Joint US and CA Juan de Fuca Chum Sampling Program 2019

Progress Report to Southern Endowment Fund: Project SF-2019-I-38A

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Abstract

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

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

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

The program began as planned on October 1st and ran until November 8th. A total of 139 sets were completed (72 in Canadian waters and 67 in US waters). A total of 762 Chum were encountered and 640 were sampled for stock id and other biologicals. There was a moderately higher average Catch per Unit Effort (CPUE) in the US side of the Strait compared to what was encountered in Canadian waters. This was the complete opposite to the significantly higher CPUE seen in Canadian waters in 2017 and 2018, but very similar to what was observed in 2016. The catch information demonstrated a slightly later timing on the

Canadian side of the Strait with a peak CPUE during week 43 and an earlier peak CPUE in the US waters during week 42. Over the period of the program, Chum CPUE alternated being higher in Canadian waters than in US waters.

Stock composition information demonstrated that Canadian Chum stocks dominated the samples throughout the Canadian waters similar to previous years. US Chum stocks in Canadian waters varied in composition but increased later in the program. In US waters, US Chum stocks dominated the mixtures throughout the program. Stock timing and distribution differences were observed and this new information has improved our understanding of Chum stock composition and timing through the migratory pathways of Juan de Fuca Strait.

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

Acknowledgments

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We would like to thank Skipper Brian Vogrig and the crew of the FV Nita Maria for helping make this program a success.

Without the support of staff from the Molecular Genetics Laboratory of the Pacific Biological Station in Nanaimo and the Sclerochronology Laboratories of the Pacific Biological Station in Nanaimo and the A-Tlegay Fisheries Society in Campbell River many of the samples would not have been analyzed.

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Introduction

The Chum Technical Committee (TCChum), in consideration of the requirements of the latest version of Annex IV, Chapter 6 (Chum Annex) of the Pacific Salmon Treaty, has determined that a significant amount of stock assessment work should be undertaken by the parties, in order to provide the level of information necessary for the successful implementation of the Annex. Annex IV of the Pacific Salmon Treaty states that both parties will submit annual reports on fishing practices from the year previous. As well as a plan for the coming year, this would include run size, total allowable catch, fishery plans for management of the stock for the respective party and estimates of how many fish will be migrating in international waters.

Part of implementing the strategic plan, the TCChum submitted various proposals over the last few years to target key components of the plan. In 2014 the first phase of the Chum Genetic and Environmental Management model (ChumGEM) was initiated to develop a run reconstruction model for Southern BC and Washington Chum salmon.

Through the initial work on ChumGEM, 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 required investigation and validation. The purpose of this project was to continue working 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.

Study Area

Juan de Fuca Strait is a partially mixed tidal channel connecting the freshwater catchment basins of the Strait of Georgia and Puget Sound to the continental margins of British Columbia and Washington State (Figure 1). The strait has a maximum depth of 200 m, a width of 25–40 km, a length of 160 km, a surface area of 4068 km^2, and a volume of 417 km^3 (Thomson, Mihály and Kulikov 2007). In order to evaluate the migration of Chum moving through this Southern Diversion pathway, the area was broken into 4 quadrants (**Error! Reference source not found.**) to sample over the duration of the program. Juan de Fuca Strait has a shared border off the coast of the United States and Canada. To simplify set locations, the area to be fished was split into four quadrants (A, B, C and D). The set location was recorded on the set log which started with the quadrant, followed by the GPS coordinates, taken when the net commenced going out.

Materials and Methods

This program entailed 3 components: Vessel operation, catch sampling including locations and sample processing.

Charter Vessel Operations and Fish Capture:

In order to reduce catch selectivity, a Purse Seine vessel was chartered to conduct the sampling to cover the main fall Chum migration time period (typically September through November). Based on the initial recommendation from 2016, the seine net was modified in depth from 675 meshes deep to 475 to allow better access to shallower locations primarily on the Canadian side of the Strait. The dimensions of the seine net used were 225 fathom (1,350 feet; 411m) long and 21 fathoms (475 meshes) deep. The vessel was monitored with a satellite Vessel Monitoring System (VMS) for real time monitoring of vessel positioning every 15 minutes. That data is available but not included in this report due to the size of the file. Individual set locations (latitude and longitude) can be found in the Appendix C: Set coordinates and time

Study Design

To understand chum salmon migration patterns and abundance, the test fishery was designed to provide equal coverage in U.S. and Canadian territorial waters. The vessel fished a total of 16 days between October 1st, and November 8th 2019, targeting the peak migration periods. Trips were typically two days of fishing in October and four days of fishing in November, with up to five days between trips. We targeted a sample rate of 100 Chum per day, to a maximum of 400 over the course of a trip. The seine vessel, was to perform a minimum of 6 sets a day, with each set requiring approximately 1-1.5 hours from commencement to completion.

