RIAS Inc.
Regulatory Impacts / Alternatives / Strategies

440 Laurier Avenue West, Suite 200
Ottawa Ontario K1R 7X6

Phone: 613 795 8426
Fax: 613 782 2228
www.riasinc.com

Economic Opportunities for Aboriginal Aquaculture in Canada

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Executive Summary

This report outlines the potential economic opportunities that aquaculture presents for Aboriginal people in Canada. Its aim is to enable greater participation of Aboriginal people in sustainable aquaculture development. Many aboriginal communities are already engaged in aquaculture, but this report points to the additional opportunities that exist.

Across Canada, 56 different species of finfish, shellfish and aquatic plants are commercially cultivated now. They are raised in marine environments, in freshwater lakes and rivers, in land-based ponds, and/or in tank facilities. Salmon accounts for about 2/3^{rds} of all aquaculture production. Aquaculture is important to the world: the Food and Agriculture Organization of the United Nations (FAO) predicts that global demand for aquaculture will grow 7% per year and will pass traditional capture fisheries in 2015. In Canada, aquaculture generates about $3.1 billion in total economic activity, much of which takes place in rural and coastal communities.

Although salmon drives much of the industry, there is opportunity for First Nations and other Aboriginal groups to expand and increase production of salmon and other existing species (most importantly trout, oyster, mussels and clams), and to diversify production by developing commercial production of new species (Arctic charr, tilapia, sturgeon, sablefish, walleye, geoduck, scallops, sea urchins, eels, wolffish, abalone, cockles, sea cucumber, marine plants are discussed). Markets locally, across Canada, throughout North America and around the world, are changing. Demand for new and different seafood products is growing.

Aboriginals are involved in aquaculture in most of Canada, though mostly in BC. Although the numbers are low, the potential is high. In their 2012 report entitled Socio-Economic Benefits of Aquaculture in Canadian Aboriginal Communities, the Aboriginal Aquaculture Association estimated that more than 50 First Nation and Aboriginal communities across Canada are directly involved in aquaculture production—or provide supplies and services to the production sector.

Some First Nation aquaculture ventures have met with notable success. For these First Nations, aquaculture has brought much-needed jobs, skills and leadership development, and wealth creation. These successes have demonstrated that aquaculture can significantly improve the socio-economic wellbeing of First Nations communities. To estimate the potential gains for First Nations, this report uses estimates of the total potential growth of the aquaculture industry in Canada over the next 5 and 10 years (based on industry estimates), and presents potential opportunities for First Nations based on the following assumptions:

- BC will have the largest growth in aquaculture in the next decade and it is estimated that Aboriginal Canadians will participate in 40% of the projected growth through investment or participation in joint ventures and partnerships.
- Ontario First Nations could have a similar 40% share of the growing production.

- In Quebec, First Nations could share in as much as 1/3 of the future growth in aquaculture.
- For Nova Scotia, as much as 40% of the gains in aquaculture could benefit First Nations.
- For New Brunswick and PEI, it is estimated that First Nations could accrue a 20% share for First Nations in future growth.
- For NL, the FN share of growth is estimated to be around 25%.
- In the Prairies and the North where production is small, Aboriginal communities may have respective 20% and 50% of the growth.

Based on these assumptions, Table 1 shows the potential gains for First Nations in terms of additional jobs and labour income.

Table 1: Potential First Nations Benefits from Future Aquaculture Development

Province/Territory	Estimated First Nations Share of Growth	Additional Jobs		Additional Labour Income (000s of $2010)	
		In 5 Years	In 10 Years	In 5 Years	In 10 Years
British Columbia	40%	1,380	3,484	62,400	164,000
Prairies	20%	17	67	1,000	3,920
Ontario	40%	74	288	4,000	15,760
Quebec	33%	41	161	1,870	7,300
New Brunswick	20%	108	398	3,960	14,560
Nova Scotia	40%	96	344	3,680	15,500
Prince Edward Island	20%	54	224	4,650	16,200
Newfoundland and Labrador	25%	176	636	7,450	26,850
Yukon, NWT, and Nunavut	50%	2	8	150	450
Total		1,948	5,610	89,160	264,540

Source: Author's own calculations. Numbers may not add due to rounding.

However, these estimates of potential growth for First Nations involvement in aquaculture need to be considered within the following context: some First Nations have met with notable failures in their attempts to develop aquaculture operations. In some cases, this lack of success has intensified pre-existing economic challenges within the community. Moreover, these failures have undoubtedly discouraged other First Nation communities from seriously considering the economic development potential of aquaculture. The failures have also contributed to the view among some economic development agencies and venture capitalists that First Nations aquaculture is a 'high risk' venture—a view that is currently limiting the ability of First Nations to access the capital necessary to fund their aquaculture ventures.

Research conducted for this report reveals that while aquacultural productive capacity within a traditional territory has often been interpreted as meaning that an economic development opportunity should be undertaken, the actual First Nations experience in aquaculture has revealed that biophysical capacity alone does not ensure success. In fact—given the

opportunities available in the supply and service sector—biophysical capacity may not even be a prerequisite for economic development through involvement in the aquaculture industry.

The biophysical capacity of a First Nation's traditional territory therefore indicates only what direct aquaculture activities could be undertaken. It does not indicate what activities should be undertaken. To fully appreciate whether a First Nation's aquaculture aspirations should be undertaken as an economic development endeavour, a diverse range of social, cultural, technological, educational, global and economic factors must be considered. In this regard, this report seeks to identify "Keys to Success" that may allow First Nations to more readily transform their aquacultural aspirations into economic development success stories. Interviews conducted for this report indicated that business development organizations—such as the Aboriginal Aquaculture Association, Waubetek Business Development Corporation, and Ulnooweg Development Group—are playing an invaluable role by encouraging First Nations to consider these keys to success in the development and implementation of their aquaculture ventures.

1. Introduction

1.1. Purpose and Scope

The purpose of this report is to present an outline of the potential economic opportunities in aquaculture in various regions across Canada.

This report expands on and updates a RIAS Inc. report prepared for the Aboriginal Aquaculture Association, and the Waubetek Business Development Corporation, which promotes business interests of First Nations in North-Eastern Ontario. Both this report and the previous report were funded through the Aboriginal Aquaculture in Canada Initiative (AACI), which receives its funding through Aboriginal Affairs and Northern Development Canada's Strategic Partnerships Initiative (SPI). The SPI is designed to increase Aboriginal participation in economic development opportunities by supporting community economic readiness activities so that communities are better prepared to engage with partners and participate fully in these opportunities.

The report is intended to provide information that will help enable greater participation of Aboriginal communities in sustainable aquaculture development. Aboriginal communities everywhere can build on many of the principles and practices outlined to actively explore further opportunities.

This paper starts by providing background on aquaculture in Canada, describing the existing operations, and how expansion into other species will help grow the business. It then provides an outline of the federal and provincial regulatory environments. Next it outlines the environment for the growth of aquaculture generally and then, based on extensive interviews with key stakeholders across Canada, examines specific issues and potential keys to success for how First Nations and Aboriginal peoples can start or further grow their aquaculture operation activities.

1.2. Background

Aquaculture is practiced in many different forms the world over from large scale, vertically integrated commercial operations serving international markets to backyard recirculation tanks raising trout for family and local consumption. Some of the earliest historical roots of aquaculture trace back thousands of years in China, and archeological evidence from BC suggests that Aboriginal peoples were also enhancing shellfish species thousands of years ago.[1]

[1] Urban, 2006 p.2.
[2] Nguyen and Williams

Aquaculture in Canada

Aquaculture in Canada occurs in every province and the Yukon Territory. Currently, about 56 different species of finfish, shellfish and aquatic plants are commercially cultivated. They are raised in marine environments, in freshwater lakes and rivers, in land-based ponds, and in tank facilities. Aquaculture production varies across the country depending upon the species being farmed, the environment within which it takes place, (marine, freshwater), the conditions on the ocean, lake or river floor (sand, rock), and the culture technologies used.

In 2013, aquaculture accounted for about 172,100 tonnes, or 17.4%, of total fish production in Canada. Aquaculture also generates about $3.1 billion in total economic activity, over $1.2 billion in GDP and about $698 million in labour income. First Nation communities are uniquely positioned to benefit from the growth and development of the industry as much of this economic activity takes place in rural and coastal communities.

Finfish represents the largest component of the aquaculture sector, with 27 different species such as salmon, trout, and charr commercially grown in Canada. Finfish is grown in all regions in Canada in both marine and freshwater environments.

Shellfish is also an important part of the aquaculture sector on both coasts with 20 different species of shellfish cultured, such as mussels, clams and scallops. Aquatic plants represent a small, but growing part of the sector, with nine species of kelp, sea lettuce and Irish moss commercially cultivated in Canada.

Other species such as sea urchins, crayfish and sea cucumber are commercially produced in small amounts. The diversity of species in all sectors is expected to grow in the coming years.

By species, in 2013, salmon accounted for 62% of all aquaculture produced in Canada by volume (tonnes), followed by mussels (16%), oysters (6%), and trout (4%).

Aquaculture and First Nations

In 2011, over 50 First Nation and Aboriginal communities across Canada had developed aquaculture business ventures and partnerships. More are now in place and many aboriginal communities are currently engaged in projects to assess aquaculture opportunities. This has resulted in new job creation, skills development and increased wealth and prosperity. It has also helped to strengthen historical connections to the aquatic environment and its resources, and to develop capacity for the increasing responsibilities of marine resource management and environmental stewardship.

Aquaculture can become a more important economic driver for First Nations communities, generating more revenues for First Nations through their direct involvement in all facets of the aquaculture value chain (hatchery, raising, harvesting, processing, packaging, and shipping or delivery), as well as indirect involvement through the provision of support services (environmental services, construction, diving, boat repair, water taxi services, etc.).

2. Current Economic Opportunities in Aquaculture

2.1. Global Demand for Aquaculture

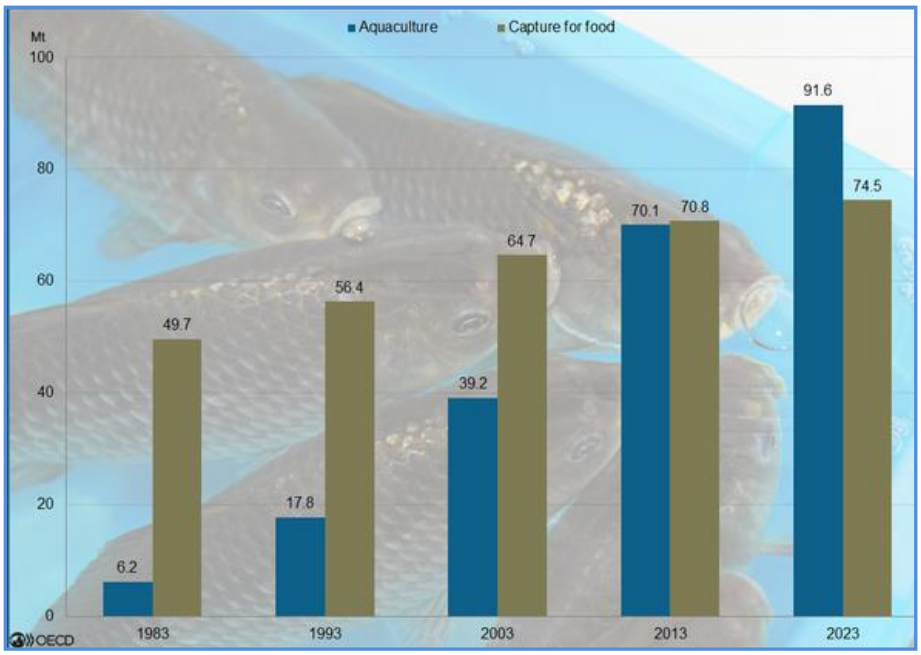
The Food and Agriculture Organisation (FAO) and Organization for Economic Cooperation and Development (OECD) predict that aquaculture production will surpass global traditional capture fisheries in 2015. Globally, traditional capture fisheries have had virtually no growth since 1990 while aquaculture production has nearly quadrupled through that period.

The main producers and market for aquaculture products are in China, which produced over 61%, or 41 million tonnes, of the world's farmed fish and seafood products in 2012. By comparison, Canada produced only 173 thousand tonnes, less than half of one percent of global production. Canada's industry is dominated by exports, primarily to the U.S. In 2011, 99% of Canada's farmed mussels and 97% of farmed salmon were exported to the U.S[2]. New opportunities for growth are developing -- these include Canada's recent free trade agreements with Europe and with Korea as well as an easing of China's trade barriers. The FAO predicts that global demand for aquaculture will grow 7% per year and will pass traditional capture fisheries in 2015. Demand will be driven largely from emerging economies in Asia, particularly China.

The FAO expects that total aquaculture production will reach over 90 million tonnes by 2023 to meet global demand for fish and seafood products. Conversely, capture fisheries production will increase very little over the coming decades. See Figure 1 below.

[2] Nguyen and Williams

Figure 1: Aquaculture and Capture Fishery Production, 1983 to 2023

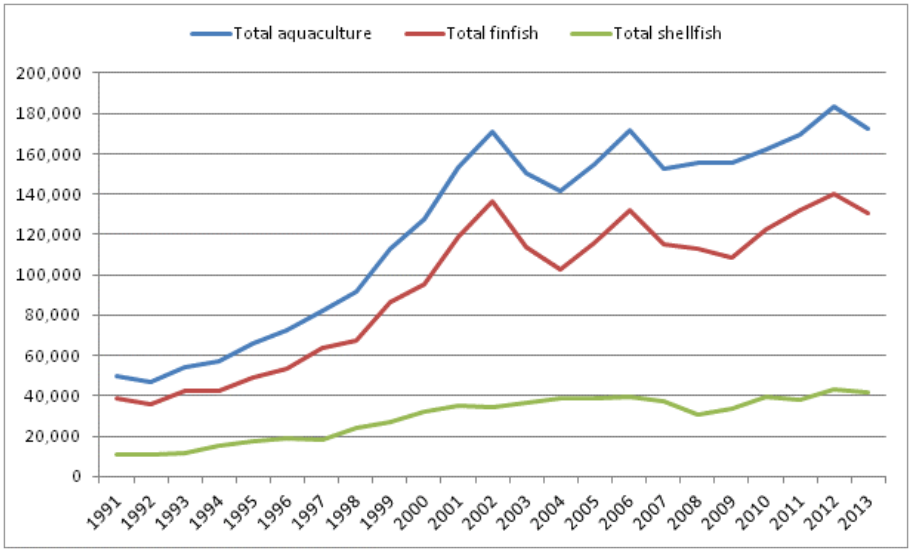


Source: OECD-FAO Agricultural Outlook 2014

2.2. Challenges and Opportunities for Aquaculture in Canada

Canada has the world's longest marine coastline and the largest number of freshwater lakes in the world. Despite this water resource advantage, aquaculture production overall has stagnated in Canada since 2001.

Figure 2: Aquaculture Production in Canada, Tonnes, 1991 to 2013



Source: Statistics Canada, Table 003-0001, *Aquaculture, production and value, annual,* CANSIM (database).

In a 2013 background report for the Library of Parliament (LofP), *Aquaculture in Canada*, Thai Nguyen and Tim Williams outlined the largest challenges facing Canada's aquaculture industry: the economics of the international marketplace, public concerns for the environment, the future sustainability of the sockeye salmon fishery in the Fraser River (the Cohen Commission report), and regulatory uncertainty.

The LofP report notes that regulatory uncertainty is currently a concern through most provinces. Various federal departments including DFO, Transport Canada, Health Canada, Agri-Food Canada, and the CFIA, are each responsible for some aspect of regulating aquaculture. In addition, provinces are generally charged with issuing site licences, leases, and permits. All of this creates a complex framework for businesses to navigate.

Despite these challenges, Nguyen and Williams point to several opportunities for the industry. For instance, the provinces and federal government are working towards greater regulatory certainty. Many stakeholders also want the federal government to adopt an explicit aquaculture legislative framework that would provide greater regulatory certainty.

Canada also has a number of untapped opportunities in new fish species (described below) that could help the industry diversify into products like sea cucumber, which are in demand in North America and abroad for sushi. New technologies and farm management practices will also lead to greater productivity in the industry.

2.3. Characteristics of Aquaculture Production in Canada: Models and Techniques

There are six aquaculture models in use in Canada:

- Cage culture – fish stocks in grow out cages floating in lakes or the ocean, e.g., rainbow trout, salmon
- Land based systems – fresh or salt water finfish or shellfish grown in tanks or ponds on land
- Bottom culture/enhancement (intertidal) – aquatic plants or shellfish are enhanced (seeded and managed) on either a leased area of the intertidal zone, or if the area is not leased, a fishing license is required for harvesting
- Long-line/cage culture – shellfish or plants grown in subtidal waters on anchored floats using trays, racks or longlines
- Bottom culture/enhancement (subtidal zone) - aquatic plants or shellfish are enhanced (seeded and managed) on either a leased area of the subtidal zone, or if the area is not leased, a fishing license is required for harvesting
- Enhancement/sea ranching – hatchery raised migratory fish are released into the ocean and upon their return to freshwater are harvested (Urban 2006).

Shellfish Production

The farming of shellfish is typically done by placing bivalves, such as oysters and clams, in bags, cages or trays set in deepwater, tidelands, bays, or rivers. Mussels are normally grown on ropes hanging off rafts in rivers or bays and on submerged lines anchored to the bottom of the ocean. When the shellfish reach market size, they are harvested and sold to seafood processors, grocery stores, seafood markets, restaurants, or directly to consumers.

Marine shellfish operations are the most common aquaculture facility in Canada. Approximately two-thirds of all shellfish facilities are on the East Coast of Canada and the rest are in BC.

Finfish Production

A variety of techniques and technologies are used to raise finfish:

- Hatcheries – most aquaculture fish begin their lives in a hatchery
- Pond culture –earthen ponds are used to culture freshwater fish, shrimp, and some marine species
- Cage culture – enclosed cages are submerged in aquatic environments
- Recirculating systems – fish, shellfish, and or plant-life are raised in "closed-loop" production systems that continuously filter and recycle water and waste
- Integrated Multi-Trophic Aquaculture – several species are raised together in a way that allows one species' by-products to be recycled as feed for another. Aquaponics is a possible route to IMTA in the freshwater areas of Central Canada

At present, cage culture net-pens are the most common form of large-scale, commercially operating aquaculture systems in Canada. Closed-containment systems remain a niche technology and the research and development of large-scale commercially viable systems are ongoing. There are some commercially operating land-based recirculating systems in Canada that are producing other finfish such as Arctic charr, sablefish and Atlantic halibut. Farming these other species is advantageous because these fish can tolerate higher stocking densities and they command a higher market price.

BC has the majority of marine finfish operations in Canada, primarily salmon aquaculture off the coast in southern and central BC. Ontario and the Prairie Provinces have viable freshwater finfish production.

Table 2: Number of Licensed Aquaculture Facilities Including Active & Inactive Sites (2010/2011)

Province	Marine Finfish	Marine Shellfish	Marine Other	Freshwater Finfish	Total
AB	0	0	0	85	85
BC	127	504	11	89	731
MB	0	0	0	43	43
NB	94	520	12	93	719
NL	78	52	0	2	132
NS	37	246	3	19	305
ON	0	0	0	99	99
PE	4	139	0	0	143
QC	0	41	6	108	155
SK	0	0	0	13	13
YT	0	0	0	14	14
Canada	**340**	**1,502**	**32**	**565**	**2,439**

Source: Aquaculture in Canada 2012: A Report on Aquaculture Sustainability, DFO, at www.dfo-mpo.gc.ca/aquaculture/lib-bib/asri-irda/asri-irda-2012-eng.htm

2.4. Established Species

There are two principal ways in which aquaculture can expand in the future. One is through increased production of already established species (this section) while the other (see next section) is through species diversification.

There are only a handful of established industrial aquaculture sectors in Canada: salmon, trout, oysters, mussels and clams. These species are well known by consumers, and show the greatest promise for expansion through both domestic and export markets.

A brief description of these species is outlined below. A full description is available in the appendix.

In 2013, Canada's aquaculture industry produced $963 million in value and 172,000 tonnes of fish. As already noted, salmon farming is the leader in Canada's aquaculture industry. In 2013, farmed salmon accounted for over 77% of all finfish production. The second most common farmed finfish was trout which accounted for 5% of finfish production.

The total value of shellfish in 2013 was $92.5 million. Mussels are the leading species, accounting for over half of the total value, followed by oysters and clams.

Salmon

Atlantic salmon (*Salmo salar*) is the predominate species farmed in Canada. In BC, two species of Pacific salmon – Chinook (*Oncorhynchus tshawytscha*) and Coho (*Oncorhynchus kisutch*) – are also farmed.

Salmon are farmed in BC, New Brunswick, Newfoundland & Labrador, and Nova Scotia. BC and New Brunswick are the predominant producers of Canadian farmed salmon. Farmed salmon is BC's largest agricultural export product - and the largest crop in the New Brunswick agri-food sector.

