Socio-Economic Contribution of Small-Scale and Large-Scale Fisheries in British Columbia

by

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Abstract

Small-scale fisheries have been the focus of much fisheries research in the last decades, as they were often overlooked in the past. Small-scale fisheries can be a challenge to study due to lack of landings and economic data or vague definitions of what and who are involved in this fishing sector. In this study, 17 features of small-scale fisheries that can apply globally have been collated through intensive literature review. All commercial fisheries and Food, Social and Ceremonial (FSC) fisheries in British Columbia are analysed qualitatively for the presence or absence of these features. Qualitative assessment suggests that FSC fisheries and Aboriginal commercial fisheries exhibit the greatest number of small-scale fishery features. These fisheries represent important cultural and economic opportunities for groups that often live in more isolated communities along the coast. Sablefish fisheries have the fewest small-scale fishery features due to the large capital investment required to purchase a licence and quota to participate, and most vessels operating on offshore fishing grounds.

Further quantitative assessment of small-scale and large-scale was carried out using three methods: (1) cumulative percent distribution; (2) vessel length split, and (3) point-based framework. All three of these approaches identify the Aboriginal commercially licensed fisheries, salmon gillnetters, salmon trollers, crab, shrimp and prawn trappers and trawlers, urchin and rockfish hook and line fisheries as small-scale. Therefore, these are regarded as constituting the small-scale fisheries sector in British Columbia. These fisheries caught 25% of the landings by weight, which corresponds to 46% of the landed value, underscoring the high prices their catches command in the market relative to those of LSF for the 2013 fishing season. In terms of ownership, individuals own 68% of the small-scale vessels in BC as opposed to 98% corporate ownership in the large-scale sector. In terms of geographical ownership, parties or individuals outside of Vancouver and its surrounding areas own 64% of the small-scale sector.

Lay Summary

This research evaluates the socio-economic contribution of small-scale fisheries (SSF) and large-scale fisheries (LSF) to British Columbia (BC). The overarching objectives of this research were to create a framework for defining small-scale fisheries; applying it to fisheries in BC; and evaluating the socio-economic contribution of the small-scale and large-scale sectors. This research demonstrates that BC does have a small-scale fisheries sector, which generates higher revenues and supports greater employment per unit weight of fish harvested, especially in smaller communities in BC. This research could contribute to federal fisheries policy in Canada, and BC, more specifically.

Preface

This thesis is a contribution to the Social Sciences and Humanities Research Council of Canada's *OceanCanada Partnership*. This is an inter-disciplinary partnership between Canadian universities, the Federal government and non-governmental organizations. The government (DFO) provided data necessary for the analysis contained herein, upon a formal request by the author. Further data was acquired through interviews with local industry members under Ethics Certificate H15-03437 from the UBC Behavioural Research Ethics Board. The author performed all literature reviews, data analysis and writing.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AFPR	Atlantic Fisheries Policy Review
BC	British Columbia
Canfisco	Canadian Fishing Company
CFAR	Canadian Fisheries Adjustment and Restructuring Program
CSA	Canadian Sablefish Association
DFO	Fisheries and Oceans Canada
EU	European Union
FAO	Food and Agriculture Organization
FSC	Food, Social and Ceremonial fisheries
GDA	Groundfish Development Authority
GT	Gross Tonnage
IPHC	International Pacific Halibut Commission
ITQ	Individual Transferable Quota
LSF	Large-scale Fisheries
PIIFCAF	Policy for Preserving the Independence of the Inshore Fleet in Canada's Atlantic Fisheries
SFF	Sustainable Fisheries Framework
SSF	Small-scale Fisheries
UFAWU	United Fishermen and Allied Workers Union
UHA	Underwater Harvester's Association
USD	US Dollar
VRN	Vessel Registration Number

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Chapter 1 Introduction

1.1 Problem Statement

For many decades, the focus of fisheries research was on industrialization and fishing capacity building for maximum efficiency. This was soon followed by a period of capacity reducing efforts in largely industrialized fleets around the world (European Commission, 2002; Dupont et al., 2002; Kirkley et al., 2003; Madau et al., 2009; Srinivasan et al., 2012). While much of fisheries research focused on large-scale industrialized fleets, there were always small-scale fleets present. In the 1980s, small-scale fisheries (SSF) began appearing in the academic literature. A table presented in Thomson (1980) was one of the first examples of comparing small- and large-scale fisheries side by side to demonstrate the contribution of SSF relative to LSF (Appendix A.1). This first effort to compare large-scale fisheries (LSF) versus SSF was followed with updated and slightly different comparisons by Berkes et al. (2001) (Appendix A.2), and Jacquet and Pauly (2008) (Appendix A.3). Even so, scientists and policy makers have routinely overlooked the importance of SSF (Carvalho et al., 2011; Guyander *et al.* 2013). However, in the last decade there has been a shift to focus on the socio-economic importance of small-scale fisheries globally by organizations such as the Food and Agricultural Organization of the United Nations (FAO). These fisheries have also been capturing the attention and focus of researchers as their importance to local economies is realized.

SSF are commonly associated with a slough of attributes, which will be discussed further in Chapter 2. One common feature is that small-scale fishers often lack capacity to lobby their interests to government members (Garcia et al., 2008). However, the stock of SSF is rising as demonstrated by the recent launching of the *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries* (FAO, 2014a). The FAO is taking the initiative to recognize SSF as a stand-alone entity and stress the ability of SSF to contribute to food security through the *Code of Conduct for Responsible Fisheries* (FAO, 1995) and the *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries* (FAO, 2014a). The guidelines specify fisheries, for which the

fishers are self-employed, keep a portion of the catch for personal/community consumption and are also important in that they are rooted in culture and local traditions (FAO, 2014a).

While some attributes are explicitly mentioned in the *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries* (FAO, 2014a), there is no strict definition of SSF, highlighting a gap in small-scale fisheries research. It is extremely difficult to participate in productive discussion about a group without explicitly explaining characters or parameters of the group.

There has also been a great deal of research by *Too Big To Ignore*, which is a global partnership of researchers who focus on issues related to SSF[1]. Again, there is no broadly used definition of SSF used throughout their organization. There is therefore a significant need to establish well-defined SSF and large-scale fisheries (LSF) for policy and management debates (Natale et al., 2015), including pressure on the FAO to request nations' catch statistics separated into catch from small- and large-scale fishing sectors (Pauly & Charles, 2015). The major concern with creating a definition for small-scale fisheries is overcoming the relativity of 'smallness'. Much of the previous work in defining or describing small-scale fisheries focuses on developing nations and does not encompass features of fleets in developed countries. That being said, there are examples of SSF in some developed countries, most of which are in Europe and the Atlantic coast of North Amercia (García-Flóres et al. 2014; Ruttan et al., 2000; Sumaila et al., 2001; Therkildsen, 2007). This creates another gap in SSF research as this class of fishery is also found in industrialized or developed countries such as Canada (Berkes & Kislalioglu, 1989).

A definition for SSF in British Columbia (BC), or even Canada as a whole would serve to identify who fits into this distinction. As Garcia et al. (2008) argue many fishers in small-scale fisheries lack the capacity to come together and lobby for their benefit to the government. By identifying which fisheries belong to SSF in BC, and therefore, which fishers are working in SSF, they may see an opportunity to come together collectively and protect their interests in the fishery. By understanding what SSF in BC may look like and what it may include creates space for

[1] Too Big To Ignore 'http://toobigtoignore.net' (Accessed January 2015)

productive policy and management debate as argued by Natale et al. (2015). Creating a definition of SSF for BC fisheries and determining their socio-economic contributions should provide a bargaining tool for those involved and produce an opportunity for further discussion within the industry. Not all of BC's fisheries have the same socio-economic concerns and by grouping small-scale enterprises under the same management as the large-scale ones, the government is perhaps missing an opportunity for socio-economic development in communities, which depend on SSF. It is worth noting that it is usual, especially nowadays, for fisheries scientists, policy makers and managers to study and organise fisheries in terms of scale – small or large. In this way the special characteristics and their policy and management implications can be taken into account. In keeping with this convention, the socio-economic analysis of fisheries in BC is done by small and large-scale sectors and not by fishery or groups of fishers as done in more traditional economic analysis.

1.2 Objectives

This research addresses the question: what is the socio-economic importance and contribution of the small-scale and large-scale fishing sectors in British Columbia. In order to evaluate the socio-economic importance of small and large-scale fisheries, this research aims first to demonstrate the existence of small-scale fisheries in BC and, second, to create a framework to define small- and large-scale fisheries in British Columbia, Canada. The objectives of this study are therefore to (i) conduct a systematic review of current approaches for making the distinction between SSF and LSF; (ii) combine quantitative and qualitative approaches, which provide stakeholder input, to reach a distinction between SSF and LSF; (iii) justify a recommended definition for SSF in British Columbia; and (iv) evaluate the socio-economic contribution of SSF in BC. This research will ultimately produce a framework for distinguishing between SSF and LSF, which may be applied to other parts of Canada and potentially other fishing countries around the world.

1.3 Small-Scale Fisheries and their Worldwide Contributions

SSF have been estimated to represent 90% of fishing vessels worldwide (Béné et al. 2007; FAO, 2010), which produce about half of the global catch of fish and shellfish (FAO, 2014b; Berkes *et al.,* 2001; Pauly, 1997; Guyander *et al.* 2013; Teh *et al.*, 2011). The contribution of SSF increases globally to two thirds when considering fish for food (FAO, 2014b). These fisheries can be linked to a strong local community and self-employment (FAO, 2014a). The Thomson (1980) and Berkes et al., (2001) and Jacquet and Pauly (2008) tables find different contributions of SSF but similar trends in contribution. Berkes et al. (2001) found significantly higher employment in SSF fisheries than Thomson (1980) and Jacquet and Pauly (2008) with an increase of approximately 40 million people in the primary sector but both comparisons found significantly higher employment in SSF than LSF. The global catch for human consumption in SSF has not increased dramatically from 20 million tonnes (Thomson, 1980) to 20-30 million tonnes (Berkes et al., 2001) to 30 million tonnes (Jacquet & Pauly, 2008). An interesting point to note is that Jacquet and Pauly (2008) have estimated SSF and LSF catch for human consumption to both be around 30 million tonnes, versus Thomson (1989) and Berkes et al. (2001) noting SSF catch slightly less by volume. Comparison of these tables also demonstrates that the global SSF fleet consumes less tonnes of fuel for each unit of catch than LSF (Thomson, 1989; Berkes et al., 2001; Jacquet & Pauly 2008).

These past evaluations and comparison tables of LSF and SSF have been done on a global scale, which would include the developing world. Many of the world's developed nations with 'industrialized fleets' may be considered LSF on a global scale. However, in many of the world's largest and most industrialized fishing nations there are still fishers participating in SSF, which, look different from those of developing nations. The differences between SSF and LSF aren't always visually obvious and require further consideration. Fisheries in Europe have been defined as SSF by the European Union (EU) if fishing with vessels under 12m that use passive gears (Martín, 2012). Small-scale fleets are generally associated with creating more socio-economic wealth within the associated communities while typically having less environmental impacts (Guyander *et al.* 2013) all of which are prevalent in industrialized nation's fleets. The

importance of SSF has been widely explored without first making the distinction of who and what is included in the category. This represents a gap in the literature that this study will attempt to fill.

1.4 Why Define Small-Scale Fisheries

The human needs to categorize and rationalize are strong components of science. The fishing industry is no exception to this phenomenon. Fleets can be categorized by gear type, vessel size, target species, etc. Even catch is commonly categorized into landed catch, landed by-catch, discarded by-catch and illegal, unreported and unregulated catches. Developing definitions and categories throughout the fishing industry is common but the categorizations of some elements in fisheries are hotly debated. Typically 'small' invokes images of raft or canoe style boats with no motor. In many cases SSF are defined as vessels without a motor (Macfadyen *et al.*, 2011). To date, most of the SSF research has taken place where 'smallness' is obvious and you can know a SSF just by looking at it (Andrew *et al.,* 2007; Béné 2006; Evans and Andrew 2009; Damasio et al., 2016).

Small-scale fishing is a term that is thrown around throughout the fisheries literature without much explanation of what and who this term encompasses. Some argue that attempts to define SSF may delay work to assist in management of SSF and stress the need to use an imprecise definition for SSF (Garcia et al., 2008; Allison and Ellis 2001). Much of the work carried out by those in support of an imprecise definition focus on fisheries in developing nations where imprecise definitions may be useful in improving management (Andrew et al., 2007; Béné et al. 2010; Ratner & Allison, 2012). Others argue that in order to improve fisheries governance, boundaries of SSF should be more conclusively described by values of social justice and ecological sustainability (Johnson, 2006). Small-scale fisheries have become vastly important on a global scale in the last thirty years, making a definition of small-scale fishing importants. The definition(s) of small-scale fishing is important for policy initiatives to aid the people who participate in and depend upon these fisheries for their sustenance.

1.5 Fisheries in Canada

Canada has rich fishing history throughout all regions of the country. Fishing has remained a cornerstone of many indigenous cultures across Canada. As a country established through colonization, natural resources have always been an important draw for immigrants to Canada and a pillar of its economy. The cod fishery on the Grand Banks off the coast of Newfoundland was one of the first draws to Canada with Vikings visiting in the late 10th and early 11th Centuries (Kurlansky, 1997). Cod in the Grand Banks continued to attract people to Canadian waters with Jacques Cartier noting 1,000 Basque fishing vessels on his journey in 1534 (Kurlansky, 1997). The cod fisheries continued to attract Spanish and Basque vessels for hundreds of years.

While cod on the Atlantic coast was a major draw for immigrants, the Pacific coast also had a bounty to offer. As more people settled along the Pacific Coast, salmon quickly became a commodity with many canneries being established on the Fraser River (Gough, 2007). The fisheries on the Atlantic and Pacific coasts have always been different in scale and species composition. Even so, SSF have been present on both the Atlantic and Pacific coasts of Canada. Newfoundland is associated with small outpost communities and small fishing enterprises, while BC has indigenous fisheries such as the herring spawn-on-kelp of Kitkatla, which have been commercialized (Newell & Ommer, 1999). The presence and appearance of SSF in Canada has shifted over time as fleets grew and became more 'industrialized'.

The collapse of cod and groundfish fisheries in Atlantic Canada suffered from one of the most devastating fishery collapses of the 20th Century. In the post-cod Canada, lobster, shrimp and crab are primary targets, with lobster commanding the highest price. The fleet in the Atlantic is certainly the largest in terms of vessel numbers and landed catch. It is also the more lucrative fishing coast in Canada, with catches commanding an average price of $3,500 CAD/tonne in 2014 compared to $2,400 CAD/tonne in BC[2]. In 2013, 35,800 people were employed in the

[2] DFO '2014 Value of Atlantic & Pacific Coasts Commercial Landings, by province' http://www.dfo-mpo.gc.ca/stats/commercial/land-debarq/sea-maritimes/s2014pv-eng.htm (Accessed September 2016).

primary sector in Atlantic Canada, landing nearly $2 billion worth of fish[2,3]. However, in BC, 5,400 were employed in the primary sector in 2013, which landed fish of approximately $250 million value[2,3].

Fisheries in Canada are one of the country's most important renewable resources providing $2.77 billion in landed value in 2014, of which BC generated 14%[2]. The Canadian fishing industry generated approximately 73,000 jobs in 2014 throughout most provinces both in the primary fishing sector (harvest) and the packaging sector (processing)[3]. It should be noted that values were used for 2014 as it is a dominant salmon cycle and demonstrates the potential size of the fishery. Data from the 2013 fishing season will be used throughout the rest of the report as it was the most recent available data at the time of the research. However, this data is for a non-dominant salmon run year. BC represented 15% of Canadian primary sector jobs and 8% of secondary sector jobs[3]. Teh and Sumaila (2013) found 130,000 ± 29,000 jobs in the primary and secondary sectors in Canadian small- and large-scale fisheries in 2003. These are considerable contributions to the Canadian economy even as these values are smaller than those generated by fishing in the 20th Century.

Fisheries and Oceans Canada (DFO) is responsible for the management and support of economic growth in marine fisheries in Canada[4]. The coasts are managed separately with complex management systems. These systems have been shaped overtime by piecemeal solutions for specific conflicts (DFO, 2012). The Policy for Preserving the Independence of the Inshore Fleet in Canada's Atlantic Fisheries (PIIFCAF) regulation, is an important regulation for SSF in Canada, however, it is only in place for Atlantic fleets. The PIIFCAF regulation is responsible for 'fleet separation' in which vessels less than 65 feet are considered 'inshore' or SSF and is mostly owner-operated (Cooper & Clift, 2012).

[3] DFO 'Fisheries and the Canadian Economy' http://www.dfo-mpo.gc.ca/stats/cfs-spc/tab/cfs-spc-tab2-eng.htm (Accessed January 2016).
[4] DFO ' Mission, Vision and Values' http://www.dfo-mpo.gc.ca/about-notre-sujet/org/vision-eng.htm (Accessed September 2016).

In Atlantic Canada, prior to the PIIFCAF regulation, many of the processing companies owned and leased vessels and quota, proliferating vertical integration and making access into the fishery nearly impossible for new entrants[5] (Cooper & Clift, 2012). Current Atlantic fisheries policy consists of conflicting objectives, achieving economic efficiency while ensuring equity and wellbeing of small communities and SSF (Barnett et al., 2016). Canadian fisheries are further concentrated by corporate interest due to Canada's anti-competition laws (or lack thereof), which allow for processors to own quota, licenses and vessels within the fishery (Haas et al., 2016). In some fisheries these companies own a majority of the quota, licences or vessels. Barnett et al. (2016) argue that players within the federal government (DFO) have promoted policies which damage the independent fleet during times of crisis in Atlantic fisheries, which complicated the role of vertical integration and privatization in fisheries crises.

According to vessel data in Transport Canada's Vessel Registration Query System[6], these companies also own a large number of vessels with licences attached in BC, which they lease out to fishers. Many of these fishers were previously able to financially support themselves in the industry (Scholz et al., 2004). In addition to the similar corporate involvement in BC's commercial fisheries, fleets have seen massive vessel reductions in the last 30 years in which many of the smaller vessels are disappearing[7].

The corporate involvement and monopolization could be socio-economically hazardous for coastal communities. An example of this hazardous industry practice is evidenced in Canadian Fishing Company (Canfisco), BC's largest fish processor announcing the closure of their canning facility in Prince Rupert, and scheduling a move to Alaska along with the some 500 jobs, which is a considerable employment cut in a city of only 12,000 residents (CBC, 2015). Smaller coastal communities in BC, like Prince Rupert, depend on the fishing industry and could benefit from

[5] DFO 'Policy for Preserving the Independence of the Inshore Fleet in Canada's Atlantic Fisheries http://www.dfo-mpo.gc.ca/fm-gp/initiatives/piifcaf-pifpcca/piifcaf-policy-politique-pifpcca-eng.htm (Accessed January 2016).
[6] Transport Canada 'Vessel Registration Query System' http://wwwapps.tc.gc.ca/saf-sec-sur/4/vrqs-srib (Accessed December 2015).
[7] DFO 'Vessel Information' http://www.dfo-mpo.gc.ca/stats/commercial/licences-permis/pacific-pacifique/pacfleet-eng.htm (Accessed December 2015).

protection through well-designed policy. SSF are present in these communities and in order to create policy to benefit these fisheries, a definition of SSF must first be suggested.

British Columbia presents an interesting case within Canada to make a distinction between SSF and LSF. Arctic fisheries are widely unregulated and are mostly SSF and indigenous fisheries. In fact, the Department of Fisheries and Oceans doesn't make any of the catch in the Arctic publically available, therefore there is little data to work with and much is unknown to the public. Fisheries in the Arctic, even though extremely important to the livelihoods of northern communities, are not as commercially important to Canada as the fisheries in the Atlantic and Pacific. Arctic fisheries are also a challenge to work with, given the large data gaps. Atlantic Canada, however, like the Pacific, has many years of detailed statistics of catch and value. But in terms of SSF, Atlantic Canada already has PIFFCAF in place to benefit owner-operators and 'inshore' or SSF vessels (Cooper & Clift, 2012). British Columbia is lacking any policy to benefit SSF participants or owner-operator fishers. My work will firstly demonstrate the presence of SSF in BC; secondly propose a definition for BC's SSF and the fishers and communities that depend on this industry for policy considerations; and thirdly, evaluate the contribution of SSF relative to LSF.

1.6 Thesis Outline

This thesis explores small-scale fisheries in BC through four main chapters. Chapter 1 (This chapter) introduces research themes as well as objectives and main questions. This involves exploring current research efforts in small-scale fisheries, which more often than not take place in developing countries. This chapter also attempts to place the research into local, regional and global frames of reference.

Chapter 2 explores features of SSF, which are commonly used in SSF literature. This chapter then addresses the presence of these features in the British Columbian fishing fleet. The degree of 'small-scaleness' in these fisheries can then be compared through the presence of these SSF features. It is acknowledged that Food, Social and Ceremonial (FSC) fisheries are an important

social and cultural fishery to indigenous peoples along the coast and many aspects of these fisheries would be considered as small. These fisheries are included in the qualitative evaluation of 'small-scaleness' along with other commercial fisheries in British Columbia. It should be noted that recreational fisheries and the aquaculture sector of the industry are considered outside the scope of this research.

Chapter 3 explores chosen methods from the literature for defining SSF. These methods are the basis for the framework developed in this study for defining SSF in British Columbia. This chapter also provides recommended definitions of SSF from these chosen methods. Finally, a socio-economic valuation and comparison of the SSF and LSF is conducted.

Finally, Chapter 4 summarizes the findings of the thesis and explores potential policy recommendations for BC, and discusses how this framework could be applied to other fisheries in Canada and the world.

Chapter 2 How Small-Scale are Fisheries in BC?

2.1 Introduction

Small-scale fisheries (SSF) are now a common research focus in fisheries, and many features have emerged as important for distinguishing between small- and large-scale fisheries. SSF make an important contribution to fisheries worldwide, but what and whom they are comprised of is very different from nation to nation. On a global scale, these fisheries employ between 44% fishers in the primary sector, 90% of both fishers and fish workers and 30% of the landed value (FAO, 2014a; Teh & Sumaila, 2013; Sumaila et al., 2007a; Swartz et al. 2013) [8]. These fisheries represent important employment opportunities for many around the world. However, in many cases, they are not clearly defined. There is currently no universally accepted definition of SSF, however, many features are associated with SSF and existing approaches from the literature that can be used to define SSF.

This chapter suggests an approach for determining SSF, which incorporates many of the existing features of SSF from the literature. I develop a list of SSF features, which are not specific to any country. This allows for the approach to potentially be applied on varying scales, i.e., local, regional, national and global. This chapter analyses each fishery in British Columbia (BC) through the lens of common SSF features found within the literature and it is noted whether these features are present or absent in each fishery. Using this approach, it can be observed that the BC fleet, which is commonly associated with being heavily industrialized, possesses a number of SSF features. The target fisheries in BC are then analysed qualitatively on a scale of most likely SSF to most likely large-scale fisheries (LSF).

Fisheries in BC are diverse and all have their unique social, economic and environmental importance and contributions. The industry has deep connections with Canada's colonial ties and there is a large shift in focus and attention in the industry through the years. Fish in BC

[8] Sea Around Us 'Real 2005 value (US$) by Fishing Sector in the Global Ocean' http://www.seaaroundus.org/data/#/global?chart=catch-chart&dimension=sector&measure=value&limit=10 (Accessed January 2017).

have always been a critical part of the economy of the province. There is a rich history of the importance of fish to coastal First Nations and the settlement of the province. In BC, fish presently support commercial, Food Social and Ceremonial (FSC) needs and recreational fisheries along the coast. The Department of Fisheries and Oceans (DFO) is responsible for the management of Canada's Oceans and does so through a series of acts and policy initiatives. Supreme court cases have contributed to the evolution of DFO's management practices, including the 1990 Sparrow decision, which required DFO to prioritize indigenous subsistence fishing after meeting conservation standards[9] (DFO, 2016a). Aboriginal use of the marine resources takes priority over any other use including commercial and recreational practices[10]. In order to determine the intensity of marine resource usage allowed, DFO manages fisheries using the Sustainable Fisheries Framework (SFF), which has a decision-making framework, including consideration of the precautionary approach while managing stocks (DFO, 2016b).

