

“A prized Pacific shark”: the rise and fall (and rise again...?) of the world's first ecolabel certified sustainable shark fishery

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Abstract

There is intense public interest surrounding the conservation and management of sharks, including a debate over whether sustainable shark fisheries are possible or fishing bans on sharks are needed to conserve these animals. An important but rarely discussed data point in discussions of global shark fisheries is the case of British Columbia's fishery for Pacific spiny dogfish, *Squalus suckleyi*, which in 2011 became the first Marine Stewardship Council–certified shark fishery anywhere in the world. A few years later, despite reportedly healthy local stocks and thriving global markets for this shark, the fishery voluntarily withdrew its MSC certification, and in recent years more than 95% of the quota for Pacific spiny dogfish has been left in the water. This study provides insight into what happened to this fishery through a review of grey literature and a series of stakeholder interviews with British Columbian fishermen, fish processors, managers and environmentalists. It is a rare case study of a fishery that largely ceased operations without a clear mechanistic explanation like a stock collapse, a government mandate to limit fishing or a clear shift in market demand. This fishery appears to have been affected by the combination of several factors, including a temporary reduction in biomass due to oceanographic effects, potential blowback from overly broad environmental messaging that did not distinguish between sustainable and unsustainable shark fisheries, management changes resulting in altered fishing incentives and changes to processing capacity associated with consolidating the fishing industry into ownership by relatively few large companies.

KEYWORDS

fisheries management, ocean conservation, shark, shark fisheries

1 | INTRODUCTION

The single largest global challenge facing sharks and their relatives is overfishing (Dulvy *et al.*, 2021). Some environmental activists believe that sustainable fisheries for sharks are impossible and cannot ever occur, and that therefore total bans on all fishing for sharks are necessary (Shiffman & Hammerschlag, 2016; Shiffman *et al.*, 2021). Although there is clear evidence that sustainable shark fisheries can and do exist (Walker, 1998) the vast majority of global shark fisheries are currently not sustainable (Simpfendorfer & Dulvy, 2017). In addition, sharks are especially vulnerable to overfishing due to their life-

history characteristics (Hoenig & Gruber, 1990), which means that any fishery must be very carefully managed to achieve sustainability.

In the midst of debates over the existence of sustainable shark fisheries, British Columbia's (BC) fishery for Pacific spiny dogfish (*Squalus suckleyi*) made history in 2011 as the world's first Marine Stewardship Council–certified sustainable fishery for sharks (MSC, 2011). Although precise definitions of sustainable well-managed fisheries can be technical and complex, eco-labels can clarify and simplify this information for consumers (Gutierrez & Thornton, 2014). If a seafood product carries an eco-label from a reliable source, it theoretically means that the fishery has met a variety

of stringent standards and requirements, and consumers can trust that it is an environmentally friendly product. The Marine Stewardship Council is a leading sustainable seafood certification organization (Gulbrandsen, 2009; Roheim, 2003). To meet the standards for Marine Stewardship Council (MSC) certification, a fishery must demonstrate that it gets a passing score of at least 60 on each of 28 indicators related to the sustainability of the target stock, by-catch rates, potential habitat impacts and effective management, and an average score of at least 80 on each of three principles (sustainability of the stock, ecosystem impacts and effective management).

In 2014, despite reportedly healthy local dogfish stocks and thriving global markets for dogfish products, the MSC certification was quietly withdrawn. BC fishermen now mostly throw back dogfish they catch, leaving more than 95% of their annual quota in the water, landing only a small fraction of what they are permitted to land (Personal Communication, Fisheries and Oceans Canada, 2019). The causes of the disappearance of this fishery have never been explained or described in the fisheries science or marine conservation literature.

Fisheries may shut down for a variety of reasons (Mullon *et al.*, 2005; Pinsky *et al.*, 2011; Roughgarden & Smith, 1996). Overharvest and overexploitation can result in the decline and possibly even the eventual collapse of biomass, most famously with Newfoundland cod stocks (Hutchings, 1996; Myers *et al.*, 1997), and these problems are often exacerbated by mismanagement. Environmental conditions can change, resulting in a biomass shift out of reach of local fisheries (Engelhard *et al.*, 2014), or in large-scale local recruitment failure of commercially important species (Pershing *et al.*, 2015). Some species of fish naturally have large inter-annual variability in biomass, making them more vulnerable to overharvest (Trochta *et al.*, 2020). Major changes in management can alter fishing incentives or profitability, resulting in fishers leaving the fishery or shifting effort to other species (Yandle & Crosson, 2015). Fisheries can also be shut down by managers when targeted stocks are healthy if there are serious issues with by-catch (e.g., the shallow-set longline swordfish fishery in Hawaii faced an emergency closure due to sea turtle by-catch, FR Doc 2018-10096). Market demand and price can also shift, as demand

for once-popular seafood dishes wanes, or public health or conservation campaigns shift consumer preferences.

As BC's Pacific spiny dogfish fishery did not show any obvious signs of any of these issues, the goal of this interdisciplinary multi-method analysis was to better understand what caused a fishery that was apparently ecologically and economically sustainable to withdraw its MSC certification and stop landing fish.

2 | MATERIALS AND METHODS

The authors examined peer-reviewed published literature related to shark fisheries in the Pacific Northwest, and relevant grey literature (industry reports, environmental non-profit reports and government analyses) to learn about the history and fate of this fishery. They also searched for stories about sharks and shark fisheries in the archives of British Columbia newspapers, the Royal British Columbia archives and in books opportunistically encountered during this expedition (including one book that was for sale on the ferry to Vancouver Island).

In addition, the authors performed a series of 19 stakeholder interviews in fishing communities around BC (Figure 1). Study sites included small towns with current and historical fishing communities like Comox and Ucluelet, towns that are home to seafood processors and distributors like Port Alberni and larger municipalities that are home to relevant government offices and industry group headquarters like Vancouver, Victoria and Nanaimo. In addition, some stakeholder interviews were conducted over the phone.