The Juan de Fuca Straits can be quite rough with winds coming off the Pacific Ocean, creating large swell. The skipper and crew did their best to follow the schedule although they took advantage of favorable weather conditions.

Vessel Operation

For the Juan de Fuca test fishery, a drum seiner was used, and each seine was conducted as follows. The set commenced when a power skiff pulled the running line, causing the net to unwind from the drum. The power skiff towed the running line into the current creating a taut line and net in a crescent shape, the line is towed between 20-40 minutes, after which the power skiff circles back to the seiner and starts closing the net. As the net is in a circular shape off the port or starboard side, the purse line is pulled up with the rings sealing the bottom of the net, once the rings are on deck they are threaded with a hairpin to hold them together. At the same time, the drum is bringing in the excess net, the rings are pulled off the hair pin tightening up the net, the net is tied off and lifted with the boom until the net creates a bunt gathering all the fish together, the crew would roll and pull the net over the side and into the vessel bringing the fish closer to the surface. The fish would be dip netted to bring them on board as random samples and all other fish released. To release the fish the cork line was dropped and the purse line loosened, the fish were counted as they swam out over the purse line. The boom was brought back down to loosen the rope allowing the net to fall free and be pulled in by the drum, the purse line and skiff were brought to the stern of the boat, tied up, to be ready for the next set.

Fish Capture

A total of 100 random samples were targeted daily. Every attempt was made to sample the catch across sets proportionate to the CPUE, that is to say, we attempted to collect samples proportional to the number of fish captured in each set. Fish to be sampled were removed from the seine using a dip net and processed as soon as possible. When the sample fish were onboard for a given set, the crew would release the cork line, drop the purse line slightly and allow the remaining fish to swim out. Lowering and raising the purse line controlled the speed at which the fish swam out. It was the observer's responsibility to communicate if the fish were swimming too quickly/slowly. A tally counter was held in hand, for every 10 fish that swam out, it would be pressed once. All species of fish swimming out of the net were identified and counted to make sure all catch were being recorded properly. The skipper and his crew ensured the observer knew all the fish they had found caught in the net and released if the observer was not able to be present on the back deck for safety reasons.

Observer Roles

Prior to setting the net, the observer would be in the wheel house communicating with the skipper about when and where was best to set. It was the observer's responsibility to fill out the set log. The set log included which quadrant the set was being performed, GPS coordinates when the net started, time the net started going out and when the rings were up. Weather and the tide were also recorded; documenting percentage of cloud coverage and fog, amount of rain, wind direction and speed, water temperature and the sea surface condition. All species of all fish caught and released were documented and how successful the assessment set was (examples in Appendix A: Set log example and Appendix B: Biosample form example). After the set log was completed the information was entered into an electronic logbook program on the DFO computer, this allowed for real-time data transmission using a satellite system. All data collected from the program is available on the DFO website.

Other responsibilities included:

- Looking for signs of fish, taking note and documenting any other wildlife in the area was another key activity of the observer.

- Watching the entirety of the set, if something happened making sure it was documented.
- When the fish were being brought in it was the observer's duty to tell the crew how many fish were required for sampling, counting how many were on board, and accurately counting the fish as them swam out of the net. +
- Once the fish were on board it was then time to perform all sampling tasks required.

