Joint US and CA Mixed-stock Chum Fisheries Sampling Design and Analysis 2017

Report to Southern Endowment Fund: Project 57943

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Abstract

We conducted Genetic Stock Identification (GSI) of 4656 Chum salmon migrating to natal streams through Johnstone Strait (Statistical Areas 12 and 13), along the central Strait of Georgia (Statistical Areas 14, 17) and the San Juan Islands (Statistical Area 7 and 7A) for 2017 using analyses of microsatellite variation. A total of 3237 Chum salmon were analyzed for Canadian fisheries (Areas 12, 13, 14, and 17) and 1419 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 (89.0% to 99.8%) comprised largely of sites in the area, the Fraser River, and Strait of Georgia (east and west sides). The central Strait of Georgia was composed of largely Canadian contributions (93.3% to 97.8%), largely from sites in the east and west sides of the area. 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: 72.5% to 99.5%, except in early November when the U.S. contribution reached 73.7%.

Overall the failure to amplify rate was low 0.5% but significantly higher than last year (0.18%). In addition, 3.04% of these samples were excluded from the analysis because the number of loci amplified was below threshold (<9 from 14 loci), also higher than the previous year (1.3%).

Acknowledgments

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Introduction

In order to facilitate management responses to Southern Chum stock strength, in accordance with Annex IV, Chapter 6 of the Pacific Salmon Treaty (The Treaty) it is necessary to provide the catch composition in fisheries targeting southern origin Chum salmon (*Oncorhynchus keta)*. This information supports the treaty requirement Section 3 to account for US chum stocks in Canadian fisheries and to account for Canadian chum stocks in US fisheries. This is the second year of an additional four year project to sample and provide Genetic Stock Identification (GSI) on key chum mixed stock fisheries within Canada and the US. This work is replicating previous annual sample collections to obtain uniform and sufficient coverage to meet Treaty requirements.

The main fisheries targeted were Johnstone Strait purse seine and gill net commercial and test fisheries (Area 12 and Area 13-Figure 1), Strait of Georgia gill net (Areas 14 and 17), as well as the US commercial purse seine and gill net fisheries occurring in the areas described as San Juan Islands/Point Roberts (SJI/PR) Fishery Management Areas 7 and 7A (Figure 2).

Both Canadian and US Chum salmon populations were grouped into genetically distinguishable groups and must be evaluated for concordance with existing Canadian Conservation Units and Evolutionary Significant Units for conservation management purposes. Besides immediate Treaty obligations, the GSI work is part of the information required for accurate post-season run reconstructions which are essential in evaluating whether domestic management actions were consistent with meeting overall objectives of the Treaty. Run reconstructions are also important in monitoring the productivity of stocks and assessing the adequacy of current escapement targets and both pre-season forecasting and in-season run assessment techniques. Without this knowledge, managing to achieve Treaty obligations would

be difficult and severely limits the assessment of factors influencing stock productivity, which appear to have fluctuated widely in recent years.

Stock specific data collected in these mixed stock areas will provide the information, deemed necessary by the PSC Joint Chum Technical Committee (Chum TC) and the PSC Southern Panel, to develop management options addressing conservation of stocks of concern while focusing fisheries on stocks of significant abundance. It will also provide a bilaterally agreed method to determine the catch composition on all mixed stock Chum fisheries in Johnstone Strait, US areas 7 and 7A and other border fisheries in accordance with Annex IV, Chapter 6 of the Treaty.

Materials and Methods

Collection of DNA Samples and Laboratory Analysis

Caudal punches were taken from sampled fish by sticking tissue on Whatman paper to air dry and DNA was extracted as described by Withler et al. (2000) or placed in vials with non-denatured ethanol preservative. The samples were collected from 3237 adult Chum salmon in 2017 captured in test and commercial fisheries from British Columbia Statistical Areas 12, 13, 14, and 17 between September 11 and October 25, in addition to a by-catch sample in Area 12 from July 11 to August 13, 2017. There were 1419 Chum salmon captured for genetic analysis in commercial fisheries from Washington State Statistical Areas 7 and 7A between October 10 and November 9, 2017. Tissue samples or purified DNA from these collections are available to be analyzed by U.S. labs at their request.

