A Policy Evaluation considering the Pacific Salmon Treaty's Impacts on the Southeast Alaska Chinook Salmon Commercial Troll Fishery

Carina Nichols

April 2021

Advised by: Dr. Grant Murray

Masters Project submitted in partial fulfillment of requirements
for the Master of Environmental Management Degree
Nicholas School of the Environment
Duke University

Table of Contents

1 Executive Summary

Conflicts regarding salmon harvest and conservation have been intensified by the highly migratory nature of the species often moving between the Pacific Northwest, British Columbia, and Alaska. Pacific salmon stocks migrate across international boundaries to rear and mature before returning to their river of origin to spawn. Consequently, salmon that spawned in the rivers of one country are subject to interceptions in another country. Negotiated in 1985 between Canada and the U.S., the Pacific Salmon Treaty represents decades of effort toward collaborative management to prevent overfishing and to provide for the optimum production and fair allocation of salmon harvest for Pacific salmon fisheries.

This report broadly seeks to understand the impacts international fishery agreements have had on small-scale, community-based fisheries through a case study evaluating the Pacific Salmon Treaty's impacts on the Southeast Alaska commercial Chinook salmon troll fishery over time. The Southeast Alaska Chinook salmon commercial troll fishery was selected due to its dependence on Chinook salmon as a substantial component of its harvest, as along with the small boat characteristics of the fishery. Chinook salmon negotiations within the Pacific Salmon Treaty have been a chronic source of tension within negotiations, and the impacts of negotiations for the Southeast Alaska Chinook salmon commercial troll fishery have resulted in dramatic reductions in harvest opportunity. Reductions in harvest have not been offset by increased consumer demand and fish prices, although these have increased over time. Domestic rivalry is apparent between Alaska and the southern U.S., and Endangered Species Act listings have further complicated negotiations and U.S. Section relations.

The report concludes with policy conclusions and recommendations intended to improve salmon management and impacts to affected stakeholders. Concluding that management actions beyond fishery harvest controls will likely be necessary to support healthy salmon populations, consideration of approaches to salmon conservation outside of Pacific Salmon Treaty jurisdiction is recommended. Recommendations also include improved process transparency, the development of a framework to evaluate long-term impacts to stakeholders resulting from management decisions, and increased accountability to maintain habitat responsibly and for the benefit of all.

2 Introduction

As economic and social drivers across Alaska and the Pacific Northwest, commercial salmon fisheries generate income and define social relationships or identity for many communities (Gislason and Lam 2017). A renewable resource, salmon are highly migratory and their management is unavoidably complex[1]. Pacific salmon migrate between boundaries of the U. S. and Canada, as well as offshore to international waters. Known as anadromous, salmon spawn in fresh water, migrate to the sea as juveniles, and then disperse into the ocean for much of their adult lives to mature. After several years at sea salmon return to their natal river to spawn and complete their life cycle (National Park Service, 2019)[2]. Adapted to the specific river systems they have evolved in; salmon populations are made up of localized stocks that are genetically and morphologically distinct (Johnson et al. 2019). This makes each stock's survival susceptible to cumulative impacts within a river system, in addition to ocean conditions and fishery harvest.

The decline of wild Chinook salmon abundance is well known and has been a topic of intense scrutiny when compared with other fisheries issues (Montgomery, 2004; Lackey, 2003). If declines in wild salmon abundance continue, socioeconomic and ecological consequences can be expected. As a result, efforts to adapt fishery management to support sustainable stocks of salmon have received increased attention.

International agreements, such as treaties, are an important part of fisheries management and affect many stakeholders, including the resource itself. A "treaty" is defined as an international agreement concluded between "States" in written form and governed by international law (Vienna Convention on the Law of Treaties, 1969). As a result of significant shared boundaries, resources and management challenges, the U.S. and Canada have established multiple agreements and treaties to ensure collaboration and sustainable management of resources. Pacific salmon's nomadic nature, along with border lines drawn without regard for salmon habitat, creates futility in Canada or the U.S. attempting to manage salmon alone (Appendix A).

Shifting and/or declining ocean conditions, along with unsustainable harvest of marine resources, have been recognized as significant contributors to environmental and socioeconomic problems

[1] Salmon are considered to be a renewable resource because they are capable of self-reproduction.
[2] Chinook salmon live at sea for 2-5 years.

worldwide (Worm, 2009). When this leads to depleted fisheries, it illuminates the difficulty in balancing management measures with available science, social and economic concerns. The Pew Oceans Commission recommended a fishery policy that "should conserve and manage fisheries in order to support diversity, flexibility, resilience, and adaptability within the industry and fishing communities" (2003). Additionally, the U.S. Commission on Ocean Policy suggests that more information on the socioeconomic and political influences on fisheries decision-making is necessary to reform the management system (2004). The Magnuson-Stevens Fishery Conservation and Management Act (MSA) and the National Environmental Policy Act (NEPA) require the integration of social considerations into the decision-making process when considering many actions, including management measures in federally-managed U.S. fisheries (National Oceanic & Atmospheric Administration (NOAA) Office of Sustainable Fisheries). A common theme is the need for increased integration and understanding of policy impacts on fishery resilience and socioeconomic factors in management. No similar requirement exists when considering international fisheries treaties outcomes to evaluate for rebuilding stocks or ensuring fishing opportunities and economic benefits are provided[3].

Chinook salmon, *Oncorhynchus tshawytscha,* are highly valued for their cultural, nutritional, ecosystem, and market value and have proved to be particularly challenging for negotiators of the PST (Congressional Research Service, 2009). Negotiation challenges have evolved as increased conservation efforts in Washington, Oregon and Idaho have become necessary due to multiple Chinook salmon stocks being listed as endangered under the ESA[4].

2.1 Concepts Utilized by the PST

The Pacific Salmon Treaty (PST) was signed on January 28, 1985 by the U.S. and Canada in an effort to end years of conflict and, at times, overharvest of Pacific salmon migrating between Alaska, British Columbia, Washington and Oregon (Pacific Salmon Commission). The PST was established under the following principles:

[3] In this case, the PST is subject to a Section 7 consultation under the Endangered Species Act because some stocks under the Treaty's jurisdiction are endangered or threatened. This consultation is not required by the PST itself, instead being required under domestic ESA laws after the Treaty has been negotiated.
[4] Chinook salmon management can be found in Chapter 3 of the Pacific Salmon Treaty

1. *With respect to stocks subject to this Treaty, each Party shall conduct its fisheries and its salmon enhancement programs so as to:*
    a. *prevent overfishing and provide for optimum production; and*
    b. *provide for each Party to* receive benefits *equivalent to the production of salmon originating in its waters"*
2. *In fulfilling their obligations pursuant to paragraph 1, the Parties shall cooperate in management, research and enhancement.*
3. *In fulfilling their obligations pursuant to paragraph 1, the Parties shall take into account:*
    a. *The desirability in most cases of reducing interceptions;*
    b. *The desirability in most cases of avoiding undue disruption of existing fisheries; and*
    c. *Annual variations in abundance of the stocks.*[5]

Facilitated by the Pacific Salmon Commission (PSC), there are several key concepts at play within the PST, including that of conservation: the concept of conservation policy is often defined by numeric limits in the harvest of individual fish for salmon stocks. Known as harvest limits or ceilings, these numbers are typically set on an annual basis to reflect abundance modelling efforts. Conservation policy is also accomplished through management measures limiting fishing effort. Fishery management measures can include gear restrictions such as reducing the number of allowable lines (trolling) and mesh size (gillnet), harvest timing, and fishing area restrictions.

As a classic example of tragedy of the commons, neither the U.S. nor Canada can optimally harvest fish originating from their waters without incidentally harvesting salmon originating from the other country. Referred to as interceptions, ensuring equity with regard to interceptions has proved to be problematic for both countries. It is not possible to completely eliminate fish of various origins from harvest in other fisheries (Pacific Salmon Commission). It is important to note that the first PST principle promotes conservation and optimum production of salmon stocks, while the second is aimed at addressing fishery interceptions. The PST provides direction

[5] PST, Article III: Principles

for Parties to also take into account the desirability of reducing interceptions, the desirability of avoiding disruption of existing fisheries, and annual variations in stock abundance. These considerations are somewhat at odds with one another, as many fisheries under the jurisdiction of the PST, including Alaska's commercial Chinook salmon troll fishery, have historically relied on interceptions to make up a portion of their harvest.

When the PST was originally signed in 1985, both countries agreed to establish a "baseline" harvest level, intended to reflect the low stock levels of Chinook salmon at that time and provide harvest comparison for future years. The years 1979-1982 were selected to form the baseline, and the goal was to increase the abundance of salmon, coast wide, in relation to this number for harvest through short-term harvest reductions referred to as fixed harvest ceilings. Fixed harvest ceilings were specific harvest limits on salmon harvest that came to be perceived as the right to catch "their" historic number of fish by various stakeholders (Miller, 2003). Over time, fishery managers found that the ceiling approach to harvest was problematic due to its lack of flexibility: in years of low abundance harvest was too high and in years of high abundance, harvest was too low (CRS, 2009).

A characteristic of Chinook salmon abundance is that it fluctuates in cycles that are related to ocean conditions (Beamish et al, 1995, Irvine and Fukuwaka, 2011). Prior to 1999 both countries relied on short-term, fixed ceiling-based fishery regimes for harvest management that were not sustainable. Negotiators introduced and applied a new approach in the 1999 Treaty agreement that linked harvest to abundance for mixed stock fisheries.

The PST language providing for each Party to receive benefits equivalent to the production of salmon originating in its waters has led to Chinook salmon being managed in consideration of the mixed stock fisheries that intercept them. The baseline established an average harvest of Chinook during the years leading up to the PST's establishment as 322,011 and the corresponding baseline abundance value was assigned to be represented as 1.0 at this number of fish. Known as Aggregate Abundance Based Management (AABM) fisheries, Chinook harvest opportunity was determined using abundance indices (1.0, 1.5, 2.0) to represent coast wide stock

trends over time for these fisheries from 1999-2018[6]. Beginning in the 2019, SEAK shifted its management approach to a tiered model that is based on empirical data collected in the SEAK commercial troll fishery to set harvest limits[7]. AABM fisheries harvest salmon to a fixed harvest limit based on a pre-season model using forecasted returns. This means that AABM fisheries have no flexibility to adjust harvest limits in-season should the observed abundance for a return be higher than was forecast.

Alternatively, a very different approach was taken for fisheries where harvest is occurring near or in the river salmon are returning to. Known as Individual Stock Based Management (ISBM) fisheries, participants in these fisheries may continue to harvest Chinook without an abundance index-based harvest ceiling, as long as the river's escapement goals and general PST obligations are being met[8]. This approach was selected because managers felt that they could control stock selectivity for ISBM harvest in a way that is not possible in the AABM fisheries, whose harvested salmon are diverse in origin. The SEAK AABM fishery is the only AABM fishery that does not have an ISBM fishery component for the management of inshore waters. Additionally, Chinook salmon returns in excess of a river's escapement goal are considered to originate from, and be a benefit for, that country since salmon harvested are in ISBM fisheries are returning to their river of origin to spawn. This approach provides for increased in-season management flexibility, and approximately 2/3 of Chinook salmon catch occurs in ISBM fisheries (Appendix B).

While the PST was designed to share the burden of conservation and available harvest, in practice the impacts vary among fisheries and the people who rely on them. To evaluate PST impacts in terms of benefits provided to the stakeholders who rely on it, the SEAK Chinook salmon commercial troll fishery was selected as a case study for consideration. This unique fishery was selected due to its rich history and significant dependency on Chinook salmon and the small-scale and community-based characteristics inherent in a small boat fishery. The report

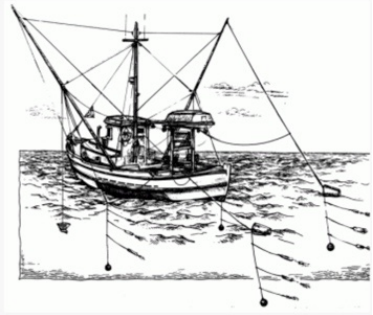
[6] There are 3 mixed stock, AABM fisheries: one is in the United States (SEAK), the other two are in Canada (Northern British Columbia and off the West Coast of Vancouver Island).
[7] British Columbia AABM fisheries did not change their approach, only SEAK
[8] Washington, Oregon and Idaho fisheries are all considered to be ISBM fisheries. There are also several ISBM fisheries in Canada. Alaska has no ISBM fisheries.

then ends with a series of policy recommendations intended to refine or improve the PST process.

3 Research Questions:

1) What events led to the PST's development and implementation, and how has the PST evolved over time?
2) How has the PST impacted small-scale fisheries, such as the SEAK Chinook salmon troll fishery with regard to benefits?
3) How could policies (overarching and within the PST) be refined to better promote salmon production and improve resource benefits for stakeholders?

3.1 Case Study Background:



Trolling is a low-impact gear type noted for its high quality of catch as each fish is individually hooked, handled and bled. As a slow and selective harvesting method, trollers use fishing lures imitating salmon prey to appeal to specific salmon species. Trollers often fish offshore for multiple days seeking areas where salmon are schooled to feed. Troll caught salmon are widely recognized as some of the highest quality and markets pay a premium price for these fish. Trollers drag lines (typically 2-6) with multiple fishing lures or bait behind them[9]. Each line is held in place with a heavy weight referred to as a 'cannon ball' as the boat moves slowly forward to draw the lures or bait through the water. Trollers have a small crew (often family members) and some captains even fish alone.

As a gear type, trolling was first developed by California sport fishermen in the 1890s (Ebbin, 2005). Trolling became possible as technological advances allowed for the use of engines instead of sails – this greatly increased the range that fishermen could travel in search of fish. The troll fishery flourished during World War I as commodities such as flax (used by gillnetters to make

[9] Historically trollers were allowed up to 8, and in some areas even 10, lines behind their boat. Decreasing the number of allowable lines is a management decision to control fishing effort.

their nets) became more costly and many gillnetters switched to a less expensive method: trolling (Lichatowich, 1999). Additionally, as fishing regulations and harvest restrictions became more stringent due to competition near the coastline and rivers among other gear types, trollers were able to travel outside of State jurisdictions and avoid these regulations. This also served as an incentive for fishermen to switch to troll gear (Taylor III, 1999). The troll fishery continued to expand until it became one of the predominant gear types from California to Alaska and was unregulated in offshore waters outside of 3 nautical miles until 1948 when the Pacific Marine Fisheries Commission was implemented (Ebbin, 2003).