Catch Sampling:

An onboard observer trained by DFO was responsible for collecting all biological data and samples. The following samples were collected from each fish:

- Length: measured using a hypural stick, the post orbital fork length
- Scale Sample: two scale samples were taken from the left side of the fish drawing a diagonal line from the dorsal fin to the anal fin, approximately 3 scales above or below the lateral line. It was focused on to only take scale samples that were taken from flesh that had not been healed over and in a cycloid shape. Scale samples were used to determine age based on protocols laid out in (MacLellan et al. 2004).
- DNA: a sample from the adipose fin is taken with a hole punch (if damaged the sample was taken from the caudal fin), having a thin tissue sample is beneficial, allowing it to dry quickly on the Whatman sheet reducing the chance of it falling off and being lost http://www.pac.dfo-mpo.gc.ca/science/facilities-installations/pbs-sbp/mgl-lgm/samp-echant/index-eng.html.
- Sex: the chum salmon were cut just passed their pectoral fin on its belly, 1-2 inches in length, one finger was inserted to feel either a smooth sperm sack or eggs

Sample processing:

Scale samples:

Scale samples were sent to the Sclerochronology Laboratory of the A-Tlegay Fisheries Society in Campbell River for age analysis. Sample preparation and scale age evaluation were completed following methods described in (MacLellan et al. 2015) and (Hudson et al. 2010). Results by fish were provided back and compiled within the database for this program.

Tissue samples for DNA:

Sample preparation

All tissue samples were sent to the Molecular Genetic Laboratory of the Pacific Biological Station for DNA extraction and analysis. The sample size (200/strata) was derived from past genetic studies. Simulations from previous Puget Sound Chum genetic stock studies in the 1980s and 1990s using less accurate electrophoresis genetic analyses methods demonstrated large increases in precision when sample size increased from 100 to 200 and a small increase in precision for sample size above 200.

Once Chum salmon genomic DNA was available, surveys of variation at the following 14 microsatellite loci were conducted: Ots3 (Banks 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 1). 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 program initiated as planned on October 1st and ran until November 8th. Data has been stratified over each week and by fishing area (see Table 2 for the week assignments). A total of 139 sets were completed (72 in Canadian fishing areas and 67 in US fishing areas). A total of 762 (compared to 1,471 in 2016,9,577 in 2017 and 8,688 in 2018) Chum were encountered and 640 were sampled for stock id and other biologicals. The majority of fish in 2019 were caught in quadrants A on the Canadian side and D on the United Sates side. Over the last four years, setting locations has been refined to areas mainly within those 2 quadrants.

Set distribution

Sets were conducted throughout the study area during the duration of the program. As this was the fourth year of this type of survey in this location, flexibility on set location was provided within a defined area to determine fish utilization and behavior (**Error! Reference source not found.**). Set locations were collected on the data sheets as well as through VMS. The GPS coordinates of each of these set locations (Appendix C: Set coordinates and time) were then incorporated into Google Earth and provided in Figure 3, Figure 4, Figure 5,Figure 6,Figure 7,and Figure 8.

All 139 sets conducted in 2019 we deemed good sets and were included in the analysis. For the 139 assessment sets 52% were within the Canadian fishing areas and 48% were conducted in US waters over the duration of the program. The original plan was to set weekly in both Canadian and US fishing areas, but due to the participation of the sampling platform in commercial fisheries, some weekly coverage in both fishing areas was not achieved.

Catch and Effort information

Catch and effort data is provided in Table 3 for the program. A total of 830 Chum, 156 adult Coho were encountered during the program. Of the catch only 762 Chum were retained for sampling and all the other Chum and Coho were released. Chum CPUE peaked during week 42 in the US and during week 43 in Canadian waters. In contrast to 2017 and 2018, where Chum CPUE tended to be higher in Canadian waters over the duration of the program (Figure 9), in 2019 the CPUE varied weekly as to whether it was higher in Canadian or US waters. As this was the fourth year of this type of sampling it is difficult to draw any conclusions as to what the CPUE encountered reflects on abundance of Chum salmon moving through this area over the time of the program.

Biological Information

All Chum retained during the project were sampled for a variety of biologicals and 640 Chum were sampled over the duration of the project.

Sex composition

The sex composition varied across weeks (Table 4). Male Chum dominated in the first weeks with female Chum composition increasing through the weeks and then dominating in week 43 (Figure 10). This pattern is indicative of chum migration seen in other areas such as the Johnstone Strait Test fishery.

Age composition

Age composition was dominated by 4_1 Chum during the first 3 weeks of the program (Table 5) but unlike 2 previous year the 3_1 age class increased in the 4^{th} week and dominated by the last 2 weeks of the survey. Compared to the other years, the age 5_1 fish made up a very small component of the run encountered during the period of sampling. The contribution of Age 3_1 fish was lower with both sexes than was observed in 2018, and similar to 2016 and 2017 (Figure 11). This result is similar to what was encountered in the 2019 Johnstone Strait test fishery samples for chum moving through the northern approach.