Farmed salmon had a farm-gate value of over $634 million in 2013. The farm-gate value represents a product's value once it is sold by the producer. BC was the largest salmon producer with a farm-gate value of $476 million, followed by Newfoundland and Labrador at about $180 million. Farmed salmon is Canada's third-largest seafood export by value, the largest agri-food export from BC, and a significant economic contributor to coastal and rural communities on the east and west coasts.

Rainbow Trout

Rainbow trout are produced in Alberta, BC, Manitoba, New Brunswick, Nova Scotia, Ontario, Quebec, Prince Edward Island, Newfoundland and Labrador, and Saskatchewan.

Trout farming accounted for a farm-gate value of $39.1 million in 2013. Ontario was the largest trout producer with a farm-gate value of $18 million, followed by Quebec at $10.7 million, BC at $5.1 million (mainly steelhead trout), and Nova Scotia at $1.8 million. Most rainbow trout is exported to the United States. In 2014, export value of rainbow trout totalled $4.9 million.

Mussels

Mussels are the most prevalent species of shellfish cultivated in Canada. They represent over half of the total value of shellfish produced in Canada.

In Eastern Canada, the primary mussel species farmed is the Blue mussel (*Mytilus edulis*). In BC, both Blue mussels and Mediterranean mussels (*Mytilus galloprovincialis*) are farmed.

In 2012, the total production value of mussels was $44.5 million. Over half of Canada's mussels are produced in Prince Edward Island. Newfoundland and Labrador was the second largest producer at around 30% of the total value or $13.5 million.

Oysters

In New Brunswick, Prince Edward Island and Nova Scotia, the primary oyster species farmed is the American oyster (*Crassostrea virginica*)– also known as the Atlantic, Malpeque or Eastern oyster. In BC, the primary farmed species is the Pacific oyster (*Crassostrea gigas*).

In 2012, 43% of the volume of Canada's oysters was produced in BC; the remainder was produced in Atlantic Canada, primarily in Prince Edward Island and New Brunswick.

Scallops

In BC, the primary species of scallop farmed is a Japanese/weathervane hybrid scallop (*Patinopecten caurinus x yessoensis*) known as the Pacific or Qualicum scallop. In Eastern Canada, the giant or sea scallop (*Placopecten magellanicus*) and the Northern Bay Scallop (*Argopecten irradians irradians*) are the primary species farmed.

Clams

The Manila clam (*Ruditapes phillippinarum*) is the primary clam species farmed in Canada. Other clam species farmed include: Softshell clams (*Mya arenaria*), hard clams or quahaugs (*Mercenaria mercenaria*), Savory or Varnish clams (*Nuttallia obscurata*) and Geoducks *(Panopea generosa).* BC is Canada's major clam producing province. Softshell clams are farmed in Nova Scotia and Quebec, and quahogs in Nova Scotia.

2.5. New/Alternative Species

The other principal way of increasing aquaculture production is through species diversification. A number of alternate species are being farmed for the first time. This development and commercialization work aims to further diversify production, enhance natural capture fisheries production, and access new market opportunities for the increasing global demand for healthy, high-quality seafoods. While farming methods for relatively new aquaculture species are still being refined and subsequently carry greater investment risks, potentially higher returns on investment are achievable for successful first movers in these farm-raised species.

Listed below are a number of alternative species that are purported to have commercial potential:

Sablefish

Sablefish - also known as Black cod - is a deep-water fish that is quite widely distributed along the continental shelf of the northern Pacific, ranging from California to Alaska and the Bering Sea. Sablefish has been identified as a priority species for US and Canadian Pacific Northwest aquaculture due to: declining commercial and recreational wild sablefish fisheries; high market value; and ability to adapt well to aquaculture rearing environments.

Sablefish are farmed in BC in Jervis Inlet and on the west coast of Vancouver Island in open sea pens.

Arctic Charr

Arctic Charr is produced in Alberta, BC, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Quebec, and Yukon territory.

Freshwater Arctic charr aquaculture is a small but growing industry in Canada. As its name suggests, Arctic charr thrives in cold water and so is suited to aquaculture in Canada's North.

While the farming of Arctic charr is still relatively young in Canada, the industry is diverse. Arctic charr operators produce both eggs and mature fish. Arctic charr eggs are exported to a number of countries eager to develop their own charr industries, while the meat is sold both domestically and abroad.

Atlantic Halibut

There is currently production in Nova Scotia and PEI and there has been significant interest expressed by First Nations and Aboriginal groups in both of those provinces in partnership development opportunities.

Tilapia

Tilapia are produced in Ontario, Alberta and BC**.**

Tilapia is a warm water, freshwater fish farmed in a few locations in Canada. All of the Canadian production is sold live to local markets, where premium prices are obtained for fresh, live fish. Toronto is the single largest market for live tilapia in North America, while burgeoning markets exist in Calgary, Edmonton, and Vancouver.

Sturgeon

White sturgeon is currently farmed in BC, Ontario and New Brunswick. Target Marine Hatcheries, located in Sechelt, BC has been raising white sturgeon since 2000 and in 2012, it is estimated that they produced about 17 tonnes of sturgeon meat and 500kg of sturgeon roe (caviar). A First Nation's community reportedly farms sturgeon in Rainy River, Emo, Ontario. Breviro Caviar operates a captive breeding facility for Acipenser Brevirostrum sturgeon in Pennfield, New Brunswick.

Geoduck

The geoduck fishery has been operating in BC since 1995. The Pacific geoduck (*panopea generosa*) is the largest burrowing clam in the world. The clam is native to the Pacific region including Baja California and the Pacific Northwest from Washington State to British Columbia and SE Alaska. Geoduck is commonly called "giant clam" or "elephant trunk clam" and generally weighs between 0.5 and 1.5 kg although specimens up to 3 kg have been recorded. Harvesters of both wild and cultured geoduck in subtidal areas operate on the ocean floor using a small hydraulic pump attached to a pipe, known as a "stinger", to liquefy the sand around the geoduck. The diver then reaches down and extracts the geoduck by its syphon from the sand mixture.

Sea Urchins

The roe (eggs) of green sea urchins (*Strongylocentrotus droebachiensis*) and red sea urchin (*S. franciscanus*) are an expensive delicacy in Japan, parts of Europe, and increasingly in the Americas. Because the demand for sea urchin roe - called "uni" in sushi bars - has grown dramatically over the past decade, many traditional fisheries have been virtually depleted of sea urchins, including those off the coast of Nova Scotia. The development of sea urchin aquaculture could create a new multi-million dollar industry in Canada – as well as contribute to the rehabilitation of wild sea urchin populations in areas depleted due to overfishing.

American Eels

American Eels (*Anquilla rostrata*) are farmed in land-based systems in Atlantic Canada. Eel is a highly valued food product in Europe and Asia. Production methods are based on capturing wild juveniles and enhancing their growth in tank systems on land.

Marine Plants

In Nova Scotia, Irish moss (*Chondrus crispus*) is farmed in land-based tanks for the edible Asian sea-vegetable market. There are also 2 kelp farms in BC.

Food grade kelps are being co-cultivated in experimental farms for Integrated Multi-Trophic Aquaculture, with the view of enhancing the sustainability of fed aquaculture systems and adding value to the overall process. Kelps can be used in a variety of traditional and novel dishes, and are an excellent source of iodine.

Abalone

The Northern or Pinto abalone (*Haliotis kamtschatkana*) are native to BC's coast. Within BC, there is significant interest in the commercial aquaculture potential of abalone; due to its significance as a traditional food, many BC First Nations have expressed support for the development of a BC abalone aquaculture industry.

Abalone flesh is creamy white, firm in texture, and has a mild flavour. It is considered a gourmet delicacy in Japanese and Chinese cuisine. Since global market demand for abalone exceeds the market supply, abalone is a highly valuable commodity (CAD$30-40/kg).

In BC abalone broodstock must be selected from wild stocks in the region. The Malcolm Island Shellfish Co-op, for example, requires about 100 animals taken from local populations to form the broodstock core of future seed production.

Sea Cucumber

Sea cucumbers (*Parastichopus californianus*) are an Asian delicacy with reported aphrodisiac qualities. Products from sea cucumber include muscle strips (fresh or frozen) and dried skins or sections. The main market for sea cucumber products is China and Japan. Sea cucumbers are co-cultured with fish and shrimp in Asia as a means of recycling nutrients and adding value to the production systems. Interest in developing sea cucumber culture in tandem with fish culture is now being evaluated in Canada as a means of enhancing the overall output of the systems.

Cockles

Cockles (*Clinocardium nuttalli*) - also called basket cockles – are native to BC's coast. Within BC, there is significant interest in the commercial aquaculture potential of cockles. Due to its significance as a traditional food, many BC First Nations have expressed support for the development of a BC cockle aquaculture industry.

Since the hardiness of cockles allows them to withstand severe winter conditions, they represent the best opportunity for intertidal bivalve culture on BC's north coast.

Spotted & Atlantic Wolffish

Due to its ability to thrive in cold marine waters, spotted and Atlantic wolffish are possible candidate species for cold water aquaculture in the North Atlantic. Wolffish also display remarkable attributes for domestication (tolerance to density, salinity, water quality changes, egg and larval size, no live prey requirements, and farming-friendly behavior) and market potential (excellent flesh and taste characteristics, niche market, price). Research efforts in Canada have been aimed at developing domestic wolffish broodstocks and improving the survival of young wolffish.

Spotted and Atlantic wolffish are listed as "threatened" in nature due to overharvesting, and no commercial harvesting is permitted. The development of farming methods for wolffish will aid conservation efforts of wild wolffish by providing much needed insight into biological factors affecting natural populations. Farmed juvenile wolfish may also play an important role in wild wolffish enhancement efforts.

2.6. Overview of Aquaculture Production Costs by Farm Model

This section reviews four types of fish farms: net pen, recirculating aquaculture systems (RAS), freshwater tank and pond/dugout.

Net pen and recirculating aquaculture systems

Net pen and recirculating aquaculture systems (RAS) were recently examined in a report prepared by Fisheries and Oceans Canada (DFO 2010). It found that capital expenses for constructing a net pen system were $5.0 million compared to $22.6 million for RAS (the analysis also found a significant advantage for net pens in terms of pre-tax income). Although RAS production showed efficiencies in biological feed conversion ratio, temperature stability, and improved environmental control, due to much higher capital and energy costs, as well as major labour requirements, the financial viability of RAS has yet to be proven. A number of pilot projects across North America have failed in recent years.

The report noted that if wider uptake within the sector is achieved, capital and operating costs may go down. If closed-containment technologies achieve a critical mass of production, operators could benefit from economies of scale in the acquisition of capital items, and their increasing expertise could help reduce operating costs. The analysis showed that RAS technology could be marginally viable from a financial perspective, but that it presents a higher level of risk compared to net-pen systems.

Marine Harvest Canada has also reported on ten years experience growing market-sized Atlantic salmon (>5kg) in tanks on land. With advancement of RAS technology over the past 26 years, MHC now relies on RAS for the majority of their smolt production (up to 800 MT / year).

MHC reports that based on their experience with both open-pen and land-based systems, a 1,000 tonne land based system requires a capital investment cost of $20,000,000 and consumes about 1,000,000 litres of freshwater daily. A 3,000 tonne typical sea cage site can be built for approximately $5,000,000. It requires little space (it is three dimensional), no freshwater, and runs almost entirely on natural tidal power.

Overall, MHC's experience indicates that full grow-out using land-based systems is not workable, due to costs, environmental footprint, and animal welfare concerns. If excellent and ample well water source that required little addition of dry buffers is available, along with cheap electricity, and ability to manage grow-out of fish at densities of 90kg/m3 (six times greater than densities at sea), a land-based system could produce a 5.5 kg salmon for about the same operating cost as in open-pen systems at sea. The catch is capital cost, space, and ground water consumption.

In a collaboration between the 'Namgis First Nation and the SOS Marine Conservation Foundation, a pilot-scale land-based RAS on the Cheslakees Indian Reserve, 5 km south of Port

McNeill on Vancouver Island is currently operating at an annual production capacity of 260 tonnes to 500 tonnes. The project has received funding from SDTC, Tides Canada and the Coast Sustainability Trust to assist with the initial $6 to $7 million in capital costs associated with the project. As of April 2014, Kuterra Atlantic salmon raised by the 'Namgis First Nation are being marketed in Safeway stores in B.C. and Alberta. It is still unknown whether full commercial-scale operations will be developed.

Freshwater Tank Systems

Other studies indicate that an investment of about $1 million is required to launch the 130-tonne per year freshwater tank system -- $700,000 for capital equipment (i.e. tanks, water filtration equipment, pumps, fish culture equipment, etc.) plus $250,000 for working capital (i.e. feed, fingerling purchases and other operating expenses). In addition to these costs, access to existing infrastructure would be required, including an agricultural building of suitable size with an adequate power supply (hog or cattle barn), an existing water supply (well), manure storage facilities, etc. The latter are considered to be sunk costs contributed to the operation.

Alberta Agriculture, Food and Rural Development prepared a budget model to illustrate the capital investment required, estimated operating costs and returns for an intensive rainbow trout fingerling enterprise designed to achieve target revenues of $100,000 per year from fingerling sales. The model indicates capital costs of about $345,000 for a 20 acre site, with a 30' x 260' pole shed housing thirty 12' diameter rearing tanks. Annual operating expenses were expected to be $95,000 with a gross operating profit of about $15,000.

Table 3: Comparison of Different Aquaculture Systems

Type	Approximate Capital Expenses	Production Costs	Advantages	Disadvantages
Net Pen System	$5 million (1,000 tonne system)	Low	Relatively economical, low freshwater use.	Complex regulatory situation particularly for development in public waters.
Recirculating Aquaculture System	$22 million (1,000 tonne system)	High	Denser stocking than open nets, better climate and water control. Good for fingerlings or smolts.	High capital cost, high water use, and animal welfare concerns Uneconomical for grow-out operations Also requires a large amount of expertise
Freshwater Tank System	$350,000 - $1 million (130 tonne system)	Medium	Can be adapted to use existing farm buildings. Profitable on a relatively small scale.	Relatively narrow profit margins at this scale

Type	Approximate Capital Expenses	Production Costs	Advantages	Disadvantages
Pond or Dugout System	Low, uses natural dugouts and ponds	Low, uses isolated and naturally occurring fresh water ponds and natural food sources	Low cost. Lower required expertise	Small scale. More suited for personal use or as part of larger tourism operation such as camp grounds or small fee-for-fishing operators.

3. Regulatory and Policy Context by Jurisdiction

3.1. Federal

Aquaculture activities in Canada are managed and regulated as a shared responsibility between the provinces and the federal government. The Department of Fisheries and Oceans (DFO) defines its roles in the industry as:

- establishing laws and regulations in our own areas of responsibility, as well as providing national guidance and advice to others;
- investing in science and research; and
- supporting industry innovation and development.

Most provinces develop their own regulations and management practices for aquaculture, but in 2010 DFO took over primary responsibility for the management and regulation of aquaculture in BC.

The *Fisheries Act*[3] is the primary legislation at the federal level for aquaculture. Nationally, DFO's specific regulatory roles for the industry are to issue "introduction and transfer" permits and manage the Canadian Shellfish Sanitation Program (CSSP).

Under authority of the *Fisheries Act*, DFO has created regional fisheries regulations, including:

- The Pacific Aquaculture Regulations[4];
- Atlantic Fishery Regulations;
- Newfoundland and Labrador Fishery Regulations;
- Ontario Fishery Regulations;
- Quebec Fishery Regulations;
- Saskatchewan Fishery Regulations;
- Yukon Fishery Regulations;
- Northwest Territories Fishery Regulations and
- Alberta Fishery Regulations.

[3] http://laws-lois.justice.gc.ca/eng/acts/F-14/

[4] Links to all regulations made under the *Fisheries Act* may be found at http://www.dfo-mpo.gc.ca/acts-loi-eng.htm.

These regulations are primarily concerned with protecting wild species at risk by regulating licences and bycatch (species caught unintentionally), and specifying rules on harvesting. Nonetheless, some of these regulations affect aquaculture operations. For example, the *Atlantic Fisheries Regulations* set out a minimum length/size for the possession of shellfish, but aquaculture producers must seed their stock with smaller sizes than allowed by these regulations.

A number of other federal regulations and acts affect aquaculture producers in Canada. The main policy goals of these acts and associated regulations are to reduce the environmental impact of aquaculture, manage Canada's waterway access, and protect human health. Examples follow.

The *Canadian Environmental Assessments Act* [5], for instance, could require an environmental assessment for new aquaculture operations that may have a high environmental impact. The Government of Canada may use the *Species at Risk Act* and associated regulations to disallow aquaculture operations to prevent the permanent loss of wildlife. The *Oceans Act*, *Canadian Environmental Protection Act*, and the *Coastal Fisheries Protection Act* may also apply to some aquaculture producers in certain cases.

Under the *Fish Inspections Act of Canada*, the Government of Canada regulates several aspects of fish inspections, imports, and exports that may affect aquaculture producers. The *Fish Inspection Act* gives the authority to the Governor in Council to regulate many aspects of the sale fish products, including:

- licencing and registration for people who inspect, import, and export fish;
- quality and packaging standards for fish; and,
- establishing inspection seizure, and detention of fish and containers.

3.2. British Columbia

In December 2010, the federal government assumed regulation of the finfish and shellfish aquaculture industries in BC. Fisheries and Oceans Canada (DFO) is now responsible for most aspects of the aquaculture industry in BC, including licensing sites, production volumes, species to be produced, fish health, sea lice levels, fish containment and waste control.

The province continues to: issue tenures where operations take place in (marine or freshwater); license marine plant cultivation; and manage business aspects of aquaculture such as work place health and safety within the province.

The BC Aquaculture Regulatory Program (BCARP) is a program within DFO that manages, administers and regulates aquaculture in BC, including finfish, shellfish and freshwater/land-based operations.

[5] Links to various Acts and statutes regarding aquaculture in other federal departments are posted on the DFO website: http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/regs-eng.htm#tab2

Implemented under the *Pacific Aquaculture Regulations*, conditions of licence and the *Fisheries Act*, BCARP is designed to ensure that aquaculture in BC is sustainable, and that it is conducted in a manner that minimizes the risks to wild fish stocks.

The program includes an enforcement component, as well as ongoing public reporting of relevant data and information on the environmental performance of the industry.

Under BCARP, DFO:

- Issues licences for marine and freshwater aquaculture, including hatcheries
- Assesses modifications to existing aquaculture sites
- Establishes conditions of licence to conserve and protect fish and fish habitat
- Enforces new aquaculture regulations
- Conducts aquaculture research programs
- Reports publicly on environmental and regulatory performance of industry.

The Province of BC:

- Issues tenures for marine or freshwater environment
- Regulates business aspects of aquaculture (e.g., workplace health and safety)
- Reports on seafood exports.

3.3. Alberta

The Fisheries (Alberta) Act[6] is used to regulate the aquaculture industry. The Alberta government states that these regulations are designed to "protect native species of fish, provincial fish hatcheries and public water bodies" (Alberta Agriculture and Rural Development). The *Fisheries Act* requires that all aquaculture producers (referred to as cultured fish producers in the *Act*) must obtain a licence to harvest, sell, transport, or purchase live fish as required in the Federal regulations. The Act also gives the minister power to regulate inspections, enforcement, record keeping, and fish health.

Licences are available for both recreation and commercial aquaculture. According to the Alberta government, some aquaculture producers will need to obtain a licence to use and divert water under the Water Act.

Sections 27 to 39 within *the Fisheries (Alberta) Regulations* define the rules for aquaculture producers with respect to licencing rules and procedures, what waters are prohibited, and what fish types are prohibited. Section 40 requires that aquaculture producers immediately notify the director of fisheries management in the Alberta government in case of a diseased or escaped fish.

Alberta currently does not issue licences for ponds located on public land.

[6] The Act and associated regulations can be found here: http://web2.gov.mb.ca/laws/statutes/ccsm/f090e.php

3.4. Saskatchewan

In Saskatchewan, the provincial government regulates aquaculture under Part VIII of Saskatchewan's *Fisheries Regulations*[7] made under the *Fisheries Act (Saskatchewan)*[8]. The *Fisheries Regulations* state that every aquaculture producer requires a licence, renewed annually. The sale, transport, release into the wild and possession of aquaculture fish all require a licence in Saskatchewan. Saskatchewan has a private licence for fish grown for personal use, and a commercial licence for fish that will be commercially sold.

Regulations made under the *Fisheries Regulations* require all incidences of diseased fish or fish accidentally released into Saskatchewan waters to be reported to the Minister. The *Fisheries Act* also covers actions the minister can take under these scenarios.

Aquaculture producers will often also need to comply with the Provincial Lands Act that defines the rules and regulations for the management and transfer of crown lands. In certain instances a number of environmental regulations may apply to aquaculture operations as well, including:

- Water Appeal Board Act[9]
- Wildlife Act
- Wildlife Habitat Protection Act, and
- Environmental Management and Protection Act.