In Canadian waters, fisheries were sampled across a broad range of dates and areas. Sockeye and Fall Chum directed fisheries were sampled in Johnstone Strait (Area 12 and 13), and Strait of Georgia terminal Chum fisheries (Areas 14 and 17). Commercial and Test fisheries were sampled in Johnstone Strait. A by-catch sample was obtained from the Area 12 Sockeye directed test fishery from July 11 to August 13. The Fall Chum test fishery occurred from September 11 to October 25. There were two commercial purse seine openings in Johnstone Strait that took place on October 2 and October 16, simultaneously in Areas 12 and 13. Commercial Vessels were sampled as they were encountered at the offload locations and 25-30 fish were randomly sampled per vessel. The catch was sampled between Areas 12 and 13 proportionate to the catch in those areas during the fishery.. Two Fall Chum gill net fisheries were sampled in the Strait of Georgia (SOG) Area 14 (Oct 14 to 27) and Area 17 (Oct 27). Table 1 summarizes all sample collections by fishery in Canadian waters.

In U.S. waters the chum directed fishery was sampled weekly in Washington Catch Management Areas 7 & 7A (San Juan Islands and Point Roberts). Catch Area 7 was split into Treaty, Non-Treaty, and test fisheries with a goal of collecting 200 samples per survey. The dates of these fisheries range from October 10 to November 9. In 7A a fisheries began on October 10 and continued until October 15. Table 1 summarizes sample collections from Treaty, Non-Treaty, and test fisheries for Areas 7 & 7A.

Once chum salmon genomic DNA was available, surveys of variation at the following 14 microsatellite loci were conducted: *Ots3* (Withler et al. 1999), *Oke3* (Buchholz et al. 2001), *Oki2* (Smith et al. 1998), *Oki100* (Beacham et al. 2008b), Ots103 (Nelson and Beacham 1999), *Omm1070* (Rexroad et al. 2001), *Omy 1011* (Spies et al. 2005), *One101, One102, One104, One111,* and *One114* (Olsen et al. 2000), *Ssa419* (Cairney et al. 2000), and *OtsG68* (Williamson et al. 2002). Microsatellites were size fractionated in an Applied Biosystems (ABI) 3730 capillary DNA sequencer, and genotypes were scored by GeneMapper software 3.0 (Applied Biosystems, Foster City, CA) using an internal lane sizing standard.

In general, polymerase chain (PCR) reactions were conducted in 10 µl volumes consisting of 0.06 units of Taq polymerase, 1µl of 30ng DNA, 1.5-2.5mM $MgCl_2$, 1mM 10x buffer, 0.8mM dNTP's, 0.006-0.065µM of labeled forward primer (depending on the locus), 0.4µM unlabeled forward primer, 0.4µM unlabeled reverse primer, and deionized H_2O. PCR was completed on an MJResearch™ DNA Engine™ PCT-200 or a DNA Engine Tetrad™ PCT-225. The amplification profile involved one cycle of 2 min @ 92°C, 30 cycles of 15 sec @ 92°C, 15 sec @ 52-60°C (depending on the locus) and 30 sec @ 72°C, and a final extension for 10 min @ 72°C. Specific PCR conditions for a particular locus could vary from this general outline. Further information on laboratory equipment and techniques is available at the Molecular Genetics

Laboratory website at http://www.pac.dfo-mpo.gc.ca/science/facilities-installations/pbs-sbp/mgl-lgm.

Baseline Populations

The baseline survey consisted of microsatellite analysis of chum salmon from 130 locations within Canada and the southern US (Table 2). Thirteen regional groupings of populations were identified based on genetic stock structure and the ability to accurately estimate known mixtures on of these groupings (DFO unpublished data). All annual baseline samples available for a specific sample location were combined to estimate population allele frequencies, as was recommended by Waples (1990).