Aboriginal fisheries consist of communal licences and individual licences, which are considered factions of the commercial fishery, as well as FSC fisheries, which are not considered part of the commercial fishery. All of the aboriginal fisheries are considered in the analysis for this Chapter 2. Communal licenses may be granted to any aboriginal organization including Indian Bands and Indian Band Councils[11]. However, for FSC fisheries, only 'status' indigenous peoples can participate and it is not a federal requirement to report this catch. It is therefore difficult to analyze the FSC fishery beyond qualitative assessment present in this Chapter. Further analysis is beyond the scope of a Master's thesis, as it would require a great deal of time and the development of strong relationships to acquire data.

Recreational and aquaculture sectors of the BC seafood industry will not be considered in this analysis. Recreational fishing is by nature, a small-scale operation, being highly selective and

[9] Parliament of Canada 'The Aboriginal Fisheries and the *Sparrow* Decision' http://www.lop.parl.gc.ca/content/lop/researchpublications/bp341-e.htm#THE%20SPARROW%20DECISION:(txt) (Accessed November 2016).
[10] DFO 'Aboriginal Fisheries Strategy' http://www.dfo-mpo.gc.ca/fm-gp/aboriginal-autochtones/afs-srapa-eng.htm (Accessed November 2016).
[11] Department of Justice Canada 'Aboriginal Communal Fishing Licences Regulations (SOR/93-332) http://laws-lois.justice.gc.ca/eng/regulations/SOR-93-332/index.html (Accessed November 2016).

consisting of strict bag limits. There are fishing lodges and charter businesses along BC's coast, and these may be perceived as a larger scale in the recreational fishery. In order to assess recreational catch, more time and data would be required. The *Sea Around Us* have attempted to create a time series database of recreational catches around the globe, noting significant catches in some countries (Cisneros-Montemayor et al., 2012; Zeller et al. 2008). Aquaculture, like commercial wild fisheries, is managed by DFO and it is part of DFO's mission to expand the aquaculture sector[4]. Aquaculture production is a different sector of the fishing industry in BC, and while facilities may operate on small or large-scales, their features do not fit with those of the commercial wild fishing fleet. Investigation of the scale of aquaculture production in BC would require a separate analysis. While not included, it should be noted that all other forms of fishing play an important role in the management and economic performance of the commercial fisheries in BC.

It is important to understand the structure of commercial fisheries in BC in order to determine the scale of these fisheries and hence develop appropriate policies. When considered on a global scale, BC's commercial fishery is relatively new and the industry experienced periods of both massive growth and reduction throughout the twentieth century. The Mifflin Plan in 1996 reduced the number of commercial salmon licenses by 42% (Brown, 2005; DFO, 2002). Figure 1 demonstrates the shrinking phase of BC's fisheries from the 1980s to present day. It demonstrates that there has been a large decrease in the number of smaller active vessels in the last thirty years. Note that this statement does not consider whether new vessels are replacing vessels leaving the fishery. All that can be determined from the data is that there have been massive reductions in the numbers of smaller relative to the larger vessels in the fishery.

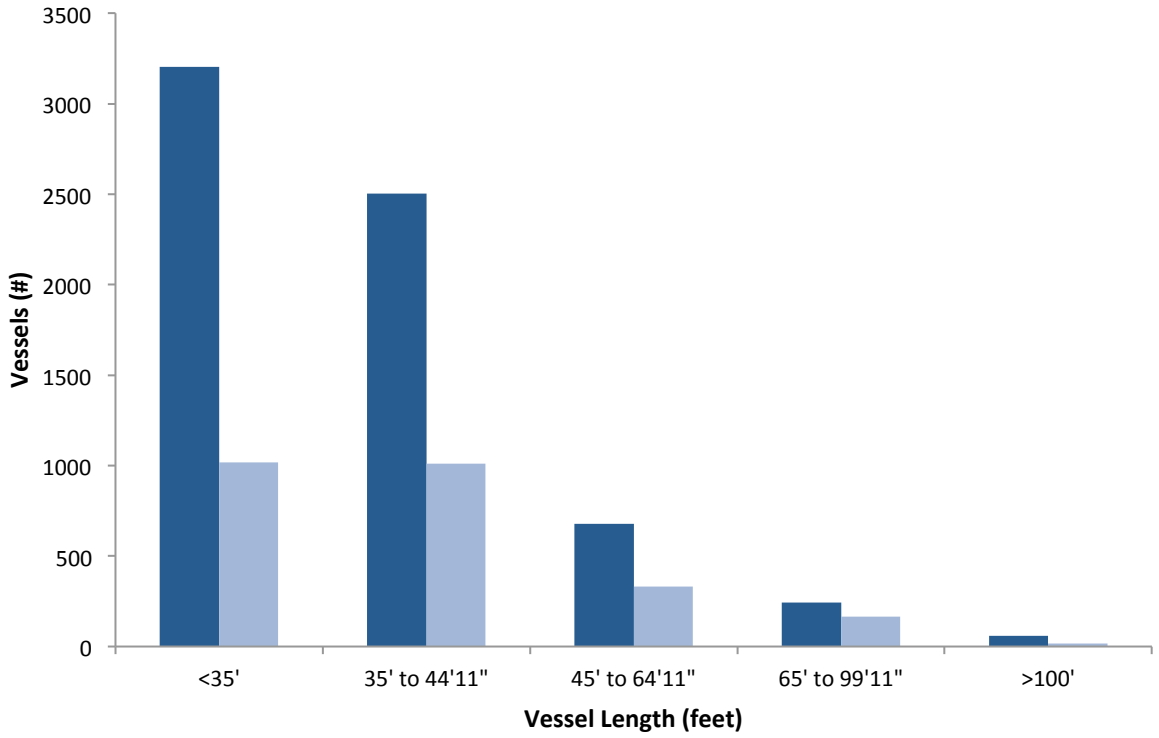

Figure 1 Change in the number of licensed vessels from 1985 to 2013 (Note that the dark bars represent 1985 and light bars represent 2013 and vessel length is in feet, not meters)[7].

The less than 35 ft. (10.6 m) and 35-45 ft. (10.6-13.7 m) vessel length categories were reduced by 68% and 60%, respectively, between 1985 and 2013 (Figure 1). This reduction in the smaller vessel portion of BC's fleet has been carried out by a series of management policies to reduce fishing capacity and rid the fleet of inefficient participants. Most of these management schemes specifically targeted reduction of capacity in the salmon fishery, which was the largest fishery in the province, at the time. These management decisions had larger overarching impacts on the entire structure of the BC fleet. In 1968, the Davis Plan sought to limit participation through licensing and reduce numbers of vessels through vessel buybacks to improve economic performance of the fishery (Brown, 2005; DFO, 2002; Gough, 2007; Healey, 1993).

The vessel numbers in 1985 represent the fleet numbers reduced by the Davis Plan (Figure 1). The apparent fleet reduction in the last thirty years may be a result of the onset of Individual Transferable Quota (ITQ) management schemes in many fisheries beginning with Geoduck in

1989 (Ecostrust 2008). This was soon followed by ITQs being introduced to the sablefish (1990), halibut (1991), sea urchin (1994), sea cucumber (1995), groundfish trawl (1997), some salmon troll (2003) and groundfish longline (2006) fisheries in the last 30 years (Ecotrust 2008). It is generally accepted that ITQs are introduced to enhance economic performance of a fishery and this often results in the reduction of participants/vessels (Clark , 2007; Clark & Munro, 2002; Sumaila, 2010; Sumaila et al., 2012). The heavy reduction of vessel numbers, especially of the smaller vessels demonstrates the need to understand SSF in BC. The prevention of further reductions in numbers of small relative to large vessels may allow some of the benefits of SSF identified in this study to be realised.

Canada is an excellent example of how diverse fisheries can exist within a country. We have a number of large and small-scale commercial marine, indigenous, freshwater and recreational fisheries. Canada's fishing culture also varies greatly from region to region. The commercial fishery in Atlantic Canada is larger than that of the Pacific and both are larger still than fisheries in the Arctic. As we consider each of the commercial fisheries within British Columbia, we recognize that some of the most commonly discussed features of SSF in developing nations are present within every target fishery of the British Columbian fleet.

2.2 Method

There are a large number of definitions or features of SSF found in the literature (Table 1). These features can be grouped into three broad categories, i.e., physical vessel, economic and social features (Table 1). Physical features include descriptors of vessels, which are the most commonly used features to distinguish between SSF and LSF (Macfadyen et al., 2011; Martín, 2012; Sumaila et al., 2012). This is because it is quite easy to acquire vessel data and it's easier for people to work with features that they can see. For example, it's relatively easy to know how many vessels are in a fleet and how many have a motor and how many do not by looking at the vessels. The physical features of vessels have important implications on the environment. A larger vessel often requires a larger engine and more fuel, contributing to the carbon footprint of fishing. Some gears such as trawlers are associated with habitat degradation and relatively high amounts of by-catch (Auster et al., 1996; Hall-Spencer et al., 2002; Jones, 1992;

Poiner et al., 1998; Sainsbury, 1993; Thrush & Dayton, 2002). The damage of a trawl fleet was evident in BC's groundfish trawl fleet, which caught 322 tonnes of cold-water coral and sponge by-catch from 1996 to 2004 (Ardron et al., 2007).

Table 1 List of common SSF features.

Number	Feature	Source
Vessel Features		
1	Vessel under 12m (39.3 ft.)	Macfadyen et al., 2011; Martín, 2012; Sumaila et al., 2012
2	Non-motorized vessel	Sumaila et al., 2012
3	Passive gear	Guyader et al., 2013
4	Multi-gear	Teh et al., 2011; Guyader et al., 2013
5	Multi-species	Teh et al., 2011; Guyader et al., 2013
6	Dated or low levels of technology, labour intensive[12]	FAO & Worldfish, 2008; Schuhbauer & Sumaila, 2016
7	Inshore, limited range to fish, fishing pressure adjacent to community	Emmerson, 1980; Panayotou, 1985; Johnson, 2006; Guyader et al., 2013
Economic Features		
8	Low fuel consumption (under $10,000)	Guyader et al., 2013
9	Relatively little capital and energy input (Under $250,000)	Berkes & Kislalioglu, 1989; Johnson, 2006; Guyader et al., 2013
10	Relatively low yield and income	Berkes & Kislalioglu, 1989; Johnson, 2006; Guyader et al., 2013
11	Part-time, seasonal, multi-occupational	Johnson 2006
12	Sold in local markets	Chuenpagdee et al., 2006
13	Sustain local or regional economies	Sumaila et al., 2016
14	Individual or community ownership	Johnson, 2006
Social Features		
15	Fish for food and community use	FAO & Worldfish, 2008; Johnson, 2006
16	Support social and cultural values	Schuhbauer & Sumaila, 2016; Sumaila et al., 2016
17	Regulated through customary rules with some government involvement	Johnson, 2006

[12] For this thesis, Labour Intensity is used in qualitative terms and is not a quantitative measure of labour in proportion to capital required for fishing.

Economic features are a slightly less tangible way of distinguishing between SSF and LSF; however, these features can describe fisheries in monetary terms, which people find relatable. For example, all else being equal, if a fishery can employ more people than another, people will likely want to participate and the government may have an incentive to invest in it. Other features may include costs, revenues, markets and ownership (Table 1). Including economic features in the analysis of SSF and LSF could provide a powerful bargaining tool for policy decisions, as it is stated in DFO's Mission, Vision and Values[4] to support economically prosperous marine sectors, which would include commercial fisheries.

Social features of a fishery are the least tangible features for determining SSF and LSF, and therefore are not often analyzed or used in practice for management. These features include how fish is consumed in non-traditional markets as well as how cultural values attached to fish can be used in management processes (Table 1). All of these features are commonly used in the literature to describe SSF in developing countries. I argue that they should not be limited to being applied only in these countries (Andrew *et al.,* 2007; Béné 2006; Béné et al. 2010; Damasio et al., 2016).

Using the list of SSF features reported in the literature, I demonstrate that these features are all present within BC's fisheries but to varying degrees. This analysis will assist in the quantitative formulation of a definition of SSF in BC to be made in Chapter 3.

2.3 Application to British Columbian Fisheries

Fisheries in BC are explored using the features of SSF commonly found in the literature (Table 1). Here, I use this method to establish where SSF attributes are present within the BC fleet. Once these features have been identified, the fisheries can be compared on a scale of most likely to be small-scale and vice versa based on the number of identified SSF attributes. It should be noted that the importance of these individual features is being equally weighted in this analysis. However, some of these features hold more importance to SSF than others. Using this method, the fisheries in BC can be considered on a relative qualitative scale of most likely

to be SSF and most likely to be LSF. One can use a scale of 0 to 17, where 0 is a fishery with not a single SSF feature and 17 is a fishery with the maximum number of features of SSF. With this scale, the closer a fishery is to having 17 features the more small-scale it is.

2.3.1 Data

The approaches require large amounts of data from varying sources. In the case of BC, data was sourced from primary literature, government sources, consultant reports for the government, as well as, personal communication and observations were used. All vessel features were acquired by cross-referencing the Department of Fisheries and Oceans[13] and Transport Canada[6] vessel databases, which are the most complete collection of vessel data for BC and therefore, an excellent resource for this information. The obvious issue with this way of acquiring vessel data is that boats can only be searched if one already knows which boat you're looking for or by searching by vessel-based license number. If searching by licence, one can only find vessels with vessel-based licences. There are also party based licenses and because these licenses are attached to a person/community/company, it's difficult to know which boat is being used.

Socio-economic data came from a series of financial profile reports and personal communication through interviews with local fishers (Nelson, 2011; GSGislasson 2011). These reports have their own assessment of the reliability of the data in which highest quality data has high quality sources and many data points; medium quality data comes from a mix of quality sources and personal communications with a moderate number of sources; and finally, low quality data comes from mostly personal communications and observations with few sources (Nelson, 2011). According to this profile, salmon seine, tuna, groundfish trawl, halibut hook and line and prawn trap fisheries have the highest reliability (Nelson, 2011). Salmon gillnet, salmon troll, sablefish hook and line, crab trap and geoduck by dive have moderate reliability of data (Nelson, 2011). Rockfish by hook and line, shrimp trawl, red urchin dive fisheries have the least quality and reliability of data (Nelson, 2011). I note that the fisheries

[13] DFO 'Licensed Fishing Vessel Search' http://www-ops2.pac.dfo-mpo.gc.ca/vrnd-rneb/index-eng.cfm?pg=VesselSearchForm (Accessed January 2015).

with the least amounts of data in BC are relatively 'small' fisheries. However, to have moderate reliability in the salmon gillnet and troll fisheries is a little concerning and the data from these profiles should be used with caution.

Some of the features found in Table 1 have limited data in the primary and grey literature and in these cases; I have used my personal observations. As a member of a fishing family and fishing community, I have an intimate knowledge of aspects of local fisheries that are not present in primary or grey literature. The following sections describe the features of fisheries in BC, with special attention to SSF features. There is assumed uncertainty within the data used however, it was not assessed for this analysis, as it is a qualitative discussion.

Salmon

The BC salmon fishery is the most important fishery in BC in terms of cultural and local, regional and national economies. The importance of these fisheries is far greater in First Nations communities as they are a part of indigenous identity and have always been a cornerstone of the traditional economy and culture (Pinkerton et al., 2014; Moss, 2016). Their anadromous nature makes them a significant fish for both the coastal and inland peoples. The social and cultural importance of salmon is present in all fishing communities along the coast. Fishers participating in the commercial salmon fishery often gift or trade fish from their catch within the family and community (O'Donnell et al., 2013). In BC, commercial, FSC and recreational salmon fisheries are supported by Coho (*Onchrhyncus kisutch*), Chinook (*Onchrhyncus*), Chum (*Onchrhyncus*), Pink (*Onchrhyncus*) and Sockeye (*Onchrhyncus nerka*) salmon. Chinook and Coho salmon are of particular importance to the recreational fishery more than the commercial fishery (DFO, 2016a).

Sockeye and pink salmon are the primary targets of the commercial fisheries with some target of Chum, Chinook and Coho fisheries. Each species and in some cases, different stocks of the same species, are different sizes, have different oil contents, flesh texture and taste. This makes some salmon species and stocks more desirable and marketable than others. Pink salmon have

high oil content and therefore do not freeze well, making them a difficult fish to process. This is problematic, as they have been increasing in numbers with climate change (Clark et al., 2011). Sockeye remains the most sought after species of pacific salmon as its deep red flesh and flavour make it highly marketable.

The social, cultural and economical important of sockeye salmon is so great to the province's commercial fisheries and indigenous peoples, that record low returns in 2009, sparked a Federal investigation by Supreme Court Justice Bruce called the Cohen Commission (Cohen, 2012). The length and level of investigation is an accurate representation of the critical importance of sockeye to British Columbians. Coho fisheries on the lower Fraser River have been closed for years due to poor stock status (DFO, 2006), which impacts on other commercial salmon fisheries. There are, however, healthy Coho stocks in northern BC, which are part of the commercial, FSC and recreational fisheries (Anon., 2011). FSC fisheries target all species of salmon whereas recreational fisheries mainly focus on sockeye, Chinook and Coho. In the following paragraphs, I describe the salmon fisheries by gear type in BC.

The Mifflin Plan of 1996 used the reoccurring recommendation of fleet reduction to implement an $80 million voluntary licence retirement scheme (Gough, 2007). The Mifflin Plan's focus was to remove effort, rather than strictly fishers (Gough, 2007). It removed nearly 800 of the 4,100 salmon licences in 1996 (Brown, 2005; DFO, 2002; Gough, 2007). In 1998, the Canadian Fisheries Adjustment and Restructuring Program (CFAR) provided $200 million in order to reduce the BC fleet by half (Gough, 2007). By 2001, the CFAR removed 1,400 salmon licences at a cost of $192 million, which also retired 1,007 (30%) of the vessels from the fleet (Gough, 2007). Through all of DFO's management efforts between 1984 and 1999, the fishery was reduced from 18,200 fishers and 7,000 vessels to 8,700 fishers and 3,900 vessels respectively (Gough, 2007). The CFAR combined with promotion of licence 'stacking' was the beginning of many economic and social concerns that are prevalent within the fishery today.

Salmon fisheries helped build modern BC through the success of canneries along the coast in the early 20th Century. The modern salmon fishery is extremely different from when it began and has been shaped by a number of management decisions, which were sometimes harsh, and plans throughout the 20th Century. Like many industrialized fleets, over-capacity was a huge concern throughout the salmon fishery in the 1960s and 1970s. The Sinclair Report of 1960 was the first recommendation of fleet reduction and area restrictions in the fishery (Gough, 2007). The Davis Plan of 1969 introduced the gear licences, which are still in use (Gough, 2007). There are three main commercial gears that target salmon ('A' licence) including troll ('AT' licence), gillnet ('AG' licence) and seine ('AS' licence). Each licence has a corresponding fishing area attached (Appendix B).

In BC, there has been a history of corporate involvement within the commercial fishery through cannery ownership. During the 1960s and 1970s, there was a 'gentlemen's agreement' that the canneries could own no more than 12% of the salmon vessels (Fraser, 1978; Gough, 2007; Parsons, 1993). However, there was no concrete legislation to uphold it and that proportion of ownership was surpassed long ago (Gough, 2007).

Salmon have always been the most important commercial fishery in BC in terms of economic importance. In the last decade, salmon represented approximately 10% of landed weight and 12% of landed value on average in BC (DFO, 2016a). The south coast is generally the dominant area for the fishery with 89% and 75% of the landed value caught in 2010 and 2014 respectively (DFO, 2016a). Recently, during non-dominant salmon return years, halibut has been contributing the largest landed weight and value in BC[14,15].

[14] DFO '2013 Atlantic & Pacific Coasts Commercial Landings, By Province (metric tonnes, live weight)' http://www.dfo-mpo.gc.ca/stats/commercial/land-debarq/sea-maritimes/s2013pq-eng.htm (Accessed November 2015).
[15] DFO '2013 Atlantic & Pacific Coasts Commercial Landings by Province (thousand dollards)' http://www.dfo-mpo.gc.ca/stats/commercial/land-debarq/sea-maritimes/s2013pv-eng.htm (Accessed November 2015).

Gillnet

Fishing using a gillnet typically involves a set or drift net where salmon will swim through and be caught by their gills, and these nets are generally considered to have a higher selectivity[16]. These vessels typically target a specific run of salmon but may catch multiple species of Pacific salmon during a set. There are always restrictions in regards to which stocks can be caught at the discretion of DFO management. The fishery is managed through input controls such as limited entry and area licensing (DFO, 2016a; DFO, 2016c). The licence prefix for the salmon gillnet fleet is AG and a vessel may hold multiple AG licences for different management areas (Appendix B.1).

Gillnetters are the most abundant salmon vessels in BC, with 597 licensed and active vessels for the 2013 season (DFO, 2016a). A crew of two or three generally operate a typical gillnet vessel (GSGislason and Associates Ltd., 2011; Nelson, 2011; pers. comm. fisher). Gillnetters operate over the entire coast of BC, Vancouver Island and usually fish near the coast, in estuaries and inlets (DFO, 2016a). The majority of active vessels are less than 45 ft. (13.7 m)[6,13]; therefore falling under the 12m (39.3 ft.) cut off used by the EU to determine artisanal/small-scale fisheries (Martín, 2012). A majority of the gillnetters in BC are constructed with reinforced plastic, were made before 1980 and have diesel engines[6]. While a gillnet is a passive gear type, which is a feature of SSF, the majority of gillnet vessels in the province have pneumatic drums to haul in the net, which is a feature of LSF (pers. obs.).

Gillnet licences in BC are 68% owned by individuals, with a majority of these individuals being located in Vancouver and the immediately adjacent cities[6]. The high proportion of individual ownership represents a feature of SSF (Johnson, 2006). The vessels operating in this fishery may also participate in other fisheries, such as crab trapping or herring roe gillnetting. By diversifying their licence holdings, these vessels are able to operate for longer periods of the year. However, vessels with only AG licences will operate through the summer and early fall.

[16] FAO 'Gillnets and Entangling Nets' http://www.fao.org/fishery/geartype/107/en (Accessed December 2016).

In terms of expenses, these vessels are typically on the lower end of the spectrum in BC, so the average vessel spends less than $10,000 per year on fuel (Nelson, 2011) as well as investing less than $250,000 in the fishing enterprise (Nelson, 2011). Along with relatively low inputs to the enterprise, there are relatively low average yield per vessel of 318,000 lbs (144 t). Catch from these vessels is sold to a number of different vendors but some of the catch can be found at local fishermen's wharves for independent sale, which is a feature of SSF. The commercial salmon gillnet fishery exhibits many of the vessel, economic and social features associated with SSF.

Troll

Pacific salmon is also targeted using trolling gear in which several hooked lines are trailed behind the vessel, which is generally considered amongst the most highly selective fishing gears[17]. However, the BC troll fleet catches a notable amount of rockfish as by-catch (DFO, 2016d). Like gillnetters, trolling gear typically will target specific salmon runs, which may consist of multiple salmon species but their overall selectivity is an important feature of SSF.

Trolling vessels are a little larger than gillnetters, with an average length of 43 ft. (13.1 m), putting them a little over the 12 m (39.3 ft.) cut-off found in the literature, however, there are many trollers below 12m (Martín, 2012; Sumaila et al., 2012; Macfadyen et al., 2011). The average trolling vessel was built in 1979, is either made of wood or reinforced plastic and runs on diesel fuel[6].