3.5. Manitoba

In Manitoba, the main regulations with respect to aquaculture are found in *the Fishing Licencing Regulations* made under *The Fisheries Act*. The sale, transportation, stocking, and harvesting of fish requires a licence issued by the Manitoba government. The licence is valid for one year.

For cage farming, aquaculture producers in Manitoba require a permit to use crown lands granted under *The Crown Lands Act* and regulations. The use of lakes bordered by crown lands is considered only on a case-by-case basis. Aquaculture operations also require a special Manitoba Conservation Work Permit to perform any activity on Crown Land.

In addition to these requirements, an aquaculture operator in Manitoba is also required to have a Manitoba Water Stewardship Rights Licence and an Environmental Licence (Manitoba Water Stewardship Fisheries Branch, 2004).

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[7] http://www.publications.gov.sk.ca/details.cfm?p=1116
[8] http://www.publications.gov.sk.ca/details.cfm?p=523
[9] Printable versions of other Acts which may impact aquaculture producers can be found on the Government of Saskatchewan Queen's Printer website: http://www.publications.gov.sk.ca/department.cfm?d=1

3.6. Ontario

Legislation: Ontario's *Fish and Wildlife Conservation Act, 1997*[10] establishes the management framework for wildlife and fisheries. The Act defines aquaculture as "the breeding or husbandry of fish"; therefore, excluding plant farming. It defines fish according to the definition in the federal *Fisheries Act.*

A licence is required for aquaculture, and only species that are prescribed by regulation may be cultured. The Act prohibits escapes and requires that escapes be reported, and also permits the killing of wildlife that may damage personal property. A land use permit under the *Public Lands Act* may be required for activities carried out on public lands and on shore lands. The Minister may sell, lease or grant a licence of occupation for Crown land.

Approval under the *Lakes and Rivers Improvement Act*[11], the legislative instrument to manage, protect and preserve Ontario lake and river waters, may be required to construct aquaculture facilities in or near water. The *Environmental Protection Act*, *Environmental Assessment Act*, *Ontario Water Resources Act*, *Pesticides Act*,; and *Beds of Navigable Waters Act*[12], are also applicable to aquaculture in Ontario.

Regulations: Ontario issues aquaculture licences for those species listed in Schedule B of the *Fishing Licence Regulations* for a five year term. Fish stocking licences are valid for a three-year term. The Minister may authorize the collection of fish from Ontario waters for aquaculture purposes. Escaped fish is one of the priorities of the regulation, which stipulates the prevention, reporting and in some cases recapture of escaped fish. The regulations also set out water quality and disease reporting requirements.

Also, the *Ontario Fishery Regulations*, under the federal *Fisheries Act*, explicitly applies to aquaculture operations within the province. The regulations confer administrative authority to the provincial Minister for licencing and placing conditions on licences that are not inconsistent with the regulations (section 4(1)). The regulations also regulate matters such as live invasive fish.

3.7. New Brunswick

The New Brunswick Department of Agriculture and Aquaculture (NBDAA) is responsible for the leasing, licensing and fish health issues associated with aquaculture produce, i.e. aquatic plants and animals raised by aquaculture. The *Fish and Wildlife Act* (NB) and Regulations provide the legal framework for the development of aquaculture in New Brunswick.

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[10] https://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_97f41_e.htm
[11] http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_960454_e.htm
[12] Printable versions of various Ontario laws and regulations can be found at http://www.e-laws.gov.on.ca/navigation?file=home

The major areas being regulated are leasing, licensing and fish health. The review and approval of marine aquaculture sites is controlled through the NBDAA. The lease designates a parcel of submerged Crown land which can be used for aquaculture purposes. The license outlines the species to be cultured and any terms and conditions under which the license holder must operate.

Under the *Act*, the Minister has the ability to direct depopulations, designate fallow periods, and decide when restocking can occur in the control and management of fish health.

Fish health monitoring and surveillance are critical to ensuring healthy stocks within the aquaculture industry. Proper testing must be completed prior to movement of stocks. All structures must remain on the site to ensure that the structures do not impose hazards to navigation or cause debris problems on the water or adjoining land.

The *Clean Environment Act*'s Water Quality Regulation specifies that no person shall, without an approval, cause or permit a source to emit, discharge, deposit, leave or throw any contaminant into or upon the environment in any location such that it may, directly or indirectly, cause water pollution to any waters of the Province.

A Certificate of Approval sets out conditions with which the aquaculture site must comply including an environmental monitoring program for the protection of the benthic environment against organic loading, record keeping and reporting requirements, waste management, noise control and chemical storage and handling.

3.8. Nova Scotia

In Nova Scotia the provincial Minister of Fisheries and Aquaculture has the primary regulatory authority to manage aquaculture in the province. The authority is provided through the Fisheries and Coastal Resources Act. Although the federal government is actively involved in aquaculture development in Nova Scotia through a series of agreements and protocols the provincial regulatory role is comprehensive.

The Fisheries and Coastal Resources Act (FCRA) was passed in 1996 in an effort to consolidate and revise the law respecting the fishery and to promote and implement programs that will sustain and improve the fishery, including aquaculture. Under the FCRA the Minister of Fisheries and Aquaculture is responsible for aquaculture projects and the general supervision and management of the Fisheries and Coastal Resources Act. The Minister of Fisheries and Aquaculture is the primary regulator and the key promoter of the aquaculture industry in the province.

Section 44 of the FCRA prohibits operation of an aquaculture site without a license. If the site is on Crown land, an aquaculture lease is also required. The decision to issue or reject an aquaculture license or lease in Nova Scotia is with the Minister of Fisheries and Aquaculture. The Minister has broad discretion to reject an application or to issue a license or lease, with or

without conditions. Section 52 of the FCRA requires an aquaculture lease to be subject to specific conditions.

An application for an aquaculture license must include the information required by the Minister. Currently the Minister requires a completed application form, a development plan and environmental baseline/background information. Baseline information includes an underwater video, current meter analysis and sediment analysis. After an application for a license has been made, provincial staff will review the application; conduct a technical review and a network review. The technical review, done by the Nova Scotia Department of Fisheries and Aquaculture, looks at the technical, biological, environmental and financial feasibility of the project. Several provincial and federal departments concurrently perform the network review. The Minister makes the decision to approve or reject the application. Should the application receive approval, the Minister may impose certain conditions of license. Inland applications that have 25 000 m3 holding capacity or greater require an approval under the Environment Act. Any watercourse alteration, including removal of material, diversion or installation of equipment requires an approval under the Environment Act.

3.9. Prince Edward Island

The Province of Prince Edwards Island does not have a provincially based regulatory framework for aquaculture. Shellfish is the dominant industry on PEI; there are only five finfish operations and all are land based. Since the first agreement in 1928, jurisdiction over aquaculture leasing on PEI sits with the federal Minister of Fisheries and Oceans. Aquaculture is managed by the PEI Aquaculture Division of Fisheries & Oceans Canada and conducted in accordance with the PEI Aquaculture Leasing Policy. The Policy states that Fisheries and Oceans Canada, Province of Prince Edward Island and the industry are committed to the development of the Prince Edward Island aquaculture industry, and consider it a priority for economic and sustainable development. The Policy further emphasizes coexistence with other stakeholders and development that is consistent with public health and safety, marine navigation and the environment.

All applications for an aquaculture lease on Prince Edward Island must be submitted to the PEI Aquaculture Division of DFO. Applications must include the form (including name, location of site, site dimensions); a digital map from the PEI Aquaculture Division showing location of site; and a site development plan showing the proposed site and utilization at full production.

Applications for aquaculture leases that pass the initial screening process move to the site evaluation process by the PEI Aquaculture Division. The requested lease site will be located and data collected on characteristics and activities in the area. Site evaluation criteria to be used in the process are outlined in Appendix 6 of the Aquaculture Leasing Policy. Appendix 4 of the Policy includes an Adaptive Management framework intended to establish a framework by which to enhance ecosystem integrity and promote sustainable shellfish aquaculture. The framework includes identifying monitoring and research needs, reviewing monitoring and

research activities and recommending direction and implementation of required environmental management actions. The Adaptive Management Committee is mandated to meet a minimum of twice each year.

Lease operations on PEI go through a series of phases. The first five years of the lease is the developmental phase during which the potential aquaculturalist will assess the biological and environmental aspects for a proposed site prior to entering full-scale commercial operations. It also allows the PEI Aquaculture Division time to assess the performance of the lessee.

If the aquaculturalist is successful in developing the site in accordance with the site development plan and meets the obligations as outlined in the lease contract, the lease will be considered to be in the commercial phase.

The Environmental Protection Act provides the legislative basis for the protection and management of the environment on PEI. The Act prohibits the discharge of a contaminant into the environment without written permission and therefore has application to certain aquaculture activities. Section 9 of the provincial Environmental Protection Act requires the filing of a written proposal for all 'undertakings' and approval by the Minister of Environment prior to commencement. Aquaculture operations are included on the list of 'common undertakings'. Public consultation is required by the PEI Environmental Impact Assessment (EIA) Guidelines (2010). The federal government does not conduct EIA on these sites before issuing a lease. The EIA requirements apply to inland sites only. On PEI all finfish sites are inland. All shellfish sites are marine-based, regulated by the federal Minister of Fisheries and not subject to provincial EIA

3.10. Newfoundland

Newfoundland and Labrador's aquaculture activities are primarily governed by the Newfoundland Department of Fisheries and Aquaculture, under the *Aquaculture Act* (1990) and Regulations (consolidated in 2005). All aquaculture-related licensing is performed under the *Act* and its regulations. Additionally, aquaculture activities may be subject to other Newfoundland fishing legislation including the *Fisheries Act* (Schedule C of the Executive Council); the *Fish Inspection Act and Regulations* (Fish Inspection Administrative Regulations, In-Province Retail Fish Establishment Regulations, Fish Inspection Operations Regulations, and Fish Inspection Ticket Offences Regulations); the *Fishing Industry Collective Bargaining Act*; the *Fish Processing Licensing Board Act*; and the *Professional Fish Harvesters Act*.

New aquaculture operations must submit an application for a license to the Department of Fisheries and Aquaculture. Applicants are obligated to: demonstrate expertise and/or training in technical and management skills; obtain two sets of 1:50,000 National Topographical maps indicating the size and layout of their operations; identify the species and strain to be harvested; submit an acceptable business plan; submit specific site information; disclose environmental

concerns; submit Crown lands application(s) for land leasing; assess the site for water quality; and submit a Production and Harvesting Plan for 5 years.

3.11. Yukon

In 1989, the federal government transferred the power to regulate fisheries to the Yukon. Fisheries management in general involves many groups including:

- management boards
- resource councils
- First Nation governments
- federal agencies
- stakeholder groups
- and the public (Environment Yukon , 2010).

In 1991, the federal government and the Yukon territorial government signed a memorandum of understanding on Aquaculture and Development that made the Yukon government the main regulator and administrator the industry.

As per the federal *Fisheries Act*, the Yukon government licences individuals to stock small pothole lakes where the farmed fish do not come into contact with native game fish. The Yukon Environment department works closely with the Yukon Fish and Game Association to manage fish stocking of pothole lakes.

Licence requirements, catch limits, and possession limits for stocked fish from pothole lakes are set in the federal *Yukon Territory Fisheries Regulations*[13].

3.12. Northwest Territories and Nunavut

Currently, there are no commercial aquaculture producers in the Northwest Territories or Nunavut and no regulations apply to the industry. The fisheries industry in both territories is regulated under the federal *Fisheries Act*.

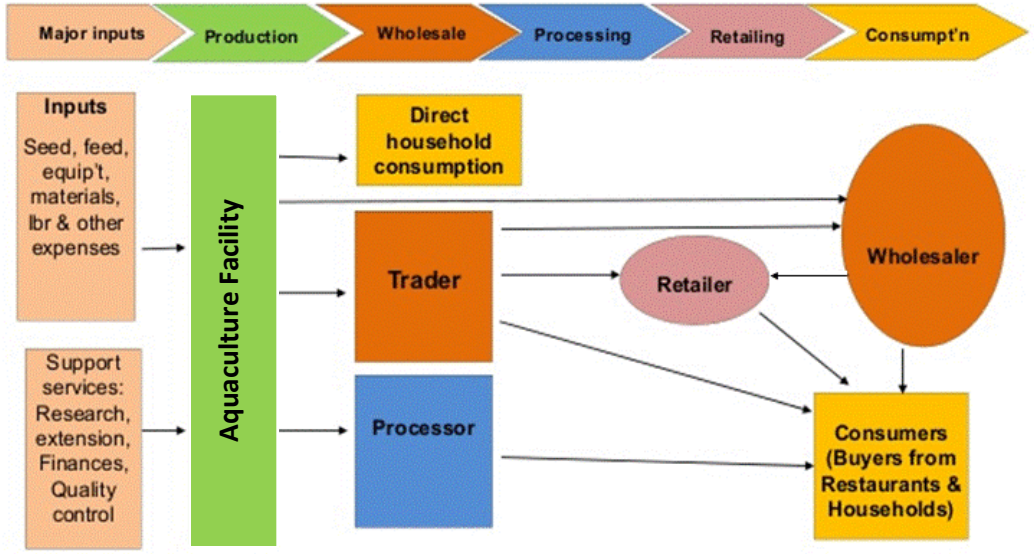
The federal *Northwest Territories Fishery Regulations*[14] do not mention aquaculture or fish farming, although they do define rules for who, when, where and how commercial fishing take place. Generally, the regulations require anglers between the ages of 16 and 65 to obtain a sport fishing licence.

[13] http://laws-lois.justice.gc.ca/eng/regulations/C.R.C., c. 854/
[14] http://laws.justice.gc.ca/eng/regulations/C.R.C., c. 847/

4. Estimating Economic Opportunities

4.1. The Aquaculture Value Chain

Figure 3: Generic Value Chain for Aquaculture



Aquaculture supports jobs throughout the seafood supply chain. Aquaculture jobs tend to be year-round, living-wage jobs centered in coastal, rural communities. Primary aquaculture operations support working waterfronts and the same infrastructure and skills as does capture fisheries such as docks, boat yards, and processing plants.

The economic impact of the industry extends well beyond benefits to aquaculture companies. "Upstream" industries that support aquaculture production include agriculture, hatcheries, feed manufacturers, equipment manufacturers, and veterinary services. "Downstream" industries supplied by aquaculture include processors, wholesalers, retailers, transportation, and food services.

A wide range of speciality companies has emerged to fulfil the supplies and services needs of the sector, some of which are identified in the lists below. Moreover, for every person employed in the production of fish and shellfish, approximately one additional person is employed in the related supplies and services sector.

Table 4: Upstream and Downstream Supplies and Services to Aquaculture

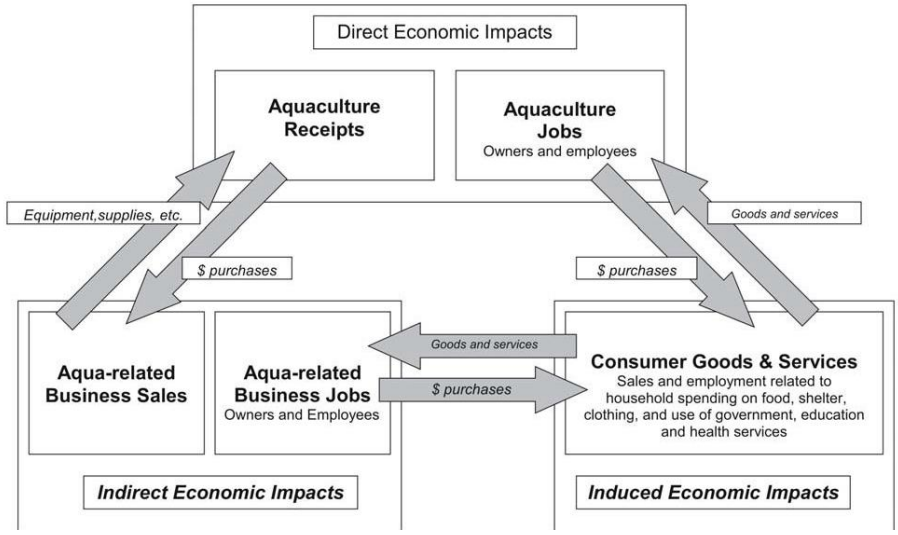
▪ Trays/Lanterns/Flupsys	▪ Management Consulting
▪ Cage Systems/Fittings/Moorings	▪ Environmental Monitoring
▪ Nets/Netting/Rope	▪ SCUBA Diving
▪ Aeration/Oxygenation Equipment	▪ Design and Construction
▪ Alarms/Monitoring Equipment	▪ Equipment Repair
▪ Veterinary Supplies/Vaccines	▪ Fish Health

▪ Software Systems	▪ Insurance
▪ Feeds and Feeding Equipment	▪ Laboratory Services
▪ Filtration Systems	▪ Research and Development
▪ Grading/Counting Equipment	▪ Product Development
▪ Hatchery Equipment	▪ Genetics
▪ Fish Processing Equipment	▪ Training and Skills Development
▪ Packaging Equipment	▪ Transportation

4.2. Direct, Indirect and Induced Impacts across the Value-Chain

Following previous DFO socioeconomic impact studies of the aquaculture industry by Gardner Pinfold (Gardner Pinfold, 2013), we have used an input-output model based on Statistics Canada modeling to capture the impact on provincial economies and national economy across a variety of benchmarks, including output, GDP, employment, and labour income. Input-output models capture three different sets of economic benefits: direct effects, indirect effects, and induced effects.

Figure 4: Economic Impacts Across the Value Chain



In Figure 4, above, the **Direct Economic Impact** refers to farm gate receipts and employment associated with on-farm activities i.e. fish production (see the Direct Gross Output in Table 5. Also this contributes to the Total Gross Output, also Table 5).

The **Indirect Economic Impact** refers to the sales and employment associated with the re-spending of the farm gate receipts on goods and services provided by aquaculture-related businesses. An aqua-related business is defined as a business that either sells products/services to aquaculture operators or buys products/services from aquaculture operators. Aqua-related businesses include companies that provide feed supplies, seed, smolt, fingerlings, nets/pens/cages/tanks, floatation systems and buildings, engines and mechanical supplies and

services, refrigeration and cooling, processing and packaging, electrical/plumbing products and services, construction services, safety devices, fuel, transportation services, insurance/finance/ accounting services, legal services, consulting and research services, etc. (this contributes to the Total Gross Output – see Table 5).

Finally, the jobholders in both the farms and the aqua-related businesses contribute to an **Induced Economic Impact** through the spending of their wages on personal / consumer items including housing, clothing, food, and transportation. This is especially important in rural Canada where it has contributed to the revitalization of many coastal communities which depend on the wealth generated from year-round, well-paying jobs and by providing the critical economic activity necessary to stimulate infrastructure development and growth in secondary and tertiary businesses.[15] They also support jobs in an array of government service sectors including health and education (this contributes to the Total Gross Output – see Table 5).

Table 5 below shows the total socio-economic impacts of aquaculture in Canada in 2010.

Table 5: Summary of the Socio-economic Impact of Aquaculture in Canada, 2010

Provinces	Direct Gross Output ($ millions)	Total Gross Output ($ millions)	GDP ($ millions)	Employment	Labour Income ($ 000s)
Newfoundland and Labrador	84,223	220,799	91,930	997	46,268
Prince Edward Island	57,846	99,657	65,917	978	38,720
Nova Scotia	45,740	136,858	51,511	712	29,045
New Brunswick	164,738	463,722	122,633	2,200	91,382
Quebec	14,000	180,600	75,007	909	42,379
Ontario	19,400	252,782	118,679	1,296	70,949
Other Provinces	10,000*	189,461	86,286	650	37,863
British Columbia	593,910	1,204,082	452,047	5,328	261,306
Total	979,857	2,747,961	1,064,010	13,070	617,912

* This figure has been added to this table. It was estimated by the authors from other available data sources.
Source: Gardner Pinfold. Socio-economic Impact of Aquaculture - 2010. October 2012 for DFO. Total Gross Output is the sum of direct + indirect + induced output.

4.3. Potential Growth in Aquaculture over the Next 5- and 10-Year Periods

The initial step in estimating the economic benefits and opportunities of aquaculture is to identify the potential growth in farm gate value of production in each area. Many factors can determine the level of potential revenues and production in each area. For example, local water sources must have the right size and environmental conditions so that aquaculture facilities may sustainably produce fish without harming the local community. Similarly, environmental factors such as water temperature and salinity affect which species of fish or shellfish can be grown in a

[15] Aboriginal Aquaculture Association. Socio-Economic Impact of Finfish Aquaculture in BC Aboriginal Communties.

specific water source. In addition, the national industry association, the Canadian Aquaculture Industry Alliance (CAIA), has identified significant impediments to growth that result from legislative, regulatory, policy and program issues at the federal and provincial/territorial levels of government.

On the socioeconomic side, there are two important factors. First, the availability of labour and local expertise in aquaculture affects the potential economic opportunities, at least in the early development phases. Second, since much of Canada's aquaculture production is sold internationally, access to U.S. and other international markets is very important, and must be fostered.

