

**PACIFIC SALMON COMMISSION
JOINT CHUM TECHNICAL COMMITTEE
2016 POST SEASON SUMMARY REPORT**

TCCHUM (19) – 01

SEPTEMBER 2019

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LIST OF ACRONYMS WITH DEFINITIONS

B.C.	British Columbia
CDFO	Canadian Department of Fisheries and Oceans or Fisheries and Oceans Canada
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
ITQ	Individual Transferable Quota
mSAT	Microsatellite DNA
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
SNPs	Single-Nucleotide Polymorphisms
TCCHUM	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 presents the information on Chum salmon stocks and fisheries in southern British Columbia (B.C.) and Washington (WA) for the year 2016 to address the specific provisions and requirements of Chapter 6, Annex IV (Chum 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. The Chum 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 various aspects of 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 of concern to the Treaty. Returns in 2016 were well above the recent 9-yr average in B.C and slightly below in WA. Catch overage was noted in US 7/7A fisheries 2014 and a portion of the overage was paid back in 2015 with the outstanding balance paid off in 2016 consistent with the Treaty. The Chum Technical Committee continued work on components of the strategic plan outlined in the 2010 report, which included collecting and exchanging tissue samples from mixed-stock fisheries and spawning escapements.

2 Status of Treaty Requirements

Chum salmon stocks and fisheries in southern B.C. and in U.S. Areas 4B, 5, 6C, 7, and 7A (Appendix B) 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 its provisions in 2016.

Paragraph 1:

The Parties were to maintain a Joint Chum Technical Committee (“the Committee”) reporting, unless otherwise agreed, to the Southern Panel and the Commission. [Specific tasks for the Committee are listed in Annex IV Chapter 6, Paragraph 1. Some of these include review stock status, develop new methods for stock management and report on management and research findings.]

The Committee convened three times in 2016: during the PSC Post-Season Meeting in January, during the PSC Annual Meeting in February, and during the Joint Chum Technical Meeting in May. In 2010 the committee developed a strategic plan to guide development and application of a jointly agreed genetic baseline for Chum salmon stocks in southern B.C. and Washington and eventual development of the Chum Genetic and Environmental Model (ChumGEM) (Figure 2-1). Four projects were funded by the PST Southern Boundary Restoration and Enhancement Fund (Southern Fund) to carry forward priorities identified by the TCCHUM. Additional detail

of the work performed by the Committee in 2016 can be found in the Committee's 2016 Work Plan (Appendix C).

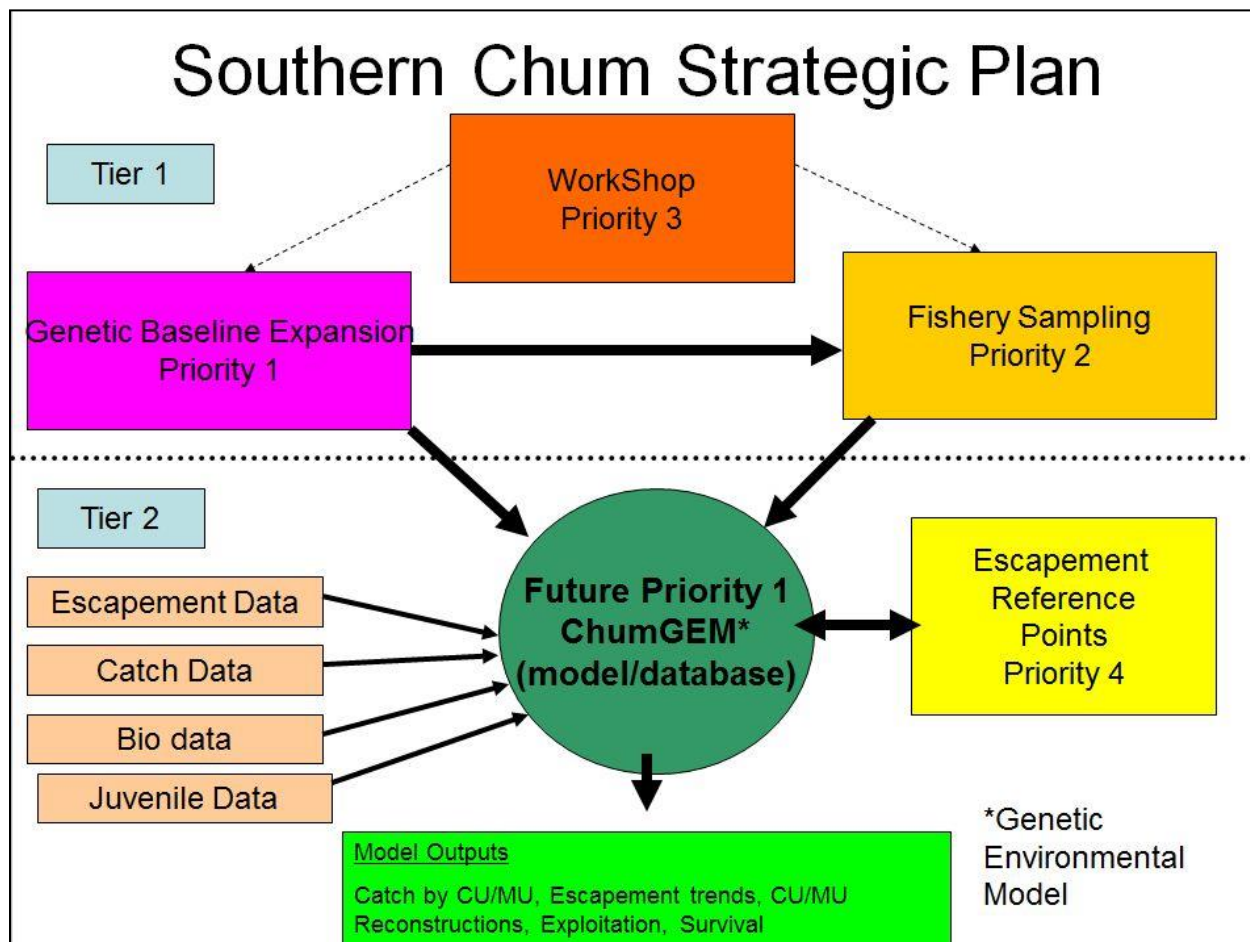


Figure 2-1. Southern Chum Strategic Plan developed by the joint Chum Technical Committee in 2012.

Paragraph 2:

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

For this report, the Committee continued to use historical stock composition information to estimate Chum salmon stock composition for 2016 fisheries. These historical stock composition estimates may no longer be representative of current stock composition, and the Committee is continuing to evaluate and implement new methods following the Committee's Strategic Plan (Figure 2-1) of which improved stock identification methodologies play a significant role. The initial stages of this Strategic Plan have been implemented and work on the development and implementation of the final stage of the plan is ongoing.

Paragraph 3:

Canada and the United States shall assess catch levels and make attempts to collect additional genetic samples from any Chum salmon caught during the July 1 through September 15 time period 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 4-4 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:

During the period from July 1 through September 15, Canada will 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 will require the same for the non-Indian seine fisheries in Areas 7 and 7A. Note: 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 will 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 (2007–2016). Historical GSI results and genetic estimates from 2007 through 2016 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 will manage its Johnstone Strait mixed stock fishery as follows:

- a) Inside Southern Chum salmon levels of less than 1.0 million as estimated by Canada are defined, for purposes of this chapter, as critical.*
- b) For run sizes above the critical threshold, Canada will 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 critical threshold, Canada will notify the United States and will only conduct assessment fisheries and non-commercial fisheries. Commercial fisheries targeting Chum salmon will be suspended.*

While no specific estimates of Inside Southern Chum salmon abundance were provided, Canada notified the U.S. in early October, on the basis of inside area fisheries, that the return abundance of Inside Southern Chum salmon was likely above the critical threshold. Canada continued to manage the Johnstone Strait fisheries to target to 20% of Inside Southern Chum.

Paragraph 7:

Canada will 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), will be suspended; and*
- b) *For Fraser River terminal area run sizes, identified in-season at levels greater than 900,000 Chum salmon, 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 2016, initial in-season abundance estimate indicated a terminal return above the specified Fraser River gross escapement threshold (see section 3.3.3).

Paragraph 8:

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

Due to above goal abundance of Nitinat Chum in 2016, both commercial gill net and purse seine fisheries occurred (see section 3.3.4.1; Table 3-10). To minimize the harvest of non-targeted stocks a variety of management actions were applied to this fishery (see section 3.3.4.1).

Paragraph 9:

Canada shall conduct a genetic sampling program of Chum salmon taken in the West Coast Vancouver Island troll fishery if early-season catch information indicates that catch totals for the July 1 through September 15 season may reach levels similar to 1985 and 1986. Sampling, should it occur, will include catches taken from the southern areas (Canadian Areas 121–124).

Chum salmon catch levels in the 2016 West Coast Vancouver Island troll fishery were significantly below the 1985 and 1986 levels. Therefore, no GSI sampling occurred.

Paragraph 10:

The United States will manage its Chum salmon fishery in Areas 7 and 7A as follows:

- a) Inside Southern Chum salmon levels of less than 1.0 million as estimated by Canada are defined, for purposes of this chapter, as critical;*
- b) For run sizes below the 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, provided that catches for the purpose of genetic stock identification sampling shall not be included in the aforementioned limit;*
- c) For run sizes above the critical threshold, the base catch ceiling for the U.S. Chum salmon fisheries in Areas 7 and 7A will be 130,000 Chum salmon;*
- d) Canada will provide a run size estimate of Chum salmon entering the Fraser River no later than October 22. If the estimate is less than 900,000, the U.S. will 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. The total catch is not to exceed the catch ceiling of 130,000 Chum salmon;*
- e) U.S. commercial fisheries for fall Chum salmon in Areas 7 and 7A will not occur prior to October 10;*
- f) The U.S. will manage the Areas 7 and 7A fisheries for Chum salmon with the intent to minimize the harvest of non-targeted species;*
- g) No U.S. catch shortfalls may be accrued; however any overages shall be carried forward as indicated in (h) and (i);*
- h) Due to management imprecision, a catch in the U.S. of up to 135,000 Chum salmon will not result in an overage calculation. Catches in excess of 135,000 Chum salmon shall result in an overage being calculated by subtracting 130,000 from the total Chum catch. Overages will be accounted for by reducing the U.S. annual catch ceiling in up to two subsequent non-critical Inside Southern Chum salmon years; and*
- i) From the day following the date the U.S. is notified of a run size below the critical threshold as defined in 10(b) or (d), any catches in excess of 20,000 Chum salmon will result in an overage. Overages will be accounted for by reducing the U.S. annual catch ceilings in up to two subsequent non-critical Inside Southern Chum salmon years.*

In 2016, U.S. fisheries in Areas 7 and 7A were managed in accordance with the above provisions. U.S. commercial fisheries were initiated as scheduled on October 10. An estimated Fraser River Chum salmon run size was provided by Canada prior to October 22, consistent with the Treaty obligations. The fishery continued through October 26. The remainder of the U.S. 2014 catch ceiling overage was paid back during 2016 (see section 4.3.2).

Paragraph 11:

The United States shall conduct its Chum salmon fishery in the Strait of Juan de Fuca (United States Areas 4B, 5, and 6C) so as to maintain the limited effort nature of this fishery, and, to the extent practicable, not increase interceptions of Canadian origin Chum salmon. The United States 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 the 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 12:

All information concerning bycatch of other salmon species from the Chum salmon fisheries covered by this chapter will be shared between the Parties 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 13:

Should circumstances arise that are inconsistent with either Parties understanding of the intent of the chapter, the Southern Panel will discuss the matter postseason and explore options for taking the appropriate corrective actions.

No such circumstances arose in 2016.

