Regulation x Sustainable Development:

A Case for Land-Based Aquaculture for First Nations

by

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Abstract

Aquaculture is gaining attention as an alternative method of protein production in a time of increased population pressure and compromised seafood stocks. Land-based aquaculture (LBA), cultivating seafood in tanks on land, holds potential for economic and community wellbeing development for First Nations. This study identifies regulatory gaps and barriers facing shellfish LBA development in British Columbia and investigates the sustainable community development effects of shellfish LBA on Nanwakolas Member Nations, on northern Vancouver Island, through two sustainable development frameworks: the Community Capital Tool and the Community Wellbeing Wheel. The report assesses how remediation of regulatory challenges could cultivate sustainable development opportunities through LBA. The study found that integrating policy changes to reduce the time required to obtain a license, creation of LBA advisory committees, and partnerships with educational LBA institutions can aid in cultivating a sustainable source of seafood, economic opportunities, resource management governance and preservation of traditional foods for Nanwakolas Nations.

Keywords: aquaculture, land-based, sustainable community development, First Nations, Vancouver Island, shellfish

Dedication

For my family, whose love, support, and belief that all education is good education have been fundamental in my work. And for Adam, my loving partner in this adventure whose patience and empathy never ceases to amaze me.

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List of Acronyms

BC	British Columbia
BCARP	British Columbia Aquaculture Regulatory Program
CBEP	Community Based Environmental Planning
CCT	Community Capital Tool
CWW	Community Wellbeing Wheel
DFO	Department of Fisheries and Oceans Canada
IMTA	Integrated Multi-Trophic Aquaculture
LBA	Land-based Aquaculture
MHC	Marine Harvest Canada
RAS	Recirculating aquaculture systems

Glossary

Community Based Environmental Planning	A bottom up approach of sustainable project development that aims for local stakeholder participation in the planning, research, development, management and policy-making of a project
Community Capital Tool	Sustainable development decision support tool developed in part by the SFU Centre for Sustainable Development to holistically assess the impacts of a project on six community capitals
Community Wellbeing Wheel	Sustainable development decision support tool developed by the Nanwakolas Council to assess a project based on five areas of community wellbeing
Flow-through Aquaculture	Aquaculture system in which water is continually taken in and discharged to the surrounding environment
Grow-out	Growing a species to full harvestable size in an aquaculture facility
Integrated Multi-trophic Aquaculture	Aquaculture system capable of growing several species of seafood and/or plants together in order to make use of waste from fish from which plants and shellfish can gain nutrients
Land-based Aquaculture	The process of cultivating seafood on land
Recirculating Aquaculture System	Land-based aquaculture system in which up to 99% of water is re-used
Salmon ranching	Releasing hatchery raised salmon into the wild
Spat	Juvenile shellfish

Chapter 1.

Introduction

Aquaculture is gaining attention as an alternative method of protein production in a time of increased human population pressure and compromised seafood stocks. In 2012, aquaculture provided approximately half of all fish for human food globally; this value is expected to rise to 62% by the year 2030 (FAO, 2014). Fishery experts agree that by 2030, an increase in global fish consumption will cause a shortfall of approximately 50-80 million tonnes of fish products worldwide (DFO, Pacific Region Integrated Fisheries Management Plan, 2014). However, traditional ocean pen aquaculture has come under question in recent years from environmental organizations, such as the David Suzuki Foundation, because of environmental concerns including affecting the health of wild salmon stocks (Werring, 2015).

Land-based aquaculture (LBA) is the process of growing fish or shellfish in tanks on land and has been gaining attention due to its ability to be operated in a range of locations and because proponents argue that it has fewer detrimental environmental impacts than ocean pen aquaculture. LBA typically uses a closed contained system that isolates the fish or shellfish tank from the surrounding ecosystems, and the modular systems can be located in a range of locations as long as there are adequate water and energy resources (Tal et al., 2009). Proponents and industry representatives believe LBA holds tremendous potential for addressing the global shortfall of seafood products, providing environmentally responsible economic opportunity and building social capital and cohesion in the communities where LBA facilities are located.

Recently, LBA has garnered attention on Vancouver Island, on the coast of British Columbia, due to the opening of a new Atlantic salmon LBA facility located near Port Hardy called Kuterra. Kuterra has been raising and selling salmon since 2014 and is 100% owned by the Namgis First Nation (Mrozewski, 2016). Several other finfish LBA operations including Little Cedar Falls and Raincoast Aquaponics in Nanaimo, British Columbia (BC) are also operating in the Pacific Northwest. Additionally, Hummingbird Cove Ltd. shellfish hatchery located in Saltery Bay, BC is scheduled to open for operation in 2017 (Schreurs, 2016). The Hummingbird Cove 34,000 square-meter facility includes shellfish research and development, a hatchery, seafood production plant, marketing and exports. The facility has commercial hatchery licensing for 24 shellfish species and future plans for growing sea cucumber to full harvestable size on land (Schreurs, 2016).

The Na̲nwak̲olas Council, representing six First Nations on Northern Vancouver Island, was interested in obtaining a better understanding of the challenges and opportunities associated with LBA for its member nations. A partnership was formed in June 2016 with the SFU Centre for Sustainable Development to better understand what is currently possible using LBA and the applicability of the technology to the Na̲nwak̲olas Member Nations from an implementation and community development perspective. This study forms part of the results of the SFU and Na̲nwak̲olas partnership.

1.1. Objective

The LBA industry in Canada is undergoing a change from a finfish conservation industry, focused on finfish hatcheries used to rebuild and supplement ocean salmon stocks, to a conservation *and commercial* industry for finfish and shellfish. In the last decade, there has been significant research and progress made related to cost reduction and technical feasibility of LBA systems and the industry is anticipated to grow globally nine-fold by the year 2030 (Jostrom & Edwards, 2015). With the significant anticipated growth of the industry, the research team at the SFU Center for Sustainable Development noticed a knowledge gap in the understanding of LBA effects on the communities that host LBA facilities. This is an especially fascinating question for First Nations on Northern Vancouver Island that have a long history with finfish and shellfish aquaculture and have recently witnessed the opening of Kuterra LBA by the Namgis First Nation in Port Hardy. There is an atmosphere of anticipation in observing whether the Kuterra facility, a joint project funded in large part by the non-government organization Tides Canada, will prove a technically and financially viable method of finfish aquaculture long term (Hicks, 2016; Hobson, 2016).

While the finfish aquaculture industry has continued to grow in BC and Canada (both water and land-based) there are several studies, including Clarke & Pennell (2013) and Howlett & Rayner (2004) focusing on the shellfish aquaculture industry on the Pacific Coast, and the Food and Agriculture Organization, 2014, looking at the shellfish aquaculture industry globally, suggesting that the shellfish industry on the Pacific Coast should have had potential to grow even more rapidly locally when one considers that shellfish aquaculture has a longer history on the Pacific Coast than finfish. The current shellfish aquaculture industry in BC is dominated by the Pacific oyster and Manila clam, and is characterized by many small operations (companies earning less than $50,000 annually) with a very small number of larger companies (Clarke & Pennell, 2013). Howlett & Rayner (2004) cite problems with intergovernmental coordination, inadequate consultation of local communities, uncertainty surrounding First Nations' claims and lack of processing facilities for this potential lag in shellfish aquaculture industry development.

Comparing the shellfish aquaculture industry in BC with those in other countries such as Japan and China, the BC shellfish industry appears to be lagging behind in the number and size of established shellfish aquaculture companies. Development of the shellfish aquaculture industry on the Pacific coast and specifically in BC is happening much more slowly than its potential would predict (Clarke & Pennell, 2013). Could the BC shellfish aquaculture industry realize its development potential through LBA?

The purpose of this study is twofold:

1. To identify regulatory gaps and barriers facing shellfish LBA, and
2. To investigate the potential sustainable community development effects of shellfish LBA on Na̱nwaḵolas Member Nations and assess how remediation of regulatory challenges could cultivate sustainable community development opportunities through LBA.

This study set out to understand and identify the broad effects of the policy governing LBA in BC in order to identify potential regulatory gaps and barriers that may be hindering the evolution of the shellfish LBA industry. The study also aims to better understand the sustainable community development effects of LBA for Nanwakolas Member Nations. The study included the following tasks:

- Undertake a comprehensive **literature search** of land based aquaculture best practices and develop a thorough understanding of where the industry is now, and the current trajectory for the industry.
- Review current land based aquaculture **regulation** and provide a historical context of how the regulations have evolved.
- Conduct **site visits** and **interviews** with Nanwakolas Member Nation representatives and relevant professionals to get a full picture of the aquaculture industry for First Nations on Northern Vancouver Island and understand the goals and interests of potential future shellfish LBA practitioners.
- Identify **gaps** in existing regulatory policies. Gap analysis techniques include a hypothetical scenario analysis to aid in identifying gaps and provide context on how LBA might impact study area communities, and commenting on what the present state is and how one could get to a desired state. The gap analysis also looks at factors that contribute to the gaps and the underlying root causes.
- Make **recommendations** for changes to existing policy to accommodate the changing technical and financial opportunities for shellfish LBA for First Nations on Northern Vancouver Island.

The title of the study: Regulation x Sustainable Development: A Case for Land-Based Aquaculture for First Nations emphasizes the synergies that this project will focus on by recommending actions that can address regulatory gaps and support sustainable development goals simultaneously.

1.1.1. Project Orientation

This project is part of a partnership with Nanwakolas Council and the Simon Fraser University Center for Sustainable Development, funded in part by MITACS, a non-profit federal research funding organization, to determine the sustainable community development impacts of LBA for Nanwakolas member nations and identify regulatory gaps that may be affecting progress of LBA facilities in BC.

The MITACS Accelerate Cluster project includes the work of three SFU Resource and Environmental Management Masters students, each focusing on a unique theme of LBA for sustainable community development. The three research themes are

1) Regulation and Planning; 2) Food Security; and 3) Business Entrepreneurship. This report summarizes the findings from the analysis of regulation and planning of LBA for sustainable community development but may make reference to findings or research for the other two research themes of food security and business entrepreneurship. The work plan outlined in the MITACS Accelerate project included the following tasks:

- Literature Review to synthesize a technical understanding of how LBA is practiced around the world;
- Interviews with community leaders and aquaculture representatives from participating Nanwakolas Member Nations and owners and operators of aquaculture businesses;
- Preliminary Report, referred to as a Meeting Primer, to synthesize findings of the literature review and interviews and to communicate findings;
- Working Group Meeting with Nanwakolas Member Nations representatives and industry professionals to discuss the findings presented in the preliminary report and to provide direction for the next phase of work; and
- Development of a Community Site Assessment Index to integrate market research with observed indicators to enable communities to more easily assess the viability of LBA projects in their particular situation, as well as guide and facilitate future collaboration between industry and communities.

At the completion of the Working Group Meeting in November 2016, the research team proposed that the Community Site Assessment Index be scaled down to accommodate the addition of an education strategy to the work plan in order to address an observed knowledge gap concerning how LBA systems work and the range of possibilities available through these systems. However, financial support from Nanwakolas Council and member nations for the completion of the MITACS work plan tasks for the development of the Community Site Assessment Index and education strategy was not available. Therefore, this particular study on regulation and planning of LBA for sustainable community development will incorporate the findings of the literature review, site visits, interviews and Working Group meeting in analysis of LBA and may be incorporated into future projects that will aim to continue development of the Community Site Assessment Index and education strategy. This regulation and planning LBA study aims to gather and disseminate knowledge for the licensing process of LBA facilities to educate interested parties in the Pacific Northwest on the challenges and potential benefits that could be realized through the further development of the LBA industry.

1.2. Background

This section will provide an introduction to aquaculture and clarify important distinctions between traditional aquaculture practices and emerging LBA practices with the intention of focusing this study on LBA rather than traditional net-pen aquaculture. An introduction to the N<u>a</u>nwa<u>k</u>olas Council will help to anchor the study location and consideration of LBA within the site and social-political conditions of the N<u>a</u>nwa<u>k</u>olas Member Nations traditional territory. Turning the focus to the sustainable community development effects of the LBA, two frameworks for community development will be presented with which to assess the effects of hypothetical LBA development scenarios on N<u>a</u>nwa<u>k</u>olas Member Nations. The first framework presented was developed by the N<u>a</u>nwa<u>k</u>olas Council, and the second was developed by the SFU Centre for Sustainable Development and Telos, the Brabant Centre for Sustainable Development at Tilburg University (Netherlands).

1.2.1. History of Aquaculture in BC

Aquaculture can be defined as the process of rearing and cultivating aquatic plants and animals for food (Fisheries and Oceans Canada, 2013). In 2010, it was a $900 million industry in Canada and, since then, has continued growth to over $1 billion in annual gross revenues (Fisheries and Oceans Canada, 2013). The term aquaculture encompasses a variety of technologies that have a broad range of scale and complexity including traditional net-pen finfish rearing, land based systems in tanks on land, and systems that are a combination of the technologies.

The broad field of aquaculture has roots as far back as the Chinese Zhou Dynasty in 2300 BC (Hicks, 2015). In Canada, although Indigenous communities have been practicing aquaculture through means such as traditional clam gardens for more than 1000 years, commercial aquaculture by settlers had its start in hatcheries established in Quebec, New Brunswick and Ontario in the mid 1800's. The first hatchery in British Columbia for Pacific salmon was established at Harrison in 1884 (Hicks, 2015). Since then, salmon ranching has become common practice for conservation and commercial purposes in BC. Salmon ranching is the process of releasing hatchery-raised salmon into the wild (Vernon, 2007). For much of the twentieth century, commercial salmon aquaculture “grow out”, or raising salmon to harvestable size, remained confined to natural water body operations. The finfish aquaculture industry fluctuated with variations in salmon market prices, the Canadian economic climate, and operational challenges including fish disease and algal blooms. Hagensberg LBA in Nanaimo, which started operations in 1989, was the first large scale attempt in BC to commercially raise salmon to harvestable size in a closed containment system (Hicks, 2015; Clarke & Pennell, 2013). Hagensberg faced challenges of system failures and high operation costs and was short-lived, closing three years later. However, research continued for LBA. Currently, closed containment recirculating aquaculture systems (RAS) are showing signs of success locally and internationally for high value finfish, in part due to their potential benefits (Summerfelt & Christianson, 2014). The benefits of LBA often touted in literature are a reduced environmental impact on sensitive coastal ecosystems and native fish stocks, accessibility for non-coastal and remote communities, and greater control of fish disease and exposure to chemicals (Soto et al., 2008).

1.2.2. What is Land Based Aquaculture?

As with the term aquaculture, the term land based aquaculture (LBA) can be used to describe a range of processes and technologies. The main differences among LBA systems are the types of animals or plants that are farmed and the how the water resource is used in the system. Some of the design considerations for LBA systems will be discussed in more detail below.

Type of Species Cultivated

It is technically feasible to farm anything from aquatic plants to shellfish to finfish in LBA systems. The focus of this study is on finfish and shellfish. There are several reasons for this area of focus: finfish and shellfish LBA follow most of the same licensing procedures in Canada for commercial production, however current DFO licensing does not allow grow-out (the cultivation of shellfish to full, harvestable size) of shellfish bivalve species (see Chapter 3). Additionally, local markets for finfish species such as salmon and halibut and international markets for species such as geoduck, and sea cucumber are strong enough to consider a business case for LBA. As such, the economics of LBA systems for high value finfish and shellfish species are most favourable.

Salt Water Vs. Freshwater

Considering water resources, appropriate siting of an LBA facility is crucially important to ensure that there is adequate quality and quantity of water to run the operation. Depending on the species being produced, both freshwater and saltwater LBA operations are technically feasible. Salt-water LBA operations either use water drawn from ocean sources or produce salt water by adding salt to existing freshwater sources.

Flow Through Vs. Recirculating

A major distinguishing factor for water resources between LBA facilities is the percent of water reuse. Facilities can be classified as either flow-through or recirculating aquaculture systems (RAS). In flow-through systems, water from a source is directed into the facility, undergoes treatment, flows through the fish or shellfish tanks, then is treated, cleaned and discharged at the other end of the process (AVKA, 2015). The flow of water through the system provides oxygen to the fish or shellfish and carries dissolved and suspended wastes out of the system. The advantage of a flow-through system is that gravity and natural water flow can often be used to ‘pump’ the water through the facility, minimizing water pumping costs. As well, less treatment of the water may be required depending on the quality of water that is coming into the facility and the quality requirements for the discharge of the water back to the environment. A significant challenge of the flow-through system is siting the facility in a location that has both the quality and quantity of water required to operate the desired flow-through system (5C's Design & Consulting, 2010).

Alternatively, RAS reuse up to 98% of the water in the systems by circulating the water from the fish or shellfish tank through a water treatment process and back to the fish or shellfish tanks (AVKA, 2015; Soto et al., 2008). An advantage of RAS is that the animals can be kept at a higher density since the system operator has control of the system temperature and water quality by removing waste and reusing the water (5C's Design & Consulting, 2010). The rate of animal growth in RAS systems is usually faster than traditional aquaculture due to the added temperature, water quality and feed controls and the system can better protect the animals from predators by being covered or located inside (5C's Design & Consulting, 2010). Additionally, RAS has the flexibility to be fully operational in any environment because it can be designed so that it does not require access to large bodies of water such as oceans, lakes or ponds. As a result, the risk of animal escapes from the system into natural fish and shellfish bearing water bodies is low. In RAS, wastes are filtered and removed from the system unlike the traditional aquaculture systems that have a high risk for escaped species and discharge wastes into the surrounding body of water (Jostrom & Edwards, 2015).

Hatchery Vs. Grow-out

The majority of land based aquaculture licenses in Canada are hatchery licenses (Aquaculture Management, 2016). However, as corroborated in recent research, there is a greater emphasis and urgency on the development and cost effectiveness of LBA grow-out facilities due to their environmental and accessibility benefits (Jostrom & Edwards, 2015). The Department of Fisheries and Oceans Canada (DFO) has also recognized the benefits of LBA facilities through the initiation of the Closed Containment Initiative that aims to modernize aquaculture management, enhance public and investor confidence in aquaculture, and provide further support for researching and developing new and more sustainable technologies (DFO, Closed Containment Initiative, 2014). The licensing and regulatory requirements for finfish grow out operations in BC currently follow much of the same regulatory requirements of hatchery operations.

The figures below show examples of an RAS, flow-through LBA and ocean net-pen aquaculture systems.

Figure 1.1 Indoor Recirculating Aquaculture Tank System
Image: Responsible Aquaculture, 2014.

Figure 1.2 Flow Through Race-way Aquaculture
Image: Korea-US Aquaculture, n.d.

Figure 1.3 Ocean Net-pen Aquaculture
Image: Parker, 2014.

1.2.3. Examples of LBA in Canada & Around the World

A scan of current LBA facilities throughout Canada and around the world was generated as part of this project to gain an understanding of the current technology available and the range of species that can be cultivated in LBA. The scan was comprised through a web-based search for facilities cultivating seafood in land-based operations. The search is not meant to be exhaustive, but to provide insight into the range of species, operational set-up and business models that currently exist. As such, the scan was not limited by geographic location or types of species cultivated. Information has been gathered directly from facility websites and promotional literature. The scan demonstrates that there are a range of possibilities for LBA when it comes to the location and size of the facility, types of species being farmed, and the business structure. A sample of some novel LBA operations discovered in the scan is provided below to provide context on the range of LBA facility possibilities. The full version of the scan is provided in Appendix A.

High value finfish have been a concentration for RAS technology in the last decade. An Internet search of LBA operations around the world reveals that the main finfish species that are produced with RAS are arctic char, Atlantic halibut, Atlantic salmon, Steelhead trout, barramundi and tilapia. Focusing on facilities in Canada, Canaqua Seafoods Limited in Advocate Harbour, Nova Scotia is a hatchery and grow-out operation producing char, halibut and salmon and supplying local markets and supporting local jobs. Canaqua Seafoods is unique in that the facility has access to both freshwater and deep saltwater wells that, according to the company's promotional material, allows the water they use to be clean, pure and pathogen free; they are in the process of transitioning to a full organic certification (Canaqua Seafoods Ltd., 2015). On the West Coast, Kuterra is an Atlantic salmon LBA RAS facility in Port Hardy, BC, that is wholly owned by the Namgis First Nation. Kuterra started production in 2014 and, according to the company, their salmon have achieved a green "Best Choice" ranking from Monterey Bay Aquarium's Seafood Watch, have been designated a Best Choice by SeaChoice, and have been designated "Ocean Wise" (Mrozewski, 2016).

While shellfish LBA operations are relatively uncommon in Canada, elsewhere around the world the industry is significantly more developed. Shellfish species that are farmed using RAS LBA include abalone, clams, geoduck, mussels, oysters, lobster, and shrimp. Abalone RAS are particularly interesting, in part, because the Northern Abalone native to coastal BC waters have been protected with a moratorium on harvesting under the federal *Species at Risk Act* since 1990 (Gov. Of Canada, Species at Risk Public Registry, 2017). Connemara Abalone out of Galway, Ireland is a commercial RAS facility operating since 2009 with hatchery and grow-out facilities for abalone. Connemara grows Ezo abalone, a Japanese variety. It is located on the shores of Galway Bay, uses seawater for production and feeds the animals locally harvested seaweed (Connemara Abalone, 2009). Taylor Shellfish, located in Seattle, Washington, has hatchery and limited grow-out facilities for clams, geoduck, mussels and oysters. Taylor Shellfish was started in 1890 and now has over 500 employees but is still largely a family run business. They use a combination of RAS technologies and shallow, protected Puget Sound sandy beaches, muddy tide flats and rocky shorelines for species grow-out (Taylor Shellfish Farms, 2016). Taylor Shellfish is one of the oyster spat (juvenile) suppliers for oyster farms in BC.

Finally, LBA facilities have the potential to cultivate more than one species of seafood or plants. Integrated Multi-Trophic Aquaculture (IMTA) land-based systems are capable of growing several species of seafood and/or plants together in order to make use of waste from fish from which plants and shellfish can gain nutrients. The shellfish or plant species in turn help to clean the water for the fish. The process associated with IMTA will be further discussed in Section 2.2. Some examples of IMTA that were identified in the LBA scan include oysters with algae at Smit & Smit in the Netherlands. Smit & Smit is an experimental, father and son, operation that is growing the algae required to feed the oysters onsite (Wright, 2016). In Nanaimo, BC, Target Marine Products Inc. is growing sturgeon and watercress. While the focus of the farm is sturgeon and sturgeon caviar production, the watercress is also sold and shipped to Vancouver area restaurants. According to Target Marine, their products are recommended by Ocean Wise, and recognized "Best Choice" by SeaChoice and Seafood Watch (Target Marine, n.d.)

1.3. Study Site

The study site for my research is on lands within the traditional territory asserted by the Nanwakolas Member Nations. The Nanwakolas have not yet identified a specific location for an LBA facility, so my research will assess the general effects of an LBA facility against overarching frameworks for community development, rather than assessing the physical conditions of a specific location (such as water and energy resources available).

1.3.1. The Nanwakolas Council

The coastal First Nations of Vancouver Island are experiencing the challenges of diminishing fisheries first-hand. Growing settler populations and the rise of commercial fisheries in the area have placed greater pressure on marine resources and have led to the development of complex and prohibitive regulatory regimes. The Nanwakolas Council is a tribal council located in Campbell River comprised of six member First Nations whose traditional territories are located in the Northern Vancouver Island and adjacent South Central Coast areas of British Columbia (Nanwakolas Council, 2011). Currently the following First Nations are members of the Nanwakolas Council:

- Mamalilikulla Nation

- Tlowitsis Nation
- Da'naxda'xw Awaetlatla First Nation
- Wei Wai Kum First Nation
- Kwiakah First Nation
- K'omoks First Nation

The Na̱nwaḵolas Council was established in 2007 to implement a 2006 Land Use Plan in cooperation with the Province of BC. The role of the Na̱nwaḵolas Council has since expanded beyond its original intent and the council now provides advocacy, technical support and coordination support for land use planning, marine planning and economic development (Na̱nwaḵolas Council, 2011).

