if an aqueous product is used), or kg (if medicated feed is used), as well as the total active ingredients used in kilograms.

There are ten approved therapeutants that can be used on fish or shellfish, intended for food use in Canada with one of these registered under the Emergency Drug Release (EDR) program (Canadian Food Inspection Agency, 2017a). The EDR program is outlined in C.08.010 and 0.11 of the federal Food and Drug Regulations (Justice Laws Website , 2018). The program allows for licensed veterinarians to access, and prescribe drugs that are sometimes unavailable in Canada, for treating or diagnosing a group of animals under their care (Government of Canada, 2016). When making a request, the EDR must originate from a licensed veterinarian, who has identified a need for the drug. When making a request, veterinarians must know the drug company, the dosage, indications and contraindications, and they must report the results of the drugs usage in the group of animals to the VDD (Government of Canada, 2016).

Table 3 illustrates the number of therapeutants that are approved for aquaculture food production in Canada. Of note is the last column, titled “Action Level” which depicts predetermined guidelines issued by Health Canada, such as Maximum Residue Limit (MRL), or Administrative Maximum Residue Limit (AMRL) – these limits

represent therapeutant residues that are acceptable when a food producing species is slaughtered (Canadian Food Inspection Agency, 2017a). Canadian law stipulates that unapproved drugs should be not detected in any cultured fish that is sold or exported in Canada. There are less than ten approved aquaculture drugs in Canada, and all drug residues must be less than the action levels before the animal can be slaughtered. Most approved aquaculture drugs are for salmonid cultivation in Canada; however, some may be prescribed by a licensed veterinarian for use in crustaceans (Canadian Food Inspection Agency, 2017a).

Table 3: The Canadian Food Inspection Agency Therapeutant Residue Monitoring List for approved aquaculture drugs in Canada (Canadian Food Inspection Agency, 2017a).

Class Name	Substance	Metabolite	Status	Species	Tissue(s)	Action Level µg/g (ppm)	Action Level ng/g (ppb)
Amphenicols	Florfenicol	Florfenicol amine	Approved	Salmonids	Muscle	0.8	800
Avermectins	Emamectin Benzoate	N/A	Approved	Salmonids	Muscle	0.1	100
Benzoylureas	Teflubenzuron	N/A	Approved	Salmonids	Muscle	0.3	300
Benzoylureas	Teflubenzuron	N/A	Approved	Salmonids	Skin	3.2	3200
Macrolides	Erythromycin	N/A	"EDR"	Fish, Crustacean	Muscle	0.03	30
Sulfonamides	Ormetoprim	N/A	Approved	Salmonids	Edible Tissue	0.1	100
Sulfonamides	Sulfadiazine	N/A	Approved	Salmonids	Edible Tissue	0.1	100
Sulfonamides	Sulfadimethoxine	N/A	Approved	Salmonids	Edible Tissue	0.1	100
Sulfonamides	Trimethoprim	N/A	Approved	Salmonids	Muscle	0.1	100

The Canadian Food Inspection Agency inspection standards are found within Appendix 1(B), of the *CFIA Standards and Methods Manual*. While inspection manuals are not found within a regulation or an Act, the CFIA can still enforce therapeutant use

under the 1985 *Food and Drugs Act* (amended in 2016) (Canadian Food Inspection Agency, 2017a). For therapeutants, if there is no predetermined residue limit that producers must adhere to, or if the therapeutant is being used off label by a prescribing veterinarian, Health Canada considers *any* residue that is found within flesh to be a violation of both Article 4 (a, and/or d) of the *Food and Drugs Act*, and Section 6 (1)(a) of the Fish Inspection Regulations (Canadian Food Inspection Agency, 2017a). When a drug is used for a purpose (indication), or for a species that is not stated explicitly on the label, it is being used "off-label". A prescribing veterinarian may do this for veterinary drugs in Canada. If this is the case, the prescribing veterinarian assumes responsibility for adverse drug events, rather than the drug's sponsor. To be able to assume the liability of prescribing the drug off-label, the prescribing veterinarian must be in good standing with the CVMA, and their provincial veterinary association (CVMA, 2018).