Estimation of Stock Composition

Analysis of fishery samples was conducted with a Bayesian procedure (BAYES) as outlined by Pella and Masuda (2001). Each locus was assumed to be in Hardy-Weinberg equilibrium, and expected genotypic frequencies were determined from the observed allele frequencies and used as model inputs. For BAYES, the initial FORTRAN-based computer program as outlined by Pella and Masuda (2001) required large amounts of computer analytical time when applied to stock identification problems with a baseline as comprehensive as employed in the current study. Given this limitation, a new version of the program was developed by our laboratory as a C-based program which is available from the Molecular Genetics Laboratory website (Neaves et al. 2005). In the analysis, ten 20,000-iteration Monte Carlo Markov chains of estimated stock compositions were produced, with initial starting values for each chain set at 0.90 for a particular population which was different for each chain. Estimated stock compositions were estimated when all Monte Carlo Markov chains had converged producing a Gelman-Rubin coefficient < 1.2 (Pella and Masuda 2001). The last 1,000 iterations from each of the 10 chains were combined, and for each fish the probability of

originating from each population in the baseline was determined. These individual probabilities were summed over all fish in the sample, and divided by the number of fish sampled to provide the point estimate of stock composition. Standard deviations of estimated stock compositions were also determined from the last 1,000 iterations from each of the 10 Monte Carlo Markov chains incorporated in the analysis.

Results and Discussion

The southern British Columbia/Washington Chum salmon baseline consisting of fourteen microsatellite markers, a subset of the Pacific Rim baseline for Chum salmon ranging from Japan, across the North Pacific (including the Yukon River) to the southern range limit of Chum salmon in the Columbia River (Beacham et al. 2008; Beacham et al. 2008b) was used to determine the compositions of the fishery samples taken in 2017 (Table 2).

Samples collected in the summer and fall from the Canadian Area 12 test fishery consisted of Canadian origin fish (89.0% to 99.8%; Table 3) predominantly from the river systems in the area; as the weeks progressed catches switched from Johnstone Strait to the Strait of Georgia (east and west sides) and the Fraser River. Chum by-caught in the July-August in Johnstone Strait are summer-run Canadian populations returning to the southern mainland inlets. Early samples were hampered by small sample sizes. In August, sample size improved with compositions being dominated by SOG East populations (86.9% to 82.9%). Fall samples from Johnstone Strait (Table 3) tended to see a buildup of Fraser stocks until week 40 then a steady decline through the end of October samples. Stocks from SOG West increased in composition through the fall time and generally SOG east declined in composition through October. The Fall SOG terminal chum fishery catches were dominated by East Vancouver Island stocks (66% to 80.4%; Table 4).

Samples collected from commercial fisheries in U.S. Area 7 also were both Canadian and U.S. origin stocks with a larger contribution of Canadian origin stocks: 72.5% to 99.5%, except in early November when the U.S. contribution reached 73.7% from North Puget Sound. The regions that dominated the assignments on Area 7 and 7A were Fraser River and Strait of Georgia stocks and Puget Sound.

Sample failure due to tissue quality (e.g. degradation, contamination) will result in absent or poor DNA amplification. Overall the failure to amplify rate was low 0.5% but significantly higher than last year (0.18%). In addition, 3.04% of these samples were excluded from the analysis because the number of loci amplified was below threshold (<9 from 14 loci), also higher than the previous year (1.3%). The Fishery with larger number of failed samples was the Area17 gillnet– with 10%. The Fishery with more samples excluded from the analyses was the Area 7 (Seine/Gillnet) with 53.9% of the samples that failed to provide sufficient information for genetic stock identification.

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Tables

Table 1. Sample size of tissue collections for DNA analysis for Chum salmon directed fisheries in 2017. Samples analyzed are the number that was effectively analyzed by the GSI program. Samples excluded are those that were included in the analyses but did not provide sufficient information for genetic stock identification. Samples that failed are those that did not amplify due to poor quality and therefore did not make it to the analyses.

Canadian Waters								
Region	**Fishery**	**Gear**	**Dates**		**Analyse**	**Exclude**	**Failed**	**Total**
Johnston Strait	Area 12 Test	Seine	Sep-11	Oct-25	1380	2	3	1385
	Area 12/13 Comm	Seine	Oct-02	Oct-02	492	7	1	327
	Area 12/13 Comm	Seine	Oct-16	Oct-16	496	4	0	673
	Area 12 bycatch	by-catch	Jul-11	Aug-13	211	1	1	213
Central Strait of Georgia	Area D(Area 14)	Gillnet	Oct-14	Oct-27	566	40	3	609
	Area E(Area 17)	Gillnet	Oct-27	Oct-27	8	19	3	30
				Subtotal:	**3153**	**73**	**11**	**3237**