A map of the traditional territories of the Na̱nwaḵolas First Nations is provided in Figure 1.4.

Figure 1.4 Nanwakolas Traditional Territory Map
Image: Nelson, 2016. Nanwakolas Council

1.3.2. Nanwakolas Historical & Current Aquaculture

The waters within the Nanwakolas traditional territory have long been productive waters for seafood harvesting and aquaculture. Many Nanwakolas First Nations members have a personal history with fishing and aquaculture, as fishing was a common occupation and several nations maintain clam beds in traditional waters. However, growing settler populations and the rise of commercial fisheries has diminished access and availability of traditional, natural fisheries (Hutchings & Meyers, 1994). Similar to the trends witnessed in other places in Canada, the number of First Nations involved in the fish and aquaculture industry is a fraction of what it once was (C. Roberts, personal communication, June 2016).

Despite the change in the fisheries landscape, there are several ocean-based aquaculture ventures currently ongoing in the traditional waters of Nanwakolas Member Nations. The majority of the ocean-based aquaculture ventures are cultivating Atlantic salmon. The ventures are often either wholly operated by, or a partnership with, an established aquaculture organization such as Marine Harvest. Marine Harvest, based in Campbell River, BC, is one of the largest seafood companies in the world and is the world's largest producer of Atlantic salmon. According to the company's website, Marine Harvest is represented in 24 countries and employs over 10,000 people (Marine Harvest, 2016).

Two member First Nations have established private aquaculture ventures: Salish Sea Foods of the K'omoks First Nation and Chief's Pride Aquaculture Corporation of the Tlowitsis First Nation.

Salish Sea Foods is a processing centre and retail store wholly owned by the K'omoks First Nation that opened in 2013. K'omoks First Nation also operates Pentlatch Seafoods, growing oysters and Manila clams in Baynes Sound to be processed by Salish Sea Foods. The processing centre and retail store offer oysters, clams, smoked salmon products and value added salmon products. A majority of the salmon processed at the centre are produced by Marine Harvest under contract with Salish Sea Foods. Oysters and clams grown and processed by the facility are marketed under the Komo

Gway brand name and are carried in select Sobey's grocery retail locations (Salish Sea Foods, 2017).

Chief's Pride Aquaculture Corporation is wholly owned by the Tlowitsis First Nation. The company grows, manages and harvests oysters for the commercial market from its approximately 30 rafts located at the entrance of Teakeme Arm near Cortes Island, BC. Chief's Pride is currently able to produce approximately 1.5 million Pacific Oysters annually. The company purchases oyster seed from established hatcheries in the UK and USA (including Taylor Shellfish) and also operates an oyster nursery capable of growing three to five million juveniles annually for transplant, or for sale to other growers (Chief's Pride Aquaculture Corporation, 2011).

1.4. Frameworks for Community Development

Two frameworks for community development will be presented and utilized to assess how the effects of implementation of a shellfish LBA facility might impact sustainable community development goals for the Member Nations of the Na̲nwak̲olas Council. The first framework that is presented is the Community Wellbeing Framework that was developed by the Na̲nwak̲olas Council in 2013 (Aweeknak'ola Newsletter, Na̲nwak̲olas Council, 2014). The second framework that will be presented is the Community Capital Framework that has been developed in part by the SFU Centre for Sustainable Development to holistically assess the impacts of specific projects on sustainable community development. The Community Capital Framework has been used both in Canada and abroad to facilitate discussions on community development goals and projects (Roseland, 2012). Both of the frameworks that are presented make use of collaboration through stakeholder involvement.

1.4.1. Community Wellbeing Wheel

The Na̲nwak̲olas Council underwent a process of consultation, investigation and dialogue with representatives from member nations in 2013 in order to identify priority strategy areas to contribute to individual and Nation wellbeing and strengthening (Aweeknak'ola Newsletter, Na̲nwak̲olas Council, 2014). This process informed some of the program development and, for this report, will be adapted as a framework for community development. The following description of the community wellbeing and strengthening activities and results is summarized from the 2014 Nanwakolas Council report: Community Wellbeing and Strengthening Plan (Roberts, 2014).

The community wellbeing and strengthening plan comes out of thinking related to Maslow's hierarchy of needs wherein, if basic needs are met as a sound foundation, advancements can be made in "improving the enjoyment or fulfillment of life in areas of wellbeing." Once individuals start to make improvements to their own wellbeing the strength and wellbeing of the community will in turn also be strengthened. The development work for the community wellbeing and strengthening plan was collectively undertaken by five participating member First Nations of the Nanwakolas Council: Mamalilikulla, Tlowitsis, Da'naxda'xw, Gwa'sala and K'omoks. The group brainstormed and examined the community wellbeing areas to determine which areas are of high priority and to establish strategies, initiatives and plans to support progress of individuals and nations towards the optimal goal of reaching an ideal state of wellbeing. The process included engagement of member Nation representatives, review of existing community plans and resources, and the formation of the Community Wellbeing Working Group. The role of the Community Wellbeing Working Group was to "help guide, oversee, review and provide feedback on the process of drafting the plan."

In the context of the community wellbeing plan, community wellbeing is defined as "referring to all things that contribute to and determine a First Nation's wellbeing, their state of happiness, and the quality of life of all members belonging to a First Nation." (Roberts, 2014, pg. 5). The Working Group came to a consensus on five main wellbeing areas: culture, community, economic prosperity, resource stewardship, and health. The first wellbeing area of **culture** includes goals such as re-establishing language, traditional practices, and passing cultural teachings on to younger generations, and emphasizes the importance of families parenting and teaching future generations. The second wellbeing area of **community** includes goals such as ensuring adequate housing, infrastructure, and community facilities, participating in land use planning for reserves, and emphasizing the importance of connectedness and community participation. The third wellbeing area of **economic prosperity** includes goals of careers and employment for members, financial stability for families, encouraging entrepreneurs and emphasizing the importance of independent financial wealth of the Nation. The fourth wellbeing area of **resource stewardship** includes goals of ensuring resources for future generations and sustainable use of resources, encouraging prevalence of traditional foods and resource security and prioritizing implementation of Guardianship programs (education and training programs for youth) to provide on-the-ground monitoring and enforcement of resources. Finally, the fifth wellbeing area of **health** includes goals of physical, mental, emotional and spiritual health, effective management of chronic diseases, a focus on healing of trauma, using traditional medicines, emphasizing the importance of community interaction, and sport and recreation activities. The Working Group was struck by the interconnectedness of the priority areas and goals and so proposed visualization of the community wellbeing areas as overlapping circles as shown in Figure 1.5.

Figure 1.5 Community Wellbeing Wheel
Image: Roberts, 2014.

The Community Wellbeing and Strengthening Plan provides impact statements and specific implementation activities that should be undertaken in order to achieve wellbeing in the particular priority areas. The report emphasizes that the ideal state of wellbeing can only be achieved if all of the priority areas are addressed. The impact statements and implementation activities for each of the community wellbeing areas are provided in Table 1.1 below.

Table 1.1 Community Wellbeing Areas, Impact Statements and Implementation Activities

Community Wellbeing Area	Impact Statement	Implementation Activities
Resource Management	Establish and broaden ability to protect and monitor lands and resources throughout First Nations' territories; and continue to strengthen the capacities needed for First Nations' governance of their lands and resources.	• Develop effective model(s) for Guardians Watchmen programs in First Nations' territories, including a coordinated approach to delivering short term training needs of the members. • Continue to strengthen governance-related resource management by the First Nations
Economic Prosperity	Establish educated, skilled and trained workforces of the member First Nations, to secure meaningful employment and careers in the mainstream economy, First Nations' government/administration, Band enterprises, and the public sector.	• Develop a Nanwakolas employment and training strategy for member First Nations. • Continue to support Band Enterprise growth and development in the context of the regional economic development approach of the Nanwakolas Council • Create an awareness and support system for potential individual entrepreneurs.
Culture	Work to establish better connections with and presence in traditional territories, and support more language and cultural revitalization activities through increased knowledge transfer opportunities and strengthened family relationships	• Support First Nations with identifying and sourcing resources (financial resources and best practices) needed to work towards and achieve their cultural CWB objectives. • Continue to strengthen, document and articulate the link between resource stewardship and cultural values and teachings. • Help build, maintain, and expand modern knowledge systems for First Nations, such as through a large cultural cedar inventory project.
Health	Continue working to improve physical, mental, and spiritual health of families and individuals on the strong foundation of a connection with and understanding of cultural values and teachings	• Establish formal relationships/partnerships with regional health and social agencies to support more robust CWB strengthening outcomes of targeted initiatives. The goal is more balance in program design and delivery, consistent with a holistic understanding of CWB. • Continue to protect and enhance harvest

		areas for traditional foods and cultural resources in planning processes and enforce protection through established Guardianship programs of the First Nations. • Explore options to support First Nations' community members having better access to traditional foods, especially for off-reserve members, with the goal of re-establishing healthier diets and better nutrition.
Community	Establish necessary investments and partnerships to meet community and remote village infrastructure needs. Ensure necessary institutions, processes and personnel (physical and knowledge infrastructure) are in place to support community member connectedness and participation.	• Support establishment of effective and consistent information management processes as they relate to so many areas of community development.

The Community Wellbeing and Strengthening Plan identified a specific goal for shellfish aquaculture as part of the overall wellbeing goals of economic development. The goal calls for "regional collaboration in the development of shellfish aquaculture business opportunities" as an implementation priority. This goal originally arose out of the 2011 Nanwakolas Regional Economic Development Strategic Plan. The community wellbeing actions targeted through shellfish aquaculture projects include:

- Increasing meaningful employment of Nations members in sustainable business opportunities based on traditional territories;
- First Nations independent wealth generation through sustainable business operations;
- Protection and restoration of cultural and traditional assets and resources for future generations...[as a] component of supporting the physical health of individuals through sustaining traditional foods availability and accessibility;
- Restoring connection to traditional territories;
- Establishing First Nation capacity for technical and scientific data collection and analysis of ecosystem changes...[to] support accountability for First Nations' resource stewardship responsibilities over their territories... and re-establishing authority, which is connected to the long-term wellbeing of a nation; and
- Restoring connections to the traditional territories, which also support the wellbeing of the individual through empowerment.

The community wellbeing framework provides a starting point of how to assess the potential impacts of LBA operations within the traditional territory of Nanwakolas member Nations.

1.4.2. Community Capital Tool and Framework

The Community Capital Tool (CCT) is a decision support and assessment instrument used to facilitate and ground community discussion for integrated planning and monitoring of sustainable community development projects (Telos, 2012). The Community Capital Framework and tool is based on assessing the impact a project has on **community capital**. Community capital can be understood as a measurement of the connectedness and social cohesion of a population and place. Community capital assessments embody a holistic approach to assessing and discussing projects by analyzing the social, environmental, and financial impacts of a project. The Community Capital Tool is made up of two instruments: the balance sheet and the scan. Both make use of six forms of community capital: natural, physical, economic, human, social and cultural. Each of the six capitals are further broken down into a set of smaller stocks and requirements used to measure capital capacity and progress towards achieving sustainability. The following stocks in Table 1.2 are built into the web platform of the community capital scan tool and are a starting point to assess the sustainable community development impact of a project.

Table 1.2 Community Capitals and Stocks

Capitals	Stocks
Natural Capital	Soil, groundwater, air, surface water, minerals and non-renewable resources, land
Physical Capital	Infrastructure, land, transportation, public facilities, housing and living conditions
Economic Capital	Labour, financial resources, economic structure
Human Capital	Education, health and wellbeing
Social Capital	Citizenship, safety
Cultural Capital	Cultural heritage, identity and diversity

The CCT allows users to visualize the effect of the project on each of the forms of capital by graphically representing the scores of each stock and capital on a sustainability hexagon. The sustainability hexagon (Figure 1.6) quickly communicates whether a given project increases or decreases each of the forms of capital. It provides a starting point for potential discussions about trade-offs or how to better address a certain capital.

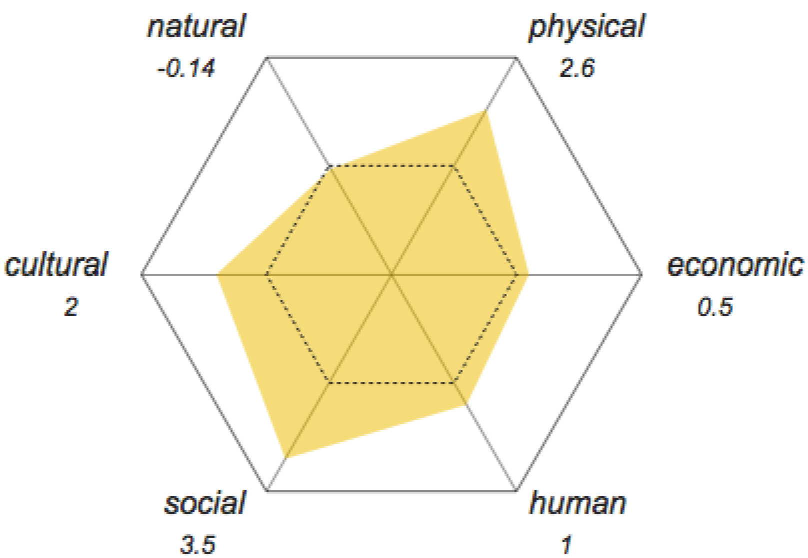

Figure 1.6 Community Capital Tool Sustainability Hexagon

The Community Capital Tool (CCT) was collaboratively developed by the SFU Centre for Sustainable Development, and Telos: the Brabant Centre for Sustainable Development at Tilburg University in the Netherlands (Roseland, 2012). The following overview of the framework and tools is summarized from Roseland's 2012 edition of Toward Sustainable Communities, Chapter 17 and the Telos Comprehensive Manual for the Community Capital Scan, 2012.

The CCT is made up of two instruments: the community capital balance sheet and the community capital scan. The tool has been developed so that the expected impact of an "integrated and pro-active community-wide planning activity" can be discussed with a selected group of stakeholders at an early stage and in a way that is structured so that adjustments and iterative evaluation can be carried out proactively for the project, if required.

There are seven steps in the implementation of the Community Capital Framework with the Tool. The process is described below.

Step 1: Visioning

The framework and tool are used to engage community members in order to define that specific community's ideal definition of a sustainable community and develop long-term requirements or metrics that must be met in order to be an ideal sustainable community. The outcome of this step is a set of goals that are used to guide decision-making.

Step 2: Community Capital Inventory

The community capital balance sheet is used to provide a measurement for each of the capitals and stocks existing in the community. The results create a picture of the strengths and weaknesses of each stock. The balance sheet gets more specific by further focusing each of the stocks using the following hierarchy: Capitals > Stocks > Indicators > Norms (see Figure 1.7). Norms are used to create quantifiable metrics with which to assess existing community conditions. For example, under Natural Capital, a stock might be air quality with the indicator of greenhouse gas emissions and the norm a specific quantity of tonnes of carbon dioxide.

Figure 1.7 Community Capitals Monitoring Hierarchy

Step 3: Considering Options

Stakeholders and project leaders come up with two to six options or alternatives for sustainable development taking into account the findings from the community capital inventory. For example, one option might specifically address a stock that was found to be weak in the community capital inventory.

Step 4: Assessing Options

The Community Capital Scan is used to assess the potential impacts of each option on the capitals. The scan uses a set of pre-determined questions designed to direct participants to assess which stocks are strengthened or weakened by the option.

Step 5: Implementation

Steps 1 through 4 represent the planning phase of a project. Project champions need to create an implementation plan, paying special attention to decision made during the vision process and providing clear direction on how to implement the option. Implementation is the process of moving an idea from concept to reality by assigning responsibility for tasks, budget and reporting requirements.

Step 6: Monitoring

In the monitoring phase, three main questions are asked of the project: first, has the project been implemented? If not, what barriers are holding it up? And lastly, what is the actual impact of the project on each of the capital stocks? The output of this step may be an iteration of the community capital balance sheet.

Step 7: Evaluation

During evaluation of a project, one can ask what contribution has the project actually made to the community and should the initiative be continued or cancelled? The findings of the evaluation may prompt the community to again undertake the steps of the community capital framework. The community capital framework is an iterative process, therefore for any given project or community, stakeholders may go through each of the steps several times.

For this LBA study, it is not yet possible to develop the full community balance sheet described in Step 2 of the Community Capital Framework Process, so I will instead use the community capital scan and the resultant sustainability hexagon (Figure 1.6) to assess the potential effects of different shellfish LBA options on community capital stocks. There are several reasons for using the scan (see Step 4 of the Community Capital Framework process) as opposed to the balance sheet (see Step 2 of the Community Capital Framework process). The balance sheet is most effective when the location for a project has been defined and data are available for the population and location. As the specific location of a hypothetical shellfish LBA has not been defined beyond it being located within the Nanwakolas Member Nation traditional territory, the level of detailed information required for the balance sheet is not available. Instead, the community capital scan will be used to try to achieve a "relative" comparative understanding of the impacts of each of the selected scenarios.

How does the Community Capital Scan Work?

The community capital scan is a tool available on a web platform at the address: http://www.ccscan-ca.cscd.sfu.ca/. The scan is preloaded with indicating questions for each of the capital stocks. For each question or long-term goal of the stock, the user estimates the impact of the project by assigning a score from –5 to +5 with 0 having no effect on the stock. Scores of +5 have a large positive effect on the stock and capital and scores of –5 have a large negative effect on the stock and capital.

The result of the scan is an overall sustainability hexagon that combines the scores of each of the stocks for a capital to a single number plotted on the sustainability hexagon axis for that capital. Each of the overall scores is connected to create a polygon that gives an indication of the overall effect of the project. The larger the area of the polygon, the greater the positive impact of the project on sustainable community development goals. The sustainability hexagon allows participants to quickly visualize how a proposal will affect each of the capitals. See Figure 1.6 for an example of a populated sustainability hexagon.

The scan also provides pie charts for each of the stocks of the capital. An example is provided for Natural Capital in Figure 1.8 below. The scores are visualized for each stock within a capital with positive scores radiating to the outer edge of the pie chart and coloured green and negative scores radiating to the edge of the midpoint of the pie chart and coloured red. Scores of 0 are shown as a grey triangle radiating half way towards the edge of the pie chart.

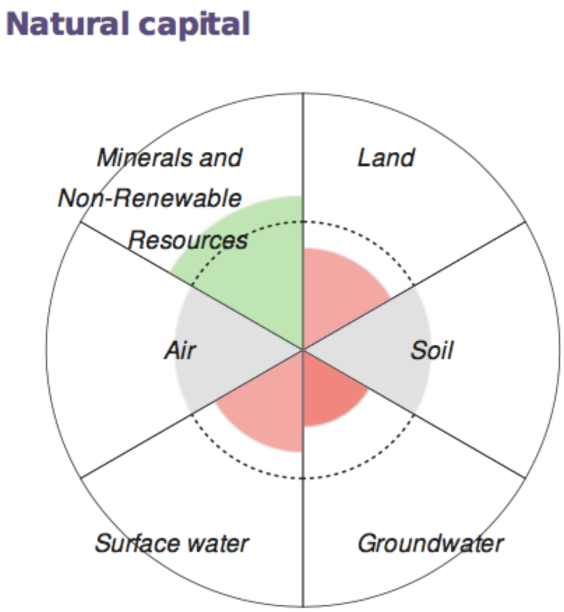

Figure 1.8 Natural Capital Stocks Pie Chart

A Note of Caution

Roseland's 2012 Towards Sustainable Communities and the Comprehensive Manual for the Community Capital Scan emphasize that the tool offers the users a platform on which to base dialogue with community members. Therefore, the analysis and results discussed in the sections below should be taken as a starting point for dialogue and not as providing any particular direction as to whether or how a shellfish LBA facility should be implemented.

Chapter 2. Technical Review of Land Based Aquaculture in British Columbia

Land based aquaculture systems are not a new technology. Land based hatcheries for finfish conservation have been commonplace in BC for about the last 100 years (Hicks, 2015). Further, the concept of LBA systems is something that most people can relate to: think of a pet goldfish in an aquarium. However, the concept of land based aquaculture with minimized input (water) and output (waste) streams on an industrial scale is pushing the boundaries of the conventional understanding of LBA, as are the number of species that can be farmed in such systems. The sections below will provide a brief technical introduction to two novel LBA system types that are showing promise in the progression of commercial scale LBA: the recirculating aquaculture system (RAS) and integrated multi-trophic aquaculture (IMTA).

2.1. Recirculating Aquaculture System

Recirculating Aquaculture Systems, or RAS, in simple terms refer to LBA systems that recirculate the water within the system from the fish or shellfish tanks to a cleaning and re-oxygenation process and back to the fish or shellfish tanks (Zhang et al, 2011). RAS has gained attention in the last decade due to its perceived environmental and economic benefits. Potential environmental benefits include less dependence on and use of water resources, and reduced contamination of the surrounding environment due to farming facilities (Tal et al, 2009; Summerfelt et al, 2015). The reported economic benefits include enhanced fish growth and survival, better product quality, and reduced treatment costs (Summerfelt et al, 2015).

A wide variety of RAS systems has been developed. Several companies offer "off the shelf" RAS systems including AKVA Group, Blue Ridge Aquaculture and Agrimarine Technologies (AVKA Group, 2015; Blue Ridge Aquaculture, Inc., 2017;

Agrimarine, 2014). However, in speaking with suppliers and operators of RAS, it is apparent that each system requires modifications specific for the location's operating parameters. Some of the operating parameters that require adjustment and oversight include air and water temperature, water quality, and type of species being produced. The general concept of the RAS process remains the same, although any system may make use of a variety of available mechanical systems. RAS are made up of four components: the grow-out tank(s), solids removal system, ammonia removal system, and oxygenation. These will be summarized below, as adapted from Blue Ridge Aquaculture, Inc. (2017) and AVKA Group (2015).

Grow-out tanks are large culture tanks where the fish or shellfish are cultivated. The conditions in the grow-out tanks must be closely monitored to ensure adequate water temperature, oxygen content, and food availability in order for the animals to survive and grow. The stocking densities of animals in the grow-out tank are higher than what the animals would experience in a natural habitat (Mussley & Goodwin, 2012). Fish wastes and uneaten feed are collected through mechanical filtration such as a mechanical sweeping arm that directs the waste to an outlet. The high-nitrogen content waste slurry is removed from the recirculation process and is either sent to landfill or used in other processes, raw and/or processed, such as fertilizer for plants or energy from waste. The remaining water that is circulated out of the grow-out tank undergoes ammonia removal or bio-filtration. During the ammonia removal stage, beneficial bacteria consume the ammonia thereby converting it to nitrogen that can be released into the atmosphere. The water then undergoes an oxygenation process where it is brought back to a state in which it can support the animals. During oxygenation, pure oxygen is injected into the water and carbon dioxide is removed. Finally, the now treated water is circulated back into the grow-out tank. RAS finfish facilities have reported over 98% water volume recirculation, meaning a very small amount of water must be injected to the system every day to maintain an optimum volume of water (Tal et al., 2009). In BC, RAS design for finfish is further developed and much more common than shellfish RAS, although, in theory, the process for RAS shellfish follows the same procedures (Helme & Bourne, 2004). However, there is some evidence to support that water circulation may be required less frequently or not at all for shellfish since shellfish are extractive, taking nitrogen and nutrients out or the water as a means of sustenance (Congrove, 2012).

The RAS process is summarized in a process schematic; see Figure 2.1.