Part 1 Sections 21.1 (1) of the *Food and Drugs Act* outlines the ministerial responsibility with respect to therapeutic products, including those employed or prescribed in aquaculture (Food and Drugs Act, 1985). If the minister: "believes that a therapeutic product may present a serious risk of injury to human health, the minister may order a person to provide the Minister with information that is in the person's control and that the Minister believes is necessary to determine whether the product presents such a risk" (Government of Canada, 1985).

The regulations regarding therapeutant use and potential risk to human health and safety are vague within the *Food and Drugs Act*. If a risk is to be found, what will actually occur to a drug and to its market authorization are difficult to interpret – they range from a full recall of the product, to the drug establishment losing their license, to the Minister making an order for the drug market authorization holder to "require the person who sells the product to, instead on requesting the product's return [recall scenario], request the product's owner or user to allow [for] corrective action to be

taken in respect of the product and then take that corrective action, or cause it to be taken, if the request is accepted] (Government of Canada, 1985).

6.4.2 Aquatic Animal Disease Reporting Requirements for Aquaculture in Canada

The Canadian Food Inspection Agency is responsible for managing aquatic animal diseases in Canada, including those that are reported within aquaculture facilities (both inland and marine) (CFIA, 2017a). In 2011, a review published by the Council of Canadian Academies titled *Healthy Animals, Healthy Canada: The Expert Panel on Approaches to Animal Health Risk Assessment* identified three deficiencies regarding aquatic animal health in Canada.

The panel argued for a single, integrated risk assessment (that would be more effective), than considering different consequences for producers differently. Integrated risk assessments that included methodologies and perspectives from other disciplines should be included to allow for the CFIA to present a united risk assessment (Academies, 2011). Further panel recommendations to the CFIA included adopting a multidimensional approach to disease management in Canada, and ensuring that greater transparency to producers, risk managers and stakeholders that are involved in the risk assessment process. To best accomplish this, the panel recommended that the CFIA have a structured prioritization process, increased documentation, and risk communication to the industry (Academies, 2011). As of 2011, stakeholders (such as importers, or government facilities) who requested a risk assessment for their animals or production facility, receive communications from CFIA at the beginning and at the end of the process. CFIA keeps the complete report confidential (Vogel, 2011).

In 2015, the National Aquatic Animal Health Program (NAAHP) was implemented by the federal government. A collaboration between the CFIA and DFO, this program sought to develop and establish an import system for products meeting Canadian standards and it established the Aquatic Animal Health Division (AAHD) (Treasury Board

of Canada Secretariat, 2015). The role of this division was to continue the amendments to the Fish Health Protection Regulations and coincided with the advent of the Aquatic Animal Health Import Program (Treasury Board of Canada Secretariat, 2015).

Aquatic animal diseases in Canada are categorized as reportable, immediately notifiable, or annually notifiable. Reportable diseases are "of significant importance to aquatic animal health or to the Canadian economy… [these diseases] either occur regionally in Canada, or do not occur in Canada" (CFIA, 2017a). For aquatic species, there are 20 reportable diseases. Anyone that owns, or works (including laboratories, analysts, or veterinarians) with aquatic species that confirms a reportable disease, must report it to the CFIA.

There are fifteen aquatic diseases that have been declared "immediately notifiable", in Canada. These are aquatic species diseases that are considered of significant importance to the Canadian economy and are not found in Canada – and are most likely to be detected by a laboratory during aquaculture surveillance screening (CFIA, 2017a). If laboratories encounter any of these fifteen diseases during screening, they must report this to the CFIA immediately.

There are six annually notifiable diseases in Canada, and these are defined by CFIA as: "[being] present in Canada and are a concern to some of Canada's trading partners" (Canadian Food Inspection Agency, 2014). Only laboratories that confirm one of these six diseases are required to contact the CFIA when they suspect or diagnose those diseases through validated laboratory methods (Canadian Food Inspection Agency, 2014). Table 4 illustrates the list of crustacean, finfish and mollusc diseases that are immediately notifiable, reportable, and annually notifiable to CFIA. Aquaculturists are required to report diseases listed as reportable as soon as confirmatory laboratory tests are completed.

Table 4: The Canadian Food Inspection Agency Aquatic Animal Disease Categories ((Government of Canada, 2017; Canadian Food Inspection Agency, 2014).