3 Southern British Columbia Chum Salmon

Southern B.C. Chum salmon stocks and fishing areas (Pacific Fishery Management Areas or PFMAs; Appendix B) 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 salmon.

3.1 Status of Treaty Requirements

During 2016, the Southern B.C. Chum salmon fisheries were managed according to the requirements of Annex IV, Chapter 6, as amended in 2009 (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 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 2016 (CDFO 2016).

Some of the key objectives of this strategy are to ensure sufficient escapement levels while providing more stable fishing opportunities (CDFO 2016). 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).

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 2016). The impact of the Johnstone Strait fisheries during the last 10 years of the fixed exploitation approach (2007–2016) on Inside Southern Chum salmon stocks is detailed in Table 3-1.

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

- continue to rebuild/maintain stocks to the optimum wild escapement objective (defined as 2.5 million wild Inside Southern Chum salmon);
- establish a 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

Table 3-1. Aggregate Inner South Coast Chum salmon total return, harvest and spawning escapements. Comparison of fixed target and actual harvest rates in the Johnstone Strait fisheries, 2007–2016¹.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
PRE-SEASON										
Inside Southern Abundance Forecast (or Outlook)	Average to Below Average	Below Average	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
POST-SEASON										
Inside Southern Abundance ²	2,728,082	2,228,121	2,227,134	1,181,534	3,449,783	3,501,098	3,156,129	2,354,404	2,751,791	6,300,737
Inside Southern Harvest	796,301	580,247	747,067	127,973	1,441,680	911,427	1,079,567	732,429	1,240,133	2,868,029
Est. Inside Southern Harvest Rate	29.19%	26.04%	33.54%	10.83%	41.79%	26.03%	34.21%	31.11%	45.07%	45.52%
Johnstone Strait Harvest										
Commercial, Sport Area 11-13 ³	480,620	299,775	513,884	55,520	750,436	392,608	635,814	332,140	529,541	1,373,171
First Nations Area 11-13	14,870	11,630	13,576	4,060	9,880	13,106	13,444	113	22,472	20,493
Johnstone Strait Harvest Total	495,490	311,405	527,460	59,580	760,316	405,714	649,258	332,253	552,013	1,393,664
Target Johnstone Strait Harvest Rate	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Est. Johnstone Strait Harvest Rate	18.16%	13.98%	23.68%	5.04%	22.04%	11.59%	20.57%	14.11%	20.06%	22.12%
ESCAPEMENT (Includes wild and enhanced)⁴										
Inside Southern Escapement	1,931,781	1,647,874	1,480,067	1,053,561	2,008,103	2,589,671	2,076,562	1,621,975	1,511,658	3,432,708

(1) Historic data in this table have been updated with most recent estimates; values may deviate from past reports.

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

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, Deserter 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 have limited use due to their inability to reasonably predict returns (CDFO 2016). The one exception is Chum salmon returning to Area 14. As a result, unlike some other units of Southern B.C. Chum Salmon (e.g. WCVI see section 3.3.4), 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 Advisory Committee (Chum Advisory Committee or Chum Working Group). The Chum 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 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 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 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 abundance is used, in addition to the in-season information listed above, to guide management decisions on fishing opportunities (CDFO 2016).

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	Overall 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	110,000
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 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 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 interim 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 Working Group. This meeting is tentatively scheduled for the first week of October; Chum Working Group meetings are subsequently held every week until late November.

Commercial Chum salmon-directed fisheries have a specific harvest strategy, implemented since 1981, that consists of limited early harvest prior to any escapement occurring. The allowable early Chum salmon harvest is set at 65% of the predicted surplus. The predicted surplus is calculated by subtracting the overall escapement goal (240,000; Table 3-2) and a buffer (100,000) from the pre-season terminal run size forecast (CDFO 2016). The buffer safeguards against errors in the pre-season forecast of Area 14 stock abundance.

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;
- 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 Working Group meetings and may include consideration for:

- *limited effort seine net fishery*: a limited effort seine 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 2016).

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 and Coho salmon populations;
- *non-retention*: of Coho salmon;
- *maximum soak time*: in the gill net fishery;
- *mandatory brailing*: in the 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 110,000. 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 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 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 2016).

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, 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 2016). 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 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 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 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 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 2016).

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 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 2016). In-season management is guided by advice from the Cowichan Fisheries Roundtable (the Roundtable) and the Chum Working Group. Commercial fishing opportunities are evaluated during the weekly in-season meetings of the Roundtable and the Chum 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 Working Group and an in-season Chum Escapement Forecast Tool based on the DIDSON count by date (CDFO 2016).

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 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 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 Working Group. Commercial fishing opportunities are evaluated at the Chum 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 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 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, with the exception of those fisheries that operate with selective gear.

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

Run Size	Harvest Plan	First Nations	Commercial	Recreational
<500,000 in Fraser	<10%	Limited (reduced hours and days/week fishing)	Closed	Mainstem Fraser River closed, restricted openings on tributaries
500,000 to 800,000 in Fraser	Directed fisheries limited to FN 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	Normal	Open (35,000- 105,000)	Open
>1,050,000 in Fraser	Commercial catch not to exceed 15% for Chum	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 run size 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 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 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 2016).

Purse seine 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 2016). 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 2016). 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 2016). 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.

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 South Coast (ISC) Chum return were expected to be both Fraser and non-Fraser stocks. These stocks are typically dominated by four year old fish which were from an average 2012 brood return that out-migrated to the ocean in 2013. It was quite apparent that other salmon species that also out-migrated in 2013 encountered improved survival conditions (i.e. Pink and Coho salmon returns in 2014). The pre-season expectation for ISC Chum salmon suggested near target returns to the area but was highly uncertain.

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), 2007–2016.

Year	Statistical Weeks	Pacific Fishery Management Area					Total
		18	19	20	21	29 ²	
2007	7/1–9/2	0	0	0	0	49	49
2008	7/1–9/2	0	0	0	0	67	67
2009	7/1–9/2	0	0	0	0	27	27
2010	7/1–9/2	0	0	16	0	384	400
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	61	61
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	1087	1087
Average		0	0	2	0	337	339

(1) Does not include PSC test fisheries harvest.

(2) Majority of this harvest is fresh water based and likely of Fraser River origin.

The following sections describe the fisheries directed at fall Chum salmon in each of the Southern B.C. areas in 2016.

3.3.1 Johnstone Strait

The Johnstone Strait test fishery provided timing and abundance information for the 2016 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 salmon being over the 1.0 million critical threshold level (requirement for commercial openings). Catch per unit effort in the test fishery was significantly higher than what was encountered in 2010 and it was determined that the ISC index of abundance was likely higher than the critical threshold required for continuation of commercial fisheries. All subsequent commercial openings in Johnstone Strait were prosecuted as planned. Age composition derived from the test fishery and commercial samples was dominated by 4 year olds throughout the season. Escapements and catches in 2016 suggested returns were very strong and well above average to ISC Chum populations. Table 3-5 outlines the duration and Chum salmon harvest in fisheries that occurred during the 2016 season.

In 2016, there were two competitive commercial purse seine openings; three gill net openings in and one troll individual transferable quota (ITQ) fishery in Johnstone Straits (Area 12 and Area 13). The total 2016 commercial harvest for Johnstone Strait, including test fishery harvest, was 1,374,455 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 ~1,000 Chum salmon; Table 3-5) with little monitoring during the month of October. First Nations FSC harvest was estimated at 20,493 in the Johnstone Strait area (Table 3-5). The total estimated harvest of Chum salmon in Johnstone Strait in 2016 was 1,395,970.

Table 3-5. Estimated Chum salmon harvest from Chum salmon-directed fisheries occurring in Johnstone Strait by PFMA, 2016.

Gear Type	PFMA	Fishery Dates		Fishery Duration (hours)	Estimated Harvest
		Start	End		
Purse Seine (Test)	12	Sep. 11	Oct. 28	n/a	40,974
Purse Seine	12	Sockeye / Pink Directed ¹		--	--
	13			--	--
	12	Oct. 3	Oct. 3	12	81,805
	13	Oct. 3	Oct. 3	12	97,258
	12	Oct. 17	Oct. 18	14	194,831
	13	Oct. 17	Oct. 18	14	673,829
Gill Net	12	Oct. 6	Oct. 8	41	44,127
	13	Oct. 6	Oct. 8	41	32,134
	12	Oct. 10	Oct. 13	63	26,674
	13	Oct. 10	Oct. 13	63	48,851
	12	Oct. 25	Oct. 27	41	13,791
	13	Oct. 25	Oct. 27	41	55,171
Troll ²	12	Sep. 28	Oct. 31	n/a ¹	0
	13	Sep. 28	Oct. 31	n/a ¹	65,010
Recreational ³	11/12	Jun.	Oct.	n/a	
	13	Sep.	Sep.	n/a	1,022
First Nations ³	12			n/a	5,755
	13	n/a	n/a	n/a	14,738
Total					1,395,970

(1) This is bycatch from Fraser Sockeye- and Pink-directed fisheries that took place during early September.

(2) The troll fishery was opened from September 28 to October 31. The fishery was an effort based quota over that time period. Stat weeks 10/1 to 10/3 are grouped and weeks 10/4 to 11/1 are grouped.

(3) The recreational and First Nation fisheries time periods varied over the season.

3.3.2 Strait of Georgia

In 2016, surplus above the escapement target was observed in all Area 14 systems. An Area D gill net fishery opened November 2 and remained open until November 21. The Area B seine fishery opened on November 5 and remained open until November 21. The Area H troll fishery was open however there was no participation. The catches in the fisheries were 231,670 Chum salmon for Area B seine and 39,084 for Area D gill net (Table 3-6).

Escapements returning to the Nanaimo River in Area 17 indicated above goal returns and fisheries were initiated. Commercial gill net fisheries took place from October 17 to November 17, harvesting a total of 86,254 Chum salmon (Table 3-6). A commercial seine opening was also provided from October 27 to November 17, harvesting a total of 61,600 Chum salmon.

In-season assessments in Area 18 identified sufficient escapement levels in the Cowichan River to initiate fisheries. Commercial gill net fisheries took place from October 27 to December 4, harvesting a

total of 201,494 Chum salmon (Table 3-6). Commercial seine fisheries took place from November 2 to November 21, harvesting a total of 90,862 Chum salmon.

The recreational creel survey within the Strait of Georgia area was not conducted after September in 2016. There were 248 Chum estimated in the creel program in 2016. The harvest by First Nations in the Strait of Georgia in 2016 was estimated to be 14,423 Chum salmon (Table 3-6).

The total estimated harvest of Chum salmon in the Strait of Georgia in 2016 was 725,635.

Table 3-6. Estimated Chum salmon harvest from Chum salmon-directed fisheries occurring in the Strait of Georgia by PFMA, 2016.

Gear Type	PFMA	Fishery Dates		Fishery Duration (hours)	Estimated Harvest
		Start	End		
Purse Seine	14	Nov. 5	Nov. 21	384	231,670
	17	Oct. 27	Nov. 17	264	61,600
	18	Nov. 2	Nov. 24	276	90,862
Gillnet	14	Nov. 2	Nov. 21	484	39,084
	17	Oct. 17	Oct. 21	36	41,632
	17	Oct. 27	Nov. 17	288	44,622
	18	Oct. 27	Dec. 4	420	201,494
Recreational ¹	14-19, 28, 29 ³	-	-	n/a	248
First Nations ²	14	n/a	n/a	n/a	0
	15	n/a	n/a	n/a	0
	16	n/a	n/a	n/a	133
	17	n/a	n/a	n/a	0
	18	n/a	n/a	n/a	14,290
	19	n/a	n/a	n/a	0
	28	n/a	n/a	n/a	0
Total					725,635

(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).

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, 2016 was 1.55 million Chum salmon. A subsequent in-season estimate of 2.00 million was provided on October 19.

