

PACIFIC SALMON COMMISSION
JOINT CHUM TECHNICAL COMMITTEE
2019 POST-SEASON SUMMARY REPORT
TCCHUM SALMON (23) – 01

MAY 2023

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LIST OF ACRONYMS AND ABBREVIATIONS

B.C.	British Columbia
CDFO	Canadian Department of Fisheries and Oceans or Fisheries and Oceans Canada
ChumTC	Joint Chum Technical Committee
ChumGEM	Chum Genetic Environmental Model
CPUE	Catch per Unit Effort
CU	Conservation Unit (Canada)
CWT	Coded-Wire Tag
EO	Economic Opportunity
ESSR	Excess Salmon to Spawning Requirements
FN	First Nation
FSC	Food, Social, and Ceremonial
GN	Gill net
GSI	Genetic Stock Identification
ISC	Inside Southern Chum
ITQ	Individual Transferable Quota
mSAT	Microsatellite
NOAA	National Oceanic and Atmospheric Administration
NWIFC	Northwest Indian Fisheries Commission
PFMA	Pacific Fishery Management Area
PNPTC	Point No Point Treaty Council
PSC	Pacific Salmon Commission
PST	Pacific Salmon Treaty
RAD	Restriction site associated DNA sequencing
SJF	Strait of Juan de Fuca
SJI/PR	San Juan Islands/Point Roberts
SN	Seine net
SNP	Single Nucleotide Polymorphism
TCCHUM	Joint Chum Technical Committee
TR	Troll
U.S.	United States of America
UW	University of Washington
WA	Washington State
WCVI	West Coast Vancouver Island
WDFW	Washington Department of Fish and Wildlife

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1 Executive Summary

This Pacific Salmon Commission (PSC) Joint Chum Technical Committee report documents the information on Chum Salmon stocks and fisheries in southern British Columbia (B.C.) and Washington (WA) for the year 2019 to address the specific provisions and requirements of Chapter 6, Annex IV (Chum Salmon Annex) of the Pacific Salmon Treaty (PST or Treaty) (Appendix A). The Treaty between the governments of Canada and the United States of America (U.S.) concerning Pacific salmon is designed to facilitate co-operation in the management, research and enhancement of Pacific Salmon stocks. On May 3, 2019, Canada and the U.S. (the Parties) ratified a new 10-year agreement for these fisheries that is now in force through 2028. The Chum Salmon Annex requires that Canada and the U.S. maintain a Joint Chum Technical Committee, reporting to the Southern Panel and the Commission, and that certain fisheries for Chum Salmon in southern B.C. and WA be managed in a specified manner (Appendix A). Certain fisheries of each country, while not specifically mentioned in the PST, are known to harvest Chum Salmon originating in the other country.

This report presents information for Chum Salmon found in B.C. waters between Vancouver Island and the mainland, off the west coast of Vancouver Island, and in WA waters. This report also discusses the management actions of Canada and the U.S. in relation to the PST requirements for Chum Salmon and provides a summary of the last 10 years of catch and escapement information for Chum Salmon stocks of concern to the Treaty.

Returns in 2019 were significantly below the recent 9-year average in B.C. and WA.

In 2019, the Chum Salmon Technical Committee continued developing components of the Southern Chum Salmon Strategic Plan.

2 Status of Treaty Requirements

Chum Salmon stocks and fisheries in southern B.C. (Appendix B-2; Appendix B-3) and in U.S. Areas 4B, 5, 6C, 7, and 7A (Appendix B-1) were managed under the terms set out in Chapter 6, Annex IV (Appendix A). The following provides a brief synopsis of the Canadian and U.S. management actions taken to meet each countries Treaty provisions in 2019.

Paragraph 1:

The Parties shall establish and maintain a Joint Chum Salmon Technical Committee (the "Committee"). The Committee shall report, unless the Parties otherwise decide, to the Southern Panel and the Commission.

Note: Specific tasks for the Committee are listed in Annex IV Chapter 6, Paragraph 1.

The Committee convened three times in the 2019-2020 season: during the Joint Chum Technical Meeting in May 2019, the PSC Post-Season Meeting in January 2020, and the PSC Annual Meeting in February 2020. Additional detail of the work performed by the Committee in 2019-2020 can be found in the Committee's 2019-2020 Work Plan (Appendix C).

In 2010 the Committee published a direction paper to guide development and application of a jointly agreed genetic baseline for Chum Salmon stocks in southern B.C. and Washington

(TCCHUM 2013). This led to the development of the Southern Chum Salmon Strategic Plan and the concept of a Chum Salmon Genetic and Environmental Model (ChumGEM) in 2011 (Figure 2-1).

In 2019, twelve projects were funded by the PST Southern Boundary Restoration and Enhancement Fund (Southern Fund) to carry forward priorities identified by the ChumTC or to further knowledge of Chum Salmon. Project inventory and final reports can be found at the PSC Southern Fund Project Reports webpages (<https://www.psc.org/publications/endowment-fund-projects/>). Detail on select projects involving ChumTC members can be found in Appendix D.

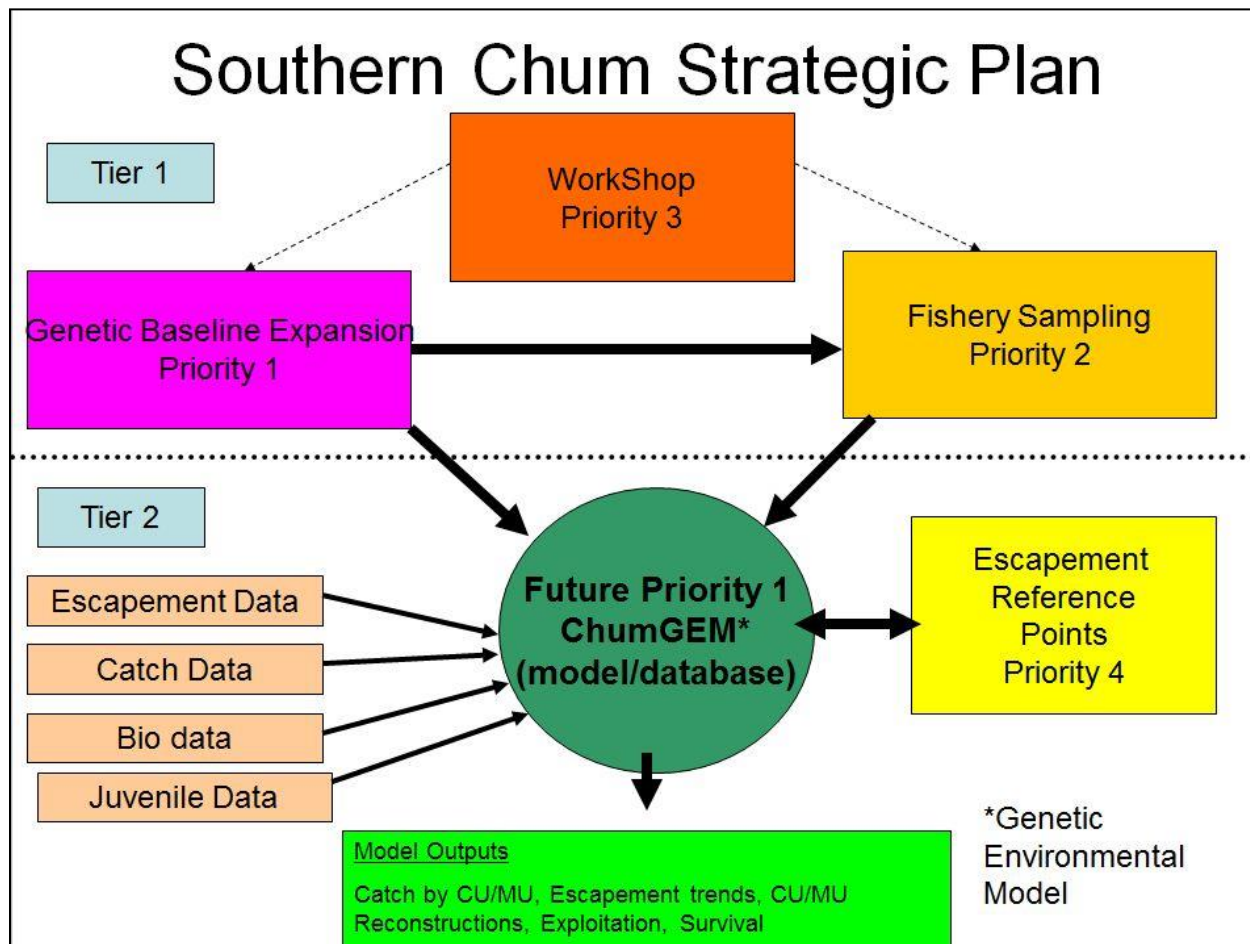


Figure 2-1. Schematic of Southern Chum Salmon Strategic Plan created by the PSC Joint Chum Technical Committee June 1-3, 2011.

Paragraph 2:

When the Parties provide stock composition information for fisheries, the Committee shall evaluate and use bilaterally approved methods to report its conclusions.

For this report, the Committee applied stock composition information obtained through sampling key fisheries during the 2019 season. Historical stock compositions were used for fisheries that were not sampled in 2019.

Paragraph 3:

The Parties shall assess catch levels and attempt to collect additional genetic samples from any chum salmon caught between July 1 and September 15 in the boundary area fisheries (U.S. Areas 4B, 5, 6C, 7, and 7A; Canadian Areas 18, 19, 20, 21, and 29).

Table 3-4 and Table 4-3 provide the harvest of Chum Salmon during the period of summer Chum Salmon migration in boundary areas. Due to the low numbers of Chum Salmon encountered, neither party collected samples for genetic stock identification (GSI) during this time period.

Paragraph 4:

From July 1 through September 15, Canada shall require the live release of chum salmon from all purse seine gear fishing in the Strait of Juan de Fuca (Canadian Area 20) and the United States (U.S.) shall require the same for the non-Indian seine fisheries in Areas 7 and 7A. By U.S. regulation, purse seine fisheries are not permitted in U.S. Areas 4B, 5 and 6C.

Regulations were implemented by both countries to require the live release of Chum Salmon in these areas during this time period.

Paragraph 5:

Canada shall manage its Johnstone Strait, Strait of Georgia, and Fraser River chum salmon fisheries to provide continued rebuilding of depressed naturally spawning chum salmon stocks, and, to the extent practicable, not increase interceptions of U.S. origin chum salmon. Terminal fisheries conducted on specific stocks with identified surpluses will be managed to minimize interception of non-targeted stocks.

Table 3-1 provides an evaluation of the performance of the current Johnstone Strait management strategy (2010–2019). Historical GSI results and genetic estimates from 2010 through 2019 continued to indicate a low contribution of U.S. stocks in Johnstone Strait, Strait of Georgia and Fraser River Chum Salmon fisheries.

Management strategies (see section 3.2) and annual fishery descriptions (see section 3.3) indicate that Canada's Johnstone Strait, Strait of Georgia, and Fraser River Chum Salmon fisheries in addition to the terminal area fisheries, were managed to meet the provisions of Paragraph 5 of Annex IV, Chapter 6, of the PST.

Paragraph 6:

Canada shall manage its Johnstone Strait mixed stock fishery as follows:

- a) The Inside Southern Chum run size estimate by Canada of 1.0 million chum is defined as the Inside Southern Chum Critical Threshold. Inside Southern Chum salmon levels of less than this Threshold are considered critical for the purposes of this Chapter;*
- b) For run sizes above the Inside Southern Chum Critical Threshold, Canada shall conduct fisheries with an exploitation rate of up to 20% in Johnstone Strait of Inside Southern chum salmon; and*

- c) *When run sizes are expected to be below the Inside Southern Chum Critical Threshold, Canada shall notify the U.S. and shall only conduct assessment fisheries and non-commercial fisheries. Canada shall suspend the operation of commercial fisheries that target chum salmon in Johnstone Strait.*

From the onset of the Johnstone Strait Test Fishing program the Chum Salmon catch per unit effort (CPUE) in the test fishery was well below what was encountered during 2010, one of the lowest Chum returns on record (1980-2018). On October 7th Canada notified the U.S. the Inside Southern Chum (ISC) index of abundance was likely below the 1.0 million critical level and any planned Johnstone Strait commercial mixed stock fisheries were suspended. For the duration of the test fishery the Chum CPUE continued to track well below 2010 and was the lowest on record.

Paragraph 7:

Canada shall manage its Fraser River fisheries for chum salmon as follows:

- a) *For Fraser River terminal area run sizes, identified in-season, at abundance levels lower than 900,000 chum salmon, the Canadian commercial chum salmon fisheries within the Fraser River and in associated marine areas (Area 29), shall be suspended; and*
- b) *For Fraser River terminal area run sizes, identified in-season at abundance levels greater than 900,000 chum salmon, the Canadian commercial chum salmon fisheries within the Fraser River, shall be guided by the limits of the in-river Total Allowable Catch set by Canada.*

In 2019, in-season abundance estimate indicated a terminal return below the specified Fraser River terminal area run size breakpoint (see section 3.3.3).

Paragraph 8:

Canada shall manage the Nitinat gill net and purse seine fisheries for chum salmon to minimize the harvest of non-targeted stocks.

Due to an extremely low Chum return, escapement goals to the Nitinat system were not met in season; therefore, no commercial fisheries were authorized in 2019. The terminal return in 2019 was estimated at 46,000 Chum Salmon which is well below the lower reference point and the lowest return over the last 10 years (see section 3.3.4.1; Table 3-10).

Paragraph 9:

The U.S. shall manage its chum salmon fishery in Areas 7 and 7A as follows:

- a) *Inside Southern chum salmon levels of less than the Inside Southern Chum Critical Threshold of 1.0 million as estimated by Canada are considered critical for purposes of this Chapter;*
- b) *For the run sizes below the Inside Southern Chum Critical Threshold, the U.S. catch of chum salmon in Areas 7 and 7A shall be limited to chum salmon taken incidentally to other species and in other minor fisheries, but shall not exceed 20,000. Catches for the purpose of genetic stock identification sampling shall not be included in this limit;*

- c) *For run sizes above the Inside Southern Chum Critical Threshold, the catch ceiling for the U.S. chum salmon fishery in Areas 7 and 7A shall be 125,000 chum salmon, except as provided in sub-paragraph;*
- d) *Canada shall provide a run size estimate of chum salmon entering the Fraser River no later than October 22 of each year. Canada shall notify the U.S. whenever Canada updates the formal Fraser River chum run size estimate if that update results in a change to the U.S. catch ceiling. If the Fraser run size estimate is less than 1,050,000, the U.S. shall limit its fishery impacts on Fraser River chum salmon by restricting catch in Areas 7 and 7A to not exceed 20,000 additional chum salmon from the day following the date the U.S. is notified. If the Fraser River run size estimate is between 1,050,000 and 1,600,000, the U.S. catch ceiling shall be revised to 160,000;*
- e) *U.S. commercial fisheries for chum salmon in Areas 7 and 7A shall not occur prior to October 10 of each year;*
- f) *The U.S. shall manage the Areas 7 and 7A fisheries for chum salmon in order to minimize the harvest of non-target species;*
- g) *U.S. catch shortfalls may not be accrued; however, overages shall be carried forward as indicated in sub-paragraphs (h), (I), and (j);*
- h) *Due to management imprecision:*
 - (i) *if the U.S. chum catch ceiling is 125,000, a catch in the U.S. of up to 135,000 chum salmon shall not result in an overage calculation. A catch that exceeds 135,000 shall result in an overage, which is calculated by subtracting 125,000 from the total U.S. chum catch; and*
 - (ii) *if the U.S. chum catch ceiling is 160,000, a catch in the U.S. of up to 170,000 shall not result in an overage calculation. A catch that exceeds 170,000 shall result in an overage, which is calculated by subtracting 160,000 from the total U.S. chum catch;*
- i) *Overages under paragraph 9 (h)(I) or 9 (h)(ii) shall be accounted for by reducing the U.S. annual catch ceilings in up to two subsequent non-critical Inside Southern chum salmon years;*
- j) *From the day following the date the U.S. is notified of a run size below the Inside Southern Chum Critical Threshold as defined in paragraph 9(a) or below a Fraser River chum run size estimate of 1,050,000, any catch that exceeds 20,000 chum salmon results in an overage. Overages shall be accounted for by reducing the U.S. annual catch ceilings in up to two subsequent non-critical Inside Southern chum salmon years;*
- k) *If, subsequent to the revision of the U.S. catch ceiling to 160,000, further in-season run size information changes such that the Fraser River chum run size estimate is revised downward to between 1,050,000 and 1,600,000, the U.S. shall manage their fisheries in Area 7 and 7A to stay below the catch ceiling of 125,000. If the lower catch ceiling has already been reached, the U.S. shall terminate these fisheries; and*

- l) In circumstances described in paragraph 9(k), overage calculations shall be based on the highest catch ceiling determined in that season provided the U.S. terminates these fisheries.*

In 2019, U.S. fisheries in Areas 7 and 7A were managed in accordance with the above provisions. Initial notification from Canada was on October 7, 2019 that the Inside Southern Chum Salmon return was expected to be below the critical threshold. Following this notification, the U.S. suspended Area 7 and 7A commercial Chum Salmon fisheries that were scheduled to open on October 10. The estimated Fraser River Chum Salmon terminal run size was provided by Canada on October 16, 2019. Consistent with the Treaty obligations, the U.S. cancelled Area 7 and 7A commercial Chum Salmon fisheries (see section 4.3.2).

Paragraph 10:

The U.S. shall conduct its chum salmon fishery in the Strait of Juan de Fuca (U.S. Areas 4B, 5 and 6C) with a view to maintaining the limited effort nature of this fishery, and, to the extent practicable, not increase interceptions of Canadian origin chum salmon. The U.S. shall continue to monitor this fishery to determine if recent catch levels indicate an increasing level of interception.

This fishery is restricted to Treaty Indian fishers from four tribes and to gill net gear only. Due to the limited effort of the Juan de Fuca fishery, the Committee has not sampled this commercial fishery for contribution of Canadian-origin Chum Salmon since 1996. Genetic stock identification (GSI) samples collected from this fishery in prior years indicated the majority of the catch is Chum Salmon of U.S. origin (Beattie *et al.* 1996).

Paragraph 11:

The Parties shall exchange all information concerning non-target catch of other salmon species, including steelhead, from the chum salmon fisheries covered by this Chapter in the annual post-season report.

Bycatch information for other salmon species was shared in accordance with the Treaty through each Party's post-season reporting process.

Paragraph 12:

If circumstances arise that are inconsistent with a Party's understanding of the intent of this Chapter, the Southern Panel shall discuss the matter in the post-season and explore options for taking the appropriate corrective action.

During 2019, with the in-season run-size for Inside Southern Chum estimated to be below the critical threshold for opening commercial fisheries, the U.S. chair of the Southern Panel notified their Canadian counterpart of a limited fishery in U.S. Area 7/7A to collect tissue samples for GSI analysis and to provide fish for tribal subsistence use. There was some uncertainty as to whether formal approval from Canada was required before conducting this type of fishery, given the language in the Treaty Chum Annex. Ultimately, this fishery did not occur in 2019 and the question of formal approval was brought to the full Southern Panel for further discussion.

3 Southern British Columbia Chum Salmon

Southern B.C. Chum Salmon stocks and fishing areas (Pacific Fishery Management Areas or PFMAs; Appendix B-2) are, for the purposes of management, analysis and reporting, grouped into four major units: Johnstone Strait, Strait of Georgia, Fraser River, and the West Coast Vancouver Island (WCVI). Additionally, Chum Salmon originating from Johnstone Strait, the Strait of Georgia, and the Fraser River are collectively described as Inside Southern Chum (ISC) Salmon.

3.1 Status of Treaty Requirements

During 2019, Southern B.C. Chum Salmon fisheries were managed according to the requirements of Annex IV, Chapter 6, as amended on May 3, 2019 (Appendix A).