Salmon trollers have an AT licence which is attached to a vessel and also is for specific management areas (Appendix B.2). Parties located on Vancouver Island and Gulf Islands own most of the troll licences[6]. Some of the areas on Vancouver Island and the some of the Gulf Islands are quite remote and fishing may be the primary economic activity, which is a feature of SSF (Sumaila et al., 2016). These vessels are nearly split 50:50 between company and individual ownership[6]. Overall, the salmon troll fleet is the smallest by numbers with only 298 licenced

[17] FAO 'Trolling Lines' http://www.fao.org/fishery/geartype/235/en (Accessed December 2016).

and active vessels in 2013 (DFO, 2016d). These vessels operate across the entire coast of British Columbia and generally have a crew of two (Nelson, 2011).

These vessels typically have a lower average capital investment relative to other BC fisheries, but over $250,000 and an average fuel cost of $4,600 per year (Nelson, 2011). The average troll licenced vessel caught $236,000/lb. ($107,000/kg) in 2013, with a landed value of $2.23/lb ($1.01/kg). (DFO, 2016d). Troll caught salmon receive the highest price per pound of the salmon fisheries as troll gear has the lowest impact overall on the appearance of the fish, and many vessels have flash freezing facilities on board. The troll fishery exhibits quite a few features of SSF but, there are fewer features present than in the gillnet fishery.

Seine

The seine fleet is the final gear type in BC's salmon fishery, which is a large, all encompassing net and has the highest potential for unwanted by-catch in the salmon fleet[18]. These vessels will target specific runs of salmon but will also catch large amounts of other species of salmon and insignificant amounts of other species (DFO, 2016d).

These vessels are typically the largest in the salmon fleet with an average length of just over 65 ft.[6], which puts them well above the commonly used 12 m (39.3 ft.) cut-off for SSF (Martín, 2012; Sumaila et al., 2012; Macfadyen et al., 2011). The average seine vessel was built in 1997, with a few vessels being over 80 years old[6]. These boats are mostly made of aluminum (45%) and steel (40%), with the rest being made of reinforced plastic and wood[6].

These boats typically employ a larger crew of 4 or 5, than other salmon vessels however; there are fewer vessels, with only 114 licensed and active vessels in 2013 (DFO, 2016d). Seine vessels carry an AS licence which again is further specified to a management area (Appendix B.3). These licenses, like other salmon licences are attached to the vessels and there may be multiple licences per vessel (i.e. for different fishing areas). Companies, including Canfisco., in the

[18] FAO 'Seine Nets' http://www.fao.org/fishery/geartype/102/en (Accessed December 2016).

Greater Vancouver area own a majority of the seine licences and vessels[6]. The concentration of ownership in the most urban area of the province and the presence of many corporate owners in this fishery are features of LSF.

The salmon seine fleet has the most features of LSF of the salmon fleet. On average, seine vessels spend over $10,000 per vessel per year on fuel, and have an average enterprise replacement cost of nearly $900,000 (Nelson, 2011). This is a large capital investment for a fishing enterprise. This fleet has receives $0.62/lb. ($0.28/kg) landed value, which is significantly lower than the other salmon fleets (DFO, 2016d). However, these vessels catch an average of over 3 millions lbs. (1,300 t) per vessel per year which is significantly higher than the troll and gillnet fleet (DFO, 2016d). The fish from seine boats are almost all sold to canneries, as canning and processing companies own most of these boats (Haas et al., 2016). A fishery which has it's catch controlled by processor who lease out vessels and catch for canning is an expected value of LSF.

Many of these large steel and aluminum vessels have been sold to Americans in the last few years (pers. comm. anonymous). It is unclear from this information whether the vessels being sold by an individual or a company. If this trend that continues over the next few years, it could have important socio-economic impacts on the salmon fishery in BC, especially in addition to the closing of Canfisco's Prince Rupert Cannery (CBC, 2015).

Groundfish

The BC groundfish trawl fishery targets all 'other' groundfishes including rockfishes (*Sebastes spp.*), Pacific Ocean perch (*Sebastes alutus*), Pacific hake (*Merluccius productus*) and Pacific cod (*Gadus mcrocephalus*). There are other fisheries for Inside Rockfish, Outside Rockfish, Lingcod (*Ophiodon elongatus*) and Dogfish (*Squalus acanthias*), which are managed separately (DFO, 2016e). Trawl fisheries consist of a vessel actively towing a net across the bottom of the

ocean[19]. These gears are considered to be highly unselective, allowing them to capture a large number of bottom species[19].

The Groundfish Development Authority (GDA) supports community and industry interests by advising the Minister on a proportion of the quota allocation (Scholz et al., 2004). The 20% of the quota that the GDA is responsible for is used for regional development and employment in communities (Clark, 2007). With the implementation of IVQs in the groundfish fishery, there was a buffer of sorts with which 80% of the Total Allowable Catch (TAC) was awarded to licence holders and the other 20% to the GDA (Nelson, 2006). The GDA is a non-profit organization, which allowed for crewmembers or processors to buy quota (Nelson, 2006).

All groundfish fisheries require 100% observer and dockside monitoring (DFO, 2016e). Data is collected through catch data in fisher logs, observer and electronic logs and unloading slips along with dockside biological samples, and research cruise sampling (DFO, 2016e). Stock assessments are carried out for the 30 commercially exploited groundfish stocks in BC using the rich databases for groundfish stocks (DFO, 2016e). All groundfishes are managed under a TAC and ITQ and any by-catch can be reallocated between vessels (DFO, 2016e).

The vessels in this fishery are among some of the largest in BC with an average length on 19.5 m (64') and the majority of the vessels are constructed with steel and some aluminum or reinforced plastic[6]. The average trawl vessel was built in 1977, however there are vessels in the fleet that are as old as 90 years old[6]. The vessels participating in the groundfish trawl fishery are widely regarded as large-scale due to their size and use of trawling gear.

These vessels are licensed with a T licence, and there were 65 licensed and active vessels in 2013 (DFO, 2016d; DFO, 2016e). Groundfish trawl vessels employ an average crew of 3 on each vessel (DFO, 2016d; Nelson, 2011; pers. comm. anonymous). In BC, 88% of the groundfish trawl vessels are owned by companies, of which 57% are located in the Greater Vancouver Area, and

[19] FAO 'Bottom Trawls' http://www.fao.org/fishery/geartype/205/en (Accessed December 2016).

34% on Vancouver Island[6]. This fishery has one of the highest amounts of company control in the province, which is an important socio-economic feature of LSF.

The nature of a quota fishery creates high capital investment, which is associated with LSF. The average replacement cost for a BC trawl enterprise is $850,000, which only includes the vessel and the licence (Nelson, 2011). The capital investment is even higher with 40,000 kg of quota valued at $110,000 and an average fuel expense of $110,000 per year (Nelson, 2011). The capital investment into these fisheries is high, considering in 2013; the average landed value was $0.26/lb. ($0.12/kg), with the average vessel landing 20 million lbs. (9,100 t) (DFO, 2016e). There are many companies participating in this fishery which is a logical progression as the capital investment required to participate in the fishery being astronomical. Even still, there remains some individual ownership and some smaller, older trawlers present in the fishery. So, even in a fishery considered highly industrialized, with many features on LSF, there is a presence of SSF features.

Halibut

Halibut are a flatfish, which are typically between 10 and 60 pounds (4.5 – 27.2 kg) (Casey *et al.* 1995). Halibut are a traditional fishery for coastal First Nations but quickly gained commercial recognition in the early 1900s (Thompson & Freeman, 1930). Halibut is a straddling stock like salmon; therefore Canada and the USA co-manage the fisheries through the International Pacific Halibut Commission (IPHC). The IPHC has been a managing body since the 1920s, long before the Pacific Salmon Treaty (Gough, 2007).

The Pacific Halibut (*Hippoglossus stenolepis*) fishery began in the early 1900s (Gough, 2007). This fishery was originally a derby style fishery with the introduction of an 'L' licence in 1979 (Gough, 2007). The fishery shifted from a 60-day season in 1982 to a 6 day season by 1990 and these conditions put fishers lives at risk and created a lot of waste and inconsistent supply throughout the year (Casey *et al.* 1995). In 1982, the Pearse Commission recommended the fishery move to an IVQ system and from 1990 to 1991, ITQs were introduced based on each

licence's catch history (Dupont, 2014; Gough, 2007). The ITQ system was successful in increasing the value of the fishery and members of the halibut fishery are able to contribute funding to the management of the fishery (Gough, 2007).

The main gear for halibut is hook and line in which a long line with baited hooks is set and can be hauled in by hand or by powered hauls[20]. Halibut may also be trawl caught by-catch from the groundfish fishery, which needs to be returned with a mortality rate of nearly 100% (Clark, 2007). The hook and line fishery catches a large number of other groundfishes, including rockfishes. The Halibut fleet is made of vessels typically between 40' (12.2 m) and 60' (18.3 m) and are often used for salmon or herring as well (Casey *et al.* 1995; DFO, 2016d). In 2013, there were 188 licensed and active vessels in the halibut longline fishery (DFO, 2016d) and have an average crew of 4 (Nelson, 2011).

Like the groundfish fishery, halibut has grown to be one of the most valuable fisheries in BC, and the most valuable in 2013, coinciding with a poor salmon return. The average landed value of halibut from L licensed vessels was $3.48/lb. ($1.58/kg) in 2013 (DFO, 2016d). This occurred even after a reduction in 32 active vessels and average vessel revenue of $14,000 (2012 CAD) from 2005 to 2012 (DFO, 2016e). The initial capital investment for a halibut enterprise is on the higher end in BC's fishing industry. The average replacement cost for a vessel and licence in the halibut fishery is $218,000 (Nelson, 2011). The capital investment is even more extraordinary once the $1.5 million 20,000 kg quota is accounted for (Nelson, 2011). The enormous cost of operating in this fishery establishes the halibut fishery as LSF. However, there are many vessels under 12m that participate in this fishery.

Sablefish

Sablefish (*Anoplopoma fimbria*) are a deep-water species and the fishing grounds are further offshore than most of the commercial fisheries. Sablefish are targeted with longlines and traps,

[20] FAO 'Hooks and Lines' http://www.fao.org/fishery/geartype/109/en (Accessed December 2016).

which are generally quite selective gears[21, 22]. Limited entry began in 1979 with 27 trap vessels and 20 longline vessels (Gough, 2007). Upon limited entry, the fishers established the Canadian Sablefish Association (CSA) in 1987. The 'K' licence was introduced in 1981 (Gough, 2007). Due to the high price per pound of Sablefish and such a limited sharing of the wealth due to limited entry, the CSA is able to fund its own observer program (Gough, 2007). ITQs were introduced to the fishery in 1990 (Dupont, 2014).

The sablefish fishery is one of BC's smallest finfish fisheries by number of participants with only 42 licences for the whole fleet (DFO, 2016d). However, only 30 licensed vessels were active in 2013, with 5 of those being protected by the 3-Party Rule so no data is available (DFO 2016). Most of the active vessels in the sablefish fleet are between 45' (13.7 m) and 100' (30.5 m), which allows them to go far offshore to target sablefish (DFO, 2016d).

Sablefish is one of the best examples of co-management in BC and while the other groundfish fisheries experienced a decrease in vessels and average revenue, sablefish experienced the addition of 5 vessels and decreased average vessel revenue of $597,000 (DFO, 2016e). This fishery has one of the highest initial capital investments in BC, with an average vessel and licence replacement cost of $779,000 (Nelson, 2011). Due to the nature of quota fisheries, the sablefish fishery has further capital required for a fishing enterprise. Sablefish quota has been estimated at nearly $2 million for 20,000 kg of quota (Nelson, 2011).

These vessels catch an average of over 2.5 million lbs. (1,100 t) of fish, including sablefish and a number of rockfish species and this fleet obtained an average landed value of $3.54/lb. ($1.61/kg) in 2013 (DFO, 2016d). This fishery is highly dependent on a Japanese export market, with nearly 90% of the harvest being exported to Japan (Sumaila et al., 2007b). The sablefish fleet has very few features of SSF but the high capital input required and the offshore nature of the sablefish fishery make more features of LSF than SSF.

[21] FAO 'Set Longlines' http://www.fao.org/fishery/geartype/232/en (Accessed December 2016).
[22] FAO 'Traps' http://www.fao.org/fishery/geartype/108/en (Accessed December 2016).

Rockfishes

Rockfishes can be targeted both by hook and line as well as by-catch in the groundfish trawl fishery. There are inshore and offshore rockfish hook and line fisheries, which operate along the coast. There were 89 licensed and active vessels in 2013, all of which were less than 35' and operate with an average crew size of two (DFO, 2016d; Nelson, 2011). These vessels are under the 12 m (39.3 ft.) SSF distinction and use a relatively low impact gear, which are features of SSF (Macfadyen et al., 2011; Martín, 2012; Sumaila et al., 2012). Rockfish licensed vessels caught an average of 121,000 lbs. (55 t) at an average landed value of $3.58/lb. ($1.62/kg) in 2013 (DFO, 2016d). Quillback (*Sebastes maliger*), Yelloweye (*Sebastes ruberrimus*), China (*Sebastes nebulosus*) and Tiger (*Sebastes nigrocinctus*) rockfishes had the highest landed value in 2013, but the fishery also includes varying amounts of 46 other rockfish and groundfish species.

These vessels have relatively low capital investments required to establish a fishing enterprise, which is a feature of SSF (Berkes & Kislalioglu, 1989; Guyader et al., 2013; Johnson, 2006). A rockfish hook and line vessel has an average replacement cost of $112,500, with inside and outside license replacement costs of $45,000 and $126,000 respectively (Nelson, 2011). These fisheries also have relatively low fuel costs with inside and outside rockfish vessels spending an average of $3,500 and $7,200 per year respectively (Nelson, 2011). Relatively low fuel cost is another attribute of SSF for the rockfish fishery (Guyader et al., 2013). Both the inside and outside rockfish fleets are likely to be considered SSF.

Herring

Pacific Herring (*Clupea pallasii*), like salmon, is of enormous social and cultural importance to Aboriginal communities along the BC coast, especially the Heiltsuk of the Central Coast and the Haida (Jones et al., 2016; Thornton & Hebert, 2014). In BC, there are roe herring fisheries and the spawn on kelp fishery (spawn on hemlock branches for the Heilstsuk), which share a resource but operate very differently from each other, and will be elaborated on below.

Herring populations can crash and bounce back in a seemingly spontaneous fashion. The fishery was closed in 1968 and reopened in 1971 (Gough, 2007). As a result of past management errors, the quotas and TACs for herring fisheries are frequently debated in BC and are currently at a maximum harvest rate of 20% (DFO, 2013a). The debate reached a climax in March of 2015 when members of Indigenous groups sat in at DFO offices downtown Vancouver, demanding closure of the fishery[23,24]. Herring stocks are assessed using a Bayesian framework as the herring catch age model based on an egg production method that estimates the number of spawning females from the surveyed number of eggs that were laid, and are managed in five major and two minor stocks on the coast (DFO, 2013a). Herring are harvested in four fisheries; roe, spawn on kelp, food and bait and special use fisheries. The 2013/2014 seasons TACs are divided into 1,535 t FSC, 3,720 t spawn on kelp, 19,700 t roe, 8,200 t food and bait and 932 t special use (DFO, 2013a). Only the spawn on kelp and roe fisheries will be discussed further in this thesis.

The herring fishery is like other fisheries in BC with the presence of armchair fishers. This phenomenon is generally associated with DFO allowing for the transferability of herring licences (Gough, 2007). The herring licences are not attached to the vessel, but rather the fishery and many fishers will stack their licences onto one boat to fish and these licenses may also be owned by corporations (Gough, 2007; pers. comm. Anonymous). This is an economic decision in order to make herring fishing viable; otherwise it would be too costly to operate one's own boat. Due to the dominance of stacking in the herring fishery, it is difficult to know which boats are fishing, how many boats are fishing and how many people are fishing.

Roe

The roe herring fishery targets the fish just before they have spawned to collect the eggs from the ripe ovary. This fishery is divided into gillnetters and seiners, similar to the salmon fishery, with many fishers able to participate in both fisheries (pers. comm. anonymous). In 1997, the

[23] Bethany Lindsay 'Heiltsuk Nation members occupy DFO office to protest herring fishery' Vancouver Sun 20 March 2015 (Accessed December 2016).
[24] The Globe and Mail 'First Nation occupies fisheries office in BC as herring fight escalates' 30 March 2015 (Accessed December 2016).

Herring Industry Board divided the BC coast into 5 herring fishing areas, with (Appendix) 250 seiners receiving 55% of the TAC and 1,260 gillnetters, 45% (Gough, 2007). There are pools of operators within each area that are given a sub-quota proportional to the number of licences operating within the pool (Gough, 2007). It is extremely challenging to know how many vessels are operating in this fishery, and as a result, how many are being employed in this fishery. The roe fishery receives the majority of the herring TAC; 19,700 t for the 2013/2014 seasons (DFO, 2013a).

The roe herring gillnet and seine fleets landed an average landed value of $0.20/lb. ($0.09/kg) and $0.15/lb. ($0.07/kg) respectively in 2013 (DFO, 2016d). This fishery is highly dependent on export markets for its success and the main market for herring has traditionally been Japan but has been on a declining trend in recent years, while China and the USA are emerging markets (DFO, 2013a). If it is assumed that there are some of the gillnetters and seiners from the salmon fleet operating in this fishery, there must be smaller vessels under 12 m, a feature of SSF (Martín, 2012). A mix of gillnetters and seiners would also have the presence of passive gears, a feature of SSF (Guyader et al., 2013). A fishing enterprise in this fishery would have similar capital investment for a vessel, however the licence and quota costs are different. There is also a mix of individual and company ownership in this fleet and it is difficult to know just how much. There have been accounts of license consolidation, which demonstrate single owners having many licences, including Jim Pattison Enterprises and subsidiaries owning 226 licenses (O'Donnell et al., 2013; Robertson et al., 2015)[25]. Overall, the roe herring fishery demonstrates a wide spectrum of involvement and does share some features of SSF and LSF.

Spawn on Kelp

The herring spawn on kelp is a critical fishery for indigenous peoples along the coast in BC. The spawn on kelp is known traditionally as k'aaw, and is often harvested by families and communities in gathering camps in the spring (Jones et al., 2016). The spawn on kelp fishery targets roe on kelp after spawning by hand with little use of nets, making it a highly selective

[25] Ecotrust Canada ' Constellations of Herring' http://data.ecotrust.ca/fisheries/herringconstellation.html (Accessed January 2017).

fishery (DFO, 2013a). The spawn on kelp fishery in BC is one of the most labour intensive fisheries and has very little technology involved, which is an important feature of SSF (FAO & Worldfish, 2008; Schuhbauer & Sumaila, 2016). Communities and individuals are designated licences for spawn on kelp therefore; it is difficult to know which vessels are participating in this fishery, along with employment estimates and licence and quota ownership.
Supreme Court decisions have restored aboriginal harvesting frights of herring spawn-on-kelp for commercial purposes for the five Nuu-chah-nulth and Heiltsuk Nations (R. v. Gladstone, 1996; Ahousaht Indian Band and Nation v. Canada, 2011). These decisions allow Indigenous groups along the coast to have greater control of their fisheries and contribute to a more formal economy in their regions. However, this fishery creates jobs and value outside of the traditional economy and embodies strong cultural and social importance, which are critical features of SSF (FAO & Worldfish, 2008; Johnson, 2006; Schuhbauer & Sumaila, 2016; Sumaila et al., 2016). There is also a market for spawn on kelp in Japan however; these exports have been declining for a number of years with more minor markets in China and the USA (DFO, 2013a). The heavy reliance of international markets for this fishery to thrive as a predominantly export fishery may be more associated with an LSF. However, the spawn on kelp fishery displays many features of SSF and may be considered likely to be a SSF.

Dive fisheries

Dive fisheries are the newest addition to the BC fishing industry and in the short time that they've been operating, they have grown to be some of the most profitable fisheries in the province. Dive fisheries involve small vessels, which do not travel far to fishing grounds and will have one or two divers and are supposed to have a dive tender on board (James, 2008). The main targets of the dive fisheries are geoduck (*Panopea abrupta*), green urchin (*Strongylocentrotus droebachiensis*), red urchin (*Strongylocentrotus franciscanus*), and sea cucumber (*Parastichopus californicus*). There were no fish slips for the cucumber fishery in 2013 so it is not considered in this analysis but a description of the fishery can be seen below in 'Other fisheries'.

Geoduck

Geoduck is a bivalve that buries itself in soft sediment and occurs in discrete beds from Alaska to Baja California (DFO, 2011). Geoducks form beds, which are linked by larvae to form meta-populations in the sediment (DFO, 2011). The biomass and stock status of Geoduck is relatively unknown due to the new nature of the fishery therefore this stock is managed using a 'precautionary approach' (DFO, 2015a). Geoducks are fished using a hose and nozzle called a stinger that 'liquefies' the sand and loosens the geoduck from the sand (James, 2008).

The commercial fishery for geoduck began as an open access fishery in 1976 (Campbell *et al.,* 1998; DFO, 1999a; Stocker et al., 2001; Heizer, 2000; James, 2008; Khan, 2006) with 7 licences for the Strait of Georgia (Heizer, 2000; James, 2008). Quotas came into play in 1979 but with the intention of just limiting effort with no real logic for the decision and harvest rate was originally set at 1% of the original biomass (DFO, 2011; DFO, 2016f). In order to cope with the derby fishery, a moratorium on licences was put in place by DFO (James, 2008; Campbell *et al.,* 1998).

The geoduck fishery is a 14-month fishery, managed through area-based quotas within a TAC (DFO, 2016f). TAC has been at 3.3 million pounds since 2012 (DFO, 2015a). The most current estimates of biomass from harvestable beds are 178,352 t (DFO, 2011). Due to geoduck being a relatively new fishery, historical data sets and aboriginal and traditional knowledge is not as readily available as salmon or herring. This is problematic as geoducks are one of the longest-lived animals in the world, surviving up to 150 years old and most are not fully recruited until 6-12 years (DFO, 2016f).The fishery soon evolved with the introduction of a 'G' fishing licence in 1983 (Campbell *et al.,* 1998; Heizer, 2000). Each licence receives 1/55 of the quota with the licence and the majority of landed quota comes from the North Coast (DFO, 2016f).

The Underwater Harvester's Association (UHA) of British Columbia is a fisher association for all dive fisheries and play a collaborative role in management with DFO. The UHA was responsible for lobbying DFO, which eventually led to the creation of Individual Vessel Quotas within the

fishery which the UHA helped pay for (Heizer, 2000; James, 2008; Khan, 2006). A detailed account of the creation and role of the UHA can be found in James (2008). The fishery is now assessed using spatial scale of geoduck beds (DFO, 2011). Dive fisheries are the most selective fisheries in the province but horse clams (*Tresus capand & Tresus nutallii*) are taken as by-catch in this fishery (DFO, 2011).

The UHA funds all of its own research, even supplying the funding for a management biologist at DFO (Heizer, 2000). This creates a potential for bias in research and management decisions. The UHA also funds on-grounds observers and a patrolman whose operation cost and salary is $140,000 annually and an additional $385,000 for a catch validation program (Heizer, 2000). The average geoduck vessel is 37' (11.3 m), which falls below 12 m (39.3 ft.), a feature of SSF, runs on diesel and is built in 1981[6] (Martín, 2012). Most of these vessels are made of reinforced plastic, which are the older vessels and aluminum, which are the newer vessels[6]. Based on vessel characteristics, the geoduck fleet exhibits many features of SSF.

This fishery currently consists of 55 licence eligibilities, however in 2013, there were only 39 licensed and active vessels (DFO, 2016d; DFO, 2015a; DFO, 2016f). Geoduck licences could be held by an individual or incorporated company (Heizer, 2000), but companies own the majority of participating vessels[6]. Companies and individuals on Vancouver Island also own the majority of these vessels with a secondary proportion located in the Greater Vancouver Area[6]. Each vessel employs an average of three crewmembers; in most cases, this is one dive tender and two divers (Nelson, 2011). In terms of ownership, even though there are individual owners within the geoduck fishery, most fishing enterprises are owned by companies, which is a feature of LSF.