Trolling is a style of hook and line fishing that has been a significant component of the SEAK economy for over 100 years. With harvest opportunities occurring year-round, the fishery targets adult feeding salmon by presenting fishing lures in the water for them to strike[10]. The commercial troll fishery is a part of the State of Alaska's limited entry program[11], using exclusiveness as a tool to overcome the challenges previously associated with Alaskan fisheries (CFEC). Southeast Alaska's troll fishery operates within State of Alaska and Federal EEZ waters east of Cape Suckling and north of Dixon Entrance (Skannes et al, 2016) (Appendix C). Salmon trolling was originally a statewide fishery, troll fishing area was reduced to only SEAK waters in 1974 (Stevens, 1986). The troll fishery is managed to regulations developed by the Alaska Board of Fisheries (BOF), the North Pacific Fishery Management Council (NPFMC), National Marine Fisheries Service (NFMS), and the Pacific Salmon Commission (PSC). The SEAK Chinook salmon fishery is managed in-season by the Alaska Department of Fish and Game (ADFG) to limit overall harvest to the annual all-gear PST allowable catch. Harvest limits were determined by the preseason abundance index (AI) that is generated by the CTC annually from 1999-2018, however SEAK's harvest limits are now managed using data collected in the Early Winter fishery. Alaska's share of the PST Chinook salmon catch is allocated among SEAK gear types in regulations established by the BOF.

[10] In terms of volume landed, Coho lead the troll fishery, followed by Chum, Chinook, Pinks and then Sockeye. In terms of ex-vessel value, Coho again lead the troll fishery, followed by Chinook, Chum, Pinks and then Sockeye. Chinook and Coho provide significantly increased revenues when compared to other species. (McDowell Report, 2019 and CFEC data)

[11] Approved by Alaska's voters in 1972, Alaska's limited entry program is overseen by the CFEC and limits the number of licenses that are issued to individual participants within a fishery or gear type.

Highly coveted by both sport anglers and the commercial troll fishery in SEAK, Chinook salmon, along with Coho and Sockeye salmon, are of higher commercial value when compared to Pink and Chum salmon (Gislason et. Al, 2017). Southeast Alaska hosts both a hand troll and power troll fishery, both of which are dependent on Chinook salmon fishing opportunity (McDowell, 2018, and CFEC data). The troll fishery is one of the largest in the State in terms of participants: 1,110 power troll and 2,254 hand troll permits exist and collectively 904 of those permits were fished in 2018 (CFEC)[12]. Alaska troll permits can be held by residents of other states, however Alaska residents in the power troll fishery contributed 85% of the harvest value in 2018.

Southeast Alaska's Chinook salmon harvest is made up of a highly mixed stock composition, approximately 75% of which originate from outside of Alaska (Gilk-Baumer et. Al, 2017). With increasing technology, stock composition estimates have become more readily available indicating there are seven Chinook salmon stock aggregates that occur most prevalently in SEAK Chinook salmon commercial troll fishery harvest (Gilk-Baumer et. Al, 2017). While increased understanding of fishery harvest has helped to refine fishery management actions, it has also set the stage for allocative battles as new information has come available.

[12] The power troll permits are more highly valued and produce a significantly higher volume of fish when compared to hand troll permits.

4 Methods

Two general approaches were used to inform this evaluation: literature review and stakeholder interviews. The literature review included legal briefs, news articles, past treaty agreements, government agency documents, and peer reviewed literature. Numerous informal meetings and conversations with stakeholders occurred to clarify information and issue comprehension. These conversations provided guidance to compile information; however, these individuals were not research subjects. Communications consisted of unstructured conversations for not more than an hour to explain information and increase comprehension of complex data.

The SEAK Chinook salmon commercial troll fishery was used as a case study to understand PST impacts on small-scale fisheries allows. Details of the economic impacts on the commercial troll fishery are from data obtained from the 2019 McDowell report, Alaska Department of Fish and Game (ADFG) data, Pacific Salmon Commission (PSC), and Commercial Fisheries Entry Commission (CFEC).

5 Findings

5.1 Part 1: Historical Developments Leading to Pacific Salmon Management

In order to understand how Pacific salmon management has evolved, one must consider events pre-PST. Non-Indian commercial fishing began on the Columbia River in the 1830s, followed by canning technologies in the 1860s. These efforts expanded rapidly, driven by what appeared to be an inexhaustible number of salmon (Blumm, 1996). However, the effects of overfishing Chinook salmon—the preferred harvest species—became apparent and management closures became necessary by 1920 (Taylor III, 1999).

It was during this timeframe that fisheries scientists began efforts to understand salmon life histories and migrations. Tagging experiments began in the 1920's and, based on these data, theories were developed that salmon travel great distances throughout their life, and that they mix with stocks from other river systems while at sea[13]. This information elevated debates regarding whose fish they were to harvest (Lichatowich, 1999).

5.2 International Management Efforts

In 1937 the U.S. and Canada's original international treaty agreement regarding salmon established the International Pacific Salmon Fisheries Commission[14]. This effort was targeted at sockeye salmon stocks in the Fraser River (located in Canada) passing through U.S. waters as they returned to spawn. Cooperative management of Fraser River sockeye salmon stocks began with the Fraser River Convention[15], however this Convention proved ineffective as a result of chronic disagreements over how to address salmon interception in fisheries (Ebbin, 2003). These efforts set the stage for future fishery agreements between the U.S. and Canada.

While the U.S. and Canada were negotiating fish sharing agreements among themselves, they also recognized the need for a coordinated response regarding Japanese gillnet boats that fished

[13] Coded-wire tags (CWT) are used to understand salmon migration patterns. CWTs are implanted into a juvenile salmon with information regarding their origin location. "Tagged" (CWT implanted) salmon caught while living in the ocean reveals where the fish originated from, and serves to inform managers about the stock's migratory route.

[14] The International Pacific Salmon Fisheries Commission was transitioned into today's Pacific Salmon Commission under the PST when it was ratified in 1985.

[15] *United States-Canada Convention for the Protection, Preservation and Extension of the Sockeye Salmon Fishery in the Fraser River System,* signed May 26, 1930, 50 Stat. 1355 (1930) 8 UST 1058, TIAS No. 3867.

on the "high seas" outside of the territorial waters of coastal states. Both the U.S. and Canada perceived Japanese interceptions of salmon originating from North America as a threat and in 1952 the U.S., Canada and Japan negotiated the International North Pacific Fisheries Convention, which established the International North Pacific Fisheries Commission. This convention embodied the 'abstention principle', a concept that arose from the Truman Proclamation (No 2668, 3 CFR 68 (1943-8)) and was championed by the U.S. as it targeted Japanese salmon fisheries that harvested U.S. stocks (Burke 1994, Ebbin, 2003). This gave management authority throughout a specific stock's migration to the country from which it originated. This concept has influenced salmon management approaches to become a defining feature of the PST, even pervading negotiations for harvest allocation between salmon stakeholders and regions in the U.S. as well.

In 1976 the Fisheries Conservation and Management Act (FCMA) was passed in the U.S., significantly expanding the federal government's role in salmon management. The FCMA declared U.S. jurisdiction over a 200 nautical mile Fishery Conservation Zone (FCZ), and established a governing system made up of eight regional Councils to manage fisheries. Following this action the U.S. exclusive economic zone (EEZ) was established by Presidential Proclamation in March of 1983[16].

Although the U.S. recognizes the United Nations Convention on the Law of the Sea (UNCLOS) as an international law, it is not a signatory. UNCLOS codified a 200-mile exclusive economic zone (EEZ) into international law in 1982, determining that coastal States must determine the maximum sustained yield (MSY) for resources within the EEZ and account for best available science to avoid over-exploitation[17]. Anadromous fish management was a prominent factor in the negotiations that led to UNCLOS (Burke 1994). Article 66 of UNCLOS gives the State of origin the "primary interest in and responsibility for" anadromous stocks of fish, and requires a State of origin to establish regulations to ensure the conservation of anadromous fish originating from its waters. While conflict regarding Pacific salmon

[16] The EEZ encompasses a broader range of resources and economic interests beyond fisheries, which was the FCZ focus

[17] This does not mean that a State must undertake science when there is uncertainty, however, it does require that coastal States use existing data to establish an allowable catch for the resource in the EEZ. In other words, impacts or data beyond the State that is using or harvesting the resource must be considered.

management continued, UNCLOS did aid in defining the U.S. and Canada's role in management.

5.3 Establishment of the Pacific Salmon Treaty

Historically dependent on abundant salmon returns, western Washington tribes (hereafter referred to as Treaty tribes) have been significantly impacted as salmon runs have become increasingly diminished from a variety of factors including habitat destruction and over harvest (Wilson, 2001). In response to the threats facing salmon throughout the Pacific Northwest and the lack of effective conservation efforts, multiple Treaty tribes sued the U.S. Secretary of Commerce in 1974 (Jensen, 1986). Federal courts recognized tribal treaty rights in a landmark 1975 court opinion known as the 'Boldt Decision' when the Ninth Circuit court affirmed a district court's interpretation of the 1855 Treaty of Medicine Creek between Washington's Treaty tribes and the U.S. (*United States v. Washington*). The Ninth Circuit interpreted the Treaties as guaranteeing tribes that were a party to the agreement the right to fifty percent of sustainable harvest of salmon available and destined to traditional fishing grounds. The impacts of this court decision were significant for Pacific salmon management and repeatedly appealed, however the 50-50 sharing arrangement between non-Indian fishermen and Treaty tribes promulgated in *United States v. Washington* is still in effect today. It was with this action that negotiations for a comprehensive agreement between Canada, the U.S. and Treaty tribes for a salmon management agreement began. Through these efforts, the PST was designed to allow for cooperative management, salmon research, and enhancement of migratory Pacific salmon stocks to provide for sustainable fisheries and long-term benefits of salmon stocks for both countries. In response to the decline of Chinook salmon and recognition of the changes occurring in the lower 48 during this time, the newly formed State of Alaska worked to reverse Chinook salmon declines for the benefit of salmon fishermen along all of the Pacific coast[18]. Salmon managers in SEAK implemented multiple fishery harvest conservation measures during this time period including the closure of waters west of Cape Suckling to trolling in 1974, constraining the troll fishery to operate only within waters between Cape Suckling and Dixon Entrance for all salmon species in an effort to conserve Chinook salmon stocks during a period of low productivity in

[18] Alaska is the only state with a mandate for sustainable fisheries written into its State Constitution.

Cook Inlet and Prince William Sound, a management measure that has remained in place to this day (CFEC)[19]. Management measures also included limited entry permits in 1975, sport fishery restrictions, a minimum size limit for Chinook salmon in 1977, reduced power troll line limits in 1980, reduced seasons and more (Stevens, 1986).

In addition to fishery harvest conservation measures, ADFG also reduced SEAK commercial troll catch ceilings and incidental catch rates in other fisheries, in their efforts to rebuild local Chinook salmon stocks. However, increased Chinook salmon harvest rates in Canadian fisheries during this time served to negate Alaska's efforts, which were intended to increase escapement rather than be intercepted by Canada (Stevens 1986). This demonstrates that the SEAK commercial troll fishery was already experiencing substantial impacts due to low abundance, conservative management measures, and international interceptions prior to the PST's implementation.

A draft Treaty was negotiated in 1982 that would establish allocations, conservation principles, a bilateral forum for collaborative management and limits on Chinook salmon harvests. An agreement was not reached due to Alaska withdrawing its support for the draft Treaty stating that the concerns of Alaska fishermen were not properly addressed and that the draft Treaty's impacts on Alaska needed to be reconsidered (Stevens, 1986). Despite Alaska's reluctance to reach an agreement, interest in a comprehensive agreement between the U.S. and Canada regarding salmon management remained (Miller, 2003).

It was when the Pacific Northwest Treaty tribes filed suit to extend the 50-50 harvest share rule that had been established in the Boldt decisions (*United States v. Washington*) as an avenue to restrict Alaska's harvest of Chinook salmon that originated from Pacific Northwest rivers that Alaska re-entered discussions to establish a comprehensive harvest sharing agreement (Yanagida, 1987, Munroe et al., 1998). The disagreement was finally resolved with Congress passing the Pacific Salmon Treaty Act of 1985, along with a side-agreement between Alaska and Pacific Northwest Tribes known as the Baldrige Stipulation (*Confederated Tribes and Bands v. Baldrige*).

[19] Concerns for far north migrating Chinook salmon stocks originating from the West Coast states and Canada, along with potential PST implications, have been the most common rationales offered by managers in support of maintaining the closure of Alaska's waters to trolling beyond Cape Suckling (CFEC).

Going into effect in 1985, the PST represents a policy designed to address cooperative management and to create incentives for salmon conservation. Both countries agreed that Chinook salmon populations in British Columbia, Washington, and Oregon were in need of rebuilding, and agreed to a fifteen-year stock rebuilding plan that reduced exploitation rates for all coastal Chinook salmon fisheries in an effort to meet escapement goals by 1998. However, this plan was not successful and escapement goals were actually worse in 1998 (Crawford, 1998). This kept PST negotiations tense as negotiators grappled with increased pressures regarding fishery harvest and salmon enhancement or mitigation measures. As Chinook salmon stock rebuilding plans have struggled to achieve their goals, there have been implications for the Alaska Chinook salmon commercial troll fishery due to the mixed-stock nature of the fishery and reliance on Chinook salmon for economic performance.

5.4 The Pacific Salmon Treaty Structure

The PST has jurisdiction over commercial, recreational, subsistence, and tribal fishing management for salmon species migrating across international borders and under different structures of State management[20]. The Pacific Salmon Commission (PSC) was established to implement the terms agreed to by each country. The PSC meets regularly to review the previous year's fishing activities, advise the PST parties on the status of fisheries, and to suggest adjustments to the management regime. Approximately every ten years the PST is renegotiated to reflect current conditions and to allow managers to respond to new challenges. A Treaty Agreement (Annex) following negotiations does not replace the 1985 PST, instead placing additional obligations on the Parties as agreed to by both countries. The primary PST chapters affecting Alaska are Chapter 1: Transboundary Rivers; Chapter 2: Northern Boundary; Chapter 3: Chinook Salmon; and Chapter 8, Yukon River. PST negotiations are confidential, and the Chinook salmon chapter is considered to be one of the most complicated and politicized elements due to their highly-migratory nature.