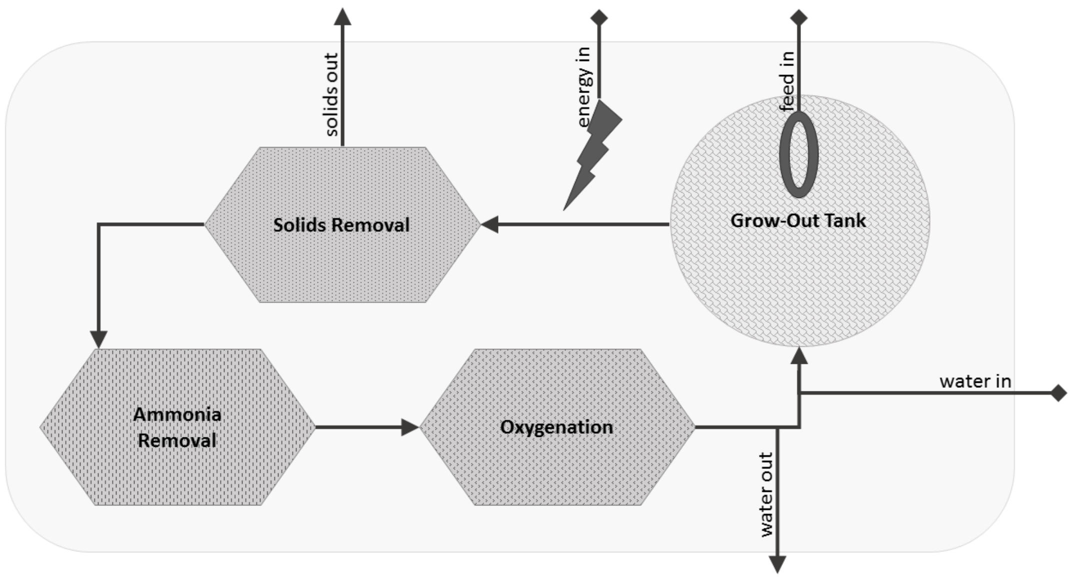

Figure 2.1 Recirculating Aquaculture System Process Diagram

2.2. Integrated Multi-trophic Aquaculture

Integrated Multi-Trophic Aquaculture (IMTA) makes use of symbiotic relationships between plants and animals to operate the system. IMTA can be a RAS, but could also operate in a traditional ocean pen or flow- through system. In IMTA, extractive crops, such as seaweeds, vegetables or shellfish, extract nutrition from the waste and other by-products of fed crops, such as finfish (Neori et al., 2007). The goal of the ITMA facilities is to balance the waste production and extraction to become "environmentally benign mini-biospheres" thereby limiting the dependency on and quantity of use of natural resources (Neori et al., 2007). The components of RAS IMTA are similar to RAS except the ammonia removal and oxygenation are performed by extractive plants, often via a floating raft planting system. IMTA systems are novel because they can reduce or eliminate the waste associated with RAS, while in the process providing a secondary marketable product such as lettuce. Energy and feed for fish inputs are still required in IMTA RAS. The IMTA process is conceptualized in Figure 2.2.

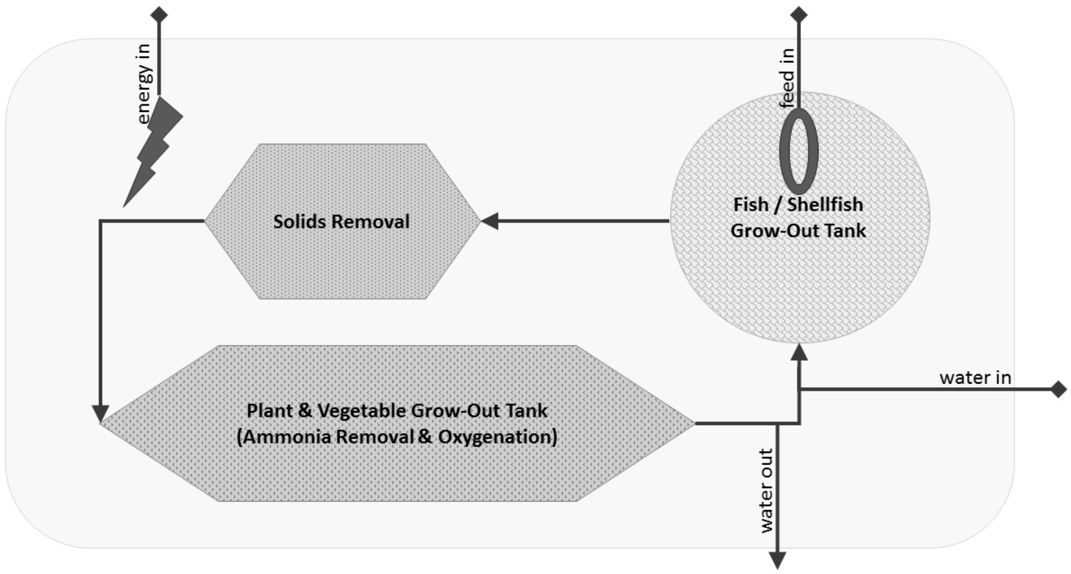

Figure 2.2 Integrated Multi-trophic Aquaculture Process Diagram

The potential benefits of reduced waste energy streams from IMTA facilities have created excitement in the industry; however, sceptics of the process cite concerns such as that the multi-million dollar costs of these facilities are unlikely to be overcome by growing and marketing products such as lettuce in the facility (S. Summerfelt, personal communication, June 2016). The research team visited several IMTA facilities in BC; all of these were experimental or were operating under an alternative business model that was not simply for-profit, such as You Grow Food in Hope, BC, that was operating as a social enterprise and did not provide full time employment for the facility owners and operators.

2.3. LBA Lessons in Failure

There have been many failed attempts at LBA in BC after the Hagensberg facility in Nanaimo, the first attempt at salmon LBA described in Chapter 1.2. As with other new industries or technical processes, there are lessons to be learned from such failures. For example, Sweet Spring Salmon based in Agassiz, BC shut its doors in 2015 (Summerfelt, 2015). One of the main challenges cited was the large start-up costs relative to the time it takes for the system to start making money by selling the harvested full-grown animals. Additionally, Sweet Spring Salmon struggled in trying to overcome the marketability issues associated with the stereotyping of all types of salmon aquaculture as detrimental to the environment (Irwin, 2011).

In Newfoundland (2012) Jim Bennet proposed and instituted a land-based fish farming system called Sustainable Blue in response to critics of ocean open net farming. The facility was showing signs of success until a power outage with coinciding uninterrupted power source failure and back-up laptop failure nine months into the operation. An entire fish cohort was lost, but the company persevered with the surviving eggs (Benjamin, 2014). Such failures of LBA facilities have so far provided important lessons about the technical processes required for successful LBA; but there is a need for research on the sustainable development effects of LBA on a community.

While some trials and experimental LBA facilities have shown incremental success, failures during the last two decades have made it difficult for would-be LBA owners to get loans or attract investment for new facilities (E. French, 2014).

Chapter 3. Regulation of Land Based Aquaculture in British Columbia

The licensing and regulatory requirements for finfish and shellfish grow-out operations in BC currently follow much of the same regulatory requirements of the established conservation-focused hatchery operations. However, there are substantial differences between hatchery and grow-out operations in terms of resource use intensity, waste streams and animal health (French, 2014).

In the *Constitution Act*, 1867, section 91(12) states that the federal government has jurisdiction over the "Sea Coast and Inland Fisheries." However, the *Constitution Act* did not transfer ownership and responsibility of the "beds of freshwater rivers and lakes" to the federal government (Dudley & Walden, 2010); those generally remain under provincial ownership and jurisdiction. Section 92(5) gives the provinces jurisdiction over "Management and Sale of Public Lands", and section 92(13) gives them jurisdiction over "Property and Civil Rights", which includes proprietary rights in fish. Therefore, in practice responsibility for fish and fisheries in Canada is shared between federal and provincial authorities. Basically, the provinces can regulate the allocation of the resource within provincial boundaries, including issuing fishing licenses, while the federal government maintains the responsibility to manage and protect the fisheries including setting maximum catch quotas (Dudley & Walden, 2010). In order to coordinate this shared jurisdiction, the federal and provincial governments have entered into a variety of harmonization agreements concerning the management of fisheries.

The management of aquaculture in Canada is also a shared responsibility (DFO, 2015). The Department of Fisheries and Oceans (DFO) is the federal lead agency for ensuring sustainable management of aquaculture activities under the *Fisheries Act*. The DFO acts through the *Fisheries Act* for aquaculture and wild caught fisheries, the *Pacific Aquaculture Regulations,* the *Fishery (General) Regulations*, and the British Columbia Aquaculture Regulatory Program (BCARP).

Other federal bodies have a role in the aquaculture industry either through regulating, supporting sustainable growth, or investing in research. These federal bodies include: the Canadian Environmental Assessment Agency, the Canadian Food Inspection Agency, Environment Canada, Health Canada, the Pest Management Regulatory Agency, the National Research Council, Natural Sciences and Engineering Research Council of Canada, and Transport Canada (DFO, 2015).

Provinces and territories also have laws and regulations that govern aquaculture to manage environmental impacts, waste and fish health and in most cases (except in British Columbia and Prince Edward Island) issue licenses. Prior to the 2009 decision of the Supreme Court of British Columbia in *Morton v. British Columbia (Agriculture and Lands)* (2009 BCSC 136), the BC government took the lead role in all aquaculture regulation and licensing in BC. In the *Morton* case, Mr. Justice Hinkson ruled that much of the provincial legislative framework governing aquaculture was invalid because it went beyond provincial jurisdiction under the *Constitution Act, 1867*. In response, the federal government developed the *Pacific Aquaculture Regulations* and the British Columbia Aquaculture Regulatory Program. The provincial government now administers some aspects of this regulatory framework through agreements with the federal government, but DFO and the federal government have the lead role. In addition, the province still exercises regulatory jurisdiction over the cultivation of marine plants.

Municipalities and other local governments may also affect LBA activities through the adoption of official community plans and zoning bylaws. LBA facilities may be acceptable under industrial or agriculture land use zoning according to zoning definitions of specific municipalities.

A summary of relevant federal LBA regulation in BC is provided in Appendix B.

A Focus on Carnivorous Fish

The focus of aquaculture regulation in Canada and worldwide is on carnivorous finfish aquaculture (Neori et al., 2007). Critics of the aquaculture industry often cite environmental degradation and risk to native fish species as major threats of traditional water-based aquaculture. While these risks may be real, the regulation and perceived widespread nature of them may not align with the overall profile of aquaculture. In 2004, 90% of the world's aquaculture production consisted of algae and molluscs. However, carnivore fish production, accounting for less than 9% of world aquaculture production in 2004, remains a dominant focus for policy makers (Neori et al., 2007).

It is possible for the regulatory focus on carnivore finfish aquaculture to change to include greater consideration of other forms of aquaculture such as land based shellfish operations. The history of aquaculture in BC has shown that DFO is interested in working with industry to strengthen local economies through aquaculture, while endeavouring to protect natural fisheries. During the growth of the salmon finfish aquaculture net-pen industry in BC, DFO welcomed industry requests for the introduction of Atlantic salmon in BC waters (Clarke & Pennell, 2013). Additionally, in the licensing of Hummingbird Cove shellfish LBA in Saltery Bay, DFO engaged heavily with the LBA developers to provide regulatory guidance to allow over 20 species of shellfish at the hatchery (D. Dyble, personal communication, February 22, 2017).

3.1. Licensing Process

Aquaculture licenses are required for all hatcheries and enhancement facilities in BC including those that are federally operated as well as non-commercial production facilities and LBA operated by First Nations and community groups. Aquaculture licenses are issued for the operation of a specific site and can take one year or more to process. Most of the land based licenses are issued for multiple years. The license terms granted through the *Fisheries Act* by DFO are up to nine years for freshwater or land-based facilities including shellfish. The licensee must apply for renewal at the expiration of their license. The main condition of the license is compliance with the *Fisheries Act* where failure to comply can result in investigation and enforcement as set out in the Act and regulations. The licensing conditions for non-commercial facilities including conservation projects or operations at teaching facilities are different than commercial conditions while still requiring adherence to fish health management and reporting. There is little information available in DFO's licensing procedure literature about shellfish health in land-based facilities (DFO, Aquaculture Licensing in BC, 2016).

Despite federal and provincial departments being involved in licensing, a single combined application is required through BC's online application centre at FrontCounterBC. The freshwater/land-based administrative flat fee is $102 (as of 2016). The freshwater aquaculture license includes land and freshwater-based operations (DFO, Aquaculture Licensing in BC, 2016). Therefore, a single type of license is issued for operations that may range from land based RAS and flow through systems; salt water land-based; freshwater net-pen in open, natural water body; and operations in a man-made body of water with no dividing interface to the surrounding environment. The license also covers hatchery operations that raise juveniles from eggs and grow-out facilities, where the animals are allowed to grow until they reach the desired size for harvesting.

The conditions for a Freshwater/Land-based Aquaculture Licence stemming from the license management plan currently restrict the grow-out of bivalves under the Site Specific Condition 1.1. stating, "The license holder must ensure that only bivalve seed harvest or transfer is permitted from this facility. No harvest or transfer of food market-size bivalve shellfish is permitted from this facility" (DFO personal email communication, November 2016). This condition is based on the requirements set out in the Canadian Shellfish Sanitation Program – Manual of Operations (CFIA, Canadian Shellfish Sanitation Program – Manual of Operations, 2012). The condition prohibiting the grow-out of bivalves in LBA may be intended to provide protection for the surrounding environment and fisheries for an aspect of the shellfish industry that has not been developed yet in Canada.

3.2. Broad Goals of Land Based Aquaculture Regulation

The *Fisheries Act* is the main piece of federal legislation that regulates LBA. The *Pacific Aquaculture Regulations* were enacted under the authority of this legislation. However, the *Fisheries Act* does not include any provisions explicitly setting out the goals of this legislation. This section will describe the implicit goals of the act.

Traditionally, the federal goal in the *Fisheries Act* was interpreted as protecting the public resource aspect of the fisheries (Dudley & Walden, 2010). Under this view, the federal government has a responsibility to protect the public resource to ensure longevity of the resource for generations to come. This thinking is still a valid interpretation of the *Fisheries Act* today. Although at one time there was a provision in the *Fisheries Act* explicitly setting out its purposes (section 2.1) that section was repealed in 1985 (R.S., 1985, c. 35 (1st Supp.), s. 6). Since there is now no clearly legislated purpose within the Act, it is up to the reader to interpret the purpose of the Act based on the provisions set out within it. Management of the fisheries, including protection of fish stocks and of fish ecosystems is the main subject matter. The Department of Justice Canada, 2010 agrees, stating that the three main subject matters dealt with in the Act are:

1. Management and control of fisheries,
2. Conservation and protection of fish, and
3. Protection of fish habitat including prevention of pollution.

Chapter 4. The Existing State of LBA Affairs

In order to investigate the potential effects of LBA on N<u>a</u>nwa<u>k</u>olas Member Nations and assess whether LBA development opportunities could aid in cultivating sustainable community development using the sustainable development frameworks introduced in Chapter 1.4, I conducted site visits and interviews, disseminated and discussed the information in a N<u>a</u>nwa<u>k</u>olas working group meeting and analyzed the interviews and discussion using NVivo software. Site visits and interviews were conducted to better understand the LBA industry on Vancouver Island and the attitudes of N<u>a</u>nwa<u>k</u>olas Member Nation representatives about different aquaculture ventures.

4.1. Site Visits & Interviews

After gaining an understanding of aquaculture and LBA history in BC as well as the regulatory requirements for the development of new sites, I investigated how LBA facilities in BC are currently operating by visiting a selection of LBA sites in BC and talking with the owners and operators. This phase of work also included conducting interviews with study area residents including N<u>a</u>nwa<u>k</u>olas Member Nation representatives to understand existing aquaculture ventures of the N<u>a</u>nwa<u>k</u>olas Member Nations and potential interests in pursuing LBA in the future. At this point in the study, the possible variety of species that would be cultivated remained broad. The reason for keeping the variety of species of broad was in part to attempt to gain a wider understanding of what is being accomplished with LBA and in part because the research team was searching for indications of what might be an appropriate species to consider for LBA for N<u>a</u>nwa<u>k</u>olas Member Nations on northern Vancouver Island.

The sites that were visited by the research team along with their location and unique site characteristics are presented below[1]. Following that, the methods for interviews conducted with Nanwakolas Member Nation representatives are presented.

4.1.1. Site Visits

The research team travelled to seven sites on Vancouver Island and in the Lower Mainland of BC to understand the breadth of possibilities with respect to technical innovations and ownership models for land based aquaculture. To capture as much of the production chain as possible, the research team visited hatcheries, grow-out facilities, aquaponics farms and processing/distribution facilities. Sites were selected through discussion with the Nanwakolas Council project manager and the LBA best practices scan. Approximately 10 facilities were contacted with the goal of speaking to the owner and touring the facility. Seven sites responded and invited me and the research team to speak with facility representatives and see the operation first hand. The facilities visited are shown in Figure 4.1 and included: Vancouver Island University, Marine Harvest, Little Cedar Falls, Salish Sea Foods, You Grow Food Aquaponics, Albion processing plant and Hummingbird Cove Ltd. Unique characteristics for each facility are summarized below.

Figure 4.1 Site Visit Locations

[1] Site visit summaries have been co-authored by the research team: Jake Bastedo, Jeff Lemon, and Elizabeth Mosier.

Vancouver Island University

Vancouver Island University (VIU) in Nanaimo, British Columbia, operates the International Centre for Sturgeon Studies (ICSS), which brings together research activities at the regional, national and international levels for the preservation of white sturgeon. Through the ICSS, VIU has also created an aquaponics program that runs on a freshwater recirculation aquaculture system and has partnered with the Culinary Institute at the university to demonstrate the potential of aquaculture and aquaponics production of a variety of species (including sturgeon) to the chefs and opinion makers of the future.

Figure 4.2 Sturgeon at Vancouver Island University

Marine Harvest Canada

Marine Harvest Canada (MHC) produces over 40,000 tonnes of Atlantic salmon each year from salmon farms on the coast of British Columbia and Vancouver Island. In 2015, they announced a $40-million-dollar infrastructure investment at the company's hatchery facilities in Big Tree Creek and Dalrymple which are slated to be finished in 2017. Designed to raise parr and smolts (juvenile salmon prior to seawater entry), MHC's reports that their new RAS hatchery lines help cut down the grow out stage by about 6 months, while using about one-hundredth of the freshwater as a traditional flow-through aquaculture system.

Figure 4.3 LBA Tank at Marine Harvest Facility

Little Cedar Falls

In Nanaimo, British Columbia, Little Cedar Falls is the first RAS facility to successfully reach continuous production with Steelhead salmon in Canada. Over 2 tonnes of fish are harvested each week, which reach markets across Vancouver Island the following day. In our site visit, owner/operator Steven Atkinson claimed that his products have exceptional quality, color, and fat content, and he attributed these to RAS technology, the feed used, and ensuring the proper depuration of the fish. In 2015, Little Cedar Falls won runner up at the Fish 2.0 Sustainable Seafood Business Competition held at Stanford University, for their sustainable business design - the entire aquafarm reuses 99.6% of its inputs. The other .4% is recirculated through their aquaponics system where they grow vegetables and leafy greens by harvesting the wastes of their farm.

Figure 4.4 Little Cedar Falls Tanks

Salish Sea Foods Processing Plant

Salish Sea Foods is a processing plant owned by the K’omoks First Nation. It is the main processing plant for K’omoks owned Komo Gway oysters and performs processing of salmon and shellfish for other local seafood producers. The processing facility was bought by K’omoks and grandfathered into a licensing agreement allowing value added processing including smoking for shellfish and salmon in a single facility - a license that would not be possible under the current Canadian Food Inspection Agency regulations. The processing facility also includes a retail store selling a variety of the products produced at the processing plant. The 7,000 square foot plant provides over 20 employment opportunities and is operating at capacity since just after its take over by K’omoks First Nation Economic Development in 2013.

Figure 4.5 Salish Sea Foods Salmon
Salmon in the smoker (left) and the final value-added products (right)

You Grow Food Aquaponics

Opening its doors in 2011, You Grow Food Aquaponics is a small social venture located in Hope, British Columbia, that works toward issues of local food security and economic development through education, capacity building, and public engagement. Operating on half an acre, the operation is run out of a small-scale commercial greenhouse that was retrofitted to house the aquaponics system. Two tanks house approximately 40 tilapias, which produces nutrient rich water for the more than 20 types of fresh herbs and greens they sell locally through community supported agriculture subscriptions. Additionally, owner/operator Stephanie Hooker is working with Kwantlen Polytechnic University in Vancouver, to turn the excess ammonia rich water into an organic fertilizer to be sold to local farmers and gardeners as a secondary market. Although the tilapia are not sold for consumption at this stage in the operation, expanding this market is part of their expansion plan. You Grow Food Aquaponics was picked as a site visit location because it highlights the potential of utilizing the waste output of an aquaculture enterprise to access secondary and tertiary markets.

Figure 4.6 You Grow Food Aquaponics
Tilapia (left) and lettuce and chives grow beds (right)

Albion Fisheries

Opened in 2013, Albion Fisheries' new processing plant has temperature control throughout the facility and high-tech processing equipment including a laser portioning machine. During the site visit, Guy Dean, Albion's Vice President, gave the research team a personal tour around the 65,300-square-foot facility. The site visit focused on all aspects of the new facility, including the examination of their highly-automated processing system (heading/gutting – cleaning – filleting – pin boning – skinning – portioning), all which augment their traditional hand cutting process. After the tour, Albion's Vice President sat down with the interns offering his insights and personal anecdotes of the seafood industry. Albion was approached because they have a foundational knowledge of the BC Seafood Market and have substantial experience in marketing and building brand loyalty. Additionally, Albion has worked with several RAS operators along the BC coast to help them get up and running. The team saw Albion as a potential ally to the Nanwakolas, in terms of the development of a land-based aquaculture project and the sale of product.

Figure 4.7 Albion Fisheries Processing Facilities
Salmon laser portioning machine (left) and refrigerated warehouse (right)

Hummingbird Cove Lifestyles Ltd.

Hummingbird Cove is a flow-through shellfish LBA facility located in Saltery Bay that is scheduled to open in 2017. The facility has hatchery licensing for over 20 varieties of shellfish. There are future plans to work with DFO to allow land based grow out licensing for sea cucumber. Researchers at Hummingbird Cove are propagating algae feed for the shellfish from native algae harvested locally from Saltery Bay. At present, 4 different types of local alga are being grown. The facility owners have plans to develop educational and learning programs partnered with aquaculture industry and research experts based in Dalian, China. Hummingbird Cove has embarked on an open and collaborative process with federal and provincial regulators and local First Nations during licensing.

Figure 4.8 The Lab buildings under construction at Hummingbird Cove

From left to right: project interpreter, facility owner, local business owner, facility owner, the friendly, resident dog and me.

4.1.2. Interviews with Member Nation Representatives

With my research colleagues, Jake Bastedo and Jeff Lemon, conducted interviews with five N<u>a</u>nwa<u>k</u>olas Member Nation representatives from four Nations. Interviewees were selected and approached by the N<u>a</u>nwa<u>k</u>olas Council project manager in an effort to connect me and the SFU research team with representatives that were knowledgeable of their Nation's relationship with aquaculture and that had the capacity to speak with us. Two representatives of the five that were interviewed were from the same Nation. In order to maintain confidentiality, the findings specific to each individual or Nation cannot be discussed; instead aggregate findings of the interviews and subsequent working group dialogue will be used this study. All of the Member Nation representatives that were interviewed emphasized that their personal stories and opinions do not and cannot be interpreted as the opinions or experiences of any of the Nations as a whole. The Nations that were represented through the interview process include Tlowitsis, K'omoks, Wei Wai Kum, and Da'naxda'xw. The interviews made use of the hypothesis-seeking Halling dialogue approach that will be discussed in more detail below. The approximately 1-hour interviews were motivated by the guiding questions below.