3.2 Conservation and Harvest Management Strategies

The general management approach adopted by Fisheries and Oceans Canada (CDFO) for Southern B.C. Chum Salmon is to achieve wild escapement targets, while augmenting production through enhancement of selected stocks. In practice, this approach is achieved through the application, in mixed stock fisheries, of harvest rates which are compatible with wild or natural stock productivity. If there are Chum Salmon stocks that return to their area of origin in numbers above that area's escapement goal, they may be subject to additional harvesting within their terminal areas.

The following describes the management strategies and fishing plans for the four units of Southern B.C. Chum Salmon stocks.

3.2.1 Johnstone Strait Chum Salmon Management Strategy

Since 2002, the mixed stock Chum Salmon directed fisheries in Johnstone Strait have been managed to approximate a fixed exploitation rate (~20%). Tagging studies conducted from 2000 through 2002 helped in the development of this fixed exploitation rate strategy by assessing the migration timing and harvest rate by fishing gear on an available abundance of Chum Salmon in Johnstone Strait. This fixed exploitation strategy continued to be employed through 2019 (CDFO 2019a).

Some of the key objectives of this strategy are to ensure sufficient escapement levels while providing more stable fishing opportunities (CDFO 2019a). The exploitation rate is set at 20% across all harvesters, when abundance is estimated to be above a critical level. The critical level, or threshold, was determined to be 1.0 million Chum Salmon (Appendix A). The Johnstone Strait Chum Salmon test fishery, as well as the information gained from any commercial openings, is used in-season to determine the likelihood of achieving the critical level for Inside Southern Chum Salmon. When expected levels are less than 1.0 million, only assessment fisheries and non-commercial fisheries will be conducted and any planned commercial fisheries targeting Chum Salmon will be suspended (Appendix A). When the critical level is expected to be achieved, fisheries with an exploitation rate of up to 20% in Johnstone Strait can be conducted (Appendix A).

Table 3-1. Aggregate Inside Southern Chum estimates of total return, harvest and spawning escapements. Comparison of fixed target and actual harvest rates in the Johnstone Strait fisheries, 2010–2019¹.

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
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PRE-SEASON

Inside Southern Abundance Forecast (or Outlook)	Average to Below Average	Average to Below Average	Average to Below Average	Average to Below Average	Average to Below Average	Average to Below Average	Average to Below Average	Average to Below Average	Average to Below Average	Average to Below Average
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POST-SEASON

Inside Southern Abundance ²	1,197,996	3,468,405	3,736,144	3,225,384	2,375,967	2,892,884	6,472,118	2,469,658	1,636,518	562,902
Inside Southern Harvest	127,805	1,423,705	912,053	1,092,206	721,539	1,249,919	2,777,575	1,147,991	365,249	39,301
Est. Inside Southern Harvest Rate	10.7%	40.6%	24.6%	34.0%	30.9%	42.8%	42.4%	46.4%	22.2%	7.0%

Johnstone Strait Harvest

Commercial, Sport PFMA ³ 11-13	56,411	750,892	392,981	635,866	332,391	536,983	1,375,476	436,520	75,322	4,728
First Nations PFMA ³ 11-13	3,943	9,436	12,365	12,919	2,010	22,312	16,788	12,013	1,969	7,702
Johnstone Strait Harvest Total	60,354	760,328	405,346	648,785	334,401	559,295	1,392,264	448,533	77,291	12,430
Target Johnstone Strait Harvest Rate	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Est. Johnstone Strait Harvest Rate	5.04%	21.92%	10.85%	20.11%	14.07%	19.33%	21.51%	18.16%	4.72%	2.21%

Escapement (Includes wild and enhanced)⁴

Inside Southern Escapement	1,070,191	2,044,700	2,824,091	2,133,178	1,654,428	1,642,965	3,694,543	1,321,667	1,271,269	523,601
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(1) Historic data in this table have been updated with most recent estimates; values may deviate from past reports.

(2) Total Inside Southern Chum abundance includes total Inside Southern Chum harvest plus escapement. Harvest composition based on historic and recent GSI for fisheries.

(3) Includes commercial, sport and test fishery harvest.

(4) Escapement estimates do not include any removals associated with hatchery rack (e.g. ESSR); those values are included in harvest. Escapement estimates have not been expanded for populations not monitored for escapement.

Of this 20%, the commercial sector is allocated 15%. The remaining 5% is set aside to provide for First Nations food, social and ceremonial needs (FSC), satisfy recreational and test fishing requirements, and to provide a buffer to the commercial exploitation (CDFO 2019a). The impact of the Johnstone Strait fisheries during the last 10 years of the fixed exploitation approach (2010–2019) on Inside Southern Chum Salmon stocks is detailed in Table 3-1.

The specific objectives of the fixed exploitation rate strategy are to:

- establish a conservative pre-season fishing plan to achieve an exploitation rate of 20% on Inside Southern Chum Salmon in the Johnstone Strait Chum Salmon fishery; and,
- stabilize commercial catch rates to provide opportunities at both low and high abundance levels.

On July 11th 2019, the Government of Canada and the Province of BC announced a comprehensive Steelhead Action Plan (CDFO 2019b) that contains new conservation measures for Thompson and Chilcotin Steelhead Trout. A decision was made to not proceed with an emergency listing of Thompson and Chilcotin (Interior Fraser River or IFR) Steelhead under SARA due to suboptimal ecological, social and economic outcomes relative to a collaborative federal/provincial Action Plan. Based on estimates of migration timing, IFR Steelhead are assumed to be encountered primarily in fisheries targeting southern Chum. A key component of the Action Plan is a series of window closures for fisheries on the approach routes of IFR Steelhead to the spawning grounds in both marine and freshwater fishing areas.

In 2019, the pre-season commercial fishing plan was a modified approach to maintain opportunity in Johnstone Strait while aligning with the intent of the Steelhead rolling window closure. With the window closures reducing access to a portion of the Inside Southern Chum (ISC) run, fisheries were planned at a reduced ER (below the typical 20% ER) (CDFO 2019a).

3.2.2 Strait of Georgia Chum Salmon Management Strategy

Chum Salmon stocks return to all areas of the Strait of Georgia (mid-Vancouver Island PFMA 14–19) and are of enhanced and wild (natural) origin. Fisheries can target enhanced returns (e.g. Area 14: Puntledge, Big Qualicum and Little Qualicum rivers), wild returns (e.g. Area 16: main river systems of Tzoonie, Deserated and Skwawka rivers in the Jervis inlet area) and mixed returns (e.g. Area 19: directed primarily at enhanced Goldstream River population although some natural Cowichan River Chum Salmon are also harvested).

With one exception, pre-season forecasts of the return of Strait of Georgia Chum Salmon for population aggregates corresponding to PFMA 14 have limited use due to their inability to reasonably predict returns (CDFO 2019a). The one exception is Chum Salmon returning to PFMA 14. As a result, unlike some other units of Southern B.C. Chum Salmon (e.g. WCVI see section 3.2.4), pre-season fishing plans based on a pre-season forecast are not typically developed for Strait of Georgia Chum Salmon stocks.

Strait of Georgia Chum Salmon are managed as a component of a “mixed-stock harvest strategy” for Johnstone Strait and the northern Strait of Georgia. In-season management of Strait of Georgia Chum Salmon is guided by advice from the South Coast Chum Salmon Advisory Committee (Chum Salmon Advisory Committee or Chum Salmon Working Group). The Chum Salmon Working Group represents interests for Strait of Georgia (mid-Vancouver Island Areas 14-19), Johnstone Strait, WCVI, and Fraser River Chum Salmon-directed fisheries. Fishing

opportunities for Chum Salmon are evaluated at weekly meetings of the Chum Salmon Working Group that usually start in the first week of October. In-season data is reviewed on a weekly basis until the conclusion of the fishing season that usually occurs around the end of November. The Chum Salmon Working Group includes internal (CDFO staff) and external (First Nations, commercial and recreational) representation and has been in operation since 2004. Additionally, Chum Salmon management in Area 18 is guided by advice from the Cowichan Fisheries Roundtable.

Chum Salmon fishing opportunities in the Strait of Georgia PFMA's are predominately shaped by in-season escapement information, test fishing data, commercial harvesting data from Johnstone Strait fisheries when available, and coast-wide allocations of Chum Salmon. When escapement goals are achieved (Table 3-2) or when stock abundance allows, commercial gill net, purse seine and troll fisheries can be permitted. As mentioned, the exception is Area 14 where a pre-season forecast of returning Chum Salmon abundance is used, in addition to the in-season information listed above, to guide management decisions on fishing opportunities (CDFO 2019a).

Table 3-2. Current spawning escapement goal, hatchery requirements and overall escapement goal for Chum Salmon returning to the Strait of Georgia by PFMA and system.

PFMA	System	Spawning Escapement Goal	Hatchery Requirements	Net Escapement Goal
14	Puntledge River	60,000	10,000	240,000
	Big Qualicum River	85,000		
	Little Qualicum River	85,000		
16	Jervis Inlet Streams	n/a	n/a	85,000
17	Nanaimo River	n/a	n/a	40,000
18	Cowichan River	n/a	n/a	160,000
19	Goldstream River	n/a	n/a	15,000

Fishing opportunities in the Strait of Georgia are constrained by concerns over bycatch of passing Chum Salmon stocks and local Chinook and Coho salmon populations. These concerns are addressed by Area-specific pre- and in-season management measures that may include:

- *area closures*: beach boundaries and limiting fisheries to terminal areas to minimize impacts on passing stocks; and,
- *non-retention*: of Chinook and Coho salmon.

As well, to reduce bycatch mortality and to improve the quality of catch data, additional pre-and in-season management measures may be implemented in the Strait of Georgia fisheries. These additional measures may include:

- *daylight fishing only*: in the gill net fishery;
- *maximum soak time*: in the gill net fishery;
- *mandatory brailing*: in the purse seine fishery;
- *barbless hooks*: in the troll fishery; and,
- *on-board observers*: if high bycatch occurs.

Pre- and in-season management measures aimed at reducing bycatch mortality are commonly implemented after consultation with the Chum Salmon Working Group.

First Nations FSC fisheries remain a priority and occur in terminal areas targeting individual populations from river systems within or adjacent to band territories. Harvest limits may be set when there are conservation concerns for the target population; however, First Nations FSC fisheries have priority over other fisheries. Generally, catch and effort in First Nations FSC Chum Salmon fisheries is low compared to commercial Chum Salmon fisheries.

Although tidal recreational fisheries are open throughout the Strait of Georgia, Chum Salmon are not commonly targeted by recreational anglers. Nevertheless, the Strait of Georgia recreational Chum Salmon catch is estimated annually through a Creel Survey conducted by CDFO. In most years, the Creel Survey operates from the beginning of May through to the end of September. Data from this survey is compiled and analyzed to produce catch and effort statistics by Area for each salmon species. Non-tidal recreational fisheries vary by Region and take into consideration FSC needs.

3.2.2.1 Area 14 Chum Salmon Management Strategy

Chum Salmon returning to Area 14 have been enhanced since the late 1960s, and terminal fisheries targeting the enhanced Chum Salmon populations of Puntledge, Big Qualicum and Little Qualicum rivers have occurred in October and November since the early 1970s. Returning Area 14 Chum Salmon abundance is forecasted pre-season using brood escapement, average survival, and age composition. In-season run strength is assessed from any early catch information, visual observations at river estuaries, and escapement counts to the three enhanced river systems.

The spawning escapement goals for Chum Salmon to the three river systems are 60,000 to Puntledge River, 85,000 to Big Qualicum River, and 85,000 to Little Qualicum River; including enhancement facility requirements of 10,000, the overall escapement goal is 240,000 Chum Salmon for Area 14 (Table 3-2). Spawning escapements are monitored by CDFO Stock Assessment and hatchery staff.

The recommended approach regarding Chum Salmon-directed fishing opportunities in Area 14 is made at the first meeting of the Chum Salmon Working Group. This meeting is tentatively scheduled for the first week of October; Chum Salmon Working Group meetings are subsequently held every week until late November.

Area 14 commercial Chum Salmon fisheries are managed based on forecasted abundance. In-season, the management strategy for considering fishery openings falls under one of two categories; Area 14 Pre-Season Forecast greater than 340,000 Chum Salmon or Area 14 Pre-Season Forecast less than 340,000 Chum Salmon. The 340,000 Chum Salmon is the aggregate escapement target (240,000) plus a 100,000 Chum Salmon buffer. The buffer safeguards against errors in the pre-season forecast of Area 14 stock abundance. When the pre-season forecast is greater than 340,000 early Chum Salmon openings would target up to 65% of the anticipated surplus above 340,000. When pre-season forecast is less than 340,000 an early timed small fleet gill net fishery would be used to evaluate the MVI aggregate abundance (CDFO 2019a).

The limited early commercial harvest of Chum Salmon is planned pre-season and executed in-season in the second or third week of October based on whether a surplus, using the formula

described above, is identified. However, if catches in the commercial Chum Salmon fisheries in Johnstone Strait indicate low Chum Salmon abundance, a decision on the approach in Area 14 may be deferred until the following week.

The management objectives for Area 14 are:

- achieve Area 14 Chum Salmon escapement requirements of 240,000;
- ensure adequate Chinook and Coho salmon escapements to Area 14 enhancement facilities;
- provide access to First Nations for FSC purposes;
- minimize the harvest of passing salmon populations;
- maximize economic return;
- work towards south coast Chum Salmon allocation targets for gill net, seine net and troll sectors; and,
- attempt to manage initial fisheries in Area 14 to avoid large surpluses (e.g. greater than 100,000).

Starting in the second or third week of October, opportunities for gill net, seine net, and troll fisheries are based on pre-season forecasts, in-season catch per unit effort (CPUE) information from commercial Chum Salmon fisheries in Johnstone Strait, and escapement information. Escapement information becomes increasingly important when considering further commercial opportunities in the latter part of October. These commercial opportunities are determined at the weekly Chum Salmon Working Group meetings and may include consideration for:

- *limited effort seine net fishery*: a limited effort seine net fishery with a harvest target will be considered from late October to late November, based on Chum Salmon escapement, abundance in the approach areas and South Coast allocation guidelines. Full fleet opportunities may also be available;
- *expanded gill net and troll fishery*: if gear counts indicate a modest fleet size of 50 vessels or less, gill net and troll openings may be expanded beyond one to two days per week; as well, additional fishing opportunities for gill net and troll may be considered following the seine net fisheries; and,
- *additional fishing days*: additional fishing days are considered if fishing time is lost due to poor weather conditions.

Once spawning escapement goals and hatchery requirements have been achieved, any returns above the overall escapement goal may be harvested (CDFO 2019a).

Commercial fishing opportunities are constrained by concerns over local and passing Chinook, Coho and Chum Salmon populations. Management measures to address these concerns can include:

- *area closures*: beach boundaries to protect Chinook and Coho salmon (boundaries may range from half a mile to one and a half miles depending upon bycatch concerns and time of year); French Creek radius boundary and Baynes Sound area closures to protect wild Chum Salmon and Coho salmon populations;
- *non-retention*: of Coho salmon;
- *maximum soak time*: in the gill net fishery;

- *mandatory brailing*: in the purse seine fishery;
- *barbless hooks*: in the troll fishery;
- *daylight fishing only*: in the gill net fishery if there are significant levels of bycatch; and,
- *outside boundaries*: designed to minimize impacts on passing salmon populations.

First Nations FSC fisheries are conducted in Area 14 and at the enhancement facilities prior to consideration of ESSR fisheries targeting Chum Salmon. Tidal recreational fisheries are subject to the normal daily and possession limits for Chum Salmon (daily limit four per day/possession limit eight) and are open throughout the Area.

Once escapements have been confirmed, non-tidal recreational fisheries for Chum Salmon in the Puntledge and Big Qualicum rivers will be considered. These fishing opportunities may occur as early as the second to fourth week of October and are based, in part, upon in-season and past return timing of Chum Salmon.

3.2.2.2 Area 16 Chum Salmon Management Strategy

This fishery targets wild Chum Salmon stocks returning to river systems in the Jervis Inlet area. The main systems are Tzoonie, Deserted and Skwawka rivers. The overall escapement goal for Jervis Inlet streams is 85,000. These terminal fisheries occur when the individual or combined escapement goals have been assured.

Area 16 Chum Salmon are managed as a component of “mixed-stock harvest strategy” for Chum Salmon, and fishing opportunities are guided by coast-wide allocations of Chum Salmon. Commercial fishing opportunities are evaluated at weekly meetings of the Chum Salmon Advisory Committee, usually starting in the first week of October. Assessment in the area is conducted by Fisheries and Oceans Canada Charter Patrol vessels, DFO Stock Assessment and Sechelt Indian Band staff. In-season data is reviewed on a weekly basis until the end of the season, which usually occurs around the end of November. Area 16 Chum Salmon fisheries are not planned based on pre-season forecasts alone. Fishing opportunities will be provided in an area when the escapement goal has been achieved. Achievement of the escapement goal includes the numbers of fish in-river plus the amount of fish inside a designated sanctuary area. The earliest potential fishing opportunity is anticipated near the end of October (CDFO 2019a).

Chum Salmon fishing opportunities are constrained by concerns over fishing impacts on Coho salmon and passing Chum Salmon populations. To address these concerns, there is mandatory non-retention of Coho salmon and fishing is limited to terminal areas.

Historically, Chum Salmon fishing opportunities in Area 16 do not occur on a regular basis. There have been no fisheries in Area 16 in recent years.

Area 16 Chum Salmon-directed fisheries target wild Chum Salmon populations returning to river systems in the Jervis Inlet area. The main systems are Tzoonie, Deserted, Brittain, Vancouver and Skwawka rivers.

3.2.2.3 Area 17 Chum Salmon Management Strategy

Chum Salmon fisheries in Area 17 are directed primarily at the Nanaimo River population. On poor return years, the Nanaimo River Chum Salmon stock is supplemented by production from the Nanaimo River Hatchery.

The overall escapement goal for the Nanaimo River is 40,000 Chum Salmon (Table 3-2). Chum Salmon escapement estimates are derived from joint DFO/Snuneymuxw in-river assessments.

Pre-season forecasts of Chum Salmon abundance are helpful in defining possible opportunities, but decisions to open commercial fisheries are not based on pre-season information (CDFO 2019a). Area 17 Chum Salmon are managed as a component of the “mixed-stock harvest strategy” for Chum Salmon, and in-season management is guided by advice from the Chum Salmon Working Group as outlined for Areas 14 and 16. Fishing opportunities are planned in-season based on escapement information and shaped by coast-wide allocations of Chum Salmon. Escapements can fluctuate annually and fishery opportunities are evaluated during the weekly in-season review of Nanaimo escapement estimates within the Chum Salmon Working Group process.

Opportunities for gill net, troll and seine net fisheries are discussed once Chum Salmon have started to enter the Nanaimo River and are present in terminal areas. Final decisions are made at the weekly Chum Salmon Working Group meetings. If commercial opportunities are identified, management will be guided by the following considerations:

- gill nets open for one or two days; fishing days and opening duration subject to escapement levels;
- troll open seven days per week due to a demonstrated low catch rate;
- after initial opening, continued fishing opportunities depend upon information derived from CPUE in the commercial fisheries, and on-going approach area and in-river assessments;
- if harvest remains “good” and the escapement goal is reached, commercial fisheries can continue; and,
- additional fishing days will be considered if time is lost due to poor weather conditions.

Commercial fishing opportunities are constrained by concerns over domestic Chinook and Coho salmon populations and passing Chum Salmon. Management measures to address these concerns can include:

- *area closures*: subarea boundaries protecting migrating Fraser River Chum Salmon and confine the fishery to the Nanaimo River stock;
- *non-retention*: of Coho and Chinook salmon;
- *maximum soak time*: in the gill net fishery if Coho salmon encounters are high;
- *barbless hooks*: in the troll fishery; and,
- *daylight fishing only*: in the gill net fishery if there are significant levels of bycatch.