Length data

Fish size range from 504mm to 754mm with the average Male Chum = 626mm and females = 616mm (Table 6). The size distribution overlapped for both sexes with male Chum tending to be skewed a bit more to larger fish (Figure 12). Fish size tended to decline over time for both sexes which coincides with a strong Age 3 female composition during much of the season (Figure 13).

Stock Composition

Stock composition of the Chum catch by week and fishing area is provided in Table 7 and Table 8 to the regional and country of origin level. Keep in mind when evaluating the assignment of stock to the samples that sample size targets were not achieved in all weeks and fishing areas.

The samples collected in the Canadian fishing areas tended to be dominated by Canadian stocks with an increase in prevalence of US stocks into the later weeks (Table 7). In US waters, the US stocks dominated all samples for the entire duration of the program with higher Canadian compositions in the earlier weeks (Table 8). Based on this information it appeared that spatially, US stocks tended to favor the “US waters” or the Southern portion of the Study Area similar to what was observed in the previous 3 years, the exception being Fraser River and West Coast Vancouver Island Chum   Temporally, US stocks increased their prevalence throughout October and into November in US fishing areas (Figure 14) but unlike 2019 the US composition in US water dominated in the 2nd week and continued through the rest of the program.

In regards to Canadian composition, Southern BC populations tended to dominate spatially in Canadian waters over the duration of the program. Fraser populations only made up a small portion of the composition in both CDN and US waters over the entire season (Figure 14), although the portion was greater than was seen in 2018 The Southern BC populations were made up primarily of Strait of Georgia West and some West Coast Vancouver Island stock early in the season which then transitioned to a Strait of Georgia West and East stock composition (Figure 15). In 2016-2018, West Coast Vancouver Island stocks (mainly Sooke River stock) made up a fairly large proportion of the Chum Catch in Canadian waters. Modifications to the fishery to target more on migrating stocks have reduced the contribution of WCVI stock to the catch. Unlike the previous years, WCVI stock was encountered in the US fishing area but this assignment is problematic due to the small sample sized encountered in 2019.

The composition of US stocks saw Hood Canal Fall Chum typically dominating in many weeks in both Canadian and US waters (Figure 16). Puget Sound North stock appeared to migrate spatially more in Canadian waters over the entire time period sampled similar to 2017 and 2018. South Sound Chum typically alternated weekly in proportion throughout the season in both Canadian and US waters. Central Puget Sound stocks tended to favour the US portions of the sampling area.

Conclusion

The program in 2019 continued to be an effective platform to sample Chum migration moving through the Strait of Juan de Fuca similar to the previous 3 years (Van Will et al., 2017; Smith-Belliveau et al, 2018). The program collected valuable stock specific information on spatial distribution and migration timing. The CPUE in 2019 tended to be lower than 2017 and 2018 and similar to 2016 (Figure 17) with a slightly earlier peak than 2018. Strong differences were observed in the stock composition over weeks and between US and CDN waters. Canadian populations dominated samples on the Canadian side of the Strait and US populations dominated in US waters. In all four years, US stocks increased in prevalence later in the season.

Recommendations

In planning for subsequent years, it is important that sample sizes by strata (week and fishing area) be achieved in order to draw appropriate conclusions regarding temporal and spatial compositions moving through the Strait of Juan de Fuca. It is imperative that we sample on both sides of the border during the same week in order to compare the catch information. It is important to gain more area familiarization to better understand the stocks migratory path through the channel. . We recommend maintaining the commencement and duration of the program as in the last 3 years along with a shift in the set location in Canadian waters to encounter more passing stocks and not terminal Sooke Chum. As the program requires permitting on both sides of the border it will be key to initiate that process well in advance of the start date to ensure all required permits are approved for the fishing activities.