U.S. Waters								
Region	**Fishery**	**Gear**	**Dates**		**Analyse**	**Exclude**	**Failed**	**Total**
Area 7 - U.S.	Area 7 (Non-Treaty)	Gillnet	Oct-30	Oct-30	54	1	1	56
	Area 7 (Non-Treaty)	Seine	Oct-23	Oct-23	111	1	3	115
	Area 7 (Treaty)	Seine	Oct-24	Oct-24	98	4	2	104
	Area 7	Gillnet	Oct-15	Nov-09	72	0	0	72
	Area 7	Seine	Oct-10	Oct-17	557	1	5	563
	Area 7	Seine/Gi	Nov-07	Nov-07	29	34	0	63
Area 7A - U.S.	Area 7A	Seine	Oct-10	Oct-15	415	29	2	446
				Subtotal:	**1336**	**70**	**13**	**1419**

Total Samples Run	**Analyse**	**Exclude**	**Failed**	**Total**
	4489	143	24	4656

Table 2. Baseline of 130 sample sites/populations by regional genetic groups used to estimate stock composition of Chum salmon from southern British Columbia and Washington State in 2017 fisheries.

Region	Populations
Johnstone Strait	Heydon Cr, Klinaklini R, Ahta R, Viner Sound, Waump Cr, Nimpkish R, Kakweiken R, Glendale Cr, Ahnuhati Cr, Mackenzie Sound, Phillips R, Viner/Scott Cove
Strait of Georgia East	Tzoonie Cr, Cheakamus R, Sliammon R, Mamquam R, Wortley Cr, Squamish R, Indian R, Theodosia R, Southgate R, Algard Cr, Orford R, Shovelnose R, Mashiter Cr, Stawamus R, Homathko R, Kwalate Cr, Lang Cr, Deserted Cr, Myrtle Cr, Snake Cr, Anderson Cr
Strait of Georgia West	Goldstream R, Cowichan R, Nanaimo R, Chemainus R, Puntledge R, Qualicum R, Little Qualicum R, Campbell R, Cold Cr, Englishman R
West Coast Vancouver Island	Smith Cr, Kirby Cr, Demaniel R, Nitinat R, Hathaway Cr, Petattum Cr, Goodspeed, R, Cayeghle Cr, Colonial R, Sugsaw, Cr, Nahmint R, Hoiss Cr, Black Cr, Parks R, Tsowwin_R, Kaouk R, Sucwoa R, Canton R, Little Toquart R, Tranquil Cr, Salmon Cr, Bedwell R, Warner Bay, Burman Cr, Sooke R
Fraser River	Silverdale Cr, Squawkum Cr, Wahleach Cr, Chilliwack R, Chehalis R, Stave R, Alouette R, Vedder R, Harrison R, Inch Cr, Lower Lillooet R, Norrish-Worth Cr, North Alouette R, Widgeon Slough, Kawkawa Cr, Blaney Cr, Chilqua Cr, Serpentine R, Kanaka Cr, Worth Cr, Hopedale Cr, Hicks Cr, Harrison Lake, Peach Cr, Sweltzer Cr, Nathan Cr, McIntyre Cr, Street Cr, Railroad, Cr, Silverhope Cr
North Puget Sound	Skagit R, County Line Cr, Grant Cr, Siberia Cr, Skykomish R, Snohomish R, Stilllaguamish R, Sauk R
South Puget Sound	Kennedy Cr, Minter Cr, Nisqually R, Mill Cr, Skookum Cr, Puyallup R, South Prairie Cr
Juan de Fuca/ Hood Canal Summer	Salmon R, Big Quilcene R
Coastal Washington	Ellsworth Cr, Bitter Cr, Quinault R, Satsop R
Nooksack	Nooksack R
Tulalip	Tulalip R
Central Puget Sound	Green R, Grovers Cr
Juan de Fuca/ Hood Canal Fall	Elwha R, Hoodsport, Spencer Cr, Big Mission Cr, Dewatto R, Hamma Hamma R, Big Beef Cr

Table 3. Estimated percentage stock composition of Chum salmon caught in Area 12 and 13 Test and Commercial and by-catch Fisheries in 2017. Stock compositions were estimated using 14 microsatellite loci and the baseline outlined in Table 2. Number of fish excluded because of their inability to provide sufficient information for genetic stock identification in parentheses. Samples that failed due to lack of amplification are not included in these analyses (see Table 1 for more details). Standard error of the estimated stock composition is in parentheses.