In-season management measures aimed at reducing bycatch mortality (e.g. maximum soak time and daylight fishing only in the gill net fishery) would be implemented after consultation with the Chum Salmon Working Group.

First Nations FSC fisheries as well as tidal/non-tidal recreational fisheries are conducted on these Area 17 populations. Local FSC opportunities are undertaken by Nanaimo First Nations in consultation with the DFO. Tidal recreational fisheries are subject to the normal daily and possession limits and there are no closed areas. There are no opportunities for non-tidal recreational fisheries in the Nanaimo River.

3.2.2.4 Area 18 Chum Salmon Management Strategy

The Area 18 fishery is directed primarily at Cowichan River stocks, although some Goldstream Chum Salmon are also harvested. The outer Cowichan Chum Salmon fishing boundary is situated to minimize encounters of Saanich Inlet Chum Salmon. Chemainus River stocks are also impacted but likely to a lesser extent (CDFO 2019a).

The escapement goal for the Cowichan River is 160,000 Chum Salmon (Table 3-2). The target was revised from 110,000 in 2009 and is based on habitat area and Chum Salmon spawning densities in the Cowichan River. In-river Chum Salmon escapement estimates are provided by the operation of a DIDSON Counter (Dual-frequency Identification Sonar) located in the lower river since 2006.

Pre-season forecasts of abundance are helpful in defining possible commercial opportunities, but decisions to open commercial fisheries are not based solely on pre-season information (CDFO 2019a). In-season management is guided by advice from the Cowichan Fisheries Roundtable (the Roundtable) and the Chum Salmon Working Group. Commercial fishing opportunities are evaluated during the weekly in-season meetings of the Roundtable and the Chum Salmon Working Group and are shaped by coast-wide allocations of Chum Salmon.

Fishery openings are planned in-season based on escapement estimates from the DIDSON counter and information from a test fishery. Management is also guided by advice from the Cowichan Fisheries Roundtable (the Roundtable), the Chum Salmon Working Group and an in-season Chum Salmon Escapement Forecast Tool based on the DIDSON count by date (CDFO 2019a).

Like other Strait of Georgia PFMA's, commercial fishing opportunities in Area 18 are constrained by concerns over domestic Chinook and Coho salmon populations and passing Chum Salmon. Management measures to address these concerns can include:

- *area closures*: subarea boundaries to protect Coho salmon holding off Cherry Point; limiting commercial fisheries to Satellite Channel to minimize impact on the earlier timed Goldstream River Chum Salmon populations; beach boundaries to protect Chinook and Coho salmon;
- *non-retention*: of Coho salmon;
- *maximum soak time*: in the gill net fishery if Coho salmon encounters are high;
- *mandatory brailing*: in the purse seine net fishery;
- *barbless hooks*: in the troll fishery; and,
- *daylight fishing only*: in the gill net fishery if there are significant levels of bycatch.

In-season management measures aimed at reducing bycatch mortality (e.g. maximum soak time and daylight fishing only in the gill net fishery) would be implemented after consultation with the Roundtable and the Chum Salmon Working Group.

First Nations FSC fisheries and tidal/non-tidal recreational fisheries are conducted on these Area 18 Chum Salmon populations. Tidal recreational fisheries are subject to the normal daily and possession limits. Non-tidal recreational fisheries will also be considered if escapement targets and First Nations FSC needs are achieved.

3.2.2.5 Area 19 Chum Salmon Management Strategy

Chum Salmon fisheries are directed primarily at the Goldstream River population although some Cowichan River Chum Salmon are also harvested. The overall escapement goal for Goldstream River is 15,000 Chum Salmon (Table 3-2). Goldstream River is a relatively small system with good viewing conditions; as such, escapement estimates are derived from stream walks.

Due to the inability of pre-season forecasts to reliably predict returns of Area 19 Chum Salmon, pre-season fishing plans are not developed for Area 19. In-season management is guided by advice from the Chum Salmon Working Group. Commercial fishing opportunities are evaluated at the Chum Salmon Working Group's weekly meetings where in-season data is reviewed. In-season escapement information forms the basis for determining commercial fishing opportunities. Area 19 falls under the same management regime as other Strait of Georgia PFMA's; consequently, fishing opportunities are also shaped by coast-wide allocations of Chum Salmon.

Commercial fishing opportunities in Area 19 are constrained by concerns over domestic Chinook and Coho salmon populations and passing Chum Salmon. Management measures to address these concerns can include:

- *area closures*: subarea boundaries to protect Goldstream River Chinook and Coho salmon holding at Squally Reach and minimize encounters of Cowichan River Chum Salmon; commercial fishery openings set for mid to late November are limited to portions of Saanich Inlet that are outside or to the north of Squally Reach;
- *non-retention*: of Coho and Chinook salmon;
- *maximum soak time*: in the gill net fishery if Coho salmon encounters are high;
- *mandatory brailing*: in the purse seine net fishery;
- *barbless hooks*: in the troll fishery;
- *daylight fishing only*: in the gill net fishery if Coho salmon encounters are high;
- *selective fishing techniques*: commercial fisheries will utilize selective fishing techniques to minimize bycatch impacts; and,
- *on-board observers*: on-board observers could be employed if high bycatch occurs.

3.2.3 Fraser River Chum Salmon Management Strategy

The management strategy for Fraser River Chum Salmon includes management goals and harvest allocation objectives for Chum Salmon fisheries occurring within the Fraser River. If the terminal return allows for commercial fisheries to occur, based on in-season information derived from the CDFO Albion Chum Salmon test fishery (see section 3.2.3.1), fisheries are structured to ensure a minimum spawning escapement of 800,000 Chum Salmon. Decision rules that guide the management of Fraser River Chum Salmon fisheries are summarized in Table 3-3.

Additionally, management of in-river Chum Salmon fisheries is guided by the need to minimize impacts on co-migrating stocks of concern, including Interior Fraser Coho Salmon and Interior Fraser River Steelhead. To limit incidental impacts on Interior Fraser Coho Salmon, fishing for salmon with non-selective gear is restricted for all sectors (First Nations, recreational, and commercial) from early September to mid-October within the Fraser River mainstem below Sawmill Creek. Conservation measures taken to protect Interior Fraser River Steelhead are

developed in conjunction with the B.C. Ministry of Environment on an annual basis and are primarily focused on reducing the impact of Fraser River commercial gill net fisheries. In recent years, these restrictions have resulted in the delay of commercial fishing opportunities for Chum Salmon until late October, except those fisheries that operate with selective gear.

Table 3-3. Key decision points for Fraser River Chum Salmon management.

Terminal Return	Harvest Plan	First Nations	Commercial	Recreational
<500,000 in Fraser	<10%	Limited (reduced hours and days/weeks fishing)	Closed	Mainstem Fraser River closed, restricted openings on tributaries
500,000 to 800,000 in Fraser	Directed fisheries limited to First Nations FSC	Normal	Closed	Mainstem Fraser River closed, restricted openings on tributaries
800,000 to 916,000 in Fraser	Catch not to exceed 91,800 (82,800 First Nations and 9,000 test fishing)	Normal	Closed	Mainstem Fraser River open, restricted openings on tributaries
916,000 to 1,050,000 in Fraser	Commercial catch not to exceed 10% for Chum Salmon	Normal	Open (35,000-105,000)	Open
>1,050,000 in Fraser	Commercial catch not to exceed 15% for Chum Salmon	Normal	Open (105,000 plus)	Open

3.2.3.1 Fraser River In-season Terminal Abundance Estimation

Terminal abundance of Fraser River Chum Salmon is estimated using a Bayesian model that incorporates post-season information on terminal return and migration timing with in-season information on Chum Salmon catch from the Albion Chum Salmon test fishery (Gazey and Palermo 2000).

The Albion Chum Salmon test fishery has operated annually since 1979 on the lower Fraser River in Area 29 near Fort Langley, B.C. The test fishery is conducted with a drifted gill net at a specific site near the old Albion ferry crossing. The test fishery begins in early September of each year, and usually fishes until the end of November. On each day of operation, the boat fishes two sets, timed to coincide with the daily high tide. The Albion Chum Salmon test fishery normally fishes every other day from September 1 through October 20, alternating days with the Albion Chinook Salmon test fishery (which fishes an 8" mesh gill net during this period). Until

2013, the Chum Salmon test fishery operated daily from October 21 through the end of November. Since 2013, the Chum Salmon test fishery operates daily from October 21 through approximately November 10 and then every other day until November 23. The gill net used in the Albion Chum Salmon test fishery is 150 fathoms long, constructed from uniform 6.75" mesh.

The first in-season estimate of terminal Fraser River Chum Salmon abundance is typically provided in mid-October. Recreational and limited First Nations FSC fisheries for Fraser Chum Salmon may be permitted prior to this date, unless a conservation concern has been identified.

3.2.4 West Coast Vancouver Island Chum Salmon Management Strategy

Chum Salmon stocks return to all areas on the West Coast of Vancouver Island (WCVI). When stock abundance allows, commercial Chum Salmon fisheries are conducted in the marine waters outside Nitinat Lake (Area 21), Barkley Sound (Area 23), Clayoquot Sound (Area 24) and Outer Nootka Sound/Thupana and Esperanza Inlet (Areas 25). Both commercial gill net and purse seine net fleets target WCVI Chum Salmon in these Areas.

A pre-season forecast of the return of WCVI Chum Salmon is predicted for population aggregates corresponding to CDFO's Pacific Fishery Management Areas. Natural and enhanced returns are approximated through separate models and summed to produce a total return forecast for each Area; however, the relative inaccuracy of the pre-season forecasts resulted in the adoption of a fixed harvest rate strategy in the early 2000s for those fisheries targeting mixed stock aggregates.

With the exception of near-terminal areas, such as Nitinat (Area 21 and 22) or Thupana Inlet (Area 25), where hatchery stocks dominate, WCVI Chum Salmon fisheries are currently managed to an exploitation rate of approximately 20% or less. Exploitation is controlled by limiting fishing effort to specific areas, specific times or to a specific number of vessel fishing days per week. Since 2012, revised fishery lower and target reference points (FLRPs and FTRPs) were developed based on the Sustainable Escapement Goal (SEG) method. The SEG approach uses the long-term escapement series to set fishery reference points. Conservative "SEGs" are defined as the 25% and 75% of a long-term escapement time series. Although the WCVI Chum Salmon forecast is highly uncertain, the forecast is used to inform pre-season fishery planning. Where the forecast is below the FLRP for an area, fisheries are curtailed. Where the forecast is below the FTRP, fisheries are more limited (CDFO 2019a).

Purse seine net opportunities generally occur when excess salmon to spawning requirements (ESSR) are identified in near terminal areas (e.g. hatchery stocks returning to Nitinat River or Thupana Inlet).

WCVI First Nations FSC fisheries remain a priority and occur in terminal areas targeting individual populations from river systems within or adjacent to band territories. Harvest limits may be set when there are conservation concerns for the target population; however, First Nations FSC fisheries have priority over other fisheries. Generally, harvest and effort in First Nations FSC Chum Salmon fisheries are low compared to commercial Chum Salmon fisheries.

Chum Salmon are not commonly targeted by recreational anglers on the WCVI. Nevertheless, the WCVI recreational Chum Salmon catch is estimated annually through a Creel Survey conducted by CDFO. Creel Survey information is augmented by logbook and manifest records

of catch and effort submitted by lodges operating guided fishing trips on the WCVI. These data are compiled and analyzed to produce catch and effort statistics by Area for each salmon species.

3.2.4.1 Nitinat Chum Salmon Management Strategy

Of importance to the Pacific Salmon Treaty is the WCVI group of Chum Salmon populations returning to the Nitinat watershed (Nitinat River and Nitinat Lake and tributaries). This Nitinat stock is the most significant WCVI group of populations and includes production from a major CDFO hatchery on the Nitinat River.

The Nitinat commercial Chum Salmon fishery (Area 21), along with the ESSR fisheries (Area 22), is the largest fishery on the WCVI and targets returning Nitinat River Hatchery Chum Salmon. In the past, catch of non-WCVI Chum Salmon has occurred in the outside seaward portion of the Nitinat fishing area. Management actions have been implemented to reduce this catch of non-WCVI Chum Salmon by restricting the Nitinat fishery to subareas closer to the terminal area (i.e. outlet of Nitinat Lake). More recently, First Nations ESSR harvests have occurred within Nitinat Lake (Area 22). Historical Chum Salmon harvest is shown in Table 3-10.

The spawning escapement target for Chum Salmon returning to the Nitinat system (i.e. Nitinat River and other tributaries to Nitinat Lake) has been set at 175,000 fish (CDFO 2019a). The target distribution of this spawning escapement between Nitinat River and the tributaries to Nitinat Lake has varied slightly over the last number of years; currently it is set at 125,000 into the Nitinat River and 50,000 into other Nitinat Lake tributaries. This spawning escapement requirement is set at a level to ensure that all run timing components are represented. Additional allocation for First Nations FSC requirements and hatchery requirements (i.e. broodstock) may total up to 50,000 Chum Salmon. Consequently, the *gross escapement requirement* (spawning escapement + FN FSC requirements + hatchery requirements) for this Nitinat group of populations is 225,000 Chum Salmon (CDFO 2019a). Historical Chum Salmon escapements are shown in Table 3-10.

A pre-season forecast of current year returns for the Nitinat stock is approximated based on brood year escapements, estimated freshwater production from natural spawners, hatchery production, average age at return, environmental and ocean condition factors during brood ocean entry and estimated marine survival of each brood year class.

A pre-season fishing plan is commonly developed by the end of the summer and is based on the forecast of current year returns. The fishery is managed through a fixed harvest rate strategy to limit the harvest rate to approximately 25%. The allowable effort of the commercial fleets was determined from an analysis of the average exploitation rate per unit effort in Nitinat Chum Salmon fisheries over the last decade.

In addition to concerns over catch of non-WCVI Chum Salmon, early season opportunities are constrained by concerns over bycatch of Interior Fraser River Steelhead and passing stocks of Coho salmon. Since 1995, these bycatch concerns in the commercial Nitinat fishery have been addressed by:

- *delayed opening dates*: the first commercial gill net fishery, if conducted, has been delayed until the beginning of October since 1998;
- *reduced fishing areas*: the traditional fishing area has been reduced to within a one-mile boundary between lines true south from Pachena and Dare Points (a portion of Area 21);

- *increased use of weed lines*: a 1.2m - 2.0m weed line for gill nets; and,
- *species selective fishing techniques*: non-retention of Coho salmon and Steelhead.

Additionally, to reduce bycatch mortality and to improve the quality of catch data, the following measures have been implemented in the Nitinat fisheries:

- daylight fishing only: gill net fishery;
- mandatory functional revival tanks: in purse seine and gill net fisheries;
- on-board observers: portions of purse seine and gill net fleet; and,
- logbooks and weekly hail-ins: purse seine and gill net fisheries.

The in-season management of the Nitinat fisheries (Area 21 and 22) are based on achieving the *gross escapement requirement* into the Nitinat watershed. Broodstock collection success, hatchery swim-ins, and visual surveys of Nitinat River spawners are used to determine whether the weekly *escapement milestone levels* into Nitinat Lake are achieved (CDFO 2019a). Weekly fisheries are generally scheduled in Area 21 and surrounding waters to harvest any identified surplus.

First Nations FSC fisheries remain a priority and occur in terminal areas of Nitinat (Areas 21 and 22). First Nations ESSR fisheries can also occur in Nitinat Lake (Area 22) targeting returns surplus to spawning and hatchery requirements.

3.3 Annual Fishery Descriptions

Fisheries targeting Chum Salmon in Johnstone Strait, Strait of Georgia, Fraser River, and on the West Coast of Vancouver Island (WCVI) generally begin in late September and end in November. These fisheries are directed at fall Chum Salmon.

Table 3-4. Estimated harvest of summer Chum Salmon by PFMA for commercial, research and test fishing vessels¹ (July through the second week of September), 2010–2019.

Year	Statistical Weeks	PFMA					
		18	19	20	21	29 ²	Total
2010	7/1–9/2	0	0	16	0	379	395
2011	7/1–9/2	0	0	0	0	883	883
2012	7/1–9/2	0	0	0	0	125	125
2013	7/1–9/2	0	0	0	0	4,516	4,516
2014	7/1–9/2	0	0	0	0	686	686
2015	7/1–9/2	0	0	0	0	1	1
2016	7/1–9/2	0	0	0	0	1,087	1,087
2017	7/1–9/2	0	0	0	0	8	8
2018	7/1–9/2	0	0	0	0	76	76
2019	7/1–9/2	0	0	0	0	6	6
Average		0	0	2	0	777	778

(1) Does not include the Pacific Salmon Commission test fisheries harvest.

(2) Majority of this harvest is terminal marine and likely of Fraser River origin.

In addition to these directed fisheries, bycatch of Chum Salmon may occur in fisheries directed at Sockeye and Pink salmon earlier in the season. This Chum Salmon bycatch is assumed to be comprised mainly of summer Chum Salmon. The summer Chum Salmon harvest in boundary area fisheries is presented in Table 3-4.

The main components of the Inside Southern Chum (ISC) Salmon return were expected to be both Fraser and non-Fraser stocks. These stocks are typically dominated by four-year-old fish which were from a below-average 2015 brood year return that out-migrated in 2016. Other salmon species that out-migrated in 2016 encountered poor survival conditions (i.e. local Pink and Coho returns in 2017 were poor). The pre-season expectation for ISC suggested below to near target returns to the area but was highly uncertain. Based on the very strong 2016 brood year, it was expected that the age 3₁ component would contribute more than average to the 2019 Chum return.

The following sections describe the fisheries directed at fall Chum Salmon in each of the Southern B.C. areas in 2019.

3.3.1 Johnstone Strait

The Johnstone Strait test fishery, which ran from September 10 through October 24, provided timing and abundance information for the 2019 return, which is important in assessing the performance of the 20% fixed exploitation rate strategy. It also provided an index of abundance, used to determine the likelihood of the number of returning Chum being over the 1.0 million critical level (requirement for commercial openings).

From the onset of the program the Chum catch per unit effort (CPUE) in the test fishery was well below what was encountered during 2010, one of the lowest Chum returns on record (1980-2018). On October 7th it was determined that the ISC index of abundance was likely below the 1.0 million critical level. In compliance with the Treaty, Canada immediately suspended any planned Johnstone Strait commercial mixed stock fisheries and notified the U.S. on October 7, 2019 that the Inside Southern Chum Salmon aggregate was estimated to be below the critical threshold of 1.0 million.

For the duration of the test fishery the Chum CPUE continued to track well below 2010 and was the lowest on record. The age composition derived from the test fishery and commercial samples exhibited a lower than average contribution of 4-year-olds throughout the season, confirming the reduced survival of the 2015 brood year. Escapements and catches in 2019 suggested returns were well below average throughout the ISC area. Table 3-5 outlines the duration and Chum Salmon harvest in fisheries that occurred during the 2019 season.

Commercial Chum fisheries in 2019 were planned as per the Pacific Salmon Treaty, however a modified approach was taken to maintain opportunity in Johnstone Strait while aligning with the intent of the Interior Fraser Steelhead rolling window closure, which was put in place to protect co-migrating stocks of concern. Fisheries are usually scheduled to achieve a 20% fixed exploitation rate (ER) on Inside Southern Chum (ISC) stocks passing through Johnstone Strait with 15% ER for commercial and 5% ER for test, FSC, recreational and a commercial buffer. Shares of the 15% commercial ER are usually shared among the Area B purse seine net (11.55%), Area D gill net (2.55%), and Area H troll fleets (0.9%). With the Steelhead window closure reducing access to a portion of the ISC, the 2019 fisheries were planned pre-season to a

reduced commercial ER of 9.83%, shared between the Area B purse seine net (6.54%), Area D gill net (2.27%), and Area H troll (1.01%) fleets.

