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How Small-Scale are Fisheries in British Columbia?

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Abstract

Small-scale fisheries have been estimated to contribute up to 50% of the global landed value. The global marine catch by the small-scale sector is caught by 44% of fishers in the primary sector, which equates to approximately 22 million fishers. A great deal of socio-economic analysis of small-scale fisheries has focused on developing countries and failed to recognize the presence and contribution of small-scale fisheries in the developed world. A list of re-occurring features of small-scale fisheries is curated from the literature. These features of small-scale fisheries capture physical, economic and social features of small-scale fisheries. Fisheries in British Columbia are diverse and often regarded as being industrialized and large-scale when analyzed in a global context. We have found that commonly used features of small-scale fisheries are present in British Columbia's fishing fleets to a varying degree. Aboriginal Food, Social and Ceremonial fisheries and all commercial fisheries in British Columbia are analysed to determine the presence or absence of each of these small-scale fishery features. The results of this research create a gradient of fisheries from smallest to largest scale. The qualitative nature of this framework creates an opportunity for any fisheries, anywhere in the world to be compared.

2.1 Introduction

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. This first effort to compare large-scale fisheries (LSF) versus SSF was followed with updated and slightly different

comparisons by Berkes et al. (2001), and Jacquet and Pauly (2008). 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) [1]. 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). SSF 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.

A 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

[1] 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).

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[2]. Again, there is no broadly used definition of SSF used throughout their organization.

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).

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. 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 over commercial and recreational practices, after meeting conservation standards[3,4] (DFO, 2016a).

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[2] Too Big To Ignore 'http://toobigtoignore.net' (Accessed January 2015)
[3] 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).
[4] DFO 'Aboriginal Fisheries Strategy' http://www.dfo-mpo.gc.ca/fm-gp/aboriginal-autochtones/afs-srapa-eng.htm (Accessed November 2016).

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. There has been a large decrease in the number of smaller active vessels in the last thirty years[5]. 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[5]. 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 Mifflin Plan in 1996 reduced the number of commercial salmon licenses by 42% (Brown, 2005; DFO, 2002).

The apparent fleet reduction in the last thirty years can further attributed 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. 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.

[5] DFO 'Vessel Information' http://www.dfo-mpo.gc.ca/stats/commercial/licences-permis/pacific-pacifique/pacfleet-eng.htm (Accessed December 2015).

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[6]	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

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

[6] 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.

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**Error! Bookmark not defined.** 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).

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 framework to establish where SSF attributes are present within the BC fleet. A feature is considered present even if it does not exist within the entire fleet. For example, many boats in the fleet may be less than 12 m (39 ft) but there may also be vessels that are greater in size. Once these features have been identified, the fisheries can be compared on a relative spectrum of most small-scale to most large-scale 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 greater importance to SSF than others. Using this framework, 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[7] and Transport Canada[8] 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 with the least amounts of data in BC are relatively 'small' fisheries. However, to have moderate

[7] DFO 'Licensed Fishing Vessel Search' http://www-ops2.pac.dfo-mpo.gc.ca/vrnd-rneb/index-eng.cfm?pg=VesselSearchForm (Accessed January 2015).
[8] Transport Canada 'Vessel Registration Query System' http://wwwapps.tc.gc.ca/saf-sec-sur/4/vrqs-srib (Accessed December 2015).

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. The analysis of each fishery can be found in the supplementary material.

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). Using this framework, the sablefish fishery exhibits the fewest features of SSF, i.e. is the largest-scale fishery (Table 2). This was an expected result as this fishery is relatively new, beginning in 1979 as an offshore trap and longline fishery (Gough, 2007). There is no cultural significance or heritage associated with this fishery. The sablefish fishery has been managed with an ITQ system as of 1990, with only 42 licenses available for the entire fleet (Dupont, 2014; DFO 2016d). Due to the exclusivity of the fishery along with an ITQ management scheme, this fishery is extremely costly to enter. There is an estimated replacement cost of $779,000 for licence and vessel, along with nearly $2 million for 20,000 kg of quota (Nelson, 2011). Another feature of LSF is evident as these fisheries are dependent on export markets to Asia in order to thrive as a small proportion of catch from these fisheries is consumed domestically (Sumaila et al., 2007).

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.