Landings peaked for the Geoduck fishery in 1987 and have since declined mostly due to TAC reductions (DFO, 2011; DFO, 2016f). The average vessel landed a value of $10.12/lb. ($4.60/kg) in 2013, which is one of the highest landed value species in BC (DFO, 2016d). The main market for Geoduck is in China, Japan and other Asian markets where Geoduck is considered a delicacy.

Due to the lucrative nature of the Geoduck fishery, there is interest for fishers wanting to enter this exclusive fishery, including Aboriginal licences, which presently don't exist.
The replacement cost of the vessel and licence of a geoduck enterprise is $2.8 million (Nelson, 2011). This fishery has the highest capital investment required (excluding quota) in BC, and this high required capital investment is a feature of LSF. Geoduck is a fleet with features of SSF, including small vessels, low fuel consumption and an extremely selective method but its enormous capital requirements, prevalence of company ownership, required access to international export markets and high technology required make geoduck a likely LSF.

Green Urchin

In BC, separate dive fisheries target red and green urchins. The fishery for green urchin began in 1987 and steadily increased until the implementation of a licencing scheme in 1991 (DFO, 2016g; Perry et al., 2002). There are now 49 licences in the green urchin fishery, however, there were only 7 licensed and actively fishing vessels in 2013 (DFO, 2016d), making it one of BC's smallest fisheries (DFO, 2016g). These vessels, like other dive fisheries, usually have a crew of 2 or 3 with one dive tender and one or two divers (Nelson, 2011).

This fishery is managed by a TAC, which has remained steady even with a recent decline in catch (DFO, 2016g). Stock assessment is done every 3 years using data from fishery dependent and independent sources (DFO, 2016g). Like other dive fisheries, which are smaller, there is a strong association, the West Coast Green Urchin Association, which has a close working relationship with DFO for management of the fishery (DFO, 2016g).

The green urchin fishery has a ZA licence, which is attached to an individual, not a vessel. This makes it challenging to determine any vessel and ownership statistics, however all vessels to land catch in 2013 were under 35' (10.7 m) in length. This means all active vessels for this year are less than the 12 m (39.3 ft.) distinction for SSF (Macfadyen et al., 2011; Martín, 2012; Sumaila et al., 2012). The participating vessels are mostly restricted to the south coast because as a live fishery, quality and perishability are of great importance (DFO, 2016g). However,

fisheries in Haida Gwaii contribute greatly as well and account for 90% of the landings combined with the South Coast and Vancouver Island (Perry et al., 2002).

The green urchin is the smaller of the two urchin fisheries and it can be assumed that replacement cost would be around the same (see below). Green urchin had a landed value of $1.52/lb ($0.69/kg) in 2013 (DFO, 2016d). The main market for green urchin is live in Japan but recently there has been competition with cheaper Russian urchins, which DFO suspects are being caught illegally (DFO, 2016g). This fishery has smaller vessels, all under 35' (10.7 m), however, it requires modern technology for harvest and doesn't employ many people therefore it exhibits some features of SSF and LSF.

Red Urchin

Red Urchin's main product is treated roe or 'Uni' which is exported to Japan, Europe and the USA while green urchin is available whole and live DFO 2016 IFMP Red Urchin). There is an average crew of three on these vessels, which generally consists of one dive tender and two divers (Nelson, 2011). The red urchin licence is known as ZC licences and is party-based, not vessel-based. As a result, there is little data for vessels involved in the fishery however, all vessels to land catch in 2013 were less than 35' (10.7 m) in length. This means all active vessels for this year are less than the 12 m (39.3 ft.) distinction for SSF (Macfadyen et al., 2011; Martín, 2012; Sumaila et al., 2012).

This fishery is managed through limited entry, minimum sizes, area quotas, individual quotas and area specific licensing (DFO, 2016h). Stock assessment is carried out by DFO, First Nations and Pacific Urchin Harvesters Association (PUHA) using biomass transect surveys and experimental harvest sites (DFO, 2016h). Landings dropped to below half of the TAC from 2006-2011, which may be attributed to stock performance or poor market performance (DFO, 2016h). The TAC is set at 10 million lbs. (4,500 t) for 2016 (DFO 2016h).

Red Urchin is not as valuable as green urchin and in order to make fishing economical, with a landed value of $0.62/lb. ($0.28/kg) in 2013 so, many fishers stack licences, similar to the herring fishery (DFO, 2016h). The market for Red Urchin, like Green Urchin is threatened by cheaper and more readily available illegal Russian Urchin in Japan (DFO, 2016h). Red urchin is a separate commercial dive urchin fishery with 110 licence eligibilities, distributed to around 33 vessels in 2013, and it also has an important FSC fishery as well (DFO, 2016d; DFO, 2016h). The cultural importance of red sea urchin to First Nations peoples on the coast is an important social feature of SSF (Schuhbauer & Sumaila, 2016).

Shrimp and Prawn

In British Columbia, trawls and traps are used to target different shrimp and prawn species; Spot Prawn (*Pandalus platyceros*), Coonstripe Shrimp (*Pandalus danae*), Humpback shrimp (*Pandalus hypsinotus*), spiny pink shrimp (*Pandalus borealis*) and the smooth pink shrimp (*Pandalus jordani*) and sidestripe shrimp (*Pandalopsis dispar*). Some species are more valuable than others and generally trap caught species are more valuable than trawl caught.

Trap

The main target of the trap fishery is spot prawn with some catch of coonstripe shrimp and humpback shrimp, with the majority of effort occurring in the Strait of Georgia (DFO, 2016i). Traps are generally viewed as a selective gear type with lower by-catch potential[22], and most of the by-catch in the BC prawn fishery consists of other species of shrimp and some octopus (DFO, 2016d). The fishery commonly opens shortly before May and is generally closed at the end of June however; there is a second opening in the fall for a humpback and coonstripe specific fishery each year (DFO, 2016i). The trap fishery is the larger of the two shrimp and prawn fisheries with 250 licence eligibilities, 57 of which are communal licenses for First Nations participation in the commercial fishery (DFO, 2016i).

The fishery is managed using licenses, in-season area closures, seasonal closures, trap mesh size limits, minimum prawn size limits, gear number and marking limits, daily fishing time

restrictions and daily single haul limits (DFO, 2016i). The stock is managed using an escapement-based model, the Spawner Index Model, using commercial landings as a suitable proxy for stock abundance (DFO, 2016i). Starting in 2016, DFO will begin to request gear and vessel information for FSC prawn and shrimp harvest by trap (DFO, 2016i). The commercial fishery members will employ J.O. Thomas and Associates, Ltd for the 2016 season to deliver in-season data to DFO (DFO, 2016i).

Prawn and shrimp trap vessels are typically smaller in size, averaging 37' (11.3 m) in overall length, made from reinforced plastic or aluminum with some other materials and run on diesel fuel[6]. Many of the vessels in this fishery demonstrate attributes of SSF, including less than 12 m (39.3 ft.) (Macfadyen et al., 2011; Martín, 2012; Sumaila et al., 2012), passive, low technology gear (Guyader et al., 2013; Schuhbauer & Sumaila, 2016), and multi-species (Guyader et al., 2013; Teh et al., 2011). Even still, there are larger trap vessels with up to 500 traps, which demonstrate LSF fishing capacity within the fishery (Nelson, 2011).

Prawn trap vessels have a W licence and are owned by companies and individuals, with slightly more companies involved[6]. There were only 180 licensed and active vessels in 2013 (DFO, 2016d), with an average crew of four (Nelson, 2011). Most of these vessels are owned on Vancouver Island, the Greater Vancouver region and the Sunshine Coast[6]. The presence of individual ownership in some less urbanized regions of the province are features of SSF (Johnson, 2006).

Prawn trap enterprises are becoming quite valuable, with increasing replacement costs and licence values. These fisheries also spend an average of $8,750 on fuel per vessel per year (Nelson, 2011), which represents reasonably low fuel consumption for a BC fleet, a feature of SSF (Guyader et al., 2013). In 2009, the average replacement cost estimate for licence and vessel were $511,00 and $135,000 respectively (Nelson, 2011). By 2013, a typical prawn trap licence increased in value to $660,600 (DFO, 2016i). Part of this may be due to a growing domestic market for BC's shrimp and prawns considering the fishery used to be nearly dependent on a Japanese market (DFO, 2016i). This fleet landed an average value of $6.41/lb.

($2.91/kg) for all species in 2013, with spot prawn having an average landed value of $6.58/lb. ($2.98/kg) (DFO, 2016d).

BC spot prawn have been gaining popularity domestically, including recognition from the Vancouver Aquarium as recommended in their OceanWise sustainable seafood program and a 'best choice' by the Monterey Bay Aquarium's Seafood watch (DFO, 2016i). For the last decade in the Vancouver area, there has been a spot prawn festival and boil to raise awareness of the species and promote its sustainable fishery. The high average capital investment for this fishery is a feature of LSF (Berkes & Kislalioglu, 1989; Guyader et al., 2013; Johnson, 2006), however a return to product being consumed by local markets versus relying on international export markets can be seen as a feature of SSF (Chenpagdee et al. 2006).

Trawl

The shrimp trawl fishery is the slightly smaller of the two fisheries targeting northern shrimp (*Pandalus borealis*), smooth pink shrimp (*Pandalus jordani*), sidestripe shrimp (*Pandalopsis dispar*), coonstripe shrimp (*Pandalus danae) and* humpback shrimp (*Pandalus hypsinotus*). Sidestripe shrimp and humpback have the higher market value in this fishery, although northern and smooth pink shrimp represent the majority of the catch by weight (DFO, 2016d; DFO, 2016j). Shrimp species have a wide distribution along the coast of BC and occur on both rocky and muddy substrates in tidal areas to depths of over 1,300 m (DFO, 2016j).

Trawling is commonly regarded as a destructive and unselective gear type[19], however, the BC shrimp trawl fishery doesn't report by-catch beyond some octopus and squid (DFO, 2016d). In 2013, there were 179 licensed and active vessels (DFO, 2016d), which generally have a crew of two (Nelson, 2011). The vessels in this fishery are mostly all under 35m long with most boats under 15m fishing in near shore and sheltered areas (DFO, 2016j). The average shrimp trawl vessel in BC is 42' (12.77m) in overall length, made of reinforced plastic, was built in 1978 and runs on diesel fuel[6]. The average length of a vessel in this fleet is longer than the 12 m (39.3 ft.)

distinction (Macfadyen et al., 2011; Martín, 2012; Sumaila et al., 2012), however, there are many active vessels in this fleet under 12m in length, a feature of SSF.

These vessels do not typically travel far to fishing grounds and are mostly only out for one day at a time (DFO, 2016j), which are attributes of SSF (Emmerson, 1980; Panayotou, 1985; Guyader et al., 2013; Johnson, 2006). However, some larger trawl activity for shrimp became apparent in March of 2015 (DFO, 2016j), but at this point, it is unknown whether this is a trend going forward. The S licence is party-based and nearly 50/50 split between company and individual ownership with very little community ownership[6]. Similar to the trap fishery, most of the licences and vessels are located on Vancouver Island and the Greater Vancouver area[6].

The BC shrimp fishery is a high cost, low volume fishery that makes it difficult to compete for international markets with the Atlantic fishery (DFO, 2016j). The replacement costs for a shrimp trawl vessel and licence are $70,000 and $25,000 respectively (Nelson, 2011), which are among the lowest in the province's fleet. However, in 2013, the average landed value of all species for this fishery was $1.13/lb. ($0.51/kg) with an average of 130,000 lbs. (59 t) landed per vessel (DFO, 2016d). In 2014, the average gross revenue for an enterprise was $38,710, with only the most active vessels having a positive return (DFO, 2016j).

Many boats in the shrimp trawl fishery will participate in other fisheries such as prawn and shrimp trap or salmon gillnet or troll in order to 'stay afloat' (DFO, 2016j). Average gross revenues for shrimp trawlers in 2014 were nearly $39,000 for 47 vessels (DFO, 2016j). BC shrimp are hand-peeled, making it a laborious process and demanding a higher price than the highly mechanized peeling and processing found in the Atlantic Canadian shrimp fishery (DFO, 2016j).

The BC shrimp trawl presents an interesting example of how the smallness of a fishery is relative. In the province, the shrimp trawl fishery exhibits features of SSF, through low income, small vessels, individual ownership, inshore activity and mostly day trips, however, it uses a

highly destructive/unselective gear type and requires high capital investment relative to the revenue, which can be viewed as attributes of LSF. Then, once this BC fleet is compared with it's Atlantic counterpart, it begins to look like a 'mom and pop shop'. The Atlantic shrimp fishery consists of some larger freezer trawlers that go far offshore and spend many days at sea. The shrimp fishery of the Atlantic produces so much, that it makes Pacific shrimp fishery barely profitable. This example supports the difficulty of distinguishing between SSF and LSF, because in one country, we have two coasts with competing fisheries that have a completely different composition and are managed differently.

Crab

BC's commercial crab fishery is a trap fishery, which primarily targets Dungeness crab (*Cancer magister*) but also catches red rock crab (*Cancer productus*), red king crab (*Paralithodes camtschatic*) and golden king crab (*Lithodes aequispinus*) (DFO, 2016b). Dungeness crab can inhabit from Mexico to Alaska from intertidal areas to depths of 230 m offshore (DFO, 2016b). Licence holders are responsible for the collection of biological data through the hiring of an observer (DFO, 2016b)

The commercial fishery is considered to have begun in 1885 with the first reported landings (DFO, 2016b). The fishery is managed under a precautionary approach, using limits on effort through seasonal closures, limits on trap numbers and sizes, daily time restrictions and weekly haul limits (DFO, 2016b). Rot panels and chords are used to account for lost traps and reduce ghost-fishing effects (DFO, 2016b). Members of the crab fishery are highly involved in the consultation process through the consultation of the Crab Sectoral Committee (DFO, 2016b).

The 'R' crab trap licence was introduced by DFO in 1990 due to high effort and a fisher could be eligible if they had laded 15,000 lbs. cumulatively from 1987-1989 (DFO, 2016b). There are 221 licence eligibilities for the 2016 crab season, which are divided into 7 management areas along the coast (DFO, 2016b). In 2013, there were 187 R licenses and active vessels (DFO, 2016d), employing an average of 3 crewmembers per vessel (Nelson, 2011; pers comm. anonymous).

The crab fishery is the second largest commercial fishery in the province in terms of active vessels, and many of these vessels often only hold a crab license (DFO, 2016b). The average crabbing vessel in BC is made of aluminum, was built in 1992, runs on diesel fuel and has an overall length of 9.5 m or 31 ft.[6]. These vessels fall well within the 12 m (39.3 ft.) distinction of SSF (Macfadyen et al., 2011; Martín, 2012; Sumaila et al., 2012) and operate using not only a passive, selective and relatively low technology gear, which is an attribute of SSF (Schuhbauer & Sumaila, 2016).

Crab licences are another vessel-based licence, which makes ownership data relatively available through DFO and Transport Canada's vessel databases. There are licences for management areas A through J (Appendix B). The majority of crab vessels are owned within the Greater Vancouver region and a notable proportion of Vancouver Island, and individuals own the majority of these vessels[6]. The prominence of individual ownership in this fishery is an important feature of SSF, and this is evident in the crab fleet (Johnson, 2006).

Dungeness crab is primarily sold live to domestic and international markets and represents nearly 30% of the wholesale value of shellfish in BC (DFO, 2016b). The landed value of Dungeness crab increased steadily from 2011 to reach a 10-year high in 2014 (DFO, 2016b), with an average landed value of $3.05/lb. ($1.38/kg) in 2013 (DFO, 2016d). Recent years have shown a shift in fishing effort to earlier and later in the year, which allows crab to be sold at a higher price (DFO, 2016b).

A crab enterprise in BC is becoming increasingly expensive to acquire (pers. comm. anonymous) which may be a reflection of the steadily increasing landed value of Dungeness crab. The replacement cost for a crabbing vessel is $212,500, which is a relatively high capital investment required (Nelson, 2011). The capital required for a crabbing enterprise massively increases with the licence. The estimated replacement costs for Area A and Area B-J licenses are $900,000 and $480,000 respectively (Nelson, 2011). The crab fishery exhibits many features of SSF in terms of fleet structure and social structure of the fleet; however, the capital requirements to enter this

fleet are rather large, which is a feature of LSF. DFO is aiming to work collaboratively with industry members to reach the most sustainable and economically viable Dungeness fishery possible to achieve social, cultural and economic objectives in the coming years (DFO, 2016b).

Aboriginal commercial fisheries

Within the commercial fleet on the Pacific coast of Canada, there are a number of licenses offered to individuals of aboriginal status as well as aboriginal communities. These licenses have the same prefixes as the other commercial fisheries but have an 'F' in front; for example, FAG is aboriginal salmon gillnet licence. These fisheries occur along the entire span of BC's coastline and cover the spectrum of the commercial fishery. The average 'F' licensed vessel is 13.17 m in length (43'), diesel run, reinforced plastic or aluminum vessel built in 1978[6]. The average vessel in this fishery is over 12 m, however, there are many vessels in this fishery under 12 m and as small as 5 m[6].

These fisheries are subject to the same management strategies as the other commercial fisheries for corresponding stocks. These fisheries are licensed in the same vessel-based or party-based manner as corresponding target fisheries. In the aboriginal commercial fishery, there is a larger proportion of community ownership amongst license and vessel holders[6]. Ownership in this sector of the fishery is approximately one half individual ownership, a quarter company ownership and a quarter community ownership[6]. This individual and community ownership is an important feature of SSF (Johnson, 2006) and highlights the importance of these fisheries to communities. This fishery also has the most diverse geographical distribution of ownership with nearly half of the vessels being owned on Vancouver Island[6]. There are a few vessels owned by individuals or communities in Haida Gwaii, the North Coast, Central Coast and Sunshine Coast.

Financial profiles of BC's commercial fisheries do not include the aboriginal commercial fishery. It can be assumed that the replacement costs of licenses and vessels are similar to the corresponding commercial fishery but slightly less. 'F' licenses are offered at reduced rates to

people with aboriginal status in the province. Overall, many of the 'F' licensed vessels receive a slightly higher average landed value per pound than the corresponding commercial fishery. It should be noted that salmon from AG and AS licensed vessels receives a higher average landed value per pound. There is large amounts of data missing in order really assess this fishery, even still, it exhibits attributes of SSF across a large range of target fisheries on the coast.

Food, social and ceremonial fisheries

Individuals with aboriginal status carry out the FSC fishery in BC for personal or community use. The FSC fishery includes a large number of species including salmon, herring, halibut and shellfishes and uses a number of gears (Teh et al., 2011; Guyader et al., 2013). Often these species are of enormous cultural importance to the people of the coast and this cultural tie to fisheries can be thought of as a feature of SSF (Schuhbauer & Sumaila, 2016; Sumaila et al., 2016). This fishery exhibits many features of SSF including catch being used for community purposes (FAO & Worldfish, 2008; Johnson, 2006), which is virtually the definition of this fishery. An important feature of this fishery is that the catch cannot be sold for profit. These fisheries have a wide range of gears, including passive gear, and low capital investment, an important feature of SSF (Berkes & Kislalioglu, 1989; Guyader et al., 2013; Johnson, 2006).

Some fishing will occur from commercial vessels while spawn on kelp is harvested by wading out into the water and low technology, labour intensive fisheries are important attributes of SSF (Schuhbauer & Sumaila, 2016; FAO & Worldfish, 2008). Due to the 'community' aspect of the FSC fishery, many of these fisheries take part with many members of the community, close to the community, and play an important role in feeding communities, which are important features of SSF (Emmerson, 1980; Panayotou, 1985; Guyader et al., 2013; Johnson, 2006). DFO plays a role in managing these fisheries to an extent as they get second priority in harvesting order (conservation, FSC, commercial, recreational), however, most of these fisheries are managed by aboriginal communities using traditional knowledge and management, a final important attribute of SSF (Johnson, 2006). Overall, these fisheries are relatively data poor and

difficult to quantitatively analyze but qualitatively, they exhibit nearly every feature of SSF found in the literature.

Other commercial fisheries

Albacore Tuna

The tuna fleet is one of a few high seas fisheries in BC, targeting albacore (*Thunnus alalunga*) with hook and line troll (DFO, 2015b). The fleet consists of 150 vessels that fish within the Canadian Exclusive Economic Zone and 30 vessels fish exclusively on the high seas (DFO, 2015b).

Krill

The krill (*Euphausiid sp.*) fishery is one of the newest and smallest fisheries in BC, managed by area-based quotas, seasonal openings, and a small TAC (500t) (DFO, 2013b). The fishery mostly occurs in the Strait of Georgia, using plankton trawl nets (DFO, 2013b). Landed value of krill can range from $0.23 to $1.54/kg for frozen fish food and freeze-dried aquarium pet food (DFO, 2013b).

Sardine

Pacific sardines are a trans-boundary species of great economic importance in the Eastern Pacific and are jointly managed by Canada, the USA and Mexico (Ishimura et al., 2013). The Pacific sardine stock is strongly influenced by climate factors and inhabits the California Current Ecosystem (Ishimura et al., 2013). The Pacific sardine (*Sardinops sagax*) fleet consists of 25 commercial and 25 communal licences that fish from 1 June to 9 February (DFO, 2015c). The fleet is comprised of 60-70 foot (18.3-21.3 m) long purse seine vessels operating with 4-5 crewmembers (DFO, 2015c). There is an annual TAC, which is divided evenly amongst licences as individual quotas with only 13-20 boats operating in any given year (DFO, 2015c).

Gooseneck Barnacle

Gooseneck barnacle (*Pollicipes polymerus*) is an intertidal barnacle, which occurs from southern Alaska to the Baja Peninsula (DFO, 1999b). There is a limited fishery as of 2013, for Nuu-chah-nulth to harvest by hand on Vancouver Island within the T'aaq-wiihak fishing area (T'aaq-wiikah 2014a). In 2013, 846.3 lbs. (380 kg.) of gooseneck barnacles were harvested in Clayoquot Sound with only 4 groups of 2-3 people (Schiller, 2015). Gooseneck barnacles from the Nuu-chah-nulth First Nations are mostly sold to the United States with some domestic consumption and they sell for an average price of $9-12/kg (USD) (Schiller, 2015). This fishery has a long-standing importance within the Nuu-chah-nulth First Nations and has potential for commercial expansion in the future, especially considering the value of the product (Schiller, 2015).

Sea Cucumber

Giant red sea cucumber, like other dive fishery targets have mostly unknown population parameters (i.e. rate of recruitment, growth, natural mortality, immigration/emigration), which makes stock assessment and setting the TAC a challenge. The fishery began in 1971 under boom-and-bust conditions and was followed by more strict management measures (O'Regan, 2015). Currently, sea cucumber in BC is considered moderately exploited and managed using TACs, area licencing (Quota Management Areas) and area quotas (O'Regan, 2015).

There is a large market for sea cucumber in Asia (O'Regan, 2015). The average price for sea cucumber has risen from $1.54/split pound ($0.70/kg) in 1993 to $5.25/split pound ($2.38/kg) in 2012 (O'Regan, 2015). The main products from the sea cucumber fishery are dried, salted (Beche-de-mer) and muscle strips (O'Regan, 2015).

Like many other fisheries in BC, there is an issue with armchair fishers i.e., many licence holder don't fish their licenses (O'Regan, 2015). These licence holders are the stakeholders involved with DFO and management and the divers themselves do not have a seat at the table (O'Regan, 2015). This is unfortunate as divers have first hand exposure to the sea cucumber grounds and a better handle on abundance (O'Regan, 2015). Again, on trend with prevalence of armchair

fishers, lease prices are high and the wealth stays with the licence holders (O'Regan, 2015). A survey by O'Regan (2015), found that 16 out of twenty harvesters believed they are not appropriately involved in decision making, with three of these sixteen being concerned with their employment opportunities under licence holders if they share conservation concerns. Diver's have tried to create a divers' association but efforts were thwarted by licence holders (O'Regan, 2015).