The authors took an ethnographic approach to questions about what drove dogfish fishers to seek MSC certification, the subsequent decision to voluntarily withdraw that certification and the cessation of the fishery (Supporting information). They spoke with representatives of the fishing industry, seafood processors and seafood market owners, environmental activists, managers at the provincial and federal levels, local scientific experts and representatives from the MSC. Their approach primarily relies upon qualitative

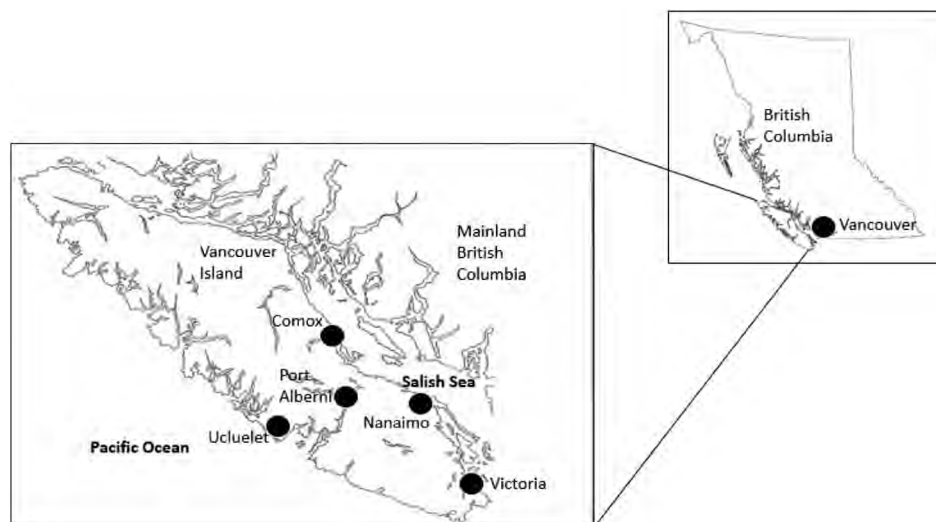


FIGURE 1 “It’s hard to find a town with no fishing history, there’s always a fish fabric here.” Map of Vancouver Island (inset: Vancouver Island relative to the city of Vancouver and the rest of BC), with cities and towns visited for this study highlighted

semi-structured, in-person interviews, which were used to better understand participant involvement in and perceptions of the fishery, as well as the broader social context in which these decisions were enmeshed. Direct quotes from stakeholders are included in subheading titles and results throughout, and indicated with quotation marks and italics. Additionally, quotes about dogfish and the fishery from a variety of sources encountered in this study are also presented (Table 1).

The authors conducted a total of 19 interviews, ranging in length from 25 min to two and a half hours. Participants were selected using a purposive nonprobability sampling approach following the process outlined in Tongco (2007). Interviewees were identified based on existing knowledge and expertise, and were not selected randomly or with the intention of generalizing about the surveyed population (Etikan *et al.*, 2016). Selection criteria were developed based on informants' personal historic or current direct or indirect knowledge of, or experience or interaction with, the Pacific dogfish fishery (Allen, 1971). The authors also employed a snowball sampling approach, in which every participant interviewed was asked whether they knew of other stakeholders who might have relevant information or perspectives (e.g., Noy, 2008). These interviews were semi-structured, including both a standard set of questions about the dogfish fishery and the flexibility to follow alternate lines of inquiry as they were raised. Detailed notes were taken by all authors during

interviews, and immediately following interviews the author C.M. conducted a detailed debriefing of all coauthors in which key direct quotes were confirmed across interviewers. Additionally clarifying information was added to notes taken during each interview, yielding a master set of interview notes used for subsequent analysis.

It is worth noting that the fishers most likely to be willing to talk to scientists or to be located through the authors' sampling approach are those who remain in the industry more than a decade after integration, and those who have a reasonably good relationship with scientists and managers, emphasizing the extent to which this study should not be seen as adequately representing the full spectrum of fisher perspectives on these issues.

3 | RESULTS

3.1 | Background

3.1.1 | The modern fishery: "Dogfish gave us something to do when there weren't salmon landings taking place"

For background information on Pacific spiny dogfish and fisheries exploitation prior to the 1960s, see the Supporting information.

TABLE 1 References to dogfish in British Columbia area newspapers and books, demonstrating a range of public opinion

Much-abused dogfish makes good eating. The most obnoxious denizen of the Strait of Georgia...a pest thoroughly detested by every sport and commercial fishermen....do not treat this cold-saffron-eyed member of the shark family with too much disdain. It's choice eating.	<i>Daily-Colonist</i> , 2 April 1967
The Delicious Dogfish: almost no one eats dogfish except the dedicated fishery biologist, the starving, or the very curious.	<i>Daily Colonist</i> , 7 September 1975
Dogfish value given support: dogfish are considered to be a pest by commercial and sports fishermen, but...they could be an economic benefit to Canadian fishermen.... said the fish were considered delicacies in Oriental and European countries.	<i>Daily Colonist</i> , 23 April 1969
Barkley Sound by Canoe: We encountered just one major problem when fishing salmon: dogfish...ugly beasts! There were times when dogfish would swim around the canoe as close as two feet from the side of the boat.	<i>Daily Colonist</i> , 27 November 1977
Scorned dogfish finding market: the first shipment of dogfish, until recently considered unpalatable, is due to arrive in Hamburg today for distribution across Germany. It was Canadian officials in West Germany who persuaded him to try to peddle the hitherto nuisance fish. Plentiful off Canada's west coast...generally considered a nuisance.	<i>Daily Colonist</i> , 7 January 1971
Dogfish are predators which cause thousands of dollars in damage to fishermen's gear. They have become so numerous that commercial fishing has been curtailed. They also interfere with sport fishing. The Federal government is confident that a concerted fishing program can control their numbers because dogfish, being member of the shark family, reproduce slowly.	<i>Daily Colonist</i> , 26 July 1959
Those pesky little sharks become a nuisance.	"Island Halibut Fishing: Halibut tips and tricks for the west coast of BC." Jones and Stefanyk
The dogfish took over the fishing hole, and, as sharks will, were munching anything that came in the way of their mouths.	The codfish dream: Chronicles of a west coast fishing guide. Gibling
A very common but usually unwanted catch....if prepared properly its flesh is truly gourmet.	Marine life of the Pacific northwest. Lamb and Hanby
Throughout history, fishermen have alternately reviled and harvested this shark...surprisingly delicious.	Coastal fishes of the Pacific Northwest. Lamb and Edgell

The modern dogfish fishery, which consists of hook and line fishing and otter trawls (including those targeting halibut, sablefish and rockfish but catching dogfish as by-catch, MSC, 2011), has existed in various forms since the 1960s and early 1970s. There were repeated references by many stakeholder groups to the idea that dogfish fishermen were considered to occupy a lower place in the social and economic hierarchy than fishers targeting more valuable species.