As returns were below the critical threshold abundance, there were no commercial Chum Salmon fisheries in Johnstone Strait directed at Inside Southern Chum in 2019.

The total 2019 commercial harvest for Johnstone Strait, including test fishery harvest, was 4,883 Chum Salmon (Table 3-5). There were no directed commercial Chum Salmon fisheries in the terminal areas of Johnstone Strait. Recreational harvest was low in Johnstone Strait (estimated at >400 Chum Salmon; Table 3-5) with little monitoring during the month of October. First Nations FSC harvest was estimated at 9,078 in the Johnstone Strait area (Table 3-5). The total estimated harvest of Chum Salmon in Johnstone Strait in 2019 was 13,961.

Table 3-5. Estimated Chum Salmon harvest from Chum Salmon-directed fisheries occurring in Johnstone Strait by PFMA, 2019.

Gear Type	PFMA	Fishery Dates		Fishery Duration (hours)	Estimated Harvest
		Start	End		
Purse Seine	12	Sep. 10	Oct. 24	n/a	4,489
Purse Seine	12	No Chum Salmon-directed commercial fisheries in 2019			0
	13				0
Gill Net	12				0
	13				0
Troll	12				0
	13				0
Recreational ¹	11/12	Jul.	Aug.	n/a	14
	13	Aug.	Oct.	n/a	380
First Nations ¹	12	n/a	n/a	n/a	342
	13	n/a	n/a	n/a	8,736
Total					13,961

(1) The recreational and First Nation fisheries time periods varied over the season.
(n/a) not applicable.

3.3.2 Strait of Georgia

Conditions for returning Chum migration and spawning in October began with drier conditions followed by significant rainfall. The end of October through mid-November were marked by below average precipitation. River levels were moderate during the peak of migration and spawning providing suitable conditions in most systems.

Returns for the Jervis/Narrows Inlet aggregate (which includes Brittain River, Skwawka River, Deserted River, Vancouver River and Tzoonie River) continued to be poor following several record-low counts in 2018. Returns came in consistently below forecast for mid-Vancouver Island systems and escapement targets were not met. Puntledge River counts were less than 20% of the 4 year average while Little Qualicum escapements were similarly poor. Big Qualicum returns did not surpass 3,000 and were less than 5% of the 15 year average. South Island systems fared slightly better with Nanaimo River reaching about 50% of the escapement target at 22,000.

Cowichan River escapement was stronger at 95K but still below the forecast and target of 160K. Goldstream River was the only system to reach the escapement target but fell short of the forecast.

There were no commercial Chum fisheries in the Strait of Georgia in 2019. In all mid-Vancouver Island streams, except the Goldstream River, Chum returns did not reach target escapements.

Recreationally, there was an estimated 68 Chum Salmon harvested in the Strait of Georgia in 2019. The harvest by First Nations in the Strait of Georgia in 2019 was estimated to be 247 Chum Salmon (Table 3-6).

The total estimated harvest of Chum Salmon in the Strait of Georgia in 2019 was 315.

Table 3-6. Estimated Chum Salmon harvest from fisheries occurring in the Strait of Georgia by PFMA, 2019.

Gear Type	PFMA	Fishery Dates		Fishery Duration (hours)	Estimated Harvest
		Start	End		
Purse Seine (Test)	18-19	n/a	n/a	n/a	0
Purse Seine	17	No Chum Salmon-directed commercial fisheries in 2019		0	0
	18			0	0
	19			0	0
Gill Net	17			0	0
	18			0	0
	19			0	0
Recreational ¹	14-19, 28, 29 ³	Sep	Sep	n/a	68
First Nations ²	14	n/a	n/a	n/a	30
	15	n/a	n/a	n/a	74
	16	n/a	n/a	n/a	0
	17	n/a	n/a	n/a	143
	18	n/a	n/a	n/a	0
	19	n/a	n/a	n/a	0
	28	n/a	n/a	n/a	0
Total					315

(1) The recreational fishery was not monitored after September; harvest of Chum Salmon was likely very low.

(2) The First Nation fisheries time periods varied over the season.

(3) Marine subareas of Area 29; i.e. does not include an estimate for Chum Salmon harvest in the tidal portion of the lower Fraser River downstream of Mission, B.C. (Appendix B-3).

(n/a) not applicable.

3.3.3 Fraser River

Directed Chum Salmon fisheries occur within the Fraser River for all fishing sectors, including First Nations, recreational, commercial, and test fisheries. In recent years, significant conservation measures have been implemented in-river during the Fraser River Chum Salmon migration period to protect co-migrating stocks of concern, particularly Interior Fraser Coho

Salmon and Interior Fraser River Steelhead. Depending on the fishery, these measures have included time and area closures, gear restrictions, and release requirements.

The escapement objective for Fraser River Chum Salmon is 800,000 spawners. As described in Section 3.2.3 (*Fraser River Chum Salmon Management Strategy*), First Nations economic opportunity (EO) and commercial Chum Salmon fishing opportunities are provided based on in-season assessments of run-size using CPUE information from the CDFO Albion Chum Salmon test fishery. The initial in-season estimate of terminal abundance provided to the US on October 17, 2019 was 564,000 Chum Salmon. A subsequent in-season estimate of 518,000 Chum Salmon was provided on October 22.

First Nations FSC gill net fisheries targeting Chum Salmon were initiated October 25 following a closure period to protect co-migrating Interior Fraser Coho Salmon. These fisheries harvested a total of 15,796 Chum Salmon (Table 3-7). First Nations EO fisheries directed at Chum Salmon did not occur in 2019; however, certain First Nations groups were provided access to Chum Salmon that returned to hatchery facilities but that were not required for broodstock. A total of 2,726 Chum Salmon deemed to be surplus to spawning requirements (ESSR) were provided to First Nations from various hatchery facilities in 2019. First Nations FSC Chinook and Pink-directed fisheries occurring in 2019 had bycatch of Fraser Chum Salmon, harvesting 31 Chum Salmon (Table 3-7).

The total harvest of Chum Salmon in all Fraser River First Nations fisheries (including hatchery ESSR fish) was 18,583 in 2019 (Table 3-7 and Table 3-8).

The major Fraser River watershed recreational salmon fisheries meaningfully impacting Chum Salmon in 2019 include fisheries occurring in the Chilliwack and Stave rivers; both tributaries to the Fraser River in the lower Fraser Valley. Other major fisheries having historically minor impacts on Chum Salmon include fisheries occurring in the lower Fraser River mainstem, the Harrison River and the Nicomen Slough/Norrish Creek system; the latter two systems are tributaries to the Fraser River in the lower Fraser Valley. The recreational fisheries occurring in the Harrison and Stave rivers were not assessed in 2019.

The entire Fraser River mainstem downstream of Alexandria Bridge (approximately 20kms upstream of Yale BC) was closed to fishing for salmon from January 1 to August 23, 2019 to protect Fraser Chinook stocks of concern (CDFO 2019a).

Table 3-7. Estimated harvest of Chum Salmon from salmon fisheries occurring in PFMA 29 (both marine and in-river) and in Region 2 (non-tidal) of the Fraser River, 2019.

Fishing Sector	Fishery Description	Target Species	Fishery Dates		Fishery Duration	Assessment Period ¹		Estimated Harvest
			Start	End		Start	End	
Test ²	Albion CH	Chinook	21-Apr	20-Oct	158 days	n/a	n/a	369
	Albion CM	Chum	01-Sep	23-Nov	52 days	n/a	n/a	3,436
	Whonnock SK	Sockeye	24-Jun	28-Sep	97 days	n/a	n/a	102
	Cottonwood SK	Sockeye	12-Jul	16-Sep	67 days	n/a	n/a	11
Test Subtotal								3,918
Commercial ²	Area E gill net	Sockeye	n/a	n/a	0	n/a	n/a	0
		Chum	n/a	n/a	0	n/a	n/a	0
	Area B purse seine	Pink	14-Sep	17-Sep	4 days	n/a	n/a	0
		Sockeye	n/a	n/a	0	n/a	n/a	0
		Chum	n/a	n/a	0	n/a	n/a	0
	Area H troll	Pink	14-Sep	22-Sep	9 days	n/a	n/a	0
		Sockeye	n/a	n/a	0	n/a	n/a	0
		Chum	n/a	n/a	0	n/a	n/a	0
Commercial Subtotal								0
Recreational ^{3,4,5}	Fraser River Mainstem (tidal) ⁷	Pink & Chum	14-Sep	20-Sep	7 days	14-Sep	20-Sep	0
	Fraser River Mainstem ⁷	Pink & Coho	n/a	n/a	n/a	02-Nov	30-Nov	0
	Chilliwack River ⁸	Mixed	01-Sep	23-Oct	53 days	15-Sep	15-Nov	921
	Nicomen Slough	Mixed	01-Jan	20-Oct	293 days	01-Oct	15-Dec	2
Recreational Subtotal								923
First Nations ^{2, 6}	FSC	Mixed	1-May	27-Sep	n/a	n/a	n/a	31
		Chum	25-Oct	24-Nov	n/a	n/a	n/a	15,796
	ESSR	Chum	n/a	n/a	n/a	n/a	n/a	2,726
	EO	Pink	17-Sep	25-Sep	9 days	n/a	n/a	30
		Sockeye	n/a	n/a	n/a	n/a	n/a	0
		Chum	n/a	n/a	n/a	n/a	n/a	0
First Nations Subtotal								18,583
Total								23,424

- (1) Assessment Period Start and End dates refer to the period of assessment for the recreational fisheries only.
- (2) Fishery Start and End Dates for the commercial and First Nations fisheries reflect the first and last date the fisheries were permitted; the fisheries were not continuous between these dates.
- (3) Fishery Start and End Dates for the recreational fisheries reflect the period the fishery was opened to the retention of Chum Salmon; retention of other salmon species may have been allowed beyond these dates.
- (4) The recreational estimates are for the periods of assessment; assessment periods may or may not coincide with Chum Salmon retention fishery opening and closing dates.
- (5) Recreational estimates are preliminary.
- (6) The Fishery Duration represents the maximum number of days provided to First Nations; individual First Nations may have fished for shorter periods.
- (7) For the Fraser River recreational fishery, the tidal portion of the Fraser R. was closed to fishing for salmon from Jan.1 to Sep.13 and Sep.21 to Nov.1; and the non-tidal portion was closed to fishing for salmon from Jan.1 to Nov.2.
- (8) The Chilliwack River recreational fishery was opened to the retention of Coho only from Jan.1 to Mar.31; closed to fishing for salmon from Apr.1 to Jun.30, and opened to the retention of Chum from Sep.1 to Oct.23.

Table 3-8. Estimated harvest of Chum Salmon from First Nations and commercial salmon fisheries occurring in PFMA 29 and the Fraser River, 2010–2019.

Year	First Nations			Commercial			Total
	FSC	EO	ESSR	Area E GN Area B SN Area H TR	Albion and PSC Test Fisheries	Other Scientific Licenses ¹	
2010	13,480	186	14,021	209	10,762	n/a	38,658
2011	25,348	4,883	50,067	36,059	3,550	n/a	119,907
2012	30,747	102,768	34,593	64,531	13,487	n/a	246,126
2013	36,852	107,959	43,176	101,890	15,382	n/a	305,259
2014	39,517	100,261	34,638	64,111	12,637	n/a	251,164
2015	36,266	122,309	15,692	127,061	10,525	n/a	311,853
2016	67,257	146,101	34,724	179,158	12,308	n/a	439,548
2017	47,051	111,524	23,106	77,382	10,681	n/a	269,744
2018	62,847	1,381	28,510	608	7,710	n/a	101,056
2019	15,827	31	2,726	0	3,918	n/a	22,502
Average	37,519	69,740	28,125	65,101	10,096	n/a	210,582

(1) Includes “experimental” selective fishing scientific licenses issued under the CDFO Selective Fishing Program. (n/a) not applicable.

Additionally, as part of the CDFO’ Interior Fraser River Steelhead conservation measures implemented in 2019 (CDFO 2019a), the tidal area of the Fraser River mainstem was closed to fishing for salmon from September 21 to November 1 and the non-tidal area was closed to fishing for salmon from September 22 to November 2 and September 26 to November 6 for the Mission to Hope BC and the Hope BC to Sawmill Creek areas, respectively.

Subsequent to these measures to protect Interior Fraser River Steelhead, areas of the Fraser River mainstem were opened to fishing for salmon but the retention of Chum Salmon was not permitted.

In part as a result of these measures, the lower Fraser River mainstem was open to the retention of Chum Salmon for seven days in 2019 (Table 3-7); this retention period is significantly less than previous years. Retention of Chum was permitted starting September 14 and ended on September 20 in the tidal area of the Fraser River mainstem (i.e. downstream of the Mission Bridge). The daily retention limit was four Chum Salmon for this fishery. Retention of Chum Salmon was not permitted in any non-tidal area of the Fraser River mainstem (i.e. upstream of the Mission Bridge) in 2019.

In 2019, the mainstem recreational fishery was assessed from September 14 to September 20 during the entire period Chum Salmon retention was permitted; no Chum Salmon were harvested or released (Table 3-7). Additional assessment of the mainstem recreational fishery occurred from November 2 to November 30, 2019 when the river was opened to fishing for salmon but closed to the retention of Chum Salmon; estimates of 0 Chum Salmon were harvested and released. No assessment took place from December 1 to December 31, 2019.

The estimated Fraser River mainstem harvest in 2019 was lower than the previous five years (averaged approximately 135 from 2014-2018) and notably less than in 2012 (Table 3-9). Two meaningful factors can be identified for this pattern. First, the estimated Fraser River Chum spawning escapement in 2019 was approximately 300,000 (the lowest estimated abundance in over 20 years) and roughly 30% of the average spawning escapement for the 2014-2018 period. And second, the CDFO closed the mainstem lower Fraser River to fishing for salmon from September 21 to November 1 to protect co-migrating stocks of concern (e.g. Interior Fraser River Steelhead), a period shown to account for greater than 90% of the Chum Salmon catch in some years (J. Tadey CDFO, pers. comm. 2023).

The Chilliwack River recreational fishery was open to the retention of Chum Salmon from September 1 to October 23, 2019 (daily retention limit of 1). This fishery was assessed from September 1 to November 15, 2019; estimates of 921 and 6,754 Chum Salmon were harvested and released, respectively (Table 3-7). The estimated Chum Salmon harvest in 2019 for the Chilliwack River was noticeably lower than the previous five years (averaged approximately 3,200 from 2014-2018) and significantly less than in 2018 (Table 3-9). Similar to the lower Fraser mainstem fishery, the period of Chum Salmon retention in the Chilliwack recreational fishery was truncated in 2019; but unlike the lower Fraser mainstem, the assessment of the Chilliwack recreational fishery has been relatively constant between 2013 and 2019.

The Harrison River, Stave River and Nicomen Slough recreational fisheries were open to the retention of Chum Salmon from April 1 to October 20 (daily retention limit of 2 per day). The retention Chum Salmon fisheries were closed in these systems on October 21 over concerns of poor coast-wide and Fraser River returns of Chum Salmon.

The Nicomen Slough fishery was assessed from October 1 to December 15, 2019. Estimates of 2 and 2,133 Chum Salmon were harvested and released, respectively for this fishery (Table 3-7). Chum Salmon harvest in this fishery was low and similar to harvest in the previous five years (averaged approximately 30 from 2014-2018) but notably less than that estimated in 2013 (Table 3-9). Recreational fisheries occurring in the Harrison and Stave rivers were not assessed in 2019.

In total, for assessed recreational fisheries occurring in the lower Fraser River watershed in 2019, estimates of 923 and 8,887 Chum Salmon were harvested and released, respectively (Table 3-7 and Table 3-9).

Commercial fisheries in the lower Fraser River (i.e. Area E gill net) are closed annually from early September to mid-October during the Interior Fraser Coho migration period. In recent years, this closure has been extended into late October to provide additional protection to Interior Fraser River Steelhead. As a result, commercial Area E gill net Chum Salmon fisheries now typically occur during the last week of October and first week of November. In 2019, there were no commercial fisheries directed on Fraser Chum Salmon due to the low abundance estimated in-season. There was no Chum Salmon bycatch in commercial fisheries directed on Pink Salmon that occurred in September (Table 3-7 and Table 3-8).

Four test fisheries operated in the Fraser River in 2019: the CDFO-operated Albion Chinook and Chum Salmon gill net test fisheries and the PSC-operated Whonnock and Cottonwood Sockeye Salmon gill net test fisheries. While Whonnock and Cottonwood test fisheries target Sockeye Salmon, the Albion test fishery assesses abundance of both Chinook and Chum Salmon, using different net configurations to target the two different species (section 3.2.3.1).

Table 3-9. Preliminary estimates of Chum Salmon harvest in assessed (i.e. surveyed) lower Fraser River recreational fisheries, 2010–2019.

Year	Recreational Fishery					
	Fraser River ¹	Chilliwack River	Nicomen Slough/Norrish Creek	Stave River	Harrison River ²	Total
2010	1,549	1,142	10	3,578	ns	6,279
2011	32	278	14	ns	ns	324
2012	2,298	4,633	9	ns	ns	6,940
2013	53	2,429	1,016	ns	ns	3,498
2014	344	2,917	15	ns	ns	3,276
2015	123	2,466	45	ns	ns	2,634
2016	34	3,253	8	ns	ns	3,295
2017	145	2,361	63	ns	ns	2,569
2018	25	5,088	2	ns	ns	5,115
2019	0	921	2	ns	ns	923
Average ³	460	2,549	118	3,578	ns	3,485

(1) Mainstem portion of the lower Fraser River (downstream of Hope, B.C.; Appendix B-3).

(2) Harrison River recreational fishery was last assessed in 2009.

(3) Average for years with an assessment.

(ns) not surveyed.

In 2019, the Albion Chinook Salmon test fishery operated from April 21 through October 20, and the Albion Chum Salmon test fishery operated from September 1 through November 23. From September 1 to October 20, the Chinook and Chum Salmon test fisheries operated on alternating days (section 3.2.3.1). Chum Salmon harvest in the Albion Chinook Salmon test fishery, representing 158 fishing days, totaled 369 and harvest in the Albion Chum Salmon test fishery, representing 52 days, totaled 3,436 Chum Salmon (Table 3-7).

The PSC Whonnock Sockeye Salmon test fishery operated for 97 days from June 24 through September 28, and harvested 102 Chum Salmon. The PSC Cottonwood Sockeye Salmon test fishery fished for 67 days from July 12 through September 16, and harvested 11 Chum Salmon (Table 3-7).

In total, an estimated 3,918 Chum Salmon were harvested in the CDFO and PSC test fisheries occurring in the Fraser River in 2019 (Table 3-7 and Table 3-8).

3.3.4 West Coast Vancouver Island

The estimated total harvest of Chum Salmon in 2019 WCVI commercial fisheries was 6,843. A limited-entry commercial fishery in Nootka Sound (Area 25) harvested an estimated 4,126 Chum Salmon and a fishery in Kyuquot Sound (Area 26) harvested an estimated 2,717 Chum Salmon.

First Nations FSC harvest of Chum Salmon occurred in all WCVI areas and totaled 1,755 for 2019.

3.3.4.1 Nitinat

In 2019, the pre-season forecast for Nitinat Chum was of 362,000. This forecast allowed for commercial Area E gill net and Area B purse seine fisheries. Due to ongoing declines in Interior Fraser River (IFR) Steelhead escapement, and the recent designation of the Thompson and Chilcotin River Steelhead as Endangered by COSEWIC, DFO implemented a precautionary approach to the management of those fisheries in southern BC that are likely to impact this stock of concern. In Areas 21 and 121, a fishing window closure was in place from September 11 to October 22 to address IFR Steelhead bycatch concerns. Following the window closure, fisheries were permitted within a two mile boundary of the shore line between Bonilla Point and Pachena Point.