- What aquaculture ventures does the Nation currently possess (i.e. ocean tenures, processing facilities, oyster rafts)?
- Is there interest in further developing aquaculture ventures for the Nation?
- What are some of the challenges that have been encountered in current aquaculture ventures?
- Are there any aquaculture activities that hold cultural significance to the Nation?
- Are there any species of seafood that hold significant cultural significance to the Nation?
- Are youth engaged in cultural food practices?
- What are some of the food-focused activities that the Nation regularly undertakes?
- What are some existing businesses that have been successful and beneficial to the community?
- Are current regulations related to fisheries and aquaculture affecting the Nation's involvement with aquaculture as a whole?

Halling Dialogue Approach

The research interviews were conducted using the Halling dialogue approach. This approach requires that the research embrace a sense of uncertainty throughout the conversation while maintaining an air of openness and vulnerability to encourage learning through storytelling (Halling ,2014). The Halling approach challenges the thinking that value depends entirely on utility and encourages time spent on building trust (Halling, 2014). Halling et al. (1994), explain that asking specific questions presupposes that the researcher knows the way to the answer. In this case, we wanted to listen to what Member Nation representatives had to say about aquaculture through the interpretation of their own personal stories with aquaculture. Instead of going in with a pre-defined set of questions, we had a range of questions that may guide the direction of the conversation but allows for fluidity. We were attempting to gather stories through the interview process to distill out the message and key themes of aquaculture for the Member Nation representatives. This interview approach was appropriate for this study because it allowed us, the researchers, to achieve our goal of bringing out the breadth and depth of experiences with aquaculture.

NVivo Qualitative Data Analysis

NVivo is a software program developed by QSR International that supports qualitative and mixed methods research. It allows the user to “organize, analyze and find insights in unstructured, or qualitative data” (QSR International, accessed Feb 19, 2017). The power of NVivo comes from its ability to organize and quickly retrieve data through coding. Coding involves the user defining a sentence or thought in a series of qualitative data to a theme, called a node. Once a series of qualitative data are coded by nodes, NVivo can then carry out different types of queries and analyses allowing the researcher to investigate the prevalence and relation of the nodes to each other. Furthermore, the nodes can be nested where a parent node may indicate an overall theme or idea with child nodes indicating more specific ideas.

The recorded interviews that were carried out by the research team with Member Nation representatives were transcribed and uploaded to NVivo. Each research team member reviewed every transcript and then met to discuss the themes and nodes that were observed to be reoccurring or significant to the discussion. The result of the research team discussion was a list of preliminary NVivo coding nodes. The team then applied the preliminary coding nodes to the NVivo interview transcriptions and added nodes and coding as required to capture ideas or themes that were not included in the preliminary coding nodes. The nodes used in the coding process are detailed in Appendix C and have the parent coding themes of Economic Development, First Nation Goals, Food Security or Sovereignty, Planning to Implementation, and Regulation and Planning

In the coding process, a consistent protocol was followed by each of the researchers to ensure consistency among the themes and nodes that were identified. Also, since coding was completed by each of the three researchers on an individual basis, a protocol was established for ensuring that each researcher's coding was preserved in the overall shared NVivo analysis. The protocols outlined in Table 4.1 were used throughout the coding process.

Table 4.1 NVivo Coding Protocol

Action	Protocol
Coding Points	Do not code at Parent Nodes. If content doesn't quite fit with an existing child node, create a new child node. Data coded at parent nodes has less functionality in NVivo analysis functions and does not provide interesting contextual layers for later comparison. Do add new nodes. If unsure under which parent node the new node belongs, add nodes to a Miscellaneous layer and observe if more context for the new potential node emerges throughout the coding process.
Editing	If a researcher notices something that requires editing either to the interview transcriptions or the node structure, do not change it in the local copy of the NVivo analysis. Make a note of it and edit it in the master file after saving or merging with the master version.

After each researcher had coded each of the transcribed interviews, coding control was handed to a single researcher, Jake Bastedo, to review the coding that had been completed, apply definitions and memos to the nodes and ensure that there was consistency throughout the coding process.

4.2. Interviews and Dialogue with Member Nation Representatives

This section will discuss the analysis that was carried out on the data collected during the interviews with representatives of Member Nations. It will also summarize the working group and dialogue that was subsequently held with representatives of Member Nations to disseminate and discuss the information learned during the course of the interviews in order to inform the next stages of the anticipated Mitacs project.

4.2.1. Qualitative NVivo Analysis of Interviews

The NVivo analysis of the interviews was completed using NVivo coded transcriptions of the interviews. Coding was completed by the research team and included the major themes of economic development, First Nation goals, food security, planning, regulation and sustainable community development. Coding was collectively completed by the research team in an effort to better understand the relationships between the main research themes.

For the analysis of regulation and planning on aquaculture for Member Nation representatives, I was interested in seeing if LBA regulation was a challenge in current aquaculture ventures. Therefore, I started with an analysis of the word frequency for the node 'Barriers to Implementation' and removed stop words (less significant words like conjunctions or prepositions, that may not be meaningful to the analysis) one at a time until a list of approximately 10 words was developed that were directly related to the barriers to implementation of an aquaculture facility and cited frequently in the interviews. The major themes that emerged for barriers to implementation of aquaculture facilities were people, water, and capacity. The theme of people as a barrier to implementation was related to having the "right" people. The definition of "right" was different among the interview participants. For some, the "right" people were people that had the knowledge in order to operate an aquaculture facility, for others, the "right" people needed to have a willingness to work long hours in often remote locations, and for still others the "right" person was someone who was willing to champion aquaculture – a nurturer of the business that had a keen interest (either economic or social) in seeing the business succeed. The barrier of water was related to availability of ocean tenures in which to situate the aquaculture, or related to the quality of water (more relevant to LBA) available. Capacity was related to education and included having employees that were trained as well as the capacity within the band to support the aquaculture initiative through funding, expertise, labour or all three. The most frequent words are shown in Figure 4.9 with the larger words being the most frequent.

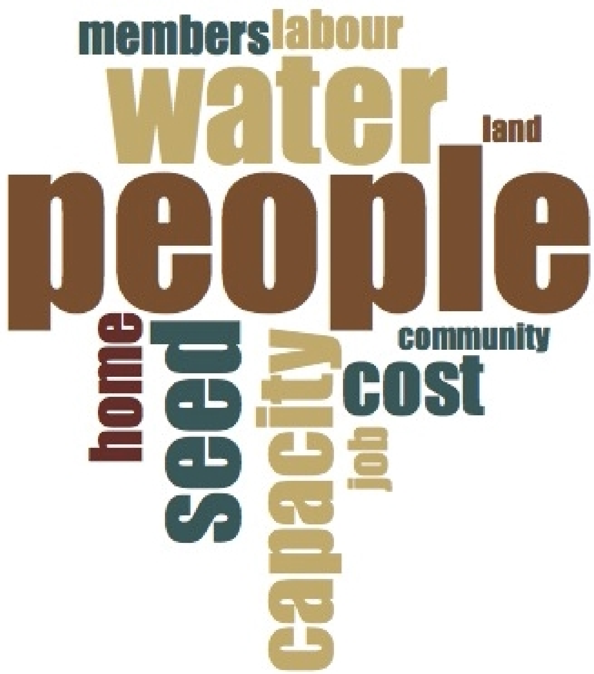

Figure 4.9 NVivo Word Frequency for Aquaculture Barriers to Implementation

With this understanding of the main barriers to implementation for aquaculture facilities, I turned to the question of how the barriers to implementation identified by Nanwakolas Member Nation representatives compare to the barriers identified in literature. While the literature often cites costs as being the major barrier to implementation of aquaculture or LBA facilities, I found that for Nanwakolas Member Nation representatives, cost was still a major factor, but the themes that were spoken about at most length were related to ”people”. Therefore, the interviews indicate that while technological advancements and capital availability are important, finding the right people that have the human capacity and can help build facility identity are keys to success in the aquaculture ventures observed by Nanwakolas Member Nation representatives.

Next, I was interested in analyzing how barriers to implementation are related to other nodes. The ‘Barrier to Implementation’ node has 63 references in the NVivo analysis. I was interested in finding out how these nodes relate to the other parent nodes identified in the NVivo coding. The main intersections of “Barriers to Implementation” were with “Economic Development” with the connecting theme being capital, “First Nation Goals” with the connecting theme being location and people willing to do the work, and “Sustainable Community Development” with the connecting theme being capital and location (where location again relates to having the “right” people available and willing to do the work). The main barrier for aquaculture identified by Nanwakolas Member Nation representatives was having the human capacity to carry out the work. However, as will be discussed in greater detail below, I found that there is generally little knowledge of land based aquaculture regulations by Member Nation representatives at this time, and the conversation often reverted back to traditional water-based aquaculture as that is what is familiar for Member Nation representatives. A lack of understanding of LBA and related regulations may further strain the human capacity needed to undertake aquaculture projects from a Nanwakolas point of view.

4.2.2. Working Group Meeting & Dialogue

The following section has been co-authored by the research team.

The research team met with a working group made up of representatives of Nanwakolas Member Nations on November 7, 2016 in Campbell River to present and discuss the research findings of the three research themes: regulation and planning, food security and business entrepreneurship[2]. The 8-person working group was made up of representatives from four Nations and two industry and aquaculture economic development professionals. Three members of the working group has also been interviewed as part of this study. The main findings for the regulation and planning

[2] The working group meeting and dialogue has been equally co-authored by the research team: Jake Bastedo, Jeff Lemon, and Elizabeth Mosier.

theme (discussed above) were the barriers to implementation, and the observation of little knowledge of regulation related to LBA. Several questions were explored through engaging dialogue throughout the one-day workshop including: is it easier to get land based licenses as opposed to traditional net pen aquaculture licenses from a regulatory point of view? If all DFO regulatory requirements could be achieved, would Member Nation representatives be more interested in finfish or shellfish land based aquaculture? What might future collaboration look like for the Nanwakolas Nations? What opportunities would an ideal land based aquaculture business bring to the community?

The dialogue motivated by these questions helped to provide more insight and context to some of the challenges surrounding LBA on northern Vancouver Island. A majority of workshop participants expressed unease and indignation surrounding the fact that bureaucratic DFO processes and political agendas may prevent the development of fisheries such as sea cucumber that are well suited to BC waters, economically favourable and hold cultural significance to First Nations. Participants also expressed a common interest in taking steps to pursue shellfish aquaculture - either land-based or traditional - for food, social, and ceremonial purposes. Participant interests include a hatchery to make more seed locally available and supporting education programs to build capacity. Participants expressed some interest in multi-phase business plan opportunities that may provide food now and profitable returns further on in the future. However, they voiced concerns about pursuing any venture that does not have economic profit as a first priority. Finally, the participants discussed and shared sentiments for working together to create strategic multi-stakeholder partnerships, as it is perceived as almost impossible for the smaller nations to attempt any substantially sized project on their own. Discussions also included the significance of a First Nations owned and operated regional hatchery in BC that could help build local capacity (i.e. skills and training), as well as promote knowledge sharing between Council nations.

On the topic of shellfish LBA, there was discussion that the land based technologies for shellfish are still too expensive; high capital and operating costs are often identified as major challenges in the development of an LBA operation. An industry representative explained that one of the main costs for shellfish LBA is producing plankton, the main food requirement for shellfish that is freely available in the ocean. Another recurring theme of discussion was that there is a deficit of human capital needed to start LBA facilities. A willing workforce with technical expertise is required.

The participants voiced interest in taking steps to pursue shellfish aquaculture, either land based or ocean based. Potential steps discussed during the dialogue included assertion of First Nation's food, social and ceremonial rights to plant shellfish seed in traditional waters and food, social and ceremonial rights to harvest culturally significant and high-value shellfish species such as geoduck and sea cucumber. The working group also discussed the potential to establish a shellfish hatchery abiding by the current licensing requirements prohibiting grow-out of bivalve species in land based operations and that, if DFO regulations shift, Member Nations would be able to expand operations to full grow-out LBA. Additionally, a Member Nation representative explained that the existing oyster companies often struggle to find and buy available local oyster seed and are at times forced to buy seed from as far away as New Zealand. Education programs to train and build the human capacity needed to operate shellfish facilities (hatchery, land-based or traditional) are desired among the workshop participants to ensure that First Nations are well positioned to take a share of the shellfish (and especially land based shellfish) industry if and when federal and provincial regulations and licenses for shellfish are further developed.

The SFU research team and I generally found that there is limited understanding of what the DFO regulations currently are surrounding shellfish aquaculture and especially LBA. Limited understanding of LBA was evident in the way that discussion at the working group repeatedly defaulted to ocean aquaculture. A proof of concept facility may be important in developing and understanding and interest from DFO to develop regulations to allow the grow-out of bivalve species. A highlight of the dialogue session was encouraging discussion about the power of a facility that could bring people together to provide education and preparedness for First Nation members that are interested in gaining a stake in the shellfish LBA industry.

4.2.3. Core Issues and Challenges Facing Aquaculture and LBA

The interviews and site visits demonstrated that there is a significant range of possibilities for the development of land based aquaculture facilities. Regulation and licensing procedures become more arduous with the complexity of the project. Small backyard facilities for educational or individual food production (such as You Grow Food) require less complicated licencing and regulation, while large-scale commercial aquaculture facilities require significant regulatory procedures. Additionally, the regulation process becomes more complex with vertical integration of business models, such as inclusion of a processing or hatchery facility.

The core issues that I observed through literature review of best practices and regulations in BC, site visits, interviews and the working group dialogue were:

- Human capacity to carry out the development and operation of facilities;
- Lack of resources to meet high capital costs and resource requirements; and
- Only a loose understanding of LBA and the regulatory requirements that come with it.

Chapter 5. Regulatory Gaps and Sustainable Development Effects for LBA

In this chapter I identify regulatory gaps for LBA in BC based on the findings of the regulation review, site visits, interviews and discussion with DFO staff. The potential regulatory gaps are discussed in relation to existing LBA regulatory requirements. Then, I present two hypothetical scenarios based on what is possible for an LBA facility located in Nanwakolas Member Nation traditional territory (based on site visits and the aquaculture best practices scan) and what Member Nations are interested in developing (based on the interviews and working group with Nanwakolas Member Nation representatives). I assess the two hypothetical shellfish/non-finfish scenarios using the sustainable development frameworks: CWW and CCT.

5.1. Regulatory Gaps

In this section I assess whether the current federal framework for aquaculture regulation under the *Fisheries Act* adequately addresses shellfish/non-finfish LBA. I also discuss problems with the broader regulatory framework for LBA in BC identified by respondents in our site visits and interviews. During the course of the site visits and interviews, the reach and extent of aquaculture regulations (as presented in Chapter 3) was interpreted and discussed with facility operators and owners. Each LBA practitioner had a different experience with the permitting and regulatory procedure that was largely determined by the characteristics of their LBA facility. However, one of the core issues related to regulatory gaps observed through the literature review, site visits, interviews and working group dialogue, is that the current aquaculture regulatory requirements do not clearly delineate responsibility. This section will provide more detail on issues associated with the current regulatory framework for shellfish/non-finfish LBA in BC.

The three goals of the *Fisheries Act* will be discussed in relation to shellfish/non-finfish LBA. Then, potential omissions and risks not addressed by the *Fisheries Act* and related regulation will be presented. Finally, the policy implications will be presented and discussed.

5.1.1. Fisheries Act Goals & LBA

The goals of the *Fisheries Act* and related regulation were presented in Section 3.2 - Broad Goals of the Fisheries Act and include the management and control of fisheries, conservation and protection of fish and the protection of fish habitat. Each goal is discussed below in relationship to LBA.

***Fisheries Act* Goal 1: Management and Control of Fisheries**

Management and control of fisheries refers to the responsibility of the federal agencies to ensure longevity of a public resource. The goal speaks to the economic importance of fisheries in creating long-term economic sustainability for commercial fishers and the delicate nature of wild fish stocks that can and have been depleted, as evidenced in the collapse of the Canadian Atlantic Cod fishery (Hutchings & Meyers, 1994). Examples such as the Cod collapse highlight the necessity for careful management of wild fisheries, but the applicability of the goal to all forms of LBA is questionable. LBA RAS or flow-through typically aims to separate cultivated animals destined for food processing from naturally occurring fisheries. The animals are contained in tanks on land with the intention to harvest every individual. In other cases, however, land based systems may hold the potential to aid in the management and control of fisheries through hatchery conservation projects. Additionally, native species at risk may be cultivated under controlled, land-based operations and released to the oceans as is the current practice of the Hummingbird Cove shellfish owner in her other facilities in the Dalian region, China (D. Dyble, personal communication, February 22, 2017). Furthermore, in my discussions with representatives of current N<u>a</u>nwa<u>k</u>olas shellfish aquaculture ventures they noted that access to reliable and available shellfish seed stock is a continued challenge for their operations. Expansion of LBA shellfish hatcheries could aid the federal government in achieving better management and control of native shellfish fisheries while bolstering local economic development by expanding shellfish LBA hatcheries.

Fisheries Act Goal 2: Conservation and Protection of Fish

Turning to the goal of conservation and protection of fish, fisheries management should ensure the protection of fish stocks from threats such as exposure to disease, predators and overharvesting. This goal may motivate actions such as the closure of a fragile fishery to protect remaining fish stocks. The goal may also refer directly to fish health, although regulations and policies under the *Fisheries Act* place emphasis on the health of the stock rather than the health of the individual fish. When applied to LBA (RAS or flow-through), the interest in protection of wild and other non-farmed stocks comes from the interaction of farmed animals with these stocks, potentially exposing non-farmed stocks to disease or other illnesses. This concern is especially relevant for flow-through LBA facilities where the water circulation between the facility and the natural source is continuous. The risks to non-farmed fish stocks from LBA may be reduced by effective regulation of species escape and water discharge. Currently, as noted by representatives of Hummingbird Cove shellfish LBA, water discharge quality regulations are determined on a case-by-case basis depending on the facility characteristics including size, location and cultivated species. Operators at Hummingbird Cove, Little Cedar Falls and You Grow Food recognized the need to establish safeguards to ensure that waste water discharged from LBA facilities has been adequately treated and does not pose significant risks to the plants and/or animals that may come into contact with the effluent.

The interpretation of the goal of conservation and protection of fish may also have an impact in terms of individual fish health. LBA facilities hold animals in significantly higher, homogenous densities than would occur in natural water bodies (Summerfelt & Christianson, 2014). Studies for finfish LBA have found that that there can be increased damage to individual fish from other fish under these higher LBA densities (Summerfelt & Christianson, 2014). In shellfish LBA, higher stocking densities have not been shown to negatively affect animal health or strength, but lower shellfish stocking densities have been correlated with more desirable product attributes including shell cup, fan appearance and meat quality (Davis, 2013).

***Fisheries Act* Goal 3: Protection of Fish Habitat**

The final goal includes ensuring the conservation of fish habitat, preserving waterways from deleterious substances, and maintaining fish pathways by minimizing the effects of dams and other obstacles on migration. The goal of protection of fish habitat is most relevant to LBA (RAS and flow-through) through the management of waste discharges from such facilities. The regulation of release of any industrial waste needs to be monitored to ensure that there is no detrimental effect to the surrounding ecosystem. As noted above, it would be advantageous for the water quality discharge requirements for LBA to be standardized. However, there is another concern related to this goal: existing LBA facilities have reported challenges including entire cohort kills due to errors in maintaining necessary water temperatures or oxygen content (Benjamin, 2014). Failures of LBA operators or technology that result in LBA animal kills could be interpreted as violations of the goal of protection of fish habitat under the *Fisheries Act.* It is even possible that a water supply that is lethal because of a control error in maintaining temperature or oxygen content may be considered a "deleterious" substance. In the case of *R. v. Suncor Inc.* [1985], 4 F.P.R. 409 (Alta. Prov. Ct.), the meaning of deleterious substance was expanded to include water changes that affect growth, oxygen content, and normal development. I discussed this issue with DFO officials and they said that bringing sanctions for deleterious substances would likely only be considered if the fish or shellfish that were being held in the facility had a direct impact on natural fish stocks; for example, if a facility was collecting wild brood stock and an LBA cohort kill resulted in the requirement to collect additional wild brood stock.

An examination of the goals of the fisheries acts highlights a lack of “fit for the purpose” to ensure environmental and animal protection in LBA operations. The focus of the goals of the *Fisheries Act* and related regulation is on wild fish stocks and natural fish habitat. The introduction of an LBA specific advisory group could aid in bringing forward some of the issues specifically related to the LBA described above. Several broad advisory groups exist and are active in the industry association meetings held several times per year (DFO, personal communication, March 6, 2017). However, there is no group that brings LBA specific concerns forward to DFO. A LBA advisory group made up of facility operators, LBA educators and researchers could initiate discussion at industry association meetings on topics like stocking density, effluent discharge and bivalve grow-out. The Industry Association Meetings offer an opportunity for the aquaculture industry, associations, regulators and First Nations to come together to voice concerns and desire for future initiatives.

The site visits revealed another feature of the LBA freshwater license that could be attributed to regulation that is not fit for the purpose: as per Chapter 3.1, licenses are granted for up to a 9-year term, at the end of which the operator is required to re-apply. The LBA owner is seemingly taking on a significant risk by incurring the large capital costs on a license that needs to be renewed well before LBA equipment would need to be replaced (D. Dyble, personal communication, February 22. 2017). However, while LBA owners may benefit from the added security that would come from an extended license term, 9-year license terms are actually quite long in comparison with the requirements for other aspects of the industry that require licensing. Seafood processing licenses are required for any commercial seafood processing facility and as per Section 31 of the Fish and Seafood Licensing Regulation, BC REG 261/2016 licenses are granted for up to 1 year. Additionally, in the years following the *Morton v. British Columbia* decision, which shifted aquaculture licensing responsibility from the provincial to the federal government, aquaculture (and LBA) license terms have been extended from 1-year to 9-years. With only seven years since this change, DFO officials say that current aquaculture practitioners are happy with the licensing terms (DFO, personal communication, March 6, 2017). Therefore, though there could be benefits of an extended license term for LBA, it will not be included in my recommendations as a priority for regulatory change.

5.1.2. LBA Risks & Omissions in the *Fisheries Act*

In addition to assessing the relevance of the goals of the *Fisheries Act* for LBA, it is also important to question whether the *Fisheries Act* and other federal and provincial legislation are adequately regulating the risks associated with LBA. In 2014, 80 scientists and operators of LBA facilities from Canada, US and Europe participated in a workshop at the Atlantic Salmon Federation came together and identified the primary weaknesses of implementation of LBA projects, internationally, to be 1) high start-up and operation costs, 2) too high environmental and energy costs, and 3) a concern for the cumulative effect of many LBA facilities on water resources and animal welfare (French, 2014). LBA in Canada is still an emerging industry and as such, regulation requirements may not be fully understood with the focus in recent years being on research for technical feasibility and reducing the high capital costs of operations. The potential adverse effects of LBA that came to light through the literature review, site visit, and interview process shed light on potential management issues including: use of water, waste effluent, regulations related to minimum water quality standards, harvesting procedures and stocking densities. Each of the potential management concerns for LBA will be discussed in the context of existing federal and BC legislation.

- **Use of Water:** Extraction and use of water for LBA facilities is regulated and monitored through the provincial water licensing system. All LBA facilities require a valid water license to divert, use or store surface or groundwater, or to make changes to a stream. Water licenses are regulated under the provincial *Water Sustainability Act* (S.B.C. 2014, c. 15). Water Licenses are used to regulate water use for large industrial and agricultural operations and therefore, may be accepted as a reasonable management tool for LBA.
- **Waste Effluent:** Waste effluent is primarily managed under the federal *Fisheries Act* and the provincial *Environment Management Act* (R.S.B.C. 2003, c.53) section 6 that includes the conduct of "prescribed industry, trade or business" for the "storage, treatment, handling, transportation, discharge, destruction, or other disposal of waste in relation to the prescribed industry, trade or business."
- **Fish Health:** minimum water quality standards, harvesting procedures, and stocking densities all relate to individual fish health. The *Fisheries Act* does not regulate the treatment of individual animals in aquaculture facilities, nor does the provincial *Fisheries Act Regulations*. The *Health of Animals Act* provides regulations for the control of disease and toxic substances that may affect aquatic animals and be transmitted from aquatic animals to people. These too, however, do not provide minimum guidelines for stocking densities, minimum water quality standards or harvesting procedures. DFO is in the process of introducing fish health management plans, however the plans are not anticipated to be prescriptive in defining minimum fish heath standards (DFO, personal communication, March 6, 2017).