In 2008, BC integrated its groundfish fisheries through a new ITQ or individual transferrable quota system (referred to locally as “*integration*” or “*groundfish integration*”). Prior to “*integration*,” local fishers had permits for (and therefore focused on targeting) one or two types of fish (e.g., there were dogfish fishers, halibut fishers, rockfish fishers, etc.) The ITQ system meant that any local participants in the fishery could potentially obtain quota for a variety of local fish stocks, which could be traded with other local fishers. According to one manager, integration was intended to reduce discarded by-catch, while producing additional data for managers, and achieving “*sustainability and accountability*.” This meant that dogfish fishers suddenly had access to more valuable halibut fisheries, and also meant that fishers previously targeting rockfish and catching dogfish as by-catch could sell their dogfish by-catch.

An interviewed former dogfish processor noted that after integration, dogfish were a secondary product for most fishers as they were caught in large numbers as by-catch, “*a second-class fish*.” Nonetheless, they could “*clear the ground a bit for more valuable species*” (i.e., contribute to covering the cost of fuel, crew and boat maintenance when caught in addition to money-making fish like salmon or halibut). Managers and fishermen all reported that halibut and salmon were the profitable fisheries, the “*big moneymakers*” in the BC groundfish fishery, despite salmon population declines that left those fisheries “*barely a shadow of what (they) used to be*.” One manager noted that BC fisheries “*haven't fished other more valuable species down enough for dogfish to be worth targeting*” with another agreeing that the “*margins were always so low on that fish and fishery*.” As one fisherman told the authors, “*One halibut is worth 500 dogfish*.”

In the modern dogfish fishery, most dogfish were caught by hook and line, with c. 25% caught as by-catch in trawl nets. Each individual fish was not worth much, and multiple fishermen referred to dogfish as “*a volume fishery*,” with repeated references to economies of scale and the significance of high volume in making it worth retaining dogfish. One fisherman noted, “*It's just not worth it for a few hundred fish*.” For this reason, dogfish are often discarded when caught, with one fisher noting that mortality rates are quite low (5%–10%) with most dogfish released alive expected to survive.

Another described dogfish fishing as easy with a longline, though he described storing caught dogfish on board as “*ice intensive*” and observed that dogfish are not as easy to stack in the hold as halibut. Fishermen also noted that even when caught as part of the integrated multi-species fishery, dogfish need to be stored separately from other species in the hold because their rough skin, dorsal spines and the urea from their blood can damage the rest of the catch, reducing the quality and value of other fish. One concern raised by fishermen is that the size of dogfish matters a lot in terms of price, noting that a

“*good-sized*” dogfish sells for \$1.25 a pound but a slightly smaller dogfish sells for just \$0.30 a pound, and that a half-pound size difference can have a big effect on price because small skinny dogfish do not have much meat but incur the same processing costs as larger dogfish. Operating costs, especially for fuel, have significantly increased, so under some conditions dogfish catch alone may not be adequate to cover fishing costs.

All-time BC dogfish landings peaked in 1942 at approximately 15,000 metric tons (DFO SAR 2010-057). As of 2011, total allowable catch was 2000 metric tons for the inside stock and 12,000 tons for the outside stock (MSC, 2011), and has ranged from about 14,000 to 18,000 metric tons total for the past several decades, though fishermen have never come close to catching the total allowable catch. Landings for the modern fishery (i.e., since the 1970s) peaked at approximately 5800 metric tons (for both stocks) in 2003, with a landed value of \$5.1 million CAD (Figure 2). Exports peaked at 3800 metric tons worth \$13.1 million, also in 2003. Landings and exports have been near zero since 2014.

3.1.2 | Markets for BC dogfish: “Fishermen are entrepreneurs, if it's possible to make money on something they'll do it”

North Pacific spiny dogfish caught in BC were processed in industrial fish processing plants in BC and in the Northwestern United States, and interviews suggest that various parts of the fish were distributed for a remarkable number of uses in a variety of distinct markets (See Supporting information).

In addition, BC Department of Agriculture statistics note that varying quantities of BC-caught dogfish were also exported to numerous other countries not mentioned by interviewed fishermen. Shark livers were exported to the Netherlands, the UAE, South Korea, France, the United States of America, Singapore, Thailand, India, Kazakhstan, Belgium, North Korea, Greece and Italy. The offal was also exported to South Korea, the USA, Italy and France. Fillets were also sent to South Africa and the United States.

Interestingly, there has never been a domestic commercial market for dogfish meat in BC (King *et al.*, 2017). One seafood market owner told the authors he was pretty sure that no Canadian has ever eaten shark meat (though with the caveat that, as discussed in Supporting information, there are long-standing Indigenous fisheries for dogfish). One interviewee involved in sustainable seafood management reported that 80% of the seafood catch in BC is exported, and that 90% of the seafood consumed in BC is imported, and that although at one time a local market had expressed interest in selling dogfish belly flaps, it “*may have disappeared*” since.

Many of the markets that became available to dogfish products in both Canada and the United States resulted from collapses of European spiny dogfish populations and fisheries in the Northeast Atlantic Ocean (see Supporting information). European markets and demand for dogfish continue, and US East Coast spiny dogfish (*S. acanthias*) fisheries are thriving (see Supporting information).