Due to an extremely low Chum return, escapement goals to the Nitinat system were not met in-season; therefore, no commercial fisheries were authorized in 2019. The terminal return in 2019 was estimated at 46,000 Chum Salmon which is well below the lower reference point and the lowest return over the last 10 years (Table 3-10).

First Nations FSC (Area 21/22) and hatchery broodstock of Chum Salmon in 2019 totaled 18,500 Chum Salmon (Table 3-10).

Table 3-10. Nitinat area¹ Chum Salmon harvest, hatchery broodstock collection and spawning escapement estimates by PFMA, 2010–2019.

Year	PFMA 21		PFMA 22	
	Purse Seine Harvest	Gill Net Harvest	In-lake Harvest & Broodstock	Natural Spawners
2010	0	0	42,971	59,900
2011	65,469	211,968	136,641	248,655
2012	97	23,219	75,816	206,704
2013	0	15,730	25,800	25,066
2014	0	0	56,069	125,500
2015	58,580	110,535	93,177	240,000
2016	269,042	137,591	145,179	445,000
2017	0	36,051	62,229	99,000
2018	0	11,467	54,363	83,794
2019	0	0	18,500	27,500
Average	98,297	78,080	71,075	156,118

(1) includes Nitinat tributaries.

3.4 Escapement

Chum Salmon that escape First Nations, commercial (including test fisheries), and recreational fisheries, and any First Nations ESSR harvests, form the escapement totals of spawning Chum Salmon for this section of the report. This *net escapement* can include Chum Salmon that spawn in natural areas and constructed spawning channels, and those that are used as broodstock in enhancement facilities for hatchery production purposes. For the purposes of this report

spawning escapement refers to salmon that spawn by their own volition in nature in either a natural (e.g. river) or man-made channel (e.g. controlled spawning channel), and does not include salmon used for broodstock.

Some river systems in southern B.C. support summer Chum Salmon populations. However, because the summer aggregate is relatively minor when compared to the larger fall aggregate in southern B.C., and due to their distinctively early run timing (e.g. July to late August in Johnstone Strait) allowing for only a minimal bycatch in southern B.C. salmon fisheries (Table 3-4), summer Chum Salmon escapement is not included in the escapement totals for this section of the report (i.e. escapement totals in this section refer to fall Chum Salmon only).

3.4.1 Inside Southern

The stocks that are managed within the context of the Inside Southern Chum (ISC) Salmon plan are the fall Chum Salmon. These Chum Salmon enter Johnstone Strait during the September to November time period. Escapement estimates for these Chum Salmon since 2010, are presented in Table 3-11. The primary enhanced escapement areas for ISC Salmon are presently limited to the mid-Vancouver Island, Squamish River, Burrard Inlet and Fraser River areas. The enhancement facilities in the mid-Vancouver Island consist of Big Qualicum, Little Qualicum and Puntledge rivers Hatcheries. There is one enhancement facility in the Burrard Inlet (Capilano River Hatchery: limited Chum Salmon hatchery production), and the Squamish watershed (Tenderfoot Creek Hatchery) and four in the Fraser River watershed (Inch Creek, Chilliwack River, and Chehalis River Hatcheries and Weaver Creek Spawning Channel). Enhancement on the Capilano River is opportunistic, only using Chum Salmon that return to the hatchery facility for broodstock.

Table 3-11. Inside Southern Chum Salmon net escapement estimates (spawning escapement plus hatchery broodstock) for Fraser and non-Fraser stock aggregates, 2010–2019 ¹.

Year	Inside Southern Chum Salmon Escapement		
	Fraser River	Non-Fraser River	Total
2010	645,449	424,742	1,070,191
2011	1,115,873	928,827	2,044,700
2012	1,524,256	1,299,835	2,824,091
2013	980,137	1,153,041	2,133,178
2014	1,133,630	520,798	1,654,428
2015	961,939	681,026	1,642,965
2016	1,988,815	1,705,728	3,694,543
2017	665,084	656,583	1,321,667
2018	680,213	591,056	1,271,269
2019	305,415	218,186	523,601
Average	1,000,081	817,982	1,818,063

(1) Does not include Chum Salmon which are surplus to spawning requirements (ESSR) and are removed from the spawning areas as they do not contribute to production in subsequent years. Those Chum Salmon are assigned to harvest. Hatchery broodstock removals are included as they contribute to subsequent production.

3.4.2 West Coast Vancouver Island

In 2019, Nitinat Chum Salmon spawning escapement was estimated at 27,500 (Table 3-10) which is a decline over the 2015 brood year (240,000) and well below average. In other WCVI Areas, Chum Salmon spawning escapements were all well below average in the areas monitored (Table 3-12). Spawning escapement estimates given for Areas 23-26 in Table 3-12 are derived from index system assessments in each area. From historical surveys of Chum Salmon streams in each area, the proportion each stream contributed (on average) to the total spawning escapement for the Area is estimated. Spawning escapement estimates from index systems currently surveyed annually, are expanded to an Area spawning escapement to account for those streams not surveyed.

Table 3-12. WCVI Chum Salmon spawning escapement estimates ¹ by PFMA, 2010–2019.

Year	WCVI Pacific Fishery Management Area			
	PFMA 23 (Barkley)	PFMA 24 (Clayoquot)	PFMA 25 ² (Nootka)	PFMA 26 (Kyuquot)
2010	24,352	61,799	54,354	36,124
2011	121,692	149,164	93,600	125,489
2012	40,419	42,276	49,148	49,433
2013	35,302	44,174	69,877	79,312
2014	12,475	36,878	51,476	40,630
2015	32,559	32,342	106,921	82,277
2016	101,006	31,051	191,259	88,676
2017	12,864	30,125	46,758	27,273
2018	6,439	25,468	85,677	20,346
2019	9,221	14,205	38,206	24,872
Averages	39,633	46,748	78,728	57,443

(1) Index system spawning escapements expanded to total spawning escapement for the PFMA.

(2) Nootka spawning escapements include hatchery river systems.

4 United States Chum Salmon

4.1 Washington Run Sizes, Spawning Escapements, and Catches

Tables 4-1 and 4-2 provide pre-season forecasts of run size, post-season estimates of run size and post-season estimates of spawning escapement for the Chum Salmon runs returning to Puget Sound and coastal Washington areas. The tables present estimates for three major Chum Salmon groupings, defined by their return timings (summer, fall and winter).

4.1.1 Summer Chum Salmon

The Strait of Juan de Fuca summer Chum Salmon post-season run size of 4,834 was 2.9 times the pre-season forecast and 60% of the 2010–2018 average post season run size (Table 4-1 and Figure 4-1). The Hood Canal summer Chum Salmon post-season run size of 7,590 was about

74% of the pre-season forecast and about 25% of the 2010–2018 average post-season run size (Table 4-1 and Figure 4-1). Approximately 99.9% of the combined Strait of Juan de Fuca and Hood Canal summer Chum Salmon run went to escapement. The post-season run size estimate of South Puget Sound summer Chum Salmon in 2019 was 16,206, which was about 57% of the pre-season forecast and 47% of the 2010-2018 average post-season run size (Table 4-1 and Figure 4-1).

Table 4-1. Puget Sound summer Chum Salmon pre- and post-season estimates of run size and spawning escapements, 2010–2019.

Region	Type	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
South Puget Sound ¹	Pre-Season	62,991	62,623	41,889	53,492	59,940	57,987	86,254	33,716	25,178	28,420
	Post-Season	49,098	39,823	38,936	38,332	25,317	32,570	19,294	38,798	25,995	16,208
	Escapement	43,739	38,515	24,521	35,444	20,593	32,521	19,068	37,372	25,358	14,769
Hood Canal	Pre-Season	5,999	9,050	8,970	19,798	31,400	22,526	22,526	34,188	17,034	10,315
	Post-Season	12,957	7,170	31,134	24,325	30,408	36,055	52,753	59,850	13,308	7,590
	Escapement	12,533	6,914	29,855	22,618	27,396	32,644	47,966	55,655	12,868	7,582
Strait of Juan de Fuca	Pre-Season	3,991	5,308	5,915	6,603	9,041	7,105	7,105	11,094	2,309	1,684
	Post-Season	9,332	5,705	6,337	14,801	8,179	15,599	9,089	2,119	1,586	4,834
	Escapement	9,179	5,675	6,304	14,727	7,811	15,532	9,077	2,113	1,567	4,830

(1) South Puget Sound estimates include only commercial harvest and escapement within Puget Sound.

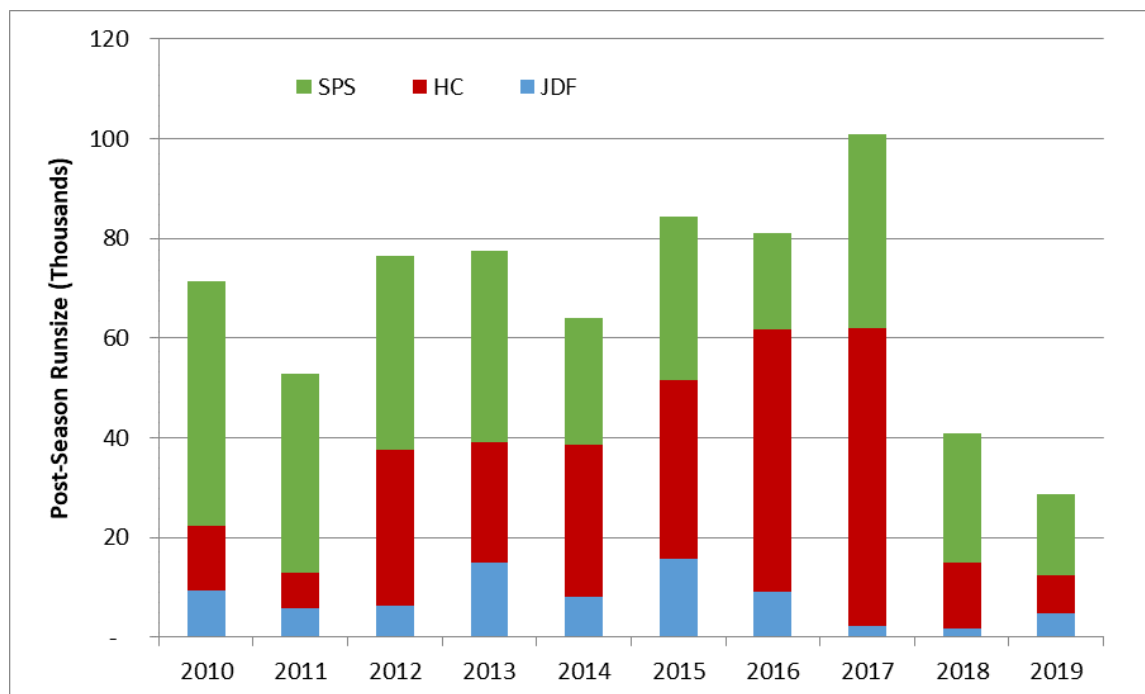


Figure 4-1. Puget Sound summer Chum Salmon abundance, 2010–2019, by region of origin (JDF: Strait of Juan de Fuca, HC: Hood Canal, SPS: South Puget Sound).

4.1.2 Fall and Winter Chum Salmon

The combined Puget Sound fall Chum Salmon post-season run size estimate was 419,856 fish, or 37% of the pre-season forecast and approximately 28% of the 2010–2018 average post-season run size.

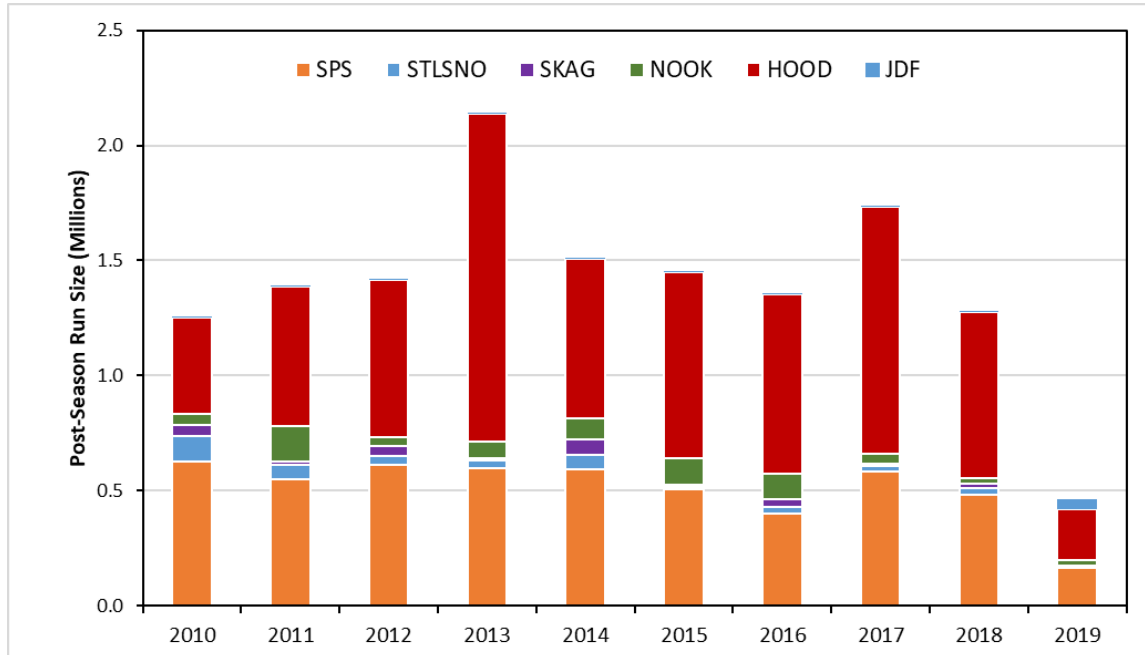


Figure 4-2. Puget Sound fall Chum Salmon abundance, 2010-2019, by region of origin (JDF: Strait of Juan de Fuca, NOOK: Nooksack-Samish, SKAG: Skagit, STLSNO: Stillaguamish/ Snohomish, SPS: South Puget Sound, HOOD: Hood Canal).

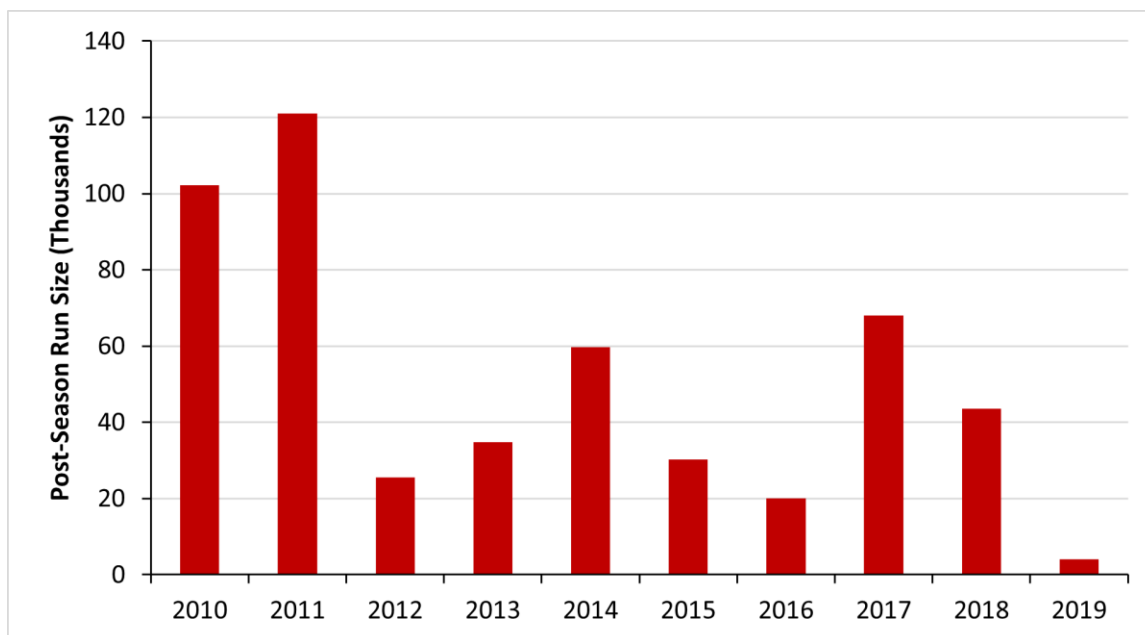


Figure 4-3. South Puget Sound winter Chum Salmon abundance, 2010–2019.

Regional post-season numbers varied in their deviation from the forecasted numbers, ranging from 57% of the pre-season forecast (Hood Canal) to 4% of the pre-season forecast (Skagit River) (Table 4-2 and Figure 4-2).

The Washington coastal (Willapa Bay and Grays Harbor) fall Chum Salmon post-season run size estimate was 82,377 fish, or approximately 66% of the pre-season forecast, and 94% of the 2010-2018 post-season average run size (Table 4-2 and Figure 4-2).

The Puget Sound winter Chum Salmon 2019 post-season run size assessment was 4,106, which was approximately 11% of the pre-season forecast and 8% of the 2010–2018 average post-season run size (Table 4-2 and Figure 4-3).

Table 4-2. Washington fall and winter Chum Salmon pre- and post-season estimates of run size and spawning escapements, 2010–2019.

Run	Region	Type	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Fall	Willapa Bay	Pre-Season	33,442	22,254	28,273	35,584	55,378	39,994	47,555	57,726	39,932	52,205
		Post-Season	26,701	69,802	43,069	27,564	30,276	48,756	86,673	22,609	41,448	43,830
		Escapement	25,204	66,871	26,640	24,979	26,508	45,409	80,931	21,986	38,582	40,893
	Grays Harbor	Pre-Season	18,492	33,669	24,603	30,716	44,670	28,852	35,700	31,300	61,144	71,959
		Post-Season	43,582	50,494	40,561	41,524	28,728	48,049	70,434	29,678	42,185	38,547
		Escapement	34,644	30,101	27,876	22,519	15,378	34,587	64,704	19,613	29,314	28,682
	Strait of Juan de Fuca	Pre-Season	2,222	1,618	1,203	813	4,369	9,305	3,240	1,688	7,076	4,467
		Post-Season	1,849	4,839	3,174	1,468	2,045	3,076	2,920	447	1,118	843
		Escapement	1,343	4,707	2,973	1,394	1,952	2,958	2,805	435	1,054	794
	Nooksack/ Samish	Pre-Season	61,827	31,924	34,739	52,585	59,908	180,759	89,207	109,337	163,114	115,653
		Post-Season	48,892	152,176	39,100	68,176	95,440	112,704	109,824	45,023	24,576	24,162
		Escapement	30,510	100,748	21,703	48,506	60,058	68,690	60,573	26,429	18,970	17,636
	Skagit	Pre-Season	50,226	26,834	59,167	15,325	16,505	47,292	45,449	6,966	124,295	84,270
		Post-Season	46,503	15,850	41,601	9,786	65,734	8,155	35,388	7,107	19,557	3,406
		Escapement	39,884	15,494	36,601	8,554	63,013	7,964	33,797	6,750	18,718	3,197
	Stillaguamish/ Snohomish	Pre-Season	90,660	71,277	86,598	48,884	87,476	168,104	32,905	26,516	132,580	80,461
		Post-Season	110,050	61,598	40,003	35,145	64,272	13,669	27,372	23,656	29,226	5,336
		Escapement	46,628	60,792	35,450	30,317	51,599	8,169	24,434	20,060	27,448	5,025
	Hood Canal	Pre-Season	477,409	352,019	426,675	323,597	442,308	394,246	489,698	492,892	432,980	389,129
		Post-Season	419,094	610,507	684,643	1,427,35	691,862	809,162	777,359	1,071,17	722,332	222,543
		Escapement	49,486	102,374	91,940	240,169	105,192	146,004	179,118	193,760	238,583	28,363
	South Puget Sound	Pre-Season	650,986	487,514	323,928	349,623	465,970	377,032	526,060	433,196	543,637	449,345
		Post-Season	627,131	548,484	611,657	597,762	589,869	503,531	401,462	584,264	480,953	163,566
		Escapement	201,992	179,094	190,817	186,457	200,660	160,260	167,561	179,797	191,425	83,718
Winter	South Puget Sound	Pre-Season	89,293	55,923	51,599	61,113	84,263	45,170	47,053	36,696	82,144	35,608
		Post-Season	102,235	121,079	25,522	34,839	59,672	30,227	20,043	67,988	43,501	4,106
		Escapement	79,550	74,110	18,987	21,754	46,587	28,855	19,600	60,420	37,127	2,955

4.1.3 Chum Salmon Harvest

Paragraph 3 of the Chapter 6, Annex IV of the Treaty requires that the United States and Canada assess catch levels of Chum Salmon during the July 1 through September 15 time period in boundary area fisheries. Table 4-3 provides Chum Salmon harvest totals during this accounting period for U.S. boundary area fisheries in Puget Sound Salmon Management and Catch Reporting Areas (Catch Areas or Areas, Appendix B-1) 4B, 5, 6C, 7 and 7A.