Table 3-7. Estimated harvest of Chum salmon from salmon fisheries occurring in Area 29 (both marine and in-river) and in Region 2 (non-tidal) of the Fraser River, 2016.

Fishing Sector	Fishery Description	Target Species	Fishery Dates		Fishery Duration	Assessment Period ¹		Estimated Harvest
			Start	End		Start	End	
Test	Albion Chinook	Chinook	24-Apr	20-Oct	179 days	n/a	n/a	2,349
	Albion Chum	Chum	01-Sep	23-Nov	58 days	n/a	n/a	9,956
	Whonnock Sockeye	Sockeye	30-Jun	11-Sep	74 days	n/a	n/a	3
	Cottonwood Sockeye	Sockeye	07-Jul	23-Aug	48 days	n/a	n/a	0
Test Subtotal								12,308
Commercial ²	Area E gill net	Chum	24-Oct	27-Oct	2 days	n/a	n/a	175,906
	Area B seine	Chum	27-Oct	28-Oct	2 days	n/a	n/a	472
	Area H troll	Chum	24-Oct	04-Nov	11 days	n/a	n/a	0
Commercial Subtotal								176,378
Recreational ^{3, 4, 5}	Fraser River Mainstem	Mixed	01-Aug	11-Aug	11 days	01-Aug	11-Aug	0
		Mixed	19-Aug	31-Dec	104 days	19-Sep	07-Oct	34
	Chilliwack River	Mixed	01-Jul	31-Dec	184 days	15-Sep	15-Nov	3,253
	Nicomen Slough	Mixed	01-Jan	31-Dec	366 days	07-Oct	30-Nov	8
Recreational Subtotal								3,295
First Nations ^{2, 6}	FSC	Mixed	01-Apr	09-Oct	n/a	n/a	n/a	1,199
		Chum	08-Oct	04-Dec	n/a	n/a	n/a	60,540
	ESSR	Chum	n/a	n/a	n/a	n/a	n/a	26,045
	EO	Chum	22-Oct	07-Nov	16 days	n/a	n/a	132,848
First Nations Subtotal								220,632
Total								412,613

(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 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.

First Nations FSC gill net fisheries targeting Chum salmon were initiated October 8 following a closure period to protect co-migrating Interior Fraser Coho salmon. These fisheries harvested a total of 60,540 Chum salmon (Table 3-7). First Nations EO fisheries directed at Chum salmon in 2016 harvested 132,848 Chum salmon (Table 3-7). In addition to these fisheries, certain First Nations groups were also provided access to Chum salmon that returned to hatchery facilities but that were not required for broodstock. A total of 26,045 Chum salmon deemed to be surplus to spawning requirements (ESSR) were provided to First Nations from various hatchery facilities in 2016. First Nations FSC Chinook and

Sockeye-directed fisheries occurring in 2016 had a small amount of bycatch of Fraser Chum salmon, harvesting 1,119 Chum salmon (Table 3-7).

The total harvest of Chum salmon in all Fraser River First Nations fisheries (including hatchery ESSR fish) was 220,632 in 2016 (Table 3-7 and Table 3-8).

Table 3-8. Estimated harvest of Chum salmon from First Nations and commercial salmon fisheries occurring in Area 29 and Fraser River, 2007–2016.

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	
2007	13,344	77,490	29,884	30,400	7,650	n/a	158,768
2008	31,553	50,004	41,683	38,006	10,155	n/a	171,401
2009	12,991	68,150	8,458	42,116	9,249	n/a	140,964
2010	13,480	186	14,021	209	10,762	n/a	38,658
2011	22,331	4,886	50,867	36,058	3,553	n/a	117,695
2012	30,746	102,185	34,593	60,404	13,487	n/a	241,415
2013	37,435	107,959	43,176	101,890	12,270	n/a	302,730
2014	39,516	100,258	34,638	164,363	12,634	n/a	351,409
2015	35,896	122,309	15,692	190,855	10,525	n/a	375,277
2016	61,739	132,848	26,045	176,378	12,308	n/a	409,318
Average	29,903	76,628	29,906	84,068	10,259	n/a	230,764

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

The major Fraser River watershed recreational salmon fisheries impacting Chum salmon in 2016 include significant fisheries occurring in the lower Fraser River mainstem, the Chilliwack River and the Stave River, and minor salmon fisheries occurring in the Harrison River and the Nicomen Slough/Norrich Creek system. The latter four 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 2016.

The lower Fraser River mainstem was open to recreational angling and the retention of Chum salmon on two separate occasions in 2016. The initial opening occurred from August 1 to August 11, 2016 (daily retention limit of 2). This was followed by a closed period of over 5 weeks before being re-opened to angling and the retention of Chum salmon from September 19 to December 31, 2016 (daily retention limit of 2). In 2016, this mainstem recreational fishery was assessed from August 1 to August 11 and September 19 to October 7, 2016; estimates of 34 and 0 Chum salmon were harvested and released, respectively (Table 3-7). The estimated harvest in 2016 was similar to the previous three years and notably less than in 2012 (Table 3-9). In part, this was due to the 2013 through 2016 assessments being truncated approximately two months earlier than 2012. In 2012, approximately 90% of the reported Chum salmon harvest in this fishery occurred from October 1 to November 30.

The Chilliwack River recreational fishery was open to the retention of Chum salmon from July 1 to December 31, 2016 (daily retention limit of 1). This fishery was assessed from September 15 to November 15, 2016; estimates of 3,253 and 11,824 Chum salmon were harvested and released, respectively (Table 3-7). Similar to the lower Fraser River mainstem recreational fishery, the estimated Chum salmon harvest in 2016 for the Chilliwack fishery was equal in magnitude to the previous three

years and notably less than in 2012 (Table 3-9); however, unlike the Fraser fishery, the duration of the Chilliwack fishery assessment was relatively consistent between 2012 and 2016.

The Harrison River, Stave River and Nicomen Slough/Norrish Creek recreational fisheries were open to the retention of Chum salmon year round (daily retention limit of 2). The Nicomen Slough/Norrish Creek fishery was assessed from October 7 to November 30, 2016. Estimates of 8 and 148 Chum salmon were harvested and released, respectively for this fishery (Table 3-7). Chum salmon catch in this fishery was similar to catch in 2014 and 2015 and notably less than that estimated in 2013. Recreational fisheries occurring in the Harrison and Stave rivers were not assessed in 2015.

In total, for assessed recreational fisheries occurring in the lower Fraser River watershed in 2016, estimates of 3,295 and 11,972 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 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 2016, there were two 12-hour Area E commercial openings in the Fraser River on October 24 and October 27 that harvested a total of 175,906 Chum salmon. The Area B seine fleet also mounted a limited-participation Chum salmon-directed fishery off the mouth of the Fraser River on October 27 and 28 that harvested 472 Chum salmon (Table 3-7). The Area H troll fishery was open from October 24 to November 4, but no fishing activity occurred.

Table 3-9. Estimated harvest of Chum salmon in assessed (i.e. surveyed) lower Fraser River recreational fisheries, 2007–2016.

Year	Recreational Fishery					
	Fraser River ¹	Chilliwack River	Nicomen Slough	Stave River	Harrison River	Total
2007	3,007	1,553	4	ns	ns	4,564
2008 *	760	3,937	0	ns	ns	4,697
2009 *	43	2,404	10	ns	742	3,199
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
Average ²	824	2,501	113	3,578	742	3,871

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

(2) Average for years with an assessment

(*) Preliminary estimates.

(ns) not surveyed.

In 2016, a total of 176,378 Chum salmon were harvested in commercial (excluding Economic Opportunity and test fisheries) fisheries in the Fraser River and the marine areas immediately off the Fraser River mouth (Table 3-7 and Table 3-8).

Four test fisheries operated in the Fraser River in 2016: 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).

In 2016, the Albion Chinook salmon test fishery operated from April 24 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 test fisheries operated on alternating days (section 3.2.3.1). The Albion test fishery did not operate on October 24 or October 27 due to gear conflicts with the Area E opening in the Fraser River. Chum salmon harvest in the Albion Chinook salmon test fishery, representing 179 fishing days, totaled 2,349 and harvest in the Albion Chum salmon test fishery, representing 58 days, totaled 9,956 Chum salmon (Table 3-7).

The PSC Whonnock Sockeye salmon test fishery operated for 74 days from June 30 through September 11, and harvested 3 Chum salmon. The PSC Cottonwood Sockeye salmon test fishery fished for 48 days from July 7 through August 23, and did not harvest any Chum salmon (Table 3-7).

In total, an estimated 12,308 Chum salmon were harvested in the CDFO and PSC test fisheries occurring in the Fraser River in 2016 (Table 3-7 and Table 3-8).

3.3.4 West Coast Vancouver Island

The total catch of Chum in 2016 WCVI commercial fisheries was about 565,148. Most of that catch occurred in the Nitinat (Area 21/22) hatchery directed fishery. A limited-entry commercial fishery in Nootka Sound (Area 25) caught about 13,336 Chum salmon.

First Nations FSC harvest of Chum salmon occurred in all WCVI areas and totaled 2,900 for 2016.

3.3.4.1 Nitinat

In 2016, the preseason forecast of 475,000 allowed for full fleet fisheries for both gillnet and seine fisheries. These fisheries occurred from October 2 to November 11. The return was steady at the beginning of October and grew stronger each week. The weekly escapement goals were exceeded early in the season and allowed for both fleets to be open continuously until further notice to November 11. Due to successful Johnstone Strait fisheries fleet sizes for both gear types were small from mid-October onward but catches were extremely good. The return in 2016 was estimated at 996,812 Chum salmon the largest return since 2005 (Table 3-10).

Gill net and seine openings (Area 21) occurred for a total catch of 137,591 and 269,042 Chum salmon respectively for a total commercial catch of 406,633 Chum salmon. First Nations FSC (Area 21/22), ESSR (Area 22) harvest and hatchery broodstock of Chum salmon in 2016 totaled 145,179 Chum salmon (Table 3-10).

Table 3-10. Nitinat area harvest, hatchery broodstock collection and spawning escapement estimates by PFMA, 2007–2016.

Year	Area 21		Area 22	
	Seine Catch	Gillnet Catch	In-lake Catch & Broodstock	Natural Spawners
2007	-	180,111	22,268	115,789
2008	18,796	23,919	34,505	52,632
2009	-	-	32,434	54,000
2010	-	-	42,971	59,900
2011	65,469	211,968	136,641	248,655
2012	97	23,219	75,816	206,704
2013	-	15,730	25,800	25,066
2014	-	-	56,069	125,500
2015	58,580	110,535	93,177	240,000
2016	269,042	137,591	145,179	445,000
Average	82,397	100,439	66,486	157,325

(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 manmade 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 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 2007, are presented in Table 3-11.

Table 3-11. Inside Southern Chum salmon net escapement estimates (spawning escapement plus hatchery broodstock) for Fraser and non-Fraser stock aggregates, 2007–2016¹.

Year	Inside Southern Chum Escapement		
	Fraser River	Non-Fraser River	Total
2007	1,026,701	902,149	1,928,850
2008	940,143	690,814	1,630,957
2009	619,363	853,501	1,472,864
2010	634,493	416,398	1,050,891
2011	1,084,652	912,293	1,996,945
2012	1,280,332	1,287,850	2,568,182
2013	799,573	1,224,131	2,023,704
2014	986,114	619,296	1,605,410
2015	808,219	659,847	1,468,066
2016	1,781,307	1,598,033	3,379,340
Average	996,090	916,431	1,912,521

(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.

The primary enhanced escapement areas for Inside Southern Chum 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.

3.4.2 West Coast Vancouver Island

In 2016, Nitinat Chum salmon spawning escapement was estimated at 445,000 (Table 3-10) which is a significant improvement compared to the 2015 return. In other WCVI Areas, Chum salmon spawning escapements varied from below average (Area 24) to above average (Area 23, 25 and 26) 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 estimates¹ by PFMA, 2006–2015.