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Tables

Table 1. 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 2019 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, Squakum 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, Collum 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 R, Big Beef Cr

Table 2. 2019 Date ranges and assigned week numbers

Date Range	Week Number
October 1 - October 7	40
October 8 - October 14	41
October 15 - October 21	42
October 22 - October 28	43
October 29 - November 4	44
November 5 - November 11	45

Table 3. Catch and Effort information for the program in 2019

Week Number/ Fishing Area	Number of Sets	Chum Kept	Chum Released	Coho adult released	Coho Jack released
40					
Canada	12	16	281	26	0
US	12	10	0	3	0
41					
Canada	12	67	862	10	0
US	12	98	0	16	0
42					
Canada	12	59	1295	1	0
US	12	253	75	6	0
43					
Canada	12	109	3852	1	0
US	7	35	174	5	0
44					
Canada	12	45	0	0	0
US	12	37	201	3	0
45					
Canada	12	11	0	0	0
US	12	22	0	0	0
Grand Total	**139**	**762**	**68**	**156**	**1**

Table 4. Chum Salmon sex composition over time

Week #	Female	Male	Sample Size
40	33%	67%	26
41	48%	52%	165
42	50%	50%	221
43	58%	42%	116
44	61%	39%	82
45	64%	36%	33
Combined	**53%**	**47%**	**643**

Table 5. Chum Salmon age composition by sex over time

	Female				**Male**			
Sex/ Week #	**Age 3**	**Age 4**	**Age 5**	**Total**	**Age 3**	**Age 4**	**Age 5**	**Total**
40	17%	13%	4%	33%	13%	42%	13%	67%
41	13%	34%	1%	48%	18%	30%	3%	52%
42	22%	27%	1%	50%	20%	28%	1%	50%
43	21%	35%	2%	58%	13%	28%	2%	42%
44	18%	39%	3%	61%	14%	24%	1%	39%
45	15%	48%	0%	64%	9%	21%	6%	36%
Combined	**19%**	**32%**	**1%**	**53%**	**17%**	**28%**	**3%**	**47%**

Table 6. Chum salmon length by sex over time

Sex/ Week#	Average Length (mm)	Standard deviation (mm)	Maximum (mm)	Minimum (mm)	Sample Size
Female	**616**	**38**	**712**	**504**	**335**
40	609	40	679	552	8
41	621	38	707	540	80
42	610	37	705	511	109
43	618	38	712	553	66
44	616	42	700	504	51
45	621	34	705	525	21
Male	**626**	**45**	**754**	**539**	**308**
40	653	35	702	573	18
41	631	40	705	547	85
42	617	45	731	539	112
43	630	51	754	544	50
44	615	41	699	543	31
45	637	64	734	540	12
Combined	**621**	**42**	**754**	**504**	**643**

Table 7. Estimated percentage stock composition of Chum salmon caught in the Juan de Fuca sampling program by week and Area (CDN: Canadian waters) in 2019. 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 beside the sample size. Standard deviation (SD) of the estimated stock composition is in parentheses.

Year	2019		2019		2019		2019		2019		2019	
Julian Date	274-275		281-282		288-289		295-296		302-303		309-310	
Gear	seine		seine		seine		seine		seine		seine	
Area	JdF_TF_CAN		JdF_TF_CAN		JdF_TF_CAN		JdF_TF_CAN		JdF_TF_CAN		JdF_TF_CAN	
Week #	Week40		Week41		Week42		Week43		Week44		Week45	
Sample Dates	Oct01-Oct02		Oct08-Oct09		Oct15-Oct16		Oct22-Oct23		Oct29-Oct30		Nov05-Nov06	
Sample Size	16 (0)		66(0)		59(0)		81(0)		44(1)		11(0)	
Region	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Fraser (F)	4.0%	(8.6%)	33.0%	(10.3%)	14.3%	(8.1%)	13.8%	(7.2%)	3.8%	(5.8)	4.6%	(10.0%)
Johnstone Strait (F)	5.9%	(10.4%)	0.7%	(2.2%)	27.5%	(9.9%)	11.8%	(12.7%)	2.0%	(5.3%)	5.9%	(11.9%)
Strait of Georgia East (F)	4.0%	(8.9%)	7.7%	(9.0%)	9.0%	(9.7%)	16.3%	(10.2%)	5.7%	(9.1%)	3.8%	(9.0%)
Strait of Georgia West (F)	78.9%	(17.9%)	26.5%	(11.1%)	19.1%	(13.7%)	20.5%	(11.2%)	63.6%	(13.4%)	66.6%	(20.5%)
West Coast Vancouver Isl (F)	2.7%	(6.4%)	20.0%	(8.7%)	27.0%	(12.7%)	11.1%	(7.8%)	1.8%	(3.6%)	2.8%	(7.6%)
Coastal Washington (F)	0.7%	(3.3%)	0.0%	(0.3%)	0.0%	(0.4%)	0.0%	(0.3%)	0.0%	(0.5%)	0.0%	(1.4%)
Hood Canal (F)	0.5%	(2.7%)	1.6%	(3.2%)	0.7%	(1.7%)	17.2%	(5.2%)	20.1%	(8.1%)	5.0%	(9.6%)
Juan de Fuca (F)	0.1%	(0.9%)	0.2%	(1.1%)	0.1%	(0.9%)	0.0%	(0.5%)	0.0%	(0.5%)	0.0%	(1.1%)
Central Puget Sound (F)	0.1%	(1.8%)	0.1%	(0.5%)	0.0%	(0.3%)	0.6%	(1.7%)	0.0%	(0.4%)	1.1%	(4.2%)
North Puget Sound (F)	0.6%	(3.3%)	10.1%	(6.8%)	2.1%	(5.0%)	1.7%	(3.3%)	2.6%	(5.7%)	10.0%	(16.0%)
South Puget Sound (F-W)	2.6%	(5.8%)	0.1%	(0.8%)	0.2%	(0.9%)	7.0%	(3.5%)	0.2%	(1.0%)	0.1%	(2.4%)
Country												
Canada	95.4%	(7.9%)	88.0%	(6.8%)	96.9%	(5.3%)	73.5%	(6.6)	77.0%	(8.7%)	83.7%	(17.4%)
US	4.6%	(7.9%)	12.0%	(6.8%)	3.1%	(5.3%)	26.5%	(6.6)	23.0%	(8.7%)	16.3%	(17.4%)