2.3.2 Results

The results demonstrate that Geoduck and groundfish fisheries, including sablefish, category II species and halibut are most likely to be considered LSF (Table 2). These fisheries can be characterized as LSF because of their large vessels, active gears, offshore fishing grounds and high capital investment required. Many of these fisheries have a high capital investment required due to being ITQ managed fisheries (Ecotrust 2008).

The FSC fishery expresses the most SSF features. However, this is not a commercial fishery so it is difficult to gather quantitative data to analyze any further. It's evident that this fishery holds many social and cultural values and practices, which are absent in other fisheries, and future research into this fishery would be valuable. The Aboriginally licensed commercial fisheries are the next most likely to be considered SSF. This license category contains a large number of target fisheries within it so, if this fishery were to be made a 'SSF' fishery, it would encompass a large variety of fishing activities. The salmon gillnet fishery is the third most likely to be considered SSF fishery. This small-scale sector of the fishery is extremely important to the province economically, as it has the highest number of licensed and active boats and directly employs the most crewmembers according to these results. It is still a fishery, which is relatively easy to invest in and it generally operates inshore.

Table 2 Appearance of common SSF features in BC fisheries. 'X' represents a present feature, 'blank' represent not present, 'n/a' denotes not available, Possible total of 17

	SSF features																	
Fishery	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
Food Social Ceremonial fisheries	X	X	X	X	X	X	X			n/a	X	n/a	X	X	X	X	X	13
Aboriginal commercial fisheries	X		X	X	X	X	X			X	X	X	X	X	X			12
Salmon Gillnet	X		X		X		X	X	X	X	X	X		X	X			11
Crab trap	X		X		X	X	X				X	X		X	X			9
Prawn trap	X		X		X	X	X	X			X	X		X				9
Salmon Troll	X				X			X			X	X		X	X			7
Shrimp and prawn trawl	X				X			X	X	X		X		X				7
Herring SOK			X			X	X				X			X	X			6
Red sea urchin	X		X						X	X		X		X				6
Rockfish	X				X			X	X			X		X				6
Green sea urchin	X		X							X		X		X				5
Herring Roe				X			X			X	X			X				5
Category II Species	X									X		X		X				5
Geoduck	X		X		X									X				4
Groundfish	X				X							X		X				4
Halibut	X							X				X		X				4
Salmon Seine					X						X			X	X			4
Sablefish				X								X		X				3

Note: A Box may contain an X if vessels or fishers within the fishery express the feature. The feature does not necessarily apply to the entire fleet.

Aboriginal commercial fisheries, or 'F' licensed fisheries, salmon gillnet, prawn trap and crab trap all exhibit as least nine of the commonly found SSF attributes from the literature. These fisheries can all occur on smaller vessels, use passive gears, target a mix of species, require relatively little capital investment, occur within a limited range and have predominantly individual or community ownership.

Sablefish and geoduck fisheries exhibit the fewest features of SSF and are most likely to be considered LSF. These fisheries require a huge capital investment in vessels and licenses, as well as highly developed technology. The sablefish fishery also occurs quite far offshore. These fisheries also require export markets to Asia in order to thrive as a small proportion of catch from these fisheries is consumed domestically (Sumaila et al., 2007).

2.4 Discussion

Overall, this method demonstrated that SSF exist in BC as each fishery within BC exhibits one or more features of SSF. Aboriginal Food, Social and Ceremonial fisheries posses the largest number of SSF features and can be considered the most small-scale in BC. It was expected that FSC fisheries would qualify as SSF as they are generally recognized of having critical social and cultural importance to Aboriginal groups on the coast. This method is useful to analyze these fisheries, as they are relatively data poor. FSC fisheries are mostly unreported, and as a result, are difficult to quantify. There are still many aspects of this fishery, which are poorly understood, and this analysis allows for data poor fisheries to be evaluated. This feature of the method is critical as many of the SSF around the world are also data poor.

Aboriginal commercially licensed fisheries follow FSC fisheries in terms of presence of SSF features. It was expected that these fisheries would be classified as small-scale. There are more quantitative data sources for the Aboriginal commercial fisheries as they are managed by DFO. There are significant landings and values data as well as vessel feature resources[6]. However, it is difficult to estimate costs of fishing, as there are reduced costs for licenses, fuel, etc. for

status indigenous peoples on the coast. Again, this more qualitative method has been useful for the Aboriginal commercial fishery as it is a relatively data poor in terms of quantitative socio-economic data.

Other commercial fisheries, including, salmon gillnetters, prawn trappers and crab trappers follow Aboriginal fisheries in terms of their likelihood to be SSF. All of these fisheries contain factions of the BC fleet that possess at least eight features of SSF. It was expected that these fisheries would also be considered SSF as they all occur on small vessels in BC, and use relatively selective gear types. These fisheries target economically and culturally important species, as they are also important to the Aboriginal fisheries in the province. The large numbers of participants in these fisheries highlight their economic importance in terms of job opportunities to the province. The high licence replacement cost for both the prawn and crab trap fisheries make them almost impossible for new fishers to enter the fishery and therefore are slightly less small than salmon gillnetters. It should also be noted that the herring fisheries in BC are also extremely important to Aboriginal people along the coast and it was expected that these might be considered small-scale. The lack of data in this commercial fishery may be the reason why it lies somewhere between the small- and large-scale ends of the spectrum.

The results suggest that geoduck, sablefish and salmon seine fleets are most likely to be LSF, as factions of their fleets only express three features of SSF. These fisheries have very different characteristics and reasons for being considered large-scale. Salmon seine fisheries target the same species as the salmon gillnet fisheries and often fish in the same areas. The seine vessels are generally much larger than gillnet vessels and seining catches salmon in much larger quantities per set than gillnetting. The physical features of salmon seining help to characterize this fishery as large-scale. The geoduck and sablefish fisheries, however, have more economic features of LSF. Both fisheries are ITQ managed and have a very limited number of licence holders. Geoduck is not a traditional fishery, as it requires the use of diving equipment for exploitation. The sablefish fishery occurs in deeper waters and requires longer trips on larger boats for exploitation. Both geoduck and sablefish fisheries have some of the highest licence

replacement costs in the BC fishery (Nelson, 2011). The high cost of these fisheries makes them most likely to be large-scale.

The approach used to determine the relative scale of fisheries in BC from small to large, utilizes a number existing features of SSF from the literature. This approach does not attempt to 'reinvent the wheel', and the use of features from the literature to evaluate the scale of fisheries allows this work to build on existing research. The use of these general features also allows for this approach to be applied to any fishery in the world to determine where it is on the scale of smallness. Finally, this approach has not been created to definitively designate SSF and LSF; however, it serves as a guide to determining the presence or degree of 'small-scaleness' in fisheries. It also uses a number of 'universal' features, which would allow for further comparison between regions or countries. While this method is only used as a qualitative tool for determining relative 'small-scaleness', it would be interesting to further explore it quantitatively. Further research using this method should also consider the weighting of these features in order to derive more quantitative results.

I have developed a method, which determines the 'small-scaleness' of a fishery based on the presence or absence of features that describe SSF found in the literature. In the case of British Columbia, FSC and Aboriginal commercial fisheries are considered the most small-scale using this method. The sablefish are found to be the most large-scale of BC's fisheries according to this method. This method provides the basis for important discussion of SSF in BC and presents a base for quantitative analysis in the following Chapter.

Chapter 3 Assessing Small-Scale and Large-Scale Fisheries Using Different Approaches

3.1 Introduction

The definition of small-scale fisheries continues to invoke debate in the academic arena. However, there is general consensus among fisheries scientists that these fisheries are socially and economically important to communities and regions across the globe. Many researchers would argue that small-scale fisheries do not exist in developed countries such as Canada, however, that is simply not the case. This chapter investigates three methods for defining small-scale fisheries from the literature: (i) cumulative percent distribution, (ii) vessel length split and (iii) point-based framework. These methods are then applied to the British Columbian fleet for the 2013 season, as this was the most recent complete year of data when this research began. All of the methods have strengths and weaknesses.

As seen in Chapter 2, it is evident that British Columbia's fishing fleets exhibit features of small-scale fisheries (SSF) even though it has a relatively industrialized image. In order to determine the socio-economic importance of the SSF sector in British Columbia (BC), it is important to determine the proportion of the fishery that fits the description of SSF and large-scale fisheries (LSF), respectively. This chapter explores a number of approaches from the literature to define SSF and LSF in the BC fleet. These methods allow British Columbian fisheries to be considered on their own scale of smallness instead of being scaled according to other widely used definitions of SSF.

The first method is based on a cumulative percent distribution, which can use landed weight or landed value to determine the scale of fisheries (Ruttan et al., 2000; Sumaila et al., 2001; Therkildsen, 2007; Damasio et al., 2016). This method has been applied to developed countries, including North Atlantic Canadian fisheries, which makes it an interesting choice to apply to British Columbian fisheries (Ruttan et al. 2001; Sumaila et al., 2001; Therkildsen, 2007). The second method is adapted from a fleet separation policy, which is currently enforced in Atlantic

Canada and will be referred to as the vessel length split method. This method splits the fleet at 65 feet in overall vessel length and all vessels under 65 feet (19.8 m) are considered to be inshore vessels, i.e. small-scale vessels. The final method is based on a point-based framework (García-Flórez et al., 2014), which uses a number of fishery features to define SSF. This method requires a large number of data sets to consider physical fleet features as well as socio-economic features of each fishery.

Once it is determined what SSF and LSF are comprised of, the socio-economic importance of each sector is evaluated. The goal of most fisheries research is to influence policy reform and new policy should be informed both by science and the stakeholders impacted by such decisions. I argue that the perspectives of fishers are important to inform new policies and decision makers and felt the need to involve them in my research. A survey of local active and retired fishers was carried out to better understand their perspective of SSF and LSF. The results of the survey are used to compliment the quantitative approaches to determine an integrated definition of SSF and LSF, which I use to evaluate the socio-economic performance of SSF in BC.

3.2 Method

3.2.1 Division of the Fleet

Cumulative percent distribution

Using the methods proposed by Ruttan et al. (2000) and improved upon and applied in Sumaila et al. (2001), Therkildsen (2007) and Damasio et al. (2016), the distinction between SSF and LSF is made using landed value as the foundation for splitting. It is thought that smaller vessels will land a smaller catch corresponding to a smaller landed value (Ruttan et al., 2000). As mentioned earlier, many distinctions of SSF and LSF are made with developing nations in mind, and these distinctions are generally more apparent for these countries (i.e. a boat with no motor or with a motor). However, the cumulative percent distribution method has created distinct SSF and LSF categories for developed countries' fisheries, including, Canada, Norway (Sumaila et al., 2001), Gulf of Maine, George's Bank (Ruttan et al., 2000) and New England

(Therkildsen, 2007). Therefore, I use it to explore how to distinguish SSF and LSF for BC's fisheries. I have chosen to use landed weight for this method as opposed to landed value as there are many small boat fisheries operating in BC which catch small amounts of high value species. The use of landed value for the cumulative percent distribution would skew these fisheries to appear as larger scale than what they actually are.

As a federal institution, DFO must obey the 3-Party Privacy Policy. Therefore, all vessel combinations with three or fewer vessels in the category are not included in the analysis (Appendix C). This will likely affect the results in an unknown way. However, there is no legal way around this and I completed the analysis with the information that is publically available, complimented with the additional information that DFO was willing to share. In order to acquire data in a useable format for this method, a formal catch statistics request was made to DFO. This data consists of species landings (both weight and value) by all active vessels in each target fishery for the 2013 season, which was the most recent and complete year of data at the beginning of this research. It should be noted that 2013 was not a salmon dominant year and therefore the results of this research will reflect that. However, 2014 was a salmon dominant year, unfortunately data for this season was not available in time for this analysis.

The Pacific fleet in BC is split into fishery combinations consisting of licence category, vessel length category and gear type (Appendix D). For example, one fishery combination would be all salmon seiners between 35' and 45'11''. These combinations are ordered in ascending order for landed weight and the proportion of landed weight of each fishery is calculated from the total landed weight in 2013 (Appendix E). A cumulative total of fishery combination proportions of landed weight are calculated (Figure 2 and Appendix E). Ruttan et al. (2000), Sumaila et al. (2001) and Therkildsen (2007) set the cut off point between SSF and LSF at 50% of the cumulative proportion. However, it is worth noting that a break at 50% of the cumulative value is not necessarily appropriate for BC's fleet, still, I have chosen to maintain 50% cumulative landed value as the split for SSF and LSF in BC (Figure 2).

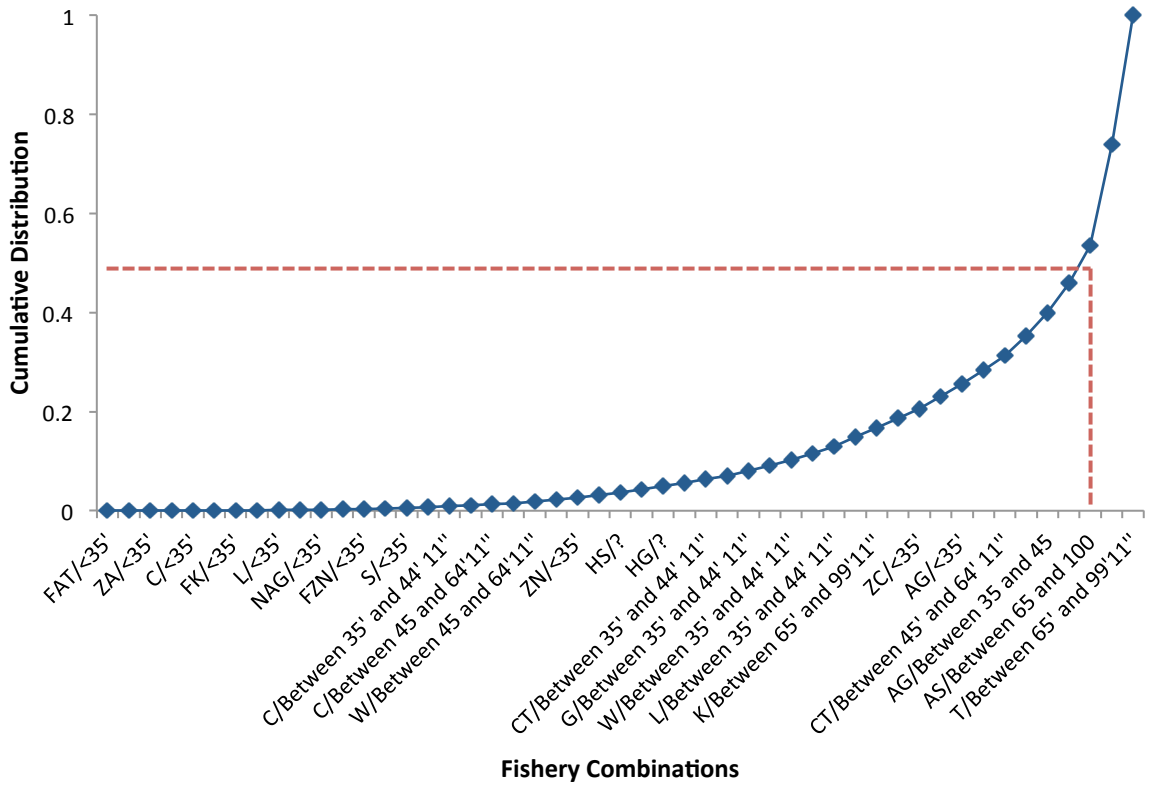

Figure 2 Cumulative percent distribution of BC's fishery by landed weight (Note that SSF are to the right of the red dotted line and LSF are to the left).

Vessel length split

This method draws inspiration from current policies in place in Atlantic Canada to protect interests of inshore, independent fishers. Canada has never managed their fisheries as a whole; each ocean and each stock is managed separately. Atlantic Canada has historically been managed quite differently from Pacific Canada. In fact, DFO acknowledges that management has been executed in a piecemeal and patchy fashion (DFO, 2012; Day, 1995). In defence of the federal government, Atlantic commercial fisheries are older, more established and larger, both in terms of landed weight and value, than those in the Pacific, which may account for some of the differences in management and policy approaches. The current regional approach is therefore likely to be appropriate.

However, with the development of the Atlantic fishing industry, processors became tightly involved in the ownership of the commercial fleet. This issue became too great and the PIFFCAF has been designed to cope with a set of evolving policies starting in the early 1980s (Cooper & Clift, 2012). Atlantic fishers have always had a strong lobbying presence and fisheries organizations such as the Maritime Fishermen's Union have been lobbying for owner-operator policies since the 1970s (Barnett et al., 2016). Former Minister LeBlanc introduced the original fleet separation policy to the Atlantic in 1979, which has evolved over the last several decades to the PIIFCAF policy today (Barnett et al., 2016; Cooper & Clift, 2012). In it's 1979 form, corporations were prohibited from holding licences on vessels under 65 feet (Barnett et al., 2016). In 1989, the fleet separation and owner-operator policy became a blanket policy for all of the Atlantic with specifics for each region within the Atlantic (Barnett et al., 2016). The blanket policy was expanded in 1996 as the 'Core Policy', which resulted in the loss of institutions representing fishers' interests (Barnett et al., 2016).

The most current form of fleet separation known as PIIFCAF, arose from the Atlantic Fisheries Policy Review (AFPR), which boasts being the largest public engagement campaign by DFO[5]. Atlantic fishers were unhappy with industry consolidation and vertical integration, which limit equitable access and wealth across Atlantic regions (Barnett et al., 2016). PIIFCAF was implemented in 2007 to promote the independent inshore sector in Atlantic Canada by creating an 'Independent Core'[5]. This addition to the fleet separation policies required licence holders to state whether they are party to and terminate Controlling Agreements as of April 24, 2014 (Barnett et al., 2016). The Policy splits the Atlantic fleet at 65 feet and all vessels under 65 feet are considered 'inshore' vessels, which qualifies them for different management regulations and purposes (Cooper & Clift, 2012). These vessels are not to be owned by processing firms and instead, operators own them. This method divides BC's fishing fleets at a 65' cut-off point, with all vessels under 65' being considered small-scale and all of those above 65' being considered large-scale.

Point-based framework

A point-based framework developed by García-Flórez et al. (2014) for defining SSF and LSF fleets in Europe provides a third approach to splitting a fleet into SSF and LSF. As European countries are often considered developed, this approach may be useful for the Pacific fleet in BC. García-Flórez et al. (2014) use overall vessel length, gross tonnage, engine power, gear type, fishing licenses allowed per year, crewmembers and daily landings as features to score fisheries. I have used a number of these features in my analysis. However, I have omitted fishing licenses allowed per year and daily landings because they are not relevant for the BC fleet, as, one can own licenses across a number of different target fisheries or fishing areas for one fishery as long as an individual has the capital required (Table 3). I have also omitted daily landings and, instead use average catch/vessel because the data for the latter are more readily available. In addition, daily landings would not offer any further information.

According to the scoring of García-Flórez et al. (2014), a fishery could score a minimum of 7 points and a maximum of 35 points. If the fishery scored less than or equal to 21, it is considered 'artisanal', and everything above is considered non-artisanal (García-Flórez et al., 2014). García-Flórez et al. (2014) further divided the artisanal fleet into coastal artisanal (16-21 points) and small-scale artisanal (under or equal to 15 points).

This analysis considers additional features as important to determining small-scaleness. These features include capital costs of fuel per year, gross-revenue, licence value, vessel replacement cost and whether the fishery is managed under ITQs or not. According to this framework, a fishery could score anywhere from 11 to 55 points. This research intends only to split the fleet into small-scale and large-scale sectors and all fisheries that score 20 or fewer points are considered small-scale while vessels that score 21 and above are considered large-scale. I am not splitting the small-scale sector further as in García-Flórez et al. (2014).

The overall vessel length is differentiated based on vessel size categories used by DFO (Figure 1). Economic variables such as costs of licence and vessel as well as gross revenue were taken

from Pacific fleet financial profiles as well as a DFO statistic request (DFO 2016d; GSGislason and Associates Ltd., 2008; GSGislason and Associates Ltd., 2011; Nelson, 2011). ITQs are generally associated with large-scale vertically integrated fisheries. The geoduck, sablefish, halibut, sea urchin, sea cucumber and groundfish fisheries are fully ITQ managed fisheries in BC, with parts of the salmon troll fishery under experimental or partial ITQ management (Ecotrust 2009; GSGislason and Associates Ltd., 2008).

Table 3 Point-based framework for Separating the Pacific Fleet. A fishery will be assigned a point based on where is falls on the scale for each feature. The totals will range from 9 to 39. Everything scoring 20 and below points in considered SSF. Note that blanks appear in the Gear and ITQ features as they are categorical and non-numerical categories.

	Points				
Features	1	2	3	4	5
Overall vessel length (m)	<35	35-45	45-65	65-100	>100
Type of Gear		Passive		Seine/Active	
Catch/Vessel (t)	<100,000	100,000-300,000	300,000-700,000	700,000-1,000,000	>1,000,000
Crew Numbers	<2	3	4	5	>6
Gross Revenue per harvester ($)	<50,000	50,000-250,000	250,000-1,000,000	1,000,000-2,000,000	>2,000,000
Licence Value ($)	<150,000	150,000-250,000	250,000-500,000	500,000-1,000,000	>1,000,000
Vessel Replacement Cost ($)	<137,000	137,000-218,000	218,000-500,000	500,000-750,000	>750,000
ITQ fishery	No		Partial		Full

The use of point-based framework for distinguishing between SSF and LSF is the most data intensive method used in this analysis. This method would work nicely if all fisheries had equal amounts of data available. However, that is not the case and indicators for some fisheries were estimated using data from a similar fishery. For example, I used the halibut hook and line fishery (L) crew estimates for Schedule II Species fisheries (C and CT) as these fisheries take place on similar or the same vessels. There is a maximum point sum of 40 and I have assumed 20 to be the dividing point total between SSF and LSF. All fisheries with 19 or less points are considered SSF and all fisheries with 20 and above points are considered LSF (Table 4).

Table 4 Results of the point-based framework. Note, a 'blank' cell = not available data

Fishery Licence	Overall Length	Type of Gear	Catch (lb.) per Vessel	Crew	Gross Revenue / Harvester	Licence Cost	Vessel Replacement Cost	ITQ Managed	Total	SSF or LSF
FAG	1	2	1	1	1			1	7	SSF
NAG	1	2	1	1	1			1	7	SSF
ZA	1	2	1	1	1			1	7	SSF
FAG	1	2	1	1	1			1	7	SSF
FZN	1	2	1	1	1			1	7	SSF
FR	1	2	1	2	1			1	8	SSF
FAT	1	4	1	1	1			1	9	SSF
FW	1	2	1	3	1			1	9	SSF
FL	1	2	1	3	1			1	9	SSF
ZN	1	2	2	1	1	1	1	1	10	SSF
FK	1	2	2	4	1			1	11	SSF
C	2	2	3		1			1	12	SSF
AG	2	2	3	1	1	1	1	1	12	SSF
S	2	4	2	1	1	1	1	1	13	SSF
W	2	2	2	3	1	1	1	1	13	SSF
FAS	1	4	3	4	1			1	14	SSF
AT	2	4	2	1	1	1	1	3	15	SSF
R	1	2	4	2	2	2	2	1	16	SSF
CT	3	4	4		1			1	16	SSF
ZC	1	2	5	2	1	1	2	5	19	SSF
L	2	2	4	3	2	2	2	5	22	LSF
AS	4	4	5	4	2	1	3	1	24	LSF
G	2	2	4	2	4	5	1	5	25	LSF
K	3	2	5	4	5	2	4	5	30	LSF

3.2.2 Socio-economic evaluation of small-scale fisheries and large-scale

Once the fleet has been split according to the methods above, the small-scale and large-scale sectors of the fishery are compared via a number of features. Some of the features used to compare SSF and LSF are taken from similar studies from the literature (Appendix F). The features are divided into three general categories, i.e., physical vessel, economic and social features.