Macro-estimates of potential farm gate value of fish and shellfish that are laid out below have been developed for this report from estimates of growth that are derived from the literature and from CAIA. In general, growth in the industry is expected to result from:

- Productivity improvements – for existing finfish species through better access to novel/ functional feeds, access to fish health products (drugs, pest control) that are available to our main competitors, and improved access to new species and broodstock for both finfish and shellfish
- Amendments/expansion of existing sites for both shellfish and finfish through reduced regulatory barriers/red tape that currently exist, and timely approval of amendment applications
- Applications for new sites for existing and new species for both shellfish and finfish through reduced regulatory barriers/red tape that currently exist, and timely approval of new site applications.

Within 5 years: Modest growth of 3-5% per year, for a total growth over the 5 year period of 20-25%. It is estimated that growth will be at the higher end (5%) for BC marine finfish as new site applications and amendments are approved post-Cohen. Five percent growth is also estimated for finfish in Atlantic Canada. Growth for marine shellfish is estimated to be as much as 15% for oysters in NB, 10% for mussels in NL. In other provinces, growth is estimated to be at 3%. Similar levels of growth are also assumed for freshwater finfish in Alberta, Saskatchewan, Manitoba, Ontario and the North.

Within 10 years: Assuming predicted growth over the next 5 years is achieved, additional investment can take place to address capacity constraints to further growth – such as the need for additional hatchery and processing facilities – and other productivity improvement constraints are also addressed. If this is achieved, it is anticipated that growth rates of 7-10% per year could result, with total growth by the end of 10 years of 90 – 115%.

Tables 6 and 7 present the potential growth in production (direct output) and other socio-economic benefits (GDP, employment and labour income) under the 5 and 10-year growth scenarios outlined above, by province/region.

Table 6: Illustration of the Potential Socio-economic Benefits After 5 years (000s of $2010)

Provinces	Direct Output	Total Output	GDP	Employment (#)	Labour Income
British Columbia	$892,000	$2,014,000	$756,000	9,541	$437,000
Prairies	$10,000	$181,000	$83,000	616	$36,000
Ontario	$18,000	$260,000	$122,000	1,336	$73,000
Quebec	$9,000	$173,000	$72,000	893	$41,000
New Brunswick	$157,000	$443,000	$117,000	2,386	$87,000
Nova Scotia	$63,000	$209,000	$79,000	1,087	$44,000
Prince Edward Island	$47,000	$156,000	$103,000	1,872	$61,000
Newfoundland and Labrador	$237,000	$622,000	$259,000	3,089	$130,000
North (Yukon, NWT, and Nunavut)	$600	$1,100	$5,000	38	$2,200

Source: Authors' calculations

Table 7: Illustration of the Potential Socio-economic Benefits After 10 years (000s of $2010)

Provinces	Direct Output	Total Output	GDP	Employment (#)	Labour Income
British Columbia	$1,433,000	$3,233,000	$1,213,000	15,316	$701,000
Prairies	$13,000	$255,000	$116,000	864	$51,000
Ontario	$25,000	$365,000	$171,000	1,874	$102,000
Quebec	$13,000	$243,000	$101,000	1,253	$57,000
New Brunswick	$253,000	$712,000	$188,000	3,834	$140,000
Nova Scotia	$99,000	$331,000	$125,000	1,723	$70,000
Prince Edward Island	$68,000	$223,000	$147,000	2,664	$86,000
Newfoundland and Labrador	$379,000	$993,000	$413,000	4,929	$208,000
North (Yukon, NWT, and Nunavut)	$800	$15,400	$7,000	64	$3,100

Source: Authors' calculations

Section 5 provides a discussion of the potential economic impacts by region.

5. Potential Economic Opportunities for Aquaculture by Region

5.1. Opportunities in BC

In 2013, BC's aquaculture industry employed close to 6,000 people, which resulted in $274 million in wages for British Columbians. About 730 aquaculture operations in BC produce salmon, other finfish and shellfish year-round, with a total harvested value of over $500 million in 2013.

The aquaculture industry in BC represents more than half the total aquaculture production in Canada. Salmon farming is the province's largest agricultural export and the weight and value of the harvest is greater than the wild salmon fishery harvest.

- Marine finfish (almost exclusively Atlantic salmon) – 127 sites primarily in the Campbell River, Port Hardy and Tofino areas.
- Shellfish (e.g., clams, oysters, mussels, scallops and geoducks) – approximately 500 sites
- Freshwater finfish (pond culture of rainbow trout; private hatcheries for sturgeon, coho salmon, and sockeye salmon) – approximately 90 sites
- Enhancement facilities where Pacific salmon are raised and released to rebuild wild fish stocks and provide fishing opportunities

The value of the aquaculture harvest in BC in 2013 was:

- Finfish, $486 million
- Shellfish, $22 million.

Issues and Barriers to Economic Development

DFO is responsible for aquaculture in BC. Some of the issues that the industry believes need to be addressed by the department include:

- Improved access to seed and broodstock – particularly for shellfish, where ocean acidification has led to significant loss of stock (oysters)
- Improved access to novel feeds and fish health products – regulatory costs and delays are hindering access to novel feeds and the most up to date fish health products, particularly with regard to managing sea lice
- Burdensome Conditions of Licence
- No freshwater policy for freshwater aquaculture
- Regulatory frameworks not in place for new sea cucumber farms
- Restrictive/uncompetitive approach to managing the geoduck fishery which creates a significant barrier to entry for potential farmed geoduck operations
- Lack of regulatory framework for sea cucumber aquaculture
- Access to the necessary capital to develop aquaculture businesses
- Restrictive regulatory conditions under the Canadian Shellfish Sanitation Program.

Through the combined efforts of the industry and DFO, some of the previous barriers including the need for multi-year aquaculture licenses and implementation of a site application and amendment service standard, are currently being resolved.

Potential Growth

There is potential for significant expansion in salmon production in BC. There is also potential for expansion of sablefish, geoduck and other shellfish.

Table 8: Potential Growth in BC (000s of $2010)

	Increase in Revenue (Direct output)	Increase in Economic Activity (Total Gross Output)	Increase in # of Jobs	Increase in Labour Income
5 years	$235,500	$721,100	3,451	$156,000
10 years	$618,700	$1,892,000	8,961	$410,000

Source: Authors' calculations

5.2. Opportunities in the Prairie Provinces

Alberta

The following fish are being farmed in Alberta: rainbow trout, brook trout, brown trout, tilapia, Arctic charr, triploid grass carp, American eel, Atlantic salmon, chinook salmon, coho salmon, sockeye/kokanee salmon, and freshwater prawns. Rainbow trout make up the majority of Alberta's production and sales.

The year 2005 performance of the Alberta aquaculture industry was estimated at $10 million: $6 million in revenue from table fish sales, and $4 million in revenue from fingerling sales, including fee-for-fishing opportunities, government contracts, private pond stocking and grass carp for biological vegetation control.

There are five types of fish operations in Alberta.

- fingerling production - Operators raise fingerlings for sale to recreational licence holders, other commercial fish farmers, bioassay labs and wholesalers
- table food market production - Operators grow fingerlings to table market size for restaurants, food stores, farmers markets, etc.
- fee-for-fishing operations - Producers stock ponds with ready-to-catch fish for the recreational fishing customer
- contract growing - Operators contract their services to raise and grow rainbow trout for stocking select ponds. The Alberta Conservation Association is responsible for the contracts and stocking. The water bodies include some of the small municipal lakes and ponds for recreational fishing. Examples are seniors' and children's ponds
- biological grass control carp - Operators raise sterile carp for weed control in water and for research purposes.

Issues and Barriers to Economic Development

None identified.

Saskatchewan

In 2002 Statistics Canada estimated the value of the aquaculture industry at $4.6 million. Aquaculture does not produce the same level of fish in terms of weight as wild fisheries but because of the value added in the sector, aquaculture has a higher dollar value. Aquaculture achieves far greater value per pound of fish harvested as all of the harvest is processed before it is exported. (Saskatchewan Environment 2006).

Saskatchewan's aquaculture industry consists of about eleven hatcheries and eighty production units at a commercial level. Unlike terrestrial agriculture, which is regulated by Saskatchewan Agriculture Food and Rural Revitalization, aquaculture is regulated by Saskatchewan Environment and Resource Management (SERM). SERM licenses hatcheries and fish production in aquaculture facilities within Saskatchewan.

The most important aquaculture species in Saskatchewan is rainbow trout. In 2000, the province ranked third among Canadian provinces, producing about 875 tonnes per year of this species. Commercial production of rainbow trout is almost entirely from Wild West Steelhead on Lake Diefenbaker. Wild West Steelhead raises trout from hatchlings to a two-kilogram market size, which are filleted and packaged on site and sold throughout North America.

While Saskatchewan aquaculture production is relatively small, the province may have a larger impact on the international aquaculture industry as a supplier of specialty feed ingredients. Saskatchewan crops such as canola and peas have been shown to be excellent sources of protein for the replacement of fish meal in aquaculture diets; several Saskatchewan companies are developing protein concentrates of peas and canola that further improve the nutritional value of these products as fish meal replacements.

Issues and Barriers to Economic Development

Wild West Steelhead, located in Lake Diefenbaker, has an established market, is in relatively close proximity to the U.S., has a hatchery for fingerlings, and has a production volume large enough to make feed shipment from B.C. feasible. However, barriers to further growth may include access to processing facilities, access to markets, and transportation/logistics for inputs and outputs, and developing production sites that have enough critical mass to address these barriers.

Manitoba

Fish farming in Manitoba is largely a cottage industry operated by about 600 people who grow Rainbow trout, Arctic charr, or other trout species for their own use of which only 25 to 30 are licensed to sell their fish for profit. Most fish farming is done in farm dugouts and small ponds.

Annually in Manitoba, there are between 25 and 30 licensed commercial operators who raise fish for sale. They primarily farm private waters, although a few are licensed to use Crown waters.

There are also approximately 500-600 unlicensed hobby fish farmers who buy fingerlings from licensed fish farmers to stock private waters for their own use. Four major operators supply almost 200,000 fingerlings annually (primarily rainbow trout) to hobby farmers. Two of these are also grow-out operations, selling about 35,000 kgs of rainbow trout and arctic charr annually. There are seven fee-for-fishing operations in Manitoba, where people pay to fish in privately stocked ponds.

While Manitoba has a small aquaculture sector characterized by part-time owner-operator ventures, the province does have considerable potential to further develop the freshwater aquaculture sector due to the availability of large quantities of high quality ground water, an inherent culture to develop and support farming and proximity to major US markets.

Issues and Barriers to Economic Development

Two issues that hamper further development of aquaculture in Manitoba are (1) the need for demonstration of aquaculture technologies that will generate awareness and stimulate investor confidence in the sector and (2) meeting the demand for fingerlings.

Potential Growth in the Prairies

Table 9: Potential Growth in the Prairies (000s of $2010)

	Increase in Revenue (Direct output)	Increase in Economic Activity (Total Gross Output)	Increase in # of Jobs	Increase in Labour Income
5 years	$1,320	$24,900	85	$5,000
10 years	$5,170	$98,000	333	$19,600

Source: Authors' calculations

5.3. Opportunities in Ontario

The majority of Canada's freshwater aquaculture production comes from Ontario-based aquaculture operations. The main species farmed in Ontario is rainbow trout, with most operations clustered largely in the Great Lakes, where the availability of high quality (ground and surface) water, suitable climate conditions, and a developed infrastructure for goods and services present conditions favourable to sector development. Cage culture operations represent about ¾ of total production capacity.

The total farm gate value associated with land based and cage aquaculture production in 2012 was approximately $18.3 million from about 100 operations.

More than 100 people are directly employed within the aquaculture sector in Ontario, largely in rural communities where traditional opportunities for sustainable economic development are limited. The aquaculture industry provides employment in numerous Northern Ontario communities; these include business services, cage fabrication, maintenance supplies and service, and construction/building materials. There are a substantial number of jobs in the value-added sector (825). In other communities outside Northern Ontario, there are opportunities with fish feed suppliers, fingerling producers as well as netting and rigging suppliers.

Issues and Barriers to Economic Development

At a time when world seafood consumption continues to expand, growth in the Ontario industry has not kept pace. The major constraint to Ontario's aquacultural development remains the complex and confusing legislative, regulatory and policy barriers that confront cage aquaculture expansion in the public waters of the Great Lakes, where 80% of Ontario's market size fish production occurs. The key issues identified are:

- Currently in Ontario the aquaculture operators are restricted by 5 year license terms, fostering business insecurity, with no provisions for re-issuance, only a complicated process for a new license application. Longer license terms would provide the industry with greater owner security and investment attractiveness
- All aquaculture ventures require a provincial aquaculture license. It is typical for licenses to be issued with conditions imposed to ensure that a licensed aquaculture venture operates in a manner that upholds the Crown's fiduciary responsibilities regarding public safety and environmental protection. In other sectors where the province issues operating licenses (e.g. commercial fisheries), the empowering legislation offers a "hearing" process by which the licensee can legally request a hearing to appeal conditions of license and seek resolutions to disputes with the province concerning licensing. A similar hearing process is not available to holders of a provincial aquaculture license
- Ontario's regulatory structure was never intended for cage culture. The current process imposes unnecessary cost and uncertainty that has restricted growth, jobs and investment. Industry has complained that the current process is driven by out-dated, false and/or sensationalized claims regarding the risks of fish farming, rather than by a modern, sustainable risk management framework. The industry has recommended that the Ministry of Natural Resources (MNR) and Ministry of Environment and Climate Change (MOECC) develop a coordinated approach to regulating cage aquaculture operations, whereby MOECC would review cage aquaculture licence applications for potential water quality and benthic/sediment impacts, and recommend conditions to be attached to the MNR issued cage aquaculture licences.

Potential Growth

Table 10: Potential Growth in Ontario (000s of $2010)

	Increase in Revenue (Direct output)	Increase in Economic Activity (Total Gross Output)	Increase in # of Jobs	Increase in Labour Income
5 years	$2,420	$35,700	184	$10,000
10 years	$9,500	$140,400	721	$39,400

Source: Authors' calculations

5.4. Opportunities in Quebec

In Quebec, revenue from aquaculture production totaled $11.8 million in 2013. The industry began with freshwater aquaculture in 1857 and then expanded into marine aquaculture; the two types account for 69% and 31% of production respectively.

Freshwater aquaculture consists primarily in farming salmonids such as brook trout and rainbow trout, while the main species in marine aquaculture is blue mussels, as well as urchin, clams, oysters and scallops.

With aquaculture production of 1,754 tonnes, Quebec makes a modest contribution to Canada's total production. However, the aquaculture industry has a significant impact in the Magdalen Islands, the Lower North Shore, Gaspé, the Eastern Townships, the Laurentians, the Outaouais and Central Quebec.

Issues and Barriers to Economic Development

None identified.

Potential Growth

Table 11: Potential Growth in Quebec (000s of $2010)

	Increase in Revenue (Direct output)	Increase in Economic Activity (Total Gross Output)	Increase in # of Jobs	Increase in Labour Income
5 years	$1,240	$23,800	123	$5,600
10 years	$4,880	$93,700	482	$22,000

Source: Authors' calculations

5.5. Opportunities in New Brunswick

New Brunswick is the third-largest aquaculture producer in Canada after BC and NL, with 19,627 tonnes and $123 million in revenue in 2013. Its main product is salmon (94%), followed by oysters (2.2%), trout (1.8%) and mussels (1.8%). In fact, New Brunswick is where salmon

farming first started in Canada in 1979. Among the other fish species raised in the province are Atlantic halibut, Atlantic cod, Atlantic and shortnose sturgeon, Bay scallops and giant scallops.

Issues and Barriers to Economic Development

The principal issue of concern in NB is the impact of climate change on water temperatures in certain regions of the province, particularly in Passamaquoddy Bay, within Bay Management Area 1. Rising water temperatures increase the risks of sea lice infestations, so in the absence of effective sea lice treatments available in Canada, salmon farming companies have had to fallow numerous sites in NB.

Potential Growth

Table 12: Potential Growth in New Brunswick (000s of $2010)

	Increase in Revenue (Direct output)	Increase in Economic Activity (Total Gross Output)	Increase in # of Jobs	Increase in Labour Income
5 years	$35,700	$100,400	541	$19,800
10 years	$131,200	$369,200	1,989	$72,800

Source: Authors' calculations

5.6. Opportunities in Nova Scotia

Nova Scotia has the third-largest aquaculture industry in eastern Canada, with revenues of $54.3 million and production of 8,748 tonnes. It produces less tonnage than Prince Edward Island, but it earns higher revenues because of the principal species farmed (salmon and blue mussels).

Over 6,500 tonnes of Atlantic salmon is farmed along the eastern shore of Nova Scotia from the Strait of Canso to Halifax, on the south shore from Halifax to Yarmouth, and in Cape Breton. Over 1,900 tonnes of blue mussel, oyster and clam production takes place primarily in the Bras d'Or Lakes area, the Annapolis Basin, Shelburne Harbour and parts of St. Margaret's Bay. Over 200 tonnes of rainbow trout is also farmed in Nova Scotia.

Issues and Barriers to Economic Development

Nova Scotia's productivity (t/ha) is lower than most provinces. After a 10-year period of stable growth (1991-2000), production in NS has not grown, and has been subject to significant year-to-year variability over the last 14 years.

NS initiated a review of aquaculture in 2011, which may have had a chilling effect on approval of new sites. NS is expected to introduce regulatory amendments in response to the review in order to establish sustainable growth for the industry.

Climate change may be having an increasing effect on NS aquaculture. Superchill events over the past 2 years have caused loss on a number of salmon farming sites.

Potential Growth

Table 13: Potential Growth in Nova Scotia (000s of $2010)

	Increase in Revenue (Direct output)	Increase in Economic Activity (Total Gross Output)	Increase in # of Jobs	Increase in Labour Income
5 years	$12,900	$43,200	225	$9,200
10 years	$49,600	$165,300	861	$35,100

Source: Authors' calculations

5.7. Opportunities in Prince Edward Island

Prince Edward Island has aquaculture revenues of $41.2 million. In 2013, its production totalled 25, 706 tonnes, almost all of it shellfish.

The province grows the majority (63.5%) of the shellfish produced in Canada, including 85% of the mussels (specifically, blue mussels). Mussels take 12 to 24 months to grow large enough for harvesting and commercial sale. They are farmed mainly along the island's northern and eastern shores.

Prince Edward Island is also the country's second-largest oyster producer (30% of Canadian production). The predominant species is the American oyster, which takes between five and seven years to reach market size.

While the production of cultured finfish is less important economically, Prince Edward Island produces rainbow trout, Atlantic salmon, fish eggs, fry and smolts, and halibut, mainly in the eastern part of the province.

Issues and Barriers to Economic Development

No specific issues identified. PEI has shown strong growth in shellfish production over the past 5 years.

Potential Growth

Table 14: Potential Growth in PEI (000s of $2010)

	Increase in Revenue (Direct output)	Increase in Economic Activity (Total Gross Output)	Increase in # of Jobs	Increase in Labour Income
5 years	$6,900	$22,700	272	$8,800
10 years	$27,000	$88,800	1,064	$34,500

Source: Authors' calculations

5.8. Opportunities in Newfoundland and Labrador

Newfoundland and Labrador ranks second among the provinces in aquaculture revenue, at $197 million. In 2013, the province produced a record 26,550 tonnes of aquaculture finfish and shellfish. While aquaculture production stagnated over the past 12 years in most provinces, production in Newfoundland and Labrador has increased by more than 5-fold since 2002. That growth was fuelled by large private- and public-sector investments in the province. The provincial government introduced support programs, the largest of which is the Aquaculture Capital Equity Investment Program. Under that program, the government make financial contributions to finfish and shellfish aquaculture projects as long as the private sector makes the initial investment.

The province's primary aquaculture species are Atlantic salmon, rainbow trout and blue mussels. The government is also making an effort to develop farmed cod. Ninety percent of the province's salmonid aquaculture is concentrated in the Bay d'Espoir and Fortune Bay region, and 85% of shellfish farming is in the area of Notre Dame Bay and Green Bay.

Issues and Barriers to Economic Development

Regulatory barriers inhibiting growth and expansion include requirements for 1-year fallow periods. Climate change may also have an increasing effect on NL aquaculture in the future, as superchill events is a risk for some salmon farming sites.

Potential Growth

Table 15: Potential Growth in Newfoundland and Labrador (000s of $2010)

	Increase in Revenue (Direct output)	Increase in Economic Activity (Total Gross Output)	Increase in # of Jobs	Increase in Labour Income
5 years	$54,200	$142,000	705	$29,800
10 years	$195,600	$512,700	2,545	$107,400

Source: Authors' calculations

5.9. Opportunities in the North

Yukon, the Northwest Territories, and Nunavut have a small aquaculture industry composed of pothole-lake fish farms, where fish are stocked and grown in closed-system pothole lakes, and tank farm operations that raise and export Arctic charr and Arctic charr eggs.