Table 4-3. Harvest of Chum Salmon in U.S. Catch Areas (Areas) in the Strait of Juan de Fuca (SJF) and the San Juan Islands (SJI) commercial fisheries during the HC/JDF summer Chum Salmon accounting period (July 1–September 15) in years 2010–2019.

Year	Strait of Juan de Fuca			San Juan Islands		Total
	Area 4B	Area 5	Area 6C	Area 7	Area 7A	
2010	95	77	0	122	29	323
2011	0	27	0	53	110	190
2012	61	63	0	9	3	136
2013	63	11	0	705	107	886
2014	6	59	0	9	258	332
2015	44	54	0	26	8	132
2016	0	27	0	0	0	27
2017	0	0	0	45	41	86
2018	0	207	0	8	18	233
2019	0	0	0	4	14	18
Average	27	53	0	98	59	236

Table 4-4. Harvest of summer, fall, and winter Chum Salmon in U.S. Catch Areas (Areas) in the Strait of Juan de Fuca (SJF), San Juan Islands and Point Roberts (SJI/PR), Puget Sound and Washington (WA), 2010–2019.

Year	Region			
	SJF (Areas 4B, 5, 6C)	SJI/PR (Areas 7, 7A)	Puget Sound ¹	WA Coast ²
2010	1,796	23,642	927,742	12,593
2011	1,865	70,359	989,986	28,251
2012	476	73,236	1,064,532	30,697
2013	1,200	80,472	1,644,328	23,060
2014	3,700	147,022	1,011,660	18,069
2015	6,858	124,791	1,037,455	20,911
2016	25,807	118,461	846,808	18,830
2017	3,426	123,282	1,282,595	12,675
2018	4,579	66,444	781,237	2,254
2019	376	612	283,526	3,590
Average	5,008	82,832	986,987	17,093

(1) All other Puget Sound freshwater and marine Catch Areas except Strait of Juan de Fuca or San Juan Islands/Point Roberts Fisheries.

(2) WA Coast combines harvest from Catch Areas 1–4 including Grays Harbor, Willapa Bay, Columbia River and Coastal Rivers.

Table 4-4 provides Chum Salmon harvest totals from the Strait of Juan de Fuca (SJF) fisheries in Catch Areas 4B, 5, and 6C and the San Juan Islands/Point Roberts (SJI/PR) fisheries in Catch Areas 7 and 7A. Table 4-4 also includes annual Chum Salmon harvest totals for the Puget Sound and the Washington Coastal areas.

4.2 Strait of Juan de Fuca Fisheries (Catch Areas 4B, 5, 6C)

4.2.1 Management Intent

During the 2019 season, the management strategy for the Strait of Juan de Fuca (SJF) fishery consisted of maintaining the limited effort nature of this fishery and considering the needs of Puget Sound stocks of Chum Salmon when making management decisions. This fishery has experienced minimal effort in recent years, resulting in relatively low harvest levels over the period of 2010–2019 (Table 4-4). Harvest and effort for the period of 2010–2019 were generally below levels observed in the late 1980s and early 1990s.

4.2.2 Fishery Description

As in previous years, the fall Chum Salmon fishery in U.S. Catch Areas 4B, 5 and 6C was restricted to Treaty Indian fishers using gill nets. The Treaty Chum Salmon fishery opened the week of October 13, 2019 with a schedule of six days per week and continued through November 9, 2019. A total of 114 Chum Salmon was harvested in this fishery, and there was a reported bycatch of 226 Coho salmon, zero Chinook salmon, and zero Steelhead.

In Catch Areas 4B, 5, and 6C, the incidental harvest of Chum Salmon prior to the Chum Salmon-directed fishing season was below the recent ten-year average. Zero Chum Salmon were harvested during the summer Chum Salmon accounting period (July 1–September 15). During the subsequent Coho salmon-directed fishery, 262 Chum Salmon were harvested.

The total 2019 Chum Salmon catch by all gears (including recreational) in the SJF was 376 Chum Salmon (Table 4-4).

4.3 San Juan Islands/Point Roberts Fisheries (Catch Areas 7, 7A)

4.3.1 Management Intent

Chum salmon fisheries in Catch Areas 7 and 7A are regulated to comply with a base harvest ceiling of 125,000 Chum salmon, unless Canada estimates Chum stocks migrating through Johnstone Strait (“Inside Southern Chum Salmon”) are below the critical threshold of 1.0 million (PST 2019). Chapter 6 of Annex IV specifies that U.S. commercial fisheries for Chum salmon in Catch Areas 7 and 7A will not occur prior to October 10. Paragraph 9 (a) specifies run sizes below 1.0 million as critical (estimated by Canada). For Inside Southern Chum run sizes below the critical threshold, Paragraph 10 (b) states the U.S. catch of Chum Salmon in Catch Areas 7 and 7A will be limited to those taken incidentally to other species and in other minor fisheries, and shall not exceed 20,000.

4.3.2 Fishery Description

On October 7, 2019 Canada notified the U.S. that the Inside Southern Chum Salmon aggregate was estimated to be below the critical threshold of 1.0 million and the U.S. was expected to limit

Chum Salmon harvest to incidental and minor fisheries not exceeding 20,000. Following this notification, the U.S. suspended Area 7 and 7A commercial Chum Salmon fisheries that were scheduled to open on October 10. Additionally, beginning October 10, the U.S. required Chum Salmon release from reef net fisheries targeting Coho, and scheduled the reef net fishery to close on October 16.

Paragraph 9 (d) states that Canada will provide an in-season estimate of Fraser River Chum salmon run size no later than October 22. If that estimate is below 1,050,000, then the U.S. will limit its fishery in Areas 7 and 7A to not exceed a catch of 20,000 additional Chum salmon from the day following notification. On October 16, 2019, Canada notified the U.S. that the Fraser River chum run size was estimated to be below the 1,050,000 fish threshold. Therefore, the U.S. was expected to limit chum harvest to not exceed 20,000 from the day following this notification. Areas 7 and 7A therefore remained closed to commercial Chum Salmon fisheries through the remainder of the Chum management period.

Chum Salmon catch by reef nets in Coho Salmon-directed fisheries between October 1 and October 10 was 574 fish (Table 4-5). There were no gill net or purse seine Chum Salmon-directed fisheries, or landings, in Areas 7 and 7A in 2019 (Table 4-5). The combined U.S. commercial catch in Areas 7 and 7A for all gear types was 574 Chum Salmon. There were no Chum Salmon harvested in recreational fisheries in Areas 6, 7 and 7A during 2019.

Although Area 6 is not mentioned in the Chum Salmon Annex, and harvests from this area do not count against the U.S. harvest ceiling, it is worth noting that no Chum Salmon were harvested from Area 6 in 2019.

Table 4-5. Harvest of Chum Salmon in U.S. Catch Areas (Areas) 6, 7 and 7A Pink and Coho Salmon fisheries, 2019.

Area	Pink Fishery	Coho Fishery
6	0	0
7	24	574
7A	14	0
Total	38	574

Table 4-6. Harvest of Chinook salmon, Coho salmon and Steelhead in U.S. Catch Areas (Areas) 6, 7 and 7A in Chum Salmon directed fisheries (October 1-October 16, 2019).

Area	Chinook	Coho	Steelhead
6	0	0	0
7	0	420	0
7A	0	8	0
Total	0	428	0

In 2019, there was a reported bycatch of zero Chinook Salmon, 428 Coho Salmon and zero Steelhead in Area 7 and 7A in Chum Salmon directed fisheries between October 1 and October 16 (Table 4-6).

The total 2019 Chum Salmon catch by all gear types in Areas 6, 7 and 7A in Coho Salmon-directed fisheries between October 1 and October 10 was 574 (Table 4-5). All of these were caught by reef nets in Catch Area 7. In addition, 38 Chum Salmon were harvested as bycatch in Fraser Panel approved Pink Salmon purse seine fisheries in Areas 7 and 7A (Table 4-5).

5. Stock Identification

5.1 Tagging of Adult Chum Salmon

No adult tagging projects were reported by either Canada or the United States in marine or nearshore areas in 2019.

5.2 Otolith Thermal Marking, Fin Marking and Coded-Wire Tagging of Juvenile Chum Salmon

5.2.1 Canada

Thermal marking of otoliths (Volk *et al.* 1987) has been used to mass mark hatchery raised salmonids in B.C. since the early 1990s (Hargreaves *et al.* 2001). The method involves manipulating the temperature of the rearing water by at least 2°C to induce lighter or darker deposition (density) of otolith layers. By systematically altering water temperature over a period of time, banding patterns (i.e. a “mark”) unique to each hatchery can be created.

Table 5-1. Releases of Chum Salmon with thermally-marked otoliths from Canadian hatchery facilities, 2010–2019.

Brood Year	Hatchery Facility Release Sites								
	Nitinat Hatchery	Conuma River Hatchery					Namgis First Nation Gwa'ni Hatchery		
	Nitinat River & Lake	Conuma River	Conuma Estuary	Tlupana River	Sucowa River	Canton River	Lower Nimpkish River	Alder Bay	Alert Bay
2009	5,252,749	18,847	1,814,475	685,465	551,365	854,548	0	0	0
2010	14,182,582	0	1,794,205	1,015,355	311,828	646,203	0	0	0
2011	25,303,286	0	1,270,286	37,241	223,882	365,682	0	0	0
2012	15,813,031	0	785,682	813,957	41,196	116,757	0	0	0
2013	9,738,442	0	1,705,633	820,612	269,435	1,009,478	0	0	0
2014	17,767,521	410,214	1,467,870	0	0	200,646	0	0	0
2015	18,236,300	534,334	723,867	452,375	0	576,649	0	0	0
2016	26,443,305	424,032	1,932,540	1,027,846	0	835,191	0	0	0
2017	7,894,803	471,129	1,624,825	580,356	213,343	203,990	8,974	5,082	0
2018	16,512,986	563,431	1,679,255	1,120,443	610,249	511,748	852,252	0	970,995
2019	5,129,890	491,912	1,477,237	408,084	497,567	465,434	1,584,751	0	0

Thermal marking was first used on Chum Salmon at Nitinat Hatchery on the West Coast of Vancouver Island in 1993 and continues to be used as a means of estimating hatchery contribution to both fisheries and escapement. Thermal marking is currently the only mark being applied to Chum Salmon from Nitinat Hatchery (Table 5-1).

A second hatchery on the West Coast of Vancouver Island, Conuma River Hatchery, first began thermally marking otoliths for several populations of Chum Salmon beginning with the 1998 brood year. This continued in 2019 with extensive releases of thermally-marked Chum Salmon in various river systems of Nootka Sound (Table 5-1). Similar to Nitinat releases, comprehensive adult sampling programs aimed at detecting (i.e. recapturing) the thermally-marked Chum Salmon have occurred during the fall Chum Salmon fisheries. Information from these programs has permitted a better understanding of timing and catch distribution for the Chum Salmon populations in Nootka Sound.

A new Chum Salmon recovery program had been initiated on the Nimpkish River which included thermal marking of various release groups for future evaluation of release strategies. Small numbers of native stock were initially marked for the 2017 brood year (Table 5-1). In subsequent brood years (2018-2019) large egg transfers from the Puntledge River were reared and released from the Namgis First Nation Gwa'ni Hatchery (formerly Nimpkish River Hatchery) with unique thermal marks (brood years 2018 and 2019)

In the past enhanced contributions of Chum Salmon from major hatchery facilities were also based on marking a portion of the fry released with a variety of fin clips. Not all hatchery release groups were represented by a mark. Contributions to fisheries and escapement for those groups were estimated by associating them with a marked release group having a similar size and release timing. Table 5-2 provides a summary of fin clip (or mark) combinations applied from 2010–2019 brood years for hatchery Chum Salmon during the period covered by this report. Fin clipping was suspended at Big Qualicum River in 2016 (Table 5-2).

Table 5-2. Releases of marked Big Qualicum River Chum Salmon from southern B.C.-based Canadian hatchery facilities, 2010–2019.

Brood Year	Fin Clip Type ¹	Clipped	Poor Clips + Unclipped	Total
2009	ADRV	250,692	8,381	259,073
2010	ADRV	201,825	5,463	207,288
2011	AD	250,337	4,011	254,348
2012	AD	249,655	3,636	253,291
2013	AD	251,108	15,932	267,040
2014	AD	191,823	7,248	199,071
2015	AD	250,646	4,423	255,069
2016	n/a	None clipped	n/a	0
2017	n/a	None clipped	n/a	0
2018	n/a	None clipped	n/a	0
2019	n/a	None clipped	n/a	0

(1) Fin Clip (or mark) Types: AD-adipose fin; LV-left ventral fin; RV-right ventral fin.
(n/a) not applicable.

There were no coded-wire tagged Chum Salmon released from Canadian facilities during the 2009–2019 time period.

5.2.2 United States

Historically, hatchery supplementation was used to enhance depressed wild summer Chum Salmon populations and to reintroduce summer Chum Salmon back into streams where the original population was extirpated. The duration of all JDF/HC hatchery supplementation programs were limited to three summer Chum Salmon generations (12 years) to minimize the likelihood for divergence between hatchery broodstocks and target natural stocks. However, the Lilliwaup supplementation program extended beyond 12 years, due to continued extremely low Lilliwaup sub-population run sizes and lack of habitat protection and restoration efforts in the Lilliwaup River.

In 2018, otolith thermal marking (Volk *et al.* 1987) ceased for hatchery supplementation and re-introduction programs for summer Chum Salmon in the Strait of Juan de Fuca and Hood Canal (Table 5-3) but continued for some fall Chum Salmon in Hood Canal, Puget Sound and the Lower Columbia River (Table 5-4). Otolith marking was used as a tool to assess program success and determine proportions of hatchery- and natural-origin fish (and identify hatchery strays) on spawning grounds.

Table 5-3. Numbers of summer Chum Salmon released in river systems within the Strait of Juan de Fuca (SJF) and Hood Canal with thermally-marked otoliths, 2010–2019.

Brood Year	SJF	Hood Canal		
	Jimmycomelately	Hamma Hamma	Lilliwaup	Tahuya
2010	85,630	0	139,816	27,706
2011	0	0	41,006	19,600
2012	0	0	157,760	110,000
2013	0	0	169,440	52,778
2014	0	0	109,680	0
2015	0	0	165,024	0
2016	0	0	199,824	0
2017	0	0	150,000	0
2018	0	0	0	0
2019	0	0	0	0

Table 5-4. Numbers of fall Chum Salmon released in river systems within Hood Canal, Puget Sound and Lower Columbia River with thermally-marked otoliths, 2010–2019.

Brood Year	Hood Canal		Puget Sound						Lower Columbia River	
	Union River	Skokomish River	Elwha River	Tulalip Bay	Kendall Creek	Terrell Creek	Whatcom Creek	Sky-komish River	Grays River Hatchery ¹	Washougal Hatchery
2010	0	0	0	0	0	0	2,000,000	0	250,000	57,455
2011	0	0	0	0	0	0	1,360,000	0	206,000	74,893
2012	0	0	0	0	0	0	1,547,900	0	157,800	58,004
2013	0	0	450,000	40,000	650,895	85,000	3,048,000	0	151,567	46,083
2014	0	0	450,000	8,000,000	1,094,383	1,000,000	2,283,000	0	192,156	400,000
2015	0	0	450,000	8,000,000	1,000,000	0	2,000,000	0	250,000	500,000
2016	0	0	450,000	8,000,000	1,000,000	0	2,000,000	0	250,000	100,000
2017	0	0	450,000	8,000,000	1,000,000	0	2,000,000	0	250,000	100,000
2018	0	11,996,785	450,000	8,000,000	1,000,000	0	2,000,000	0	250,000	0
2019	35,000	0	450,000	8,000,000	2,000,000	0	2,000,000	41,532	250,000	0

(1) Includes Grays River broodstock released in Big Creek, OR.

5.3 Genetic Stock Identification

In 2010, the Committee completed a joint recommendation to the Southern Panel concerning the type of genetic stock identification (GSI) methodology to be used for immediate and future application of Canada and United States Chum Salmon stock assessment (TCCHUM 2013). The Pacific Salmon Treaty (Annex IV, Chapter 6, Section 2) states:

“When the Parties provide stock composition information for fisheries, the Committee shall evaluate and report its conclusions using bilaterally agreed upon methods.”

Fisheries of interest include Johnstone Strait, east coast of Vancouver Island, Fraser River, and Nitinat in Canada and Point Roberts, San Juan Islands and the Strait of Juan de Fuca in the U.S.

5.3.1 Fishery Sample Collection for Genetic Stock Identification

5.3.1.1 Canada

In 2019, work began on expanding the joint bilateral (DFO and WDFW) SNP baseline. Through 2018, the Canadian baseline consisting of 38 populations with an additional 25 populations (Sutherland *et al.* 2020). The Canadian panel consists of around 500 polymorphic markers which are expected to show improved resolution over the microsatellite panel of 15 markers.

Since no commercial fisheries occurred in 2019, in either Johnstone Strait (Areas 12-13) or east coast of Vancouver Island, only the 1,267 Johnstone Strait purse seine test fishery samples were analysed in 2019 (Table 5-5). These samples were analysed for microsatellite markers using the fourth year of four years of funding supported by the Southern Endowment Funds. Since few samples were collected in 2019, these were combined with the 2020 results for Southern Fund reporting purposes (Candy *et al.* 2021). In a separate Southern Fund project, the Juan de Fuca

assessment fishery started in 2016. In 2019, 639 Chum Salmon were analysed with microsatellites from this assessment fishery (Watkins *et al.* 2019).

Table 5-5. Chum Salmon tissue samples collected and analyzed in Johnstone Strait (PFMAs 12-13), east coast of Vancouver Island (PFMAs 14-17), and Juan de Fuca (PFMA 20/US Areas 5, 6) from commercial and test fisheries 2010-2019.