Vessel features are frequently used to determine the scale of a fishery (FAO & Worldfish, 2008; Guyader et al., 2013; Macfadyen et al., 2011; Martín, 2012; Sumaila et al., 2012; Teh et al., 2011). Physical vessel features' data is relatively easily acquired for BC's fleet. Vessels

participating in SSF and LSF are compared by average vessel length participating in the sector, gear employed, as well as gross tonnage and engine power (García-Flórez et al., 2014). The comparison of these features can determine the contribution of the two sectors to societies goals for fisheries.

Comparison of economic features of small-scale and large-scale sectors allows for the importance of these fisheries to the economy to be analysed. The economic and social features covered in the analysis are fuel spending, capital input, yield, employment and ownership type and location (Berkes & Kislalioglu, 1989; Chuenpagdee, et al. 2006; Guyader et al., 2013; Johnson, 2006; Sumaila et al., 2016). In BC, there are many barriers to entering the fishery and analysis of capital requirements for the target fisheries provides important insight into the financial limitations to new entrants. The analysis of ownership provides insight on who owns licenses and vessels as well as where these are owned. With this analysis, it can be seen which fisheries are important to smaller communities along the coast.

3.3 Data

These methods require landings and landed value of fisheries based on target fishery and vessel length. I submitted a formal catch statistic request to DFO to obtain the necessary data. The data obtained included the number of licensed and active vessels in each category for 2013's fishing season. The cumulative percent distribution and vessel length split methods require relatively little data to make the distinction between SSF and LSF. However, in order to analyze the socio-economic features of SSF and LSF, many more sets of data are required. Landings data is publicly available through DFO's webpage. However, the formats by which the data is provided are limited. *Sea Around Us* also has detailed statistics of a reconstructed catch but these values were lower in the years analyzed and are, therefore not used for the purpose of this research. The DFO catch statistic request also provided corresponding landed value of catch, which was used in this analysis.

Data for vessel characteristics were acquired through DFO's vessel database[13], a DFO catch statistic request, Transport Canada's vessel database[6] and financial profiles (Nelson, 2011; GSGislason and Associates Ltd., 2011). These databases also provided a wide range of ownership information. However, this is only the case for vessel based licensed fisheries. So, there will be some missing information here but, the largest proportion of active vessels in the fisheries participate in vessel-based licensed fisheries (i.e. salmon, crab and prawn). Crew/employment estimates were collected for various fisheries through IFMPs (DFO, 2016a; DFO, 2016b; DFO, 2016c; DFO, 2016e; DFO, 2016f; DFO, 2016g; DFO, 2016h; DFO, 2016i; DFO, 2016j; DFO, 2016k), financial profiles (GSGislason and Associates Ltd., 2011; Nelson, 2011), and interviews with local fishers. All financial data including replacement costs, licence costs, quota costs, expenses and gross revenue were taken from Pacific fleet financial profiles as these are believed to be the most recent and complete estimates of these values (GSGislason and Associates Ltd., 2011; Nelson, 2011). It should be noted that these data are not for the 2013 season but they are the most complete set of estimates available.

Fuel estimates were taken from Nelson (2011), as it contains the most complete estimates of financial profiles for the BC fleets. Fuel consumption estimates are presented in cost per year (Nelson, 2011) and I converted them to litres of consumed fuel using fuel unit cost from fuel surveys in real 2016 $CAD[26,27]. These fuel cost estimates only consider 1,472 vessels, which is believed to be conservative as there were an estimated 2,437 licensed and active vessels in 2013 (DFO, 2106d). This estimate does not include the herring fishery because, even though many herring vessels also participate in the salmon fishery, it is impossible to know how many herring vessels are participating in the fishery.

There are many tiers of ownership in the BC fleet (Haas et al., 2016). People, companies and communities can own vessels, quotas and licences throughout the fisheries. This work will investigate the concentration of vessel ownership within the BC fleet both by SSF/LSF and

[26] Active Captain 'Canadian fuel prices in British Columbia' https://activecaptain.com/fuelLists/fuelIndexCA.php?st=BC (accessed 3 November 2016).
[27] Fine Edge 'Fine Edge Fuel Survey' http://fineedge.com/fuelsurvey.html (accessed 3 November 2016).

geographically. Many fisheries have a licence attached to the vessel. Ownership is categorized as First Nations/Community, Individual or Company. Ownership and the distribution of wealth from fisheries as a resource is a hugely contentious issue in BC. The analysis of vessel ownership was carried out to begin to understand how the wealth of the industry may be distributed. Ownership information is found through the DFO vessel query but the use of this database slightly skews the results as it only evaluates vessels with an attached licence. For example, vessels used for herring fisheries alone would not be included in this analysis.

There are various types of owners found within this data. Individuals, incorporated individuals, companies and aboriginal groups may own vessels and licences in BC. Ownership was divided into individuals and companies. In this industry, many individuals will incorporate or become limited for legal and tax purposes. This doesn't discount the fact that these individuals could still be owner-operators. Incorporated individuals were considered individuals if they own one or two vessels because it is assumed that it is possible to fish two boats in two different fisheries as an individual. Three or more vessels are assumed to be a company, as it doesn't seem feasible for an individual to participate in three separate fisheries with three different vessels. Due to the nature of some fisheries, different vessels may be required for different target species or seasons. However, there were many individuals who owned two vessels with the same licence. It is assumed that these individuals are not fishing with both vessels. It is also assumed that if an individual or incorporated individual owns 3 or more vessels, it is not possible for that individual to be operating all vessels themselves. Vessel and licence ownership can be seen as a proxy for wealth distribution. For example, a vessel owner in the lower mainland area is likely to spend money and reinvest in the same region. This analysis could potentially be enhanced using a DFO data request.

Other vessel features were found through cross-referencing vessel names and Vessel Registration Numbers (VRN) in DFO[13] and Transport Canada[6] vessel databases. All estimates of crewmembers, replacement costs, fuel consumption and ownership are the same as above sources for previous methods (GSGislason and Associates Ltd., 2011; Nelson, 2011). Other

economic information in regards to vessel ownership was also acquired through DFO[13] and Transport Canada[6] databases.

Socio-economic data of the target fishery were sourced from a number of consulting documents, DFO sources and via interviews with local fishers (DFO, 2016a; DFO, 2016b; DFO, 2016c; DFO, 2016d; DFO, 2016e; DFO, 2016f; DFO, 2016g; DFO, 2016h; DFO, 2016i; DFO, 2016j; DFO, 2016k; GSGislason and Associates Ltd., 2011; Nelson, 2011). This socio-economic information includes crew estimates, fuel consumption and replacement costs of licenses and vessels. This data was sourced and treated as in the case of the above methods. It should be noted that there is inherent uncertainty in the data used. While uncertainty is not assessed here, it would be considered in further works.

3.4 Results

3.4.1 Cumulative percent distribution

According to this approach, a majority of the BC fisheries fall into the small-scale designation. Using the cumulative percent distribution method, the average overall length of SSF vessels is 11.5m (Table 5). This length is below 12m, which is commonly used as a distinction between artisanal and industrial fisheries in the literature and in Europe (Macfadyen et al., 2011; Martín, 2012; Sumaila et al., 2012). As expected, the vessels participating in SSF are smaller than those of LSF, which also means that they land smaller catches and have smaller gross tonnage using less engine power (Table 5). The average SSF vessel does consume more fuel per tonne landed but spends less on fuel per $100,000 landed value (Table 5). It should be noted that the fuel estimates exclude aboriginal licensed commercial fisheries as well as the herring fishery. The number and type of vessels participating in the herring fishery are relatively unknown and there is not enough data available for accurate fuel estimates. Aboriginal commercial fisheries were not assessed in terms of fuel consumption as Indigenous status individuals can purchase fuel at lower prices than other non-indigenous individuals in the province. There would be a number of assumptions necessary to produce an estimate of fuel consumption in these fisheries.

The small-scale sector lands 46% of the landed weight, which corresponds, to 86% of the landed value for 2013 (Table 5). SSF clearly have a larger contribution to the economy in terms of landed value. An explanation for this seemingly highly inflated landed value with relatively little weight is the inclusion of high value targets. Geoduck, spot prawn, etc. are high value targets, which are not always caught in large quantities. These fisheries should not necessarily be considered small-scale. However, this method distinguishes between small and large solely on the assumption that small boats catch small amounts of fish (Ruttan et al., 2000). This neglects other economic aspects of a fishery, for example, the geoduck fishery has the highest licence replacement cost in BC (Nelson, 2011).

Table 5 SSF and LSF sectors using the cumulative percent distribution by landed weight.

	SSF	***LSF***
Landings (t)	550,407	647,251
Proportion of landed weight (%)	46	54
Landed value ($)	2,628,469,981	420,004,136
Proportion of landed value (%)	86	14
Average price ($/lb.)	2.17	0.29
Top 3 species landed by weight	Dungeness crab Sockeye salmon Chum salmon	Pacific hake Pink salmon Arrowtooth flounder
Licensed and active vessels (#)	2,336	107
Average overall vessel length (m)	11.5	24.3
Fuel consumption (L/t landed)	28	6
Fuel consumption ($/$100,000 landed)	664	1,056
Crew (#)	6,284	445
Fishers employed per $100,000 landed value	0.24	0.11
Type of ownership (%)	Individual – 56 Community – 5 Company – 39	Individual – 8 Community – 0 Company – 92
Ownership in Greater Vancouver (%)	37	68

Note: The number of active vessels, crew, ownership and fuel estimates could differ slightly with the inclusion of the herring fishery but no data was available due to the licensing system in place. Also note that the estimates of fuel consumption do not include aboriginal licensed fisheries or herring vessels.

As expected, there are significantly more vessels and therefore, more crewmembers employed by the small-scale sector of the fishery using this distinction (Table 5). SSF are typically associated with higher employment than LSF, accounting for roughly 90% of fishers and fish workers globally (FAO, 2010). Employment is a major concern for economic performance of the fishery but where the employment is located and the type of ownership of fishing enterprises is critical to understanding the economic importance of fisheries. The SSF sector can further be considered to have an important economic contribution by providing more primary jobs because there are more vessels requiring crew than the LSF sector (Table 5). Jobs in this industry are important to coastal communities throughout BC.

The vessels participating in SSF are typically associated with a number of features including fishing near shore, which corresponds to lower fuel consumption. However, in this case, more litres of fuel are used per landed tonne than LSF (Table 5). This may be due to more active vessels, which land fewer tonnes of fish collectively. While the SSF sector of the fishery may consume more fuel, they require less fuel to land each $100,000 worth of catch. This is because, small vessels landing little but high value catch fisheries present within the SSF sector using this method.

Individuals own over half of the vessels participating in the SSF sector, which is a heavy contrast to the 8% individual ownership in the LSF sector (Table 5). The ownership within the fishery can also be observed in geographic terms, as some areas in the province are heavily dependent on the fishing industry. Only 37% of SSF vessels are owned by entities in Greater Vancouver and surrounding areas versus 68% in the LSF sector (Table 5). This demonstrates that a majority of vessels within the SSF sector are owned throughout BC, and not concentrated on the South Coast as it is the case for LSF. Vancouver and its surrounding areas offer a number of alternative industries and options for employment than other communities along the coast and on the islands. Individuals and communities own approximately 61% of the vessel-based licences (i.e. vessels) in the SSF category (Table 5). This is significantly higher than the 10% of individual and community ownership in the LSF sector. In addition to a higher number of individuals involved

in the under 65' proportion of the fishery, only 37% of these vessels are owned by companies or individuals in the lower mainland, which represents Vancouver and all of it's surrounding areas (Table 5), therefore 63% of owners of under 65' vessels elsewhere in the province, compared to 30% over 65' (Table 5). Therefore, most of the smaller vessels within BC's fleet are located in communities along the coast, which vary in size and infrastructure. Companies and individuals in the lower mainland where there is a great deal of infrastructure and alternative livelihoods own most of the large vessels in province.

Splitting the BC fleet using the cumulative percent distribution provides expected results for the SSF sector. Upon analysis of the sectors, it can be seen that SSF provides more jobs and more revenue for the province and the country. Many of the features of the SSF sector are in line with features of SSF found throughout the literature, including a smaller average vessel size, smaller catch, more employment opportunities, more individual ownership and more geographically diverse ownership.

3.4.2 Vessel length split

Using the PIFFCAF 65' cut off to divide BC's fleet, the socio-economic results follow the same general trends as the cumulative percent distribution however, there is a slightly different distribution of the fisheries into small-scale and large scale. The average overall length of vessels participating in the SSF sector is 11.3m, which falls below the 12m artisanal definition found in the literature (Macfadyen et al., 2011; Martín, 2012; Sumaila et al., 2012). As expected, with this method, the average overall length of participating vessels is lower in the small-scale sector and there are more vessels participating.

Using vessel length as a feature for determining SSF in BC, SSF land 42% of the province's landings, which corresponds, to 76% of the value (Table 6). Fewer fish landed for a greater value is the general trend in both divisions of the fleet. This corresponds to smaller vessels receiving a price per pound that is four times higher than that of the over 65' category. The SSF portion of the fleet is able to produce a higher value from the fishery while taking a smaller

amount of biomass. This result is similar to that of the cumulative percent distribution by landed value. Many of the smaller vessel fisheries are landing higher value species such as geoduck and prawn in lower quantities. However, using vessel length to split the fleet has a few more fisheries included in the large-scale designation, which contribute to higher landings and a higher overall landed value. This equates to landings of the SSF sector receiving a higher average price per pound landed, however the difference in price between the small-scale and large-scale sectors is not as large as with the cumulative percent distribution.

Table 6 Indicators for SSF and LSF according to vessel length split.

	SSF <65'	***LSF >65'***
Landings (t)	496,851	686,703
Proportion of landed weight (%)	42	58
Landed value ($)	2,324,705,282	716,322,975
Proportion of landed value (%)	76	24
Average price ($/lb.)	1.09	0.74
Top 3 species landed by weight	Dungeness Crab Sockeye Salmon Chum Salmon	Pacific Hake Pink Salmon Arrowtooth Flounder
Licensed and active vessels (#)	2,293	150
Average vessel length (m)	11.3	24.2
Fuel consumption (L/t landed)	0.03	0.16
Fuel consumption ($/$100,000 landed)	717	736
Crew (#)	6,212	629
Fishers employed per $100,000 landed (#)	0.27	0.09
Type of ownership (%)	Individual – 56 Company – 39 Community – 5	Individual – 8 Company – 90 Community – 2
Ownership in Greater Vancouver (%)	37	63

Similar to the previous method, there are more active and licensed vessels in the SSF sector and therefore, more crew opportunities. There is over nine times the number of crew participating in the SSF sector than the LSF sector (Table 6). This approach estimates that there are over

2,000 vessels participating in the small-scale sector, which can employ over 6,000 crewmembers (Table 6). DFO provides a primary employment estimate for 2013 of 5,385 for the entire fleet. However, there isn't a clear unit of employment (i.e. full or part-time employment)[3]. My estimates of crew employed are higher than those of DFO. The vast difference in vessel numbers between SSF and LSF demonstrates that this portion of the industry can employ more people (Table 6). This estimate demonstrates that SSF can employ nearly ten times the crew of LSF using this distinction. These jobs can be of particular importance to coastal communities in BC. There is significantly more individual vessel ownership within the less than 65 ft. sector, which means less vertical integration in the small-scale sector. The majority of ownership of these vessels is outside of Vancouver and surrounding areas in the small-scale sector. This means that more people who own a small-scale vessel are based out of regions of the province, which may have few alternative livelihood options.

3.4.3 Point-based framework

The point-based framework allows for many socio-economic features to be considered in the division of the fleet. This designation of SSF and LSF fleets has the same trends as previous methods in terms of landings by weight and value. As in the previous two methods, SSF accounts for a smaller proportion of the landed weight of the fishery while generating a majority of the landed value (Table 7). This approach estimates that SSF catch is only 26% of the landed weight and 47% of the landed value. In this case, SSF as a group earn $2.10/lb. on average compared to the $0.84/lb. earned by LSF. Similar to the vessel length split, which splits the fleet based on vessel length, SSF demonstrates its economic importance and the high value of its catch.

There are similar trends within participating vessels and crew numbers, with SSF having more licensed and active vessels with more crew opportunities (Table 7). Individuals and community groups own the majority of small-scale vessels, which is an important feature of SSF (Johnson, 2006). Individuals and groups outside of the Greater Vancouver area mostly own small-scale vessels, which highlights the presence of SSF in smaller communities along the coast (Table 7).

Table 7 Socio-economic features of SSF and LSF according to the point-based framework.

	SSF	*LSF*
Landings (t)	414,756	782,902
Proportion of landed weight (%)	35	65
Landed value ($)	2,158,579,097	889,895,020
Proportion of landed value (%)	71	29
Average price $/lb.	1.11	0.72
Top 3 species landed by weight	Dungeness crab Pacific halibut Albacore tuna	Pacific hake Pink salmon Chum salmon
Licensed and active vessels (#)	2,012	413
Average vessel length (m)	11.22	19.84
Fuel consumption (L/t landed)	37.7	8.9
Fuel consumption ($/$100,000 landed)	916	482
Crew (#)	5,082	1,759
Fishers employed per $100,000 landed (#)	0.24	0.20
Type of ownership and proportion (%)	Individual – 60 Company – 35 Community – 5	Individual – 14 Company – 85 Community – 1
Ownership in Greater Vancouver (%)	36	60

As expected, a concern with this method is that entire target fisheries end up being considered small-scale or large-scale. Other methods allow portions of each target fishery to be considered small-scale.

3.5 Bringing it Together

3.5.1 Division of the Fleet

All three methods for splitting fishing fleets into small-scale and large-scale have their pros and cons and there is some overlap between the results they produce. Figure 3 demonstrates the overlap of fisheries found to be small-scale in each of the three methods discussed above. These methods mostly capture the same fisheries within their individual definition of SSF. All

Aboriginal commercial fisheries are considered small using all three methods, which is reassuring given that most people would agree. Also, the qualitative analysis in Chapter 2 demonstrated that these fisheries exhibit the most features of SSF in the commercial fishery in BC.

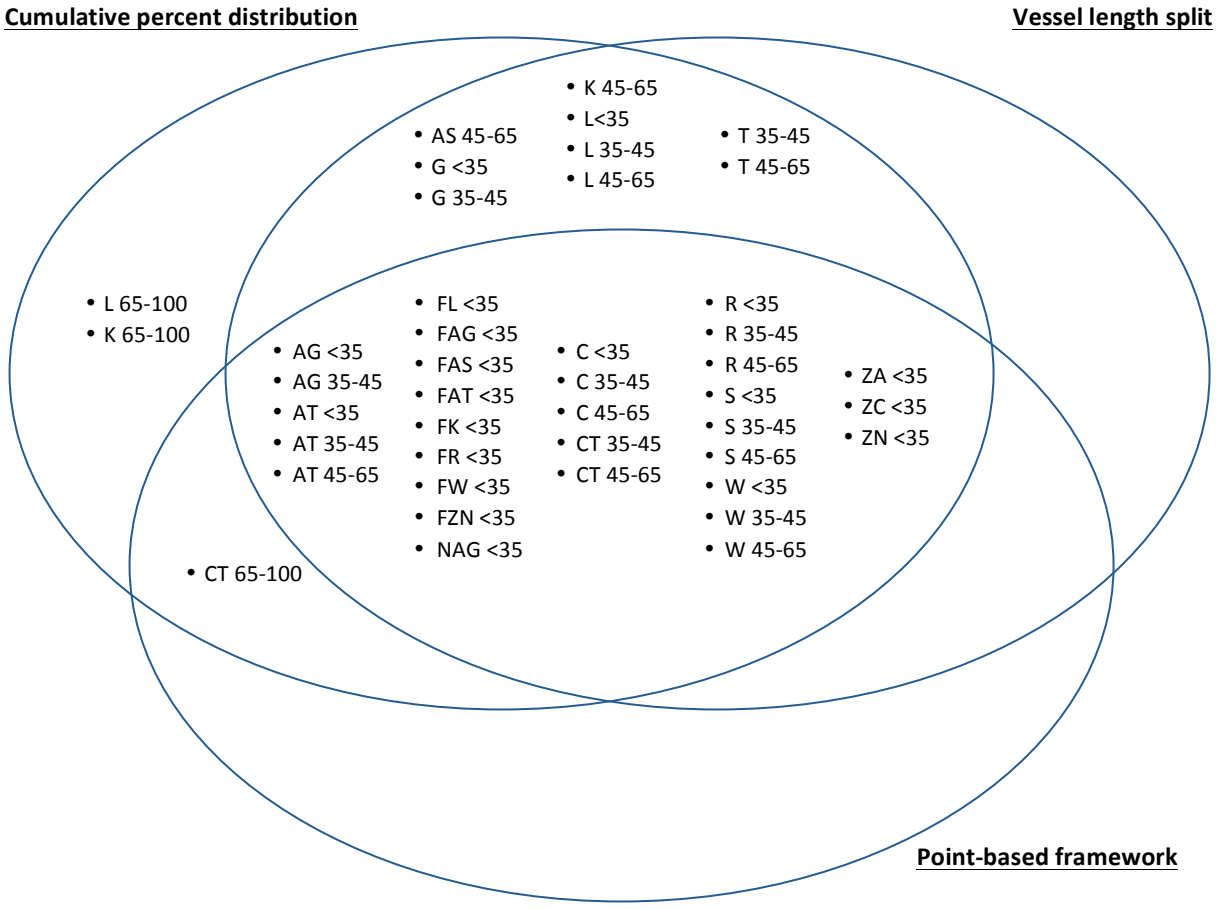

Figure 3 Venn diagram of Fleets considered SSF by all three methods.

Salmon gillnet and troll fisheries are found to be small-scale in all three methods as well, which is another expected result (Figure 3). There is an abundance of salmon gillnetters and trollers along the coast of BC, which demonstrates the fisheries importance to communities through employment opportunities. Many of the invertebrate fisheries were found to be small-scale using all three methods as well. The crab trap, shrimp trawl, prawn trap and green and red

urchin dive fisheries were all found to be small-scale (Figure 3). These fisheries are typically small in many ways however; they have higher capital investment in order to enter the fishery, which is a feature of LSF. Finally rockfish, schedule II ground fish and tuna are also considered small-scale under all three methods.

There were also some fisheries, which were considered small in one or two of the methods (Figure 3). Relatively small salmon seiners and groundfish trawlers are considered small under the cumulative percent distribution and the vessel length split. These fisheries operate with highly unselective gears and have higher rates of by-catch. These fisheries are considered small using these methods due to their smaller size and few vessels catching relatively small amounts. The cumulative percent distribution and vessel length split also consider halibut, sablefish and geoduck fisheries with small vessel size to be small. It is not expected for these fisheries to be considered small as they have high replacement and quota costs, which are likely tied to being ITQ, managed fisheries.

There is also overlap present between the cumulative percent distribution and the point-based framework with tuna vessels between 65’ and 100’ (Figure 3). This fishery operates on vessels so large, they could not be considered small in any sense. These methods have found this fishery to be small as a result of few licenses operating (7) and as a result, this fishery catches relatively little. It is also not a capital-intensive fishery like others, which make it appear small.

Finally, the cumulative percent distribution was the only method to classify halibut and sablefish licensed vessels between 65’ and 100’ as small-scale (Figure 3). The halibut and sablefish fisheries having only 24 and 12 licensed and active vessels, respectively, for the 2013 fishing season can explain this result. These fisheries should be considered large-scale because they are large boats that operate in a capital-intensive fishery.