Year	2017		2017		2017		2017		2017		2017		2017		2017		2017		2017		2017		2017		2017		2017	
Julian date	192-197		200-204		205-210		214-217		219-225		254-260		261-265		268-271		275-280		275		282-286		289-295		289		296-298	
Gear	seine		seine		seine		seine		seine		seine		seine		seine		seine		seine		seine		seine		seine		seine	
Stat Area	Area12bycatch		Area12bycatch		Area12bycatch		Area12bycatch		Area12bycatch		Area12TF		Area12TF		Area12TF		Area12TF		Area12Comm-Area13Comm		Area12TF		Area12TF		Area12Comm-Area13Comm		Area12TF	
Fishery Type	Week28		Week29		Week30		Week31		Week32		Week37		Week38		Week39		Week40		Week40		Week41		Week42		Week42		Week43	
Dates	Jul11-Jul16		Jul19-Jul23		Jul24-Jul29		Aug02-Aug05		Aug07-Aug13		Sep11-Sep17		Sep18-Sep22		Sep25-Sep28		Oct02-Oct07		Oct02		Oct09-Oct13		Oct16-Oct22		Oct16		Oct23-Oct25	
sample Size	10(0)		12(0)		6(0)		103(0)		80(1)		232(0)		167(0)		199(0)		199(1)		492(7)		200(0)		240(0)		496(4)		144(0)	
Region	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
Johnstone Strait	31.4	(16.4)	29.5	(20.4)	87.5	(21.5)	6.4	(6.2)	13.3	(10.4)	10.6	(7.1)	3.5	(5.3)	9.7	(4.0)	0.4	(1.5)	7.7	(2.5)	0.9	(2.1)	0.1	(0.4)	0.2	(0.7)	8.8	(5.9)
Strait of Georgia East (F)	0.4	(4.0)	39.0	(22.6)	5.0	(12.4)	86.9	(6.7)	82.9	(9.5)	30.3	(8.1)	26.7	(7.2)	15.4	(5.4)	17.2	(5.9)	24.9	(4.0)	19.8	(6.0)	17.4	(5.1)	21.2	(3.9)	4.7	(4.3)
Strait of Georgia West (F)	0.2	(3.0)	12.5	(18.7)	0.8	(6.3)	0.4	(1.5)	1.9	(3.8)	15.5	(7.1)	21.4	(7.4)	23.3	(5.6)	32.6	(6.4)	17.9	(3.9)	37.1	(6.1)	52.3	(5.6)	48.4	(4.4)	51.3	(8.0)
Fraser River (F)	8.0	(10.6)	2.2	(7.3)	2.0	(9.7)	1.1	(1.9)	0.4	(1.3)	39.7	(4.6)	47.0	(5.6)	51.2	(4.8)	48.9	(4.8)	49.3	(2.9)	37.0	(4.6)	27.7	(3.9)	27.8	(2.8)	23.5	(4.9)
West Coast Vancouver I(F)	56.2	(17.4)	14.7	(17.0)	0.8	(8.1)	0.2	(0.7)	0.6	(1.6)	1.3	(1.5)	0.8	(1.4)	0.2	(0.6)	0.4	(0.9)	0.1	(0.3)	0.5	(1.0)	0.3	(0.7)	0.2	(0.5)	0.6	(1.3)
North Puget Sound (F)	1.8	(7.0)	1.1	(4.6)	4.0	(10.5)	0.4	(1.2)	1.0	(2.3)	0.4	(1.1)	0.4	(1.2)	0.1	(0.6)	0.1	(0.5)	0.1	(0.3)	0.2	(0.8)	0.1	(0.6)	0.0	(0.2)	5.3	(2.9)
Central Puget Central (F)	0.2	(1.9)	0.1	(1.8)	0.0	(2.3)	0.5	(1.4)	0.0	(0.2)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.2)	0.0	(0.1)	0.1	(0.4)	0.1	(0.3)	0.0	(0.1)	0.7	(0.9)
South Puget Sound (F-W)	1.1	(4.8)	0.3	(2.7)	0.0	(2.8)	2.0	(1.8)	0.0	(0.4)	1.2	(1.1)	0.0	(0.2)	0.0	(0.1)	0.0	(0.2)	0.0	(0.1)	0.0	(0.2)	0.0	(0.3)	0.2	(0.5)	0.2	(0.6)
Hood Canal (S)	0.0	(1.3)	0.0	(0.9)	0.0	(1.4)	2.0	(1.4)	0.0	(0.1)	0.1	(0.3)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.0)	0.0	(0.1)	0.0	(0.1)	0.0	(0.0)	0.0	(0.1)
Hood Canal (F)	0.5	(3.1)	0.5	(3.3)	0.0	(3.2)	0.1	(0.6)	0.0	(0.4)	0.8	(0.8)	0.2	(0.6)	0.0	(0.2)	0.4	(1.0)	0.1	(0.3)	4.4	(2.1)	2.0	(1.4)	2.0	(0.9)	4.7	(2.5)
Juan de Fuca (F)	0.0	(0.9)	0.1	(1.1)	0.0	(1.3)	0.0	(0.1)	0.0	(0.2)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.1	(0.4)
Coastal Washington (F)	0.2	(2.4)	0.0	(1.2)	0.0	(2.4)	0.0	(0.3)	0.0	(0.2)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.2)
Country																												
Canada	96.2	(9.2)	97.9	(6.8)	95.9	(11.8)	95.0	(2.6)	99.0	(2.4)	97.4	(1.7)	99.4	(1.3)	99.8	(0.7)	99.5	(1.1)	99.8	(0.4)	95.3	(2.3)	97.7	(1.5)	97.7	(0.9)	89.0	(3.9)
US	3.8	(9.2)	2.1	(6.8)	4.1	(11.8)	5.0	(2.6)	1.0	(2.4)	2.6	(1.7)	0.6	(1.3)	0.2	(0.7)	0.5	(1.1)	0.2	(0.4)	4.7	(2.3)	2.3	(1.5)	2.3	(0.9)	11.0	(3.9)