Year	WCVI Pacific Fishery Management Area			
	Area 23 (Barkley)	Area 24 (Clayoquot)	Area 25 ² (Nootka)	Area 26 (Kyuquot)
2007	58,012	82,272	43,178	91,197
2008	24,630	25,978	46,495	33,392
2009	27,920	35,392	82,138	32,532
2010	24,352	61,799	51,160	36,624
2011	121,692	149,164	91,989	125,989
2012	40,419	42,276	49,148	49,933
2013	35,302	44,174	69,877	79,812
2014	12,475	36,878	51,323	41,130
2015	32,559	33,299	108,154	82,277
2016	101,006	31,049	191,074	88,676
Average	47,837	54,228	78,454	66,156

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

(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 through 4-3 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.

4.1.1 Summer Chum salmon

The Strait of Juan de Fuca summer Chum salmon post-season run size of 9,088 was about 10% less than the pre-season forecast, but still about 10% greater than the 2007–2015 average post season run size. The Hood Canal summer Chum salmon run size of 52,664 was about 1.8 times larger than the pre-season forecast and about 2.6 times larger than the 2007–2015 average post-season run size. Approximately 92% of the combined Strait of Juan de Fuca and Hood Canal summer Chum salmon run went to escapement. The summer Chum salmon pre-season forecast for South Puget Sound for 2016 was estimated at approximately 86,254 fish. The post-season run size estimate of South Puget Sound summer Chum salmon in 2016 was 19,294, which was 78% lower than the pre-season forecast and 50% lower than the 2007–2015 average post-season run size.

Table 4-1. Puget Sound summer Chum salmon pre-and post-season estimates of run size and spawning escapements, 2007–2016.

Region	Type	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Strait of Juan de Fuca	Pre-Season	8,566	5,969	5,198	3,991	5,308	5,915	6,603	9,040	7,105	10,074
	Post-Season	3,324	3,576	5,147	9,332	5,705	6,337	14,801	8,179	15,602	9,088
	Escapement	3,219	3,449	5,029	9,179	5,675	6,304	14,727	7,811	15,535	9,076
Hood Canal	Pre-Season	23,729	20,159	18,009	5,998	9,050	8,970	19,798	31,400	22,525	29,358
	Post-Season	12,838	17,618	9,200	12,957	7,170	31,134	24,325	30,408	36,055	52,664
	Escapement	10,539	15,112	7,236	12,533	6,914	29,855	22,618	27,396	32,644	47,880
South Puget Sound ¹	Pre-Season	39,840	64,229	57,352	62,991	62,623	41,889	53,492	59,940	57,987	86,254
	Post-Season	57,786	32,065	25,010	49,098	39,823	38,936	38,332	25,317	32,570	19,294
	Escapement	52,668	20,872	21,660	43,739	38,515	24,521	35,444	20,593	32,521	19,068

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

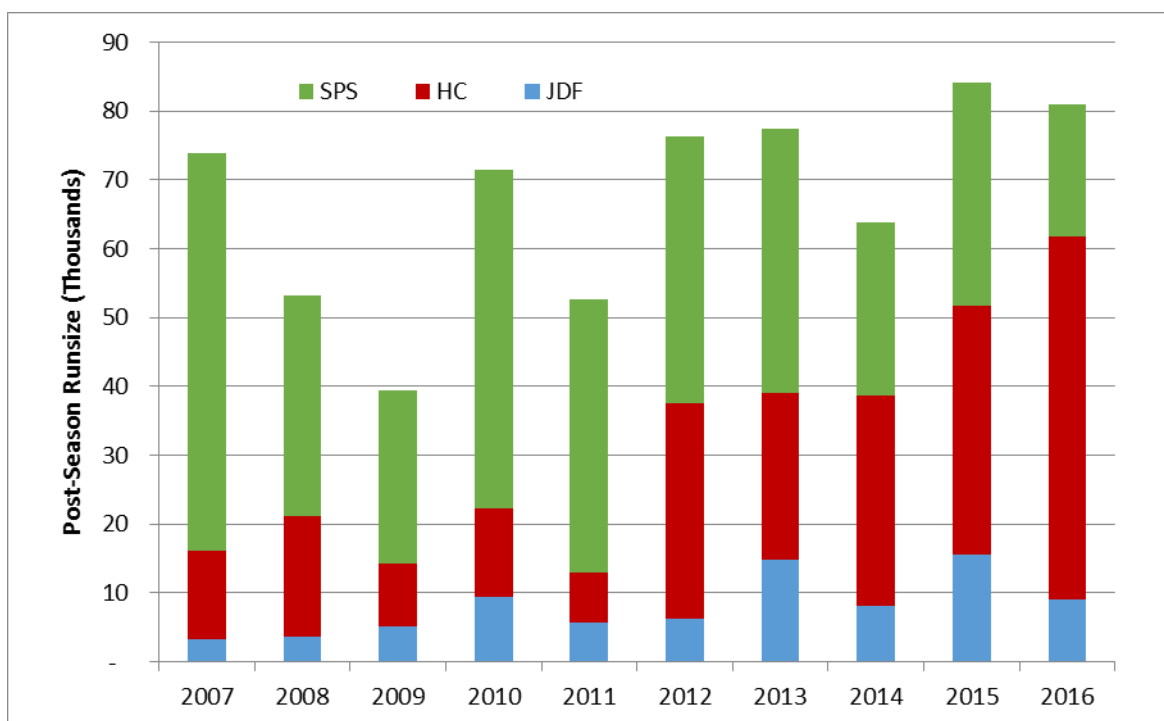


Figure 4-1. Puget Sound summer Chum salmon abundance, 2007–2016, by region of origin (JDF: Strait of Juan de Fuca, HC: Hood Canal, SPS: South Puget Sound).

4.1.2 Fall and Winter Chum salmon

The Puget Sound fall Chum salmon post-season assessment total was 1,354,325 fish, or 12% larger than the pre-season forecast and approximately 8% less than the 2007–2016 average run size. Regional post-season numbers varied in their deviation from the forecasted numbers, ranging from 58% larger than the pre-season forecast (Hood Canal) to 24% below the pre-season forecast (Central/South Puget Sound) (Table 4-2, Figure 4-2). The Washington coastal (Willapa Bay and Grays Harbor) fall Chum salmon post-season assessment total was 157,107 fish, or approximately 53% above the pre-season forecast, and 5.53 times above the 2007-2015 average run size.

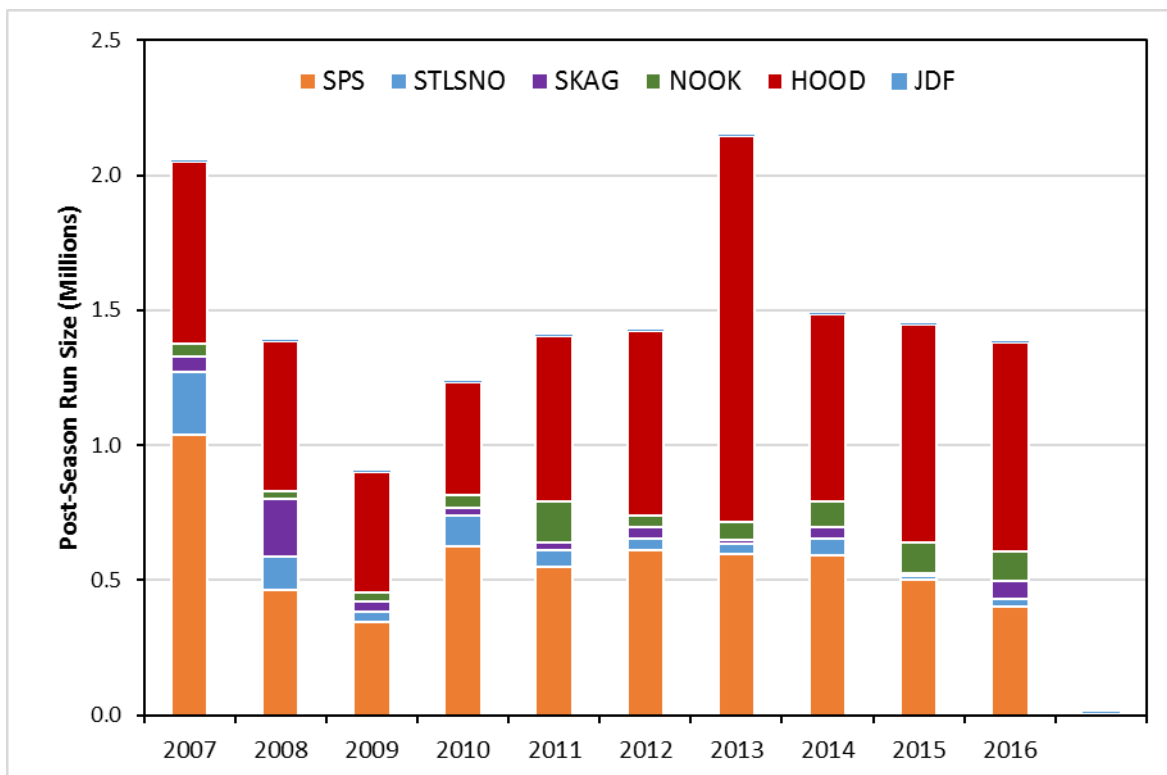


Figure 4-2. Puget Sound fall Chum salmon abundance, 2007-2016, by region of origin (JDF: Strait of Juan de Fuca, NOOK: Nooksack-Samish, SKAG: Skagit, STLSNO: Stillaguamish/Snohomish, SPS: South Puget Sound, HOOD: Hood Canal).

The Puget Sound winter Chum salmon 2016 post-season run size assessment was 20,043, which was approximately 42% below the pre-season forecast and 71% below the 2007–2016 average run size (Table 4-3, Figure 4-3).

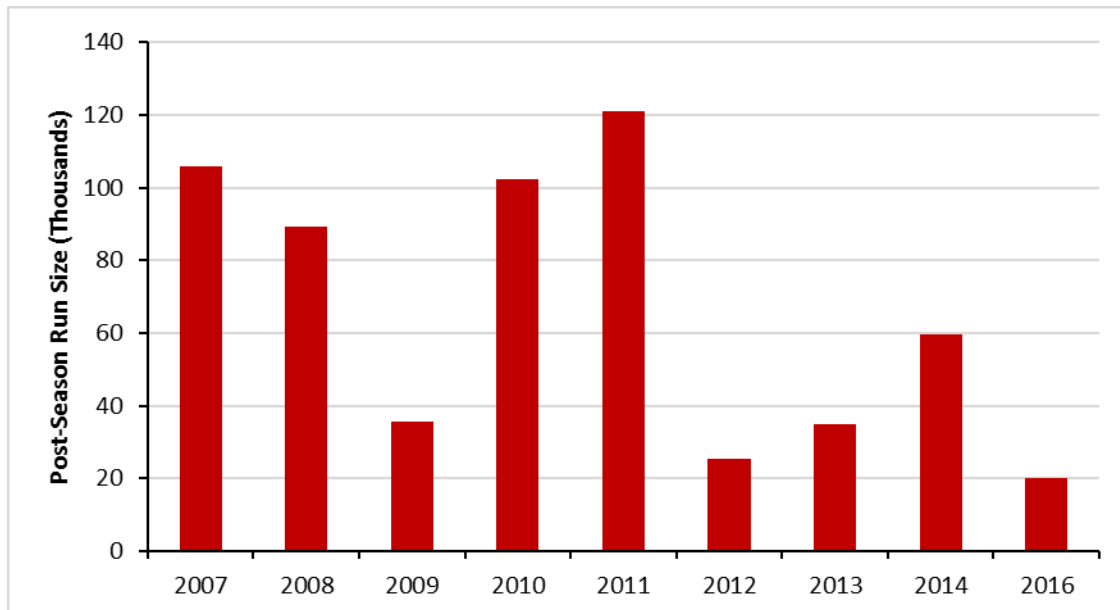


Figure 4-3. South Puget Sound winter Chum salmon abundance, 2007–2016.