The PSC is divided into two national sections - U.S. and Canada - that have equal votes and must reach agreement to move forward. The U.S. section has four commissioners, of which three have

[20] AK, Northern BC, Southern BC, and WA fisheries are not managed identically, as management needs and decisions have varied across the regions.

a vote that is counted towards an agreement. This voting arrangement is unique in that the Federal government does not hold a vote that is counted. The three votes that count for the U.S. are represented as one each: Alaska, Washington and Oregon combined, and the Treaty tribes located in Washington, Oregon and Idaho combined[21]. The U.S. position must have consensus with one another, which allows for any Commissioner to halt any action, regardless of if the others believe it is appropriate[22]. Should the two countries fail to reach an agreement on a fishing regime, management authority then goes to the state or Federal jurisdiction for that fishery. Each of these four major interests (Canada, Alaska, Oregon/Washington and Treaty tribes) bring different management objectives and bargaining power to PST negotiations (Miller, 2003).

To assist the PSC, there are five geographically oriented panels with appointed representatives from both countries[23]. Each panel provides recommendations or comments on the management of fisheries occurring in or salmon stocks originating from that geographic area. For example, the Northern Panel focuses on SEAK and northern British Columbia, reviewing data and management plans to provide PST Commissioners with recommendations[24]. The PSC also relies on scientists from each country to serve on panels to offer the Commission policy options for the 'best' approach to conservation and management solutions. The Chinook Technical Committee (CTC) provides the PSC with annual catch and escapement data for Chinook salmon stocks managed under their jurisdiction to formulate science and management measures necessary to achieve their objectives[25].

The PST institutionalized salmon management for what it is today, with Oregon, Washington, Alaska, and the Treaty tribes charged with implementing the outcomes of PST negotiations, such as the collection and timely analysis of stock assessments and fishery data. Concerns around

[21] 'Treaty Indian tribe' means any of the federally recognized Indian tribes of the Columbia River basin, Washington coast or Puget Sound areas having reserved fishing rights to salmon stocks subject to the [PST] under treaties with the U.S. Government." 16 U.S.C. § 3631.
[22] This is known as a consensus rule, it gives veto power over proposed fishing regimes to the Canadian delegation and to any of the U.S. Commissioners: Alaska, Washington/Oregon, or Treaty Indian Tribes (Yanagida, 1987, Munro et al., 1998)
[23] Panels: Northern, Southern, Fraser River, Transboundary and Yukon River. Yukon River Panel is unique in that it follows its own internal procedures and does not report to the PSC or its Commissioners. There were originally only 3 Panels, Transboundary and Yukon were added in later rounds of negotiations.
[24] Agreement from Panel members of both countries is needed for any decision or recommendation to be forwarded to the Commission.
[25] Each committee relies on information provided by Canadian and U.S. fishery management bodies.

fishery interceptions historically created disincentives for conservation that made both countries hesitant to invest in restoration or enhancement projects for salmon (Jensen 1986). However, the PST now receives significant funding from the U.S. government for implementation, mitigation measures such as habitat restoration and enhancement projects, and programming.

5.5 Part 2: Implications for SEAK Chinook Salmon Commercial Troll Fishery

PST negotiations have been challenged by the migratory life cycle of salmon. Chinook salmon from the Columbia River system, from drainages entering Puget Sound, and from central and northern Oregon rivers often migrate north when they enter the ocean as juveniles. Additionally, Chinook stocks from the upper Columbia River, along with Oregon and Washington coastal Chinook, migrate long distances to the north and can be intercepted in SEAK and northern British Columbia fisheries. Conversely, Lower Columbia River Chinook stocks are dominated by hatchery fish, which generally do not migrate north of Vancouver Island (CRS, 2009). These varied migration patterns and consequential interceptions have often complicated PST negotiations as U.S. salmon originating from Washington are caught in Canadian and Alaskan fisheries. Very few Chinook salmon originating from Alaska are intercepted by Canada or the southern U.S., as Chinook salmon tend to migrate northward.

Thus, in developing the PST, Alaska did not have the same potential gains by participating that Washington and British Columbia had. Negotiations did not move forward until the Baldrige Agreement came about, which gave Alaska, Washington/Oregon, and the Treaty tribes PST representation and veto power within the process, and the Treaty tribes agreed to forego their right to litigate Chinook salmon allocations for Alaska (Stevens, 1986; Yanagida, 1987). Essentially, Alaska was faced with the choice of either joining Washington in a 50-50 harvest sharing arrangement with Treaty tribes, or supporting the negotiations that ultimately resulted in the PST agreement made between the U.S. and Canada on December 15th, 1984 (Jensen, 1986).

The PST was welcomed as "a peace treaty memorializing the end of the Pacific salmon war" (Jensen, 1986) and initially appeared to solve many salmon management conflicts. However, some Chinook salmon stocks have continued to decline, which has placed great strain on PST

negotiations. This has led to differing views about how best to achieve the conservation and harvest-sharing goals established and agreed upon within the PST.

Both the U.S. and Canada abandoned the PST by 1997 because they were unable to reach consensus on annual salmon harvests (Brown, 1999). There is no penalty for not reaching an agreement, both countries can harvest salmon through an extension of status quo annual maximum catch limits (harvest ceilings). As both countries failed to agree on management decisions, outdated harvest ceilings were extended throughout the 1990s for the interim, even as Chinook salmon abundance continued to decline (Rutter 1997).

In 1996, after 3 years with no agreement between the U.S. and Canada, the *Letter of Agreement Regarding an Abundance-Based Approach to Managing Chinook Fisheries in Southeast Alaska* (LOA) was signed by PST members of the U.S. Section (Skannes, 2016). This agreement was in effect from 1996-1998 and established an annual Chinook salmon harvest number based on abundance estimates developed both pre-season and in-season. Concerns regarding Alaska's Chinook salmon interceptions were an issue of contention and contributed to the lack of consensus and the LOA seen leading up to the 1999 agreement (Rutter 1997). Ongoing disputes during this time even led to Canadian fishermen blockading an Alaska state ferry in Prince Rupert for three days (Kiffer, 2007).

During this time the U.S. and Canada engaged in high level negotiations that PST Commissioners were not allowed to join as they also worked to resolve these conflicts (Miller, 2003). Both countries also commissioned a report known as The Strangway and Ruckelshaus Report to identify sources of dispute and potential solutions. This report concluded that bilateral concessions would be critical to success, and recommended focused efforts on a "practical framework for implementing Article III of the treaty (Principles) leading to the establishment of longer-term fishing arrangements" (Strangway and Ruckelshaus, 1998). The report also advised the two countries to review the PSC process to make it "a functional institution for the preservation and management of the Pacific Salmon" (Strangway and Ruckelshaus, 1998). Collaborative salmon management efforts between Canada and the U.S. were restored when the PST was reauthorized in 1999, despite many salmon populations continuing to decrease in abundance in Washington and Oregon. While the PST has been successfully renegotiated in both

decades since the 1999 agreement, the negotiations have remained tense and stakeholder satisfaction is questionable.

Historically, Alaska and Washington's fisheries intercept significant numbers of Canadian salmon, and Canadian fisheries intercept significant numbers of Washington and Oregon salmon (Huppert, 1995 and Shepard and Argue, 1998). As salmon populations have declined in Washington and Oregon, Canada's opportunity to intercept salmon of U.S. origin has declined as well. This has resulted in rates of interception that Canada has perceived as inequitable at times. This perception led to Canada demanding that the U.S. offset the inequity by reducing its interception of Canadian salmon by Alaskan fisheries in exchange for them agreeing to a revised PST agreement (Rutter, 1997).

5.6 The U.S. Position is Inherently Divided

The U.S. position is divided due to British Columbia's location between Alaska and Washington and because Chinook salmon originating in the Pacific Northwest migrate north through British Columbia and Alaska, while Chinook salmon stocks originating in Alaska typically migrate within Alaskan waters. The PST's limited ability to reduce rivalry regarding salmon access between Alaska and the southern U.S. is expressed in the negotiations conducted every decade when each member of the U.S. Section's incentives for economic maximization and rivalry for resource access come into play for their region. The PST implementation language mandates Commission positions and provides veto authority for any voting member of the U.S. Section (16 U.S.C. § 3632 (a)-(h)). This gives each U.S. Commissioner veto authority, however Canada, having less diverse interests among its commissioners, has exploited U.S. circumstances of split positions to influence the PST negotiations (CRS 2009).

Previous to the 1999 negotiations, fishing regimes primarily consisted of harvest ceilings based on location and species. The new approach to abundance-based management in the 1999 Agreement shifted how Chinook salmon harvested in northern British Columbia and SEAK was apportioned. Previously, Chinook salmon were divided equally between the two and likely provided motivation for them to coordinate support for maintaining harvest opportunity in those

fisheries. As a result, motivation for collaboration no longer exists as Alaska and northern British Columbia's Chinook salmon allocations are negotiated separately.

5.7 Assessing Policy-Induced Impacts on the SEAK Chinook Salmon Commercial Troll Fishery

The 1985 PST agreement reduced SEAK historical average Chinook salmon harvest to create "saved" Chinook salmon to be reallocated for harvest and escapement in British Columbia, Washington and Oregon. This resulted in the historic "baseline" average harvest of 322,011 Chinook salmon in SEAK being reduced to 290,815 Chinook salmon in SEAK annually when the PST went into effect. Alaska has never made it through a PST negotiation without a loss in allowable harvest levels when considering their percentage of allocation, however the abundance-based approach adopted in the 1999 Agreement has allowed for increased harvest in years of increased abundance.

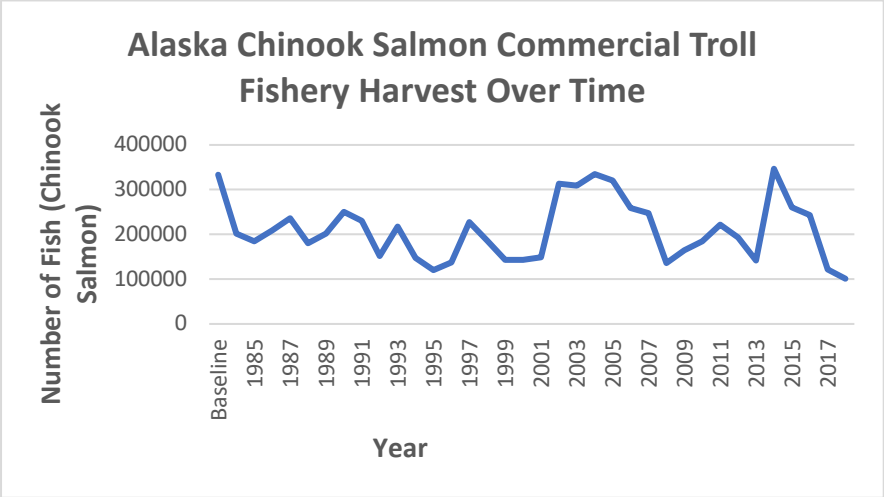


Figure 1

Cumulative impacts of lost harvest opportunity can be considered in a variety of ways and from various perspectives, as fishery management has shifted in its approach over time. The table below represents the total SEAK Chinook salmon catch harvested and the percentage of change when compared to the 1979-1982 Baseline. To account for interannual variability in abundance, the period of years under each PST Agreement were averaged, and hatchery add-ons (fish

attributed to production from Alaskan hatchery facilities above levels observed prior to the 1985 PST and so, not counted in the PST harvest ceiling) and terminal exclusion (fish taken in terminal commercial fisheries in transboundary river "exclusion zones" defined in Chapter 1 of the PST) are included:

1975-1978 SEAK Average Chinook Salmon Harvest	324,265 (pre-PST)	
1979-1982 SEAK Historic Average Chinook Salmon Catch (Baseline)	322,011 (pre-PST)	
1985-1995 Average Harvest	290,815	-13%
1996-1998 Average Harvest (LOA)	283,285	-15%
1999-2008 Average Harvest (1999 Agreement)	372,304	+11%
2009-2018 Average Harvest (2009 Agreement)	314,304	-6%
2019-2020 Average Harvest (2019 Agreement)	204,942	-38%

Table 1

However, Alaska's increased hatchery production of salmon has affected SEAK fisheries harvest– including the SEAK Chinook salmon commercial troll fishery. The table below represents SEAK commercial troll Chinook salmon harvest and the percentage of change when compared to the 1979-1982 Baseline, and includes all Chinook salmon, including those originating from Alaskan hatcheries:

1975-1978 SEAK Average Chinook Salmon Harvest	291,559 (pre-PST)	
1979-1982 SEAK Historic Average Chinook Salmon Catch (Baseline)	272,752 (pre-PST)	
1985-1995 Average Harvest	222,752	-18%
1996-1998 Average Harvest (LOA)	193,309	-29%
1999-2008 Average Harvest (1999 Agreement)	250,972	-8%
2009-2018 Average Harvest (2009 Agreement)	211,153	-23%
2019-2020 Average Harvest (2019 Agreement)	139,640	-51%

Table 2

It is difficult to say precisely what the impacts of only the PST have been for the SEAK Chinook salmon commercial troll fishery, as BOF actions have also created impacts. For example, a burgeoning sport sector since the PST's inception created the need for BOF action. The sport sectors development caused in-state "fish wars" that culminated in a Chinook salmon management plan. Additionally, BOF conservation restrictions for SEAK Chinook salmon stocks of concern have affected the SEAK commercial troll fishery. However, substantial impacts can be attributed to the negotiations occurring under the PST.