SPECIES	IMMEDIATELY NOTIFIABLE	REPORTABLE	ANNUALLY NOTIFIABLE
CRUSTACEANS			
	Crayfish plague (*Aphanomyces astaci*)		
	Infectious hypodermal and haematopoietic necrosis (Infectious Hypodermal and Haematopoietic Necrosis Virus)	**White spot disease**	
	Infectious myonecrosis (Infectious Myonecrosis Virus)	**Yellow Head Disease**	
	Necrotizing hepatopancreatitis		
	White tail disease (White Tail Virus)		
FINFISH			
	Epizootic ulcerative syndrome (*Aphanomyces invadans*)	**Ceratomyxosis** (Ceratomyxa shasta)	**Bacterial kidney disease** (*Renibacterium salmoninarum*)
	Gyrodactylosis (*Gyrodactylus salaris*)	**Koi herpesvirus disease**	
	***Oncorhynchus masou* virus disease** (Oncorhynchus Masou Virus)	**Spring viraemia of carp**	
	Red sea bream iridoviral disease (Red Sea Bream Iridovirus)	**Epizootic haematopoietic necrosis (EHNV)**	**Enteric red mouth disease** (*Yersinia ruckeri*)
	Gyrodactylosis (*Gyrodactylus salaris*)	**Infectious haematopoietic necrosis**	**Furunculosis** (*Aeromonas salmonicida*)
		Infectious pancreatic necrosis	**Streptococcosis** (*Streptococcus iniae*)
		Viral haemorrhagic septicaemia	
		Whirling disease (Myxobolus cerebralis)	
		White sturgeon iridoviral disease	
MOLLUSCS			
	Abalone viral mortality (Abalone Herpes-like Virus)	Disease caused by **Bonamia ostreae**	**QPX disease** (Quahog parasite unknown)

	Disease caused by *Bonamia exitiosa*	Disease caused by **Haplosporidium nelsoni**	**Seaside organism** (*Haplosporidium costale*)
	Disease caused by *Bonamia roughleyi*	Disease caused by **Marteilia refringens**	
	Brown ring disease (*Vibrio tapetis*)	Disease caused by **Marteiliodes chungmuensis**	
	Disease caused by *Marteilia sydneyi*	Disease caused by **Mikrocytos mackini**	
	Withering syndrome of abalone (*Xenohaliotis californiensis*)	Disease caused by **Perkinsus marinus**	
		Disease caused by **Perkinsus olseni**	

In Canada, the CFIA monitors aquatic animal diseases in aquaculture through the development of surveys and sampling plans to gather the required data used to evaluate the disease likelihood, ensure sampling protocols are standardized for samples submitted by industry, and analyze the data collected in the context of international standards for disease reporting that are set by the World Organisation for Animal Health (OIE) (Canadian Food Inspection Agency, 2015). Data is collected and organized according to management zones. These are achieved through collaboration with other federal and provincial agencies – and with industry. Collaboration with industry and other private organizations, researchers, and Aboriginal groups allow for the CFIA's disease surveillance screening programs to be successful (Canadian Food Inspection Agency, 2015). Figures 3 and 4 outline the CFIA declared disease zones in British Columbia. Figure 3 represents CFIA's finfish disease monitoring area that begins at the inner boundary of the territorial sea and the outer limit of the contiguous zone that extends from Dixon Entrance to the Juan de Fuca Strait (outlined). CFIA adheres to these boundaries when disease containment is required (Canadian Food Inspection Agency, 2018c). Figure 4 represents the declared area for shellfish disease in the Pacific Ocean

North and Pacific Ocean South regions of British Columbia that was produced by CFIA for presenting areas of Canada that were assigned an aquatic animal disease status for the Domestic Movement Control Program. Figure 4 represents the monitoring area that begins at the inner boundary of the territorial sea and the outer limit of the contiguous zone that extends from Dixon Entrance to the Juan de Fuca Strait. CFIA adheres to these boundaries when disease containment is required (Canadian Food Inspection Agency, 2018c).