Table 4-2. Washington fall Chum salmon pre-and post-season estimates of run size and spawning escapements, 2007–2016.

Region	Type	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Willapa Bay	Pre-Season	23,798	40,022	7,139	33,442	22,254	28,273	35,584	55,378	39,994	47,555
	Post-Season	17,668	12,989	17,444	26,701	69,802	43,069	27,564	30,276	48,756	86,673
	Escapement	17,392	9,511	12,743	25,204	66,871	26,640	24,979	26,508	45,409	80,931
Grays Harbor	Pre-Season	12,000	9,903	17,665	18,492	33,669	24,603	30,716	44,670	28,852	35,700
	Post-Season	12,136	8,879	19,776	43,582	50,494	40,561	41,524	28,728	48,049	70,434
	Escapement	11,342	6,249	15,216	34,644	30,101	27,876	22,519	15,378	34,587	64,704
Strait of Juan de Fuca	Pre-Season	2,143	2,745	2,587	2,222	1,618	1,203	813	4,369	9,305	3,240
	Post-Season	769	842	1,462	1,849	4,839	3,174	1,468	2,045	3,076	2,920
	Escapement	503	454	1,305	1,343	4,707	2,973	1,394	1,952	2,958	2,805
Nooksack/ Samish	Pre-Season	19,414	130,070	69,145	61,827	31,924	34,739	52,585	59,908	180,759	89,207
	Post-Season	48,632	27,471	32,007	48,892	152,176	39,100	68,176	95,440	112,704	109,824
	Escapement	21,572	16,257	26,268	30,510	100,748	21,703	48,506	60,058	68,690	60,573
Skagit	Pre-Season	90,481	132,036	26,828	50,226	26,834	59,167	15,325	16,505	47,292	45,449
	Post-Season	37,627	29,946	29,479	46,503	15,850	41,601	9,786	65,734	8,155	35,388
	Escapement	19,576	22,067	26,744	39,884	15,494	36,601	8,554	63,013	7,964	33,797
Stillaguamish/ Snohomish	Pre-Season	287,993	229,251	92,477	90,660	71,277	86,598	48,884	87,476	168,104	32,905
	Post-Season	235,799	125,064	37,689	110,050	61,598	40,003	35,145	64,272	13,669	27,372
	Escapement	43,664	38,553	29,378	46,628	60,792	35,450	30,317	51,599	8,169	24,434
South Puget Sound	Pre-Season	408,040	686,511	348,333	650,986	487,514	323,928	349,623	465,970	377,032	526,060
	Post-Season	1,036,772	464,193	344,854	627,131	548,484	611,657	597,762	589,869	503,531	401,462
	Escapement	368,848	152,549	150,732	201,992	179,094	190,817	186,457	200,660	160,260	167,561
Hood Canal	Pre-Season	587,155	668,397	374,929	477,409	352,019	426,675	323,597	442,308	394,246	489,698
	Post-Season	677,761	553,122	446,476	419,094	610,507	684,643	1,427,350	691,862	809,162	777,359
	Escapement	162,425	71,925	55,879	49,486	102,374	91,940	240,169	105,192	146,004	179,118

Table 4-3. Washington winter Chum salmon pre- and post-season estimates of run size and spawning escapements, 2007–2016.

Region	Type	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
South Puget Sound	Pre-Season	81,065	98,922	83,380	89,293	55,923	51,599	61,113	84,263	45,170	47,053
	Post-Season	105,933	89,271	35,544	102,235	121,079	25,522	34,839	59,672	30,227	20,043
	Escapement	73,442	45,162	15,486	79,550	74,110	18,987	21,754	46,587	28,855	19,600

4.1.3 Chum Harvest

Paragraph 3 of the Chapter 6, Annex IV of the Treaty requires that Canada and the United States assess catch levels of summer Chum salmon caught during the August 1 through September 15 time period in boundary area fisheries. Table 4-4 provides Chum salmon harvest during this summer Chum salmon accounting period for U.S. boundary area fisheries. Table 4-5 provides Chum salmon harvest information from the Strait of Juan de Fuca (SJF) fisheries in Areas 4B, 5, and 6C and the San Juan Islands/Point Roberts (SJI/PR) fisheries in Areas 7 and 7A (Appendix B-1). Table 4-5 also includes annual Chum salmon harvest totals for the Puget Sound and the Washington Coastal areas.

Table 4-4. Harvest of Chum salmon 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 2007–2016.

Year	Time Period ¹					Yearly Total
	7/1–8/18	8/19–8/25	8/26–9/1	9/2–9/8	9/9–9/15	
95–97 GSI ²	0.68	0.4	0.45	0.14	0.07	
2007	0	0	0	0	9	9
2008	237	1	0	0	29	267
2009	4	0	1	14	25	44
2010	64	107	48	44	26	289
2011	29	0	3	118	30	180
2012	120	0	0	0	0	120
2013	44	21	123	131	556	875
2014	49	27	14	24	215	329
2015	97	0	27	0	0	124
2016	25	0	0	0	0	25
Averages	67	16	22	33	89	226

- (1) Indicates cumulative catch of chum salmon during the Hood Canal/Juan de Fuca summer Chum salmon period. Time period notation is month/day (e.g. 7/1–8/11 refers to July 1 to August 11).
- (2) Stock proportions (from GSI from 1995–1997) that are applied to the Chum salmon catch in U.S. Areas 4b, 5, 6C, and 7 to estimate the proportion of Hood Canal/Juan de Fuca summer Chum salmon caught in those areas. GSI proportions have not been applied to Chum salmon harvest numbers in the tables.

Table 4-5. Harvest of summer, fall, and winter Chum salmon in SJF, SJI/PR, Puget Sound and Washington coastal areas, 2007–2016.

Year	Region			
	SJF	SJI/PR	Puget Sound ¹	WA Coast ²
	(Areas 4B, 5, 6C)	(Areas 7, 7A)		
2007	6,671	27,384	1,457,278	2,728
2008	5,495	75,365	940,686	7,067
2009	574	24,233	622,372	10,351
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
Average	5,444	76,497	1,054,285	17,256

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

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

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

4.2.1 Management Intent

During the 2016 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 2007–2016 (Table 4-5). Harvest and effort for the period of 2007–2016 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 Areas 4B, 5 and 6C was restricted to Treaty Indian fishers using gill nets. The Treaty Chum salmon fishery opened the week of October 9, 2016 with a schedule of six days per week and continued through November 12, 2016. A total of 25,807 Chum salmon was harvested in this fishery, and there was a reported bycatch of 581 Coho salmon, 0 Steelhead, and 59 Chinook salmon.

In Areas 4B, 5, and 6C, the incidental harvests of Chum salmon prior to the Chum salmon-directed fishing season was below the recent ten year average. A total of 27 Chum salmon, including those harvested in SJF test fisheries, were recorded during the summer Chum salmon

accounting period (July 1–September 15). During the subsequent Coho salmon-directed fishery, 0 Chum salmon were harvested.

The total 2016 Chum salmon catch by all gears (including recreational) in the SJF was 25,807 Chum salmon (Table 4-5).

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

4.3.1 Management Intent

Chum salmon fisheries in Areas 7 and 7A are regulated to comply with a base harvest ceiling of 130,000 Chum salmon, unless a critically low level of abundance (<1,000,000) is identified for those populations migrating through Johnstone Strait (Inside Chum salmon). Chapter 6, Annex IV, specifies that Chum salmon-directed fishing is not allowed in Areas 7 and 7A before October 10. Paragraph 10 (a-b) specifies that for run sizes below the critical threshold, harvest of Chum salmon in Areas 7 and 7A will be limited to those taken incidentally to other species and in other minor fisheries, and shall not exceed.

4.3.2 Fishery Description

An estimated Fraser River Chum salmon run size of 1,550,000 was provided by Canada on October 20.

Non-Tribal reef nets in Areas 7 and 7A were open to Chum salmon retention daily starting October 1, while the last day of Chum salmon harvest by reef nets occurred on October 14. Chum salmon catch by reef nets during this time was 2,334 fish (Table 4-6). Tribal and non-Tribal gill net and purse seine Chum salmon fisheries in Areas 7 and 7A began on October 10 and continued through October 27, with daily catch monitoring used to inform fisheries management. The U.S. catch for gill nets and purse seines in Area 7 and 7A was 116,127 Chum salmon (Table 4-6). The combined U.S. commercial catch in Areas 7 and 7A for all gear types was 118,461 Chum salmon.

Although Area 6 is not mentioned in the Chum Annex, and harvests from this area do not count against the U.S. harvest ceiling of 130,000 Chum salmon, it is worth noting that 875 Chum salmon were harvested from Area 6 in 2016.

There were no Chum salmon harvested in recreational fisheries in Areas 6, 7 and 7A during the October 1–October 31 time period.

The total 2016 Chum salmon catch by all gear types (including recreational) in Areas 6, 7 and 7A for the October 1 to October 27 time period was 119,336. Catch distribution, between Areas 6, 7 and 7A was 0.7%, 62.7% and 36.5%, respectively.

Table 4-6. Harvest of Chum Salmon in U.S. Areas 6, 7 and 7A Chum fisheries during 2016.

Catch Area	Gill Net	Purse Seine	Reef Net
6	875		
7	6,344	66,185	2,334
7A	29,852	13,746	
Total	37,071	79,931	2,334

In 2014, U.S. Chum salmon catches in Areas 7 and 7A exceeded the U.S. catch ceiling by 16,571 Chum salmon. Paragraph 10(h) of the Chum annex stipulates that *...catches in excess of 135,000 Chum salmon shall result in an overage being calculated by subtracting 130,000 from the total Chum catch. Overages will be accounted for by reducing the U.S. annual catch ceiling in up to two subsequent non-critical Inside Southern Chum salmon years.* During 2015, the U.S. harvested 5,260 fewer Chum salmon in Areas 7 and 7A than the U.S. catch ceiling of 130,000, leaving 11,311 fish remaining to be paid back. In 2016 the U.S. Chum salmon catches in Areas 7 and 7A totaled 118,461 fish, 11,539 less than the U.S. catch ceiling, effectively paying back the remaining Chum salmon from the 2014 overharvest.

In 2016 there were no Fraser Panel approved Sockeye salmon fisheries in Areas 6, 7 and 7A, so there is no bycatch of Chum salmon to report. During Chum salmon-directed fisheries in Areas 6, 7, and 7A, there was a reported bycatch of 15 Chinook salmon, 4,064 Coho salmon and zero Steelhead (Table 4-7).

Table 4-7. Bycatch of Chinook salmon, Coho salmon and Steelhead during the 2016 U.S. Chum salmon commercial fishing period beginning October 1 in Areas 6, 7 and 7A.

Catch Area	Chinook	Coho	Steelhead
6		9	0
7	2	3,486	0
7A	1	346	0
Total	3	3,841	0

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 2016.

5.2 Otolith, Fin Marking and Coded Wire Tagging (CWT)

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.

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).

Table 5-1. Releases of Chum salmon with thermally-marked otoliths from WCVI-based Canadian hatchery facilities, 2007–2016.