*(F)=Fall run Chum, (F-W)= Fall and winter run Chum

Table 8. Estimated percentage stock composition of Chum salmon caught in the Juan de Fuca sampling program by week and Area (US: United States waters) in 2019. 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 beside the sample size. Standard deviation (SD) of the estimated stock composition is in parentheses.

Year	2019		2019		2019		2019		2019		2019	
Julian Date	276-277		283-284		290-291		297-298		304-305		311-312	
Gear	seine		seine		seine		seine		seine		seine	
Area	JdF_TF_US		JdF_TF_US		JdF_TF_US		JdF_TF_US		JdF_TF_US		JdF_TF_US	
Week #	Week40		Week41		Week42		Week43		Week44		Week45	
Sample Dates	Oct03-Oct04		Oct10-Oct11		Oct17-Oct18		Oct24-Oct25		Oct 31-Nov01		Nov7-Nov08	
Sample Size	10(0)		96(0)		162(0)		35(0)		37(0)		22(0)	
Region	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Fraser (F)	26.0%	(16.3%)	1.1%	(1.8%)	1.0%	(1.5%)	0.4%	(2.1%)	4.2%	(6.0%)	0.8%	(3.3%)
Johnstone Strait (F)	3.2%	(8.2%)	0.2%	(0.9%)	0.1%	(0.6%)	0.0%	(1.1%)	0.6%	(2.6%)	0.2%	(1.8%)
Strait of Georgia East (F)	6.2%	(10.5%)	0.6%	(1.3%)	5.9%	(3.2%)	0.1%	(1.3%)	3.0%	(5.0%)	0.9%	(3.4%)
Strait of Georgia West (F)	2.3%	(7.8%)	3.4%	(3.1%)	0.8%	(1.8%)	0.0%	(0.8%)	5.9%	(7.5%)	2.4%	(4.6%)
West Coast Vancouver Isl (F)	20.6%	(17.7%)	0.7%	(1.7%)	2.0%	(1.5%)	0.4%	(2.0%)	1.0%	(3.3%)	0.1%	(2.3%)
Coastal Washington (F)	0.0%	(1.8%)	0.0%	(0.2%)	0.0%	(0.2%)	0.0%	(0.5%)	0.0%	(0.5%)	0.0%	(0.8%)
Hood Canal (F)	0.2%	(3.0%)	54.8%	(5.9%)	37.1%	(4.7%)	54.8%	(9.5%)	44.2%	(10.7%)	21.5%	(10.8%)
Juan de Fuca (F)	0.0%	(1.1%)	0.2%	(1.0%)	0.0%	(0.1%)	0.0%	(0.2%)	0.0%	(0.4%)	0.0%	(0.5%)
Central Puget Sound (F)	0.4%	(3.4%)	14.5%	(4.7%)	13.9%	(3.9%)	4.7%	(6.4%)	19.4%	(8.4%)	2.7%	(6.8%)
North Puget Sound (F)	0.2%	(2.8%)	0.6%	(1.5%)	12.7%	(3.7%)	1.2%	(3.0%)	2.8%	(5.6%)	1.4%	(4.2%)
South Puget Sound (F-W)	40.8%	(14.7%)	23.9%	(5.7%)	26.5%	(4.2%)	38.2%	(9.9%)	18.9%	(9.2%)	69.9%	(13.2%)
Country												
Canada	58.5%	(14.9%)	5.9%	(3.5%)	9.8%	(3.5%)	1.0%	(3.5%)	14.8%	(9.1%)	4.4%	(6.5%)
US	41.5%	(14.9%)	94.1%	(3.5%)	90.2%	(3.5%)	99.0%	(3.5%)	85.2%	(9.1%)	95.6%	(6.5%)