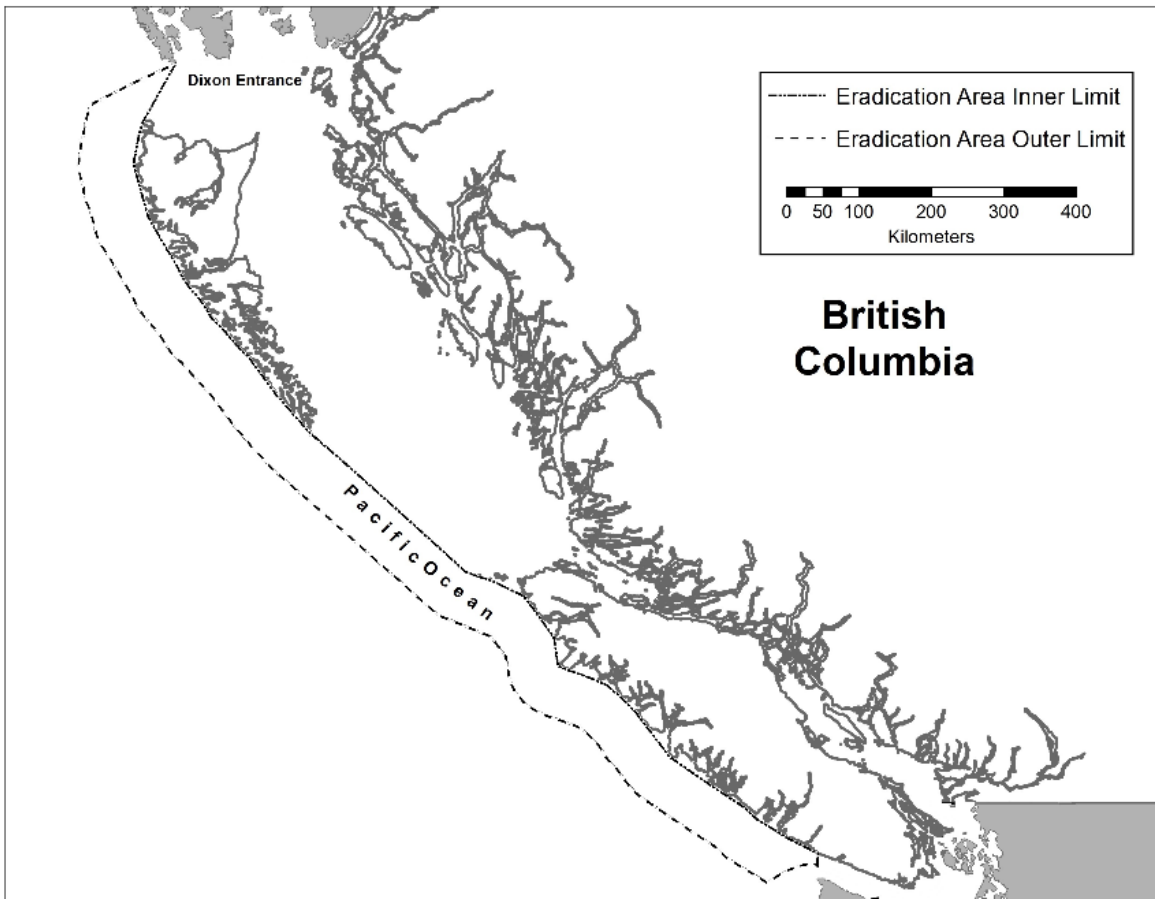

Figure 3: Map of declared area for finfish diseases in the Pacific Ocean North and Pacific Ocean South regions of British Columbia.