In addition to the quantitative analysis, a variety of local fishers (both active and retired) and those involved in the fishing industry were interviewed in order to gain new perspective on the

many issues of the Pacific fleet. Ten interviews were conducted with a variety of fishers from the lower mainland. Some interviewees were recruited through already established local connections to the fishing industry. Others were recruited via snowballing from those already interviewed in line with ethics board regulations. All snowball recruits were to contact me for an interview to comply with ethics board regulations.

A majority of the interviews were recorded and transcribed. However, I did experience some hesitation to be recorded by some. There are political rifts present within BC's fishing industry and while many fishers are full of opinions, there could be potential economic repercussions for vocalizing unpopular thoughts on record. Each interview ran between 30 and 45 minutes and the interviews were recorded and transcribed (Interview Transcript Appendix G).

A portion of these interviews involved showing the interviewee photographs of a variety of fishing vessels from the Vancouver area. These photos were edited to hide any identifiers of the vessel. The size and licence were included with the photo for scale reference. The use of photographs is taken and modified from Roth (2012), which investigates people's opinions of what race looks like amongst Latino populations. This method translates nicely to fisheries opinions as a way to standardize more qualitative data, which are obtained through interviews, are intended to compliment and perhaps reveal some aspects of the fisheries in BC that would otherwise be missed through the other methods.

Due to the complex socio-economic nature of the fishing industry, interviews proved revealing and provided insight to the thoughts of local fishers. Opinions of SSF gathered from interviews with fishers mostly found the same fisheries qualifying as small-scale. For example, it was nearly unanimous amongst interviewees that salmon gillnetting and crab trapping are considered small-scale. It was more difficult to distinguish other fisheries as small-scale or large-scale. For example, fishers who were involved in salmon gillnetting referred to salmon seining as large-scale but fishers involved in salmon seining considered this fishery to be medium-scale. Unfortunately, due to the limitations of a Masters thesis, there was not enough

time to effectively explore this method for primary data gathering. In order to improve this method for analysis, at least 40 more interviews would need to be conducted. It would also be important to include interviewees from a larger variety of fisheries and larger geographical range.

Furthermore, one potential pitfall to the use of photographs in the interview process was the need to include size on the picture for a frame of reference. This may have influenced the interviewee to think of scale in terms of vessel length instead of choosing other fishery characteristics. So, the data acquired through the interview process was used with caution when considering its influence in making the SSF and LSF distinction.

3.5.2 Socio-Economic Evaluation of Small-Scale and Large-Scale Fisheries

Using a combination of the three methods to determine which fleets belong in the SSF category produces similar socio-economic trends (Table 8). The fisheries included in SSF catch a smaller proportion of the landed value of catch, which corresponds to a higher proportion of the landed value (Table 8). This trend is in line with all three of the above methods.

There are nearly five times the licensed and active vessels in the small-scale sector compared to the large-scale (Table 8). The larger number of vessels provides a larger number of employment opportunities in the small-scale sector in the province. Ownership of the fleet is another important feature while discussing SSF. After combining results from the above methods, the small-scale sector demonstrates that individuals and communities own a majority of the vessels participating in the fisheries (Table 8). Individuals or groups outside of Vancouver and surrounding areas own most of the vessels in the SSF sector. The prevalence of individual ownership in relatively 'rural' communities in the province is and important feature of SSF (Johson 2006). Many of the fisheries present in the small-scale sector are aboriginal commercial fisheries. These fisheries will have important social implications to aboriginal communities which again, is a valuable feature of SSF (Johnson, 2006; Schuhbauer & Sumaila, 2016; Sumaila

et al., 2016). In contrast, the large-scale sector has mostly company ownership, with many of the owners being located in Vancouver and neighbouring cities (Table 8).

Table 8 Socio-economic features for SSF and LSF using the overlap of all results.

	SSF	***LSF***
Landings (t)	301,123	882,432
Proportion of landed weight (%)	25	75
Landed value ($)	1,402,881,358	1,638,146,900
Proportion of landed value (%)	46	54
Average price $/lb.	1.30	0.80
Top 3 species landed by weight	Dungeness crab Sockeye salmon Albacore tuna	Pacific hake Pink salmon Pacific halibut
Licensed and active vessels (#)	2,005	438
Average vessel length (m)	11.02	24.32
Fuel consumption (L/t landed)	37.7	8.9
Fuel consumption ($/$100,000 landed)	0.35	0.11
Crew (#)	4,887	1,787
Fishers employed per $100,000 landed (#)	0.35	0.11
Type of ownership (%)	Individual 68 Company 35 Community 5	Individual 8 Company 92 Community 0
Ownership in Greater Vancouver (%)	36	68

3.6 Discussion

All of the methods explored in this chapter require large swaths of quantitative data. They explore different features of fisheries in order to distinguish between SSF and LSF. However, when the results of the three methods are compared, they capture mostly the same fisheries under the small-scale designation. Using these methods, all aboriginal commercial fisheries, salmon gillnetters, trollers as well as shellfish fisheries operating in BC are classified as small-scale. Surprisingly, the deeper water fisheries such as halibut, sablefish and other ground fishes are not considered large under all three methods. It should be noted that there is inherent

uncertainty associated with data. However, the uncertainty of data sets is not quantitatively assessed for this analysis and would be conducted in future work.

The cumulative percent distribution is founded on the assumption that a small vessel catches small amounts of fish relative to large vessels (Ruttan et al., 2000). This exposes this method to debate, as fisheries that land high value species or a high quantity due to a large number of active vessels may appear to be large scale on the cumulative distribution. A cumulative distribution was executed for landed weight and another for value for 2013's fishing season. The split of SSF and LSF at 50% cumulative value is a distinction from Ruttan *et al.* (2000), however; this split is arbitrary. The 50% split was seen as reasonable for the cumulative distribution of landed weight due to no presence of a natural pattern change (Figure 2; Appendix D).

When the fisheries combinations are distributed based on cumulative proportion of landed weight, the majority of fisheries combinations for BC's fisheries fall into the SSF category (Figure 2 and Appendix E). This is not necessarily an accurate depiction of SSF and LSF in BC. In using this distinction, salmon seiners up to 65', which catch enormous quantities of fish, and sablefish vessels up to 100', which travel far offshore to target this deep-water species would typically be considered large-scale. It should be noted that the split of fisheries using this method would be slightly different for a salmon dominant year. All of the salmon fisheries combinations would have higher landings and would all be skewed towards LSF (may or may not fall into LSF). Only trawlers and salmon seiners over 65' are considered LSF in this method, which is an accurate depiction of what is typically recognized as large-scale. Large seiners and trawlers have enormous catch capacity per vessel therefore catch the most by volume in the Pacific fleet. Perhaps the split between SSF and LSF could be made at a lower cumulative percentage (e.g. 30% or 40%) but there is no obvious choice for this distinction.

Another issue with the cumulative percent distribution method is that the split between SSF and LSF is arbitrarily determined to be at 50% of the cumulative proportion. A natural break in

the cumulative percent distribution of BC's fleet was anticipated however, it never materialized and a very gradual distribution was produced. So, in keeping with this method, the distinction between SSF and LSF was determined to be at 50%.

The cumulative percent distribution can also be carried out using landed value to split the fishery. In BC, the most obviously concern with splitting the fishery based on landed value is that fisheries like geoduck and crab which are highly selective, occur on small boats and don't travel far to fishing grounds appear to be large. This same version of the cumulative percent distribution has 100' groundfish trawlers appearing as small-scale when in fact; these are large boats fishing in deeper waters with a highly destructive unselective fishing method. There are just few boats participating in that category and they land lower value species, therefore appearing as 'small'. However, these fisheries are extremely costly to enter and maintain, which can be considered a feature of large-scale fishing. This is why landed weight was used for this cumulative percent distribution analysis.

The vessel-length split method of determining SSF is an effective method as it's tangible and currently is a part of a formal policy in Atlantic Canada. This method effectively captures the anticipated features of SSF such as low landed weight, high value, many jobs and more diverse ownership type and location (Table 5). But, this method doesn't resolve the issue of the small boat, high value fisheries. For example, the landed weight of SSF using a vessel length division captures all of the small vessels participating in the prawn and crab trap fisheries, along with the dive fisheries for geoduck, urchin and sea cucumber. In a way, it's obvious to expect a low landed weight and high landed value in SSF if these fisheries are included. What this method doesn't capture is that small boat, high value fisheries are extremely expensive to enter and maybe do not exhibit all features of SSF. For example, the geoduck fishery has the highest estimated replacement cost for licence and vessel, which is a feature of LSF but all vessels participating are less than 45' (13.7 m) in overall length, which is a feature of SSF (Nelson, 2011).

Implementing Atlantic Canada's fleet separation and owner-operator policies on the West coast of Canada would allow for up to 76% of the landed value to be caught by owner-operators. Many of these owner-operators live along the entire coast of BC, which would create a more even distribution of the wealth generated by the fishery. Using this method to distinguish between SSF and LSF is a novel approach as it's the current approach used on the Atlantic coast of Canada and United Fishermen and Allied Workers Union (UFAWU) are pursuing it. This could potentially have incredible social and economic impacts on the industry, especially in the case of aboriginal licensed fisheries and smaller coastal communities. The vessels under 65' (19.8 m) are more frequent in the smaller communities in the province and implementation of a PIIFCAF style policy in BC would help the vessels and their fisheries stay in these communities.

The point-based framework is a way to include many characteristics of a fishery in decision-making (García-Flórez et al., 2008). Instead of using one feature to determine scale, this method captures a number of physical vessel features along with more economic features such as crew and replacement costs of the enterprise. It is, however, a relatively complicated method of making this distinction and requires a lot of data for each fishery. One concern with this method is that it considers a target fishery as a whole and uses the average of the fishery to determine its corresponding score for the feature. The other two methods explored in this chapter consider factions of each target fishery according to vessel length. I believe that having factions of target fisheries being included in both SSF and LSF is a more accurate depiction of scale in fisheries. Each target fishery is too broad to lump the entire fishery into small and large categories.

The method proves good at identifying the fisheries that are expected to be large-scale such as salmon seiners, geoduck divers, groundfish trawlers, sablefish long-liners and halibut hook and liners (Table 4). It is important to note that this method uses average values for the descriptors for each fishery and doesn't split fisheries based on vessel length. Similar to the cumulative percent distribution, all aboriginal commercial fisheries are considered SSF. This is to be expected as these fisheries commonly use smaller vessels that catch less fish. Commercial

licence costs and vessel replacement costs could not be used as a proxy for Aboriginal licence and vessel replacement costs as these licenses are offered at a discounted rate. There is a certain tax saving associated with Aboriginal status, therefore vessel replacement costs of the commercial fleet weren't considered an appropriate proxy.

The point-based framework is also useful as it considers many socio-economic indicators as part of the assessment as opposed to after as with the other two methods. Unfortunately, this method requires large amounts of data, which aren't available for each fishery, making it hard to evaluate all commercial fisheries on the BC coast. For example, the herring fisheries are difficult to find information about active vessels and the number of people working on these boats. There was also no financial information provided in the Pacific Fleet Financial Profiles (GSGislason and Associates Ltd., 2011; Nelson, 2011).

A challenge of studying small-scale fisheries is to understand what and who are encompassed by this term. In order to have a productive discussion about small-scale fisheries, I argue that they first need to be defined. This chapter explores three methods found within the literature that define small-scale and large-scale fisheries. Each method has weaknesses and strengths in determining what defines SSF.

The cumulative percent distribution by landed value skews small vessel, high value catch into LSF. By traditional concepts of SSF, the small vessel, high value catch fisheries may be small but the high capital investment required to enter makes them large-scale. The cumulative percent distribution captures a more traditional sense of SSF, assuming smaller boats catch smaller amounts. This is true for the most part however; this method fails to capture the social features of SSF.

The vessel length split, is a more traditional method for fleet separation and works well for decision makers. This type of fleet structure is already being employed on Canada's Atlantic coast and has made it more difficult, although not impossible, for corporations to own vessels

and licenses in the 'small-scale' fishery. The EU also defines their SSF or 'artisanal' fisheries using a 12m overall vessel length cut-off (Martín, 2012).

The point-based framework is the most effective method for capturing socio-economic features of SSF along with physical vessel characteristics. However, this method requires large amounts of data to make this determination and groups a whole fishery into small-scale or large-scale. It's the most complicated and data intensive of the methods and produces a result near enough to the others.

Even with large amounts of data and methods from the literature, there is still an element of arbitrary designation in each of these. The cumulative percent distribution has assumed that under 50% of the cumulative distribution of landed value is SSF, vessel length split assumes less than 65' to be SSF and the point-based framework assumes less than or equal to 22 points is SSF. One can put all of the effort and data they want into developing a decision framework to determine SSF, but there will always be an arbitrary decision for where the split between SSF and LSF is made. Because all of these methods come down to an arbitrary division of a fleet, the vessel length fleet separation is the most elegant in its simplicity and ease with which it can be applied.

While I would recommend the vessel length split method that is based on an existing fleet separation policy in Atlantic Canada to define SSF for British Columbia, the decision should ultimately be left to the stakeholders. These results are an excellent start to understanding what small-scale fishing may look like in BC and how we could justify a fleet separation and owner-operator policy such as the PIIFCAF regulation. However, this regulation comes with its own set of pitfalls and financial loopholes for processors to still have control of fisher behaviour. A similar policy for BC fisheries would require careful language and enforcement to close these loopholes prior to implementation.

Chapter 4 Conclusions

4.1 Discussion

Small-scale fisheries have important global impacts on marine fisheries as they have been estimated to catch half of all marine fish and shellfish (FAO, 2014b; Berkes et al., 2001; Pauly, 1997; Guyander et al. 2013; Teh et al., 2011). In addition to a significant proportion of the global marine catch, SSF contribute to food security and local employment in many regions of the world (FAO, 2014b). In recent years, there has been a big push for SSF research around the world, with much of this research focusing on developing countries or data poor fisheries (Andrew *et al.,* 2007; Béné 2006; Evans and Andrew 2009; Damasio et al., 2016). As a result SSF in developed countries are often assumed to be non-existent.

The *Sea Around Us* has reconstructed SSF catches from 1950 to date. These reconstructed estimates include developed nations with largely industrialized fleets. The *Sea Around Us* estimates that small scale catches were 22 million tonnes globally in 2010 and these catches show a growing trend (Pauly & Zeller, 2016). The growing trend in SSF catches further highlights the relevance of SSF research, even in developed countries. The EU has recognized the importance of SSF as they have a working definition for a small-scale fleet, which includes vessels under 12m that use passive gear (Martín, 2012).

Canada currently has no nation-wide working definition of SSF, but Atlantic Canadian fisheries have an inshore sector, which is virtually an equivalent to a small-scale sector. These fisheries were determined to have a social and economic importance to coastal communities in Atlantic Canada through the AFPR, and a special designation was made for them. To date, no such policy review has been executed for Canada's Pacific fishing fleet. This does not mean that BC's fisheries policies are perfect or that a small-scale fishing sector does not exist in BC.

Results of this work suggest that many features of SSF are present within BC's fishing fleets. There are varying numbers of small-scale features present depending on the fleet. FSC,

Aboriginal commercial fisheries and salmon gillnetters are the most small-scale using the framework from Chapter 2. FSC fisheries were not quantitatively analysed in Chapter 3. The results of quantitative analysis suggest that there are many factions of the BC fleet, which are small-scale. All Aboriginal commercial, salmon gillnet and troll, crab trap, prawn and shrimp trap and trawl, schedule II species, red and green urchin dive and rockfish hook and line fisheries are all considered small-scale after employing three different quantitative methods. Small-scale fisheries land a smaller proportion of catch relative to large-scale ones but command a higher average price per tonne than the catches of large-scale.

Even with the presence of SSF and desire for owner-operator policies in BC, it is unclear why there has not been a similar or the same policy in place for the Pacific fishery. There is no evidence that a similar policy has been explored by DFO for the Pacific region. This may be due to a lack of collective pressure from fishers and/or political pressure from certain stakeholders to ignore such a policy. However, with the closure of the Canfisco's Prince Rupert cannery in November 2015, members of the UFAWU released letters[28] to both Prince Rupert Businesses and the former Fisheries Minister Hunter Tootoo, requesting the application of Atlantic Canada's fleet separation and owner-operator policies to the Pacific fleet (UFAWU-UNIFOR, 2015; UFAWU-UNIFOR, 2016). These requests have not amounted to any policy reform at this point in time but they demonstrate stakeholder interest in policies to protect BC owner-operators.

There is a lot of room for owner-operator and independent fisher policy discussion in BC. It is important to consider the performance of Atlantic Canada's PIIFCAF, which intends to have an independent owner-operator sector of the fishery. However, there are loopholes in PIICAF for corporations through Controlling Agreements. These are agreements between a licence holder and a person, corporation or other entity, which allows 'an outsider' to influence licence transfer. The Controlling Agreement loopholes create an environment in which operators effectively become employees of the processors that require the operator to sell their catch

[28] Northern View 'Fishermen's union takes fights to Minister Tootoo, story and video' http://www.thenorthernview.com/news/366202161.html (Accessed January 2016).

back to the processor. The Controlling Agreements force typical revenue sharing agreements to be restructured. For example, one fisher gave 47% of the catch revenue to the buyer (processor) and after fishing expenses the rest was shared between captain and crew (Barnett & Eakin, 2015).

While there is an overarching concern for the loss of independent control of the resource in smaller communities, the Controlling Agreements have allowed for some fishers to stay active in the fishery through financial aide (Anon., 2012; Barnett & Eakin, 2015; Barnett et al., 2016). Contention of the Controlling Agreement loopholes has occurred since the 1990s and remains one of the greatest concerns with the implementation of fleet separation and PIIFCAF (Anon., 2012; Barnett et al., 2016). A further concern with PIIFCAF, is the exclusion of ITQ fisheries (Barnett et al., 2016). This is regrettable, as ITQ fisheries generally known to have the highest numbers of so called “armchair fishers” and BC has a number of important fisheries that are managed with ITQs. Many fisher organizations from Atlantic Canada have expressed the view that they do not want to see their licence and quota in the hands of non-fishers as it could have negative impacts on the interests of coastal communities and their fishers (Anon., 2012).

Fisheries organizations in Newfoundland have been able to inject social principles into political representation (Foley et al., 2015). The Pacific fisheries are experiencing similar corporate consolidation and vertical integration to those that the Atlantic experienced and no regulations have been put in place to ensure a reserve of owner-operator vessels in the fishery (Haas et al., 2016). In addition to these concerns, there has been no Pacific equivalent to the AFPR to date. To establish a Pacific version of the AFPR would be time consuming and costly to the federal government. Exploring the Pacific fleet through an SSF lens will provide important insight as to what a similar policy may look like for the Pacific without the time and financial investment by the federal government.

4.2 Strengths, Weaknesses and Future Work

This research has created both qualitative and quantitative frameworks for distinguishing between small- and large-scale fisheries. The qualitative method developed in Chapter 2 allows for fisheries to be analyzed using a relative scale of 'smallness'. This may be effective for comparing scale of fisheries in different regions or countries. I have chosen to apply this method qualitatively, but it could be made more quantitative by weighting the SSF features in order to produce a number that categorically identifies a fishery as small-scale or not. Quantitative methods in Chapter 3 build on findings from the qualitative framework in Chapter 2. Combining qualitative and quantitative methods provides layers to this research, which provide more than adequate evidence for the existence and importance of SSF in BC. Furthermore, the overlapping of three quantitative methods in Chapter 3 confirms the results of multiple methods. I believe overlapping methods increases the value and validity of the results. These results are also mostly supported by the results of the qualitative framework in Chapter 2.

While combined methods strengthen results, there are some weaknesses with the data used. All fisheries research suffers from issues with data availability and quality and this research is no exception. There is limited data, especially in the case of party-based licences for ownership information. DFO provides data of valid licenses on their website and because party-based licenses are not attached to a vessel, the vessels, which the licenses that are used to fish cannot be found. The party-based licenses include herring, rockfish and some dive fisheries (Appendix D). Herring fisheries have important implications for the economy and coastal Indigenous communities. Vessel data from these fisheries is therefore not included in the socio-economic analysis of this research.

In terms of socio-economic data, there are limited accounts of fixed and variable costs for various fleets. Again, herring fisheries are poorly accounted for in financial data sources. It is difficult to acquire estimates of herring licence and quota prices as well as fuel cost estimates. This is due to the high degree of licence stacking of party-based licenses on vessels. It is

therefore difficult to account for how many boats and people participate in the fishery. In addition to few accounts of fleet financial data, the data is a few years old now. More current estimates of costs would be valuable for further socio-economic analysis of fishing fleets.

Again, there were limitations to interviews carried out to fill in data gaps and understand fisher perspectives of SSF. These interviews were limited by time and geography, and more interviews would be useful to support the findings from this research. I was not able to reach fishers outside of Vancouver and its surrounding areas, or certain groups within the fishery. For example, there are many crab trap licence holders in the Vancouver area of Vietnamese heritage, which were not interviewed for this thesis work. Their inclusion in this data would have been extremely important as crab trappers occur as small-scale under all three quantitative methods.

A large number of data gaps present many areas for further research in this area. The framework for finding SSF in Chapter 2 could be enhanced by weighting the importance of SSF features for analysis. This would create the opportunity to quantitatively distinguish between SSF and LSF using this framework. Again, this framework could be applied to fisheries individually or comparatively across any scale. This research could further be enhanced with a quantitative assessment of uncertainty of data sets used.

This research is based on the lack of a definition or distinction between SSF and LSF in Canada, and BC more specifically. Atlantic Canada has a working definition of inshore fisheries, which is considered equivalent to SSF. The PIIFCAF policy is currently in place in Atlantic Canada to protect the socio-economic structure of the inshore fleet. This policy was established through the AFPR and a similar policy review for the Pacific has not been completed. Before considering the implementation of a similar policy to PIIFCAF for Pacific Canada, there must be an analysis of the effectiveness of the Atlantic PIIFCAF and owner-operator policies.

Finally, this work contributes a valuable evaluation of the socio-economic contribution of SSF in BC. It is a great starting point for a conversation in regards to the value of SSF in BC. An effective next step for this research would be to follow the money through the value chain from landed catch to consumer or export. It could be determined whether landed value is remaining within small BC communities or it goes to large urban centres and large companies.

4.3 Concluding Remarks

This work provides evidence that small-scale fishing occurs in a developed country such as Canada. BC has an important small-scale fishing sector and this sector contributes significantly to the economy. SSF in BC capture less biomass at a higher average price per pound. There are more licensed and active vessels in the small-scale sector, which have the capacity to employ more people, contributing greatly to local economies along the coast. An analysis of vessel-based licence ownership find that a majority of the small-scale sector is owned by individuals and parties outside of Vancouver and its neighbouring areas. In addition, individuals own the majority of vessel-based licenses in the small-scale sector. Understanding ownership has potential implications for understanding trickle down economics in communities along the coast. There is still much work to be done with the inclusion of all stakeholders similar to the AFPR for BC. This will be a necessary step for the creation of a small-scale fisheries policy on the Pacific coast.