Broodyear	Nitinat Hatchery Release Sites		Conuma Hatchery Release Sites				
	Nitinat River & Lake	Klanawa River	Conuma River	Conuma Estuary	Tlupana River	Sucowa River	Canton River
2007	13,004,189	0	0	271,820	109,922	15,701	47,846
2008	7,631,058	0	0	1,011,562	254,905	292,430	418,655
2009	5,252,749	0	18,847	1,814,475	685,465	551,365	854,548
2010	14,182,582	0	0	1,794,205	1,015,355	311,828	646,203
2011	25,303,286	0	0	1,270,286	37,241	223,882	365,682
2012	15,813,031	0	0	785,682	813,957	41,196	116,757
2013	9,738,442	0	0	1,705,633	820,612	269,435	1,009,478
2014	17,767,521	0	410,214	1,467,870	0	0	200,646
2015	18,236,300	0	534,334	723,867	452,375	0	576,649
2016	26,443,305	0	424,032	1,932,540	1,027,846	0	835,191

A second hatchery on the West Coast of Vancouver Island, Conuma Hatchery, first began thermally marking otoliths for several populations of Chum salmon beginning with the 1998 broodyear. This continued in 2016 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.

Table 5-2. Releases of marked Chum salmon from southern B.C.-based Canadian hatchery facilities, 2007–2016.

Population	Broodyear	Fin Clip Type ¹	Clipped	Poor Clips + Unclipped	Total
Big Qualicum River	2007	ADRV	251,329	9,471	260,800
	2008	ADRV	204,801	5,409	210,210
	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	No clip			

(1) Clip Types: AD-adipose fin; LV-left ventral fin; RV-right ventral fin.

Not all 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 mark/tag combinations applied from 2007–2016 broodyears. Fin clipping was suspended at Big Qualicum River in 2016 (Table 5-2).

There were no coded wire tagged Chum salmon released from Canadian facilities during the 2007–2016 time period.

5.2.2 United States

Otolith marking (Volk et al. 1987) was used in several hatchery supplementation and re-introduction programs for summer Chum salmon in the Hood Canal and Strait of Juan de Fuca regions (Table 5-3), and for fall Chum salmon in 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 Hood Canal summer Chum salmon released with thermally-marked otoliths by brood year, 2007–2016.

Hood Canal Summer Chum Salmon				
Broodyear	Jimmycomelately	Hamma Hamma	Lilliwaup	Tahuya
2007	73,840	48,530	0	53,632
2008	88,766	208,450	68,810	97,142
2009	92,200	-	140,210	69,711
2010	85,630	-	139,816	27,706
2011	-	-	41,006	19,600
2012	-	-	157,760	110,000
2013	-	-	169,440	52,778
2014	-	-	109,680	-
2015	-	-	165,024	-
2016	-	-	199,824	-

Table 5-4. Numbers of Puget Sound and Lower Columbia River fall Chum salmon released with thermally-marked otoliths, 2007–2016.

Broodyear	Puget Sound					Lower Columbia River	
	Elwha River	Tulalip Bay	Kendall Creek	Terrell Creek	Whatcom Creek	Grays River Hatchery ¹	Washougal Hatchery
2006	0	0	0	0	0	129,427	0
2007	0	0	0	0	450,000	77,609	0
2008	0	0	0	0	400,000	104,600	0
2009	0	0	0	0	0	300,000	70,000
2010	0	0	0	0	2,000,000	250,000	57,455
2011	0	0	0	0	1,360,000	206,000	74,893
2012	0	0	0	0	1,547,900	157,800	58,004
2013	450,000	40,000	650,895	85,000	3,048,000	151,567	46,083
2014	450,000	8,000,000	1,094,383	1,000,000	2,283,000	192,156	400,000
2015	450,000	8,000,000	1,000,000	0	2,000,000	250,000	500,000

(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 stock identification methodology to be used for immediate and future application of Canada and United States (U.S.) Chum salmon stock assessment (Appendix C). 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, Qualicum River, 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

GSI samples were collected during the Johnstone Straits purse seine fisheries (commercial and test fishery) in 2016 (Table 5-5). In 2016, these samples were analysed for microsatellite markers using the first year of four years of funding supported by the Southern Endowment Funds (Candy et al. 2017).

Table 5-5. Chum salmon tissue samples collected in Johnstone Strait fisheries and analyzed for GSI, 2007–2016.

Year	Commercial Samples		Test Fishery Samples	
	Collected	Analysed	Collected	Analysed
2007	879	869	0	0
2008	995	868	830	449
2009	1,418	1,101	999	0
2010	400	400	1,015	1,114
2011	865	863	1,404	905
2012	987	935	1,275	1,261
2013	1,185	973	1,311	1,291
2014	1,087	990	1,369	1,342
2015	1,348	982	1,395	1,326
2016	1,267	1,231	1,350	1,341

5.3.1.2 United States

Among focused studies, WDFW used GSI to distinguish supplementation-origin and natural-origin adult summer Chum salmon in Hood Canal as part of the effort to monitor the Hood Canal summer Chum salmon recovery program. For instance, from 2006–2009 mSAT DNA data were used to clarify uncertain hatchery assignments when otoliths were broken or thermal marks were ambiguous. Each supplementation program for summer Chum salmon had a unique otolith mark and spawners could be identified as supplementation-origin or natural-origin, but not identified to their program of origin if their otolith mark was ambiguous.

These ambiguous supplementation program fish were genotyped and identified by assigning them to populations in the Hood Canal summer Chum salmon genetic baseline. Genetic analysis was used to evaluate impacts of supplementation on the Hood Canal summer Chum salmon metapopulation (Small et al. 2009). WDFW also conducted juvenile stock assignment studies in the Strait of Juan de Fuca and Hood Canal during 2009–2015. The juvenile studies documented

emigration timing and relative production of summer and fall Chum salmon in key populations. Further, 732 tissue samples were collected near Apple Cove Point in Puget Sound Area 9 in the eleventh year of Chum salmon DNA collection from this test fishery and an additional 357 tissues were collected in Area 9.

Fisheries in Area 7 and Area 7a were sampled and tissues analyzed (Table 5-6) from the fourth year of Southern Endowment Funding project using microsatellites (Candy et al. 2017).

Table 5-6. Chum salmon tissue samples from Areas 7 and 7a analyzed for GSI in 2007–2016.

Year	Area 7	Area 7A
2007	675	700
2008	711	651
2009	0	0
2010	403	203
2011	0	0
2012	1,328	829
2013	419	423
2014	121	285
2015	196	123
2016	784	336

5.3.2 Baseline Collection for Genetic Stock Identification

5.3.2.1 Canada

In 2016, CDFO continued to collect baseline GSI tissue samples of Southern British Columbia Chum salmon populations (Table 5-7).

Table 5-7. Fall Chum salmon GSI tissue collections from Southern B.C. by Conservation Unit, collection site, life stage, and influence¹ of enhancement, 2016.

Conservation Unit	Collection Site	Life Stage	Enhancement Level ¹	Sample Size
Lower Fraser	Barnes Cr	Adult	Natural	57
Lower Fraser	Chilqua Cr	Adult	Hatchery	101
Fraser Canyon	Hunter Cr	Adult	Natural	63
Fraser Canyon	Sucker (Kawkawa) Cr	Adult	Natural	97
Lower Fraser	Railroad Cr	Adult	Hatchery	118
Lower Fraser	Siddle Cr	Adult	Mixed	3
Howe Sound-Burrard Inlet	Cheakamus R	Adult	Natural	100

- (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 2016 the Chum salmon SNP baseline project focused on improving population sampling and developing amplicon sequencing. Over 2000 samples from 20 Chum salmon populations in Washington and southern British Columbia were collected and archived at WDFW Molecular Genetics lab in Olympia to expand the Chum salmon SNP genetic baseline. In fall 2014, WDFW prepared 192 Chum salmon sample libraries for RAD sequencing, which was completed in winter 2015 on contract to the University of Oregon. WDFW conducted bioinformatics on the RAD sequences in 2015–2016, developed a Chum salmon RAD catalogue of sequences, and compared the catalogue to a UW Chum salmon RAD catalogue developed from populations from different locations. The comparison identified matching and different SNPs and SNPs with high resolving power for Southern Boundary region populations. We identified a “white list” of 5000 candidate SNPs from the WDFW Chum salmon RAD catalogue and worked towards developing two amplicon panels, one with 335 loci that were mostly originally Taqman assays, and a second panel of 389 newly developed SNPs, for 724 total SNPs. The UW lab worked on developing a Genotype-in-Thousands by sequencing (GTseq) protocol to genotype samples with the two panels.

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APPENDICES

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

Southern British Columbia and Washington State Chum Salmon

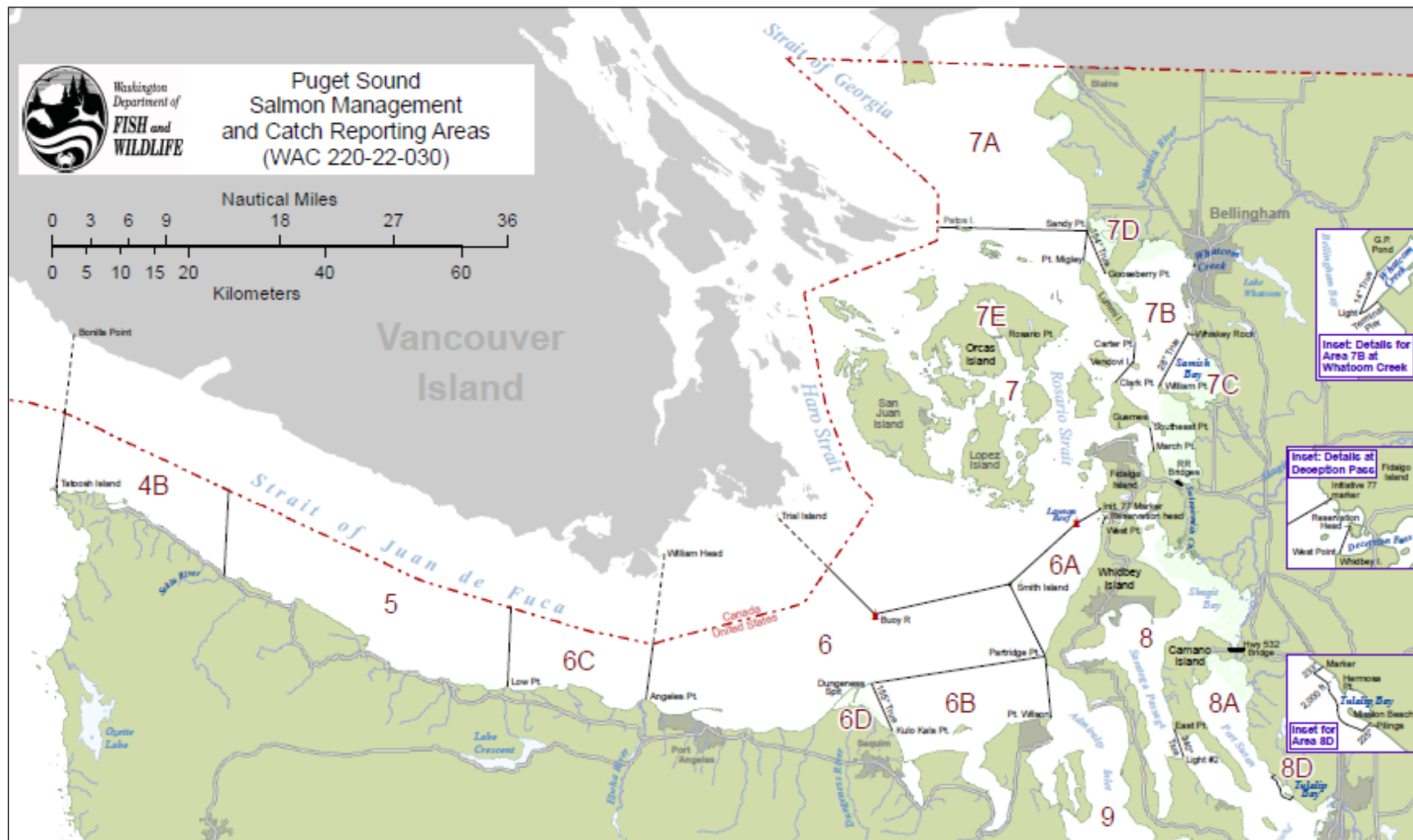
The provisions of this Chapter shall apply for the period 2010 through 2018.