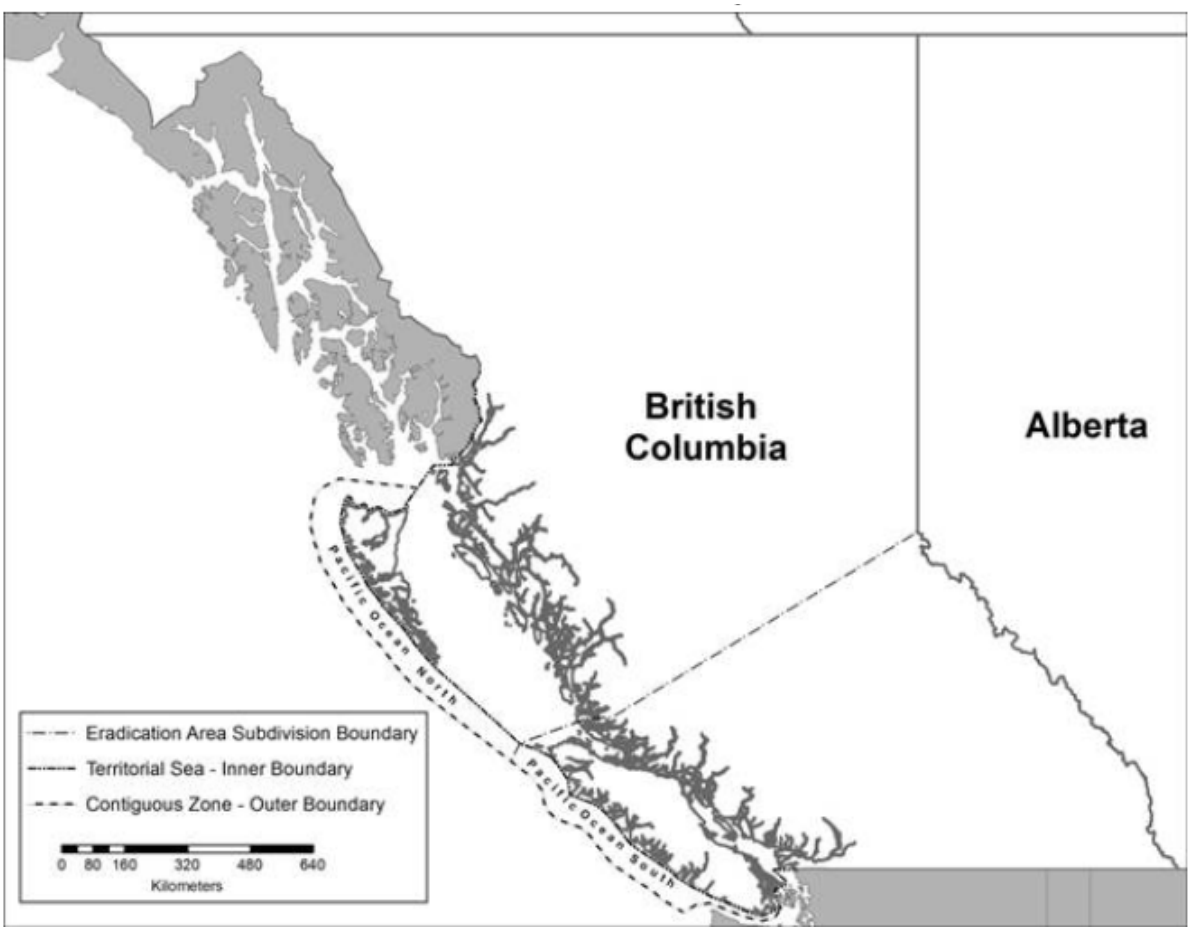

Figure 4: Map of declared area for shellfish diseases in the Pacific Ocean North and Pacific Ocean South regions of British Columbia.

6.4.3 Feeds Act: Importation Requirements for Aquaculture Feed in Canada

Aquaculture feed legislation is regulated by the federal *Feeds Act* (1985) (Government of Canada, 2018). The *Feeds Act* regulates and controls the sale of feed in Canada. The *Feeds Act* prohibits the sale, manufacture, and importation of feed unless it is packaged, labelled and manufactured in a way that conforms to regulated standards (Canadian Food Inspection Agency, 2018a).

In the 1985 Act, feed is defined as "any substance, mixture of substance containing amino acids, anti-oxidants, carbohydrates, condiments, enzymes, fats, minerals, non-protein nitrogen products, proteins or vitamins, or pelletizing, coloring, foaming or flavoring agents and any other substance manufactured sold, or represented for use" (Justice Laws, 2018). This includes any feed that is marked for consumption of livestock, for providing the nutritional requirements of livestock, and for preventing, or correcting nutritional disorders of livestock (Government of Canada, 1985). This clause within the 1985 Act aims to remove any feed presenting a risk of harm to livestock, by preventing the manufacturing, sale, importation or export of any feed that could be of harm to human or animal, or to the environment in Canada. Similarly, feed is restricted from moving between provinces, unless the exportation is completed by a health veterinary professional who has received regulatory permission from the Canadian federal government (Justice Laws, 2018).

The Canadian Food Inspection Agency verifies that feed that is imported, or manufactured in Canada is safe, is efficacious in the target animal(s), and labelled appropriately (Canadian Food Inspection Agency, 2018a). Through regulation, livestock producers are ensured that feed is imported and manufactured in an acceptable and safe manner. Canadian livestock feed regulations, and the *Feeds Act* (1985) ensures that any feed that enters Canada is safe, and that it contributes to healthy production of livestock animals and other safe foods of animal origin.