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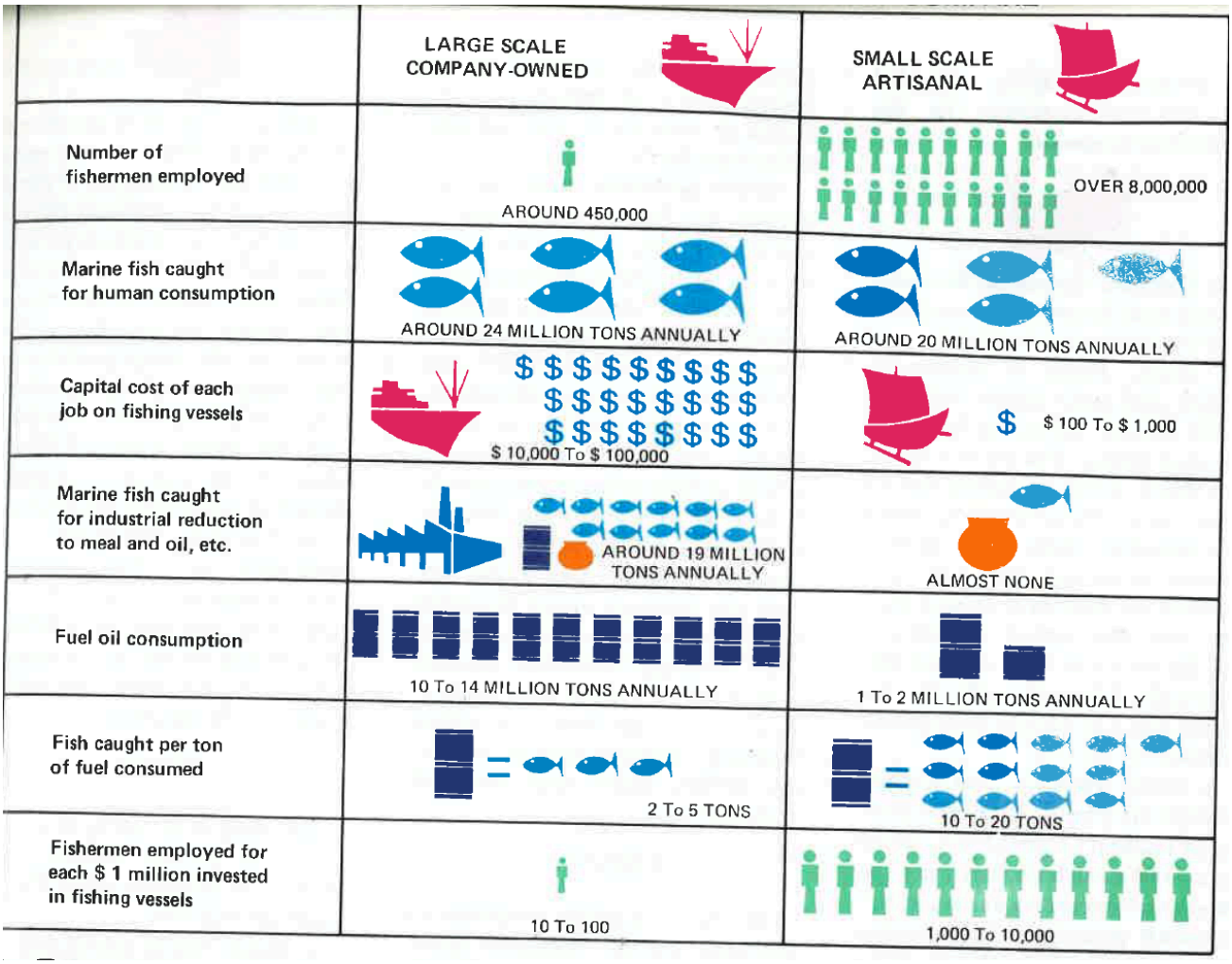
Appendices

Appendix A – Small-Scale and Large-Scale Comparison Tables

A.1 Thomson (1980) Table Comparing Small-Scale and Large-Scale Fisheries



A.2 Berkes et al. (2001) Table Comparing Small-Scale and Large-Scale Fisheries

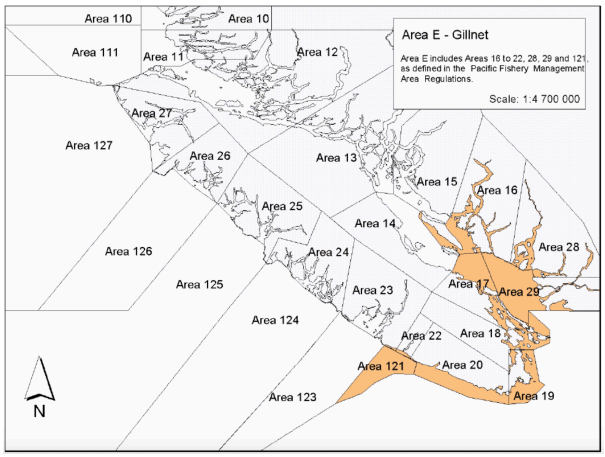
KEY FEATURES OF THE FISHERIES	LARGE-SCALE FISHERIES	SMALL-SCALE FISHERIES
Direct employment in fishing	500 000 people	50 000 000 people
Fishery-related occupations	—	150 000 000 people
Fishing household dependents	—	250 000 000 people
Capital cost per fishing job	US$30 000 – $300 000	US$20 – $300
Annual catch for food	15 – 40 million tonnes	20 – 30 million tonnes
Annual fish bycatch	5 – 20 million tonnes	< 1 million tonnes
Annual fuel oil consumption	14 – 19 million tonnes	1 – 2.5 million tonnes
Catch per metric tonnes of oil used	2 – 5 metric tonnes	10 – 20 tonnes

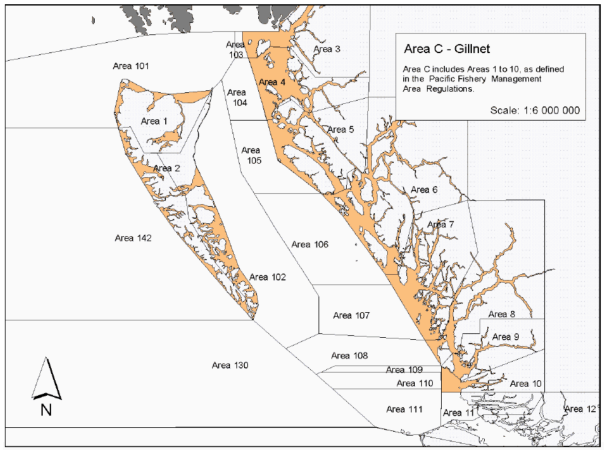
A.3 Jacquet and Pauly (2008) Table Comparing Small-Scale and Large-Scale Fisheries

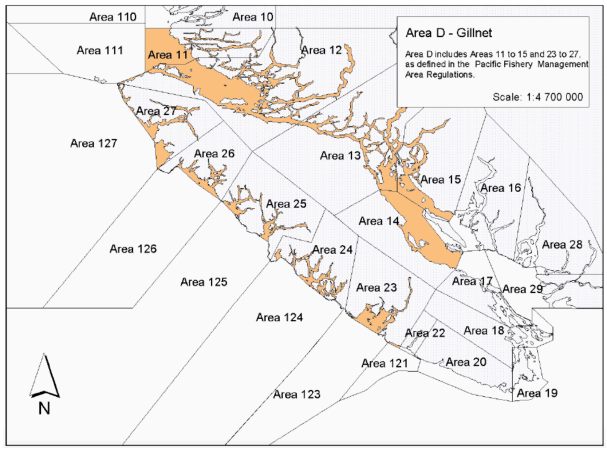
FISHERY / BENEFITS	LARGE SCALE	SMALL SCALE
Subsidies	$$$$$ 25-27 billion	$ 5-7 billion
Number of fishers employed	about 1/2 million	over 12 million
Annual catch for human consumption	about 30 million t	same: about 30 million t
Annual catch reduced to fishmeal and oils	35 million t	Almost none
Annual fuel oil consumption	about 37 million t	about 5 million t
Catch per tonne of fuel consumed	= 1-2 t	= 4–8 t
Fish and other sealife discarded at sea	8–20 million tonnes	Very little

Appendix B – Management Areas

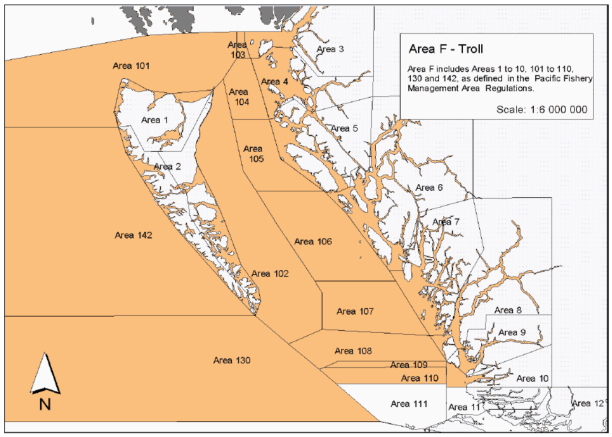
B.1 Salmon Gillnet Management Areas

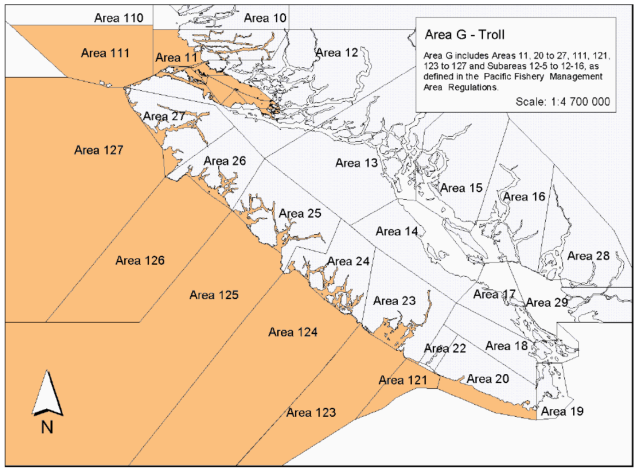


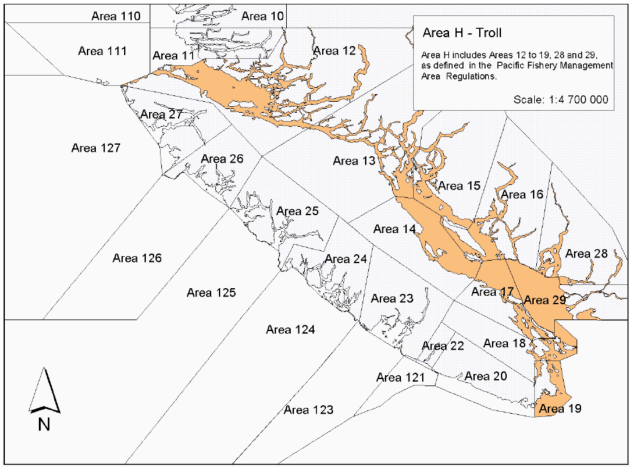




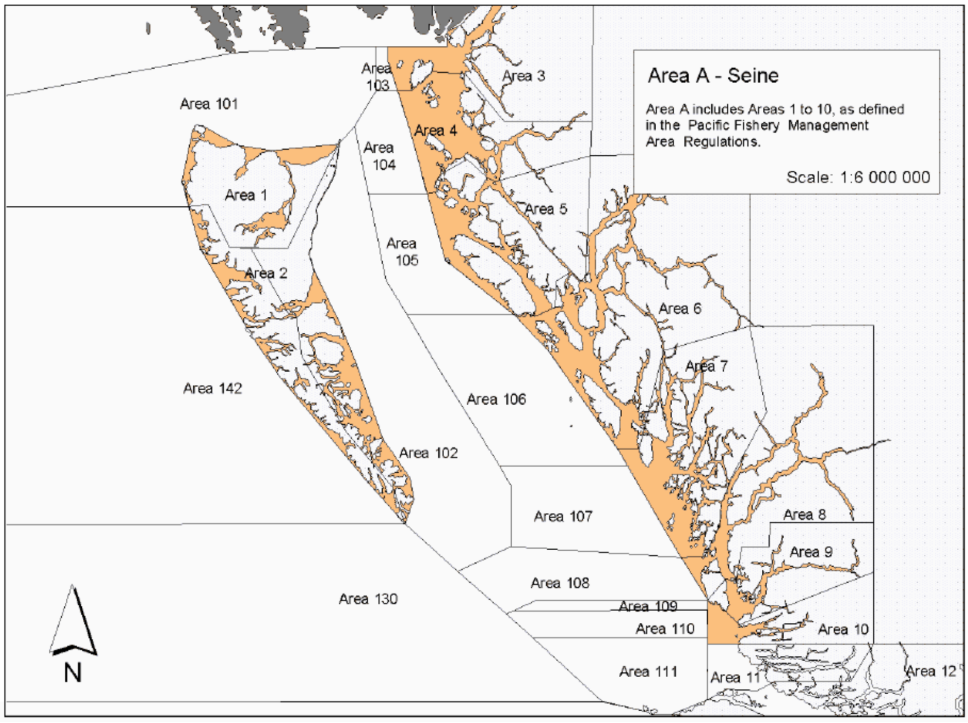
B.2 Salmon Troll Management Areas

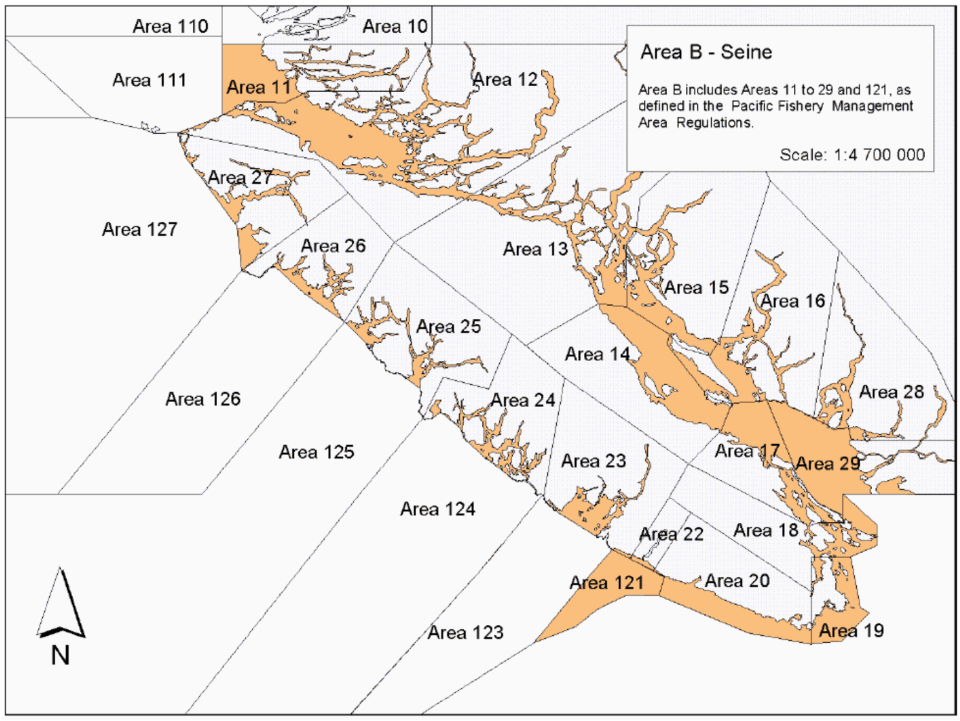






B.3 Salmon Seine Management Areas





Appendix C - Fisheries Categories Excluded from Analysis Due to Three Party Rule

Fishery Description	Licence	Vessel Length	Number of Licensed Vessels	Number of Licensed and Active Vessels	Reason for excluded data
Eulachon	ZU	<35’	10	2	3 Party Rule
Aboriginal Sardine by Seine	ZSF	<35’	7	-	No Catch
Sardine by Seine	ZS	<35’	5	-	No Catch
Rockfish Hook and Line	ZN	35’-44’11’’	1	1	3 Party Rule
Euphausid	ZF	<35’	8	-	No Catch
Sea Cucumber by Dive	ZD	<35’	30	-	No Catch
Prawn and Shrimp by Trap	W	65’-99’11’’	1	1	3 Party Rule
Groundfish by Trawl	T	<35’	16		No Catch
Shrimp by Trawl	S	>100’	1	1	3 Party Rule
Shrimp by Trawl	S	65’-100’	13	-	No Catch
Crab by Trap	R	65’-99’11’’	1	1	3 Party Rule
Sablefish by Longline or Trap	K	>100’	1	1	3 Party Rule
Sablefish by Longline or Trap	K	35’-44’11’’	4	2	3 Party Rule
Sablefish by Longline or Trap	K	<35’	4	-	No Catch
Geoduck by Dive	G	45’-64’11’’	1	1	3 Party Rule
Aboriginal Red Sea Urchin by Dive	FZC	<35’	15	-	No Catch
Aboriginal Groundfish by Trawl	FT	<35’	1	1	3 Party Rule
Aboriginal Shrimp by Trawl	FS	<35’	1	-	No Catch
Aboriginal Category II Species by Hook and Line	FC	<35’	4	-	No Catch
Category II Species by Hook and Line	C	65’-99’11’’	6	-	No Catch
Salmon by Troll	AT	>100’	1	1	3 Party Rule
Salmon by Troll	AT	65’-100’	1	1	3 Party Rule
Salmon by Seine	AS	>100’	1	1	3 Party Rule
Salmon by Seine	AS	35-44’11’’	2	2	3 Party Rule
Salmon by Gillnet	AG	45-64’11’’	5	2	3 Party Rule
Tuna by Troll	USA 68	<35’	23	-	No Catch
Tuna by Troll	USA 68	>100’	1	-	No Catch

Appendix D - DFO Fisheries Licence Prefixes[i]

Prefix	Description
	Vessel Based Licenses
AG	Salmon by Gillnet
AS	Salmon by Seine
AT	Salmon by Troll
C	Schedule II Species by Hook and Line
CT	Schedule II Species (Tuna)
G	Geoduck & Horseclam by Dive
K	Sablefish by Longline and Trap
L	Halibut by Hook and Line
R	Crab by Trap
S	Shrimp by Trawl
T	Groundfish by Trawl
USA 68	USA 68 Section 68 Albacore in USA Waters
W	Prawn and Shrimp by Trap
	Party Based Licenses
HG	Herring Roe by Gillnet
HS	Herring Roe by Seine
J	Herring Spawn on Kelp
NAG	Salmon by Gillnet – Northern Native Fishing Corp.
ZA	Green Sea Urchin by Dive
ZC	Red Sea Urchin by Dive
ZD	Sea Cucumber by Dive
ZN	Rockfish by Hook and Line
	Communal Commercial Licenses
FAG	Aboriginal Salmon by Gillnet
FAS	Aboriginal Salmon by Seine
FAT	Aboriginal Salmon by Troll
FG	Aboriginal Geoduck & Horseclam by Dive
FK	Aboriginal Sablefish by Longline or Trap
FL	Aboriginal Halibut by Hook and Line
FR	Aboriginal Crab by Trap
FS	Aboriginal Shrimp by Trawl
FT	Aboriginal Groundfish by Trawl
FW	Aboriginal Prawn and Shrimp by Trap
FZN	Aboriginal Rockfish by Hook and Line

Appendix E – List of SSF and LSF Fisheries from Cumulative Percent Distribution for 2013

Fishery	Landings (t)	Landed Value ($)	Licensed and Active Vessels (#)
Small-Scale Fisheries			
Aboriginal salmon troll under 35’	71	395,416	17
Spawn on kelp (herring)	74	2,013,606	N/A
Green sea urchin dive under 35’	123	411,432	7
Aboriginal prawn trap under 35’	131	2,101,911	31
Schedule II species hook and line under 35’	138	337,597	5
Aboriginal crab trap under 35’	218	2,227,652	23
Aboriginal sablefish longline or trap under 35’	284	2,226,748	5
Aboriginal salmon gillnet under 35’	328	585,632	38
Halibut hook and line under 35’	335	2,495,172	6
Salmon troll under 35’	481	1,557,753	5
Salmon gillnet – Northern Native Fishing Corp. under 35’	504	993,153	110
Groundfish trawl between 35’ and 44’11’’	799	3,621,000	8
Aboriginal rockfish hook and line under 35’	861	6,150,474	19
Aboriginal halibut hook and line under 35’	1,167	8,836,501	41
Shrimp trawl under 35’	1,191	3,345,956	33
Aboriginal salmon seine under 35’	1,996	1,614,955	13
Schedule II species hook and line between 35 and 44’11’’	2,185	2,900,730	11
Shrimp and prawn trawl between 45’ and 64’11’’	2,239	3,611,219	24
Schedule II species hook and line between 45’ and 64’11’’	2,613	1,746,736	6
Geoduck dive under 35’	2,695	60,186,585	9
Prawn trap between 45’ and 64’11’’	3,823	54,528,098	21
Schedule II species (tuna) between 65’ and 99’11’’	4,735	16,210,485	7
Rockfish hook and line under 35’	4,885	38,604,083	89
Prawn trap under 35’	5,835	80,435,496	54
Herring roe seine between 35’ and 44’11’’	6,842	2,262,502	N/A
Shrimp and prawn trawl between 35’ and 44’11’’	7,181	19,561,651	122
Herring roe gillnet	7,189	3,169,752	N/A
Sablefish longline and trap between 45’ and 64’11’’	8,405	60,032,667	13
Schedule II species (tuna) between 35’ and 44’11’’	8,671	29,065,901	49
Salmon troll between 45’ and 64’11’’	8,799	43,474,202	69

Appendix E (continued)			
Geoduck dive between 35’ and 44’11’’	11,718	261,491,437	30
Halibut hook and line between 65’ and 99’11’’	12,550	101,429,957	24
Prawn trap between 35’ and 44’11’’	13,446	191,801,298	105
Crab trap between 45’ and 64’11’’	15,171	80,907,751	11
Halibut hook and line between 35’ and 44’11’’	18,187	139,511,771	83
Crab trap between 35’ and 44’11’’	22,147	129,609,137	40
Sablefish longline or trap between 65’ and 99’11’’	22,167	178,678,396	12
Salmon troll between 35’ and 44’11’’	22,716	112,238,256	224
Red sea urchin dive under 35’	24,361	33,101,000	33
Crab trap under 35’	29,269	236,988,982	136
Salmon gillnet under 35’	30,379	72,938,989	264
Halibut hook and line between 45’ and 64’11’’	33,150	249,893,432	75
Schedule II species (tuna) between 45’ and 64’11’’	34,163	113,391,218	67
Groundfish trawl between 45’ and 64’11’’	48,764	47,082,380	12
Salmon gillnet between 35’ and 44’11’’	55,747	127,191,428	333
Salmon seine between 45’ and 64’11’’	71,674	97,509,482	52
Large-Scale Fisheries			
Salmon seine between 65’ and 99’11’’	90,419	123,055,093	62
Groundfish trawl greater than 100’	245,273	114,379,042	11
Groundfish trawl between 65’ and 99’11’’	311,559	182,570,002	34

Appendix F – Social, Economic and Environmental Indicators of SSF and LSF

Sumaila et al., 2001	Therkildsen, 2007	Thomson, 1980
• Number of fishers	• Annual landings and landed values	• Number of fishermen employed
• Number of vessels	• Amount of labour and number of vessels	• Marine fish caught for human consumption
• Annual catch (1,000 t)	• Annual catch for industrial reduction or bait	• Capital cost of each job on fishing vessels
• Annual catch (1,000 t) of marine fish for human consumption	• Discards	• Marine caught for industrial reduction to meal and oil, etc.
• Annual catch (1,000 t) of marine fish for industrial reduction to meal and oil, etc.	• Energy intensity	• Fuel oil consumption
• Landed Value (million US$)	• Overlap in target species	• Fish caught per tonne of fuel consumed
• Total fuel consumed (million L)	• Distance from shore	• Fishermen employed for each $1 million invested in fishing vessels
• Energy Intensity (L/t)		
• Fishers employed for each $1 million landed value		

Appendix G - Interview Transcript

- Describe your history in the industry:
    - Why do you fish?
    - When did you start?
    - Which fisheries have you participated in? When? Where?
    - Which fisheries do you participate in now?
- Describe the vessel that you work on:
    - Length
    - Gear
    - Material
    - Gross tonnage
    - Engine power
    - Year built
    - Trip distances and times
    - Crew size
- Do you consider yourself to be a small-scale fisher?
- Show vessel pictures – ask which scale of fishing
- What is the cost of entry/maintenance of the fishery?
    - Gear
    - Licence
    - Quota
    - Vessel
    - Repairs
    - Fuel-unit?
- Have you ever leased your licence? Or do you lease a licence and quota?
- Other comments?

[i] DFO Licence Prefix Categories http://www.pac.dfo-mpo.gc.ca/fm-gp/licence-permis/lpc-eng.html (Accessed January 2014)