Year	Commercial Samples				Test Fishery Samples			
	PFMAs 14-18		PFMAs 12-13		PFMA 12		PFMA 20/Areas 5-6	
	Collected	Analysed	Collected	Analysed	Collected	Analysed	Collected	Analysed
2010	59	59			1,015	1,014	0	0
2011	101	101			1,404		0	0
2012	307	307			1,275		0	0
2013	0	0	1,185		1,311		0	0
2014	0	0	1,087	990	1,369	1,342	0	0
2015	0	0			1,395		0	0
2016	0	0			1,350		1,025	1,025
2017	633	574			1,415		1,538	1,534
2018	224	224	600	500	1,473	1,244	1,656	1,619
2019	0	0	0	0	1,274	1,267	643	639

5.3.1.2 United States

In 2018, WDFW started employing the Chum Salmon SNPs to genotype hatchery broodstocks used in the Lower Columbia Chum Salmon reintroduction work for parent-based tagging: genotype broodstocks, in subsequent years genotype spawners that are potentially offspring of the hatchery parents, assign the spawners to the broodstocks and determine which program they came from or if they were born in the wild, rather than a hatchery (Hillson 2018). WDFW has also conducted juvenile stock assignment studies in the Strait of Juan de Fuca and Hood Canal during 2009–2019. The juvenile studies documented emigration timing and relative production of summer and fall Chum Salmon in key populations. In another application of the SNP baseline, WDFW characterized Chum Salmon in the Elwha and Lyre rivers in the Strait of Juan de Fuca to estimate the contributions of hatchery Chum Salmon to recolonization in the Elwha River following dam removal (Small *et al.* 2018a).

Mixed-stock fishery GSI sampling efforts occurred in various U.S. Chum Salmon fisheries. A GSI analysis of the 2019 Catch Area 10/11 fishery (N = 672) in South Puget Sound was funded by the Southern Endowment Fund and used the Chum Salmon SNP baseline (Table 5-6). In 2019, no fishery occurred in U.S. Catch Areas 7 and 7A, and therefore no Chum Salmon samples were collected. Samples were collected in U.S. Catch Area 9 from Chum Salmon in the test fishery as well as from the commercial fishery, though these have not been analyzed (Table 5-6).

Table 5-6. Chum Salmon tissue samples from U.S. Catch Areas (Areas) 7, 7A, 9, and 10/11 analyzed ¹ for GSI in 2010–2019.

Year	Area 7	Area 7A	Area 9			Area 10/11
	Commercial		Test	Commercial	Research	Commercial
2010	403	203	352	0	0	0
2011	0	0	527	0	366	0
2012	1,328	829	493	0	50	0
2013	419	423	692	0	961	0
2014	121	285	877	0	504	0
2015	196	123	732	0	357	0
2016	784	336	718	288	0	0
2017	921	415	749	450	0	1,447
2018	0	0	809	593	933	730
2019	0	0	0	0	0	672

(1) These years of samples were analyzed by CDFO lab using microsatellite DNA.

5.3.2 Baseline Collection for Genetic Stock Identification

In 2019 researchers in Canada and US continued to collect baseline samples in anticipation of the completion of the development phase of the Chum Salmon SNP locus panel with funding from the Southern Fund. The Chum Salmon SNP panel would allow Chum Salmon researchers in any lab to genotype Chum Salmon and generate compatible data to be entered into a common Chum Salmon genetic database.

5.3.2.1 Canada

In 2019, CDFO continued to collect baseline GSI tissue samples of Southern British Columbia Chum Salmon populations (Table 5-7). The focus was to sample fish from the east coast of Vancouver Island from natural spawning populations to improve resolution between these populations. The CDFO Molecular Genetics Lab continues to expand the southern BC baseline SNP panel in collaboration with the WDFW lab.

Table 5-7. Fall Chum Salmon GSI tissue collections from Southern B.C. by Conservation Unit, collection site, life stage, and influence ¹ of enhancement, 2019.

Conservation Unit	Collection Site	Life Stage	Enhancement Level ¹	Sample Size
Loughborough	Heydon Creek	Adult	Natural	199
Georgia Strait	Theodosia River	Adult	Natural	3
Georgia Strait	Goldstream River	Adult	Mixed	97
Lower Fraser	Chilliwack River	Adult	Mixed	94

(1) Enhancement level refers to the degree to which the CDFO Committee members believed hatchery production contributed to the returns to the collection site. Based partly on the enhancement history in the CDFO hatchery production database, enhancement level is subjectively classified as either *hatchery* (insignificant contribution of natural production to returns), *mixed* (both enhanced and natural production contribute significantly to returns) or *natural* (insignificant contribution of hatchery production to returns).

5.3.2.2 United States

In 2018, the UW lab finalized GTseq development of two SNP panels and the WDFW lab implemented the GTseq protocol to genotype baseline samples (Small *et al.* 2018b). Because there were two GTseq amplicon panels, the costs to the WDFW lab limited genotyping to half the samples originally intended (Table 5-8). Further, WDFW encountered difficulties with high throughput genotyping because the GTseq method was more sensitive to sample quality than Taqman assays and most of the samples were from carcasses. Because of these challenges, WDFW reassessed the SNP loci and the GTseq protocol. WDFW reorganized the SNP loci into a single panel of 350 SNP loci and modified the DNA extraction protocol to improve genotyping results. The WDFW lab genotyped an initial baseline data set of 43 collections (N = 2466 total fish) from the Southern Boundary Region.

Table 5-8. List of collections genotyped with 350 SNPs to expand the Southern Boundary Chum Salmon SNP baseline in 2019.

Regional Grouping	Collection Name	Number of Samples Processed	Collection Code
Strait of Juan de Fuca	Dungeness (Beebe Cr)	39	10LK
Strait of Juan de Fuca	Elwha River	53	96EH
Strait of Juan de Fuca	Lyre Cr	51	18JR
Strait of Juan de Fuca	Pysht	95	05MT
Strait of Juan de Fuca	Hoko	43	96EJ
Strait of Juan de Fuca	Hoko	2	95GM
North Puget Sound	Nooksack	65	98LC
North Puget Sound	Lower Sauk	50	14DC
North Puget Sound	Skagit lower mainstem	48	98HF
North Puget Sound	Snohomish/Skykomish	62	18MH
North Puget Sound	Stillaguamish	57	18MI
Central Puget Sound	Curley Cr	95	02KS
Central Puget Sound-Falls	Green R Hatchery	95	07LB
South Puget Sound	Minter Cr H	95	03JO
South Puget Sound	Mill Cr (Shelton)	67	11KW
South Puget Sound	Sherwood (F)	95	94GS
South Puget Sound	Sherwood (S)	91	94GR
South Puget Sound-Falls	Chico/Grovers	40	11ML
South Puget Sound-Falls	Kennedy	44	10MG
South Puget Sound-Falls	Skookum	58	11KU
South Puget Sound-Winters	Nisqually	21	10ME
South Puget Sound-Winters	Diru Puyallup H	52	11KR
Hood Canal-Summers	Dosewallips S	48	03FF
Hood Canal-Falls	Dewatto F	48	98JR
Hood Canal-Falls	NF Skokomish F	42	16LA
Hood Canal-Falls	Hoodspout H F	95	10LH

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APPENDICES

Appendix A. Annex IV, Chapter 6, of the Pacific Salmon Treaty.

Southern British Columbia and Washington State Chum Salmon

This Chapter shall apply to the period from 2019 through 2028.

1. The Parties shall establish and maintain a Joint Chum Technical Committee (the “Committee”). The Committee shall report, unless the Parties otherwise decide, to the Southern Panel and the Commission. The Committee shall, inter alia:
 - (a) maintain and present to the Panel historical catch and escapement information for stocks referred to in this Chapter;
 - (b) use available information to estimate and document stock composition and exploitation rates in fisheries referred to in this Chapter;
 - (c) annually review the Parties’ assessment of stock status and fisheries activities for chum fisheries referred to in this Chapter;
 - (d) identify high priority research and information needs for the Parties, including fishery and escapement monitoring and assessment, stock identification, and enhancement; and
 - (e) periodically or when requested by the Panel;
 - (i) exchange available information on the productivity and escapement requirements of stocks referred to in this this Chapter,
 - (ii) identify and document stocks of concern (with respect to conservation) referred to in this Chapter,
 - (iii) evaluate the effectiveness and performance of management strategies, and
 - (iv) evaluate the effectiveness of alternative regulatory and production strategies recommended by the Parties.
2. When the Parties provide stock composition information for fisheries, the Committee shall evaluate and use bilaterally approved methods to report its conclusions.
3. The Parties shall assess catch levels and attempt to collect additional genetic samples from any chum salmon caught between July 1 and September 15 in the boundary area fisheries (U.S. Areas 4B, 5, 6C, 7, and 7A; Canadian Areas 18, 19, 20, 21, and 29).
4. From July 1 to September 15, Canada shall require the live release of chum salmon from all purse seine gear fishing in the Strait of Juan de Fuca (Canadian Area 20) and the United States (U.S.) shall require the same for the non-Indian seine net fisheries in Areas 7 and 7A. By U.S. regulation, purse seine fisheries are not permitted in U.S. Areas 4B, 5, or 6C.
5. Canada shall manage its Johnstone Strait, Strait of Georgia, and Fraser River chum salmon fisheries to provide continued rebuilding of depressed naturally spawning chum

salmon stocks, and, to the extent practicable, not increase interceptions of U.S. origin chum salmon. Terminal fisheries conducted on specific stocks with identified surpluses shall be managed to minimize the interception of non-targeted stocks.

6. Canada shall manage its Johnstone Strait mixed stock fishery as follows:
 - (a) The Inside Southern Chum run size estimate by Canada of 1.0 million chum is defined as the Inside Southern Chum Critical Threshold. Inside Southern Chum salmon levels of less than this Threshold are considered critical for the purposes of this Chapter;
 - (b) For run sizes above the Inside Southern Chum Critical Threshold, Canada shall conduct fisheries with an exploitation rate of up to 20% in Johnstone Strait of Inside Southern chum salmon; and
 - (c) When run sizes are expected to be below the Inside Southern Chum Critical Threshold, Canada shall notify the U.S. and shall only conduct assessment fisheries and non-commercial fisheries. Canada shall suspend the operation of commercial fisheries that target chum salmon in Johnstone Strait.
7. Canada shall manage its Fraser River fisheries for chum salmon as follows:
 - (a) For Fraser River terminal area run sizes, identified in-season at abundance levels lower than 900,000 chum salmon, the Canadian commercial chum salmon fisheries within the Fraser River and in associated marine areas (Area 29), shall be suspended; and
 - (b) For Fraser River terminal area run sizes, identified in-season at abundance levels greater than 900,000 chum salmon, the Canadian commercial chum salmon fisheries within the Fraser River shall be guided by the limits of the in-river Total Allowable Catch set by Canada.
8. Canada shall manage the Nitinat gill net and purse seine fisheries for chum salmon to minimize the harvest of non-targeted stocks.
9. The U.S. shall manage its chum salmon fishery in Areas 7 and 7A as follows:
 - (a) Inside Southern chum salmon levels of less than the Inside Southern Chum Critical Threshold of 1.0 million as estimated by Canada are considered critical for purposes of this Chapter;
 - (b) For the run sizes below the Inside Southern Chum Critical Threshold, the U.S. catch of chum salmon in Areas 7 and 7A shall be limited to chum salmon taken incidentally to other species and in other minor fisheries, but shall not exceed 20,000. Catches for the purpose of genetic stock identification sampling shall not be included in this limit;
 - (c) For run sizes above the Inside Southern Chum Critical Threshold, the catch ceiling for the U.S. chum salmon fishery in Areas 7 and 7A shall be 125,000 chum salmon, except as provided in sub-paragraph (d);
 - (d) Canada shall provide a run size estimate of chum salmon entering the Fraser River no later than October 22 of each year. Canada shall notify the U.S. whenever Canada updates the formal Fraser River chum run size estimate if that

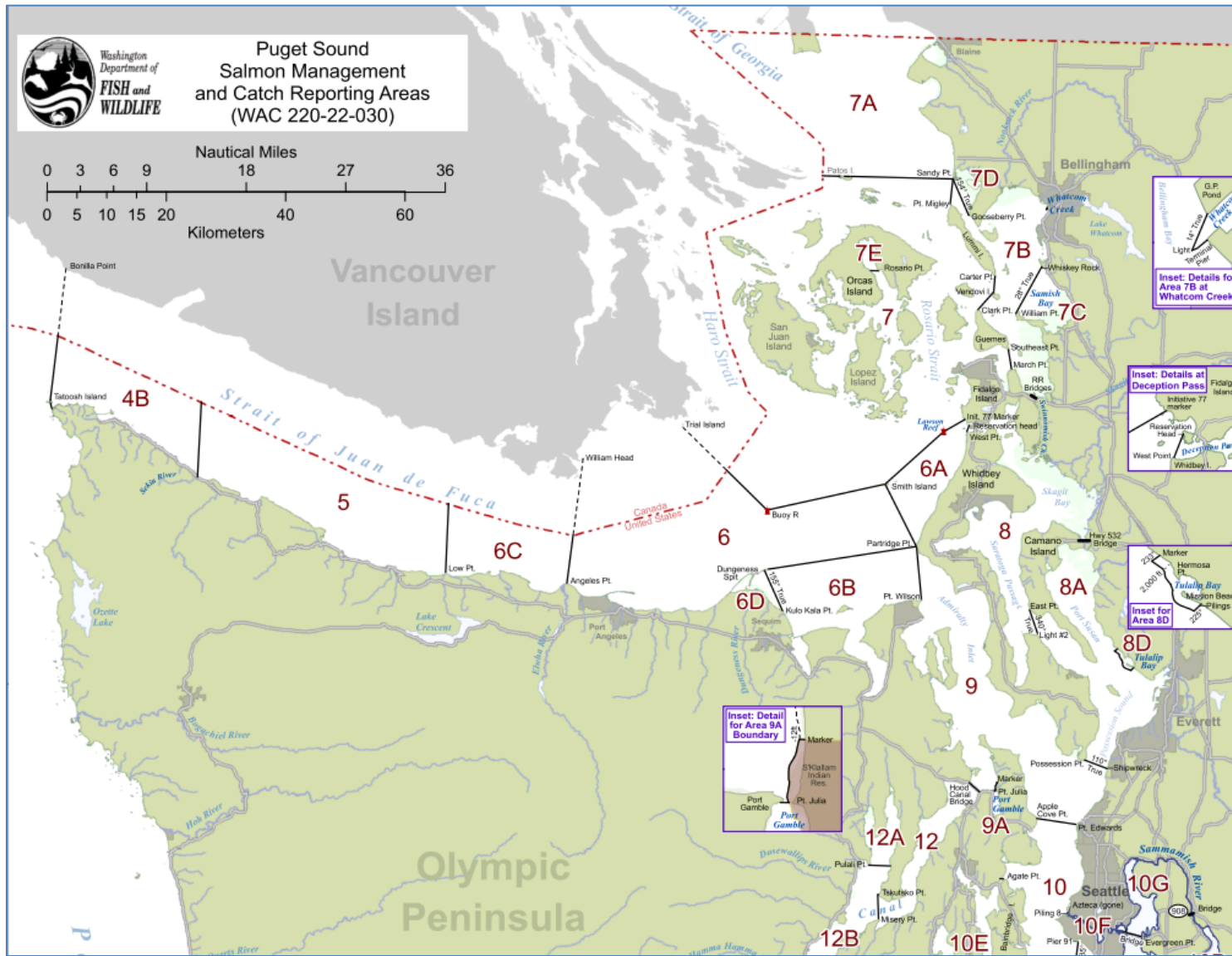
update results in a change to the U.S. catch ceiling. If the Fraser run size estimate is less than 1,050,000, the U. S. shall limit its fishery impacts on Fraser River chum salmon by restricting catch in Areas 7 and 7A to not exceed 20,000 additional chum salmon from the day following the date the U.S. is notified. If the Fraser River run size estimate is between 1,050,000 and 1,600,000, the U.S catch ceiling shall remain at 125,000. If the Fraser River run size estimate is above 1,600,000, the U.S. catch ceiling shall be revised to 160,000;

- (e) U.S. commercial fisheries for chum salmon in Areas 7 and 7A shall not occur prior to October 10 of each year;
 - (f) The U. S. shall manage the Areas 7 and 7A fisheries for chum salmon in order to minimize the harvest of non-target species;
 - (g) U.S. catch shortfalls may not be accrued; however, overages shall be carried forward as indicated in sub-paragraphs (h), (i), and (j);
 - (h) Due to management imprecision:
 - (i) if the U.S. chum catch ceiling is 125,000, a catch in the U.S. of up to 135,000 chum salmon shall not result in an overage calculation. A catch that exceeds 135,000 shall result in an overage, which is calculated by subtracting 125,000 from the total U.S. chum catch; and
 - (ii) if the U.S. chum catch ceiling is 160,000, a catch in the U.S. of up to 170,000 shall not result in an overage calculation. A catch that exceeds 170,000 shall result in an overage, which is calculated by subtracting 160,000 from the total U.S. chum catch;
 - (i) Overages under paragraph 9 (h)(i) or 9 (h)(ii) shall be accounted for by reducing the U.S. annual catch ceilings in up to two subsequent non-critical Inside Southern chum salmon years;
 - (j) From the day following the date the U.S. is notified of a run size below the Inside Southern Chum Critical Threshold as defined in paragraph 9(a) or below a Fraser River chum run size estimate of 1,050,000, any catch that exceeds 20,000 chum salmon results in an overage. Overages shall be accounted for by reducing the U.S. annual catch ceilings in up to two subsequent non-critical Inside Southern chum salmon years;
 - (k) If, subsequent to the revision of the U.S. catch ceiling to 160,000, further in-season run size information changes such that the Fraser River chum run size estimate is revised downward to between 1,050,000 and 1,600,000, the U.S. shall manage their fisheries in Area 7 and 7A to stay below the catch ceiling of 125,000. If the lower catch ceiling has already been reached, the U.S. shall terminate these fisheries; and
 - (l) In the circumstances described in paragraph 9(k), overage calculations shall be based on the highest catch ceiling determined in that season provided the U.S. terminates these fisheries.
10. The U.S. shall conduct its chum salmon fishery in the Strait of Juan de Fuca (U.S. Areas 4B, 5 and 6C) with a view to maintaining the limited effort nature of this fishery, and, to

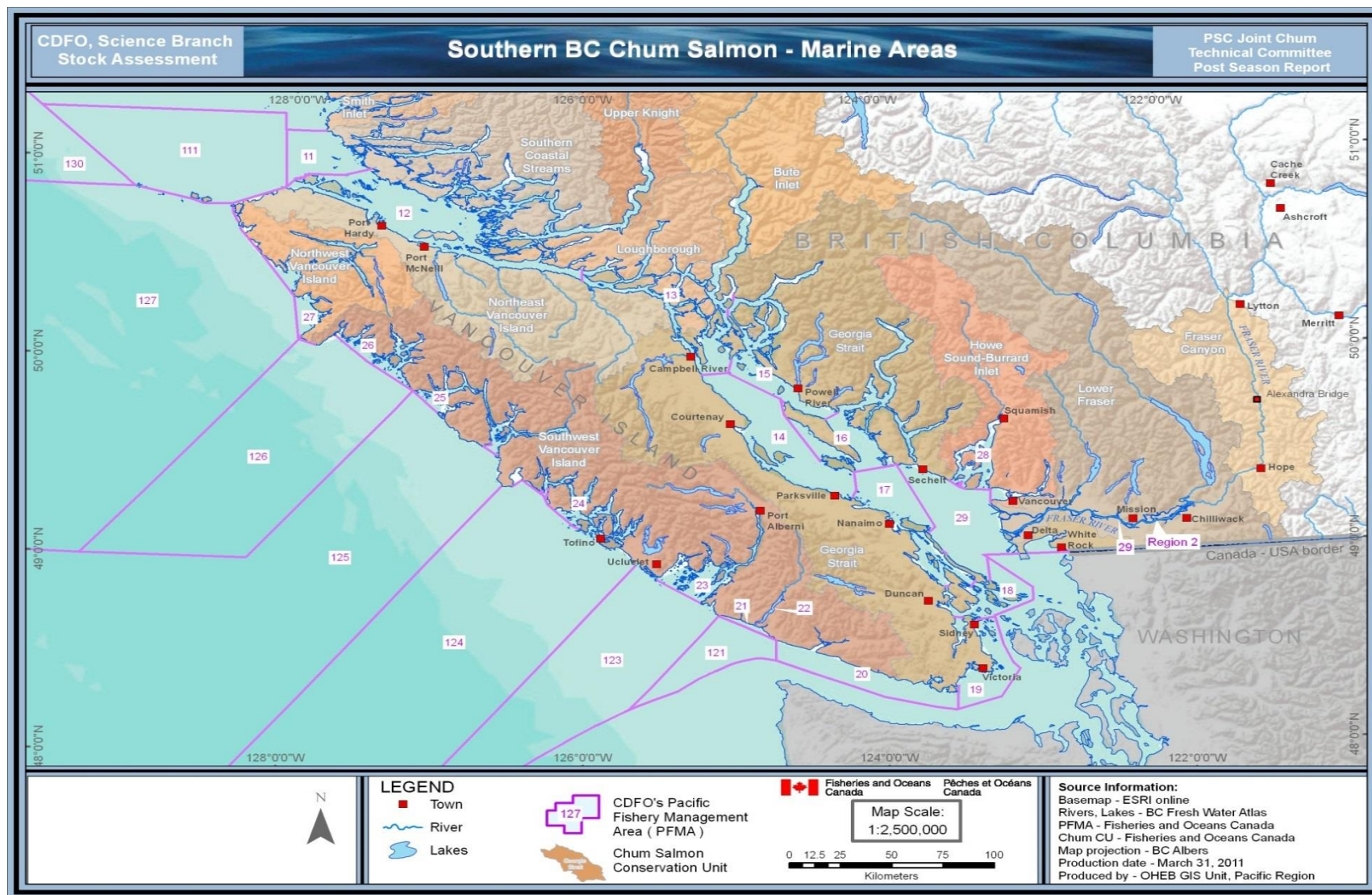
the extent practicable, not increase interceptions of Canadian origin chum salmon. The U.S. shall continue to monitor this fishery to determine if recent catch levels indicate an increasing level of interception.