*(F)=Fall run Chum, (F-W)= Fall and winter run Chum

Figures

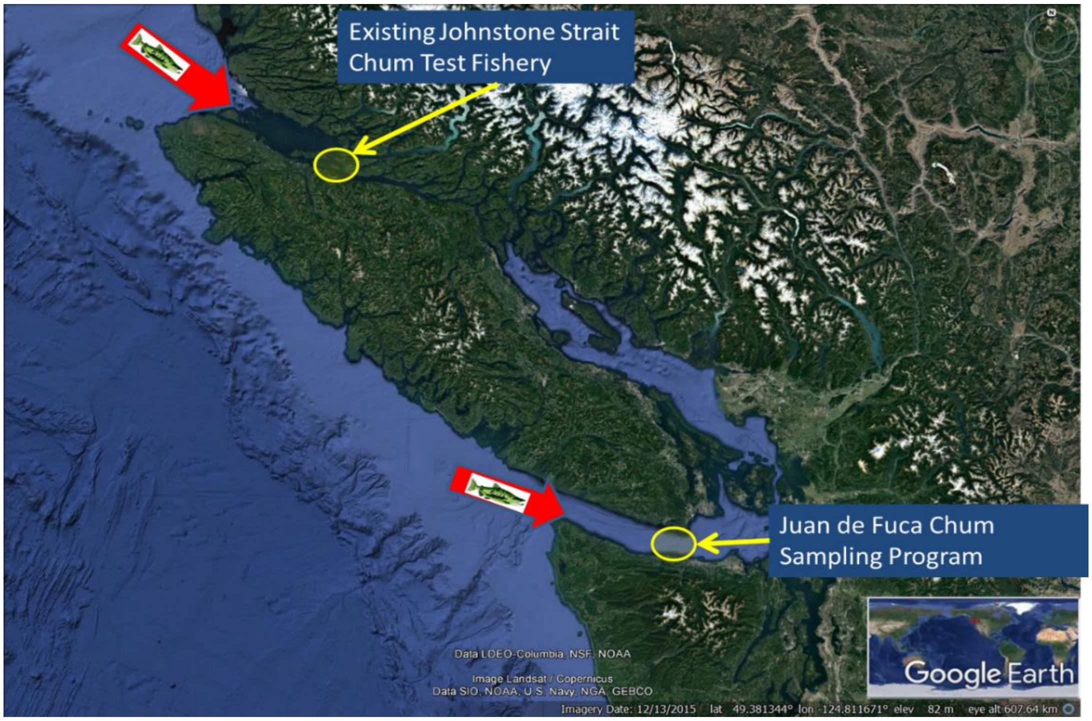


Figure 1. Map of migration pathways for Fall Chum returning to Southern BC and Washington State