Omissions of LBA regulation in the *Fisheries Act* that may be covered in other regulation reinforce one the concerns that was raised by facility operators that one of the most time-consuming challenges of LBA is satisfying fractured, multi-level governance requiring the duplication of information for several different government agencies. The issue is exacerbated when one considers documentation requirements and correspondence to satisfy the Provincial Government, Federal Government and First

Nations governance through the duty to consult for resource develop projects that may affect Aboriginal rights. While the hypothetical scenarios presented in this report involve projects being developed by or on behalf of First Nations, a duty to consult may still exist and may include discussions with several First Nations. Another specific challenge highlighted by DFO, is license challenges for species at risk that are protected under the *Species at Risk Act* (S.C. 2002, c. 29). There currently is not a process for LBA licensing of species that have not previously been licensed in BC or that are protected under the *Species at Risk Act*, such as Northern Abalone. Licensing for new species are evaluated on a case-by-case basis and significant information gathering is required of the license proponent (DFO, personal communication, March 6, 2017).

5.1.3. Policy Implications

Although the *Fisheries Act* is a broad law with goals not specifically aligned with management issues of LBA, in many ways it could be sufficient for the regulation and management of LBA, operating in conjunction with provincial government policies and legislation such as the *Water Sustainability Act* and the *Environment Management Act*, if the overall regulatory framework was comprehensive and properly coordinated and integrated. The main gaps in the current regulatory framework with respect to LBA are a lack of “fit for the purpose” LBA regulation and a fractured multi-level governance structure. The lack of “fit for the purpose” LBA regulation is highlighted by a focus on wild fish habitat in bodies of water and suggests a need for an LBA specific advisory group. The fractured multi-level governance structure is evidenced by limited protection of individual animal health and duplication of submission requirements and correspondence across provincial, federal and First Nations cited by two facility operators that I visited, along with no established process for licensing of new species in BC. The main policy implications of each of the gaps are described in Table 5.1 below. Howlett & Rayner (2004) supported this finding by showing that aquaculture policy tools tend to fall into two types: substantive tools used to directly delivery goods to users and procedural like the creation of advisory committees. Substantive policy tools are more prevalent in current aquaculture regulation (Holwett & Rayner, 2004).

Table 5.1 Current LBA Regulatory Gaps Policy Implications

Gap	Example	Effect on LBA
No "Fit for the Purpose" LBA Regulation	Focus on natural fish habitats in naturally occurring bodies of water	- Minimal consideration of aquaculture effects on terrestrial species by way of effluent release and waste contamination
	Need for LBA specific advisory group	- Challenges and issues experienced by LBA operators do not have an established method for communication with regulators - No clear paths for information sharing, education and training
Fractured, Multi-Level Governance	Limited protection of individual fish health and omissions specific to LBA environmental risk	- No readily available requirements for effluent discharge from LBA - No existing fish health standards; future fish health management plans are not expected to be prescriptive
	No established process for licensing of new species; submission duplication requirements across Provincial, Federal and First Nations Governments	- Time-consuming application process that was generally reported to take upwards of 2 years increasing startup costs - Little consideration at the outset of the reporting requirements for Fist Nation governments including who to talk to, when, or what the First Nation capacity is to review and comment on a potential development

The LBA industry for finfish and shellfish is still an emerging industry in Canada. New Zealand, however, is home to an established LBA finfish industry and has taken steps to identify regulatory requirements of LBA facilities. In 2013, the New Zealand Department of Conservation completed a review of their LBA regime and found shortcomings of their current regime to be duplication of assessments federally and provincially leading to increased start-up costs and delays, out-dated fisheries regulations that were difficult to interpret, a limiting 14-year term licencing system, emphasis on the transfer of farmed species (including escape) and a need for a greater focus on "fit for purpose" biosecurity and compliance management (New Zealand Department of Conservation, 2013). The shortcomings identified by the New Zealand Department of Conservation are to a large extent reflected in BC LBA regulations with complicated, out-dated fisheries regulation and a lack of fit for purpose LBA legislation. Following New Zealand's example, it is in Canada and BC's interest to identify and remedy legislation that may unreasonably hinder expansion of the LBA industry, be unclear on the regulation's purpose and ramifications, be non-specific on preventing and handling potential animal escapes and waste generation, and not adequately protect the health of individual animals.

5.2. Frameworks for Sustainable Community Development Scans

This section describes the methodology for the selection of two LBA hypothetical scenarios based on the information gained from site visits, interviews and the best practices scan. The analysis makes use of two frameworks for sustainable development: the Community Capital Tool (CCT) and the Community Wellbeing Wheel (CWW) described in Chapter 1.4. A summary of the process for applying the community wellbeing wheel and community capital scans to the selected scenarios is then presented.

5.2.1. LBA Scenario Selection

Two hypothetical scenarios were selected based on the range of the facilities that were visited and discussions with the Nanwakolas Member Nation interviewees. Based on the interview and working group dialogue results, it was determined that shellfish LBA is more desirable for Nanwakolas member nations than finfish, therefore the scenarios will focus on shellfish (or non-finfish) species. The scenarios were selected to cover two ends of a spectrum within the realm of possibility of shellfish/non-finfish species. In speaking with the LBA experts from the Dalian Aquaculture Institute at Hummingbird Cove, they supported the view of the industry representative comment form the working group meeting that shellfish grow out in LBA is difficult to make economically viable and can decrease the quality of the shellfish product, but that sea cucumber grow out in LBA is feasible and has been successful in several operations in Dalian, China (D. Dyble, personal communication, February 22, 2017). The fact that shellfish grow out is unattractive for LBA aligns with the existing regulatory conditions of operation that prohibit grow-out of bivalves in LBA. This prohibition, however, does not apply to sea cucumbers that have been successfully grown on land and belong to the echinoderm family, not bivalve, of marine animals including animals such as sea stars and sea urchins (Regents of the University of California, 2006).

Scenario selection started with a summary of the characteristics of the sites that the research team visited during the project to help in depicting the range of aquaculture facility setups observed (see Table 5.2).

Table 5.2 Site Visit Facility Characteristics

Site	Size & Technology	Ownership & Operating Model	Species	Vertical Integration	Market
Vancouver Island University	Small RAS	Educational Research	Sturgeon, salmon	Education	n/a
Marine Harvest	Large RAS + Ocean	Corporation	Atlantic Salmon	Hatchery/LBA/ Ocean	Global
Little Cedar Falls	Medium RAS	Owner-operator	Steelhead	Aquaponics	Local
Salish Sea Foods	Large Ocean	First Nations Corporation	Oysters, mussels	Ocean Growing/ processing	Local
You Grow Food	Small RAS	Owner-operator / Social Venture	Greens, Tilapia	Aquaponics/ social venture	Community Supported Aquaculture
Albion Fisheries	Large Varied	Corporation	Varied	Processing	Global
Hummingbird Cove	Medium Flow-through	Corporation	Shellfish (varied), sea cucumber	Hatchery/grow-out	Global

Based on the range of shellfish/non-finfish LBA described above, two hypothetical scenarios were selected that were within the realm of possibility as a development project for the First Nations represented by the Nanwakolas Council. The characteristics of the selected scenarios are provided in Table 5.3.

Table 5.3 Shellfish/Non-Finfish LBA Scenarios

Site	Size & Technology	Ownership & Operating Model	Species	Vertical Integration	Market
Scenario 1	Medium RAS	Owner-operator	Shellfish (varied)	Hatchery	Local
Scenario 2	Medium Flow-through	Corporation	Sea Cucumber	Hatchery/grow-out	Local

The following assumptions were considered during the sustainability framework scans:

- Facilities are located on an ocean access property within the traditional territory of the Nanwakolas Member Nations
- Facilities are not located within a park or conservation area and are located on land zoned agricultural or industrial
- Protection of the existing environment will be considered with respect to the water intake, effluent discharge, and energy requirements
- Since many locations within the Nanwakolas Member Nations are remote, assume energy requirements are provided via on-site propane boilers (as per Hummingbird Cove facility attribute)
- Market is strong enough to support the business with access to buyers
- Education and training programs are part of implementation plans to build capacity for the workforce to operate the facilities and will be organized through the facility owner (potentially partnered with international LBA research institutes)
- Species of cultivated seafood are culturally significant and considered part of traditional food heritage of Member Nations

5.2.2. Community Capital Tool & Community Wellbeing Wheel Scans

Scans were completed for each of the two scenarios using both frameworks for sustainable development: the community capital framework and the community wellbeing wheel.

Community Capital Tool

The Community Capital Framework scans were completed using the online platform available at http://www.ccscan-ca.cscd.sfu.ca/community-capital-scan/. I created a profile and then ran Scenario 1 and Scenario 2 through the indicator questions for each of the capitals and stocks. For each indicator, I assigned a subjective score from -5 to +5 and included reasoning for my score selection in the appropriate text box. Throughout the scoring procedure, I concentrated on features of the project that would have a direct impact on the indicator being assessed. The results of the Community Capital Scans were automatically generated by the website. Results summaries downloaded from the web platform are provided in Appendix D. A summary of the scores and reasoning are provided in Table 5.4.

Table 5.4 Community Capital Scan Scores

Capital	Stock	Indicator	Scenario 1: Medium RAS Shellfish Hatchery Score	Scenario 1: Medium RAS Shellfish Hatchery Reason	Scenario 2: Medium Flow-through Sea Cucumber Score	Scenario 2: Medium Flow-through Sea Cucumber Reason
Natural	Land	Ensure protection of biodiversity Increase preservation of natural areas and sensitive ecosystems by parks or conservation areas Preserve Scenic and attractive views	2	Safeguards will be in place with the aim of ensuring biodiversity, but the existence of the facility provides some risk to the natural biodiversity of the area; alternatively, the facility could cultivate brood stock for protection of native species biodiversity The facility will consist of several buildings on a coast access property, likely in a location zoned for agricultural or industrial, there will likely be few neighbouring properties and as such limited effect on scenic and attractive views Facility is not located within a marine or terrestrial park	0	Facility regulatory requirements will aim to ensure protection of biodiversity, however, the flow-through nature of the project means that any contaminants either into our out of the facility will be spread more quickly than RAS Natural areas will be protected by limiting the effect of the facility on the natural ecosystem; facility will be located on vacant coast line Facility is not located within a marine or terrestrial park
Natural	Soil	Eliminate all pollutants and contaminants Expand the preservation of fertile agricultural land Eliminate soil erosion or instability	-2	The facility will have requirements for contaminant and pollutant discharge to the environment, but the existence of the facility increases the risk of soil pollution in the area Located on a property zoned agricultural or industrial (depending on the jurisdiction), and located fairly remotely within the Nanwakolas Member Nations traditional territory, there is likely little effect on expanding the preservation of fertile agricultural land Could increase soil erosion or instability	-3	Facility will have requirements for contaminant and pollutant discharge to the environment, but the existence of the facility increases risk Located on a vacant coastline property zoned agricultural or industrial, and located fairly remotely within Nanwakolas Member Nation traditional territory, there is likely little effect on expanding the preservation of fertile agricultural land (indirect effects may displace conventional agricultural farming?) Could increase soil erosion and instability

			Scenario 1: Medium RAS Shellfish Hatchery		Scenario 2: Medium Flow-through Sea Cucumber	
Capital	Stock	Indicator	Score	Reason	Score	Reason
Natural	Groundwater	Eliminate all pollutants and contaminants Preservation of existing reservoirs and replenishment through natural processes	-1	The facility will have requirements for pollutant and contaminant discharge to groundwater, but the existence of the facility comes with some risk to the area groundwater in the form of effluent and waste discharge Will draw on ocean water resources, that in turn affect surrounding groundwater resources; the effect is expected to be negligent, but risk exists	-2	Facility will have requirements for pollutant and contaminant discharge to ocean and groundwater, however, existence of the facility will increase risk of pollutants Will draw on ocean water resources, with minimal effects to groundwater but risk does exist
Natural	Surface water	Eliminate all pollutants and contaminants Ensure that surface water quality is suitable for human and agricultural use	-1	Requirements in place for pollutant and contaminant discharge to surface water, but the existence of the facility comes with some risk to the area surface water in the form of effluent and waste discharge Water intake and effluent regulations should protect surface water for human and agricultural use; some risk comes with the mere existence of the facility	-1	Facility requirements will be in place for pollutant and contaminant discharge to surface water, but the existence of the facility comes with some risk to the area surface water in the form of effluent and waste discharge Water intake and effluent regulations should protect surface water for human and agricultural use; some risk comes with facility existence
Natural	Air	Eliminate all pollutants and contaminants Reduce greenhouse gas emissions	-2	Requirements in place for pollutant and contaminant discharge to air; the main source of air pollution is expected to be exhaust from the onsite energy source: propane boilers Project will have some associated greenhouse gas emissions (RAS less than flow-through) that will be greater that typical BC industrial process emissions due to potential remote location and need for propane boilers	-2.5	Requirements in place for pollutant and contaminant discharge to air; main source of air pollution is expected to be exhaust from the onsite energy source: propane boilers Project will have some associated greenhouse gas emissions (RAS less than flow-through) that will be greater than typical BC industrial process emissions due to potential remote location and need for propane boilers

			Scenario 1: Medium RAS Shellfish Hatchery		Scenario 2: Medium Flow-through Sea Cucumber	
Capital	Stock	Indicator	Score	Reason	Score	Reason
Natural	Minerals and Non-Renewable Resources	Reduce the extraction rate of non-renewable resources Use only environmentally safe extraction practices	-2	Project will have an effect on non-renewable resources through the need for propane boilers due the remote location of the facility Propane will be bought via regular methods that assume environmentally safe extraction processes	-2	Project will have an effect on non-renewable resources through the need for propane boilers due the remote location of the facility Propane will be bought via regular methods that assume environmentally safe extraction processes
Physical	Infrastructure	Provide safe and reliable water to all citizens Ensure that waste management systems are clean and efficient Ensure that energy is transmitted through a safe, efficient, and reliable system Provide adequate access to reliable telecommunications systems for all citizens	-0.5	Project will have little effect on existing water sources for surrounding citizens Specifications will aim to ensure clean and efficient waste management systems Energy will be provided via propane due to remote study area location; energy source will be safe, reliable, efficient but no renewable Little effect on telecommunications systems for all citizens	-1	Project will have little effect on existing water sources for surrounding citizens Specifications will aim to ensure clean and efficient waste management systems but there is a risk that contamination could spread more quickly with flow-through Energy will be provided via propane due to remote study area location; energy source will be safe, reliable, efficient but no renewable Little effect on telecommunications systems for all citizens
Physical	Land	Ensure that suitable land is available for different uses (e.g.. industry, agriculture, housing, etc.)	0	Project will be located on land zoned agricultural or industrial	-0.5	Project will be located on land zoned agricultural or industrial with ocean access
Physical	Transportation	Create a robust and reliable public transportation system Provide safe, efficient, and well maintained rail and road infrastructure	0.5	Access road construction may be required as part of facility construction Little effect on rail and road infrastructure	-0.5	Access road construction may be required as part of facility construction Little effect on rail and road infrastructure

			Scenario 1: Medium RAS Shellfish Hatchery		Scenario 2: Medium Flow-through Sea Cucumber	
Capital	Stock	Indicator	Score	Reason	Score	Reason
Physical	Housing and Living Conditions	Ensure adequate access to housing, food and clothing for every citizen	2	Project will provide some economic development that could in turn increase resources for adequate housing and clothing Project will provide food to the local market Project will ensure seed availability for other existing local shellfish aquaculture ventures	1	Project will provide some economic development that could in turn increase resources for adequate housing and clothing Project will provide food to the local market
Physical	Public Facilities	Ensure adequate facilities for schools, hospitals, community centers, etc.	0	Some economic development that could in turn increase resources for schools, hospitals, community centers, etc.; overall impact is expected to be minimal due to facility size and remote location	0	Some economic development that could in turn increase resources for schools, hospitals, community centers, etc.; overall impact is expected to be minimal due to facility size and remote location
Economic	Labour	Balanced labour market that includes a variety of job types and salary ranges Adequate training for workforce Work is safe, healthy and allows for appropriate work life balance Wages are adequate to provide decent livelihoods	3	Project will provide approx. 20 - 40 jobs (scaled Hummingbird Cove estimates) in an emerging industry in BC Training would be required for expansion of Nanwakolas Member Nations employees into this emerging market in BC Work is safe, remote location may impede work-life balance (refer to challenges sited in interviews related to finding people willing to work remotely) Wages would be adequate to provide decent livelihoods	2	Project will provide approx. 20 jobs (scaled Hummingbird Cove estimates) in an emerging industry in BC Training would be required for expansion of Nanwakolas Member Nations employees into this emerging market in BC but scale of development of sea cucumber market may be slower than shellfish hatchery Work is safe, remote location may impede work-life balance (refer to challenges sited in interviews related to finding people willing to work remotely) Wages would be adequate to provide decent livelihoods
Economic	Financial Resources	Public bodies have adequate financial capacity to ensure the availability and accessibility of public goods and services Local companies are able to make sufficient profit and	0	Privately owned corporation will pay taxes but have limited effect on the financial capacity of public bodies to provide public goods and services Local market is assumed to be strong enough to support medium RAS shellfish hatchery	0	Privately owned corporation will pay taxes but have limited effect on the financial capacity of public bodies to provide public goods and services Local market is assumed to be strong enough to support medium RAS shellfish hatchery

			Scenario 1: Medium RAS Shellfish Hatchery		Scenario 2: Medium Flow-through Sea Cucumber	
Capital	Stock	Indicator	Score	Reason	Score	Reason
		investment				
Economic	Economic Structure	A good mix of productive and service industries Constant economic regeneration through innovation, new enterprise development and re-location to the community Companies are investing in emissions and pollution prevention and reducing the use of non-renewable resources	2	Jobs from the project will include a desirable mix of R&D, labour, marketing Project will provide entry into an emerging market for Nanwakolas Member Nations Current assumptions do not support transition away from non-renewable resources due to remote location of project; however, the project could in the future employ non-renewable resource energy	2	Jobs from the project will include a desirable mix of R&D, labour, marketing Project will provide entry into an emerging market for Nanwakolas Member Nations Current assumptions do not support transition away from non-renewable resources due to remote location of project; however, the project could in the future employ non-renewable resource energy
Human	Education	Education meets the needs of both society and individuals Education is of high quality and easily accessible	3	Training required to build capacity in RAS shellfish hatchery Education would be provided by the facility owner who has an interest in providing high quality and easily accessible education	1	Training required to build capacity in sea cucumber but there is not a huge demand for sea cucumber training in BC at this time Education would be provided by the facility owner who has an interest in providing high quality and easily accessible education
Human	Health and Wellbeing	Citizens are physically, mentally, and spiritually healthy All citizens have access to health care services for illness prevention and treatment	0	Job creation may in turn contribute to citizen physical, metal and spiritual health but no direct correlation Job may provide access to health care services through benefit packages but no direct correlation	0	Job creation may in turn contribute to citizen physical, metal and spiritual health but no direct correlation Job may provide access to health care services through benefit packages but no direct correlation
Social	Citizenship	Community has social cohesion Social solidarity between citizens Opportunity for citizens to build strong networks	2	Facility would provide seed to existing Nanwakolas aquaculture operations increasing social cohesion and solidarity between Nanwakolas Member Nations Will contribute to the minimization of poverty and exclusion	1	Facility would provide traditional food product to market that may aid in increasing social cohesion and solidarity between Nanwakolas Member Nations Will contribute to the minimization of poverty and exclusion

			Scenario 1: Medium RAS Shellfish Hatchery		Scenario 2: Medium Flow-through Sea Cucumber	
Capital	Stock	Indicator	Score	Reason	Score	Reason
		between each other No poverty or exclusion				
Social	Safety	Citizens feels safe and have access to support systems which encourage safety No violence or crime	0	No direct correlation to citizen access to support systems to encourage safety, potential cascading effects are considered No direct effect on violence or crime	0	No direct correlation to citizen access to support systems to encourage safety, potential cascading effects are considered No direct effect on violence or crime
Cultural	Cultural Heritage	Art is encouraged and celebrated Community acknowledges traditions and celebrations A diversity of culture and tradition is present Cultural heritage is preserved	4	Project will have significant impact on community traditions and celebrations through cultivation of traditional foods and dissemination of cultivation training and education	3	Project will have significant impact on community traditions and celebrations through cultivation of traditional sea cucumber and dissemination of cultivation training and education Only sea cucumber will be cultivated - could benefit from impact of a range of shellfish
Cultural	Identity and Diversity	Citizens are encouraged to express individual identity while not restricting others' freedoms of expression The community has a defined identity	3	Project may contribute to defined identify as witnessed at Salish Sea Foods during site visits	3	Project may contribute to defined identify as witnessed at Salish Sea Foods during site visits

Community Wellbeing Wheel

Scans for each of the two scenarios were also completed using the Community Wellbeing Wheel Framework. The method of analysis that was followed is similar to the methodology for the Community Capital Framework except that there is no web platform available to aid with recording and generating scores. Therefore, I developed a spreadsheet in the style of the above Community Capital Scan Scores table and substituted Community Wellbeing areas for Community Capital capitals and implementation activities for indicators. I then scored each category from -5 to +5 and provided subjective reasoning for the scores concentrating again on the direct impacts of the project on the Community Wellbeing Wheel implementation Actions. Summaries of the scores for the Community Wellbeing Wheel analysis are provided in Table 5.5.

I generated the results in Microsoft Excel™ using a 5-cricle Venn Diagram as per the diagram presented in the 2014 Nanwakolas Council Report: Community Wellbeing and Strengthening Plan. As per the 2014 report, circle size is relative based on the score, from -5 to +5, assigned to the implementation activity description. For illustration purposes, I generated Community Wellbeing Wheel results for a project with no impact or a zero score in all categories (Figure 5.1) and a project with a maximum score or a score of 5 in all categories (Figure 5.2).

Figure 5.1 No Impact Community Wellbeing Score

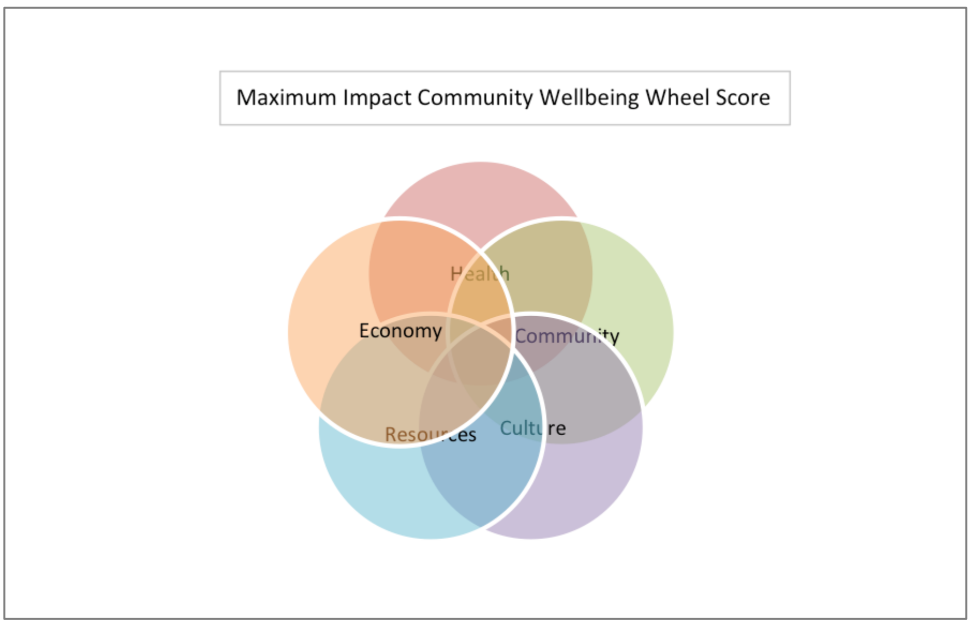

Figure 5.2 Maximum Impact Community Wellbeing Score

The results of the Community Wellbeing Scan were also used to generate a radar chart since it is an automated data driven chart available in Microsoft Excel™. The results in the form of a Venn diagram and radar chart will be presented in section 5.3. In an effort to stay true to the representation set out in the 2014 Community Wellbeing and

Strengthen Plan while providing robust and accurate data presentation, the results of the CWW have been presented both as a Venn diagram and in the style of the CCT sustainability hexagon radar chart. While this presentation allows for comparison between the scenarios and across the frameworks, it does not assume that the units of measurement for the CCT and CWW are the same. The differences in measurements of sustainable development through the CCT and CWW frameworks will be further discussed in Chapter 5.3.