If a distinction of SSF was made on physical features of the fishery alone, geoduck may be categorized as SSF. Geoduck is a fishery that occurs on small vessels with minimal by-catch due to targeted diving techniques and these features are associated with small-scale fisheries. However, once economic and social features of SSF are considered it can be noted that the geoduck fishery is larger-scale. The geoduck fishery is managed by ITQs, has a limit of 55 licence eligibilities and licences may be owned by incorporated companies (Heizer, 2000; James, 2008; Khan, 2006; DFO 2016f). These features contribute to an estimated $2.8 million replacement cost of a vessel and licence for this fishery which, is the highest in the province (Nelson, 2011). The geoduck fishery further displays features of LSF, as it is highly dependent upon foreign markets in Asian and a very small portion of the landed catch would be consumed domestically (DFO 2016f).

The Food, Social and Ceremonial (FSC) fishery exhibits the greatest number of SSF features and is a fishery for individuals with indigenous status in Canada. Catch from this fishery is to be used for personal or community consumption and is not to be commercially sold[9]. The FSC fishery targets a number of species with enormous social and cultural significance to coastal indigenous peoples. For example, herring is one targeted species of the FSC fishery both for roe and for spawn on kelp, also known as k'aaw, which is harvested, by families and communities in the spring (Jones et al. 2016). These fisheries also have minimal government involvement and are mostly community managed. This is not a commercial fishery so it is difficult to gather quantitative data to analyze any further. However, it is evident that this fishery holds many social and cultural values and practices, which are absent in other fisheries.

The aboriginally licensed commercial fishery is the next 'smallest' fishery. 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. These fisheries operate on

[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).

smaller vessels, which would operate relatively closer to the community than larger-scale fisheries. Physically, the aboriginally licensed commercial fishery can be considered smaller-scale. A catch statistic request to DFO presented data for the landed value of these fisheries however, other economic data is difficult to acquire. There are different costs for licenses, vessels and fuel in these fisheries compared to their 'other' commercial counterparts.

The salmon gillnet fishery is the third smallest fishery in BC using this framework. This fishery occurs on smaller vessels, closer to shore than other commercial fisheries in the province. However, it is the most abundant fishery in terms of participating vessels and fishers (DFO, 2016a). These fisheries also have some of the lowest financial thresholds to enter the fishery in the province with an estimated replacement cost of $145,000 for a single licensed vessel (Nelson, 2011). Salmon are the most socially and culturally important species on the coast and the commercial fishery still provides fish to families and communities through gifting and trade (O'Donnell et al., 2013). Salmon gillnetters represent the smallest-scale commercial fishery in the province using this framework and this result was expected.

2.4 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).

Overall, this framework demonstrates that SSF exist in BC as each fishery within BC exhibits one or more features of SSF. Aboriginal FSC 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 number of SSF features present. 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[8]. 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 'smallness' 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 'smallness', 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.

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Supplementary Material

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[10,11].

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[12]. 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

[10] 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).
[11] 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).
[12] FAO 'Gillnets and Entangling Nets' http://www.fao.org/fishery/geartype/107/en (Accessed December 2016).

(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)[7,8]; 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[8]. 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[8]. 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.

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[13]. 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[8].

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[8]. 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[8]. Overall, the salmon troll fleet is the smallest by numbers with only 298 licenced 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.

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

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[14]. 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.[7,8], 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[8]. These boats are mostly made of aluminum (45%) and steel (40%), with the rest being made of reinforced plastic and wood[8].

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 Greater Vancouver area own a majority of the seine licences and vessels[8]. 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

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

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[15]. These gears are considered to be highly unselective, allowing them to capture a large number of bottom species[15].

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).

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

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[8]. The average trawl vessel was built in 1977, however there are vessels in the fleet that are as old as 90 years old[8]. 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 34% on Vancouver Island[8]. 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[16]. 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

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

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, which are generally quite selective gears[17, 18]. 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).

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

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[19,20]. 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;

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

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 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)[21]. 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 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

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

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[8] (Martín, 2012). Most of these vessels are made of reinforced plastic, which are the older vessels and aluminum, which are the newer vessels[8]. 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[8]. Companies and individuals on Vancouver Island also own the majority of these vessels with a secondary proportion located in the Greater Vancouver Area[8]. 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 (DFO 2016d). 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, 2016g). 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 (DFO 2016d). 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**Error! Bookmark not defined.**, 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[8]. 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[8]. 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[8]. 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 (Chuenpagdee 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**Error! Bookmark not defined.**, 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[8]. 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[8]. Similar to the trap fishery, most of the licences and vessels are located on Vancouver Island and the Greater Vancouver area[8].

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.[8]. 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[8]. 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[8]. 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[8].

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[8]. Ownership in this sector of the fishery is approximately one half individual ownership, a quarter company ownership and a quarter community ownership[8] 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**Error! Bookmark not defined.**. 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

2014). 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).