1. The Parties shall maintain a Joint Chum Technical Committee (“the Committee”) reporting, unless otherwise agreed, to the Southern Panel and the Commission. The Committee will undertake to, *inter alia*:
 - a) maintain and present historical catch and escapement information for stocks relevant to the Treaty;
 - b) utilize available information to estimate and document stock composition and exploitation rates in fisheries of concern to the Treaty;
 - c) review annually the Parties’ assessment of stock status and fisheries activities for Chum fisheries of concern to the Treaty;
 - 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 and/or when requested;
 - i. Exchange available information on the productivity and escapement requirements of stocks relevant to the treaty;
 - ii. Identify and document stocks of concern (with respect to conservation) relevant to the treaty;
 - 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 report its conclusions using bilaterally agreed upon methods.
3. Canada and the United States shall assess catch levels and make attempts to collect additional genetic samples from any Chum salmon caught during the July 1 through September 15 time period in the Boundary Area fisheries (U.S. Areas 4B, 5, 6C, 7 and 7A; Canadian Areas 18, 19, 20, 21, and 29).
4. During the period from July 1 through September 15, Canada will 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 will require the same for the non-Indian seine fisheries in Areas 7 and 7A. Note: By U.S. regulation, purse seine fisheries are not permitted in U.S. Areas 4B, 5 and 6C.

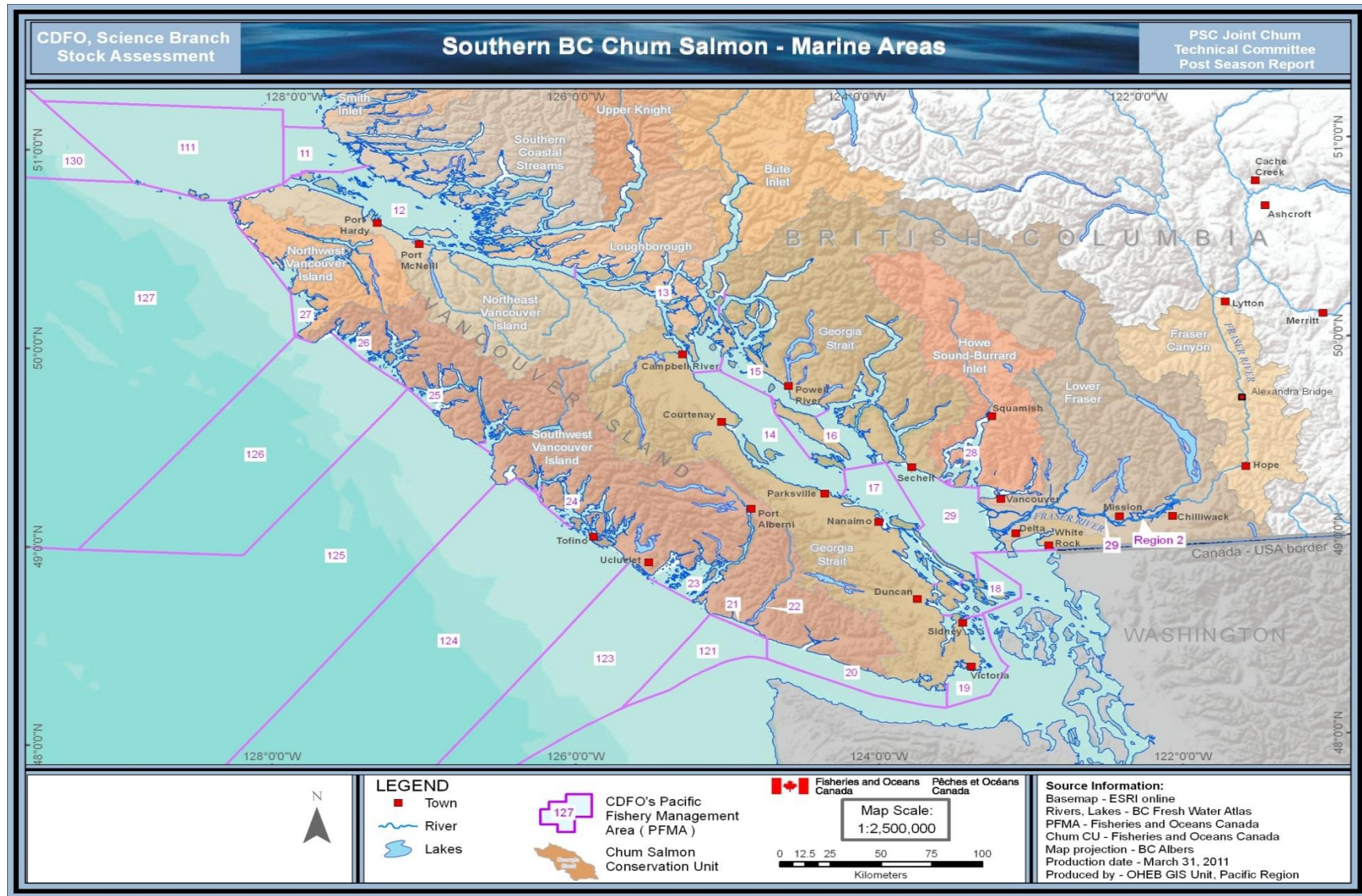
5. Canada will manage its Johnstone Strait, Strait of Georgia, and Fraser River Chum salmon fisheries to provide continued rebuilding of depressed naturally spawning Chum salmon stocks, and, to the extent practicable, not increase interceptions of U.S. origin Chum salmon. Terminal fisheries conducted on specific stocks with identified surpluses will be managed to minimize interception of non-targeted stocks.
6. Canada will manage its Johnstone Strait mixed stock fishery as follows:
 - a) Inside Southern Chum salmon levels of less than 1.0 million as estimated by Canada are defined, for purposes of this chapter, as critical;
 - b) For run sizes above the critical threshold, Canada will 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 critical threshold, Canada will notify the United States and will only conduct assessment fisheries and non-commercial fisheries. Commercial fisheries targeting Chum salmon will be suspended.
7. Canada will 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), will be suspended; and
 - b) For Fraser River terminal area run sizes, identified in-season at levels greater than 900,000 Chum salmon, 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 will manage the Nitinat gill net and purse seine fisheries for Chum salmon to minimize the harvest of non-targeted stocks.
9. Canada shall conduct a genetic sampling program of Chum salmon taken in the West Coast Vancouver Island troll fishery if early-season catch information indicates that catch totals for the July 1 through September 15 season may reach levels similar to 1985 and 1986. Sampling, should it occur, will include catches taken from the southern areas (Canadian Areas 121-124).
10. The United States will manage its Chum salmon fishery in Areas 7 and 7A as follows:
 - a) Inside Southern Chum salmon levels of less than 1.0 million as estimated by Canada are defined, for purposes of this chapter, as critical;
 - b) For run sizes below the 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, provided that catches for the purpose of genetic stock identification sampling shall not be included in the aforementioned limit;

- c) For run sizes above the critical threshold, the base catch ceiling for the U.S. Chum salmon fisheries in Areas 7 and 7A will be 130,000 Chum salmon;
 - d) Canada will provide a run size estimate of Chum salmon entering the Fraser River no later than October 22. If the estimate is less than 900,000, the U.S. will limit its fishery impacts on Fraser River Chum salmon by restricting catch in Areas 7 and 7A to not exceed 20,000 additional Chum from the day following the date the U.S. is notified. The total catch is not to exceed the catch ceiling of 130,000 Chum salmon;
 - e) U.S. commercial fisheries for fall Chum salmon in Areas 7 and 7A will not occur prior to October 10;
 - f) The U.S. will manage the Areas 7 and 7A fisheries for Chum salmon with the intent to minimize the harvest of non-targeted species;
 - g) No U.S. catch shortfalls may be accrued; however any overages shall be carried forward as indicated in (h) and (i);
 - h) Due to management imprecision, a catch in the U.S. of up to 135,000 Chum salmon will not result in an overage calculation. Catches in excess of 135,000 Chum salmon shall result in an overage being calculated by subtracting 130,000 from the total Chum catch. Overages will be accounted for by reducing the U.S. annual catch ceiling in up to two subsequent non-critical Inside Southern Chum salmon years; and
 - i) From the day following the date the U.S. is notified of a run size below the critical threshold as defined in 10(b) or (d), any catches in excess of 20,000 Chum salmon will result in an overage. Overages will be accounted for by reducing the U.S. annual catch ceilings in up to two subsequent non-critical Inside Southern Chum salmon years.
11. The United States shall conduct its Chum salmon fishery in the Strait of Juan de Fuca (United States Areas 4B, 5, and 6C) so as to maintain the limited effort nature of this fishery, and, to the extent practicable, not increase interceptions of Canadian origin Chum salmon. The United States shall continue to monitor this fishery to determine if recent catch levels indicate an increasing level of interception.
 12. All information concerning bycatch of other salmon species from the Chum salmon fisheries covered by this chapter will be shared between the Parties in the annual Post Season Report.
 13. Should circumstances arise that are inconsistent with either Parties understanding of the intent of the chapter, the Southern Panel will discuss the matter postseason and explore options for taking the appropriate corrective actions.

Appendix B-1. United States commercial salmon catch areas for the Strait of Juan de Fuca and Northern Puget Sound.

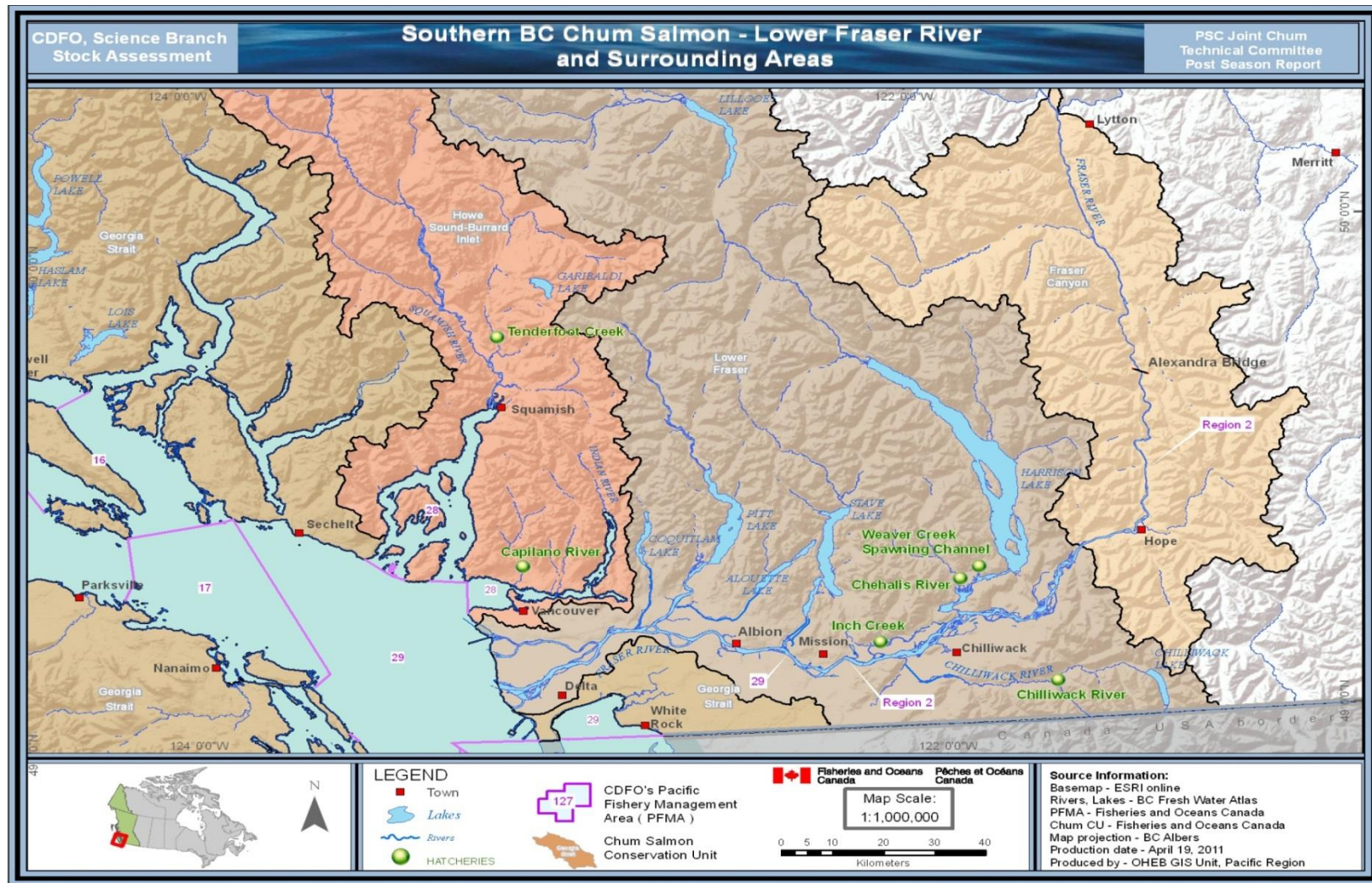


Appendix B-2. Canadian Pacific Fishery Management Areas (PFMA) for Southern B.C. - Marine areas.