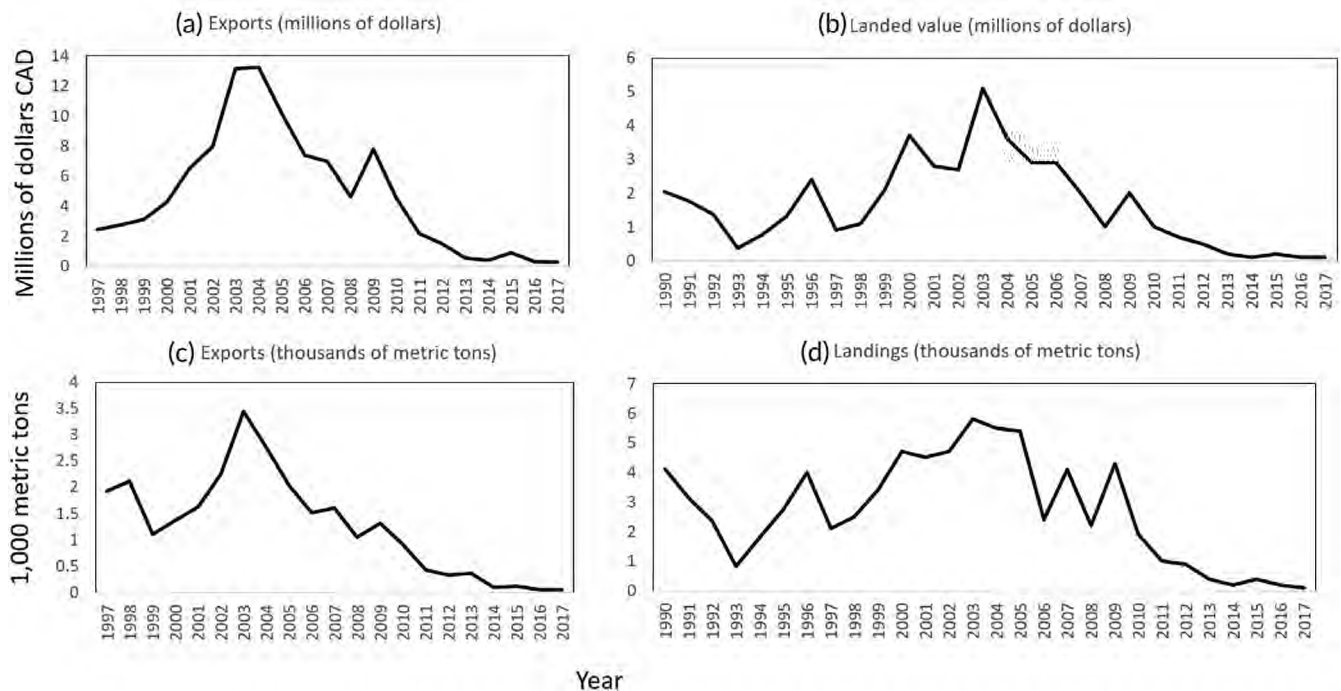


FIGURE 2 Exports and landings data for the BC Dogfish Fishery from 1997 to 2017, data courtesy of British Columbia Ministry of Agriculture

Several interview subjects suggested that US East Coast dogfish became more desirable than BC Dogfish in valuable European markets due to a combination of higher catch volume and shorter shipping routes and lower shipping costs, which may have allowed the Atlantic fishery to outcompete the Pacific fishery in these markets (see Supporting information). Atlantic spiny dogfish are also targeted by commercial fisheries on the Canadian east coast, with the majority of landings occurring within the Bay of Fundy and off southwest Nova Scotia and Halifax (Personal Communication, Fisheries and Oceans Canada, 2007; Wallace *et al.*, 2009) (see Supporting information). Pacific spiny dogfish have also been targeted in US West Coast fisheries based in Washington, Oregon and northern California, though these fisheries followed the boom-bust pattern of many industrialized shark fisheries in the 20th century (Musick *et al.*, 2000, see Supporting information).

3.1.3 | “The fishery manages itself, we have these cameras running all the time,” management requirements of the BC-integrated groundfish fishery

The BC-integrated groundfish management plan, as of 2006, includes 100% at-sea monitoring and 100% dockside monitoring (MSC, 2011). Two interviewed fishermen demonstrated the high-tech monitoring system for their fishery, which involves HD video recordings of all catch integrated with an electronic tablet, to the authors. Fishermen repeatedly spoke of this monitoring system and associated management with evident pride, with one pointing out “we’re doing a good

job...we’ve never exceeded an annual quota since integration” and another describing the integrated fishery as “one of the best managed fisheries in the world.”

Although most interviewees expressed positive views of integration, these feelings are not universal (see Figure 3), with some fishers expressing frustration with limited quotas and environmental conservationists pushing for additional regulation or marine protected areas; one opined, “They’re turning as much of the coast as possible into an aquarium.” A processor observed, “I don’t know anyone who’s happy with the management regime, personally,” and another interviewee noted, “(i)t’s a thankless job, to manage a fishery...communities may hold fifty-year grudges.” In addition, integration led to consolidation of previously small independent fishing vessels and companies and processing houses, and the relatively positive view the authors encountered of the process may be biased because those driven out of the fishery a decade before this study were not interviewed here.

3.1.4 | “MSC certification and withdrawal”

In 2010, the British Columbia Dogfish Hook and Line Industry Association requested that the BC spiny dogfish fishery be evaluated for possible certification by the MSC. The certification process requires the fishery to pay for an independent audit focusing on the sustainability of the targeted stock, impacts on non-target species and the ecosystem itself and an evaluation of management. In 2011, certification was granted (MSC, 2011), with the fishery scoring over 80% in each of MSC’s principal areas. Notably, the lead author of the