Yukon's aquaculture industry has two very different components. The first involves the stocking of fish under licence into pothole lakes, growing them for sale. There are currently 16 fish farm licenses issued on 23 pothole lakes, but not all are active. These lakes are closed systems with no native game fish. Licensed fish farms include small hobby-operations as well as commercial

enterprises with substantial private investment. In 2007, 900 kilograms of fish were harvested from three lakes.

The second component of Yukon's aquaculture sector involves the raising of fish in tank farms and hatcheries. There are two such facilities in Yukon and both of these raise Arctic charr. The output from these facilities is about one million eggs annually and approximately 30,000 kilograms of dressed Arctic charr for local markets and export.

The estimated value of all Yukon aquaculture is about $500,000. The economic benefits of aquaculture are varied and include revenue from sales, local employment, and related purchases by industry.

Issues and Barriers to Economic Development

The key issues and barriers to economic development of the aquaculture sector in the North relate to the limited size of the local markets and distance from major markets such as the U.S.

Potential Growth

Table 16: Potential Growth in the Yukon, NWT, and Nunavut (000s of $2010)

	Increase in Revenue (Direct output)	Increase in Economic Activity (Total Gross Output)	Increase in # of Jobs	Increase in Labour Income
5 years	$100	$1,500	5	$300
10 years	$300	$4,500	15	$900

Source: Authors' calculations

6. Potential Economic Opportunities for First Nations

The following sections of this report are primarily based upon phone interviews with twenty-one aquaculture industry members, aquaculture consultants, and aquaculture experts within both the federal and provincial governments. The information provided during the interviews has been supplemented with additional information from resources identified by the interviewees. A list of individuals interviewed appears at the end of this report.

6.1. Overview of Current First Nations Involvement in Aquaculture

First Nations' aquaculture operations exist in many regions of Canada. The growing interest in aquaculture reflects its acceptance by communities that are seeking economic development opportunities that are a fit for their people and their land. Changes in the legal landscape are also enhancing the appeal of aquaculture for First Nations. These changes are leading industry to take a fresh approach to relationships with Aboriginal communities. Rather than carrying out limited

consultation and accommodation negotiations, many businesses now seek to build cooperative relationships based on the recognition of consent and mutually beneficial partnerships.

As Aboriginal communities become more involved in economic development, the demand for suitable investment opportunities is also increasing. Supported by business-savvy leadership and a development-friendly agenda, more and more communities are looking for opportunities to become business owners, and for support to help them along that path.

While the main activity associated with aquaculture is the grow-out of fish and shellfish in marine and freshwater, other activities in the aquaculture value chain can provide opportunities for Aboriginal participation. The range of activities means that there are opportunities to suit different skill sets and capacities for investment and partnership.

The interviews conducted for this report revealed that some First Nation aquaculture ventures have met with notable success. For these First Nations, aquaculture has brought much-needed jobs, skills and leadership development, and wealth creation. These successes clearly demonstrate that aquaculture has the potential to significantly impact the socio-economic wellbeing of First Nations communities.

However, the aquaculture initiatives of other First Nations have met with notable failure. In some cases, this lack of success has intensified pre-existing economic challenges within the community. Moreover, these failures have undoubtedly discouraged other First Nation communities from seriously considering the economic development potential of aquaculture. The failures have also contributed to the view among some economic development agencies and venture capitalists that First Nations aquaculture is a 'high risk' venture—a view that is currently limiting the ability of First Nations to access the capital necessary to fund their aquaculture ventures. To enhance the potential of aquaculture in the eyes of both First Nations and venture capitalists, interviewees emphasized that understanding the factors underlying the failures of previous Aboriginal aquaculture ventures holds the key to ensuring the success of future ventures. A consideration of these factors—and their impact on success—is presented in *Section 6.4 Realizing Economic Benefit From Aquaculture*.

The 2001 INAC report entitled *Opportunities in Aquaculture for First Nations Communities* seemed to imply that the presence of the aquacultural productive capacity within a traditional territory reflected an economic development opportunity that *should* be undertaken. However, the actual First Nations experience in aquaculture has revealed that biophysical capacity alone does not ensure success. In fact—given the opportunities available in the supply and service sector—biophysical capacity may not even be a prerequisite for economic development through involvement in the aquaculture industry.

The biophysical capacity of a First Nation's traditional territory therefore indicates only what direct aquaculture activities *could* be undertaken. It does not indicate what activities *should* be undertaken. To fully appreciate whether a First Nation's aquaculture aspirations *should* be

undertaken as an economic development endeavour, a diverse range of social, cultural, technological, educational, global and economic factors must be considered. Many of those interviewed for this report indicated that business development organizations—such as the Aboriginal Aquaculture Association, Waubetek Business Development Corporation, and Ulnooweg Development Group—are playing an invaluable role by encouraging First Nations to consider this diverse range of factors in their feasibility studies and business plans.

British Columbia

In BC, First Nations are directly involved in the production of a range of species, including Atlantic salmon, Chinook salmon, Coho salmon, oysters, clams, scallops, cockles, and sablefish. While the vast majority of this activity occurs along coastal regions, the development of land-based aquaculture and aquaponic systems may create opportunities for inland BC First Nations to also participate in the aquaculture industry.

Salmon

Approximately 78% of BC's annual production of farmed salmon is harvested from areas covered by agreements with First Nations. At least 28 BC First Nations have salmon aquaculture operations within their traditional territory. While the majority of these operations are open ocean net-pen grow-out facilities, the 'Namgis First Nation has established a land-based, closed containment salmon production facility within their traditional territory.

First Nations communities now provide ~30% of the workforce on the farms of BC's four largest salmon farming companies. Aboriginal people hold management, production and administrative positions throughout the production sector.

Aboriginal people also play a significant role in other links in the farmed salmon value chain. Overall, Aboriginals represent at least 36% of the labor force of farmed salmon processing operations. Moreover, the workforce at one Tofino farmed salmon processing plant is comprised almost completely of First Nations people from the Tla-o-qui-aht and neighboring Ahousaht bands.

Grow-out Opportunities

BC First Nation participation in salmon aquaculture continues to increase. This participation increase is related—at least in part—to two factors:

1. The socio-economic impact of salmon aquaculture within communities of participating First Nations is encouraging other First Nations to become involved
2. Improved environmental regulations (e.g. Pacific Aquaculture Regulations) provide increased confidence in the sustainability of salmon aquaculture.

The current expansion of net-pen production systems—as well as the development of new land-based systems—is creating new opportunities for Aboriginal communities to participate in salmon aquaculture. Recent legal decisions in BC—that have continued to uphold and clarify Aboriginal rights and title—are enhancing these opportunities. These decisions are changing the way industry interacts with Aboriginal communities; there is a movement away from consultation and accommodation, and toward open and honest relationships built on a foundation of consent. This shift provides communities with more leverage for negotiations.

These new opportunities are evident in recent developments such as:

1. At least 6 First Nations are currently negotiating new protocol agreements with salmon farming companies
2. Some BC First Nations have developed partnerships that provide ownership of the aquaculture tenure to the First Nation
3. The Tlatlasikwala First Nation recently celebrated the approval of two new salmon farm applications located within their traditional territory. This First Nation believes that these farms will revitalize the socio-economic environment of their community—and thereby encourage the return of band members who have left the community in search of employment
4. The ‘Namgis First Nation has plans to expand its closed containment facility from a single module pilot project to a 5-module commercial operation. If successful, this venture would create long-term jobs and business opportunities—while at the same time honoring the 'Namgis perspectives on environmental sustainability
5. The K'ómoks First Nation has created a strategic plan to establish a salmon aquaculture operation within the northern region of their traditional territory
6. Inland First Nations have expressed significant interest in Golden Eagle Aquaculture’s land-based Coho salmon facility in Agassiz, BC. Since Coho do not require salt water during their life cycle, First Nations along the Fraser River have access to a water resource that could readily support Coho culture.

Hatchery and Processing Opportunities

While there is currently sufficient hatchery and processing capacity, the growth of the industry will create greater opportunities in both hatchery and processing sectors.

Supply and Service Opportunities

Aquaculture operations rely on the local supply and service sectors (e.g. processors, harvesters, trucking, diving, vessel maintenance and repairs, fuel suppliers, ship chandlers, salmon farm equipment and suppliers, feed suppliers, etc.) to support their activities. Aboriginal entrepreneurs are capitalizing upon the supply and service opportunities created by the industry. For example, the James Walkus Fishing Company—a First Nations, family-owned and run company—

recently launched a $9-million boat to support the aquaculture industry; the boat is the largest harvest vessel used in BC.

The increased participation of BC First Nations in salmon aquaculture will create further opportunities for regional service provider contracts. According to one estimate, the development of two proposed salmon farms could triple the business of the current providers.

For some Aboriginals, involvement in the salmon aquaculture industry through the supply/service sector may be a 'better fit' than direct participation in on-farm activities. In most cases, supply and service businesses do not need to conform to the rigid schedules associated with farm operations and fish husbandry. As a result, the supplies and services can often be scheduled to avoid conflict with cultural, community, and family responsibilities.

Shellfish

Despite a significant level of provincial government support, BC First Nations' involvement in shellfish aquaculture has not yet achieved its potential. First Nations groups may farm as little as 8% of the land under shellfish aquaculture tenure in B.C. Some First Nations that have acquired tenures have not proceeded with aquaculture development; other ventures were abandoned due to lower than anticipated production—or a variety of other social, cultural or community circumstances.

Pentlatch Seafoods

Pentlatch Seafoods—a shellfish harvesting company established in 2003—is an example of an Aboriginal shellfish venture that has capitalized on provincial government incentives. Pentlatch is wholly owned by the K'ómoks First Nation. The company currently produces over 2 million oysters a year—and has worldwide sales that include Taiwan, China, and the US. Pentlatch also annually harvests over 227,000 kg of Manila clams that generate revenues of over $1.1 million. The company presently provides fulltime employment for 20 individuals.

Building on the success of Pentlatch Seafoods, the K'ómoks First Nation purchased the federally registered Aquatec Seafoods processing plant in 2013. Now known as Salish Sea Foods LP, the processing plant doubled its working staff from 12 to 25—and consequently expanded annual sales from $1.2 million to $3.2 million—in its first year of operation.

The K'ómoks First Nation has also created Salish Sea Farms LP to oversee their plans to cultivate sub-tidal geoducks and other experimental species—including sea cucumbers, sea urchins and horse clams. Salish Sea Farms will also manage the expansion of the K'ómoks First Nation into salmon aquaculture.

Coastal Shellfish

Coastal Shellfish LP is a First Nations-owned shellfish production operation that includes hatchery and processing facilities in Prince Rupert and shellfish farms along the north coast of British Columbia and Haida Gwaii. The company was established in 2011 to capitalize on the results of a 7-year R&D project that concluded that scallops were the shellfish most suited to the cold waters of their traditional territory. While still in its very early stages, the company achieved commercial success with its 2013 scallop harvest. Expansion plans call for production capacity to increase significantly within the next 2-3 years.

In addition to providing scallop seed for its own farms, the productive capacity of Coastal Shellfish's hatchery will be able to support the scallop aquaculture initiatives of other First Nations in the region. The Coastal Shellfish hatchery also produces geoduck seed—and will therefore be capable of supplying seed to future First Nations' geoduck ventures.

Shellfish Opportunities

Given the rapidly increasing global demand for shellfish—and the current underutilized production capacity of tenures within First Nations territories—the primary shellfish aquaculture species (oysters, clams, scallops) continue to offer BC First Nations potential for economic development.

Current limitations in the availability of oyster seed may create a further opportunity for economic development within the shellfish industry. Historically, almost all oyster seed for the BC oyster industry has been imported from Washington, Oregon, and Hawaii. The low cost of US seed has offered little incentive for the development of hatcheries in BC.

However, due to ocean acidification, US hatcheries have been challenged with high rates of larval mortality. As a result, the hatcheries are struggling to meet domestic requirements—and therefore have significantly less seed available for export to BC.

To overcome the reduced availability of US seed, the BC industry has begun to import oyster seed from Chile. While reliance upon Chilean seed provides a short-term solution, dependence on foreign seed leaves the industry susceptible to issues of trade security risk related to permitting/regulatory issues and competition. The lack of a secure seed supply—combined with growth in the oyster aquaculture industry—could create the opportunity for the development of a First Nations oyster hatchery.

In addition to expanding the production of existing species, economic opportunities through the culture of new species—such as geoduck, sea urchin, and sea cucumber—may also soon be available for First Nations. For example, the K'omoks First Nation—through Salish Sea Farms LP—has made off-bottom tenure applications to the Province of BC for 515 hectares for the purposes of culturing geoduck and sea cucumbers. This initiative is predicted to increase the

annual shellfish aquaculture revenues in the region by $50 million—and provide annual indirect revenues in excess of $100 million.

Sablefish

Sablefish aquaculture is currently being conducted within the traditional territories of the Kyuquot-Checlesaht First Nations through a protocol agreement with a sablefish farming company. Farmed sablefish is a very high value product with huge demand in Japan—and throughout many Asian countries.

Until recently, production at the grow-out sites has been challenged by high hatchery mortality. As a result, employment has been limited to 8 individuals. However, resolution of the mortality issue will soon allow increased employment opportunities for community members—as well as increased revenues through the community's provision of supplies and services (e.g. dock services, fuel).

The long-term goal of both the Kyuquot-Checlesaht First Nations and the sablefish company envisions that the First Nations will eventually assume full ownership of some of the sablefish production units. Moreover, as production capacity continues to expand, production sites will be sought outside of Kyuquot Sound—thereby creating the possibility for other First Nations to participate in sablefish aquaculture.

Sturgeon

Due to a lack of broodstock, BC currently has only one commercial sturgeon producer. For sturgeon aquaculture to expand, the industry will require access to wild sturgeon populations to obtain new broodstock. For those First Nations with wild sturgeon populations within their traditional territories, the need for broodstock may offer a significant economic development opportunity. To capitalize on this opportunity, it has been suggested that First Nations with access to the wild resource could consider establishing sturgeon hatcheries to support industry growth.

Provincial Challenges and Limitations

Sluggish growth in the BC shellfish industry

In 2013, the value of BC's shellfish production was $22 million—far below the initial projections that the shellfish industry could reach $100 million by 2007. The slow overall growth of the industry does little to attract the attention of First Nations seeking economic development opportunities.

Inadequate oyster seed supply

As described previously, the BC oyster industry currently lacks a secure source of seed. If the supply of seed remains insecure, the potential for industry growth may be significantly impacted.

Integrated Geoduck Management Framework

In 2013, Fisheries and Oceans Canada released a draft of its Pacific Region Integrated Geoduck Management Framework that outlined its intended plan for the management of geoduck aquaculture. In the view of BC First Nations poised to initiate geoduck aquaculture, this framework fails to create the conditions that would ensure profitability for their geoduck ventures—and seriously limits the economic potential of this emerging industry to contribute to economic growth. Fisheries and Oceans Canada has been very slow in responding to submissions made First Nations and industry organizations—and is thereby delaying the initiation of farming activities.

Opposition by Coastal First Nations

While support for salmon aquaculture is clearly growing among coastal First Nations, a significant proportion appears to remain opposed. While this opposition does not prohibit industry growth, it undoubtedly slows the rate of government approvals and procedures.

The opposition to salmon aquaculture is largely due to perceived environmental impacts caused by net-pen production systems. As a result, many First Nations opposed to net-pen systems have expressed strong support for the 'Namgis First Nation's closed containment system.

Alberta

No Alberta First Nations are currently active in commercial aquaculture production. Moreover, while both the Aboriginal Aquaculture Association and Alberta government aquaculture specialists have received inquiries from First Nations, no pilot projects or feasibility studies have been initiated. Alberta's restrictive policy regarding the placement of net-pens on lakes undoubtedly inhibits forms of freshwater aquaculture currently being explored by First Nations in Manitoba and Ontario.

As an alternative to traditional production systems, Alberta fish culturists are investigating the potential of aquaponics. Aquaponic systems combine aquatic animal production with hydroponics (cultivation of plants in water) in a symbiotic environment. Currently, tilapia is the fish most commonly used in Alberta aquaponic systems. As a warm water fish, tilapia are compatible with the warm water requirements of the hydroponic component of the system. However, Alberta researchers have developed a system that does not require an elevated water temperature—thereby creating the opportunity to grow coldwater species (e.g. trout) within aquaponic systems.

To demonstrate the potential of aquaponics to supply an economical, healthy diet to First Nations communities, Thunderbird Farms is currently developing a 'family sized' aquaponic system on the Blood First Nation in southern Alberta. Thunderbird Farms is operated by two aboriginal entrepreneurs living on the reserve. To encourage other members of the community to consider aquaponic systems, the company will offer workshops and other support to community members.

While the primary goal of the company is to develop self sufficiency within individual families to produce a healthy food supply, the opportunity may also exist to develop niche markets for excess products e.g. farmers markets.

Saskatchewan

Commercial aquaculture activity in Saskatchewan is limited to one non-aboriginal producer of rainbow trout on Lake Diefenbaker. While there have been some expressions of interest in the past, there are no currently no known First Nations aquaculture initiatives underway.

Manitoba

Few Manitoba First Nations have yet explored the potential of aquaculture. However, the Sagkeeng First Nation—located on the east side of Lake Winnipeg—has recently launched a trout aquaculture feasibility study with funding from the National Aboriginal Aquaculture Fund (NAAF). The NAAF project also provided funding for the Sagkeeng First Nation to undertake community engagement activities related to the potential aquaculture opportunity.

Trout aquaculture was chosen over other business opportunities (e.g. high tech businesses) because of its connection to traditional resources and values.

The Sagkeeng Nation has developed a business plan—and is conducting a feasibility study—for the establishment of a production system that will include hatchery, grow-out, and processing facilities. Both the hatchery and processing facilities will have the capacity to support the development of trout aquaculture on other Manitoba First Nations.

With minimal commercial aquaculture in Manitoba, there are currently no trout egg producers or dedicated aquaculture feed companies in the province. However, the preliminary feasibility study suggests that eggs can be economically imported from Ontario (which could then be reared to the fingerling stage in the Sagkeeng hatchery)—and a Manitoba livestock feed company affiliated with Skretting can supply the feed. Given the distance to market, the preliminary feasibility study also recognizes the need to develop a strong transport and marketing system. As the aquaculture venture matures, these challenges could offer business opportunities for entrepreneurs within the community.

Ontario

Ontario's strong trout aquaculture industry is encouraging First Nations to consider aquaculture as an economic development opportunity. In addition to trout, Ontario First Nations are expressing interest in farming walleye, perch, and whitefish.

Since Ontario First Nations do not recognize provincial government authority to issue aquaculture licences to First Nations communities or individuals, they do not apply for aquaculture licenses and permits. The development of First Nations aquaculture projects

therefore does not face the regulatory delays that can impede the progress of non-aboriginal aquaculture development projects.

Trout

Currently, there are four Ontario trout farms with significant First Nations involvement: Aqua-Cage Fisheries, Wabuno Fisheries, Buzwah Fisheries, and Fulltime Fisheries.

Aqua-Cage Fisheries

Aqua-Cage Fisheries—Ontario's largest trout farm—is a non-aboriginally owned farm situated on the Wasauksing First Nation since 1983. All non-management or family employees of the company are band members or reserve residents—creating year-round employment for 18 individuals. In addition to employment, Aqua-Cage actively participates in the Wasauksing community through team sponsorship, fish donations to special events, and support for other community activities.

Buzwah Fisheries

Buzwah Fisheries—located on Wikwemikong Unceded Indian Reserve (Manitoulin Island)—is operated by an aboriginal entrepreneur. To share the risk, the entrepreneur initially partnered with an established non-aboriginal trout farming company. However, the entrepreneur is now the sole owner. The entrepreneur receives permission to operate from the Wikwemikong Chief and Council. Since this First Nation has no treaty (which allows it to sell reserve land), Buzwah Fisheries now owns the shoreline adjacent to the farm site.

Fulltime Fisheries

Fulltime Fisheries—located on the Wikwemikong Unceded Indian Reserve—is solely owned by two aboriginal entrepreneurs. Fulltime Fisheries began operation in October 2012. Like Buzwah Fisheries, the company receives permission to operate from the Wikwemikong Chief and Council. At present, the operation consists of six submersible cages with approximately 150,000 organically grown rainbow trout on site.

Wabuno Fisheries

Wabuno Fisheries—located on the Aundeck Omni Kaning Reserve—was established in 1992 by the Aundeck Omni Kaning First Nation. Due to challenges related to their business governance model and other factors, the business has now been leased to a non-aboriginal company. While the managers of the company are now non-aboriginals, all employees continue to be aboriginals.

The success of these companies may encourage other First Nations to initiate trout aquaculture projects. As the Ontario trout industry continues to grow, First Nations may also be able to capitalize on an increased demand for seed and fingerlings by establishing hatcheries and broodstock facilities. However, construction and operation of these facilities would require a high level of expertise and capital.

Walleye

Ontario First Nations are expressing significant interest in walleye aquaculture. This interest was made evident by the advance registration of over 100 individuals for a Walleye Aquaculture Workshop hosted by Waubetek Business Development Corporation in March 2015.