Under the *Feeds Act*, Canadian and international feed manufacturers must have strict quality control and manufacturing procedures in place to ensure that feed is manufactured in a safe manner (Justice Laws, 2018). The indirect transmission of material harmful to humans could always occur, particularly if feed residue were to meet food (e.g. meat, eggs or cheese), through worker exposure, or through the environment. This risk can be mitigated through these strict quality control guidelines. If transmission or exposure were to occur, these strict quality control measures and

manufacturing guidelines can identify problems quickly because of batch traceability. As a condition of license, feed manufacturers are required to have internal methods for batch traceability so that if their products ever need to be recalled from the market, they can be traced (Health Canada, 2015).

Feed ingredients are regulated through Schedules IV and V of the *Feeds* Act, and feed manufacturers must uphold strict standards to ensure that all aspects of their production will be safe for both livestock and humans, should inadvertent exposure or consumption occur (Canadian Food Inspection Agency, 2017b). A feed manufacturer must ensure that the active ingredients are not only eligible for approval as a livestock feed in Canada, but they must demonstrate that the active ingredient is efficacious in the target animal(s). The Canadian Food Inspection Agency ensures that feed imported into Canada is held to the same standard as that is produced by domestic feed producers.

Under the Canadian *Feeds Act* (1985), fish are considered livestock. This means that aquaculture feed producers are held to the same standard as beef or pork producers despite having significantly smaller market share. It is a feed producer's responsibility to be aware of the regulations and of their reporting and production responsibilities under the Act – and producers must be aware of the penalties that they could be subject to if they are non-compliant (Canadian Food Inspection Agency, 2018a).

Within Schedules IV and V of the *Feeds Act*, producers are regulated in both the way that feed is produced in Canada, and the types of ingredients that can be used (Canadian Food Inspection Agency, 2018a). Aquaculture feed that is medicated for treatment purposes is permissible in Canada, however its ingredients and manufacturing is regulated differently. Medicated feed in Canada is considered a veterinary drug product and is therefore regulated by the VDD of Health Canada, under the *Food and Drugs Act* (Health Canada, 2013).

A Canadian aquaculture feed producer must complete two initial steps before they can either manufacture or import aquaculture feed into Canada. First, feed producer candidates must complete a mandatory pre-market assessment. This assessment requires potential feed manufacturers to submit information on the safety and efficacy of their product (CFIA, 2017b). Second, feed manufacturers are required to participate in the National Feed Inspection Program (Canadian Food Inspection Agency, 2017b), which sets out the parameters within which feed producers may manufacture feed domestically, and which ingredients may be used (CFIA, 2017b).

The range of nutrients that must be present in salmonid feeds are found in Table 4, of Schedule 1 of the *Feeds Act* (1985) (Canadian Food Inspection Agency, 2018a). The original Table 4, enacted with the *Feed Act* (1985) outlined the registration procedures, manufacturing requirements for producers, and registration exemption criteria for chicken, turkey, swine beef and dairy cattle, and sheep. However, in 1990, Table 4 was amended to include salmonid fish (Canadian Food Inspection Agency, 2018b). All international and domestic feed manufacturers that intend to sell product in Canada must adhere to Health Canada's Good Manufacturing Practices Guidelines (Health Canada, 2015). These requirements are designed to ensure an effective overall approach to product quality control and risk management. To achieve this, Health Canada sets standards and practices that manufacturers must adhere to for the manufacturing, packaging, labeling, storage of Natural Health Products (NHPs) intended for sale into Canada (Health Canada, 2015).

Under current regulations, all domestic and international feed manufacturers that intend to sell feed in Canada must demonstrate that they manufacture a complete feed which provides nutrients for [salmonid fish] which fall within the ranges of those macronutrients listed in Table 4; or those producers who manufacture a supplement which has directions for use which would result in a complete feed that provides nutrients which fall within Table 4 ranges (Canadian Food Inspection Agency, 2018b),

are exempted from registration. Those that do not fall in either of these two categories or fall outside of any of the ranges provided in the regulations are not exempted from registration and must be assessed and go through the registration process by the Canadian Food Inspection Agency prior to the product being manufactured, sold or imported into Canada.