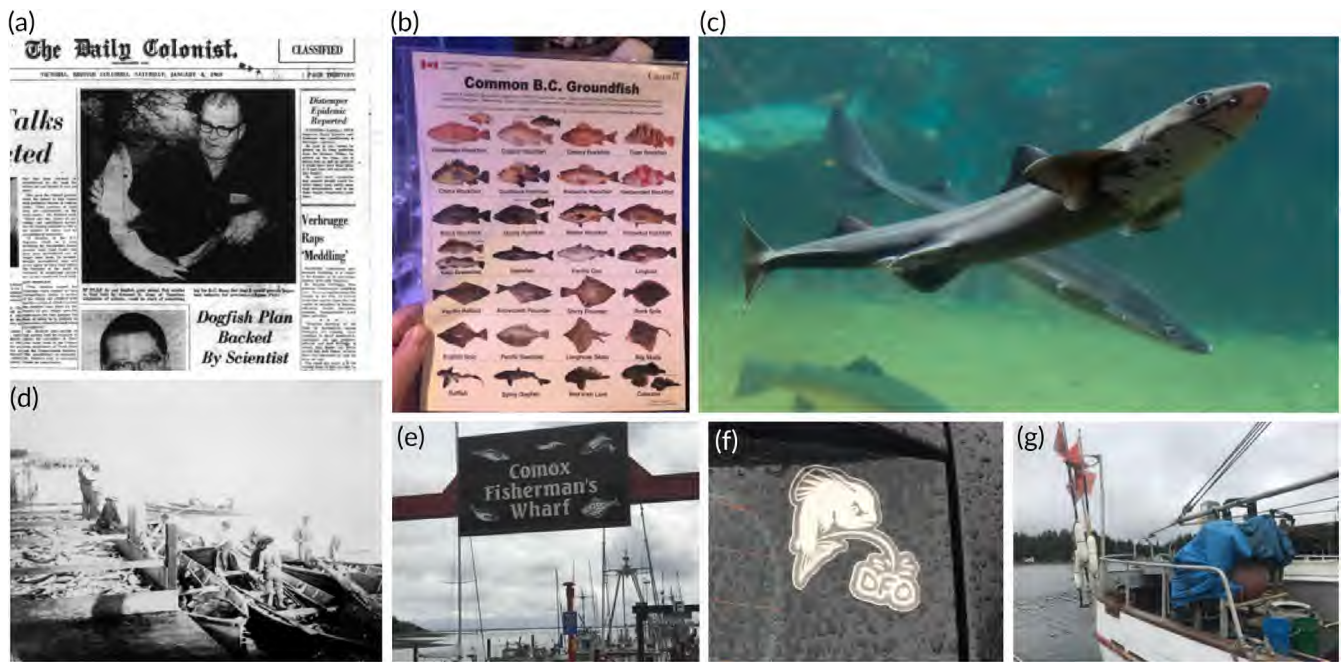


FIGURE 3 Images associated with the fishery and this project. (a) The cover of the 4 January 1969 edition of the *Daily Colonist*, Vancouver Island's largest newspaper, showing a spiny dogfish and the headline “dogfish plan backed by scientist.” (b) This photo shows a well-worn fishermen's copy of a local species identification guide, with dogfish on the bottom row. Photo by the author D.S.S. with permission of the fisherman. (c) A photo of Pacific spiny dogfish, courtesy Seattle Aquarium. (d) Photo from BC Royal Museum archives of fishermen at Esquimalt unloading a haul of dogfish, c. 1900. (e) A photo by the author D.S.S. of one of the interview sites, the Comox Fishermen's Wharf, showing high-value species like salmon and halibut on the signage. (f) A photo by the author D.S.S. of a bumper sticker in the parking lot of Comox Fishermen's Wharf demonstrating that not all fishers approve of DFO's management. (g) One of the fishing vessels most heavily involved in dogfish fishing, showing the longline (spooled and partially covered by a blue tarp). Photo by the author D.S.S. with permission of the fishermen

certification report was Dr. Jack Musick, a distinguished fellow of the American Elasmobranch Society and one of the world's leading experts in the biology and management of chondrichthyan fishes. The certified fishery included 24 fishing vessels based throughout coastal BC, concentrated along Vancouver Island's west coast. The fishery voluntarily withdrew its MSC certification in 2014 with no explanation provided.

3.2 | What happened to the fishery?

Different stakeholders proposed a variety of explanations for the cessation of the BC spiny dogfish fishery, which are outlined below. It should be noted that only one interviewee stakeholder expressed a belief that there was any chance that the fishery wasn't really biologically sustainable, and no one reported that the fishery's closure was due to a biomass collapse.

3.2.1 | Market shifts. “Are folks willing to eat it?”

The existence of certified sustainable Atlantic-caught dogfish makes it hard for Pacific sources to compete in European markets, given reduced shipping costs from Atlantic Canada and the USA to Europe

compared with BC. In addition, some fishers raised the possibility that demand had shifted or declined, but other analysed data suggested that this is not the case elsewhere in the world; indeed other commercial dogfish fisheries are thriving.

Nonetheless, many interviewees came back to the issue of economic demand for dogfish and the existence of available markets for it as central to the disappearance of the fishery, with one interviewee pointing out “making something sustainable doesn't mean you have a market.” A manager noted, “There aren't fisheries-side barriers to a successful fishery” but that “by themselves dogfish could not have a sustained fishery” because of their low value. Another interviewee described ITQ fisheries management as already “leaving more palatable fish than dogfish in the water.” A former processor reported, “If there was a market for it people would still be fishing...there's no market for it anymore.”

3.2.2 | The blob: did stock availability move/change?

Several interview subjects mentioned a temporary decline in locally available dogfish associated with “the blob,” a destructive patch of warm water that affected the entire ecosystem by causing a variety of marine animals to either die or temporarily relocate (Yang *et al.*, 2018),

noting that local dogfish abundance has since recovered. To make an initial, informal assessment of this hypothesis, the authors classified spiny dogfish catches in International Pacific Halibut Commission (IPHC) trawl survey data by region: Southern Alaska (IPHC region 3A), BC (IPHC region 2B) and US West Coast (IPHC area 2A). These catches were summarized as the annual mean number of dogfish captured per tow for the years 1999–2018 and plotted by year. These plots showed that Southern Alaska and BC survey catches followed similar general trends from 2003 to 2014, after which catches in Southern Alaska showed considerable increases from 2015 to 2017, whereas catches declined in BC. This trend was also seen in the US West Coast region, where catches had been steadily increasing since 2010 and showed a dramatic increase in 2018. Although catches in British Columbia were always at least double those in Southern Alaska and the US West Coast, the fact that declines in BC from 2015 to 2017 coincided with noteworthy increases in the two US regions during this same time frame is suggestive. Changing oceanographic conditions resulting from climate change have already been documented as causing range shifts in marine species and are especially likely to affect the distribution of highly migratory species such as spiny dogfish and other sharks (Hare *et al.*, 2016; Nye *et al.*, 2009). Associations of Pacific spiny dogfish distribution with environmental conditions and large-scale climatic events such as El Niño/La Niña and “the blob” warrant further study. Although there does seem to have been a short-term shift in biomass that may have caused temporary disruption to this fishery, this alone would not have caused the cessation in fishing. In contrast to these results, at least one fisher reported that the fishery stopped because catches of dogfish locally had fallen when biomass moved “suddenly” rather than being caused by declines in demand or price, and that the disappearance of the fishery was related to the reduced availability of dogfish, noting that they would retain them if they started showing up again in large numbers (Figure 4).