First Nations interest in walleye reflects a range of objectives. Some First Nations are evaluating the potential of walleye aquaculture for the enhancement of wild stocks to support a recreational fishery (tourism) and/or a commercial fishery. Other First Nations have community food security and/or commercial aquaculture production objectives.

The potential of walleye to support these First Nations objectives is supported by the extensive involvement of US Midwestern tribes in walleye culture. In 2012, the 14 tribal hatcheries around the Great Lakes produced a total of 34.4 million fry and 2.2 million fingerlings. Production from these hatcheries supported tribal and commercial needs—as well as a large recreational fishery serving non-aboriginal fishermen.

Quebec

There are at least four First Nations located in the Gaspe region of Quebec that are committed to aquaculture development:

- The Listuguj First Nation was an early entrant into mussel aquaculture; however, the venture was unsuccessful due to management and environmental challenges. With the support of the Ulnooweg Development Group, Listuguj is currently evaluating the potential of scallop aquaculture

- Through the Mi'kmaq Maliseet Aboriginal Fisheries Management Association (MMAFMA), the Gesgepegiag, Gespeg and Viger First Nations launched a pilot project to evaluate the economic development potential of sugar kelp in 2012. The MMAFMA business plan calls for a seed hatchery, grow-out operation and processing plant. Kelp products produced by this venture will carry a First Nations brand. Marketing will target restaurants and Asian communities in Quebec, Toronto, and New York City.

New Brunswick

At least 3 New Brunswick First Nations are investigating—or are already involved in—some form of aquaculture. Both the Indian Island and the Elsipogog First Nations are currently farming oysters. The Eel River Bar First Nation has undertaken preliminary studies to investigate the potential of oyster and clam aquaculture.

Nova Scotia

A significant number of Nova Scotia's First Nations have recognized the economic potential of aquaculture. While many of them have faced business and environmentally related challenges, they appear to remain committed to the development of the industry.

Trout

In 2011, the Waycobah First Nation entered into a joint venture with a non-aboriginal trout farming company to develop a large-scale trout farm. The partnership agreement requires that risk is shared by both partners: the First Nation constructed and owns the farm (which required an investment of $1 million in equipment, barges and a processing facility)—while the partner company owns the fish and operates the farm. The agreement requires that the partner company hire and train members of the Waycobah First Nation.

In 2003, the Millbrook First Nation established an Arctic charr recirculating aquaculture system within its territory. Unfortunately, Iceland is currently flooding the global market with Arctic charr—causing prices to fall to a point where Millbrook can no longer be competitive. As a result, the facility is now transitioning toward the production of trout and salmon.

Trout Opportunities

1. The Waycobah and Millbrook aquaculture ventures provide strong working examples for other Nova Scotia First Nations whose territories have similar biophysical capabilities. For example, the Membertou First Nation is exploring the feasibility of establishing a land-based finfish facility.

2. Currently, there is only one North American source of certified disease-free marine steelhead (Trout Lodge, Sumner, WA). While other certified seed sources do exist in Denmark and Spain, the dependence on foreign seed would leave an expanded trout aquaculture industry susceptible to issues of trade security risk related to permitting /regulatory issues and competition. The growth of the Nova Scotia trout industry may therefore create the opportunity for First Nations to participate in the development of a certified disease-free marine steelhead strain.

3. The Waycobah trout farm contracts out egg-to-fry rearing to a number of small growers. Fry mortality within these facilities is >40%; this rate of mortality does not allow the Waycobah grow-out facility to operate at its full capacity. This inefficiency may offer a First Nation the opportunity to construct a large fry production unit that could provide standardized control of the rearing environment—and thereby yield more fry for grow-out.

Oysters

Cape Breton Island's Bras d'Or Lake has excellent biophysical capabilities for oyster aquaculture. First Nations in this region—including the Eskasoni, Potlotek, and Waycobah Nations—have already established oyster populations and have the infrastructure (including a processing plant) to begin commercial production. However, development plans have been stalled due to the presence of MSX—a disease that kills oysters before they reach market size.

Since MSX was first detected in 2002, members of the Nova Scotia oyster industry (including the Bras d'Or region First Nations) have worked tirelessly to overcome this challenge through the development of disease-resistant oyster strains—as well as rearing protocols that allow the oyster to reach market size before experiencing the impact of MSX. With new oyster strains and rearing protocols in place, it is believed that oyster aquaculture will be capable of contributing significantly to the economic development of Bras d'Or region First Nations.

First Nations on mainland Nova Scotia are also predicted to contribute to the growth of the oyster industry. For example, the Paqtnkek First Nation is in the preliminary stages of establishing oyster aquaculture—and is also exploring the economic potential of harvesting wild spat to supply the oyster aquaculture industry. The economic potential of establishing an oyster hatchery is also being considered by some First Nations.

Other Opportunities

The anticipated growth in the trout and oyster industries will create opportunities for the supply and service sectors. For example, the Eskasoni First Nation already owns and operates an environmental monitoring lab to service the aquaculture industry. Other First Nations (e.g. the Membertou Nation) are also investigating the economic potential of creating supply and service businesses. Nova Scotia's live fish transport capacity has been identified as a service that would need to expand to meet the needs of a growing trout aquaculture industry.

Prince Edward Island

On Prince Edward Island, two First Nations have some involvement in aquaculture. The Abegweit First Nation operates a brook trout and Atlantic salmon hatchery to support enhancement initiatives. In 2014, the hatchery supplied 50,000 fish to be released into local rivers. The Lennox Island First Nation currently owns the inactive Ellerslie oyster hatchery —

and is investigating the feasibility of using it to produce seed to meet the demand of a growing Nova Scotia oyster industry.

Newfoundland & Labrador

In Newfoundland, the Miawpukek First Nation—and members of the Qalipu First Nation—have had long-term involvement in aquaculture.

Trout

The Miawpukek First Nation has been an active participant in Newfoundland's finfish aquaculture industry for many years. In fact, the First Nation was once the majority shareholder of the province's largest finfish producer. However, a series of disease and market challenges forced the cessation of the Miawpukek Nation's direct involvement in aquaculture in 2001. Nonetheless, the First Nation continued to support the industry through the provision of workers and services (transport, towing, diving, net cleaning) to finfish farms operating in the region.

In 2014, the Miawpukek First Nation completed a feasibility study and business plan for a trout farm operation as a means of generating revenue for the community and employment for band members. In addition to a net-cage grow-out facility, the business plan calls for the construction of a community smoker; smoked product will initially be targeted to niche markets in Newfoundland.

Members of the Miawpukek Nation are divided about the decision to re-enter the aquaculture industry. The reluctance of some members is based on the economic challenges brought on by the Nation's previous aquaculture business failure. However, the resistance is primarily due to garbage from existing aquaculture operations that accumulates along the shores of their territory.

The farms closest to the Miawpukek Nation are primarily smaller scale trout operations that purchase feed in bags (rather than bulk); strong winds then blow the bags into the water and subsequently onto the shore. Additionally, empty cages are often stored close to shore during the winter—where shifting sea ice breaks the plastic frames into pieces that also accumulate onshore.

Supporters of the Miawpukek trout venture hope that the Coast of Bays joint mayors' initiative to develop and implement a Solid Waste Management Plan will help to resolve the garbage problem—and thereby generate greater support for the community's aquaculture aspirations.

Mussels

The Qalipu First Nation is a "landless band" with members distributed primarily on the Northeast and West coasts of Newfoundland. A significant number of members of the Qalipu Nation are either owners or employees of mussel farms. In fact, Newfoundland's 2nd largest mussel producer is a member of this Nation.

Mussel Opportunities

Newfoundland has extensive regions available for mussel production. With strong support from the Province of Newfoundland, mussel production is expected to increase by 30% in the next 3 years. Due to their established involvement in the mussel industry, members of the Qalipu First Nation could play a significant role in this expansion.

Other Opportunities

Fisheries and Oceans Canada aquaculture experts have held informal discussions with Innu communities in Labrador regarding the potential of aquaculture development near the Churchill River hydroelectric project; heated wastewater from the project could be used in a land-based production system for Arctic charr or whitefish.

The North (Yukon, Northwest Territories, Nunavut)

The economic potential of Aboriginal aquaculture in these regions remains unknown.

6.2. Socioeconomic Impact on First Nations

The local impact on First Nations largely depends on how much of the total direct, indirect, and induced economic activity will take place locally in the region where the aquaculture operations are located. The level of local economic development that may take place with new aquaculture development will vary greatly, particularly depending on how much of the inputs, such as feed and equipment, come from local sources. Previous studies by Gardner Pinfold on local economic impacts of aquaculture in Canada can serve as a guide for the potential level of economic impact new aquaculture may have on local First Nations.

Based on discussions with the industry[16], Gardner Pinfold estimated that across Canada 40% - 70% of the direct, indirect and induced economic impacts of aquaculture were local. For example, Gardner Pinfold estimated that in the Comox-Strathcona region of BC (which contains 95% of all shellfish aquaculture activity in BC), 50% of the indirect and induced economic gains remained in the region.

Table 17: Regional Economic Impacts for Comox-Strathcona, 2010

	British Columbia		Comox-Strathcona	
	Jobs (FTE)	Income ($000s)	Jobs (FTE)	Income ($000s)
Direct	2,477	91,923	2,353	87,327
indirect	2,283	115,394	1,142	57,697
Induced	947	53,990	474	26,995
Total	5,707	261,307	3,968	172,019

Source: Gardner Pinfold (2013), Table 5, p. 7.

[16] Gardner Pinfold, 2013.

Using the Gardner Pinfold study, new First Nations aquaculture projects would likely capture the majority of the direct benefits, including the employment and income of people hired to work at the aquaculture project. In addition, about half of indirect and induced benefits would also remain within the local region. Of course, the local economic impacts may be shared among First Nations and other locals. How these local economic benefits are shared depends on the level of First Nations engagement in the industry.

It is very difficult to estimate how much of the total economic impacts First Nations and other Aboriginal groups could capture. However, the higher growth in BC and Ontario as well as the higher engagement and geographic location of the industries in these provinces make First Nations group there better poised to capture more of the possible economic gains.

BC is the largest aquaculture-producing province in Canada and is expected to be the area with the largest growth over the next decade, particularly with the end of the moratorium on net-cage salmon aquaculture in many areas. In BC, nearly three-dozen First Nations groups have already entered into joint venture agreements with aquaculture producers. This creates a source of experience and expertise for further involvement of First Nations in the province. First Nations groups would also be able to enter new shellfish species markets such as geoduck, sea cucumber, abalone, and others. Here, we have assumed that up to 40% of the gains could remain with First Nations communities.

The freshwater aquaculture industries in Manitoba, Saskatchewan, and Alberta are underdeveloped compared to the freshwater cage aquaculture in Ontario. First Nations-led growth could create a larger industry, particularly given the number of opportunities for trout farming, but beyond that as well. To make this happen, Aboriginal groups would need to find expertise, probably from outside of these provinces, particularly for the development of new species such as arctic charr, perch, and walleye. Given the relative lack of experience and a small industry, we have assumed that 20% of the gains will be for First Nations groups in the Prairies.

In Ontario, many First Nations people already live in areas with significant aquaculture operations. Further, according to the 2001 OCAD study, First Nations farm a number of aquaculture species across the province, including rainbow trout, sturgeon and perch. For example, the Lake Huron/Manitoulin Island is already home to First Nations freshwater trout operations, at Cape Croker, and in the vicinity of Manitoulin, in South Bay, and near Little Current. Sturgeon is farmed on the Rainy River, in Emo, Ontario, and perch is farmed in Cornwall, Ontario. Based on these successes, we have assumed that 40% of the gains in Ontario aquaculture could accrue to First Nations groups.

In Quebec, we have assumed that First Nations could share in as much as 1/3 of the future growth in aquaculture. For Nova Scotia, we estimate that as much as 40% of the gains in aquaculture could benefit First Nations, particularly if the MSX oyster issue is resolved. For New

Brunswick and PEI, we estimate a 20% share for First Nations in future growth. For NL, the FN share of growth is estimated to be around 25%.

Many of people living in the North are First Nations or Inuit. However, the industry is limited in its potential growth due to its distance from major markets such as the U.S. The development of more small pothole lakes for fishing in the N.W.T. is certainly possible. The North is also a good candidate for raising arctic charr that thrives at water temperatures below 7 ° C. Aquaculture producers in the North may also need to rely more on suppliers outside of the Territories. Here, we have estimated that 50% of the economic gains could remain within Aboriginal communities.

Table 18: Potential First Nations Benefits from Future Aquaculture Development

Province/Territory	Additional Jobs		Additional Labour Income (000s of $2010)	
	In 5 Years	In 10 Years	In 5 Years	In 10 Years
British Columbia	1,380	3,484	62,400	164,000
Prairies	17	67	1,000	3,920
Ontario	74	288	4,000	15,760
Quebec	41	161	1,870	7,300
New Brunswick	108	398	3,960	14,560
Nova Scotia	96	344	3,680	15,500
Prince Edward Island	54	224	4,650	16,200
Newfoundland and Labrador	176	636	7,450	26,850
Yukon, NWT, and Nunavut	2	8	150	450
Total	1,948	5,610	89,160	264,540

Source: Author's own calculations. Numbers may not add due to rounding.

The greatest economic gains for First Nation groups from aquaculture are likely in BC, Ontario and Atlantic Canada where the industries are well established and there is already some engagement with First Nations groups. In total, aquaculture could produce about 3,500 new jobs and $164 million per year in labour income for First Nations in BC in 10 years (by 2024). In Ontario, 288 new jobs and $15.8 million per year in labour income per year could be created for First Nations.

In Atlantic Canada, New Brunswick First Nations could see an increase of almost 400 jobs and $16.2 million in additional labour income. First Nations in Nova Scotia could witness an increase of over 340 jobs and $15.5 million in labour income in aquaculture. For PEI, 224 jobs and over $16 million in labour income could be created, and First Nations in NL could see a major increase of 636 jobs and almost $27 million in additional labour income.

Although the opportunities are more limited in the Prairies, the total benefit to First Nations and Aboriginal groups may be $4 million in labour income per year from 67 new jobs. First Nations and other Aboriginal groups in the North may benefit from about 8 new jobs and $450,000 in new income.

6.3. Some Keys to Successful Investment in Aquaculture

Aquaculture as an economic activity has attributes that are attractive to many First Nations. It takes place in rural and coastal locations and frequently nearby or within territorial boundaries. It has enough in common with capture fisheries that much of the environmental knowledge, expertise, gear, equipment, and vessels that are used for other fisheries can be easily adapted to aquaculture. Many communities have both underutilized hatchery facilities at their disposal that could be retrofitted for aquaculture, and personnel with hatchery skills. Growing safe product requires good environmental sustainability. Finally, aquaculture is not unheard of as an Aboriginal practise. Historically, building berms on beaches to enhance shellfish and creating fending inshore to corral finfish was practiced in some west coast Aboriginal cultures.

Below are some keys to successful investment in aquaculture:

Location – superior sites yield superior biological results and when it comes to aquaculture, an abundant supply of high quality water, the right climate, and where appropriate, good soil quality with ideal texture for fishpond construction, are all key ingredients. Proximity to traditional infrastructure, aquaculture infrastructure and strong markets for the farm-raised products are important ingredients for success.

Type of Operation – Aquaculture development presents a promising area of economic activity for First Nations. With the variety of aquaculture models available, many First Nations in Canada, whether inland or coastal, should be able to find a model that meets their needs. Aquaculture production goals (export markets or local rural markets) and the farming environment (marine, freshwater, lake, pond) will narrow down the choices for a First Nation, but there is lots of room for customizing a system to meet any number of unique social or environmental goals and varying budgets.

Scale of Operation- The greatest returns on investment in the aquaculture industry are achieved by maximizing economies of scale and internally controlling all the major components that go into producing the final form of the farm-raised product being grown. At each level, incrementally higher returns are achieved by investing in research and development, hatcheries, aquaculture feeds, grow-out operations, processing plant operations, seafood sales, marketing and distribution.

Species- selecting the right species is one way to mitigate some of the risk associated with growing live animals. Methods for raising farmed species like salmon, trout and tilapia are all well established, and markets for these species are in place, all of which serves to lower overall risks. On the other, the farming methods for relatively new aquaculture species are still being refined and subsequently carry greater investment risks but potentially higher returns on investment.

Partnership Development – Establishment of strategic partnerships between First Nation communities and corporate ventures can enhance sustainable aboriginal economic development. First Nations offer tangible assets in the form of production sites, labour and traditional ecological knowledge while the private sector offers experience, capital, market access and training. Changes in the legal landscape are also leading industry to take a fresh approach to relationships with First Nation communities; many businesses seek to build cooperative relationships based on the recognition of consent and mutually beneficial partnerships. The Aboriginal Aquaculture Association has developed a Guide for Aboriginal Communities to assist in developing Aquaculture Partnerships.

First Nation Branding – Potential exists to successfully market a First Nation 'brand', particularly in Europe and Asia. A First Nations brand evokes positive associations to be capitalized on from a marketing perspective including, associations with pristine conditions, and a rich indigenous cultural and traditional history. Work is being done on Marketing and Branding as part of the Aboriginal Aquaculture in Canada initiative that will provide further guidance and information.

6.4. Realizing Economic Benefit from Aquaculture

Like all developing industries, Canadian aquaculture has seen many business restructurings and failures. These restructurings and failures have occurred in both aboriginal and non-aboriginal businesses. However, their impact upon aboriginal businesses has likely been far more significant: when an aboriginal business fails, often it is not simply a company and a small group of shareholders that are impacted—rather, the entire, already economically-challenged, community may suffer. The support and guidance provided by First Nations organizations—such as the Aboriginal Aquaculture Association, Waubetek Business Development Corporation, and Ulnooweg Development Group—is therefore critical in reducing the potential for the failure of a First Nation aquaculture venture.

Defining an Economic Opportunity

The challenges faced by a number of the First Nation aquaculture ventures that have struggled to achieve viability have been well documented. And individuals with first hand knowledge of the experience are remarkably candid with their assessments of the decisions and actions that may have negatively impacted the venture's viability. While the experience of every venture is unique, these assessments reveal key elements common to all aquaculture development initiatives that must be specifically addressed in order to increase the probability of success.

Keys to Success

As indicated previously, biophysical capacity for aquaculture production may be a prerequisite for direct involvement in aquaculture; however, it alone offers no guarantee of success. During

the interview component of this project, the following areas were identified as 'keys' for maximizing the opportunity for First Nations to successfully generate employment and economic prosperity for their communities.

Feasibility Study

An in-depth feasibility study will help a First Nation to identify the strengths/weaknesses of a proposed aquaculture project. The study should consider all key elements relevant to developing and operating a successful commercial aquaculture venture such as: site selection, existing infrastructure, species selection, market identification/evaluation, evaluation of potential production strategies and financial feasibility.

Business Plan

The development of a business plan allows a First Nation to evaluate their proposed aquaculture venture's chance of success. It provides a business management strategy and a tool for comparing targeted and actual results. It is also a requirement for successfully attracting investment capital, securing loan financing, and obtaining various permits & economic/financial incentives.

The lack of a sound business plan has been identified as one of the primary factors contributing to the failure of First Nations aquaculture development projects. The pressure to quickly generate community prosperity—and to service debt associated with the venture—has caused some First Nations to base their operations on unworkable business models and unrealistic financial projections.

Business models adopted by early entrants into aquaculture often sought to take advantage of economies of scale. This model required levels of debt financing and capital requirements that could not withstand disease outbreaks or market fluctuations. To avoid the pitfalls of this model, many of the business plans now being developed (e.g. the MMAFMA seaweed venture; the Miawpukek trout venture) focus on initiating the venture on a much smaller scale (with lower associated risk and funding requirements). Expansion of these ventures can then be undertaken as their profitability, expertise, and capacity increases.

Governance Structure

First Nations' aquaculture ventures are managed according to a range of governance models. The models chosen often reflects the goals and objectives of the First Nation—as well as many other social, cultural, and economic factors.

Band ownership

Under the Band ownership governance structure, the Chief and Council are responsible for all management and economic development decisions. This business model has not always proven successful in providing stable governance for First Nation aquaculture ventures. The primary

challenge that confronts this model is that the Indian Act requires a First Nation to hold elections for Chief and Council every two years. As a result, aquaculture ventures initiated by one set of leaders may receive much less support—or even be abandoned—two years later by a succeeding leadership.

The frequency of elections creates a further challenge for aquacultures ventures governed by this model. To secure frequent re-election, the business decisions and practices of Council members have sometimes been strongly influenced by the need to secure re-election—rather than the need to ensure effective management and operation of an aquaculture venture.

Despite these potential challenges, Band ownership may prove successful if its limitations are recognized early—and policies are established to circumvent them. For example, the Miawpukek First Nation will use this model to govern its trout aquaculture initiative because the Nation has a very stable council with established policies to ensure separation between politics and business.

Economic Development Corporation

To avoid the challenges arising from management by an elected body, successful First Nations aquaculture ventures—such as the K'ómoks First Nation's Pentlatch Seafoods and Salish Seafoods—have established economic development corporations. Within these corporations, all management decisions are the responsibility of a board of directors that is independent of Chief and Council. This leadership stability allows for the type of strategic management and planning that is essential for the success of aquaculture ventures.