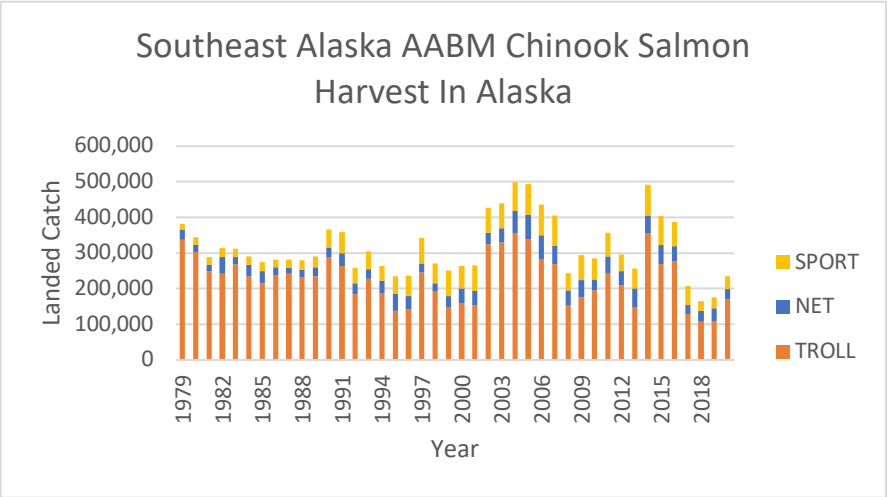


Figure 2

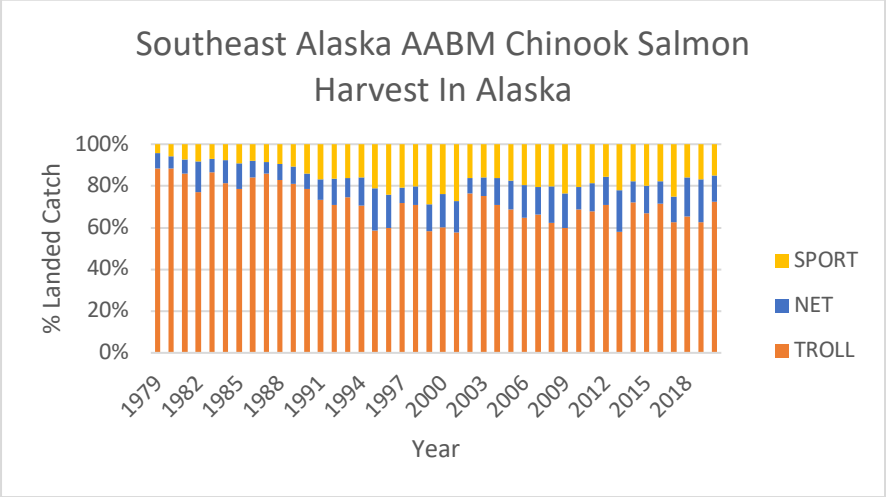


Figure 3

This report considers how Alaska's commercial salmon troll fishery has experienced significantly reduced Chinook salmon harvest opportunity, however consideration of the PST's impacts to other fishery stakeholders, along with consideration of fishery management and structure decisions in other regions is needed to truly understand the PST's impacts on fisheries. Other regions and fisheries under the authority of the PST have taken harvest reductions as well; understanding Chinook salmon harvest impacts across stakeholders may find consideration of what proportion of PST coastwide Chinook salmon harvest was allowed for among stakeholders to be useful.

Although annual troll harvest varies significantly, the commercial troll fleet has an estimated annual economic impact in SEAK of $85 million in total output (McDowell, 2018). Chinook salmon harvest plays a critical role in the financial performance of the SEAK troll fleet however their Chinook salmon harvest has declined due to harvest restrictions imposed by the PST's coastwide Chinook salmon rebuilding efforts, status of local SEAK Chinook salmon stocks, and through shifts in BOF conservation and allocation guidelines. Since 2006, the SEAK PST Chinook salmon allowable harvest has been allocated as follows: 4.3% to the seine fleet, 2.9% to the drift gillnet fleet, and 1,000 Chinook to set net fishermen. The remaining 92.8% after the 7.2% of commercial net fishery allocations are subtracted, is split between troll (80%) and sport (20%). Also of note, is that while the harvest limits for Chinook salmon have dropped, the number of commercial salmon troll permits has not. This has created increased competition among fishermen for harvest opportunity targeting Chinook salmon.

5.8 Impacts of the 2019 Agreement on the SEAK Chinook Salmon Commercial Troll Fishery

PST Commissioners agreed on recommendations for new fishing agreements under the PST that went into effect in 2019 (2019 Agreement). Reductions in Chinook salmon harvest are partly due to harvest restrictions implemented to protect SEAK Chinook salmon stocks of concern. These conservation actions have substantially reduced spring Chinook salmon commercial troll opportunity, including Alaskan produced hatchery Chinook salmon, many of which do not accumulate toward the PST Chinook salmon harvest limit. By volume, the poundage of Chinook salmon harvested by the troll fleet was 1.55 million pounds in 2017 and 1.42 million pounds in 2018, however the previous 10-year average between 2007-2016 was 3.18 million pounds of Chinook salmon (McDowell, 2019). 2017 and 2018 were the lowest troll harvests of Chinook salmon ever recorded, both before the PST's inception and since its implementation (Appendix D and E).

From 2000 through 2018, Chinook salmon accounted for an annual average of 44% of the troll fleet's total ex-vessel earnings with the lowest year being 2013 at 27% and the highest year being 2015 at 58% (McDowell, 2019). While the poundage of Chinook salmon harvested by the troll

fleet has decreased over time, the ex-vessel prices have substantially increased, offsetting some impacts of lost harvest opportunity[26].

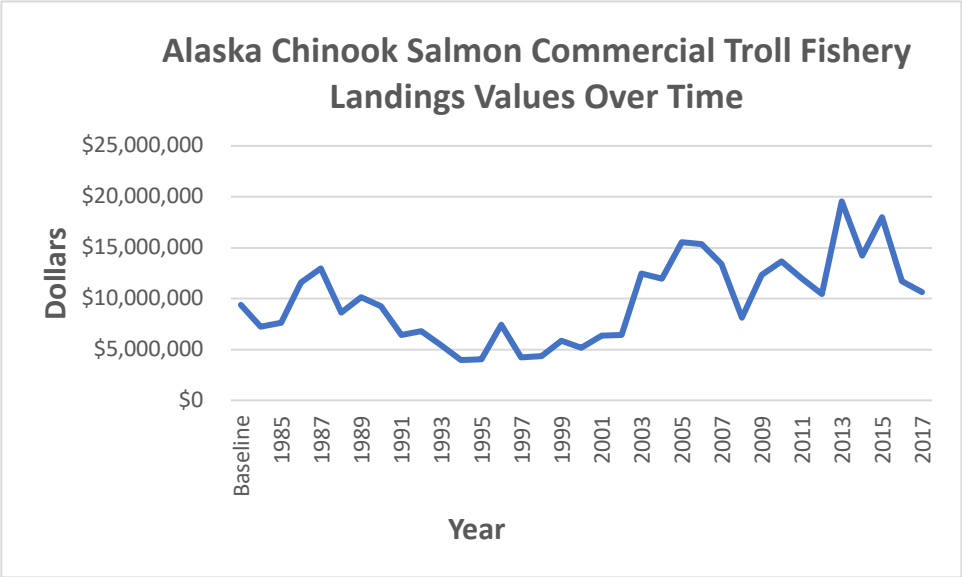


Figure 4

Also notable, is that some segments of the SEAK troll fleet have diversified for a variety of reasons. As the Chinook salmon season has become more compressed to constrain harvest, some fishermen are not targeting Chinook salmon because they also participate in other fisheries whose seasons may overlap. Additionally, more diversified participants may operate in the commercial troll fishery for only a portion of their season. In summary, the large number of fishery participants and year-round fishing opportunities has led to a diversified troll fleet across SEAK with some individuals more reliant on Chinook salmon harvest opportunity than others.

In addition to each country taking cuts in harvest levels in 2019, negotiators removed the Standardized Fishing Regime provision in the PST. This removal allows fishery managers the flexibility to transfer allocation across gear sectors if one sector is under or over the pre-season limit. Also new in the 2019 agreement, is the concept of fishery 'paybacks' in AABM fisheries, of which SEAK is the only one for the U.S. Section. The "payback" provision, found in Chapter 3: Chinook Salmon (6)(h), states:

[26] Based on McDowell Report, 2018 calculations using ADFG volume and total value data.

(h) the following actions in AABM fisheries shall be taken if the actual catch differs from the pre-season limit (management error);

(i) if the actual catch exceeds the pre-season catch limit (overage) then the overage shall be paid back in the fishing year after the overage occurs, and

(ii) if the actual catch is lower than the pre-season catch limit (underage) then the underage shall not be accumulated;

This provision has resulted in ADFG implementing a 2% reduction in Chinook salmon harvest as a buffer to avoid exceeding the all-gear limit and payback provisions agreed to by the U.S. within the PST (ADFG News Release, 2019). The overage provision in the 2019 agreement could create additional cost to SEAK and the commercial troll fishery (beyond the 1.5%-7.5% associated with the Abundance Index) in the value of unharvested allocation that is given up to avoid overage that cannot be carried forward to be applied in the next season. However, this has not occurred as the 2019 Agreement also now allows for the transfer of allocation. ADFG has transferred unused Chinook salmon allocation to the SEAK commercial troll fleet at the end of the summer fishing season (ADFG).

Another notable change beginning in the 2019 Agreement, the SEAK AABM fishery's annual PST pre-season catch limits are based on calculations that use the catch per unit effort (CPUE) in the SEAK winter troll fishery in District 13 during statistical weeks 41-48 (Oct. 11-Nov. 30) (Appendix F)[27]. This is a new approach is tier-based and was agreed to due to ongoing suspicions that modelling data was being manipulated to decrease abundance indices, which are used to determine annual catch limits (Miller, 2003, ADFG).

Additionally, SEAK fisheries have experienced increasingly restrictive management measures regarding Chinook stocks as multiple SEAK river systems have not met escapement goals in recent years and are experiencing a period of poor productivity[28]. Some of these Chinook salmon

[27] SEAK AABM catch limits were previously based on modelling conducted at the PSC.
[28] A stock of concern listing means that population of salmon has repeatedly fallen short of goals developed for the number of fish surviving and making it back to it's spawning waters. Listing a stock results in an action plan detailing management measures to help the stock recover.

stocks have had poor production since 2012, and most escapement goals were not met between 2016-2018. As more restrictive management measures have been implemented, more escapement goals have been met but overall stock performance has not improved.

The SEAK commercial Chinook salmon troll fishery is experiencing historic lows in Chinook salmon harvest as a result of both PST-related measures and Alaska's BOF conservation measures. These management actions are problematic for the SEAK commercial troll fishery as the fleet has simultaneously lost harvest opportunity for hatchery Chinook salmon originating from Alaska that intermingle with other wild Chinook salmon stocks at sea and do not accumulate toward PST harvest limits in the same way. Alaska's salmon hatchery policies require that Alaska hatcheries use local broodstock sources, however this means that these salmon have the same run-timing as their wild counterparts. These substantial troll harvest restrictions have targeted the spring troll fishery due to run-timing for stocks of concern occurring during this period. The spring fishery is also when Chinook salmon prices have historically been at their highest[29]. These management actions have resulted in lost revenue for Alaska's Chinook salmon commercial troll fishery.

5.9 Endangered Species Act Listings Affecting the SEAK Chinook Salmon Commercial Troll Fishery

Passed in 1973, the ESA mandates for the conservation and recovery of depleted species. The National Marine Fisheries Service (NMFS) is responsible for implementing ESA conservation measures for salmon and many marine mammals[30]. ESA listings have become a source of concern for fishermen, as some wild stocks of Chinook that are listed and subject to these conservation efforts are also caught in fisheries. NMFS defines regional aggregates of populations to which the ESA can be applied to as Evolutionarily Significant Units (ESU). There

[29] Spring commercial troll harvest restrictions and closures has shifted additional allowable catch into the summer fishery, which is prosecuted derby style with a July 1 opener. This may result in reduced participation, markets being flooded, or reduced prices when compared to the spring fishery.

[30] The Marine Mammal Protection Act designates that the Secretary of Commerce, acting through NMFS, is responsible for the conservation and management of whales, dolphins, porpoises, seals, and sea lions. The Secretary of the Interior, acting through the U.S. Fish and Wildlife Service (FWS), is responsible for walruses, sea otters, polar bears, manatees, and dugongs.

are many ESUs for salmon, which are considered to be a "distinct population segment" and thus a "species" under the ESA (Appendix G).

Canada's approach to species recovery is different than the U.S. Known as the Species at Risk Act (SARA), both countries share overlapping goals but SARA is conducted by a single national scientific body. Canada takes factors other than species status into account while deciding to list a species, while the ESA's listing decisions cannot consider socioeconomic factors (Waples et. Al, 2013). These fundamental differences have led to the ESA experiencing significant litigation to ensure compliance since its inception (Kagan, 2001). Alternatively, Canada's parliamentary system tends to produce discretionary laws, and environmental litigation is less prevalent than in the U.S. (Illical and Harrison, 2007)[31].

The ESA prohibits the "take" of listed species without a permit (16 U.S. Code § 1532. Definitions (19)). NMFS has the authority grant exemptions for take for certain activities if they meet certain criteria. It is impossible to discern ESA listed Chinook salmon from other stocks when they are encountered in fisheries, and while management efforts are taken to avoid harvest of these stocks, commercial harvest of ESA listed salmon species is unavoidable. Fishery harvest is carefully evaluated by NMFS before it is authorized.

Additional ESA complexity was added to salmon management when NMFS listed Southern Resident Killer Whales (SRKW) as endangered in 2006 (SRKW, DPS listed under 70 FR 69903). Declines in SRKW populations have been linked to an aggregate of factors including pollution, noise disturbance and prey availability (U.S. Environmental Protection Agency, 2017). While fisheries have no direct interactions with SRKWs, Chinook salmon have been identified as preferred prey for SRKW. Additionally, most of Puget Sound has been designated as SRKW critical habitat, an area that many Chinook salmon under the jurisdiction of the PST originate from[32] (Appendix H). As a result of this designation there has been significant debate on what

[31] Under SARA, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) provides a classification of species at risk of extinction. This status is not legally binding. Its results are reported to the Canadian government and the public. Informed by COSEWIC, the Minister of the Environment then decides if a species is added to the List of Wildlife Species at Risk.