3.2.3 | Did management changes alter fishing incentives? “It took small fishermen off the water”

BC fisheries switched from species-specific quotas (some fishermen targeted halibut, some targeted dogfish, *etc.*) to an integrated groundfish fisheries management plan with ITQ in 2009. This provided several benefits, especially from a conservation and management perspective – fishermen who catch any managed fish species are now permitted to sell it, which would not be the case if they only had a permit for another species, leading to reduced wastage of valuable by-catch. In addition, although the ITQ system and integration meant that former halibut fishermen were now able to catch and sell dogfish, it also meant that dogfish fishermen could catch and sell more valuable halibut. One fisher said he thought integration might have helped keep the dogfish fishery operating longer because of access to more valuable by-catch.

Several interviewed stakeholders noted that integration, while less wasteful (by allowing fishers to sell what they catch regardless of

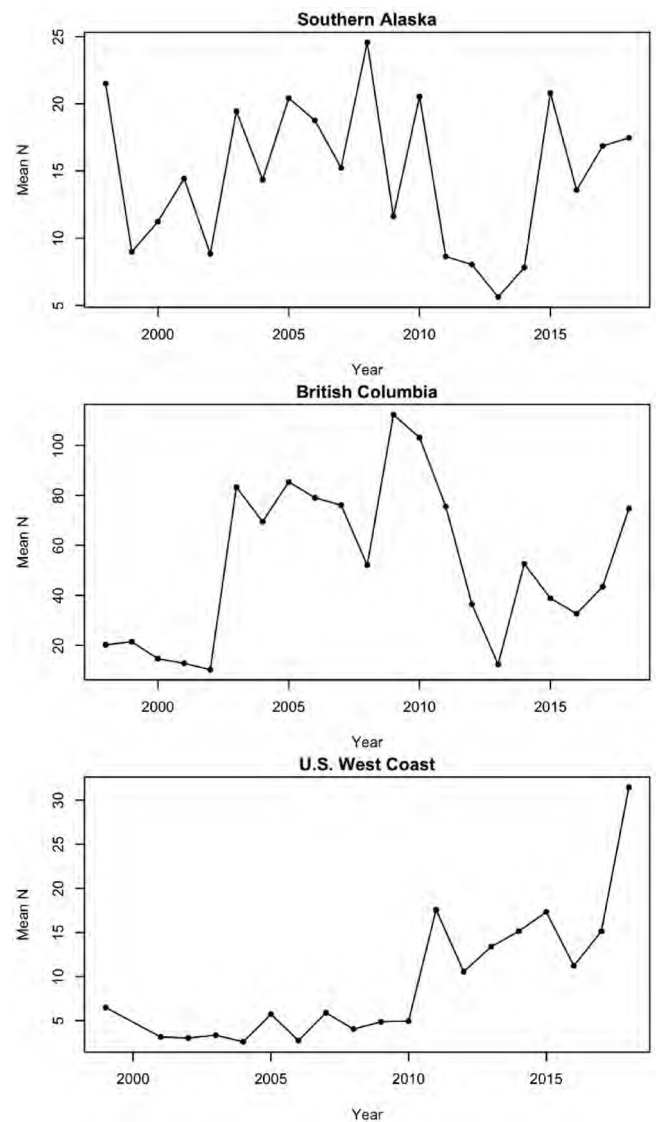


FIGURE 4 Dogfish catch in 3 regions of interest, Data courtesy International Pacific Halibut Commission

species), had a variety of potentially negative socio-economic effects. A fisher’s union representative reported that because quota is expensive under integration, it has led to consolidation by larger fishing companies, squeezing out smaller owner-operators. A government manager noted that integration was generally a better deal for fishers targeting higher-value species like halibut than those targeting lower-value species like dogfish, because it is cheaper for the relatively profitable halibut fishery to buy extra dogfish quota than *vice versa*. The cost of conforming to new reporting regulations was significant, and several interviewees noted that small operators targeting lower-value fish like dogfish were the most likely to leave the industry because they were unable to meet regulatory costs.

Because quota is expensive to purchase, this ITQ system led to the rise of investors owning quota rather than fishermen. In 1991, owner-operator fishing captains caught 90% of halibut, but by 2016 this group owned just 15% of the available halibut quota (Edwards & Pinkerton, 2019). One former dogfish fisher said that 85%

of his profits went to the quota owner, who was “*not doing any of the work, just sitting on a beach somewhere getting rich.*” The idea that ITQ systems favour larger commercial operators (and associated consolidation) has been noted before (Amigo-Dobaño *et al.*, 2012). Fishermen in other fisheries switching to ITQ systems object to the fairness of quota distribution, the size of quota distribution and the associated administrative burden (Knapp, 1997). Knapp (1997) also showed that the larger the quota an interviewed fisher held, the more likely he or she was to have a positive opinion of the ITQ management system. A former processor noted that smaller operators who previously targeted lower-value fish like dogfish were likely to get squeezed out of the fishery by larger boats targeting higher-value fish like halibut, and that he has seen a general trend in this direction since integration.