Joint venture partnership

Joint venture partnerships can contribute significantly to the success of First Nations aquaculture ventures by enhancing business and aquaculture expertise—as well as by increasing access to investment capital. For example, partnership with an established trout production company has contributed greatly to the success of the Waycobah First Nations' trout aquaculture operation.

In BC, the 'Namgis First Nations' salmon closed containment project—and the North Coast First Nations' Coastal Shellfish LP—have both developed complex partnerships to support their endeavors.

Individual Ownership

Within some First Nations communities, the establishment of profitable aquaculture operations has been challenged by:

- Under-motivation of the workforce due to long reliance upon social and unemployment insurance programs

- Hiring and HR practices that are influenced by cultural, social and familial relationships

As an alternative to community management, some First Nations leaders are encouraging highly motivated, entrepreneurial individuals to launch private aquaculture enterprises. These owner/operators—such as Ontario's Ben Kanaswe (Buzwah Fisheries) and Rose & Armando Shawanda (Fulltime Fisheries)—are then able to manage their workforce according to established business practices.

Individual ownership has also proven to be a successful model for aboriginal entrepreneurs in the aquaculture supply and service sector. While the success of James Walkus in BC attracts a great deal of attention, there are many aboriginal entrepreneurs supporting the aquaculture sector through the provision of services such as water taxis, mortality collection, and net cleaning.

Protocol Agreements

Currently, 19 BC First Nations have signed protocol agreements with non-aboriginal salmon farming companies to guide aquaculture development within their traditional territories. While each agreement is unique, it *may* include considerations such as:

1. Stipulations that the First Nation will be the holder of the aquaculture tenure—while the salmon farming company will retain ownership of the infrastructure and the fish
2. Stipulations related to: equity interests; royalties, profit shares or fixed cash amounts that will accrue to the First Nation
3. Stipulation of a hiring policy that gives preference to First Nation job candidates and sets targets or quotas for First Nation employment
4. Stipulation of a policy for awarding contracts that gives priority to First Nation businesses
5. Stipulations for the provision of scholarships, sponsorships and donations to specified community service groups.

In return, the First Nation grants permission to the company to establish and conduct aquaculture operations within its territory—and often agrees to offer its support as a willing partner during company/government interactions. Within some protocol agreements, it is a stated goal that the First Nation will eventually assume part ownership of the operation.

Equity and Access to Investment Capital

Private market capital—including debt and equity—is a key driver of economic activity. Market sources of capital acquired through mainstream financial instruments (e.g. bank loans, bonds, and venture capital) represent over 95% of the capital at work in the Canadian economy. Yet—for aboriginals—access to market capital or private financing remains challenging.

On reserves, these challenges are largely the result of provisions within the antiquated Indian Act that impede direct access to collateral and security, impose obstacles to direct management of

reserve land by First Nations, and create barriers to money management. All of these factors combined can deter investment.

The limitations of the Indian Act present particular challenges to creating an environment attractive to raising capital. For example:

1. Barriers to leveraging land and assets on-reserve act as structural obstacles to accessing market capital. Section 89 of the Indian Act provides that the real and personal property of a First Nation—or an individual situated on-reserve—is not subject to mortgage, levy, or seizure. Therefore, neither First Nation governments nor individuals can directly mortgage their land on-reserve—and they are impeded from using their assets fully as collateral to access market capital without the involvement of the federal government.
2. The Indian Act designation and leasing process on-reserve can serve as a structural barrier that impedes the development of relationships with on-reserve investors. While leases are possible under the Indian Act, the procedure is time-consuming because it requires two steps: a) a community vote to designate the land; b) the approval of the minister for the designation of land.

   Provisions in the Jobs and Growth Act of 2012 have assisted some First Nations in accelerating the development process for reserve lands; however, the Indian Act system remains a process that often requires lengthy and complex lease negotiations involving the department, First Nations, the Department of Justice, and other stakeholders. This can result in delays, added costs, and missed opportunities compared to land development off-reserve.
3. Monies management under the Indian Act can impede First Nations' ability to leverage their own-source revenues to access market capital. Sections 61- 69 of the Indian Act state that: all Indian monies will be held in the consolidated revenue fund and can only be expended for the use and benefit of a First Nation, as determined by the Governor in Council. These provisions delay and restrict the disbursement and use of a First Nations' monies.

Non-legislative barriers

A number of non-legislative barriers also represent obstacles to First Nations seeking access to private financing.

A lack of financial management capacity within aboriginal governments is often cited as an impediment to acquiring and managing debt. Furthermore, a lack of access to financing options can contribute to deficits in public infrastructure, service delivery, and government operations. These, in turn, further deter private sector investment.

Difficulties in accessing private market capital include:

1. perceptions by mainstream lenders of higher risk
2. limited entrepreneurship and management experience
3. lack of financial literacy
4. a lack of high-quality financial assets
5. legal and legislative impediments to obtaining collateral for loans
6. the remote locations of many communities.

According to the think tank, Fiscal Realities Economists, doing business on-reserve can cost four to six times as much as off-reserve. This creates further private sector reluctance to engage in doing business on-reserve.

Strategies to Address Structural Barriers

To address structural barriers faced by First Nations, the federal government has developed a number of optional legislative tools. These optional regimes include the First Nations Fiscal Management Act, the First Nations Land Management Act, and the First Nations Commercial and Industrial Development Act. These Acts provide First Nation governments with the ability to remove themselves from many of the restrictive provisions of the Indian Act.

Moreover, these Acts together provide ways for First Nation governments to leverage on-reserve property taxation, own-source revenues, and a strong land base to gain access to capital markets—and gain control over financial management and lands management.

As a result of these opt-in legislative models, First Nations can now remove themselves from 48 sections of the Indian Act that are recognized as barriers to economic development.

First Nations operating under the First Nations Land Management Act and/or the First Nations Fiscal Management Act report that banks now find their development projects to be more attractive as investment opportunities.

For communities currently operating under the Indian Act, AANDC is also working to improve the leasing environment on-reserve to create a more attractive climate for investment.

Unfulfilled Requirements

Financial management skills and financial literacy are still lacking in many First Nations. These First Nations require support to develop their financial management capabilities in order to engage in the large and complex commercial transactions that they increasingly face. According to recent studies by the National Aboriginal Economic Development Board, financial literacy remains a significant barrier for the creation and growth of aboriginal businesses, particularly on-reserve.

Access to Funding Support

To support their aquaculture ventures, First Nations have utilized a variety of funding sources, including community, regional, provincial and national sources. Government funding programs are highly competitive—with funding more likely to be allocated to lower risk projects. Given that aquaculture is viewed as 'high risk' by many agencies, aquaculture ventures often experience difficulties in obtaining significant support.

Community Funds

With limited availability of investment capital, First Nations have sometimes invested social program funding in their aquaculture ventures. The failure of these ventures can further intensify economic challenges already existing within the community. Utilization of social program funding may therefore be ill-advised.

Other community sources sometimes used to fund aquaculture ventures include revenues from other business units and commercial fishery revenues.

Aboriginal Business and Entrepreneurship Development Program (ABED)

AANDC's ABED program works with Aboriginal entrepreneurs to provide a range of services and supports that promote the growth of a strong Aboriginal business sector in Canada. The funds for this program are administered by 14 institutions across Canada—including Wabautek Business Development Corp. and Ulnooweg Development Group.

National Aboriginal Aquaculture Fund (NAAF)

The NAAF program was established through Fisheries and Oceans Canada's Aboriginal Aquaculture in Canada Initiative. NAAF funding (~$630,000) was available nationally to First Nations, Aboriginal organizations and entrepreneurs for the fiscal year 2014-2015. Activities eligible for funding included:

- Development of partnerships or joint ventures with private sector companies
- Strategic planning, pre-feasibility and feasibility studies
- Pilot projects necessary to demonstrate 'proof of concept'

Many members of the industry consider that the NAAF program was highly successful in putting the tools in place that will support the further development of Aboriginal aquaculture. The program seems to have brought a new enthusiasm and energy to Aboriginal aquaculture by attracting a new set of individuals and organizations.

With the NAAF funding cycle now completed, industry members are suggesting that support must continue to be available to the initial group of new entrants—and additional aboriginal individuals and groups must be attracted to aquaculture. Suggested next steps include:

1. Creation of a Capital Fund for Aboriginal aquaculture

2. Government support for the integration of aquaculture expertise into lending agencies

Regional and Provincial Funding

Regional and Provincial support for aboriginal aquaculture includes:

1. Atlantic Canada Opportunities Agency
2. Newfoundland Loan Guarantee Program
3. Aboriginal Economic Development Fund (ON)
4. First Nations Economic Development Funds (BC).

Training

Advanced training is increasingly required for participation in the aquaculture industry. For a First Nation seeking to initiate an aquaculture project, advanced training in a diverse range of disciplines—including business management and financial management—is essential.

Even entry-level jobs on some salmon farms now require formal aquaculture training. In order to obtain this advanced training, some First Nations members may first require much more basic educational support. For example, due to inadequate educational opportunities, some individuals may need assistance in completing government forms and applications; others may need help in completing the written requirements associated with obtaining a drivers' license.

Some educational institutions have developed strong programs to prepare individuals to work in the aquaculture industry. These institutions include:

- Excel Career College (BC)
- North Island College (BC)
- Vancouver Island University (BC)
- Fleming College (ON)
- University of Guelph (ON)
- École des pêches et de l'aquaculture du Québec (ÉPAQ)
- Dalhousie University (NS)
- New Brunswick Community College (NB)
- Fisheries and Marine Institute, Memorial University (NL)

However, many First Nations members are unable or unwilling to leave their communities to seek aquaculture training at these institutions. As an alternative, some First Nations and aquaculture companies have developed unique training programs, including on-site mentorship programs. Several of the BC salmon companies prefer on-site training over institutionally based training.

Communication and Conflict Resolution

For the success of First Nations aquaculture ventures, open communication between a First Nation and its partners, management, staff, and contractors is essential.

While the benefits of partnering with a non-aboriginal partner are many, these partnerships have revealed that partners may have very different goals and objectives. For example, a First Nation's goals may to be to maximize revenues to reduce its debt load as quickly as possible—while the company may be focused on operating in the most cost effective manner. When the goals of the partners conflict in this way, the survival of the partnership may depend upon open communication that facilitates conflict resolution.

First Nations partnerships can also be challenged by cultural misunderstandings between the partners—as well as between non-aboriginal managers and aboriginal employees. In an effort to promote better cultural understanding, some BC salmon companies now encourage non-aboriginal managers to attend courses—such as the *Working with Aboriginal Peoples* course offered by Indigenous Corporate Training—to facilitate greater cultural understanding.

Support and Advocacy of Industry Associations

Further development of aboriginal aquaculture will require the continued support of industry associations and business development agencies. These organizations play an important role by helping with business planning and capacity development, providing technical and professional development support, and advocating for the industry.

7. Conclusion

The research and interviews conducted for this report clearly suggest that many Aboriginal communities are well positioned to generate significant economic benefit through enhanced engagement in commercial aquaculture. Some First Nation aquaculture ventures have already met with notable success. For these First Nations, aquaculture has brought much-needed jobs, skills and leadership development, and wealth creation.

However—due to the diverse range of factors impacting an Aboriginal aquaculture venture—the achievement of success for some First Nations may be challenging. To successfully transform their aquacultural aspirations into economic development success stories, First Nations will require strong support in areas such as financial and business management, farm management, animal husbandry, and marketing. Organizations—such as the Aboriginal Aquaculture Association, Waubetek Business Development Corp., and Ulnooweg Development Group—have a demonstrated capacity to provide the expertise necessary to support Aboriginal aquaculture ventures. These organizations—and other support initiatives—will be essential in ensuring that Aboriginal aquaculture in Canada achieves its potential.

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9. Appendices

9.1. Established Species – Detailed Information

Table 19: Species by Province

	Finfish	Shellfish	Aquatic Plants
Newfoundland and Labrador	American Eel Arctic Charr Atlantic Salmon Rainbow Trout/Steelhead[1]	Blue Mussel	
Nova Scotia	American Eel Arctic Charr Atlantic Halibut Atlantic Salmon European Sea Bass Striped Bass Gilthead Sea Bream Brook & Speckled Trout Rainbow Trout/Steelhead	American Oyster European/Flat Oyster Bay Scallop Sea Scallop Blue Mussel Soft-Shell Clam Hard Clam (Quahog)	Irish Moss Brown Algae Seaweed spp. Dulse Kelp spp.
Prince Edward Island	Arctic Charr Atlantic Salmon Rainbow Trout/Steelhead	American Oyster European/Flat Oyster Blue Mussel	
New Brunswick	Arctic Charr American Eel Atlantic Salmon Atlantic Sturgeon Brook & Speckled Trout Cunners Short-Nose Sturgeon Rainbow Trout/Steelhead	American Oyster European/Flat Oyster Blue Mussel Bay Scallop Sea Scallop	Seaweed spp. Kelp spp.
Quebec	Arctic Charr Landlocked Atlantic Salmon (FW) Smallmouth Bass Brook, Speckled & Brown Trout Rainbow Trout/Steelhead Lake Trout/Lake Charr Walleye/Pickerel Yellow Perch	Blue Mussel Soft-Shell Clam Sea Scallop	
Ontario	Arctic Charr Largemouth Bass Tilapia Brook, Speckled & Brown Trout Rainbow Trout/Steelhead Walleye/Pickerel Yellow Perch		
Manitoba	Arctic Charr Brook, Speckled & Brown Trout Rainbow Trout/Steelhead Walleye/Pickerel Yellow Perch		
Saskatchewan	Brook, Speckled & Brown Trout Rainbow Trout/Steelhead		
Alberta	Arctic Charr Bigmouth Buffalo Fish Grass Carp (Triploid) Tilapia Brook & Speckled Trout Rainbow Trout/Steelhead		

British Columbia	Arctic Charr Atlantic Salmon Chinook Salmon Coho Salmon Sockeye Salmon White Sturgeon Rainbow Trout/Steelhead Smallmouth Bass Tilapia	Abalone Pacific Blue Mussel Gallo/Mediterranean Mussel Geoduck Clam Littleneck Clam Manila Clam Varnish Clam Giant Rock Scallop Japanese Scallop Sea Scallop Cockle Pacific Oyster	Kelp spp. Marine Micro Algae Sea Lettuce
Yukon	Arctic Charr		

Source: DFO (2013)
[1]Rainbow Trout and Steelhead are the same fish (*Oncorhynchus mykiss*). When cultured in freshwater, they are called Rainbow, in the marine environment, Steelhead.

Salmon

Atlantic salmon (*Salmo salar*) is the predominate species farmed in Canada. In BC, two species of Pacific salmon – Chinook (*Oncorhynchus tshawytscha*) and Coho (*Oncorhynchus kisutch*) – are also farmed.

Locations: Salmon are farmed in BC, New Brunswick, Newfoundland & Labrador, Nova Scotia. BC and New Brunswick are the predominant producers of Canadian farmed salmon. Farmed salmon is BC's largest agricultural export product - and the largest crop in the New Brunswick agri-food sector.

Methods: land based hatchery facilities (flow-through and recirculation), grow-out via marine net pens.

Production: Farmed salmon had a farm-gate value of about $600 million in 2012. The farm-gate value represents a product's value once it is sold by the producer. BC was the largest salmon producer with a farm-gate value of $374 million, followed by New Brunswick at $185 million. Farmed salmon is Canada's third-largest seafood export by value, the largest agri-food export from BC, and a significant economic contributor to coastal and rural communities on the east and west coasts.

In 2012, BC and New Brunswick produced 102,215 tonnes of salmon, representing 95% of total salmon production in Canada. Canada's farmed salmon industry provides more than 10,000 jobs, the majority of which are in coastal communities across BC, in New Brunswick's Bay of Fundy area, and increasingly in Newfoundland and Labrador as well as in Nova Scotia. Farmed salmon operations also provide employment to residents of Aboriginal communities and have played a role in reviving communities located in remote coastal areas of Newfoundland and Labrador.

Hatchery - fertilized eggs are incubated in temperature-controlled tanks at a freshwater hatchery. Once they hatch, the baby salmon are nurtured at the hatchery for up to 18 months. At this age, the young salmon then begin to smoltify – a natural process of physiological change that enables

them to live in salt water. Once this process is complete, the smolts – about 12cm long and weighing 100g – are transferred from the hatchery to net pens floating in the ocean. Over the next 18 months, the smolts grow into adult salmon with a harvest weight of about 4.5kg.

Salmon are fed nutrient-dense, dry pellets consisting of natural products. Using ingredients that are tested for quality and purity, feed manufacturers tailor-make feeds to suit the exact dietary requirements of the salmon at each stage of their life cycle. Canadian feed manufacturers are developing new feeds that are increasingly replacing some of the fish-based ingredients in salmon feed with ingredients from sustainable sources such as vegetables – yet still provide high quality, nutritious farmed salmon.

Farmed salmon convert feed into their muscles, fat and bones very efficiently. While a cow needs about 7 kg of feed for every kg of weight that it gains, farmed salmon require only about 1.2 kg of feed. New studies show that by further improving their feed, salmon will soon need less than 1 kg of feed for every kg of weight gained.

Rainbow Trout

Locations: Alberta, BC, Manitoba, New Brunswick, Nova Scotia, Ontario, Quebec, Prince Edward Island, Newfoundland and Labrador, and Saskatchewan

Methods: land based hatchery facilities (flow-through and recirculation), grow-out via freshwater net pens, saltwater net pens (for Steelhead culture), land-based raceways, and ponds

Production: Trout farming accounted for a farm-gate value of $28.8 million in 2012. Ontario was the largest trout producer with a farm-gate value of $18.3 million, followed by BC at $5.7 million, Quebec at $1.95 million, Nova Scotia and New Brunswick at $1.4 million each. In 2012, export value totalled $6.5 million.

To produce the highest quality farmed trout, eggs are fertilized and incubated in the temperature-controlled tanks of a freshwater hatchery. Once they hatch, the baby trout are typically nurtured in circular tanks and cement raceways at the hatchery until they reach ~8-10 cm in length. Upon reaching this size, most young trout are moved to larger indoor or outdoor tanks. Some trout are also raised in net-cages suspended in lakes. Depending upon the type of production system used, the young trout can take from 9 – 22 months to reach a marketable size of 0.5 to 1.0 kg.

Farmed trout are fed nutrient- dense digestible feed pellets which the fish convert efficiently- for example, while rainbow trout once required 2 kg of feed for every kg of weight gained, today only about 0.5 kg (or less) of feed may be required.

Rainbow trout are relatively easy to culture, as they are a versatile species that can tolerate a wide range of water temperatures (from 0-27˚C) and there are numerous freshwater sources in which they can be grown: they thrive in water originating from aquifers, springs and streams – as

well as in lakes. They can even be cultured in seawater where they are referred to as steelhead. This versatility makes them ideal for Canada's diverse fresh and saltwater environments. Farmed Rainbow Trout are an excellent source of Omega-3 Essential Fatty Acids and are available at most grocery stores across North America in the form of bone-out fillets and whole dressed fish.

Mussels

In Eastern Canada, the primary mussel species farmed is the Blue mussel (*Mytilus edulis*). In BC, both Blue mussels and Mediterranean mussels (*Mytilus galloprovincialis*) are farmed. The BC mussel industry is growing rapidly – but remains small relative to Eastern Canada.

Methods: A variety of systems are used for mussel grow-out but most of them fall under either raft or long-line systems. One grower in BC uses salmon net pens to contain the culture and has installed barrel and timber floats inside the perimeter to hang the mussel socks. The net pen provides a barrier to duck predation. The principle concerns for grow-out systems are predation control and ensuring calm conditions prevail around the mussels. Too much agitation caused by rough water conditions can result in mussel detachment and significant stock losses.

Long lines are the most common system in use on the Atlantic coast. On the Pacific Coast, both long-lines and raft systems are used. Where conditions are reasonably calm and protected, rafts may be the most suitable system. In the Puget Sound area, rafts are used more frequently than long-lines.

Rafts have the advantage of offering the potential for very high stock densities, but there will be limitations depending on water flow and food availability. One grower in Washington reports that at specific sites, around 10,000 feet of grow-out socking is attached to each 30 by 34 foot raft producing about 18,000 pounds of mussels. Nets can be hung around rafts to prevent access by diving ducks.

For higher energy sites with greater wave and current action, long-lines may be more suitable. They are better able to withstand such conditions and absorb the energy better than rafts, keeping in mind mussels can be lost as a result of excessive movement. However, predator control is generally more difficult with a long-line system.

The production cycle on a Canadian mussel farm begins with the collection/production of mussel larvae. In Atlantic Canada, larvae are usually collected in the wild. In BC, all mussel larvae come from hatchery broodstock.