[32] Critical habitat is defined as: Specific areas within the geographical area occupied by the species at the time of listing that contain physical or biological features essential to conservation of the species and that may require special management considerations or protections; and specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation (U.S. Code § 1532.Definitions (5)(A)).

effects salmon fishery harvest may have on SRKWs, since Chinook salmon have been identified as a significant part of SRKW diet (Hanson et al, 2021), along with efforts to understand the effects salmon fisheries might have on SRKW recovery efforts (Pacific Fishery Management Council, 2020).

Access to salmon sustains many rural and remote local economies, yet many stocks are declining due to factors that are much-studied and not completely understood (Lackey, 2004). There are numerous environmental factors that influence salmon productivity and recruitment. Salmon abundance fluctuations are linked to ocean conditions and climate change, something we have limited ability to affect (Irvine and Fukuwaka, 2011).

NMFS has acknowledged that climate change may threaten the survival of some species, but has grappled with how to address this when implementing the ESA. The ESA's implementing regulations direct agencies to consider "natural or manmade factors affecting continued existence" and require them to analyze cumulative effects on a species' survival when analyzing if an action will jeopardize a listed species. Federal actions that are considered unrelated to the proposed action require a separate consultation and are not considered under cumulative effects (Endangered Species Consultation Handbook, 1998)[33]. Legal challenges have influenced ESA implementation; however, courts have not required the U.S. government to curb activities that may contribute to climate change to protect ESA listed species (Tsang, 2019). This means that salmon abundance and ecosystem variability can be influenced by climatic and ocean conditions, or anthropogenic factors such as fishing, species competition or introduced species (Jiao, 2009). Increased pressure with regard to PST harvest allocations has raised questions regarding habitat destruction and its linkage to declining Pacific salmon populations. Habitat loss and construction has caused hardship for salmon recruitment and survival, however the degree to which this has affected salmon - and how best to mitigate this - remains an ongoing discussion. This is relevant because only some of these are actionable items under the ESA or the PST. Managers can cut fishery harvest but they do not have the authority to address ocean conditions, habitat destruction or marine mammal conservation management.

[33] Per the Endangered Species Consultation Handbook, analyzed cumulative effects are often poorly documented due to a lack of definitive information for future actions.

Section 7 of the ESA requires that federal agencies "insure that any action authorized, funded, or carried out by such an agency…is not likely to jeopardize the continued existence of any endangered or threatened species…" (50 CFR § 402.02). Jeopardy results in situations where an action can be reasonably expected to directly or indirectly appreciably reduce the likelihood of the survival and recovery of a listed species (50 C.F.R. § 402.02).
To fulfill the responsibilities mandated under Section 7 of the ESA, those proposing the action must consult with NMFS regarding potential effects (50 C.F.R. § 402.14(a)). The consultation is concluded with NMFS issuing a Biological Opinion (BiOp) that determines if the proposed action is likely to jeopardize ESA listed stocks, or result in the destruction or adverse modification of critical habitat (50 C.F.R. § 402.14(h)(3)). Once NMFS makes a determination, they issue an incidental take statement with the BiOp (16 U.S.C. § 1536(b)(4)). SEAK's fisheries must undergo this process because of the Federal management instituted under the PST. Without approval from NMFS, fisheries are not authorized to occur. It is during this process that NMFS also approves the delegation of SEAK salmon fishery management to the State of Alaska for fisheries in the exclusive economic zone (EEZ, 3-200 nm) off the coast of Alaska.

After each round of PST negotiations, NMFS prepares a BiOp considering the federal actions proposed under the terms agreed to. The 2019 Agreement's BiOp takes a unique focus on Alaska when compared to previous BiOps which covered all U.S. PST fisheries. Previously, PST BiOps considered two things: the Federal government's approval of the Agreement as a whole (all U.S. PST fisheries), and the delegation of management authority for Alaska fisheries to the State of Alaska. The 2019 BiOp only consults on the delegation of management authority to the State of Alaska, which causes it to consider only Alaska's potential ESA impacts. It also considers a multi-million dollar conservation program focused on Puget Sound and SRKW prey production to offset harvest impacts (BiOp, 2019). Despite the PST's integrated management approach and coast-wide authority, this links the conservation program directly to only SEAK fisheries' impacts, despite the fact that the program is designed offset impacts of all PST fisheries, as well as the cumulative impacts of habitat degradation in Puget Sound. The 2019 BiOp focused on SEAK has a determination stating that SEAK fisheries are likely to adversely affect SRKW, and that SEAK fisheries are likely to adversely affect critical habitat requirements – even though SRKW do not occur in Alaskan waters. As a result, this BiOp creates unique vulnerability for

SEAK fisheries in a way that is not present for southern U.S. fisheries, which also target Chinook salmon but were not linked to SRKW conservation measures. This new approach put Alaska in a position to lose its authority to manage SEAK fisheries should the requested funding for the PST implementation and conservation ($109 million) not be provided by Congress, to NMFS, to support ESA listed species in Puget Sound and SRKW. Meanwhile, southern U.S. ISBM fisheries harvesting Chinook salmon within SRKW range and critical habitat areas are not, and would not be, impacted or held accountable in the same way.

Under State of Alaska management, measures have been taken to reduce harvest for ESA listed Chinook salmon. As previously discussed, reductions have been taken in Alaskan fisheries to gain Canada's cooperation for additional reductions of Canadian Chinook salmon harvest in the West Coast Vancouver Island (WCVI) AABM fishery with the intent of benefiting threatened species in Puget Sound (CRS, 2009). The 7.5% reduction in SEAK Chinook salmon harvest mandated by the 2019 Agreement is valued as an isolated reallocation of Chinook salmon for conservation in the 2019 BiOp, and is currently under litigation to determine if this action will ensure SEAK fisheries do not jeopardize the continued existence of ESA listed species. This is problematic for the commercial troll fishery as they are not being credited for the cumulative efforts put forth to aid in ESA listed salmon recovery.

The SEAK fishery is the only U.S. fishery under the jurisdiction of the PST that is considered to be AABM, which leaves it vulnerable to increased restrictions since it is managed to a numeric limit separately from ISBM fisheries. When considering the 2019 BiOp only consulting on the SEAK fishery, it may be relevant to ask if this approach would be different if any southern U.S. fisheries were managed as AABM. Southern U.S. fisheries also experience significant variability in the stocks of salmon they harvest, including ESA listed stocks originating from Puget Sound. This is evidenced in Appendix E of the PSC's joint CTC report. (Appendix I). The two regions are competitive, which has led to negotiations gaming for favorable harvest outcomes within the U.S. Section (Schmidt, 1996).

The 2019 BiOp is also unusual because NMFS West Coast Region completed the consultation because the ESA listed stocks are located in the region, even though the proposed action (delegated management of the salmon fishery) occurs in the Alaska Region. It may have been more appropriate for the Alaska region of NMFS to have taken a more active role in the

preparation of the 2019 BiOp, particularly as the BiOp considers the novel approach to link SEAK fisheries to ESA listed stocks despite the mixed stock nature of some lower 48 fisheries as well. This BiOp is particularly relevant for the SEAK commercial troll fishery because of its dependence on Chinook salmon harvest opportunity.

Compensatory mitigation is an allowable conservation measure under Section 7 of the ESA to address adverse impacts that a proposed action may have on a listed species. This is particularly relevant in this case, as 4.2 million people live in the Puget Sound region and continued population growth is expected (Puget Sound Regional Council, 2020). It is a modern reality that anthropogenic impacts will likely continue to exacerbate the conditions that have created disturbances affecting wildlife (such as salmon and SRKW), and that these impacts are inextricably intertwined with conservation ecology (Ayres et al, 2012). Ongoing development may lead to impacts that cannot be mitigated. In the case of Alaska's Chinook salmon commercial troll fishery, it may be that no amount of money spent on restoration and enhancement can effectively reverse the downward trajectory of ESA listed species in Washington without also considering the accumulation of anthropogenic impacts such as pollution or development. This means that under the current management strategy Alaska's Chinook salmon commercial troll fishery may be forced to continue to give up Chinook salmon harvest opportunity without any actual benefit to the ESA-listed Chinook salmon stocks in Washington that the PST negotiated actions are designed to address.

6 Policy Conclusions and Recommendations

The PST impacts seen in the SEAK Chinook salmon commercial troll fishery expose difficulties balancing fishery management actions intended to achieve sustainable fisheries. There are, essentially, not enough salmon to satisfy the number of stakeholders who rely on harvest opportunity. The SEAK troll fishery has experienced a reduction of approximately 50% in Chinook salmon harvest over nearly 50 years. This reduction in harvest has not contributed in parallel for the value of the fishery, as fish prices have increased with consumer demand as availability has decreased. However, the future of salmon and the fishermen who depend on them for their livelihoods are inextricably linked to complex factors such as whole-of-government approaches to species diversity, ocean health, and climate change; along with reliance on outcomes of PST negotiations.

In considering whether policies could be refined to better promote salmon conservation and improve resource benefits for stakeholders, it is difficult to predict how the current policy will play out if status quo is maintained. Salmon conservation and benefit measures are dependent on stakeholder collaboration, harvest management and ESA conservation measures, and future PST negotiation outcomes. While beyond the jurisdiction of the PST, research indicates that status quo management may be overcome by the negative impacts of climatic and anthropogenic influences on species without meaningful action (Crozier et al, 2021).

There are many variables that complicate salmon management, creating added dysfunction. Unavoidable divergent trends in Alaskan and southern U.S. salmon abundance have changed the interceptions of salmon spawned in each nation's rivers, and may lead to additional breakdowns in collaboration. With these new realities in salmon abundance, previous precedents or compromises set within the PST process may no longer be tolerable to some stakeholders.

There are also many unanswered questions and concerns regarding the viability and sustainability of PST commitments to support collaborative management of Pacific salmon. The negotiations and outcomes are costly, and while the PST has provided a forum for coordinated salmon management efforts to occur, these efforts have not benefitted stakeholders in the manner that was originally anticipated. Policy changes are not likely without identification and consensus around if there is an issue and, if so, how to define it. With regard to fishermen, their ability to effect change is likely limited. The Chinook salmon commercial troll fishery may find its resilience limited as harvest opportunity decreases due to their reliance on Chinook salmon.

Fundamental to salmon disputes between the U.S. and Canada is the widely practiced tradition of catching fish where they are found, regardless of origin. Salmon fishery management became necessary when fish moved from being a subsistence food to a focus of economic exchange. Over time this focus has led to changes in technology, fleet structures, fisheries management, and access rights, along with increased quality and timeliness in fishery data. Governments play an important role in fishery management, working to ensure economic and societal benefits. With these responsibilities and over time, concepts such as ecosystem-based fishery management have developed to allow for a holistic approach to managing resources that accounts for the entire ecosystem of the species being managed (NOAA Fisheries). With these changes in how fishery management is approached, policy changes regarding salmon management, put in place in 1985, may be appropriate.

Recommendations to better promote salmon conservation and improve resource benefits for stakeholders, such as small-scale fishermen:

1. *The U.S. and Canada should clearly articulate objectives and principles to guide the management of Pacific salmon in explicit, unambiguous terms.*

   In addition to conservation, these terms should include provisions for the long-term biological and economic sustainability to benefit stakeholders dependent on the resource. Both countries acknowledge the benefits in collaborative salmon management, however the absence of clear guidance regarding the allocation of benefits has strained the PSC's ability to de-escalate tense relations between both countries and their stakeholders. Updated PST guidance for implementing Article III Principles to reflect harvest share and benefits, along with consideration of present-day challenges not foreseen in 1985 could increase the PSC's ability to function effectively. Additional guidance could include:

   a. assess the impacts of anthropogenic activities (including fishing) and environmental factors on stocks under the jurisdiction of the PST (or whose management affects PST management decisions, such as SRKW)
   b. take into account the interests and stability of small-scale and community-based fisheries

c. consider fishing capacity and evaluate if the levels of fishing effort exceed sustainable use of the resource
d. implement effective conservation and management measures for accountability considering sources of impact negatively affecting salmon productivity
e. consider management planning that is comprehensive: situations such as the 2019 BiOp's sole focus on SEAK fisheries, rather than considering all authorized actions under the PST confounds today's holistic, ecosystem-based management approach for species conservation
f. Bilaterally agreed to standards for fishery data collection, reporting, and timeliness

2. Transparency within the PST process should be increased.

Cooperative, transparent, science-based, and objective management is critical to ensure resource sustainability and ecosystem health. International coordination in fisheries promotes transparency in terms of sustainability, however process and outcomes are often not well understood by fishery participants (Walton et al, 2021). Fundamental to negotiations, transparency has been proven to increase legitimacy and stakeholder acceptance of management decisions (Davis and Hanich, 2020). Transparency can promote honesty in policy and decision-making, and could be made up of elements such as accountability, incentives, or adaptability (Grafton et al, 2007). The confidential nature of the PST has long been a point of contention for stakeholders and a lack of information may lead to assumptions or perceptions that are not accurate at the expense of negotiators. Some efforts have been made to increase PST transparency[34], however additional efforts could be beneficial.

The conversion of scientific and management advice into policy through a participatory and transparent process is often considered to be a core element in achieving fisheries sustainability and stability. When management measures are enacted without allowing for public analysis to understand the magnitude of impacts, negotiators or stakeholders may not understand the tradeoffs made during PST negotiations.

[34] State of Alaska publication "Pacific Salmon Treaty Transparency" April 2018

The PST 2019 Agreement negotiations were held in confidence from the public and the new language was not released for stakeholder review until after it took effect on January 1, 2019. Stakeholders only became familiar with the new stipulations affecting salmon fisheries when management strategies were developed for the upcoming season. This caused significant anxiety for many stakeholders, especially the Alaska Chinook salmon troll fishery[35].

3. *The PSC should develop a comprehensive framework to evaluate for long-term impacts of management strategies to stakeholders.*

Establishing a framework to understand the economic impacts of management decisions would allow for additional perspective in PST negotiations. Utilizing social and economic data to evaluate management strategy impacts to stakeholders could work to quantify adverse impacts on fishermen and fishing communities. How each party structures its allocation management domestically to achieve that allocation is not considered within the PST, so long as each party meets its agreed upon management objectives.