Integration also resulted in improved relations between stakeholders and managers; DFO was described by one fisher as “*pretty great to work with.*” An interviewed environmentalist noted that it was pleasant working with BC fishers, saying “*there’s a lot of common ground, because a fishery is the output of a healthy productive ecosystem.*” BC fishermen mentioned their general confidence in the science behind management decisions and their belief that the regulations they obeyed were clear (if sometimes expensive to fully comply with). Even where frustration with management existed, fishers acknowledged that the ITQ system had enhanced fisheries sustainability, with one describing more wasteful pre-integration fisheries by saying “*it got as stupid as it could get.*” This has not necessarily been the norm in other fisheries; for instance, in a survey of fishermen targeting groundfish in New England, only 7% of fishermen believed the science in support of regulations was accurate, and 82% reported they felt regulations were unclear (Holland & Wiersma, 2010). Relationships between managers and fishers are often adversarial, and although there have been calls for management strategies which include fishers in the process and emphasize co-management techniques while also protecting marine resources, successful examples of such management regimes are relatively rare (Kaplan & McCay, 2004).

It should be noted, however, that if a bumper sticker observed by the authors in the parking lot of a marina is any indication (Figure 3), positive relations between fishers and managers are not universal. One processor noted the “*overwhelming cost of regulations*” and said the “*odds are stacked up against the small operator,*” describing big business, big government and big labour as arrayed against small businesses. Another fishermen referred the authors to the Great Big Sea song “*fishermen’s lament,*” which is, to the authors’ knowledge, the only song in history written by a band with multiple platinum-selling albums to be explicitly about fisheries management overreach. One manager told them he “*had not heard*” about consolidation in the industry as a result of integration, though almost every other stakeholder mentioned it as significant to varying degrees.

There was broad agreement across most interviewed stakeholders that the shift to an ITQ system had offered management and conservation benefits, with one fisher noting that “*equally distributed poverty*” was the alternative, and a manager observing: “*I think fishermen are totally on board...because the alternative is not fishing.*”

3.2.4 | Did the cost or availability of processing change? “*Processing fish is as different as the fish themselves*”

Interview subjects noted that processing landed dogfish requires specialized tools and training, requiring careful treatment to release urea from the dogfish’s blood, and noted that the rough skin is particularly damaging to knives (for removing meat) and grinders (for turning the offal and remains into fertilizer). In addition, the multiple uses of different parts of the dogfish required extremely specialized processing tools, and dogfish need to be fileted and skinned rather than being “*J-cut*” as many teleost fish are. Processing dogfish required at least 15 highly skilled people, and interviewees mentioned the need for “*economies of scale*” in processing, as a dogfish processing line was highly specialized. In some cases, processing dogfish was a secondary business for processors in much the same way it could be for fishers, with dogfish “*helping keep the doors open during the salmon off-season.*” In the early days of the modern fishery, processing primarily took place in two facilities in BC, one in Delta (outside Vancouver) and one in Port Hardy (MSC, 2011). A fisheries manager reported that a processing plant in Bellingham, Washington, just over the US border from BC, also used to receive and process BC dogfish, which helped keep labour costs low as processors in the United States are paid less. Another pointed to the importance of immigrants in staffing processing plants in Canada, and the key role of skilled labour availability in supporting the fishery. A fishermen’s union representative complained that recent economic trends have resulted in consolidation of processing houses. He noted that there used to be many small independent fish processors including some that could specialize in dogfish, but now a handful of large companies own them all – making the entire fishery vulnerable to a few companies choosing not to process dogfish anymore.

One company, Canfisco (Canadian Fish Company), shut down the main dogfish processing line in Port Hardy immediately after purchasing that processing house, according to a former employee of that processor. A Canfisco representative told the authors that after they purchased that processor, they assessed the profitability of dogfish processing, concluded that the need for multiple markets and complexity of processing made it difficult to make an adequate level of profit and decided to close the dogfish line and reinvest in higher-value, simpler-to-process species like halibut and other groundfish. Multiple interviewees pointed to processing capacity as a need that would have to be met for the fishery to successfully resume.

3.2.5 | Impacts of whaling? “*We may never see herring like that again*”

One interviewed fisherman, who had a college degree in marine biology and used technical ecological terms when speaking with the authors, proposed an interesting hypothesis. He suggested that historical whaling had collapsed whale populations, leading to a predation release of Pacific herring (*Clupea pallasii*), which is notably an important prey species for both whales and dogfish. This may have

led to a temporary alternative stable state of unusually high dogfish numbers, which was driven back down to normal when whales recovered and started eating more herring. The fisherman noted that he had no evidence for this but had thought about it for years.

3.2.6 | Certifying too early before eco-certifications caught on: “Like driving a Cadillac while being paid to drive a Volkswagen”

The quote here referenced a concern that it costs more to fish sustainably, but at the time of certification fishermen were not receiving a premium price for their more-expensive sustainable product. Millennials care about eco-certification more now than they did 10 years ago, according to an MSC representative interviewed, and sustainability is a more powerful marketing tool now than even a few years ago. Oceanwise, a Vancouver-based sustainable seafood organization that is widely used and respected in Canada, decided not to recommend the BC spiny dogfish fishery in 2011. Nonetheless, the authors were informed that the same fishery would count as sustainable under current Oceanwise guidelines if assessed today, as Oceanwise standards have since changed. The stated goal of Oceanwise was to promote sustainable small-scale Canadian fisheries that were not well represented in the recommendations of SeafoodWatch, a larger organization that focuses on the most common seafood items available in the United States.

An Oceanwise representative thought that there could be a good market for dogfish as a novelty item like a special on a menu, specifically mentioning grilled dogfish tacos. The Oceanwise representative also noted that most North Americans do not think of sharks as food, but also that most Canadians do not realize that dogfish is shark.

The literature suggests that consumers will (and do) pay a premium for eco-labelled seafood products (Maesano *et al.*, 2020), but that this may not translate to fishers receiving premium prices for their catch (Blomquist *et al.*, 2015). The cost of certification, especially in a low-value fishery, may not deliver much of a return – as one interviewee put it, “(Certifications) are really expensive – artisanal fisheries get squashed.” Another told the authors “no one speaks about it anymore...it’s a black hole.” Although there wasn’t clear agreement on whether the certification would have offered more benefits to the fishery if it had been undertaken later, one interviewee from a non-governmental organization (NGO) pointed out that certifications may offer market access but not a premium price for a product that is not in demand, asking whether certifying agencies and NGOs are responsible for creating the market for more sustainable products.