G:\projects\science\PieterVanWill\BC Albers\Southern Chum CU's map\Working\southern bc chum salmon - Marine areas.mxd

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



G:\projects\science\PieterVanWill\BC Albers\Southern Chum CU's map\Final\southern bc chum salmon - lower fraser river and surrounding areas.mxd

PACIFIC SALMON COMMISSION WORK PLAN
[2016-2017]

Update on Bi-lateral Tasks Assigned Under Current PSC Agreement:

- Assembling draft annual report covering 2014 fisheries and research will be a principal focus during the PSC meetings in January 2017. It is expected that this report will be finalized shortly after the meeting.
- Initiate the 2015 report with the assignment of tasks and timelines
- The committee's other focus will be continued development of the following aspects of the strategic plan. These include:
 - Further evaluation and testing of the first iteration of the ChumGEM model. Need to document issues, gaps and possible improvements to ensure future work on the model has appropriate direction. No funding associated with this project has been identified but it is still deemed a priority by the technical committee.
 - To provide updates on any approved 2016 SEF projects: Currently 3 Chum salmon projects are being conducted in 2016:
 - **Sampling program in the Strait of Juan de Fuca**
 - **Estimate of total Fraser River escapement using GSI information at Albion Test Fishery and enumeration of Chilliwack River escapement**
 - **Mixed-stock GSI in Southern BC and Puget Sound**
 - Work on 2016 reports associated with SEF projects for later submission
 - Review of SEF priorities and ensure projects are ready for 2017 implementation should funding be awarded.
 - 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:

Chum Technical Committee:

- While support from the Southern Endowment Fund has facilitated our efforts to implement the TCCHUM strategic plan, time constraints for committee members remains a challenge to task completion.
- The Chum chapter is in renegotiations; the final product will affect time constraints for committee members.

Proposed Meeting Dates and Draft Agendas:

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

Chum Technical Committee:

- January 9– 13, 2017 – PSC Post-Season Meeting, Vancouver, BC
 - Review and discuss preliminary post-season 2016 fisheries information
 - Collate and review report items for 2014 and 2015 final post-season report
 - Finalize 2014 annual report for submittal
 - Initiate drafting of 2015 final 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 1st phase of ChumGEM
 - Updates on any completed SEF programs related to Chum
 - Review and discuss research and analysis activities essential to the Committee tasks
 - Provide any bilateral analyses, as requested by the Southern Panel.
- February 13 – 17, 2017 – PSC Annual Meeting, Portland, OR
 - 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
 - Continue work on 2015 annual report.
- May 2017 – PSC Chum TC Spring Meeting, location to be determined
 - Finalize the 2015 annual report
 - Continue to define and develop Tier 2 components of the Southern Chum Strategic Plan
 - Review status of all SEF related projects and develop plan for new submission following identified priorities

Status of Technical or Annual Reports:

Chum Technical Committee:

- The committee anticipates having the 2014 Annual Report complete by the end of the January meetings in 2017.
- The committee also hopes to have the 2015 report completed after the May meetings

Appendix D. Pacific Salmon Commission Southern Boundary Restoration and Enhancement Fund Projects in 2016

Project Title: S16-109A Joint US and Canada Mixed-Stock Chum Fisheries Sampling Design and Analysis 2016 (Candy et al. 2017)

<https://www.psc.org/download/462/information/10505/s16-i09a-southern-british-columbia-chum-salmon-mixed-stock-identification-report-year-1.pdf>

We conducted Genetic Stock Identification (GSI) of 4,342 Chum salmon migrating to natal streams through Johnstone Strait (Statistical Areas 12 and 13), along East Coast of Vancouver Island (Statistical Areas 14 and 18) and through the San Juan Islands (Statistical Area 7 and 7A) for 2016 using analyses of microsatellite variation. A total of 3100 Chum salmon were analyzed for Canadian fisheries (Areas 12, 13, 14, 18) and 1,154 Chum salmon for U.S. fisheries (Area 7-7A).

The analysis of Chum Salmon sampled in the commercial and test fisheries in Johnstone Strait were mainly from Canadian populations (ranging from 90.2% to 99.8%) comprised largely of Fraser River (ranging from 36.% to 55.5%) and Strait of Georgia (east and west sides). The analysis of Chum Salmon caught in commercial fisheries in the San Juan Islands were from both Canadian and U.S. origin stocks with a larger contribution of Canadian origin stocks: 99.7% and 99.8% in Area 7A and 95.3% to 99.2% in Area 7. The Lummi Island reef net fishery had a stock composition with 99.4% Chum of Canadian origin. East coast of Vancouver Island commercial samples (Areas 14 and 18) were largely Canadian contributions (95.8% to 99.6%).

Overall the failure to amplify rate was very low (0.18%) for these samples. In addition, 1.3% of these samples were excluded from the analysis because the number of loci amplified was below threshold.

Project Title: S16-I14B Joint U.S. and CA Juan de Fuca Chum Sampling Program Year 1 of 4 (Van Will et al. 2017)

<https://www.psc.org/download/462/information/8118/s16-i14a-juan-de-fuca-strait-chum-sampling-program-dfo-portion-year-1-of-4.pdf>

<https://www.psc.org/fund-project/juan-de-fuca-strait-chum-sampling-program-dfo-portion-year-1-of-4/>

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 first year of this multi-year program was initiated in 2016. The program began as planned on September 27th and ran until October 31st. A total of 104 sets were completed (44 in Canadian waters and 60 in US waters). A total of 1,471 Chum were encountered and 1,024 were sampled for stock id and other biologicals. The catch information demonstrated a later timing than originally expected, also observed in the Johnstone Strait Test Fisheries, with the highest Chum Catch per Unit Effort (CPUE) occurring in week 44. Over the period of the program, Chum CPUE was higher in US waters than in Canadian waters except in the first week. Stock composition information demonstrated that Canadian stocks dominated the samples early in both US and Canadian fishing areas. In Canadian waters US stocks increased in composition later in the program and were prevalent throughout the sampling in US waters dominating the mixture after week 41. Stock timing and distribution differences were observed and this new information has improved our understanding of stock composition and timing through the Strait of Juan de Fuca.

Project Title: S16-I05 Adapting benchmarks of biological status for persistent changes in productivity and variability in exploitation history with a focus on data-limited populations (Conservation Units) of Chum Salmon in southern BC. (Holt et al., 2017)

<https://www.psc.org/download/462/information/8459/s16-i05-adapting-benchmarks-of-biological-status-for-persistent-changes-in-productivity-and-variability-in-exploitation-history-with-a-focus-on-data-limited-populations-conservation-units-of-chum-sa.pdf>

Canada's Wild Salmon Policy requires the biological assessment of conservation units (CUs) of Pacific salmon to ensure their conservation for future generations. A "stop light" approach has been adopted that uses stock-recruitment models to calculate benchmarks and assign green, amber, or red status to CUs. Data limitations for many CUs require the exploration of alternative benchmarks to ensure conservation objectives are achieved when stock-recruitment data are not available. In this study we compare the performance of alternative lower and upper benchmarks for data-limited CUs based on 25th and 75th percentiles of observed abundances, using prospective simulation modelling and retrospective analyses of empirical data for Chum Salmon in southern BC. In retrospective analyses, we found that benchmarks based on percentiles of escapement time series were generally more precautionary than previously adopted stock recruitment based benchmarks for the 9 CUs and 5 stock management units of Chum Salmon analyzed here. The simulation study yielded similar results. However, when population productivity was moderate to low and harvest rates were high, percentile-based lower benchmarks tended to be below "true" lower benchmarks. In those cases, we recommend a higher percentile be applied as lower benchmark, such as 50th percentile, instead of the 25th percentile. We further provide recommendations on when percentile benchmarks should not be applied, based on estimates of productivity and harvest rates.

Project Title: Albion-based estimate of total Fraser River Chum Salmon escapement using GSI at Albion and an estimate of Chilliwack River Chum Salmon escapement, 2016 (Cone et al. 2017)

<https://www.psc.org/download/462/information/10255/s16-i23-albion-based-estimate-of-fraser-river-chum-escapement-using-gsi-and-estimate-of-chilliwack-river-chum-escapement-interim-presentation-2016.pdf>

During the fall of 2016, a two component pilot project was undertaken in the lower Fraser River to determine the feasibility of estimating the total Chum Salmon escapement to the Fraser River using a GSI estimate of the percentage of Chilliwack River Chum Salmon (*Oncorhynchus keta*) in the total Fraser River Chum caught by the CDFO Albion Test Fishery, with a high precision estimate of Chum Salmon escapement to the Chilliwack River.

The first component leverage Chum Salmon bio-samples collected during the conduct of the Albion Test Fishery in the lower Fraser River at Mission. From September 23 to November 9, the Albion Test Fishery caught 9,528 Chum Salmon. A total of 958 Chum Salmon were bio-sampled for scales. Of these, 252 scale samples were sent to the CDFO Pacific Biological Station for DNA extraction and GSI analysis. The weighted mean percentage of Chilliwack River to total Fraser River Chum at Albion in 2016 was estimated at 8.8% (SD 5.9%).

The second component of this project involved the implementation of an enumeration study to obtain a high precision estimate of Chum Salmon escapement to the Chilliwack River. A mark-recapture study design was conducted from October 3 to December 19 in the Chilliwack River watershed. Tags were applied to 1,078 Chum Salmon from October 3 to November 29 and a total of 46,255 Chum Salmon carcasses were recovered from October 13 to December 19. Of these recoveries, 557 were tagged. Both application and recovery biases were detected in the analysis of the mark-recapture data. For this reason, the pooled Petersen estimate was rejected and the stratified Darroch's maximum likelihood (ML) estimate was chosen as the most appropriate estimate. In 2016, Chum Salmon escapement to the Chilliwack River was estimated at 200,036 (95% confidence interval of 146,534 to 253,538).

An estimate of the total Fraser River Chum Salmon escapement was generated from the product of the Chilliwack River escapement estimate and the ratio of total Fraser to Chilliwack Chum Salmon estimated at Albion. The escapement of Chum Salmon to the Fraser River in 2016 was estimated at 2,273,136 (95% confidence interval of 1,665,030 to 2,881,243).