Table 4. Estimated percentage stock composition of Chum salmon caught in the Strait of Georgia (Areas 14 and 17) Fall Chum Fisheries in 2017. Stock compositions were estimated using 14 microsatellite loci and the baseline outlined in Table 2. Number of fish excluded because of their inability to provide sufficient information for genetic stock identification in parentheses. Samples that failed due to lack of amplification are not included in these analyses (see Table 1 for more details). Standard error of the estimated stock composition is in parentheses.

Year	2017		2017		2017	
Julian date	287-288		289-295		300	
Gear	gill		gill		gill	
Stat Area	AreaD_A14		AreaD_A14		AreaD_A14-AreaE_A17	
Fishery Type	Week41		Week42		Week43	
Dates	Oct14-Oct15		Oct16-Oct22		Oct27	
sample Size	62(5)		365(26)		147(28)	
Region	Estimate	SD	Estimate	SD	Estimate	SD
Johnstone Strait	1.5	(3.9)	9.1	(3.1)	1.3	(2.6)
Strait of Georgia East (F)	19.0	(11.9)	3.7	(3.7)	10.3	(7.6)
Strait of Georgia West (F)	66.0	(10.6)	74.3	(4.4)	80.4	(8.6)
Fraser River (F)	8.1	(5.9)	9.9	(2.6)	0.3	(1.0)
West Coast Vancouver I(F)	0.4	(1.4)	0.7	(0.9)	1.0	(1.8)
North Puget Sound (F)	4.7	(7.5)	0.2	(0.6)	3.5	(4.4)
Central Puget Central (F)	0.0	(0.5)	0.0	(0.1)	0.0	(0.2)
South Puget Sound (F-W)	0.2	(0.8)	0.0	(0.1)	0.2	(0.6)
Hood Canal (S)	0.0	(0.3)	0.0	(0.1)	0.0	(0.1)
Hood Canal (F)	0.1	(0.7)	1.3	(1.1)	2.2	(2.0)
Juan de Fuca (F)	0.0	(0.1)	0.7	(1.0)	0.7	(1.6)
Coastal Washington (F)	0.0	(0.4)	0.0	(0.1)	0.0	(0.1)
Country						
Canada	95.0	(7.5)	97.8	(1.5)	93.3	(4.0)
US	5.0	(7.5)	2.2	(1.5)	6.7	(4.0)

Table 5. Estimated percentage stock composition of Chum salmon caught in Area 7 and 7A (Treaty, Non-treaty, and Test Fisheries) in 2017. Stock compositions were estimated using 14 microsatellite loci and the baseline outlined in Table 1. Number of fish excluded because of their inability to provide sufficient information for genetic stock identification in parentheses. Samples that failed due to lack of amplification are not included in these analyses (see Table 1 for more details). Standard error of the estimated stock composition is in parentheses.