Table 5.5 Community Wellbeing Wheel Scores

		Scenario 1: Medium RAS Shellfish Hatchery		Scenario 2: Medium Flow-through Sea Cucumber	
Area	Implementation Activity	Score	Reason	Score	Reason
Resource Management	Develop effective model(s) for Guardian Watchmen programs in First Nations' territories, including a coordinated approach to delivering short term training needs of the members Continue to strengthen governance related resource management by the First Nations	4	Project would provide short term training to members. Secondary education programs may include Guardian Watchmen programs. Shellfish hatchery would provide impact and governance to resource management through availability of seed to existing Member Nation aquaculture ventures	2	Project would provide less requested short term training to members. Secondary education programs may include Guardian Watchmen programs. Sea Cucumber hatchery/grow-out would provide impact and governance to resource management through sea cucumber resource management
Economic Prosperity	Develop Nanwakolas employment and training strategy for member First Nations Continue to support Band Enterprise growth and development in the context of the regional economic development approach of the Nanwakolas Council Create an awareness and support system for potential individual entrepreneurs	2	RAS Shellfish hatchery would provide training to member First Nations to build capacity in employment pool Economic development from facility would support regional economic development approach of the Nanwakolas Council Education and training could support individual entrepreneurs in shellfish LBA hatchery development	1	Flow-through sea cucumber hatchery/grow-out would provide training to member First Nations to build capacity in employment pool that is not actively developing at this time Economic development from facility would support regional economic development approach of the Nanwakolas Council Education and training could support individual entrepreneurs in sea cucumber
Culture	Support First Nations with identifying and sourcing resources (financial and best practices) needed to work towards and achieve their cultural CWB objectives Continue to strengthen, document and articulate the link between resource stewardship and cultural values and teachings Help build, maintain, and expand modern knowledge systems for First Nations, such as through a large cultural cedar inventory project	3	Education and training will provide best practice resources related to shellfish cultural CWB objectives; no direct impact to sourcing financial or non-shellfish hatchery resources Facility could provide articulation and practice of resource stewardship with cultural values Education and training for RAS shellfish hatchery helps to build knowledge of emerging technical industries	2	Education and training will provide best practice resources related to sea cucumber cultivation but not specifically part of CWB objectives; no direct impact to sourcing financial or non-sea cucumber resources Facility could provide articulation and practice of resource stewardship with cultural values Education and training for sea cucumber LBA cultivation helps to build knowledge of emerging technical industries

		Scenario 1: Medium RAS Shellfish Hatchery		Scenario 2: Medium Flow-through Sea Cucumber	
Area	Implementation Activity	Score	Reason	Score	Reason
Health	Establish formal relationships/partnerships with regional health and social agencies to support more robust CWB strengthening outcomes of targeted initiatives. The goal is more balance in program design and delivery, consistent with a holistic understanding of CWB Continue to protect and enhance harvest areas for traditional foods and cultural resources in planning processes and enforce protection through established Guardianship programs of the First Nations Explore options to support First Nations' community members having better access to traditional foods, especially off-reserve members, with the goal of re-establishing healthier diets and better nutrition	2	No direct effect on partnerships with regional health and social agencies LBA shellfish hatchery will aid in enhancing harvest ability of traditional foods; project may have cascading effect for establishment of Guardianship programs RAS Shellfish hatchery will greatly increase member access to traditional foods, especially for members in close proximity to the facility and local market. Secondary effects could impact diets and lead to better, more traditional nutrition but this is no necessarily a direct effect.	0.5	No direct effect on partnerships with regional health and social agencies LBA sea cucumber cultivation will aid in enhancing availability of sea cucumber Minimally increase member access to traditional foods, especially for members in close proximity to the facility and local market.
Community	Support establishment of effective and consistent information management processes as they relate to so many areas of community development	0	No direct effect on establishment of effective and consistent information management processes	0	No direct effect on establishment of effective and consistent information management processes

5.3. Anticipated Effects of LBA – Sustainable Development Frameworks Scenarios

Two scenarios of potential LBA facilities for Nanwakolas Member Nations were analyzed using the frameworks presented in Chapter 1.4. The scenarios that were selected based on the range of possibilities witnessed during the site visits and Member Nation preferences based on interview responses were:

- Scenario 1: Medium RAS shellfish hatchery
- Scenario 2: Medium flow-through sea cucumber grow out and hatchery

In the sections that follow, the results of the Community Capital Scan and the Community Wellbeing Wheel are presented to identify which of the two scenarios better achieves sustainable community development objectives based on the given tool. Then, the frameworks are compared to explore the questions:

- What insights into the scenarios are gained from one tool to the other?
- What do the scenarios show are the strengths and weaknesses of the tool frameworks as a decision support tool?

Finally, the overall sustainable development analysis for LBA development in Nanwakolas territory is summarized.

5.3.1. Community Capital Tool

A table summarizing the detailed score and reasoning of the Community Capital Tool was provided in Table 5.4. The detailed indicator and community capital score diagram outputs of the web tool are available in Appendix D. The resultant sustainability hexagon for Scenario 1 medium RAS shellfish hatchery and Scenario 2 medium flow-through sea cucumber hatchery and grow-out are presented in Figure 5.3 and Figure 5.4 respectively.

CCT Scenario 1: Medium RAS Shellfish Hatchery

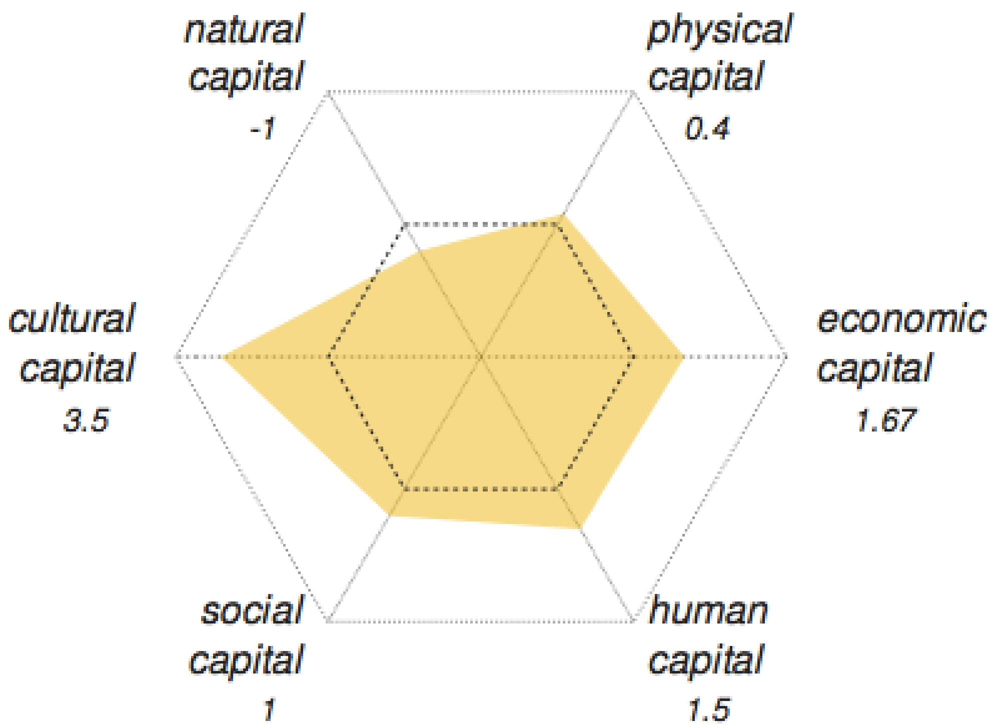

Figure 5.3 CCT: Scenario 1 Medium RAS Shellfish Hatchery

The CCT analysis for Scenario 1: Medium RAS Shellfish Hatchery indicated that the project would have a negative effect on natural capital. This negative natural capital score is due to the fact that the scenario assumed that the project will be developed on a currently undeveloped property. Any development that is constructed on a natural piece of land will have some negative impact to the surrounding environment. A consideration of the project must be to weigh the benefits and risks and support the project to proceed if the impacts on other capitals outweigh the risks to natural capital for new development. One way to increase the natural capital score would be to locate the project on a piece of land that is already naturally degraded, perhaps through an old industrial facility, and remediate the natural surroundings allowing the project to have a positive effect on natural capital.

The analysis indicated moderately positive effects on other forms of capitals including physical, economic, human and social largely due to the addition of revenue streams and education in the community. Cultural capital was found to have the greatest positive effect arising from Scenario 1. High cultural capital scores are due to the project's significant impact on traditions and increasing community identity. An increase to community identity through the implementation of a project such as shellfish aquaculture was discussed in the interviews; participants described a sense of pride and increased teamwork within the Nation as a result of being recognized for their shellfish products from other global corporations that have local storefronts.

CCT Scenario 2: Medium Flow-Through Sea Cucumber Hatchery & Grow-out

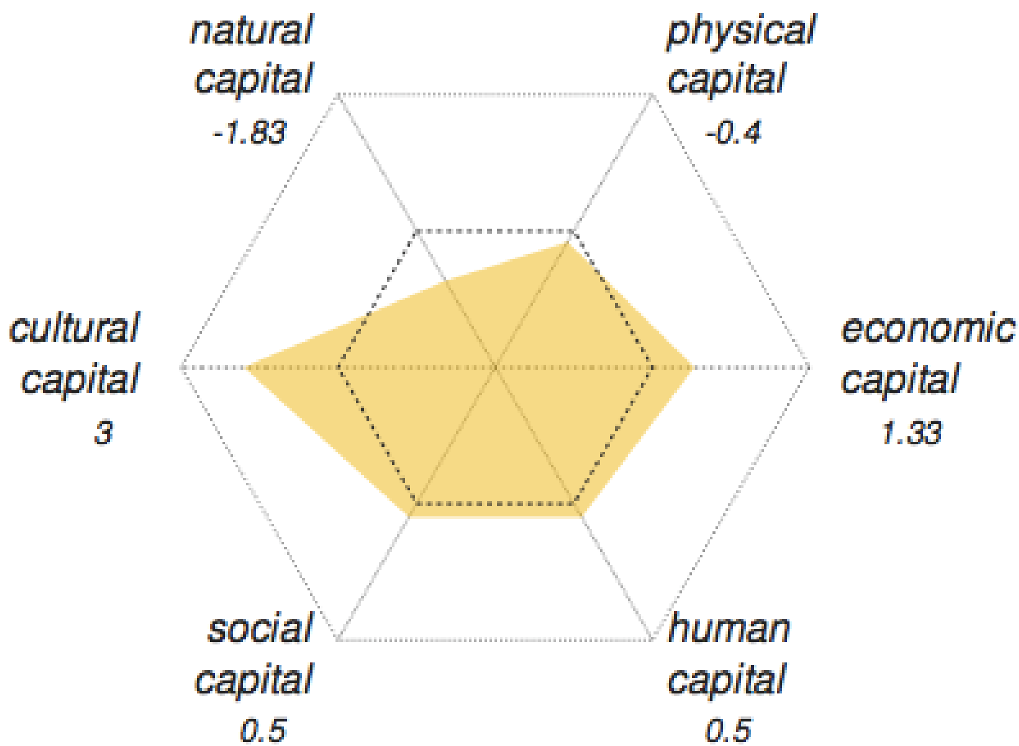

Figure 5.4 CCT: Scenario 2 Medium Flow-through Sea Cucumber Hatchery & Grow-out

The CCT Scenario 2: Medium Flow-through sea cucumber hatchery and grow-out analysis also indicated a negative effect on natural capital, again due to the assumption that the facility will be developed on an existing undeveloped piece of land. Any development on an undeveloped land parcel will likely have some negative effect on the natural flora, fauna and water systems. However, the flow-through nature of Scenario 2 further reduces the score on natural capital. Flow-through systems, by nature, interact quickly with their surrounding environment since they are constantly taking in and discharging water. Therefore, any potential breach in LBA biosecurity systems may result in contaminants entering groundwater, surface water and the ocean at a quicker rate than a RAS system. The more integrated water system of a flow-through aquaculture system also affects the score assigned to physical capital for Scenario 2. Throughout the analysis, only the direct effects of the project were considered, however, an indirect effect of Scenario 2 as described by Hummingbird Cove representatives is that a flow through aquaculture system may contribute to cleaner overall ocean water by consuming algae and minimizing the effects of ocean acidification (NOAA, n.d.). However, the effects on ocean chemistry composition can be assumed to be negligent for a single facility. The cumulative effects of many shellfish hatcheries could increase the positive effects on ocean acidification in a particular region, but other environmental risks such as development on coastlines, would need to be considered.

Environmental, human, social and cultural capitals were found to be moderately positive in Scenario 2, but less so than Scenario 1. The scores for these capitals are positive and lower than Scenario 1 because, based on the interviews and dialogue, the research team did not notice strong interest from Member Nation representatives in cultivating sea cucumber. There may be several reasons for this including a lack of availability or knowledge of the animal, a weak local sea cucumber market or, a limited interest in eating sea cucumber. So, while the project may increase education, training and access to sea cucumber – a traditional food source – it is not as high of an aquaculture priority as shellfish.

CCT Summary Between Scenarios

Both Scenarios were shown to follow the same trend with the lowest scores in natural capital and the highest scores in cultural capital. Scenario 1 was found to have a more positive effect on community capital due in large part to the species selection of shellfish. Shellfish align better with current business and educational needs and wants. Additionally, a shellfish hatchery could provide seed to existing First Nation aquaculture businesses and the natural capital risks associated with the project are projected to be less than a flow-through LBA. High cultural capital scores associated with providing access to traditional foods is a significant benefit that aligns with the Government of Canada's goals carried out through Indigenous and Northern Affairs Canada to improve social wellbeing and economic prosperity for First Nations (Government of Canada, 2017). In either scenario, the actual economic viability of the project in BC has not been proven. The development and future operation of Hummingbird Cove in Saltery Bay could help to prove the viability of the industry in BC and Canada.

5.3.2. Community Wellbeing Wheel

The scores and results of the sustainable development analysis using the Community Wellbeing Wheel are provided in Table 5.5. The resulting Community Wellbeing Wheel Venn diagram and supplementary radial pie charts are presented below (see Figure 5.5 to Figure 5.8 below).

CWW Scenario 1: Medium RAS Shellfish Hatchery

Figure 5.5 CWW: Scenario 1 Medium RAS Shellfish Hatchery

The CWW analysis for Scenario 1 medium RAS shellfish hatchery indicated no net effect on the community wellbeing area of community. A potential reason for this is the guiding implementation activity for community wellbeing in the CWW framework is "to support the establishment of effective and consistent information management processes" and the LBA project as proposed does not have a direct effect on this action. Scenario 1 has the most significant effect on the area of resources. The score is based on actions to strengthen governance related to resource management. Moderate positive effects were indicated in the areas of economy, health, and culture. In the area of economy, the score is based on development of Nanwakolas employment and training strategies and support for band enterprise growth. In the area of health, the project was considered to have a positive effect on protecting and enhancing availability of traditional foods. For the area of culture, the project will have a positive effect on strengthening, documenting and articulating the link between resource stewardship and cultural values and teachings.

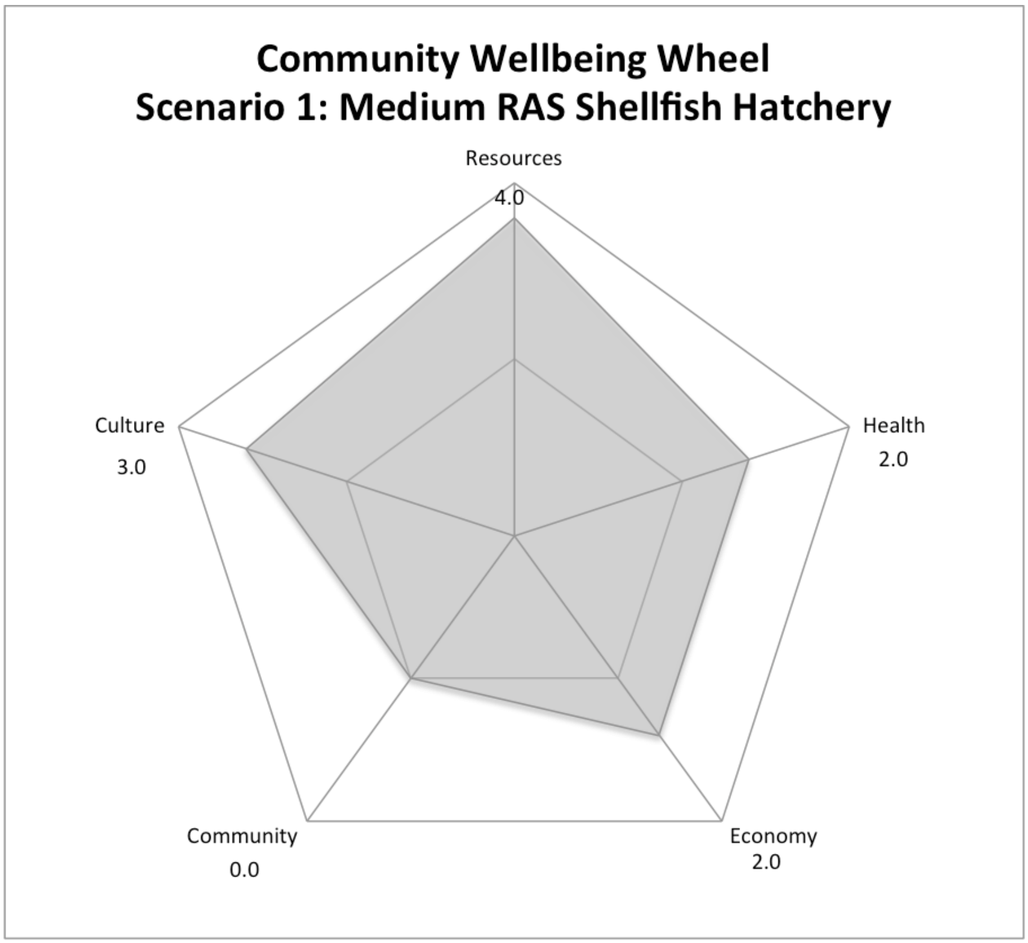

Figure 5.6 CWW: Scenario 1 Alternate Radar Plot Display

CWW Scenario 2: Medium Flow-Through Sea Cucumber Hatchery & Grow-out

Figure 5.7 CWW: Scenario 2 Medium Flow-through Sea Cucumber Hatchery & Grow-out

In the analysis of CWW Scenario 2, a medium flow-through sea cucumber hatchery and grow out facility, there again is no indication of any net effect on community. The greatest effects in Scenario 2 are in the areas of resources and culture with both categories having a score of 2 but coming in with a score lower than Scenario 1. The score in the area of resources is based on the project's ability to provide education to community members, as discussed above, about sea cucumbers; not necessarily in the areas of expertise that members are currently seeking education. The project would, however, still enhance resource management governance for a traditional food source. In the area of culture, the scores were again related to education and training. Education and training would be provided, but is the community currently requesting it? The findings from the interviews and dialogue indicate: no. A sea cucumber LBA would provide a link between resource stewardship and cultural values and teachings. Modest positive effects were indicated in the areas of economy and health due to the limited effect a sea cucumber facility would have on established First Nation aquaculture businesses. Indirectly, there may be opportunity for a sea cucumber facility to lead development of a new aquaculture industry.

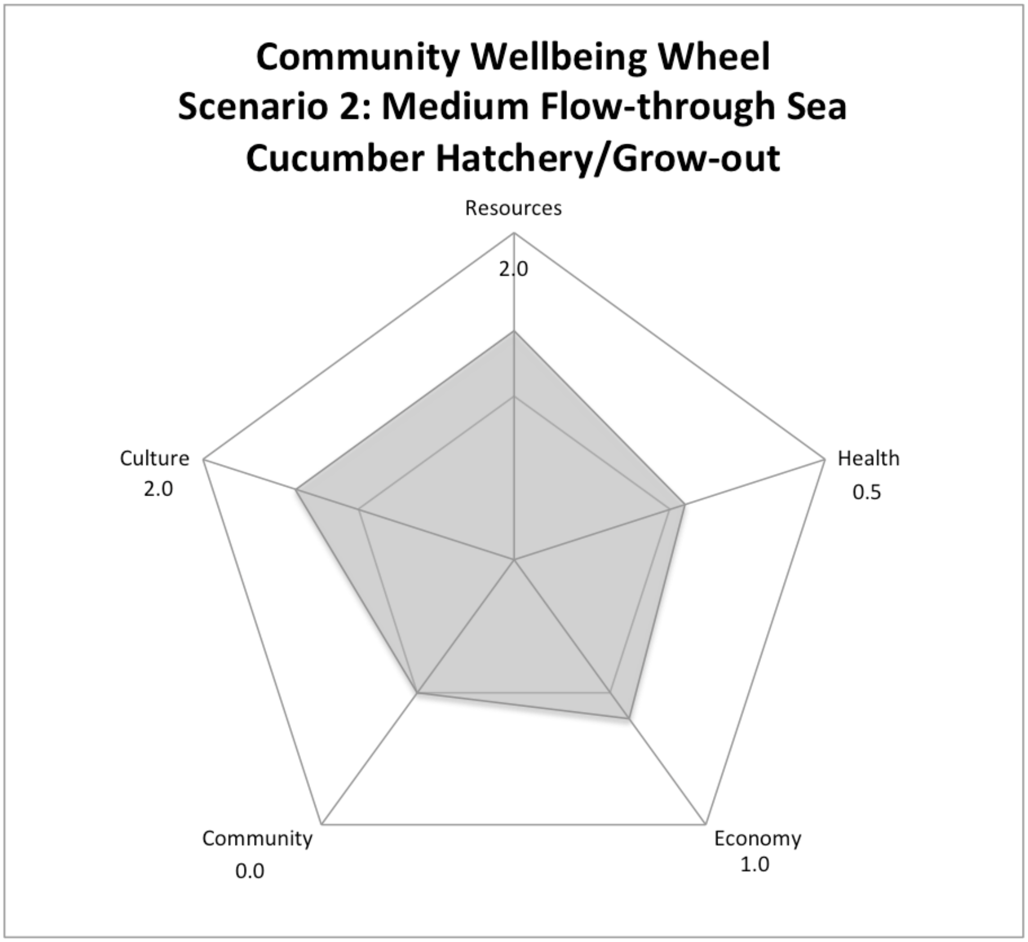

Figure 5.8 CWW: Scenario 2 Alternate Radar Plot Display

CWW Summary Between Scenarios

The overall analysis of the results of the CWW for Scenarios 1 and 2 show that Scenario 1 has a greater positive effect on the goals of the Community Wellbeing Wheel framework, although both projects have a positive effect. The type of species cultivated seems to play an important role in the overall score. Integrating information management goals could strengthen Community Wellbeing Wheel scores for both scenarios. The LBA scenarios could realize Nanwakolas community wellbeing and strengthening goals identified in Chapter 1.4: to participate in regional collaboration in the development of shellfish aquaculture business opportunities by increasing meaningful employment for community members in shellfish aquaculture; and to restore connections to traditional territories.