As a social-ecological system, both fisheries and human behavior are strongly affected by the availability and distribution of the resource – in this case, salmon (Berke, 1998). Changing the economic foundation of a region can alter its demographic composition and reduce the ability of those reliant on fisheries access to remain in the area (Gosnell & Abrams, 2011). As a result, managers must evaluate the biological, social, and economic condition of a fishery to truly assess its performance. Fishery policy is designed to address complex problems, in this case salmon management, and objectives often hold conflicting paradigms for interests such as a community or fishermen versus conservation. Fisheries management creates a forum to resolve these resource challenges. Fisheries management is often based on competing objectives that are developed in an attempt to design a policy that considers conflicting or inconsistent objectives

[35] See KCAW articles: Forum to examine politics behind Alaska's chinook conservation problem, March 2018 and In a tough year for trollers, Mallott backs Alaska's salmon treaty team, March 2018. Additionally, Business in Vancouver: Pacific Salmon Treaty 3.0 looms for B.C. Fishing Industry, May 2018.

simultaneously (Jensen, 1999). The PST's Article III Principles seek to promote salmon production and balance benefits to each country, while also considering interceptions, fishery disruptions and annual variations in abundance. The Article III Principles create conflict as objectives cannot be achieved with balancing one against others. As a result, conservation, benefit allocation, and social and economic impacts should be carefully considered to inform decision-makers.

Mandated by the MSA, U.S. Federal fisheries management is guided by principles known as the National Standards (NS). These standards are applied in any fishery management plan (FMP) when NMFS prepares analysis evaluating impacts caused by changes in management. Utilizing a similar approach to assess impacts under the PST may provide relevant information for decision-makers. Particularly in communities where fishery harvest benefits often translate directly to economies that are not diverse or are socially disadvantaged. Analysis of social and economic impacts could also increase process transparency.

Stakeholders cannot appeal a Treaty agreement and there are no requirements to measure a renegotiated Treaty's effectiveness beyond salmon production and allocation of benefits[36]. Establishing an evaluation framework to identify factors influencing the effectiveness of a governance system such as the PST may be beneficial in evaluating weaknesses in management systems that are creating barriers to effective management. This approach could support a more comprehensive evaluation for sustainable fisheries.

4. *Increase each country's responsibility to protect salmon habitat or implement habitat loss accountability into harvest objectives.*

As salmon abundance shifts, it may be appropriate to also consider anthropogenic or climatic affects impacting salmon abundance. For example, accountability measures reducing harvest benefits could be implemented in consideration of regional actions to impacting salmon productivity for stakeholders under PST jurisdiction.

5. *Consider approaches to salmon conservation and the allocation of benefits beyond fishery harvest control.*

[36] An exception may be within agreed to mitigation programs. For example, commitments to produce a specific amount of hatchery production.

Healthy salmon stocks depend on the overall health of the ecosystems they rely on. The challenges faced by the PST can be sourced from multiple influences: Environmental effects such as habitat loss and climate change present significant threats to salmon stocks, contributing disproportionately to salmon stock decline (Katz et al. 2013, Lichatowich, 1999). Fisheries management is "gradually becoming more ecological", as it moves away from a traditional focus on assessment of an individual species to multi-species stock analyses and is integrating a wider range of ecosystem-based management (Hughes, 2005 and Mollmann, 2014). Shifts in abundance and productivity have led to changes in the balance of "interceptions" between Canada and the U.S., exacerbating management disputes as a result (Miller, 2003). Additionally, significant uncertainty and difficulty exists in efforts to quantify natural and anthropogenic sources of salmon variability, productivity and survival (Crozier et al, 2021).

Salmon management difficulties are further compounded by the significant costs and logistical feasibility of managing fisheries in remote locations. For fishermen and fishing communities, the competence of the PST as an institution is undermined, as it does not have the authority needed to address these issues to support salmon conservation or the allocation of benefits. As a result, the PST is left with the continued erosion of benefits through harvest control policies and increased demand for mitigation funding. In considering approaches to salmon conservation and the allocation of benefits beyond fishery harvest control, feasibility must be considered. These scenarios are unlikely to occur without a nationally-driven Administration prioritization of salmon conservation along with fishery stability objectives.

The U.S. and Canada (or Alaska and the southern U.S.) could also consider a quid pro quo scenario when considering PST negotiations. This may be feasible as the two countries and the states involved interact for many issues beyond the PST, creating potential opportunity to create incentives for increased negotiation collaboration or compromise. Doing this could create additional incentives or tradeoffs when renegotiating the PST every decade. It would likely be controversial for this scenario to play a role for the PST as it would be a government-to-government interaction with PST Commissioners having no jurisdiction or authority over these outcomes.

Within the 1999 PST agreement, Attachment E (known as the Habitat and Restoration agreement) included a request for the PSC to report annually on the status of natural stocks that are not producing at optimum production, to identify the non-fishing factors that could be limiting production, options to address these factors, and the progress achieved within optimum production objectives. Additional focus could be placed on these reports as non-fishing factors influence salmon productivity and should be reported on for PST negotiators to consider.

7 Personal Reflections

As conservation efforts have failed to rebuild some salmon stocks, Alaska is experiencing consequences in harvest that were likely not anticipated in 1985. This paper could have looked to understand the effects of the PST on Alaska, since the region is considered as one AABM fishery within the PST. However, I wanted to understand how these impacts are filtering down to impact specific fishing fleets and individual fishermen.

The PST is a negotiation conflict as much as it is a policy problem, and it is impossible to discuss without understanding the divisions and gaming within the U.S. Section and across the Treaty forum. However, my intent in this report is to look at how this international forum's negotiations are translating to impacts for the commercial salmon troll fishery, which is an important part of SEAK's economy. In considering recommendations, it is much harder to make changes when the institution is imbedded into the societies who depend on salmon now, making consensus among stakeholders unlikely.

In my efforts to understand and evaluate the PST, I observed that the funding aspects of the PST often come up. The PST is complex and data intensive, and therefore costly to implement. It utilizes two endowment funds established in the 1999 Agreement for projects supporting research, management, data needs, enhancement and restoration needs for both the U.S. and Canada. There is clear, strong interest in how and where the funding is used in supporting salmon stocks and habitat. This phenomenon became apparent in discussions clarifying my understanding of the $109 million conservation and implementation program identified in the 2019 BiOp. These funds are used widely in support of the PST's objectives; however, it became clear that strategies to secure funds between regions are occurring and that the region receiving much of the funds (Washington) has developed an environmental and conservation focused

industry that is dependent on continued funds being made available for the restoration of salmon stocks and habitat. It seems likely that this funding, along with access to harvest opportunity, has been integrated into the rivalry seen between Alaska and the southern U.S., particularly as the 2019 BiOp places only Alaskan fisheries accountable should conservation funds for Washington ESA requirements not be provided. This is not an equitable sharing in the burden of conservation, and reducing Alaskan Chinook salmon harvest is not likely change the trajectory of ESA listed species without additional, substantial, conservation and restoration measures being taken.

It is an unfortunate reality that collaboration and reduced rivalry are not likely without fundamental changes to the PST structure. Divided U.S. interests will likely continue to overshadow negotiations with Canada, as there is no mechanism that allows incompatible interests being represented to be overcome. Meanwhile, the impacts of these divisions are not being considered with regard to affects to individual stakeholders. A more cooperative atmosphere within the U.S. Section could decrease strategies leveraging U.S. interests against one another, however it appears that domestic interests regarding salmon are divided to a level that is beyond the PST's ability to find compromise. I observed widespread support for salmon conservation and restoration among stakeholders, it is how (and to whom) the burden of conservation and reduced harvest opportunity are distributed that divisions and disproportionate affects from management decisions appear. This is particularly relevant for Alaska, given the low level of SEAK AABM fishery impacts on ESA-listed stocks, and the unique restrictions placed on the SEAK AABM fishery that have not been imposed on all fisheries. Additional efforts may be appropriate to ensure that conservation efforts are spread equitably among stakeholders, both internationally and domestically.

8 List of Acronyms

AABM – Aggregate Abundance-Based Management
ADFG – Alaska Department of Fish and Game
AI – Abundance Index
BOF – Board of Fisheries (Alaska)
CFEC – Commercial Fisheries Entry Commission
CPUE – Catch Per Unit of Effort
CTC – Chinook Technical Committee
EEZ – Exclusive Economic Zone
EIS – Environmental Impact Statement
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FCMA – Fisheries Conservation Management Act
FCZ – Fishery Conservation Zone
GOA – Gulf of Alaska
ISBM – Individual Stock-Based Management
LOA – Letter of Agreement
MSA – Magnuson-Stevens Fishery Conservation and Management Act
MSY – Maximum Sustained Yield
NMFS – National Marine Fishery Service
NPFMC – North Pacific Fishery Management Council
NS – National Standard
PCSRF – Pacific Coastal Salmon Recovery Fund
PSC – Pacific Salmon Commission
PST – Pacific Salmon Treaty
SEAK – Southeast Alaska
SRKW – southern resident Killer Whale
UNCLOS – United Nations Convention on the Law of the Sea
WCVI – West Coast Vancouver Island

9 Literature Cited:

Alaska Department of Fish and Game News Release. 2019 Southeast Alaska Troll Chinook Salmon Harvest Allocation and Chinook Salmon Management Restrictions. 2019. Division of Commercial Fisheries. http://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1021987160.pdf

Ayres, K. L., Booth, R. K., Hempelmann, J. A., Koski, K. L., Emmons, C. K., Baird, R. W., Balcomb-Bartok, K., Hanson, M. B., Ford, M. J., & Wasser, S. K. (2012). Distinguishing the impacts of inadequate prey and vessel traffic on an endangered killer whale (Orcinus orca) population. *PloS one*, *7*(6), e36842. https://doi.org/10.1371/journal.pone.0036842

Hare, S. R., Francis, R. C., Beamish, R. J. Climate change and salmon production in the northeast Pacific Ocean. 1995. *Ocean Climate and Northern Fish Populations*. Canadian Special Publication of Fisheries and Aquatic Sciences, 121 p. 357-372.

Berkes, F., Folke C. (Eds.). Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience. 1998 Cambridge University Press, New York, NY https://www.researchgate.net/publication/208573509_Linking_Social_and_Ecological_Systems_Management_Practices_and_Social_Mechanisms_for_Building_Resilience

Blumm, Michael C., Bodi, Lorraine F., Upstream: Salmon and Society in the Pacific Northwest. 1996. National Research Council. P. 268-272. Kindle.

Brown, Karol d. Truce in the Salmon War: Alternatives for the Pacific Salmon Treaty, 1999. Symposium, 74 Washington Law Review. 605 https://digitalcommons.law.uw.edu/wlr/vol74/iss3/4

Burke, William T. The New International Law of Fisheries: UNCLOS 1982 and Beyond. 1994. Clarendon Press, Oxford.

Chinook Technical Committee Annual Catch and Escapement Report for 2020. Pacific Salmon Commission.

Cline, Timothy, Schindler, Daniel., Hilborn, Ray. Fisheries portfolio diversification and turnover buffer Alaskan fishing communities from abrupt resource and market changes. *Nature Communications*, 2017; 8: 14042 DOI: 10.1038/NCOMMS14042

Congressional Research Service. The Pacific Salmon Treaty: The 1999 Agreement and Renegotiated Annex IV. 2009.

Crozier, Lisa G., Burke, Brian J., Chasco, Brandon E., Widener, Daniel L., Zabel, Richard W. Climate Change Threatens Chinook Salmon Throughout their Life Cycle. 2021. Communications Biology 4**,** 222 (2021). https://doi.org/10.1038/s42003-021-01734-w

Davis, Ruth, Hanich, Quentin. Transparency in fisheries conservation and management measures. 2020. Marine Policuy 104088. ISSN 0308-597X, https://doi.org/10.1016/j.marpol.2020.104088

Ebbin, Syma A. The Impact of the EEZ on Pacific Salmon Management: An Examination of Institutional Innovation and Interplay in the U.S. Pacific Northwest. 2005. https://www.researchgate.net/publication/226384623

Food and Agriculture Organization of the United Nations. Artisanal Fisheries. 2015. The Fish Project. http://www.fao.org/family-farming/detail/en/c/335263/

Gilk-Baumer, S., Evenson, D., Shedd, K., Templin, W. Mixed Stock Analysis of Chinook Harvested in Southeast Alaska Commercial Troll Fisheries, 2015. 2017. Alaska Department of Fish and Game Divisions of Sport Fish and Commerical Fisheries. Fishery Data Series No. 17-41 www.adfg.alaska.gov/FedAidPDFs/FDS17-41.pdf

Gislason, G., Lam, E., Knapp, G., Guettabi, M. Economic Impacts of Pacific Salmon Fisheries. 2017. Prepared for: Pacific Salmon Commission.

Gosnell, H., Abrams, J. Amenity Migration: Diverse conceptualizations of drivers, socioeconomic dimensions, and emerging challenges. 2011. GeoJournal, 76(4) 303-322 https://doi.org/10.1007/s10708-009-9295-4

Grafton, Quentin, Kompas, Tom, McLoughlin, Richard, Rayns, Nick. Benchmarking for fisheries governance. 2007. Marine Policy, Volume 31, Issue 4, Pages 470-479, ISSN 0308-597X, https://doi.org/10.1016/j.marpol.2006.12.007.

Hanson M., Emmons C., Ford M., Everett M., Parsons K., Park L., et al. (2021) Endangered predators and endangered prey: Seasonal diet of Southern Resident killer whales. PLoS ONE 16(3): e0247031. https://doi.org/10.1371/journal.pone.0247031

Hughes, T. P., Bellwood, D. R., Folke, C., Steneck, R. S., Wilson, J. New paradigms for supporting the resilience of marine ecosystems. 2005.Trends Ecol. Evol., 20 (7), pp. 380-386

Huppert, Daniel, D. Why the Pacific Salmon Treaty Failed to End the Salmon Wars. 1995. Scholar of Marine Affairs, University of Washington. SMA 95-1, Seattle.