Year	2017		2017		2017		2017		2017		2017		3917		3917	
Julian date	283-288		289-290		297		296		303		311-313		283-285		288	
Gear	gill-seine		gill-seine		seine		seine		gill		gill-PS_GN		seine		seine	
Stat Area	Area7		Area7		A7_Treaty		A7_Non-Treaty		A7_Non-Treaty		Area7		Area7A		Area7A	
Fishery Type	Week41		Week42		Week43		Week43		Week44		Week45		Week41		Week42	
Dates	Oct10-Oct15		Oct16-Oct17		Oct24		Oct23		Oct30		Nov07-Nov09		Oct10-Oct12		Oct15	
sample Size	332(30)		249(4)		99(4)		111(1)		54(1)		76(1)		264(11)		151(18)	
Region	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Johnstone Strait	1.7	(1.9)	0.2	(0.8)	0.3	(1.5)	28.1	(7.4)	18.8	(9.7)	0.1	(0.7)	7.8	(5.0)	0.3	(1.2)
Strait of Georgia East (F)	25.5	(6.7)	11.8	(6.2)	23.4	(10.5)	1.7	(3.1)	17.4	(15.8)	11.7	(6.6)	3.9	(4.2)	7.9	(5.3)
Strait of Georgia West (F)	22.9	(6.9)	30.1	(6.1)	25.2	(11.3)	39.1	(7.9)	27.4	(20.5)	13.5	(7.0)	8.6	(4.4)	18.4	(6.8)
Fraser River (F)	47.1	(3.9)	53.1	(4.8)	23.0	(6.6)	21.7	(5.4)	9.9	(5.5)	0.8	(2.1)	78.4	(4.4)	70.0	(5.5)
West Coast Vancouver I(F)	1.2	(1.3)	2.1	(1.9)	0.5	(1.6)	0.5	(1.3)	0.2	(1.3)	0.2	(1.1)	0.8	(1.4)	0.4	(1.0)
North Puget Sound (F)	1.1	(1.8)	0.9	(2.2)	20.7	(7.8)	5.2	(4.9)	24.3	(8.9)	73.3	(6.4)	0.4	(1.1)	2.7	(3.7)
Central Puget Central (F)	0.0	(0.1)	0.0	(0.1)	0.1	(0.6)	0.2	(0.8)	0.2	(0.8)	0.0	(0.2)	0.0	(0.1)	0.0	(0.1)
South Puget Sound (F-W)	0.3	(0.7)	1.1	(1.3)	0.4	(1.5)	0.1	(0.6)	1.0	(1.8)	0.0	(0.4)	0.1	(0.3)	0.1	(0.4)
Hood Canal (S)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.3)	0.0	(0.3)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)
Hood Canal (F)	0.2	(0.7)	0.7	(1.0)	6.3	(3.7)	3.4	(2.6)	0.7	(1.8)	0.3	(1.2)	0.0	(0.2)	0.0	(0.3)
Juan de Fuca (F)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)	0.0	(0.3)	0.0	(0.2)	0.0	(0.4)	0.0	(0.1)	0.0	(0.1)
Coastal Washington (F)	0.0	(0.1)	0.0	(0.2)	0.0	(0.2)	0.0	(0.2)	0.1	(0.6)	0.0	(0.3)	0.0	(0.1)	0.1	(0.4)
Country																
Canada	98.4	(2.0)	97.3	(2.6)	72.5	(8.6)	91.0	(5.5)	73.7	(9.1)	26.3	(6.4)	99.5	(1.2)	97.1	(3.8)
US	1.6	(2.0)	2.7	(2.6)	27.5	(8.6)	9.0	(5.5)	26.3	(9.1)	73.7	(6.4)	0.5	(1.2)	2.9	(3.8)