3.2.7 | Public misunderstanding of key environmental issues: “Collateral damage to the shark finning campaigns”

One possible explanation that several interview subjects proposed (and others dismissed) was that pressure from the environmental

community to stop unsustainable shark fishing (including but not limited to shark finning) affected public perceptions of sustainable shark fisheries like the BC Pacific spiny dogfish fishery, possibly leading to market shifts in Europe. These perceptions may also have contributed to pressure being placed on grocery stores and shipping lines to not carry shark products of any kind—Dent and Clarke (2015) reported declines in shark fin imports that was attributed to public advocacy campaigns by some NGOs.

One manager reported that he had heard his stakeholders reference this controversy, whereas the MSC reported that overly broadly framed shark conservation campaigns had affected some other potential sustainability certifications for sharks. The MSC representatives the authors spoke to reported that one shipping firm would not transport the products of a certified sustainable shark fishery because of pressure from environmentalists who incorrectly claimed that all shark fishing was inherently unsustainable, and some grocery stores faced similar pressures about carrying shark products. Another interviewee noted that he thought concerns about this may be true “to an extent” based on difficulties with market penetration of Atlantic dogfish fisheries in the US and Canadian markets as a result of conservation concerns and efforts from NGOs to prevent trade in sharks.

One fisher noted that despite markets being international, they had received confusing pushback from a local environmentalist with respect to shark finning, which has been illegal in Canada since the 1990s. “People said we shouldn’t be doing that (shark finning) here... well, we’re not,” the fisher reported. Another interview subject asked if people want sustainable shark fisheries or no shark fisheries at all, and said that the answer to that question would affect the future of many fisheries. Several interviewees expressed opposition to added conservation policies, with one fisher observing: “we don’t feel ENGOs have much to teach us about managing our fisheries here.”

Large-scale public misunderstanding of what shark finning means (and does not mean), as well as large-scale public misunderstanding about the sustainability of shark fisheries in general, has been reported in the ocean conservation literature (Shiffman & Hammerschlag, 2016; Shiffman *et al.*, 2021). Some interview subjects in this study suggested that such misunderstanding may have contributed to the closure of a sustainable fishery via shifting demand and putting public pressure on supply chains, though the authors note that demand remains high in much of the world. An interviewed fisheries manager also noted that a proposal to list Atlantic spiny dogfish *S. acanthias* on appendix II of CITES resulted in some concerns among BC fishermen at the time as it might have made exporting product more complicated, but the measure did not pass.

Several informants reported scepticism towards this argument, with one manager reporting that this angle “does not ring true” given perceptions of dogfish in BC, including a lack of knowledge that dogfish are sharks. A fisher noted that he did not think public attitudes about protecting sharks were relevant to the lack of market demand for dogfish, noting that “they’re not a beloved species” and in his view “there’s not a lot of sympathy there.” An environmental non-profit representative the authors spoke to does not feel that pressure from other non-profits played a role in the issues facing the BC spiny

dogfish fishery, and a former processor said he had never heard this argument expressed by the fishers he used to work with.

3.2.8 | Could the fishery start again? “From a fishing perspective, there's no barrier, they're there,” a fisher told the authors.

Many interviewed stakeholders expressed the idea that the fishery could restart, and several interviewed stakeholders said they thought this was already starting to happen. All noted that restarting the fishery would require a dedicated production line at a processing facility and reliable consistent demand for dogfish products, which may not be likely without some kind of directed outside intervention. One noted that dogfish could absolutely support a small but minimally profitable (compared to halibut and salmon) operation, noting “*in a small community, twenty jobs is a big deal,*” and that there'd be enough money from selling dogfish to keep people employed if not to get rich off of. Another NGO employee interviewed noted that fishing is “*almost irrelevant*” economically in these communities, saying “*no one would think of this as a fishing community*” anymore. Another noted that restarting the fishery would help other fisheries by keeping dogfish numbers down, preventing them from interfering with catch of other species.

One thing is clear from the interviews – the dogfish are there, the fishermen are catching them (but currently throwing them back) and thriving markets for dogfish products exist around the world.

4 | CONCLUSIONS

The BC spiny dogfish fishery was the first eco-certified sustainable shark fishery anywhere in the world, and despite the (possibly temporary) closure, there was little doubt expressed by interviewed experts that the fishery was indeed biologically sustainable. So what happened to it?

This appears to be a rare case of a fishery shutting down without a biomass collapse, government intervention due to by-catch issues or habitat destruction, or a reduction in demand. It appears to be a “*death by a thousand cuts*” situation. Temporarily fluctuating supply resulting from “*the blob,*” changing economic incentives due to integration of the groundfish fishery, potential confusion caused by broad environmental advocacy campaigns and bad timing with respect to market trends for eco-certified products and novelty seafood products all could have played a role in Canfisco's decision to close the main dogfish processing house, which seems to have been the key reason the fishery ceased even limited operations. With no processor and wholesaler to buy, process and redistribute dogfish, there was no point in fishermen landing them, even if market demand remained strong and supply was as high as ever.

This study is an interesting data point in an ongoing discussion about sustainable shark fisheries and their role in the global conservation and management of this taxon. This fishery illustrated for the first

time that for abundant species, fisheries exploitation can be sustainable enough to meet the standards of an MSC certification. The results demonstrate that management is complicated, with many intersecting factors contributing to the success or failure of a fishery, especially one with low profit margins. This fishery was shaped by the complexity of global supply chains, with products from one fish being sent to independent markets on different continents. Respondents made clear that introducing an ITQ system may have many benefits, but also has potential socio-economic costs that should be considered, and it provides further evidence that the consolidation that follows increasing quota or operations costs may result in reduced diversity of fisheries. Processor consolidation, appearing here as a large company choosing to focus on maximizing profit, has greatly increased impacts when a few companies own most of the fisheries or processors in a region. Ecological and oceanographic conditions like the blob resulted in temporary shifts in biomass that disrupted catch, whereas public misunderstanding may have disrupted market demand.

As one fisher shruggingly observed in response to the questions, “*I've heard a little bit of all those things.*” Another interview subject, talking about fisheries management, told with a sigh: “*It's never as easy as it looks...it's all connected*”.

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SUPPORTING INFORMATION

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