Illical M., Harrison, K., Protecting endangered species in the US and Canada: The role of negative lesson drawing. 2007. Canadian Journal of Political Science. 40:376-394. https://www.jstor.org/stable/25166103

Irvine, James R., Fukuwaka, Masa-Aki. Pacific Salmon Abundance Trends and Climate Change. 2011. ICES Journal of Marine Science 68(6):1122-1130 DOI: 10.1093/icesjms/fsq199

Jensen, Carsten. A Critical Review of the Common Fisheries Policy. 1999. University of Southern Denmark, Esbjerg.

Jensen, Thomas C. The United States-Canada Pacific Salmon Interception Treaty: An Historical and Legal Overview. 1986. Environmental Law, *16*(3), 363-422. http://www.jstor.org/stable/43265761

Johnson, Bobbi M., Johnson, McClain, S., Thorgaard, Gary H. Salmon Genetics and Management in the Columbia River Basin. (2019) Northwest Science, 92(sp5), 346-363. https://doi.org/10.3955/046.092.0505

Johnston, Brent, R. H., Swimming Against a Legal Current: A Critical Analysis of the Pacific Salmon Treaty. 1998. 7 Dal J Leg Stud 125.

Kagan, R. A., *Adversarial Legalism: The American Way of Law.* 2001. Harvard University Press

Katz, J., Moyle, P. B., Quinones, R. M., Israel, J., Purdy, S. Impending extinction of salmon, steelhead, and trout (Salmonidae) in California. 2013. Environmental Biology of Fishes. V 96:1169-1186.

Kiffer, D. Alaska/Canada Salmon 'War' Was 10 Years Ago. 2007. SitNews: Stories in the News. Ketchikan, Alaska. http://www.sitnews.us/Kiffer/SalmonWars/071907_salmonwars.html

Knudsen, E. Managing Pacific salmon escapements: The gaps between theory and reality. 2000 Sustainable Fisheries Management: Pacific Salmon. Edited by E. Knudsen, C. Steward, D. MacDonald, J. Williams and D. Reiser, 237-72.

Lacy, R.C., Williams, R., Ashe, E. *et al.* Evaluating anthropogenic threats to endangered killer whales to inform effective recovery plans. *Sci Rep* **7,** 14119 (2017). https://doi.org/10.1038/s41598-017-14471-0

Lackey, Robert T. 2003. Pacific Northwest Salmon: forecasting their status in 2100. Reviews in Fisheries Science. 11(1): 35-88.

Lackey, R. T. A Salmon-Centric View of the 21st Century in the Western United States. (2004) Simon Fraser University, Burnaby, BC, Canada, , 131-137.

Lichatowich, J., Mobrand, L., Lestelle, L. Depletion and extinction of Pacific salmon (*Oncorhynchus* spp.): A different perspective. 1999. *ICES Journal of Marine Science*, Volume 56, Issue 4, P. 467–472 https://doi.org/10.1006/jmsc.1999.0457

Local Catch Network. 2020. https://localcatch.org/core-values/

McDowell Group. Economic Impact of the Pacific Salmon Treaty on the Alaska Troll Fishery. 2019. http://www.aktrollers.org/wp-content/uploads/2021/01/Economic-Impact-of-the-PST-on-SE-Trollers-Final-Report-12-5-2019-2-2-1.pdf

Miller, Kathleen, A., North American Pacific Salmon: A Case of Fragile Cooperation. 2003. Environmental and Societal Impacts Group, National Center for Atmospheric Research. Food and Agriculture Organization of the United Nations. http://www.fao.org/3/y4652e/y4652e09.htm

Möllmann, C., Lindegren, M., Blenckner, T., Bergström, L, Casini, M., Diekmann, R., Flinkman, J., Müller-Karulis, B., Neuenfeldt, S., Schmidt, J. O., Tomczak, M., Voss, R., Gårdmark, A. Implementing ecosystem-based fisheries management: from single-species to integrated ecosystem assessment and advice for Baltic Sea fish stocks. 2014. ICES J. Mar. Sci., 71 (5), pp. 1187-1197

Montgomery, DR. (2003) *King of Fish: The Thousand Year Run of Salmon*. Westview, Press, Boulder, CO.

National Marine Fisheries Service, West Coast Region. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response. Consultation on the Delegation of Management Authority for Specified Salmon Fisheries to the State of Alaska. 2019. NMFS Consultation Number: WCR-2018-106660

National Park Service. Olympic National Park, Washington. The Salmon Life Cycle. 2019. https://www.nps.gov/olym/learn/nature/the-salmon-life-cycle.htm

Noakes, D., Fang, L., Hipel, K. et. Al. The Pacific Salmon Treaty: A Century of Debate and an Uncertain Future. (2005). Group Decision Negotiations 14, 501-522. https://doi.org/10.1007/s10726-005-9005-7

Pacific Fishery Management Council. Pacific Fishery Management Council Salmon Fishery Management Plan Impacts to Southern Resident Killer Whales. Risk Assessment. 2020. SRKW Workgroup Report 1. https://www.pcouncil.org/documents/2020/05/e-2-srkw-workgroup-report-1-pacific-fishery-management-council-salmon-fishery-management-plan-impacts-to-southern-resident-killer-whales-risk-assessment-electronic-only.pdf/

The Pacific Salmon Treaty Act of 1985. P.L. 99-5, 99 Stat. 7; 16 U.S.C. 3631-3634

Rutter, Larry G., Salmon Fisheries in the Pacific Northwest: How are Harvest Decisions Made? 1997. Pacific Salmon & Their Ecosystems.

Schmidt, R. Jr., International negotiations paralyzed by domestic politics: two-level game theory and the problem of the Pacific Salmon Commission. 1996. Environmental Law 26: 95-139. https://www.jstor.org/stable/43266468?seq=1

Schoen, Erik, Wipfli, Mark, Trammell, Jamie, Rinella, Daniel, Floyd, Anjelica, Grunblatt, Jess, McCarthy, Molly, Meyer, Benjamin, Morton, John, Powell, James, Prakash, Anupma, Reimer, Matthew, Stuefer, Svetlana, Toniolo, Horacio, Wells, Brett, Witmer, Frank. (2017) Future of Pacific Salmon in the Face of Environmental Change: Lessons from One of the World's Remaining Productive Salmon Regions, Fisheries, 42:10, 538-553. DOI: 10.1080/03632415.2017.1374251

Shepard, M. P., Argue, A. W., Ocean Pasturage in the Pacific Salmon Treaty Fact or Fiction? 1998. Canadian Industry Report of Fisheries and Aquatic Science 242. Department of Fisheries and Oceans Canada, Vanouver, B.C. https://waves-vagues.dfo-mpo.gc.ca/Library/222014.pdf

Skannes, Pattie, Hagerman, Grant, Shaul, Leon. Annual Management Report for the 2015 Southeast Alaska/Yakutat Salmon Troll Fisheries. 2016. Alaska Department of Fish and Game, Division of Sport Fish and Commercial Fisheries. Fishery Management Report No. 16-05.

State of Salmon in Watersheds. 2020. https://stateofsalmon.wa.gov/

Stevens, Ted. United States-Canada Salmon Treaty Negotiations: The Alaskan Perspective. 1986. Environmental Law. Vol. 16:423. Copy provided by Alaska Resources Library & Information Services.

Strangway, David., and Ruckelshaus, William. Pacific Salmon**.** 1998. Report to the Prime Minister of Canada and the President of the United States. Washington, DC. As released by the Bureau of Oceans and International Environmental and Scientific Affairs. https://1997-2001.state.gov/global/oes/oceans/salmon_980112.html

Taylor, Joseph E. III. Making Salmon: An Environmental History of the Northwest Fisheries Crisis. Foreword by William Cronon. (Weyerhaeuser Environmental Books.) Seattle: University of Washington Press. 1999.

Tsang, L. The Endangered Species Act and Climate Change: Selected Legal Issues. 2019. Congressional Research Service (CRS).

United States Department of State. International Fisheries Management. Office of Marine Conservation. www.state.gov/key-topics-office-of-marine-conservation/#fisheries

United States Department of Commerce. National Oceanic and Atmospheric Administration. 50 CFR Part 222 [Docket No. 980414094-9287-02; I.D. No. 091797A] RIN 0648-AK55 Endangered and Threatened Wildlife and Plants; Definition of ``Harm''. National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce. Final rule. Federal Register: November 8, 1999 (Volume 64, Number 215). Rules and Regulations. P 60727-60731. From the Federal Register Online via GPO Access [wais.access.gpo.gov]. https://www.fws.gov/endangered/laws-policies/definition-of-harm.html

United States Convention on the Law of the Sea (UNCLOS) art. 57, 1982. Note: Canada ratified UNCLOS in 2003, the United States has not ratified UNCLOS.

United States v. Washington (Phase I), 520 F.2d 9th Cir. 1975.

Vienna Convention on the Law of Treaties. May 23, 1969, art. 2(1)(a), 1155 U.N.T.S. 331. https://www.jus.uio.no/lm/un.law.of.treaties.convention.1969/2.html

Walters, C. J., Martell, S. D., Fisheries Ecology and Management. 2004. Princeton (New Jersey): Princeton University Press p.399

Waples, Robin S., Nammack, Marta, Cochrane, Jean Fitts, Hutchings, Jeffrey A. A Tale of Two Acts: Endangered Species Listing Practices in Canada and the United States. 2013. *BioScience*, Volume 63, Issue 9 (723–734) https://doi.org/10.1525/bio.2013.63.9.8

Williams, Austin. The Pacific Salmon Treaty: A Historical Analysis and Prescription for the Future. 2007. 22 J. Envtl. L. & Litig. 153.

Wilson, Rollie. Removing Dam Development to Recover Columbia Basin Treaty Protected Salmon Economies. 2001. American Indian Law Review 24:2 357 https://digitalcommons.law.ou.edu/ailr/vol24/iss2/4

Personal communications:

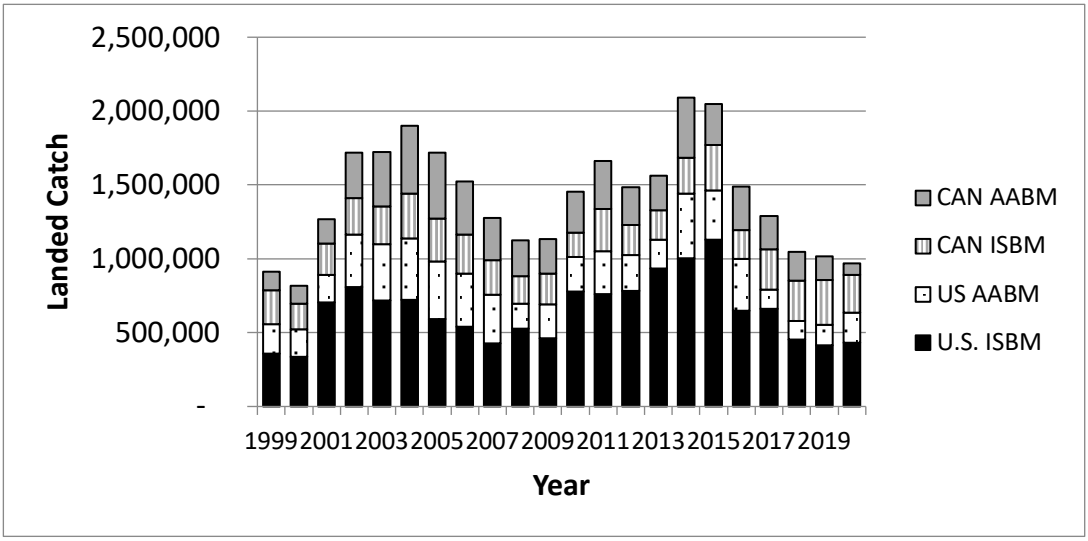
- Dani Evenson, ADFG Treaty Coordinator
- Deborah Lyons, stakeholder and Northern Panel representative
- David Balton, Wilson Center
- Clem Tillion
- Garrett Evridge, fisheries economist

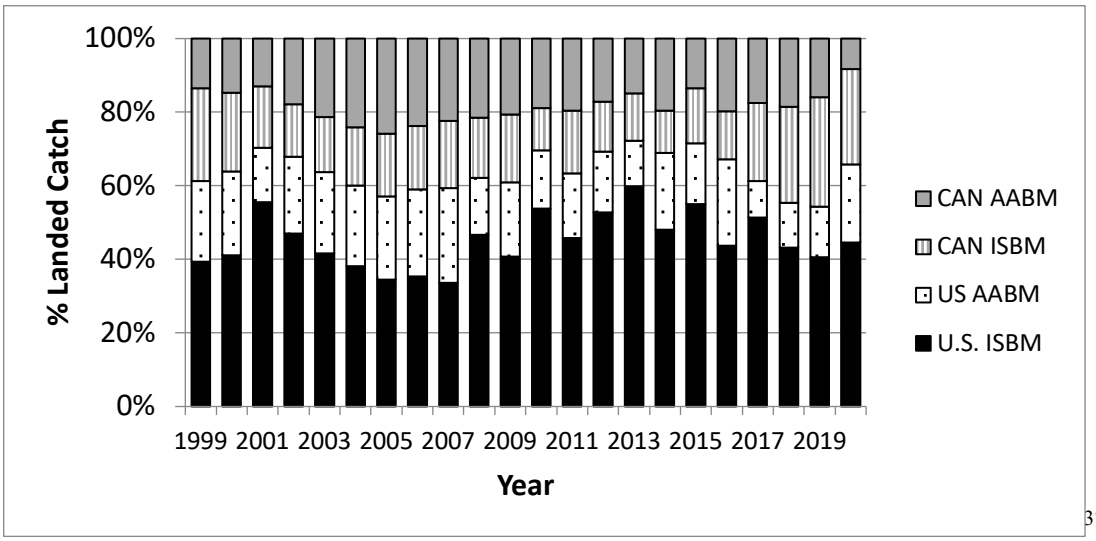
- Bill Auger, stakeholder and Panel representative
- Ann Robertson, Senate legislative staff
- Dan Lesh, fisheries analyst