Figures

Figure 1. Map of Statistical Areas outlining Chum salmon fishing locations in southern British Columbia 2013-2017

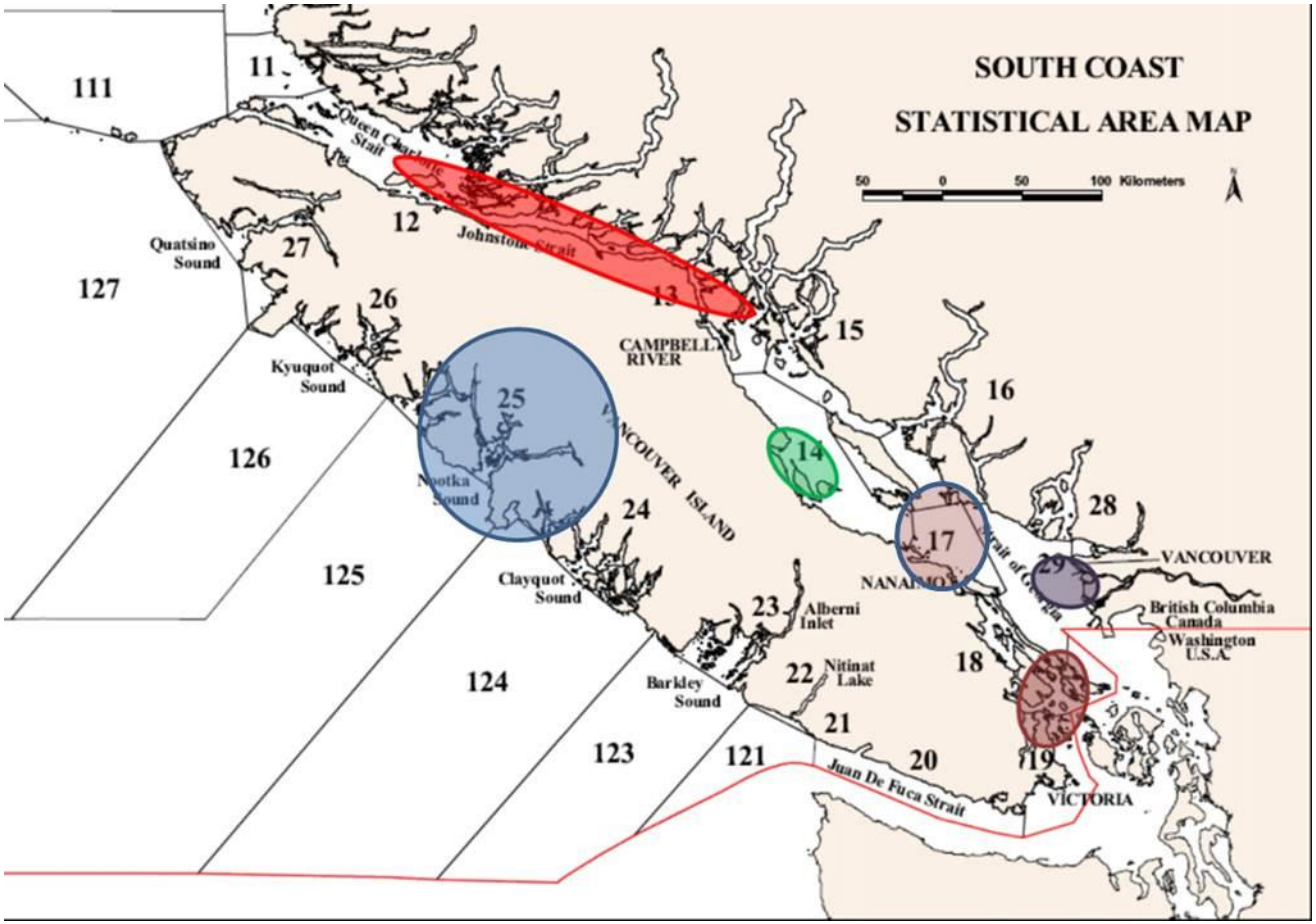

Figure 2. Map of Statistical Areas outlining Chum salmon fishing locations in Puget Sound 2013-2017.