5.3.3. Comparing and Contrasting the Frameworks

This section provides a general comparison of the frameworks, then summarizes the findings based on the questions:

- What insights into the scenarios are gained from one tool to the other?
- What do the scenarios show are the strengths and weaknesses of the frameworks as decision support tools?

The results of the frameworks for each scenario are presented again side-by-side to inform the discussion comparing the frameworks below (see Figure 5.9 and Figure 5.10).

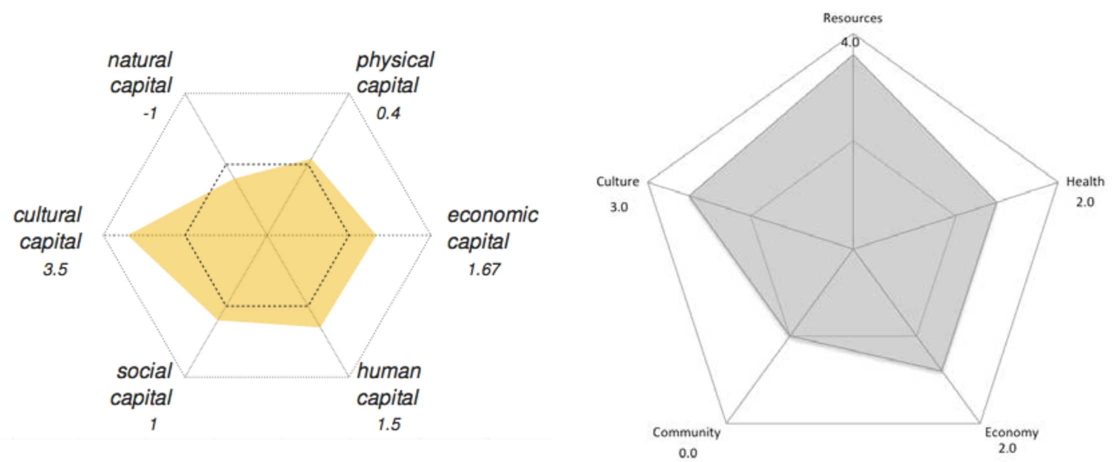

Figure 5.9 Scenario 1: CCT and CWW Results
Scenario 1: Medium RAS Shellfish Hatchery CCT (left) and CWW (right) sustainability polygons

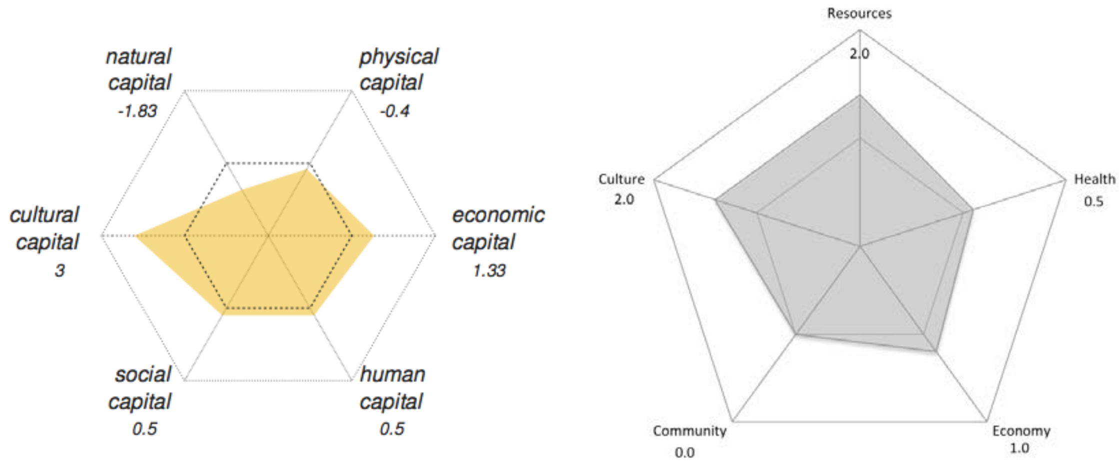

Figure 5.10 Scenario 2: CCT and CWW Results
Scenario 2: Medium Flow-through Sea Cucumber Hatchery and Grow-out CCT (left) and CWW (right) sustainability polygons

The Community Capital Framework and Community Wellbeing Wheel share the distinct similarity of acting as a decision support tool for sustainable development projects and initiatives. As part of this analysis, I was interested in gaining a better understanding of the similarities and differences of the frameworks and to determine if one framework for sustainable development is more appropriate than the other for this application. To start with the similarities, both frameworks have headings of culture and economy. Natural capital in the CCT might also be closely aligned with the Resource heading in the CWW. The definitions, however, for each of these headings differ across the frameworks. For example, CCT cultural capital includes indicators on heritage (art, diversity, cultural traditions and preservation) and identity and diversity while the CWW area of culture includes strengthening the link between resource stewardship and cultural values and teachings. In this case, the main focus in CWW is preservation; therefore, diversity may be interpreted as not aligning with the goal. For economy, both tools include availability and quality of training or education, while CCT economic capital asks more specific questions related to wages, local company profit and investment and the mix of services in a community. CCT natural capital and the CWW area of resources differ with the CWW concentrating on education and governance and the CCT focusing on attributes of the project with direct environmental impacts.

One way to summarize the distinctions in the frameworks is that they seem to be using different starting points of the Community Capital Framework Process. In Chapter 1.4, the 7 steps of the Community Capital Framework were introduced. The community capital scan is completed in step 4 (see Figure 5.11 below) of the process when the goals and indicators have already been established. In many cases, the goals of the CCT are broad enough that it is acceptable to start the scan, for demonstration or discussion purposes, without having undergone an extensive visioning process (i.e. skip steps 1 to 3). The CWW is starting from a different point in the process that I would place at the end of Step 1 visioning. The Nanwakolas Council underwent an extensive consultation process to develop the community wellbeing areas, goals and implementation actions with a proportion of the actions having measureable indicators. However, to be used as a score tool, all of the implementation actions would benefit from providing measurable actions and questions to dig into each aspect of the CWW area.

Figure 5.11 Community Capital Framework Process

What insights into the scenarios are gained from one tool to the other?

Utilizing either of the frameworks can provide some insight into the strengths and weaknesses of the scenarios. Both frameworks identified strong aspects of preservation of traditions and resource management and governance. In the CWW, this was evident through the implementation activity scores for resources to strengthen governance related to resource management by First Nations and activities for the CWW area of culture to strengthen and document the link between resource stewardship and cultural values. The CWW area of health also included an implementation activity that scored well related to establishing better access to traditional foods. In CCT, strong aspects of preservation of traditions and resource management and governance are described in natural capital in the preservation of land, soil, groundwater and surface water and through cultural capital with the indicator of preservation of cultural heritage.

The main insight that was clear in the analysis with the CCT that was not evident in the CWW was the physical impact that any potential LBA facility would have on the surrounding environment. The CWW does not distinguish the effects of the project on the natural environment including land, soil, groundwater, surface water and air. In analyzing direct impacts of a project, the environmental effects of any development are not evident in CWW. As well, governance of resources and self are included in implementation activities in the CWW, but actual indicators such as number of jobs created, amount of housing or community amenities provided through the project that are included in CCT are not specifically addressed in the CWW. However, the CWW does a more robust job of assessing the project from a cultural value perspective since most implementation activities for all CWW areas could be interpreted as having cultural capital ties in CCT. In may be important to consider that cultural effects of a project may be of more significant importance to Na̲nwak̲olas than Euro-Canadian goals that are largely focused on capitalization of business development.

What do the scenarios show are the strengths and weaknesses of the tool frameworks as a decision support tool?

The examples above highlight that CWW implementation actions can at times act as indicators and at others provide statements similar to policies (that could in turn be used to develop more specific indicators or implementation actions). Therefore, it was challenging to assign a “score” to CWW areas based on direct impacts of the project for implementation actions since the implementation actions are at times broad. However, the power of a sustainability tool in providing a score can help to facilitate discussion and decision making for a project by helping to make sure participants understand others' point of view.

A strength of the CWW is that it has been conceived and developed by the communities that would use it and therefore is more ideally suited to support those communities' decisions. In particular, the CWW might incorporate or balance First Nation values of the Member Nations more completely than the CCT that has been largely developed and tested in Euro-Canadian contexts.

In using either of the frameworks, it is important to consider that the scores and responses are subjective and are meant to be used as a decision *support* tool, not a decision-making tool. Both of the frameworks encourage consideration of a broad range of community dimensions beyond conventional economic and cost-benefit analysis. Discussion and engagement with community members that will be impacted by the project is essential to ensure that the needs of a community are adequately satisfied by any development project.

5.3.4. Summary of Sustainable Development Frameworks Analysis for LBA

The findings of the analysis of the sustainable development frameworks are summarized below.

- Both the CCT and the CWW indicate that Scenario 1 (Medium RAS Shellfish Hatchery) would have a greater benefit on the case community in holistically achieving the sustainable development goals set out in the sustainable development frameworks.
- Cultivating various species of shellfish, with integration of shellfish-compatible species such as sea cucumber, could better achieve, in particular, cultural objectives for sustainable development.
- CCT results indicated that either LBA development scenario would have a negative impact on Natural Capital; this finding was not evident through the results of the CWW. CCT scores in Natural Capital could be improved through the integration of a renewable energy source to the project.

- Based on the fact that the trends observed in both the CCT and CWW were similar, CCT could be an appropriate decision support tool to assess sustainable community development projects for First Nations. However, several warnings append this statement: the CWW has been developed by the Nanwakolas Council, and so, is more aligned with the values of the represented First Nation Members; decision support requires a robust process of community consultation.

- The CWW could benefit from further development of indicators to focus in on measureable targets of the values desired in sustainable development projects.

- Overall, the analyses indicate that shellfish/non-finfish LBA could positively contribute to Nanwakolas community wellbeing goals.

Chapter 6. Recommendations

Studies cited by Clarke & Pennell, 2013, suggest that the shellfish industry in BC is predicted to grow more rapidly in the future than it has to date. Additionally, recent environmental changes have increased the risks for traditional marine shellfish aquaculture. For example, a recent collapse of a Qualicum Bay scallop aquaculture initiative saw 10 million scallops killed and the layoff of approximately 30% of the company workforce due to high ocean acidity near the ocean farms (Rardon, 2014). It is possible that changes in water temperature, pH and wind patterns due to climate change could be increasingly disruptive to an industry that is already undercapitalized (Clarke & Pennell, 2013). Could shellfish LBA be leveraged to better protect natural stocks while growing and strengthening the shellfish aquaculture industry on Vancouver Island?

The following sections will summarize recommendations and priorities to address policy gaps in LBA regulation and recommendations to capitalize on the positive effects of LBA for sustainable development goals. Finally, a way forward will be proposed to unite the work to address regulatory gaps with tools to better support LBA to achieve sustainable development objectives.

6.1. Policy Recommendations

Throughout the course of this study, many criteria for shellfish/non-finfish LBA regulation have been examined in relationship to the existing aquaculture regulations in BC. Problems with the regulatory framework that were found to be important to the development of LBA include a focus on natural fisheries and habitats, no existing LBA specific advisory group, and unclear requirements for licensing resulting in significant time (upwards of two years according to site visit participants) to attain a licence and increased capital and start-up costs. The unclear licensing requirements stem from the many regulations that govern aquaculture in BC and the fractured multi-level governance structure that includes Provincial, Federal and First Nation levels of governments.

The condition for the Freshwater/Land based Aquaculture Licence, Site Condition 1.1 that prohibits the grow out of bivalves and states that “only seed harvest or transfer is permitted from this facility,” (DFO, personal communication, November 2016) was found to not be a significant challenge or factor in the current shellfish LBA industry in Canada. The technical challenges of propagating large amounts of algae for the grow out of shellfish on land coupled with the fact that shellfish food is plentiful and free in the ocean means that the economics for growing shellfish beyond seed size on land are not currently favourable according to several industry representatives. However, other countries are successful cultivating shellfish in land-based operations. DFO, in an effort to proactively establish requirements for bivalve grow-out in LBA is currently exploring shellfish grow out with the Strategic Management Committee on Aquaculture (DFO, personal communication, March 6, 2017).

With the above considerations in mind, my recommendations for the modification of existing regulation to ensure that LBA is adequately regulated and provides opportunity to grow the industry are to:

- Specifically include LBA in existing regulation the *Environment Management Act* for escape of farmed species and handling and disposal of waste;
- Support the creation of shellfish/non-finfish specific LBA advisory committees;
- Develop processes and partnerships to aid in fast-tracking the time to licensing for LBA operations and permitting of new species like abalone or sea cucumber grow out. Partnerships with organizations in Canada and globally could aid in developing processes through information sharing, education and training; and
- Develop minimum fish health standards including some prescriptive measurements for factors such as maximum stocking density

6.2. Sustainable Development Recommendations

The analysis of shellfish/non-finfish LBA development in a N<u>a</u>nwa<u>k</u>olas Member Nation community to achieve sustainable community development goals indicates that an LBA project could positively contribute to cultural objectives using both the CCT and CWW. Additionally, education and training for LBA showed potential for easing the barriers to implementation of aquaculture projects for the Nanwakolas Member Nations by building capacity and human resources and providing jobs to community members. Therefore, with respect to LBA and sustainable development, I recommend:

- Development and support of education and training programs for LBA to build capacity; and
- Pursuing creation of an LBA specific advisory group to aid in knowledge sharing partnerships and the remediation of regulatory gaps in order to bolster the business case of LBA development for Nanwakolas Member First Nations.

LBA development could allow Nanwakolas Member Nations to realize, at least in part, the shellfish aquaculture goals identified in the 2014 Community Wellbeing and Strengthening Plan to participate in regional collaboration in development of shellfish aquaculture business opportunities by increasing meaningful employment opportunities for community members and restoring connections to traditional territories. The sustainable development framework analyses indicated similar effects of the scenarios on sustainable development and community wellbeing objectives. The CWW is accepted as a more appropriate tool for First Nation sustainable development and community wellbeing project decision support (since it was developed in consultation with Nanwakolas Member Nation representatives) but more development is necessary to bring the tool from a value based policy framework to a rigorous decision support tool. I recommend further development of the tool and application of the CWW to other development projects to test and scrutinize the results.

6.3. Way Forward

This study identified, through analysis of regulatory gaps, interviews with Nanwakolas Member Nation representatives and sustainable development tools, that education, training and building up project champions for LBA is important for the successful growth of the industry on northern Vancouver Island. LBA proponents, operators, and enthusiasts can assist in liaising with DFO to focus policy changes and work with educational partnerships to broaden the knowledge of LBA for Nanwakolas Member Nations. In fact, Nanwakolas Member Nations may have a fantastic opportunity to get in on the cusp of the growing LBA shellfish industry on northern Vancouver Island while at the same time further achieve community wellbeing objectives for increasing their role in governance of resource management. Integrating policy changes to limit the time to licensing for new shellfish/non-finfish LBA operations, supporting the creation of LBA specific advisory committees and creating partnerships with other institutions worldwide to support capacity building and training can aid in cultivating a sustainable source of seafood, building economic opportunities, improving resource management governance and preserving traditional food culture for Nanwakolas Member Nations. LBA will continue to be an important tool for meeting the growing demand for seafood products. As progress continues in the development of economically feasible LBA grow-out technologies, proactive accommodation of LBA in existing fisheries and agriculture regulation and as a tool for sustainable development will help ensure sustainable, environmentally responsible, risk appropriate and high quality development of LBA facilities in BC.

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Appendix A.

Land-Based Aquaculture Practices Scan

LAND-BASED AQUACULTURE PRACTICES SCAN

Group	Species	Operation	Type of Facility	Description	Key Points of Operation (market, innovation, etc.)	Link(s)
Finfish	Arctic char, Atlantic halibut, Atlantic salmon	Canaqua Seafoods Limited, Advocate Harbour, NS	Hatchery, grow-out; Proven RAS	Annual production - 250 MT total Operation supplies local markets with three species of finfish; Transitioning to full organic certification Supports local jobs and industry in rural NS	Access to both fresh & salt water wells Well depth allows water to be clean, pure and pathogen-free; water is also at a constant temperature, year-round	http://canaquaseafoods.ca/ http://aquacultur enorthamerica.com/profiles/canadian-organic-salmon%3A-a-new-venture-for-canaqua-seafoods/
Finfish	Atlantic Halibut	Halibut PEI; Victoria, PEI	Grow-out; Saltwater RAS started experimental in 2008	Pilot project began in 2008 in an abandoned lobster holding facility in Victoria, PEI. The location has three deep salt wells; the pure salt water requires no antibiotics and results in a low environmental footprint. The project demonstrated acceptable salinity levels and temperature from the water wells	The facility makes use of a costly technology to develop by reusing the salt water well facility for lobster holding tanks. The facility is unique due to its natural salt water wells	http://halibutpei.ca/about -us/our-story/
Finfish	Atlantic Salmon	Kuterra; Port Hardy, BC	Grow-out; hatchery (possible); RAS, experimental	One of the first land-based Atlantic salmon farms globally to achieve sales quotas. Currently designed: 470 MT/year; Future expansion: potential to add 2000-3000 metric tonnes, hatchery, on- site solid waste composting, &	Utilizes SCD principals for success of enterprise: the 'Namgis First Nation, project partner SOS Marine Conservation Foundation, funder & advisor Tides Canada, and seafood distributor Albion Fisheries. 100-percent 'Namgis First Nation	http://www.kuterra/com

Group	Species	Operation	Type of Facility	Description	Key Points of Operation (market, innovation, etc.)	Link(s)
				aquaponics. Grow four cohorts (batches) at a time at about 40,000 fish per cohort; 160,000 total Kuterra salmon have achieved a green, "Best Choice" ranking from Monterey Bay Aquarium's Seafood Watch, designated a Best Choice by SeaChoice, and designated "Ocean Wise"	ownership; benefits 'Namgis community Module one has five direct operations staff. Full-size farm to create 29 downstream jobs, measured with standard industry multipliers Preliminary discussions of partnerships to offer training and certification in RAS technology; need for qualified staff (& training) is likely to increase as demand RAS in Canada and globally expands.	
Finfish	Atlantic Salmon	Marine Harvest; Campbell River, BC	Hatchery, grow-out, processing, distribution; RAS	Hatchery/grow out takes place in RAS system; last stages of grow out happen in traditional pens off BC coastline	1. Smolts - Smolts are grown in RAS hatchery until the mature into adult salmon; for final stages of grow out (3-6 months), salmon are moved to pen enclosures off the coast 2. Harvest - After fish have reached market weight (4.5 to 5.5kg) and are then harvested and taken to a MH processing facility 3. Processing / Distribution - Processing activities take place in specialized facilities; once processed, MH uses a combination of road, rail, ship and airfreight for distribution to maintain product freshness and to minimize travel time.	http://www.marineharves t.ca/

Group	Species	Operation	Type of Facility	Description	Key Points of Operation (market, innovation, etc.)	Link(s)
Finfish	Barramundi	Mainstream Aquaculture; Austrailia	Hatchery. Grow-out, processing, distribution, R&D; RAS	Developed proprietary RAS technology unique in enabling continuous (year round) high quality production of the popular table fish, Barramundi. Operates largest recirculating aquaculture system in mainland Australia; top 5 domestic provider of Barramundi in Australia. Distributes food products into premium retail outlets around Australia and exports juvenile Barramundi to 17 countries, across 5 continents.	Operation is supported by an advanced selective breeding program conducted in the world's largest Barramundi hatchery in Melbourne, Australia Breeding program underpins Mainstream's production process through the supply of high quality juvenile Barramundi that demonstrate rapid growth, low growth variance, high fillet yield and disease resistance.	http://www.mainstreama quaculture.com/
Finfish	Tilapia	Redfish Ranch; Courtenay, BC	Hatchery. Grow-out; RAS	Started in 2000, still running in 2010 but hard to find anything since then Up for sale in 2010; no website, probably now defunct	Privately owned, Selling live to mostly Asian buyers in the lower mainland.	http://www.bcbusiness.c a/natural-resources/fish-farming-tilapia-in-bc
Finfish	Tilapia	Tropical Aquaculture Products; headquarters in Vermont, USA; farms in Brazil, Columbia & Equador	Hatchery, grow-out, processing; land pen flow through with filtering	Vermont employ 15 people; company partners with tilapia farms around the world.	Similar to a co-op model, Tropical distributes tilapia farmed elsewhere in the world. The fish are raised in ponds on land with access to natural water sources. Fish feed is 94% vegetables, 4% fish meal; the protein production ration is just 0.24:1.	http://www.eattilapia.co m/operations/tilapia - farming/

Group	Species	Operation	Type of Facility	Description	Key Points of Operation (market, innovation, etc.)	Link(s)
Multi-trophic	Oysters/algae	Smit & Smit; Netherlands	Grow-out; RAS	Father and Son team starting world's first RAS oyster production system with full grow out	Growing the algae that feed the oysters onsite. Completely isolated RAS, so substantially reduced risk of disease	http://advocate.gaalliance .org/dutch-shellfish- farmers-bringing-the- sea-onto-land/
Multi-trophic	Steelhead salmon / aquaponics	Little Cedar Falls; Nanaimo, BC	Grow-out; RAS (experimental)	Production will reach 100 MT of Steelhead annually - 3 cohorts stocked in the system at a time; 100% hormone and antibiotic free 10,000 fish stocked every 8 weeks; growth from 20gm to 2kg in 45 weeks @ 15 Celsius Operation won runner-up for innovation at Stanford's Fish 2.0	Operation cost $1.4M to build; Atkinson suggests that building a second facility at same time would have dropped costs and decreased vulnerability of operation over the long run Worked with Tides Canada, Albion Fisheries, and other special interest groups	http://www.littlecedarfall s.com/steelhead-salmon.html http://www.tidescanada.o rg/wp-content/uploads/2015/03/ D-2-4SteveAtkinson NanaimoLanD-BaseD- SteelheaD-MoD-elAquafarm.pdf
Multi-trophic	Sturgeon / Aquaponics	Target Marine; Nanaimo, BC	Hatchery, grow-out, processing; RAS	Sturgeon & caviar production; facility has hatchery, grow-out sites, & processing plant Aquaponics system grows watercress to filter out nitrates & effluent	Sells product to Albion Fisheries Products are Certified Organic, recommended by Ocean Wise, and recognized BEST CHOICE by SeaChoice and SeafoodWatch Watercress is shipped and sold to Vancouver restaurants	http://www.northerndivin e.com/ VIDEO - https://www.youtube.co m/watch?v=gueSq_E1Gi k

Group	Species	Operation	Type of Facility	Description	Key Points of Operation (market, innovation, etc.)	Link(s)
Multi-trophic	Tilapia / aquaponics	Blue Ridge Aquaculture; Martinsville, Virginia, USA	Grow-out; RAS	Largest RAS tilapia operation in the world; 4 million pounds per year Entire system is closed loop; adding only feed for the tilapia.	Designed as a multi-purpose facility for research into the science, technology, and economic potential of fish and shellfish production using RAS Aquaponics utilize: traditional hydroponic techniques (nutrient film and gutter systems), raft (floating Styrofoam boards), & drip irrigation systems. Aquaponics - grows basil, peppers, tomatoes, and different types of lettuces (butterhead, red leaf, romaine and lollo)	http://advocate.gaalliance .org/dutch-shellfish- farmers-bringing-the- sea-onto-land/
Shellfish	Abalone	Connemara; Galway, Ireland	Hatchery, grow-out; RAS	Grow Ezo (haliotis discus hannai) Japanese variety. Facility is located on the shores of Galway Bay and uses sea water, abalone are fed locally harvested seaweed	One of two abalone operating producers in Ireland. Abalone was first introduced to the area in 1980.	http://www.abalone.ie/ our-location.html
Shellfish	Abalone	Pure Australian Abalone; Australia: Bicheno, Bremer Bay, Kangaroo Island, Port Lincoln, Portland	Hatchery, grow-out processing, distribution; RAS	Australian abalone aquaculture industry pioneers; grow premium (sashimi grade) species including Greenlip (Haliotis Laevigata) and Tiger (Haliotis x Rubra) abalone Distribute IQF (individually quick frozen) abalone to wholesalers & distributors across the globe; live abalone pack & hand delivered to Australian customers	1. Baby abalone start their lives attached to layered vertical sheets. These are covered with algae (food source) for these growing creatures as they are in their juvenile stage. Trials are carried out to ensure abalone are receiving the best diets to aid health and growth 2. RAS tech circulate fresh seawater in the tanks; tanks cleaned regularly	http://www.ausab.com.au