Once the larvae begin to develop into mature mussels, they are placed into lengths of mesh sleeves called socks. The socks are then attached to a rope that is suspended from an anchored buoy in deep sub-tidal water; the mesh of the sock ensures that the mussels have access to nutrient-rich seawater. The mussels remain within the sock until they reach market size – which takes 18 months to 3 years.

Mussels are filter feeders: they obtain all their required nutrients by drawing sea water through their gills and filtering out naturally occurring tiny plants and animals called plankton. Mussel farmers therefore do not need to feed their stock.

Oysters

In New Brunswick, Prince Edward Island and Nova Scotia, the primary oyster species farmed is the American oyster (*Crassostrea virginica*)– also known as the Atlantic, Malpeque or Eastern oyster. In BC, the primary farmed species is the Pacific oyster (*Crassostrea gigas*).

Canadian oyster production is distinctly divided between two regions: in 2006, 60% of the volume of Canada's oysters was produced in BC; the remainder was produced in Atlantic Canada.

Methods: The production cycle on a Canadian oyster farm begins with the collection/production of oyster larvae. In both Atlantic and Pacific Canada, some farmers collect the larvae in the wild. However, larvae are increasingly produced in controlled hatchery facilities from spawning adult broodstock. The larvae are kept suspended in tanks by circulating water - and in a few weeks they transform into tiny seed. The seed is essentially a very small version of the adult oyster.

Once the seed reaches an appropriate size, it can be transferred to the ocean for final grow-out. However - in BC – before final grow-out the oyster seed is often transferred to a 'floating upwelling system' (referred to as a 'flupsy') that is housed on a raft on the ocean. The seed are kept in compartments on the flupsy whereby nutrient rich ocean water is circulated – thereby allowing them to reach a larger size before the final grow-out phase.

When the seed is ready for the grow-out phase, it is transferred to the ocean where it may be reared in one of a variety of systems:

- Beach or seabed culture: Individual oysters are 'planted' on the ocean floor. This form of farming has been ongoing in Canada since the 1800s and the first aquaculture leases granted were for oysters in the 1850s in Prince Edward Island for this type of farming.
- Tube culture: The flupsy stage is not used for tube culture. The larvae are allowed to set along lengths of plastic tubing or rope- where the seed then naturally attaches itself to the surface. The tubing/rope is then vertically suspended from a secured flotation device (e.g. raft or buoy) in deep subtidal water.
- Raft culture: Oysters are placed in trays which are then suspended from a secured flotation device (e.g. raft or buoy) in deep subtidal water.
- Floating line systems, with bags or OysterGro cages.

Oysters are filter feeders: they obtain all their required nutrients by drawing sea water through their gills and filtering out naturally occurring tiny plants and animals called plankton. Oyster farmers therefore do not need to feed their stock, and rely solely on natural food supplies.

Oyster farming is, by definition, green and sustainable. Oysters cannot tolerate the discharge of sewage or other toxins; the presence of oyster farming, therefore, often results in increased awareness and monitoring of coastal waters. In addition to being important modulators of nutrient cycles in ecological systems, farmed oysters help to reduce greenhouse gases by removing carbon dioxide from the ocean for shell formation.

Clams

The Manila clam (*Ruditapes phillippinarum*) is the primary clam species farmed in Canada. Other clam species farmed include: Softshell clams (*Mya arenaria*), hard clams or quahaugs (*Mercenaria mercenaria*), Savory or Varnish clams (*Nuttallia obscurata*) and Geoducks *(Panopea generosa).*

BC is Canada's major clam producing province. Softshell clams are farmed in Nova Scotia and Quebec, and quahaugs in Nova Scotia.

Methods: The production cycle on a Canadian clam farm begins with the collection/production of clam larvae and juveniles. All clam larvae are produced in a hatchery from spawning adult broodstock. The larvae are kept in hatchery tanks where they transform into tiny juvenile clams (seed) within a few weeks. The seed is essentially a very small version of the adult clam. On the east coast, juvenile clams are collected in natural nursery areas using various collector substrates.

After leaving the hatchery, the young clams are transferred to nursery facilities to allow them to reach a larger size. One type of nursery system that is commonly used in BC is a 'floating upwelling system' (referred to as a 'flupsy') that is housed on a raft on the ocean. The seed are kept in compartments on the flupsy where nutrient rich ocean water is circulated – thereby allowing them to reach a larger size before the final grow-out phase.

Once the nursery phase is completed, the juvenile clams are carefully spread on subtidal regions of an ocean beach where they then burrow into the substrate. Clams remain on the beach for 2 to 4 years – until they reach marketable size. Clams are usually harvested by hand using a long tined rake. Yields of clams on well-managed farm plots can reach to over 2kg per square meter each year.

Clams are both filter feeders and deposit feeders: they obtain all their required nutrients by drawing sea water through their gills and filtering out naturally occurring tiny plants and animals called plankton, as well as organic material on the seabed. Clam farmers therefore do not need to feed their stock, and rely solely on natural food supplies for production.

Clam farming is, by definition, green and sustainable. Clams cannot tolerate the discharge of sewage or other toxins; the presence of clam farming, therefore, often results in increased awareness and monitoring of coastal waters for pollution control. In addition to being important

modulators of nutrient cycles in ecological systems, farmed clams help to reduce greenhouse gases by removing carbon dioxide from the ocean for shell formation.

9.2. Alternative Species – Detailed Information

A number of alternate, newer species are under development and commercialization in Canada. The purpose is to diversify production, enhance natural capture fisheries production, and access new market opportunities for the increasing global demand for healthy, high quality seafoods.

Sablefish

Sablefish - also known as Black cod - is a deep-water fish that is quite widely distributed along the continental shelf of the Northern Pacific Ocean ranging from California north to Alaska and the Bearing Sea. Sablefish has been identified as a priority species for Pacific Northwest aquaculture due to: declining commercial and recreational wild sablefish fisheries; high market value; ability to adapt well to aquaculture rearing practices.

Sablefish are farmed in BC in Jervis inlet and on the west coast of Vancouver Island.

Sablefish are raised in open sea pens. Sablefish eggs are hatched within specialized hatchery facilities. The young fish remain in the hatchery until they reach ~30 grams. The fish are then transferred by trucks to the grow-out ocean pens. Sablefish take 2.5 years to reach a 2.5 to 3 kg size.

Sablefish are fed nutrient-dense, dry pellets made of fish meal, fish oil and wheat. No pigmentation is added to the fish feed to adjust flesh color. The fish meal and oil are primarily made from Herring by catch or anchovies. The Feed manufacture also adds essential vitamins, and minerals to feed.

Sablefish is renowned for its smooth, luxurious texture and rich, velvety taste. Its high oil content, mild sweet flavour and delicate white flake create a unique mouth and plate appeal much sought after by discriminating chefs and consumers.

Arctic Charr

Locations: Alberta, BC, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Quebec, Yukon territory

Methods: land-based hatchery facilities (flow through and recirculation), grow out via land-based systems (flow through and recirculation) and saltwater net pens

Freshwater Arctic charr aquaculture is a small, but growing industry in Canada. As its name suggests, Arctic charr thrives in cold water and so is suited to aquaculture in Canada's North.

While the farming of Arctic charr is still relatively young in Canada, the industry is diverse. Arctic charr operators produce both eggs and mature fish. Arctic charr eggs are exported to a number of countries eager to develop their own charr industries, while the meat is sold both domestically and abroad.

Arctic charr are raised in land-based systems. Arctic charr eggs are hatched within specialized hatchery facilities. The young fish remain in the hatchery until they reach ~100 grams; the fish are then transferred to tanks at the grow-out facilities. Each of these tanks is capable of holding 5000 fish. While they take almost a year to reach 100 grams, Arctic charr exhibit a rapid growth spurt during the grow-out phase – reaching market weight (1-2.5kg) within the next 12 months.

Arctic charr are fed nutrient-dense, dry pellets.

In winter, wild Arctic charr gather close together in small pockets of unfrozen fresh water – they are therefore accustomed to living in very close quarters with one another. As a result, farmed Arctic charr must also be stocked at high densities in the rearing tanks; when stocked at low densities, the charr grow poorly and have a higher incidence of illness.

Tilapia

Locations: Ontario, Alberta and BC

Methods: Tilapia are stocked in tanks at very small fingerling sizes less than 2 grams supplied from a Canadian hatchery breeding stock. They can grow to 45 cm in size and up to 2 kg in weight; however market size fish of 200-400 grams are preferred for the live markets. Growth from fingerling to market size typically takes less than 10 months in land-based rearing systems

Tilapia is a warm water, freshwater fish farmed in a few locations in Canada. All of the Canadian production is sold live to local markets, where premium prices are obtained for fresh, live fish. Toronto is the single largest market for live tilapia in North America, and burgeoning markets exist in Calgary, Edmonton, and Vancouver.

Tilapia require temperatures above 24 C in order to thrive. Their fast growth means the fish reach maturity at only a few months of age, and as such can produce several broods each year, unlike our cold-water species, which typically only produce one brood per year.

Tilapia are omnivorous, eating a variety of plant and animal products. Commercial diets consist mostly of lower cost plant-protein ingredients. Work is underway to more effectively utilize cereal and grain crops in the Prairie provinces of Canada for tilapia diets in Canada and globally, with the view of adding value to these agriculture commodities.

Tilapia production requires minimal access to water as it can be produced in high densities in land-based systems with relatively little water turnover. The systems employed for culture are

self-cleaning and generate little in the way of organic and inorganic waste, resulting in extremely low to nil environmental impacts on the surrounding environment.

Small, compact tilapia production systems (2-5 tonnes per year) are capable of being operated in relatively small basements of homes. Several such systems are found increasingly in urban North America settings for live fish production for the restaurant trade.

Sturgeon

Locations: BC

Methods: Closed containment. White sturgeon is currently farmed by only one operation, Target Marine Hatcheries, located in Sechelt, BC. The farm has been raising white sturgeon since 2000 and in 2012, it is estimated that they produced about 17 tonnes of sturgeon meat and 500kg of sturgeon roe.

Geoduck

Geoducks have always been a food of sustenance for BC coastal First Nations. This is evident as many of the First Nations peoples have an aboriginal name for geoducks. An example of this is the Kwakwaka'wakw Tribes who call the geoduck "Kwixwani". Geoduck sites can be found fronting many Indian Reserves.

Commercial culture of geoduck has been under development for almost twenty years in British Columbia. During this time the technology for geoduck culture in BC has been refined and developed and culture of the geoduck is now poised to move forward into commercial development and expansion.

Geoduck have a five to seven year culture cycle from planting to harvest, requiring a significant level of planning, management and investment capital. It is a high value product that has the potential to realize a significant return on investment. Geoduck aquaculture in BC has focussed on sub-tidal culture technology. As commercial aquaculture of geoduck moves forward in BC, a combination of inter-tidal and sub-tidal techniques will likely be employed.

Geoduck seed are supplied by hatcheries and planted by hand individually into PVC sections, plastic mesh tubes, or under raised netting or rigid mesh tunnels. Recent studies have shown that biodegradable tubes can also be used. Mesh netting is placed either over each individual tube or over groups of tubes to protect small Geoducks from predation. Netting and tubes are removed after one to two years as the developing Geoducks burrow deeper into the substrate. They attain harvestable size (one to two lbs.) after a total of five or six years, depending on planting density, food and nutrient levels, and temperature. Geoducks are grown at lower intertidal or even sub tidal elevations. By harvest, the clam resides as much as a meter deep in the sand, with its long siphon extended to the seafloor surface.

Regulatory challenges continue to exist for farmed geoduck. In December 2013, DFO issued a draft Pacific Region Integrated Geoduck Management Framework that First Nations groups and the aquaculture industry believes is unworkable, erecting significant barriers to entry for geoduck farmers.

Scallops

In BC, the primary species of scallop farmed is a Japanese/weathervane hybrid scallop (*Patinopecten caurinus x yessoensis*) known as the Pacific or Qualicum scallop. In Eastern Canada, the giant or sea scallop (*Placopecten magellanicus*) and the Northern Bay Scallop (*Argopecten irradians irradians*) are the primary species farmed.

Methods: The production cycle on a Canadian scallop farm begins with the collection/production of scallop larvae. On Canada's Atlantic coast, larvae are collected from adults spawning in the wild – as well as from hatchery broodstock. In BC, all scallop larvae come from hatchery broodstock.

As the larvae settle and become juvenile scallops, they begin to develop into mature scallops; they are transferred to a fine mesh bag or tray – which is then attached to a secured flotation device and suspended in the ocean.

When the scallops are large enough to begin the final grow-out phase of production, some Canadian farmers 'seed' the scallops on the ocean floor (bottom culture). Other farmers transfer their scallops to larger mesh bags or trays – and re-suspend them from secured flotation devices (suspension culture). Scallops grown in suspension systems take six months to three years to reach market size depending on the final product - whereas bottom grown scallops require a further two to three years.

Scallops are filter feeders: they obtain all their required nutrients by drawing sea water through their gills and filtering out naturally occurring tiny plants and animals called plankton. Scallop farmers ensure that the mesh size of the scallop rearing bags is large enough to ensure good flow-through of nutrient rich sea water. As a result, scallop farmers do not need to feed their stock. They rely solely on the provision of high quality, natural food from the environment.

Scallop farming is, by definition, green and sustainable. Scallops cannot tolerate the discharge of sewage or other toxins; the presence of scallop farming, therefore, often results in increased awareness and monitoring of coastal waters.

In addition to being important modulators of nutrient cycles in ecological systems, farmed scallops help to reduce greenhouse gases by removing carbon dioxide from the ocean for shell formation.

Sea Urchins

The roe (eggs) of green sea urchins (*Strongylocentrotus droebachiensis*) and red sea urchin (*S. franciscanus*) are an expensive delicacy in Japan, parts of Europe, and increasingly in South and North America. Because the demand for sea urchin roe - called "uni" in sushi bars - has grown dramatically over the past decade, many traditional fisheries have been virtually depleted of sea urchins. The development of sea urchin aquaculture could create a new multi-million dollar industry in Canada – as well as contribute to the rehabilitation of wild sea urchin populations in areas depleted due to overfishing.

American Eels

American Eels (*Anquilla rostrata*) are farmed in land-based systems in Atlantic Canada. Eel is a highly valued food product in Europe and Asia. Production methods are based on capturing wild juveniles and enhancing their growth in tank systems on land. Research will focus on developing broodstock and hatchery seed sources to ensure long term sustainability of the developing industry.

Marine Plants

In Nova Scotia, Irish moss (*Chondrus crispus*) is farmed in land-based tanks for the edible Asian sea-vegetable market.

Food grade kelps are being co-cultivated in experimental farms for Integrated-Multi-Trophic Aquaculture, with the view of enhancing the sustainability of fed aquaculture systems and adding value to the overall process. Kelps can be used in a variety of traditional and novel dishes, and are an excellent source of iodine.

Abalone

The Northern or Pinto abalone (*Haliotis kamtschatkana*) are native to BC's coast. Within BC, there is significant interest in the commercial aquaculture potential of abalone; due to its significance as a traditional food, many BC First Nations have expressed support for the development of a BC abalone aquaculture industry.

Abalone flesh is creamy white, firm in texture, and has a mild flavour. It is considered a gourmet delicacy in Japanese and Chinese cuisine. Since global market demand for abalone exceeds the market supply, abalone is a highly valuable commodity (CAD$30-40/kg).

Methods: The production cycle consists of a hatchery phase(spawning and larval stages), juvenile phase and grow-out phase. Where abalone are already cultured, they are usually reared in land-based tank systems necessitating high capital investment in sea water pumping systems and infrastructure. Feed, usually kelp, must also be supplied to abalone stock in such production

systems. Suspended systems in sea water have also been investigated and attempted with some degree of success. Various types of containment have been implemented including plastic barrels as well as mesh pouches. Rigid plastic mesh cages suspended from rafts have also been used successfully in California. However, feeding the stock is still a requirement for these systems and an efficient means of accessing the containers to insert feed is necessary.

The requirement for regular feeding and maintenance of the abalone stock will likely lead most abalone farms to adopt tanks or raceways as the primary culture system. The Malcolm Island operation, for example, is developing a land-based tank and raceway system modelled on techniques used in South Australia. Kelp, usually species of Macrocystis, Laminaria or Nereocystis will be harvested from the local area and fed to the abalone. However, due to the limited availability of kelp, there has been an increasing effort to produce a cost-effective manufactured feed.

In BC abalone broodstock must be selected from wild stocks in the region. The Malcolm Island Shellfish Co-op, for example, require about 100 animals taken from local populations to form the broodstock core of future seed production. Regulatory barriers have made access to broodstock a major problem for abalone culture in BC.

Sea Cucumber

Sea cucumbers (*Parastichopus californianus*) are an Asian delicacy with reported aphrodisiac qualities. Products from sea cucumber include muscle strips (fresh or frozen) and dried skins or sections. The main market for sea cucumber products is China and Japan. Sea cucumbers are co-cultured with fish and shrimp in Asia as a means of recycling nutrients and adding value to the production systems. Interest in developing sea cucumber culture in tandem with fish culture is now being evaluated in Canada as a means of enhancing the overall output of the systems.

Cockles

Cockles (*Clinocardium nuttalli*) - also called basket cockles – are native to BC's coast. Within BC, there is significant interest in the commercial aquaculture potential of cockles; due to its significance as a traditional food, many BC First Nations have expressed support for the development of a BC cockle aquaculture industry.

Since the hardiness of cockles allows them to withstand severe winter conditions, they represent the best opportunity for intertidal bivalve culture on BC's north coast. Market research indicates that cockles would be readily accepted into the upscale food service trade and sushi market.

Spotted & Atlantic Wolffish

Due to its ability to thrive in cold marine waters, spotted and Atlantic wolffish are considered very promising candidate species for cold water aquaculture in the North Atlantic. Wolffish also

display remarkable attributes for domestication (tolerance to density, salinity, water quality changes, egg and larval size, no live prey requirements, and farming-friendly behavior) and market potential (excellent flesh and taste characteristics, niche market, price). Research efforts in Canada are aimed at developing domestic wolffish broodstocks and improving the survival of young wolffish.

Spotted and Atlantic wolffish are listed as "threatened" in nature due to overharvesting, and no commercial harvesting is permitted. The development of farming methods for wolffish will aid conservation efforts of wild wolffish by providing much needed insight into biological factors affecting natural populations. Farmed juvenile wolfish may also play an important role in wild wolffish enhancement efforts.

9.3. Interviewee List

Industry Representatives	
Catherine Lambert Koizumi	Executive Director Mi'kmaq Maliseet Aboriginal Fisheries Management Association Gesgapegiag, QC
Laurie Jensen	Communications & Corporate Sustainability Manager, Cermaq Canada Campbell River, BC
Richard Hardy	Manager, Pentlatch Seafoods Ltd. K'ómoks First Nation Comox, BC
Linda Hiemstra	Golden Eagle Aquaculture Inc. Aggasiz, BC
Marilyn Hutchinson	Director of Sustainability and Growth, Grieg Seafood Ltd., Campbell River, BC
Robin Stuart	Operations Manager, Atoqwa'su Farms Ltd, Whycocomagh, NS
Shayne McDonald	Director of Justice and Legal Affairs, Miawpukek First Nation, Conne River, NL
Tim Rundle	General Manager, Creative Salmon Ltd., Tofino, BC
Government Representatives	
Cindy Webster	Director of Aquaculture - Maritimes Region, Fisheries and Oceans Canada, Dartmouth, Nova Scotia
Corey Jackson	Manager, Aquaculture Programs – Pacific Region Fisheries and Oceans Canada, Vancouver, BC
Dan Watson	Provincial Aquaculture Biologist Alberta Agriculture and Rural Development

	Livestock Research and Extension Division Livestock Research Branch Lethbridge, AB
Geoff Perry	Director of Aquaculture – Newfoundland & Labrador Region, Fisheries and Oceans Canada, St. John's, NL
Jeff Eastman	Business Development Specialist – Aquaculture, Manitoba Agriculture, Food and Rural Development, Winnipeg, MB
Keith Were	Senior Fisheries & Aquaculture Management Officer, Fisheries and Oceans Canada, Ottawa, ON
Steve Naylor	Aquaculture Specialist Aquaculture Development Branch, Ontario Agriculture, Food, & Rural Affairs Guelph, ON
Tyler Collie	Manager, Enterprise Development, Pacific Integrated Commercial Fisheries Initiative, Treaty & Aboriginal Policy Directorate, Fisheries and Oceans Canada, Vancouver, BC
Stephen Purvis	Senior Policy Analyst, Aboriginal Affairs & Northern Development Canada Ottawa, ON (email interview)
Business Development and Association Representatives	
Fernando Salazar	Fishery Business Development Advisor, Aquaculture, Ulnooweg Development Group Inc., Truro, NS
Marguerite Parker	Director of Development, Aboriginal Aquaculture Association, Campbell River, BC
Jennifer Woodland	Aquaculture Business Technical Expert, Aboriginal Aquaculture Association, Campbell River, BC
Richard Harry	Executive Director/President, Aboriginal Aquaculture Association, Campbell River, BC
Todd Gordon	Aquaculture Technical Expert, Waubetek Business Development Corp., Birch Island, ON