In 2018, the Canadian Food Inspection Agency released a proposal for determining maximum nutrient values in marine and freshwater fish feeds, with the goal of modernizing the regulations surrounding aquaculture feed production. Dialogue that took place between aquaculture stakeholders and the Canadian Food Inspection Agency, lead regulators to the determination that the current regulations establish nutrient ranges only for salmonid species (salmon and trout) in Canada. Other commercially important species in Canada have no established standards, nor any regulations surrounding the registration, or any manufacturing standards regarding feed production in Canada. With over thirty finfish, shellfish and crustacean species currently being cultivated in Canada, this remains a serious regulatory and enforcement gap (Canadian Aquaculture Industry Alliance, 2017c).

Since 2015, The Canadian Food Inspection Agency has attempted to modernize its regulations, but the process has been difficult. In the 2015 proposal, and in the Feed Regulatory Renewal Consolidated Modernized Framework Proposal – November 2015 (Consolidated Proposal), CFIA sought stakeholder consultation regarding the removal of Table 4 from the regulations, that producers no longer be required to register their feed product(s) based solely on levels of nutrients, and the establishment of maximum nutrient levels for cultivated freshwater and marine species.

Adoption of this proposal could have significant impacts for Canadian aquaculture feed producers, as they would be required to prove that their feed products are suitable for their intended purpose and they meet the nutritional requirements of the target animal(s). In addition, under this proposal maximum levels for nutrients

would be established initially for finned fish that are raised *commercially* for human consumption, and nutrient maximum levels would be incorporated by reference in the Feeds Regulations for updating, if required, or if deemed necessary by regulators (Canadian Food Inspection Agency, 2018b).

Changes to the Regulations through the removal of Table 4 would satisfy concerns identified by stakeholders, including their claims that the nutrient ranges provided in Table 4 impeded new products from entering the marketplace. Salmonid feed producers argued that being regulated the same as beef, or chicken producers in Canada, would prevent new feed formulations from entering the market (Canadian Food Inspection Agency, 2018a). Developing new feed formulations for aquatic species (which have a smaller market share) would not be financially feasible for manufacturers. Furthermore, it addresses concerns regarding the harmful impact that higher levels of certain nutrients may have on livestock or the resulting food products and underscores the modernized regulatory framework's focus on health and safety for humans, animals, and the environment (Canadian Food Inspection Agency, 2018b).

Through the modernization of the Regulations, the Canadian Food Inspection Agency aims to provide aquaculture feed producers the flexibility to manufacture feeds with nutrient contents that meet industry needs without requiring the pre-market authorization and Canadian Food Inspection Agency authorization. Second, the modernization will allow the CFIA to continue regulatory purview to identify hazards that could negatively impact human or animal health or the environment. Modernization would also allow for timely updates to the standards, and therefore would reduce the regulatory burden for feed producers that manufacture products for small-markets, but who desire to get new aquaculture feed products into the marketplace (Canadian Food Inspection Agency, 2018b).

7.0 Conclusion

According to the Food and Agricultural Organization (FAO), world aquaculture production of fish and aquatic plants in 2016 was 110.2 million tonnes, with the first-sale value estimated at USD 243.5 billion (FAO, 2018b). Sustainable aquaculture production alleviates fishing pressure on captive fisheries and provides indirect and direct economic benefit to many local and regional economies, including Canada's (Fisheries and Oceans Canada, 2018b).

Annually, the global population continues to increase, as does per-capita fish consumption. The FAO and UN estimate that by 2050, the global population will have grown to 9.77 billion people (FAO, 2016). If the per-capita consumption of seafood remains constant, Marine Harvest estimates that this will translate into a 35% increase in seafood demand by this time. Estimates from the United Nations suggest that this per-capita demand for seafood will double (Marine Harvest, 2018).

The Food and Agriculture Organization estimates that in 2016, aquaculture accounted for more than half of all fish supplies destined for direct human consumption (FAO, 2018b). Aquaculture can fill the supply-demand gap that is set to widen as wild fisheries landings continue to stagnate, and in their 2013 report *Fish to 2030*, the World Bank estimates that by 2030, aquaculture will supply approximately 65% of fish for human consumption (The World Bank, December 2013).

Aquaculture operators have the potential to meet this growing global demand because of progress made in biosecurity protocols, environmental management standards, improvements in animal health, system designs (recirculating aquaculture systems), and feed technologies (automated feed technologies) in the second half of the twentieth century. This progress has allowed commercial aquaculture to expand to

multiple species and increase significantly in production volumes (Marine Harvest, 2018).