Group	Species	Operation	Type of Facility	Description	Key Points of Operation (market, innovation, etc.)	Link(s)
					to ensure the abalone have the best possible environment in which to thrive 3. Abalone are hand fed daily on a 100% natural diet with essential nutrients until they reach maturity and commercial size [3 yrs.] 4. Harvest team removes each abalone by hand from the tanks; abalone are then taken to the processing room where they are snap frozen before being packaged and delivered to customers around the world.	
Shellfish	Abalone	Tower Aqua Products; Cork Ireland	Grow-out; RAS	Grow Eso Awabi (haliotis discus hannai) Japanese variety & Haliotis Tuberculata. Facility is computer controlled and fed organic sustainable seaweed (fed by hand).	Provides end to end consultancy services (primarily in Europe) for farmers that need assistance developing a farm. Farm has build out capacity to 80 tonnes; currently operating at 45 tonnes. 20,000 sq. ft purpose built facility with sea water heat exchange and gravity fed water make up. Current activities are aimed at developing the business model and increasing operational efficiency.	http://www.toweraqua.co m/ http://www.fishtech.c om /qa.html

Group	Species	Operation	Type of Facility	Description	Key Points of Operation (market, innovation, etc.)	Link(s)
Shellfish	Abalone	Wild Coast; East London, South Africa	Hatchery, grow-out; RAS	Grow abalone (Haliotis discus) in land-based tanks. Also grow all of the seaweed (kelp?) necessary to feed the abalone in open air raceways.	Seems that breeding, hatching, grow out and processing are all done on site, as well as feed production. In the video [see link(s)], a program is described that releases some spawn to restock wild populations Grow about 600 tonnes of seaweed a year, processing about 130 tonnes abalone a year.	https://www.youtube .co m/watch?v=Id6248 PXzk Y (this is a decent little doc about SA abalone crisis, start at 17:35 for content specific to this farm)
Shellfish	Clams, geoduck, mussels, oysters	Taylor Shellfish; Seattle WA	Hatchery, grow-out; RAS	Started in the mid-1980's, now over 500 employees and still largely a family business.	Started in the mid-1980's, now over 500 employees and still largely a family business.	https://www.taylorsh ellfi shfarms.com/about - us/our-story
Shellfish	Lobster	Norwegian Lobster Farm; Norway	Hatchery, grow-out; RAS (experiment al)	Lobster are cannibal throughout lifecycle; must be kept separated throughout entire lifecycle. Fishing for berried lobsters was protected in 2008; Norwegian Lobster Farm began as a project to developing a living gene bank for restocking purposes Tech is patented; provides lobster w/ optimal growth conditions, animal welfare & biosecurity throughout production cycle.	European lobster is considered to be a high-end seafood; price is high and stable, both nationally and internationally Demand outstrips market supply; estimated market potential is more than 50,000MT and price generally increases with demand throughout the year	http://www.norwegia n- lobster- farm.com/en/

Group	Species	Operation	Type of Facility	Description	Key Points of Operation (market, innovation, etc.)	Link(s)
Shellfish	Shrimp	First Ontario Shrimp Farm; Campbellford, ON	Grow-out; RAS (experimental)	Shrimp come from a pathogen free hatchery in Florida RAS most sustainable way to farm shrimp	Shrimp is the most consumed seafood in North America Retrofitted hog farm; RAS offered alternative uses for their empty barns Delivers to restaurants & fish mongers in Toronto; shrimp fetch higher prices / lbs. than imported shrimp	http://firstontarioshrimp. com/about-us.php
Shellfish	Shrimp	Ocean Institute; Hawaii, USA	Grow-out; RAS (experimental)	An intensive grow out trial produced 5.7 kg/m2 of market-size shrimp in 14 weeks	Alternative management strategies allowed the elimination of costly external bio filters and other system, thereby reducing production costs.	http://pdf.gaalliance. org/ pdf/GAA-Otoshi- July06.pdf
Shellfish	Shrimp	Planet Shrimp; Aylmer, ON	Grow-out; RAS (experimental)	Massive shrimp farm in a former Imperial Tobacco plant Producing 3,600 kilograms of shrimp a week to start; ramping up to more than 29,000 kilograms per week.	Starting with four production modules, each about the size of a football field Intends to expand facility to almost 225,000 square feet; expansion will create largest facility in N. America Endorsed by OceanWise & SeaChoice	http://www.planetshrimp .com/
Shellfish	Shrimp	Virginia Shrimp Farms; Martinsville, USA	Broodstock, hatchery, nursery, grow-out; RAS (experimental)	Working w/ Virginia Tech to develop large-scale shellfish production Infrastructure necessary to develop production technologies for fish and shellfish species in RAS. Facility includes dedicated spaces for grow out systems, a hatchery and nursery room, brood stock tanks and	Shrimp is top seafood species consumed in the US, it represents the largest potential market Designed as a multi- purpose facility for research into the science, technology, and economic potential of fish and shellfish production using RAS	http://www.blueridgeaqu aculture.com/research.cf m

Group	Species	Operation	Type of Facility	Description	Key Points of Operation (market, innovation, etc.)	Link(s)
				laboratories. Nursery & hatchery rooms - live feed production, including an algae culture room, live feed tanks, and distribution systems. Brood stock rooms include a separate filtration system & darkened rooms with photo-manipulation capabilities		

Appendix B.

Summary of Relevant Federal LBA Regulation in BC

Fisheries Act

Through the *Fisheries Act*, DFO manages both aquaculture and wild caught fisheries through the definition of fisheries provided in section 2(1) of the *Fisheries Act* that includes "the area, locality, place or station in or on which a pound seine, net, weir, or other fishing appliance is used, set, laced, or located and the area, tract or stretch of water in or from which fish may be taken by the said pound, seine, net, weir or other fishing appliance, and also the pound, seine, net, weir or other fishing appliance used in connection therewith."

Fisheries Development Act

The purpose of the *Fisheries Development Act* is to provide resources and regulatory oversight for the development of commercial fisheries in Canada. Under the *Act,* the Minister may undertake projects for more efficient exploitation of fisheries resources, introduction and demonstration of new types of fishing vessels, equipment and techniques and for the development of new fishery products.

Health of Animals Act

The *Health of Animals Act* is intended to protect animals and animal health through the control of toxic substances that can affect aquatic animals. The *Act* also includes provisions for diseases and toxic substances that may be transmitted by animals to people.

Pacific Aquaculture Regulations

The *Pacific Aquaculture Regulations* SOR/2010-270 govern the licensing process for aquaculture. The *Pacific Aquaculture Regulations* outline the cost of aquaculture licenses, considerations that should be included in the license such as escape of fish, and relations to the *Fishery (General) Regulations*.

In British Columbia, DFO manages and licenses aquaculture operations under the *Pacific Aquaculture Regulations* and the *Fisheries (General) Regulations*. Under

Section 2, the *Pacific Aquaculture Regulations* apply to aquaculture activities in "(a) the territorial sea of Canada off the Coast of British Columbia; (b) the internal waters of Canada off the coast of British Columbia that are not in that province; (c) the internal waters of Canada in British Columbia; and (d) any facility in British Columbia from which any fish may escape into Canadian fisheries waters."

Fishery (General) Regulations

The *Fishery (General) Regulations* apply, as per section 3(1)(b) to "fishing and related activities in the provinces of Nova Scotia, New Brunswick, British Columbia, Prince Edward Island, and Newfoundland and Labrador and in the Yukon Territory and Northwest Territories." The regulations provide information on close times, fishing quotas, fish size and weight limits and on fishing for experimental, scientific or educational purposes.

British Columbia Aquaculture Regulatory Program (BCARP)

The British Columbia Aquaculture Regulatory Program (BCARP) is a subsidiary of DFO responsible for implementing regulations under the *Fisheries Act*, *Pacific Aquaculture Regulations and Fishery (General) Regulations.* The main responsibilities of the BCARP are licensing, liaison with First Nations, stakeholders and government, reporting on the aquaculture industry, planning, and ensuring compliance for fish health and environmental performance (DFO, 2015).

Appendix C.

Nvivo Coding Nodes

The nodes used in the coding process are provided below in the format:

- **Parent Node**
    - Child 1 Node
        - Child 2 Node

The nodes used in the NVivo qualitative analysis of interview with Member Nation representatives are:

- **Economic Development**
    - Business Development
    - Business Ventures
    - Capacity Building
    - Economies of Scale
    - Funding
    - Market Expansion
    - Social Enterprise or Innovation
- **First Nation Goals**
    - Capacity Building
    - Community Wellness
        - Community Dialogue
        - Cultural Shift
        - Strategic or Long Term Planning
    - Environmental Sustainability
    - Fair Share
    - Resource Management
    - Historical or Traditional Management
    - Resource Management to Assert Rights
    - Self Governance

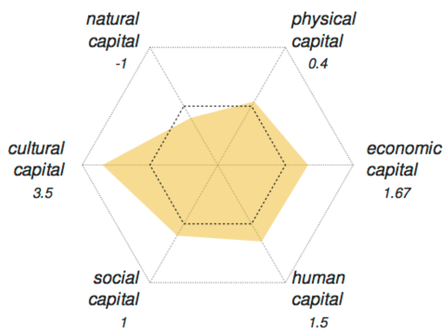
    - Traditional Ecological Knowledge
    - Title Rights
    - Traditional or Cultural Food
- **Food Security or Sovereignty**
    - Food Insecurity
    - Food Sovereignty
    - Solutions
- **Planning to Implementation**
    - Barriers to Implementation
    - Opportunities to Implementation
- **Regulation and Policy**
    - Canadian Food Inspection Agency
    - Interpersonal Connections to Agencies
    - Department of Fisheries and Oceans
    - Regulatory Red Tape
- Sustainable Community Development
    - Cooperation and Collaboration
    - Dialogue
    - Engagement
    - Job Opportunities
    - Partnerships

Appendix D.

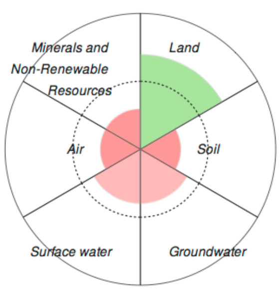
Community Capital Scans Results

Results and report

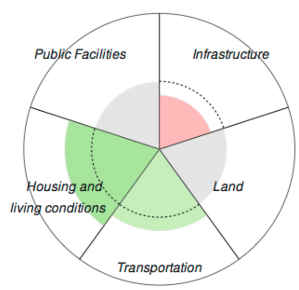
Case Study 1: Medium RAS Shellfish Hatchery



Natural capital



Physical capital



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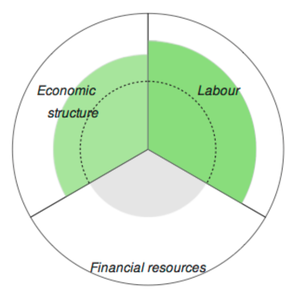
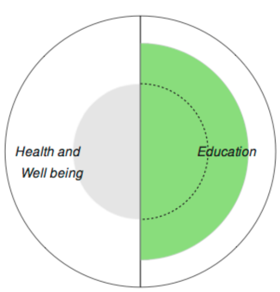
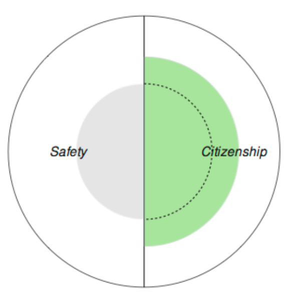


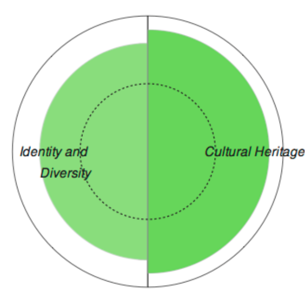
Human capital



Social capital



Cultural capital



Comments

Natural capital	Reasoning	Points for improvement
Land	- Safeguards will be in place with the aim of ensuring biodiversity, but the existence of the facility provides some risk to the natural biodiversity of the area; alternatively, the facility could cultivate brood stock for protection of native species biodiversity - the facility will consist of several buildings on a coast access property, likely in a location zoned for agricultural or industrial, there will likely be few neighbouring properties and as such limited effect on scenic and attractive views - facility is not located within a marine or	

	terrestrial park	
Soil	- The facility will have requirements for contaminant and pollutant discharge to the environment, but the existence of the facility increases the risk of soil pollution in the area - Located on a property zoned agricultural or industrial (depending on the jurisdiction), and located fairly remotely within the Nanwakolas Member Nations traditional territory, there is likely little effect on expanding the preservation of fertile agricultural land - Could increase soil erosion or instability	
Groundwater	- The facility will have requirements for pollutant and contaminant discharge to groundwater, but the existence of the facility comes with some risk to the area groundwater in the form of effluent and waste discharge - Will draw on ocean water resources, that in turn affect surrounding groundwater resources; the effect is expected to be negligent, but risk exists	
Surface water	- Requirements in place for pollutant and contaminant discharge to surface water, but the existence of the facility comes with some risk to the area surface water in the form of effluent and waste discharge - Water intake and effluent regulations should protect surface water for human and agricultural use; some risk comes with the mere existence of the facility	
Air	- Requirements in place for pollutant and contaminant discharge to air; the main source of air pollution is expected to be exhaust from the onsite energy source: propane boilers - Project will have some associated greenhouse gas emissions (RAS less than flow-through) that will be greater that typical BC industrial process emissions due to potential remote location and need for propane boilers	
Minerals and Non-Renewable Resources	- Project will have an effect on non-renewable resources through the need for propane boilers due the remote location of the facility - Propane will be bought via regular methods that assume environmentally safe extraction processes	

Physical capital	**Reasoning**	**Points for improvement**
Infrastructure	- Project will have little effect on existing water sources for surrounding citizens - Specifications will aim to ensure clean and efficient waste management systems - Energy will be provided via propane due to remote study area location; energy source will be safe, reliable, efficient but no renewable - Little effect on telecommunications systems for all citizens	
Land	- Project will be located on land zoned agricultural or industrial	
Transportation	- Access road construction may be required as part of facility construction - Little effect on rail and road infrastructure	
Housing and living conditions	- Project will provide some economic development that could in turn increase resources for adequate housing and clothing - Project will provide food to the local market - Project will ensure seed availability for other existing local shellfish aquaculture ventures	
Public Facilities	- Some economic development that could in turn increase resources for schools, hospitals, community centers, etc.; overall impact is expected to be minimal due to facility size and remote location	

Economic capital	Reasoning	Points for improvement
Labour	- Project will provide approx. 20 - 40 jobs (scaled Hummingbird Cove estimates) in an emerging industry in BC - Training would be required for expansion of Nanwakolas Member Nations employees into this emerging market in BC - Work is safe, remote location may impede work-life balance (refer to challenges sited in interviews related to finding people willing to work remotely) - Wages would be adequate to provide decent livelihoods	
Financial resources	- Privately owned corporation will pay taxes but have limited effect on the financial capacity of public bodies to provide public goods and services - Local market is assumed to be strong enough to support medium RAS shellfish hatchery	
Economic structure	- Jobs from the project will include a desirable mix of R&D, labour, marketing - Project will provide entry into an emerging market for Nanwakolas Member Nations - Current assumptions do not support transition away from non-renewable resources due to remote location of project; however, the project could in the future employ non-renewable resource energy	

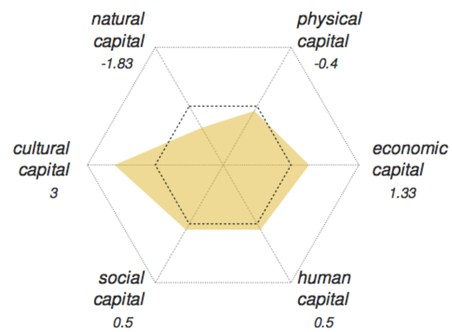
Human capital	Reasoning	Points for improvement
Education	- Training required to build capacity in RAS shellfish hatchery - Education would be provided by the facility owner who has an interest in providing high quality and easily accessible education	
Health and Well being	- Job creation may in turn contribute to citizen physical, metal and spiritual health but no direct correlation - Job may provide access to health care services through benefit packages but no direct correlation	

Social capital	Reasoning	Points for improvement
Citizenship	- Facility would provide seed to existing Nanwakolas aquaculture operations increasing social cohesion and solidarity between Nanwakolas Member Nations - Will contribute to the minimization of poverty and exclusion	
Safety	- No direct correlation to citizen access to support systems to encourage safety, potential cascading effects are considered - No direct effect on violence or crime	

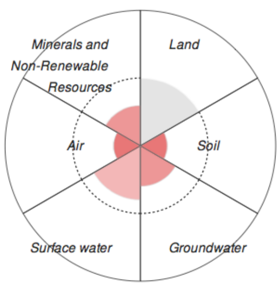
Cultural capital	Reasoning	Points for improvement
Cultural Heritage	- Project will have significant impact on community traditions and celebrations through cultivation of traditional foods and dissemination of cultivation training and education	
Identity and Diversity	- Project may contribute to defined identify as witnessed at Salish Sea Foods during site visits	

Results and report

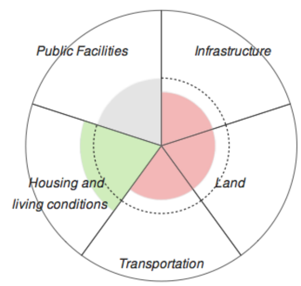
Case Study 2: Medium Flo-thru Sea Cucumber



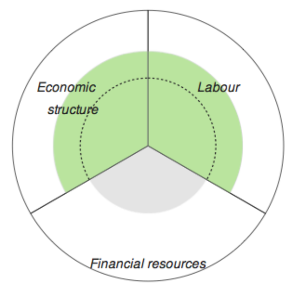
Natural capital



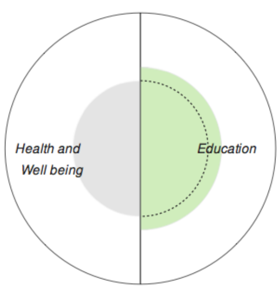
Physical capital



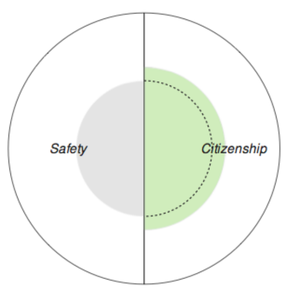
Economic capital



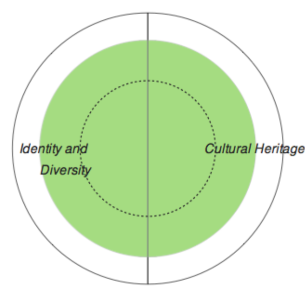
Human capital



Social capital



Cultural capital



Comments

Natural capital	Reasoning	Points for improvement
Land	- Facility regulatory requirements will aim to ensure protection of biodiversity, however, the flow-through nature of the project means that any contaminants either into our out of the facility will be spread more quickly than RAS - Natural areas will be protected by limiting the effect of the facility on the natural ecosystem; facility will be located on vacant coast line - Facility is not located within a marine or terrestrial park	
Soil	- Facility will have requirements for contaminant and pollutant discharge to the	

	environment, but the existence of the facility increases risk - Located on a vacant coastline property zoned agricultural or industrial, and located fairly remotely within Nanwakolas Member Nation traditional territory, there is likely little effect on expanding the preservation of fertile agricultural land (indirect effects may displace conventional agricultural farming?) - Could increase soil erosion and instability	
Groundwater	- Facility will have requirements for pollutant and contaminant discharge to ocean and groundwater, however, existence of the facility will increase risk of pollutants - Will draw on ocean water resources, with minimal effects to groundwater but risk does exist	
Surface water	- Facility requirements will be in place for pollutant and contaminant discharge to surface water, but the existence of the facility comes with some risk to the area surface water in the form of effluent and waste discharge - Water intake and effluent regulations should protect surface water for human and agricultural use; some risk comes with facility existence	
Air	- Requirements in place for pollutant and contaminant discharge to air; main source of air pollution is expected to be exhaust from the onsite energy source: propane boilers - Project will have some associated greenhouse gas emissions (RAS less than flow-through) that will be greater than typical BC industrial process emissions due to potential remote location and need for propane boilers	
Minerals and Non-Renewable Resources	- Project will have an effect on non-renewable resources through the need for propane boilers due the remote location of the facility - Propane will be bought via regular methods that assume environmentally safe extraction processes	

Physical capital	**Reasoning**	**Points for improvement**
Infrastructure	- Project will have little effect on existing water sources for surrounding citizens - Specifications will aim to ensure clean and efficient waste management systems but there is a risk that contamination could spread more quickly with flow-through - Energy will be provided via propane due to remote study area location; energy source will be safe, reliable, efficient but no renewable - Little effect on telecommunications systems for all citizens	
Land	- Project will be located on land zoned agricultural or industrial with ocean access	
Transportation	- Access road construction may be required as part of facility construction - Little effect on rail and road infrastructure	
Housing and living conditions	- Project will provide some economic development that could in turn increase resources for adequate housing and clothing - Project will provide food to the local market	
Public Facilities	- Some economic development that could in turn increase resources for schools, hospitals, community centers, etc.; overall impact is expected to be minimal due to facility size and remote location	

Economic capital	**Reasoning**	**Points for improvement**
Labour	- Project will provide approx. 20 jobs (scaled Hummingbird Cove estimates) in an emerging	

	industry in BC - Training would be required for expansion of Nanwakolas Member Nations employees into this emerging market in BC but scale of development of sea cucumber market may be slower than shellfish hatchery - Work is safe, remote location may impede work-life balance (refer to challenges sited in interviews related to finding people willing to work remotely) - Wages would be adequate to provide decent livelihoods	
Financial resources	- Privately owned corporation will pay taxes but have limited effect on the financial capacity of public bodies to provide public goods and services - Local market is assumed to be strong enough to support medium RAS shellfish hatchery	
Economic structure	- Jobs from the project will include a desirable mix of R&D, labour, marketing - Project will provide entry into an emerging market for Nanwakolas Member Nations - Current assumptions do not support transition away from non-renewable resources due to remote location of project; however, the project could in the future employ non-renewable resource energy	

Human capital	Reasoning	Points for improvement
Education	- Training required to build capacity in sea cucumber but there is not a huge demand for sea cucumber training in BC at this time - Education would be provided by the facility owner who has an interest in providing high quality and easily accessible education	
Health and Well being	- Job creation may in turn contribute to citizen physical, metal and spiritual health but no direct correlation - Job may provide access to health care services through benefit packages but no direct correlation	

Social capital	Reasoning	Points for improvement
Citizenship	- Facility would provide traditional food product to market that may aid in increasing social cohesion and solidarity between Nanwakolas Member Nations - Will contribute to the minimization of poverty and exclusion	
Safety	- No direct correlation to citizen access to support systems to encourage safety, potential cascading effects are considered - No direct effect on violence or crime	

Cultural capital	Reasoning	Points for improvement
Cultural Heritage	- Project will have significant impact on community traditions and celebrations through cultivation of traditional sea cucumber and dissemination of cultivation training and education - Only sea cucumber will be cultivated - could benefit from impact of a range of shellfish	
Identity and Diversity	- Project may contribute to defined identify as witnessed at Salish Sea Foods during site visits	