10 Appendices

10.1 Appendix A: Pacific Salmon Treaty Map

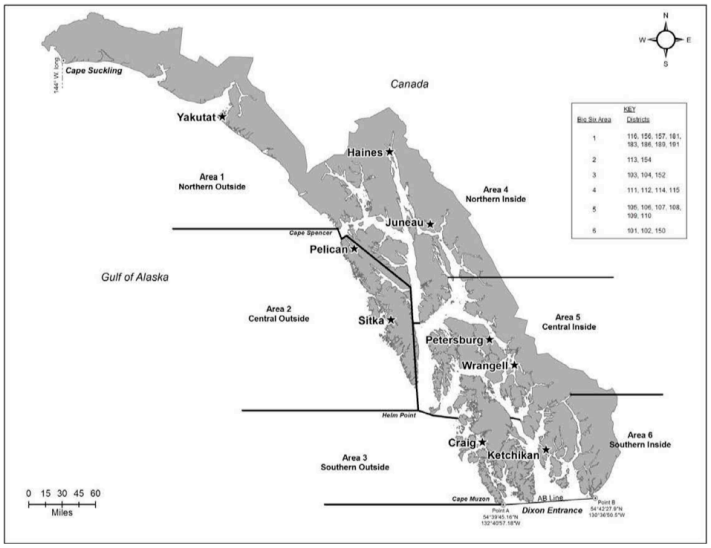
10.2 Appendix B: Total Landed Chinook Salmon Catch All ISBM and AABM Fisheries, Landed Catch and Percentage





[37]

10.3 Appendix C: Southeast Alaska Commercial Troll Fishery Area



[37] Source: Chinook Technical Committee Annual Catch and Escapement Report for 2020

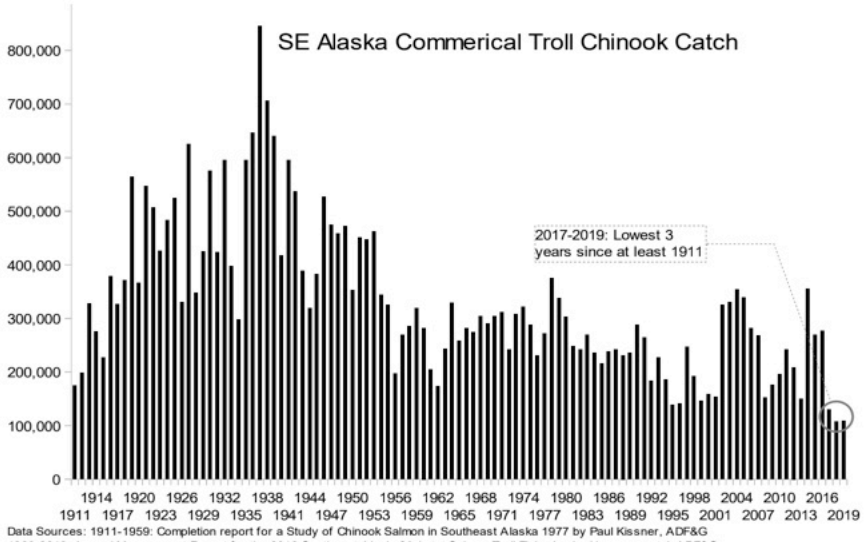
10.4 Appendix D: Southeast Alaska Troll Harvest by Species

Table 5. Power Troll Harvest by Species, Pounds (Net Weight), 2000-2018

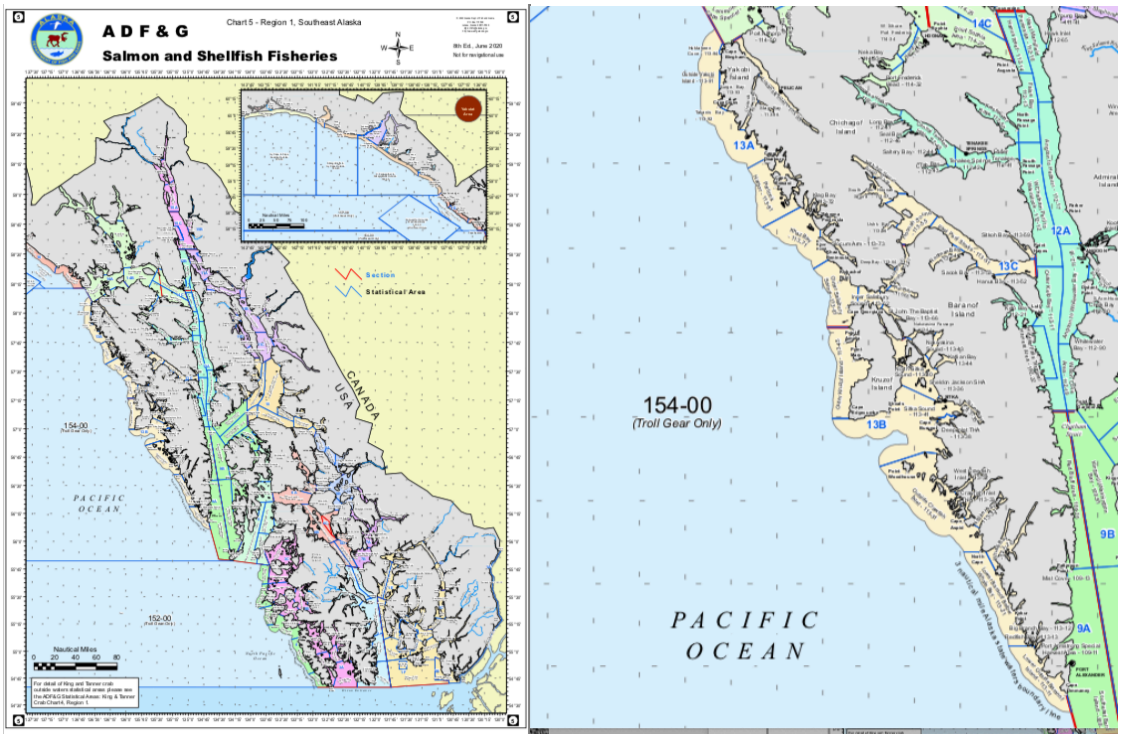
Year	Chum	Coho	Chinook	Pink	Sockeye	Total
2000	4,454,690	6,876,689	2,304,149	681,205	23,276	**14,340,009**
2001	4,296,366	10,578,360	2,361,299	934,222	47,760	**18,218,007**
2002	1,060,290	8,565,918	5,035,050	290,346	6,835	**14,958,439**
2003	2,214,286	7,482,035	4,732,299	575,135	23,194	**15,026,949**
2004	1,398,856	11,974,212	4,944,674	207,133	26,521	**18,551,396**
2005	1,451,247	10,772,611	4,421,504	373,635	62,728	**17,081,725**
2006	1,459,752	8,235,880	3,840,731	226,457	38,562	**13,801,382**
2007	1,481,123	7,486,694	3,586,749	379,566	34,411	**12,968,543**
2008	547,602	8,947,777	2,026,860	106,300	6,638	**11,635,177**
2009	2,792,398	8,682,320	2,254,614	231,554	15,342	**13,976,228**
2010	3,431,009	8,673,824	2,573,166	331,244	9,871	**15,019,114**
2011	5,479,778	6,489,221	2,843,819	1,829,869	26,789	**16,669,476**
2012	4,723,509	6,470,075	2,443,601	557,463	16,770	**14,211,418**
2013	8,171,040	12,271,832	1,744,082	2,177,320	22,955	**24,387,229**
2014	1,821,287	13,536,285	4,016,894	285,620	35,755	**19,695,841**
2015	3,433,074	7,027,117	3,016,512	976,055	27,131	**14,479,889**
2016	1,397,452	8,784,558	2,788,559	198,538	30,782	**13,199,889**
2017	3,747,874	10,437,314	1,344,135	192,471	24,122	**15,745,916**
2018	4,453,343	6,285,100	1,204,833	209,364	21,882	**12,174,522**

Source: ADFG, 2019.
Note: 2018 data are preliminary.

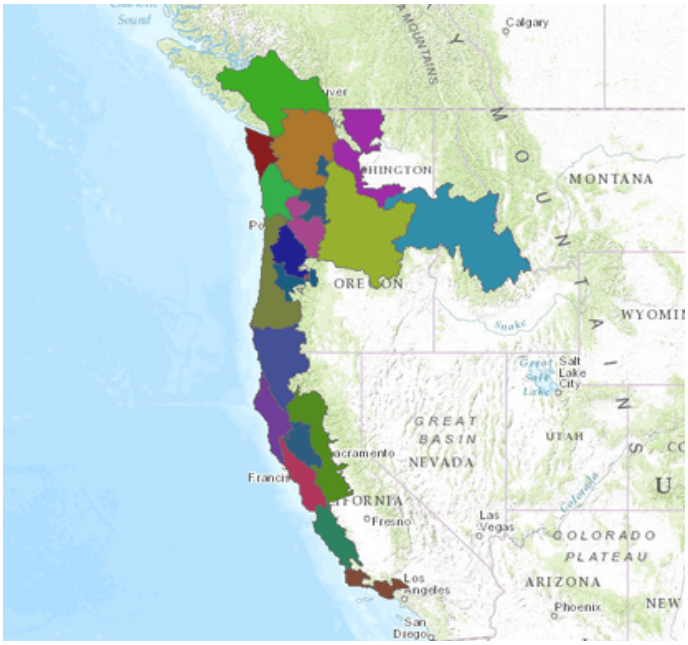
10.5 Appendix E: Southeast Alaska Commercial Troll Chinook Catch Over Time



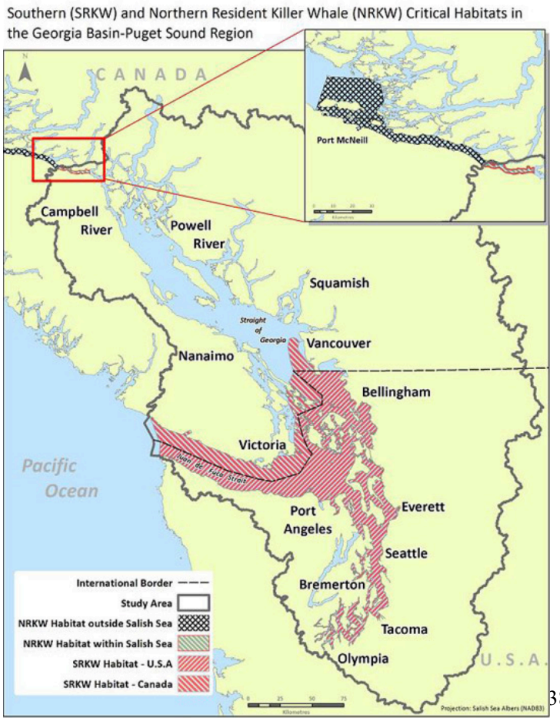
10.6 Appendix F: Salmon Statistical Area Maps for Southeast Alaska



10.7 Appendix G: Map Showing Boundaries of Evolutionarily Significant Units (ESUs) of Salmon on the West Coast of the U.S.



10.8 Appendix H: Southern Resident Killer Whale Critical Habitat in the Puget Sound Region



[38]

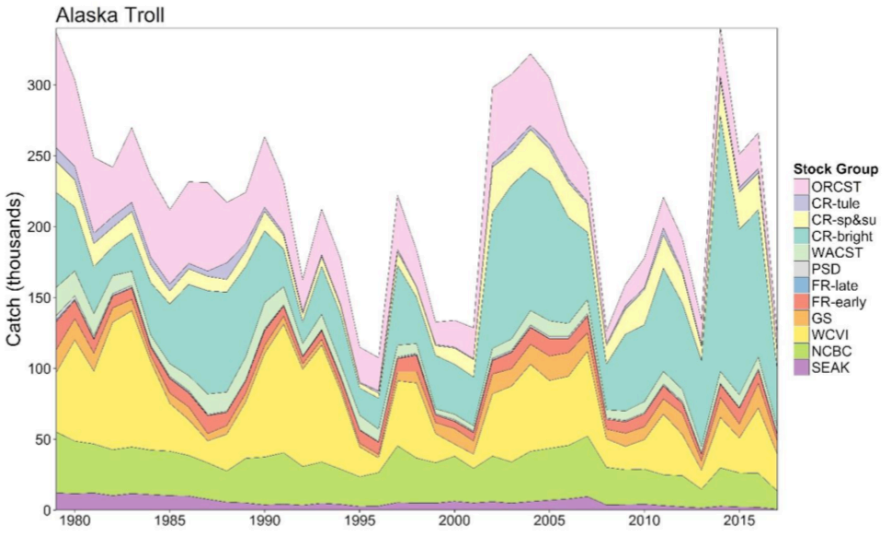
10.9 Appendix I: Chinook Salmon Stock Composition of Landed Catch

APPENDIX E: FIGURES OF CHINOOK MODEL-GENERATED STOCK COMPOSITION OF ACTUAL LANDED CATCH FOR ALL (AABM AND ISBM) MODEL FISHERIES, 1979-2017

Stock abbreviations in each figure correspond to the following model stocks and aggregations:

ORCST	Oregon Coast
CR-tule	Columbia River-Fall Tule stocks (Spring Creek, Lower River Hatchery, and Cowlitz Fall)
CR-sp&su	Columbia River Spring and Summer stocks (Willamette, Cowlitz Spring, Columbia Summers)
CR-bright	Columbia River Fall Bright stocks (Upriver, Mid-Columbia, Lewis River Wild, Lyons Ferry)
WACST	Washington Coast
PSD	Puget Sound stocks (Nooksack Fall and Spring, Natural Fall Fingerlings, Hatchery Fall Fingerlings, Hatchery Yearlings, Skagit Wild, Stillaguamish Wild, Snohomish Wild)
FR-late	Fraser River Late stock
FR-early	Fraser River Early stocks
GS	Georgia Strait stocks (Upper, Lower Natural, Lower Hatchery)
WCVI	West Coast Vancouver Island Stocks (hatchery and natural)
NCBC	North Central British Columbia stocks
SEAK	Southeast Alaska stocks

[38] The SRKW critical habitat is one habitat, but is displayed as two separate areas to help illustrate what portion of the habitat is on each side of the Canadian and U.S. border.



Appendix E5–Chinook Model Estimates of landed catch stock composition for Washington and Oregon troll, 1979–2017.