Regulation of aquaculture among provinces in Canada varies significantly. If regulation of aquaculture in Canada can be modernized, according to CAIA, seafood production in Canada can continue to occur responsibly and sustainably while also becoming more efficient. Aquaculture regulatory reform and standardization would represent a step forward in modernizing how Canada views, regulates, and enables growth of national aquaculture; rather than being regulated with legislation such as the *Fisheries Act*. Aquaculture specific stand-alone regulations that are the same among provinces would reduce regulatory burden and promote the sustainable growth of Canada's seafood industry (Canadian Aquaculture Industry Alliance, 2017c).

The current method of aquaculture regulation in Canada is effective; the involvement of multiple agencies places a series of "checks and balances" at the federal and provincial levels and ensures that aquaculture is managed appropriately. However, management of the industry differs regionally. The adoption of standardized methods for aquaculture management in Canada would lead to greater transparency, and increased efficiency for aquaculture producers. Moving forward, a hybridized approach using aspects of the current regulatory model and aspects of the British Columbian model would be beneficial because requirements would be standardized between Canadian provinces and territories. By standardizing aquaculture siting, wastewater discharge and environmental monitoring standards, aquaculturists could expand operations (and meet increasing seafood demand), protect the environment and be sustainable in all their operations across Canada.

Currently, the Department of Fisheries and Oceans is the federal agency that is best suited to maintain regulatory authority of aquaculture in Canada. Maintaining DFO as the lead regulator would ensure that an evidence-based, accountable and transparent management of the industry would continue. However, aquaculture

regulation needs to be better defined, and standardized between provinces, and the federal government. Adopting new legislation or an agreement to outline the responsibilities of the provincial and federal agencies would be positive for both sides.

Having a concise outline of responsibilities would encourage regulatory efficiency and the standardization of regulation between provinces for siting, benthic monitoring, wastewater discharge, food safety, and disease monitoring would encourage aquaculturists to grow their operations. Standardization of these parameters would encourage growth - and Canada could be a global leader in sustainable and responsible aquaculture practices (Canadian Aquaculture Industry Alliance, 2017c).

Modernizing Canada's aquaculture legislation would lead to greater collaboration between the federal and provincial governments, reducing regulatory inefficiencies. Currently, there are areas of Canada's farmed seafood industry that are burdened with multiple government agencies having management responsibility at the provincial and federal levels. In the future, a hybridized approach, would foster collaboration between the federal and provincial governments, and reduce regulatory inefficiencies. The current system limits growth of the aquaculture industry because it is regulated by legislation that differs between provinces, and much of the legislation is found within the *Fisheries Act (1985)*. As of 2018, Canadian aquaculture is large enough to have its own set of legislation. Currently, the way that the industry is regulated does not allow the industry to produce enough product to satisfy consumer demand.

In the future, for the industry to keep up with demand, having regulations standardized among provinces would be positive. Large companies could grow quickly in multiple provinces if siting requirements were standardized, and more species could be cultivated. If the environmental requirements were standardized between provinces, aquaculture producers could align their internal environmental management strategies to that of the regulators'. Environmental monitoring of all aquaculture needs to continue. The aquaculture industry is committed to environmental sustainability in

Canada. However, with environmental monitoring being standardized among provinces, aquaculture producers could anticipate, and plan site fallowing periods – and potentially reduce production shortfalls.

CAIA believes that the purpose of regulatory standardization, with DFO continuing as the lead regulator, would result in five important benefits: first, it would foster a healthy, responsible and sustainable farmed seafood sector in Canada. Second, it would ensure that a science-based, accountable and transparent management approach would be undertaken by regulators. Third, aquaculture would continue to revitalize hard-hit coastal communities including First Nations communities and provide them with sustainable high-value jobs. Fourth, if Canada could move towards a hybridized regulatory regime that incorporated all current federal regulatory agencies but clearly outlining federal and provincial responsibilities through new legislation, there would be greater federal/provincial co-operation and collaboration. This would encourage regulatory efficiency in the aquaculture sector. Finally, with greater collaboration between provinces and the federal government, Canada could help meet future seafood demand with global best practices and international competitiveness (Canadian Aquaculture Industry Alliance, 2017c).

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