11. The Parties shall exchange all information concerning non-target catch of other salmon species, including steelhead, from the chum salmon fisheries covered by this Chapter in the annual post-season report.
12. If circumstances arise that are inconsistent with a Party's understanding of the intent of this Chapter, the Southern Panel shall discuss the matter in the post-season and explore options for taking the appropriate corrective action.

Appendix B-1. United States Puget Sound Salmon Management and Catch Reporting Areas for the Strait of Juan de Fuca and Northern Puget Sound.

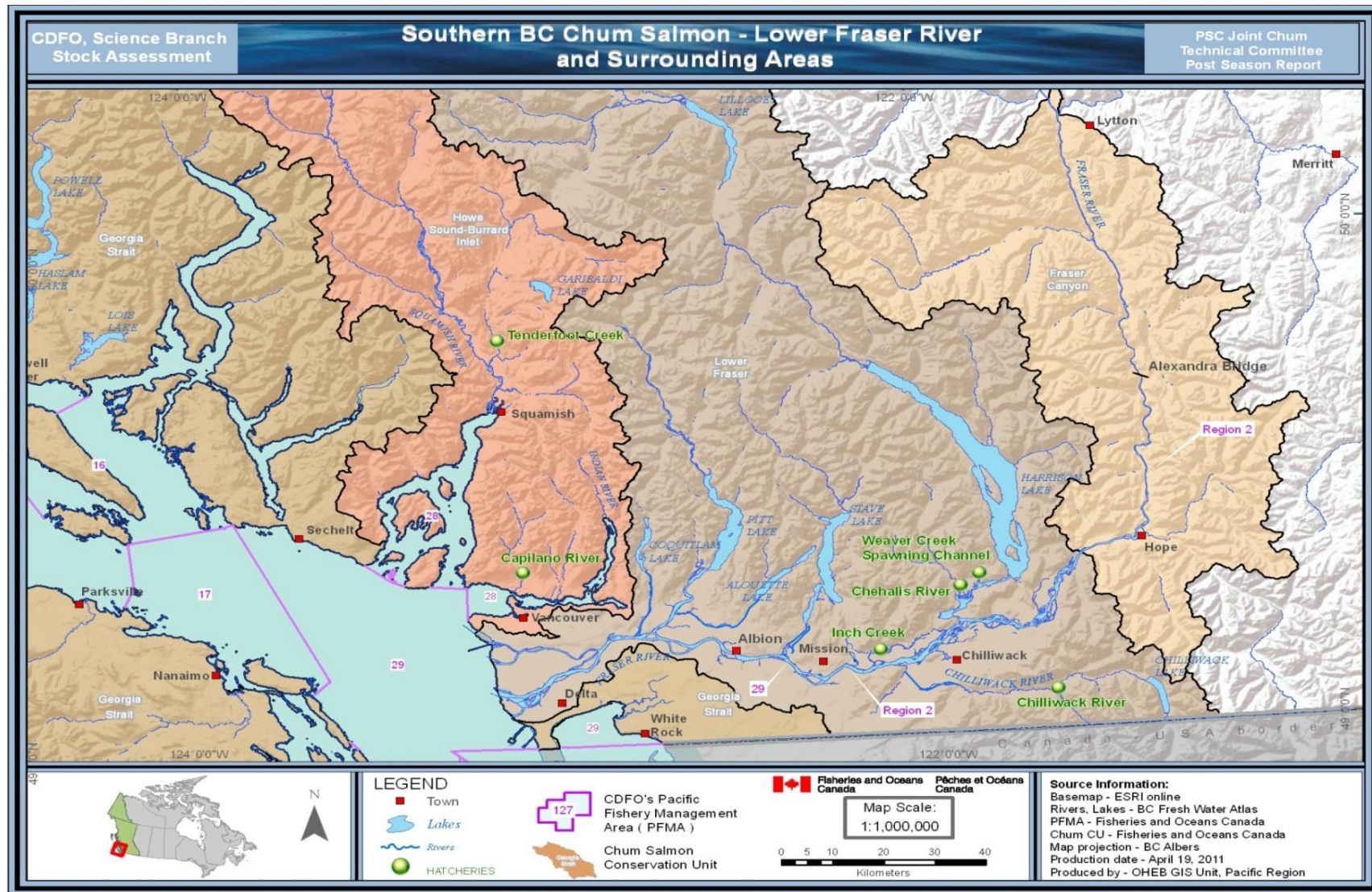


Appendix B-2. Canadian Pacific Fishery Management Areas (PFMA) for Southern B.C. - Marine areas.



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Appendix B-3. Canadian Pacific Fishery Management Areas (PFMA) for Southern B.C. - Lower Fraser River and surrounding areas.



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PACIFIC SALMON COMMISSION WORK PLAN
[2019-2020]

Panel / Committee

The Joint Chum Salmon Technical Committee reports to the Southern Panel.

Update on Bi-lateral Tasks Assigned Under Current PSC Agreement

The following list includes updates on the status of ongoing tasks from previous work plans, as well as descriptions of bilateral tasks planned for 2019-20:

- Begin working on the draft report covering 2017 fisheries and research as a principal focus during the PSC meetings in January 2019;
- Review of new treaty language to evaluate data and analysis needs to conform to the information required;
 - Determine actual assessment program needs to effectively implement the Chapter 6 language,
 - Describe assessment program coverage needed by region/country to effectively implement the Chapter,
 - Create a table and narrative of what is actually being implemented by region/country,
 - Summarize significant gaps, and
 - Develop an annual reporting tool to provide a summary of the activities and identified gaps.
- The committee's other focus will be to continue developing the following aspects of the strategic plan (see attached Figure 2-1);
- To provide updates on any status of approved 2019 SEF projects: Currently four Chum Salmon projects are being conducted in 2019:
 - Further development of the run reconstruction module for Southern BC and Washington State Chum (ChumGEM model) (Year 2),
 - Sampling program in the Strait of Juan de Fuca (Year 4),
 - Estimate of total Fraser River escapement using GSI information at Albion Test Fishery and enumeration of Chilliwack River escapement (Year 4), and
 - Mixed stock GSI in Southern BC and Puget Sound (Year 4).
- Work on 2019 reports associated with SEF projects for later submission;
- Review of SEF priorities and ensure projects are ready for 2020 implementation should funding materializes; and
- Identify additional sampling requirements to complete and/or update the existing baseline collections seeking other funding opportunities or resources to help with the database development, and other priority items such as the Escapement Reference Point development (Update on Holt *et al.* work).

Obstacles to Completing above Bi-lateral Tasks

While support from the Southern Endowment Fund has facilitated our efforts to implement the ChumTC strategic plan, time constraints for committee members remain a challenge for task completion.

Outline of Other Panel / Committee Tasks or Emerging Issues

None presently identified.

Potential Issues for Commissioners, including enhancement activities to be reported under Article V

Guidance will be needed regarding establishment of a process to provide the Chum TC with the opportunity to review relevant proposals that are submitted for Southern Endowment Fund support. In addition, progress and final reports for Southern Endowment Fund projects involving Chum should be routinely provided to Chum TC for information.

Potential Issues for Committee on Scientific Cooperation

The PSC should consider establishing a coast-wide, multi-species forum under the oversight of the Committee on Scientific Cooperation to share developments and advice regarding adaptation of Pacific salmon management approaches to environmental change. There is strong evidence that environmental change is occurring and accelerating to a degree such that past experience cannot be expected to serve as a reliable basis to forecast the future. Increases in uncertainty, variability, and directional change are expected to alter hydrologic, precipitation, and temperature patterns which, in turn, are likely to affect the productivity, abundance, distribution, and migration patterns of Pacific salmon. The forum should provide reporting of significant developments in the knowledge base as well as vetting of recommendations for monitoring and reporting systems, and potential adaptation strategies.

Proposed Meeting Dates and Draft Agendas

Attendance at meetings for Technical Committee members may be dependent on available resources.

- January 13-17, 2020 – PSC Post Season Meeting, Portland, OR:
 - Review and discuss preliminary post-season 2019 fisheries information,
 - Collate and review report items for 2017 final post-season report,
 - Continue work on Southern Chum genetic baseline inventory and expansion for adequately identifying stock origin of fish in mixed stock fisheries on both sides of the border,
 - Continue to evaluate and test the ChumGEM model; presentation on ChumGEM progress, issues and next steps,
 - Updates on any completed SEF programs related to Chum,
 - Review and discuss research and analysis activities essential to the Committee tasks,
 - Review Chum Strategic plan and update, and
 - Provide any bilateral analyses, as requested by the Southern Panel.

- February 17-21, 2020 – PSC Annual Meeting, Vancouver, BC:
 - Continue work on 2017 annual report,
 - Address any specific tasks assigned to the Committee by the Southern Panel at the January meeting,
 - Continue work on tasks not completed at the January meeting,
 - Assign workgroups and workgroup tasks for items still pending at the end of the February meeting,
 - SEF projects for 2020-2021 should be identified and program planning initiated,
 - Start to develop new SEF priorities document for upcoming call, and
 - Initiate 2018 annual report.
- May 4-8 2020 – PSC Chum TC Spring Meeting, Nanaimo, BC:
 - Finalize 2017 annual report for submittal,
 - Continue to define and develop Tier 2 components of the Southern Chum Strategic Plan, and
 - Review status of all SEF related projects and develop plan for new submission following identified priorities.

Status of Technical or Annual Reports

The Committee anticipates having the 2017 Annual Report complete at the May 2020 ChumTC meeting. The Committee anticipates having the 2018 Annual Report complete by the end of the February meeting in 2020.

Project Title: SF-2019-I-38A Joint US and CA Juan de Fuca Chum Sampling Program 2019 (Van Will *et al.* 2020)

The project plan for 2019 was very similar to previous years. Once approvals were obtained for clearance to fish in both US and Canadian waters, the vessel Nita Maria was chartered to fish based on a 4day per week schedule (2 days in Canadian waters and 2 days in US waters) for a 6 week period starting the week of October 2019 is the fourth year of this project. Through the initial work on the ChumGEM reconstruction model, it was very apparent that the diversion of Chum salmon stocks through the southern route (Strait of Juan de Fuca) was a significant gap in our information needed to populate the model. Currently the model structure is available to incorporate this information but the assumptions on the migration pathways being used require investigation and validation.

The purpose of this project was to work towards addressing that data gap by sampling this migration route in both US and Canadian waters to determine:

- The spatial and temporal stock composition of Chum salmon migrating through the Southern Diversion route,
- Provide sampling platform for stock identification, migration rate studies etc.
- Develop time series of Catch per Unit effort data to pair with the Johnstone Strait Test Fishery to determine diversion rate of various Chum populations.

The program began as planned on October 1st and ran until November 8th. A total of 139 sets were completed (72 in Canadian waters and 67 in US waters). A total of 762 Chum were encountered and 640 were sampled for stock id and other biologicals. There was a moderately higher average Catch per Unit Effort (CPUE) in the US side of the Strait compared to what was encountered in Canadian waters. This was the complete opposite to the significantly higher CPUE seen in Canadian waters in 2017 and 2018, but very similar to what was observed in 2016. The catch information demonstrated a slightly later timing on the Canadian side of the Strait with a peak CPUE during week 43 and an earlier peak CPUE in the US waters during week 42. Over the period of the program, Chum CPUE alternated being higher in Canadian waters than in US waters. Stock composition information demonstrated that Canadian Chum stocks dominated the samples throughout the Canadian waters similar to previous years. US Chum stocks in Canadian waters varied in composition but increased later in the program. In US waters, US Chum stocks dominated the mixtures throughout the program. Stock timing and distribution differences were observed and this new information has improved our understanding of Chum stock composition and timing through the migratory pathways of Juan de Fuca Strait.

Low Chum CPUE resulting in well below target sample size were the biggest issues during the 2019 program. While problematic in looking at weekly stock compositions, it did show that the sampling program was sensitive to the generally depressed Chum abundance that was observed in 2019 for most of these populations. The relationship between CPUE and abundance is there for the Northern Approach (through Johnstone Strait) and it is hoped that the information collected via this Southern Approach (through Juan de Fuca) would contribute to that relationship.

Project Title: SF_2019_SP_13 Puget Sound Chum Salmon Genetic Stock Identification (Litz *et al.* 2020)

This project addressed two Southern Panel priorities: genetic stock identification (GSI) sampling of Chum salmon and developing the Chum salmon Single Nucleotide Polymorphism (SNP) genetic baseline. The project identified fall-, winter-, and summer-run Chum salmon population contributions to mixed fisheries in the commercial Chum salmon fishery in US Marine Areas 10 and 11. The project added six key Chum salmon populations to the SNP baseline and augmented four other key Chum salmon populations in the baseline (Table 1) to improve baseline representation of Puget Sound Chum salmon populations. We applied the baseline to the Area 10/11 fishery in 2018 and re-analyzed the fishery from 2017 with the improved baseline. In the 2018 fishery the baseline identified roughly one Canadian-origin fish per collection week and no Hood Canal summer-run Chum salmon. The South Puget Sound and the Hood Canal falls were the largest and second largest components, respectively, and the South Puget Sound winters were a distant third component at less than 2% of the fishery, mostly from Diru Hatchery. The baseline identified contributions from hatchery and wild-origin Chum salmon throughout South Puget Sound and Hood Canal. In the 2017 fishery, similar to the original analysis, the improved baseline identified the Canadian Chum salmon and Hood Canal Summer Chum salmon. In contrast to the original 2017 fishery analysis, the improved baseline showed the relative contributions of hatchery and wild-origin Chum salmon and showed that the majority of the contributions of winter-run Chum salmon were from Diru Hatchery and relatively few were from Nisqually River.

Project Title: SF_2019_SP_37 Joint US and CA Mixed-stock Chum Fisheries Sampling Design and Analysis 2019-20 (Candy *et al.* 2021)

We conducted Genetic Stock Identification (GSI) on 3780 Chum salmon migrating to natal streams through Johnstone Strait (Statistical Areas 12 and 13) in 2019-2020, and along the east coast of Vancouver Island (Statistical Area 14-17) in 2020. A total of 1274 samples were analyzed in Johnstone Strait in 2019, and 1627 in 2020. A total of 879 Chum salmon samples were analyzed in 2020 from fisheries along the east coast of Vancouver Island. The bilateral Single Nucleotide Polymorphism (SNP) baseline developed jointly by the DFO Molecular Genetics Laboratory, and the Washington Department of Fish and Wildlife Genetics Laboratory was used for the first time in 2020 replacing the microsatellite baseline. A set of 500+ SNPs markers developed collaboratively between Canada and the US provided a standard set of 300+ SNPs in use between the two labs.

The analysis of chum salmon sampled in Johnstone Strait commercial (2020 only) and test fisheries (2019 and 2020) were mainly from Canadian populations (in 2019, 99.4% to 91.8% and in 2020 98.5% to 96.0%) comprised largely of sites in that local area (Johnstone Strait), the Fraser River, and Strait of Georgia (east and west coasts). East coast of Vancouver Island in 2020 was composed of largely Canadian contributions (97.1% to 100.0%) with one sample of five fish report 80% Canadian contribution. No samples were analyzed by DFO's genetics lab in 2019 or 2020 from US fisheries in Area 7 or 7A.

Project Title: SF_2019_SP_39 Modifications to the Chum Genetic and Environmental Management Model (ChumGEM), a run reconstruction model (Jenewein *et al.* 2020)

Sustainable fisheries management is challenging when and where multiple populations of varying productivity are harvested together. To reduce the likelihood of management errors that may cause serious conservation harm to depleted populations and economic harm to fisheries targeting more-abundant populations, salmon managers need to understand the expected abundance in each fishery on an annual basis. The Chum Genetic and Environmental Management Model (ChumGEM), a run reconstruction model, was originally developed between 2013 and 2015 to assist in post-season run reconstruction analyses for Chum Salmon fisheries in southern British Columbia and Puget Sound, Washington. The model uses a genetic data set, historic catch data, and escapement estimates to provide estimates of run-specific parameters such as abundance and arrival timing. It also provides annual estimates of exploitation rates and escapement by genetic unit (GU).

Not long after the work was completed in 2015, it was identified that substantial modifications would be needed to make the ChumGEM model a useful tool for fisheries management. Testing of the model was conducted in 2017, which concluded that the model should still be considered a work in progress pending further data verification, model checks, and sensitivity analysis. Furthermore, changes to the model structure are likely required. The objective of this project is to modify and improve the ChumGEM model so that it can be used as a fisheries management tool. This report is an update on the final year of the project.

Project Title: SF-2019-SP-14 Fraser River Chum Salmon Spawning Ground Survey Life Study, 2019 (Tadey *et al.* draft)

Spawning Chum Salmon enumeration in the lower Fraser River area utilizes, in part, systematic visual surveys to generate area-under-the-curve (AUC) estimates of spawner abundance. This AUC methodology is used for roughly 40 spawning sites or populations (around 35% of the roughly 120 lower Fraser River Chum Salmon populations), making it a critical tool in assessing and monitoring Chum Salmon stocks escaping to the Fraser River.

An essential component in creating estimates using AUC methodology is the determining the amount of time that Chum Salmon spend in the study area (i.e. amount of time at the spawning site). This time is termed survey life (SL). At present, there is a lack of SL information specific to lower Fraser River Chum Salmon populations. This has resulted in the use of an average literature SL value derived from assessment throughout the entire Pacific region. Since variation in SL can occur between systems (and years) due to differences in system size, study design, fish run timing and migration differences, water temperatures and flows, fish body size and fish densities, the use of this regional SL value is thought to introduce significant bias into AUC estimates for Fraser River Chum populations.

This project improved our ability to provide accurate spawning escapement estimates for Chum Salmon. Accurate estimates are important to all aspects of Fraser River Chum Salmon management including annual stock run reconstruction (ChumGEM), production forecasting, in-season terminal abundance estimates (CDFO Albion Chum Model), harvest sharing, and the evaluation of management decisions/actions. Additionally, work is underway to correct an expected SL bias in over 20 years of AUC spawning ground estimation in the lower Fraser River.