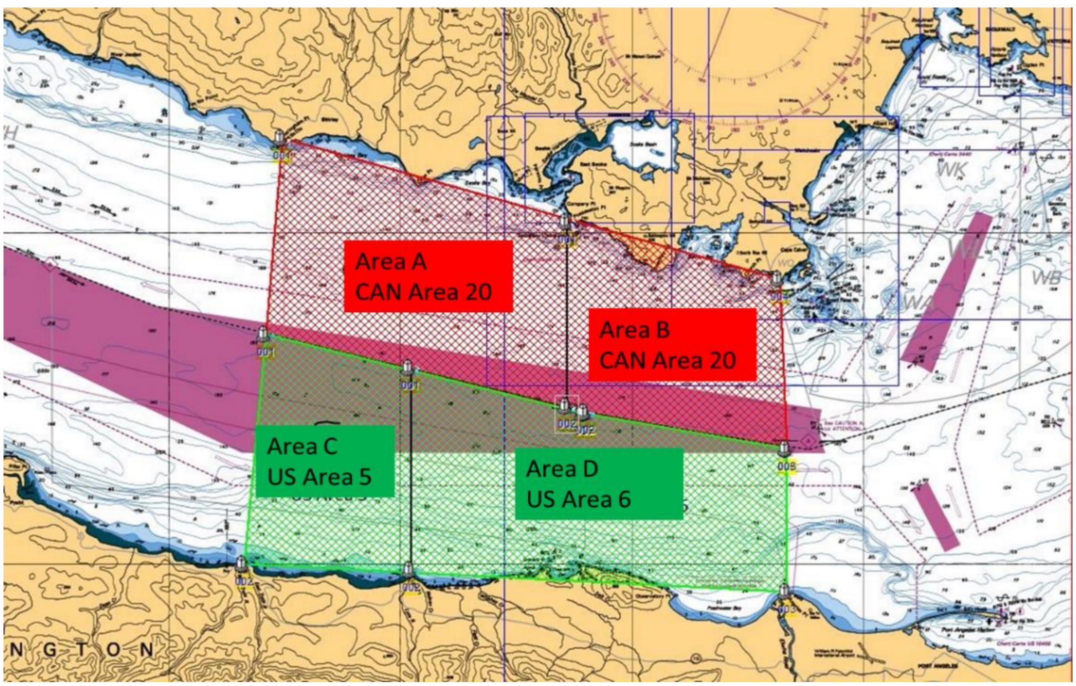


Figure 2. Map of fishing quadrants in Juan de Fuca Strait

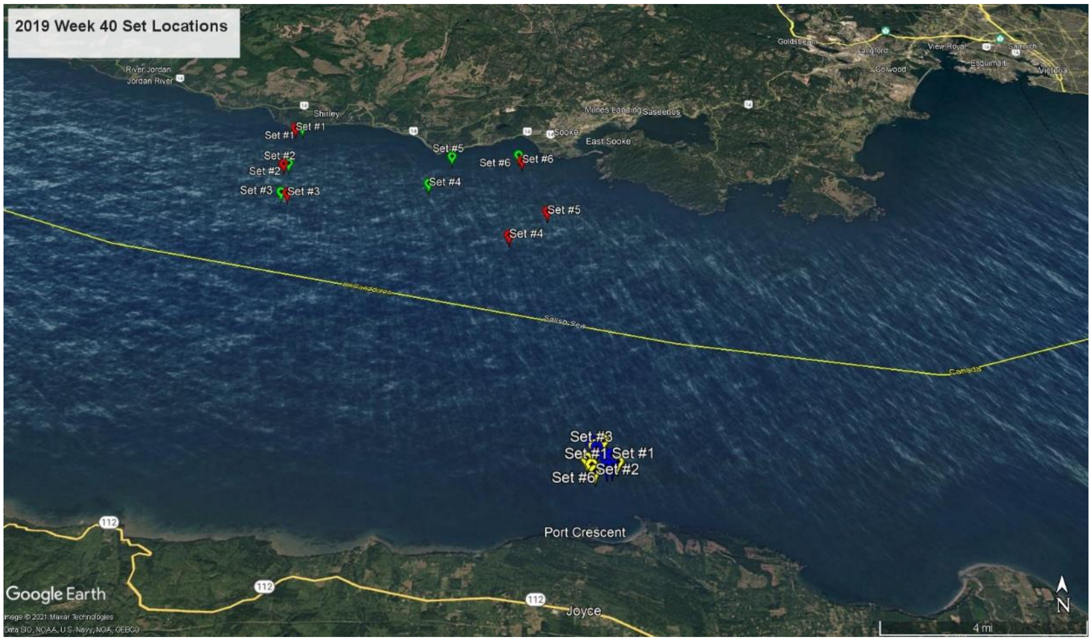


Figure 3. Set locations Week 40 (October 1- 7)

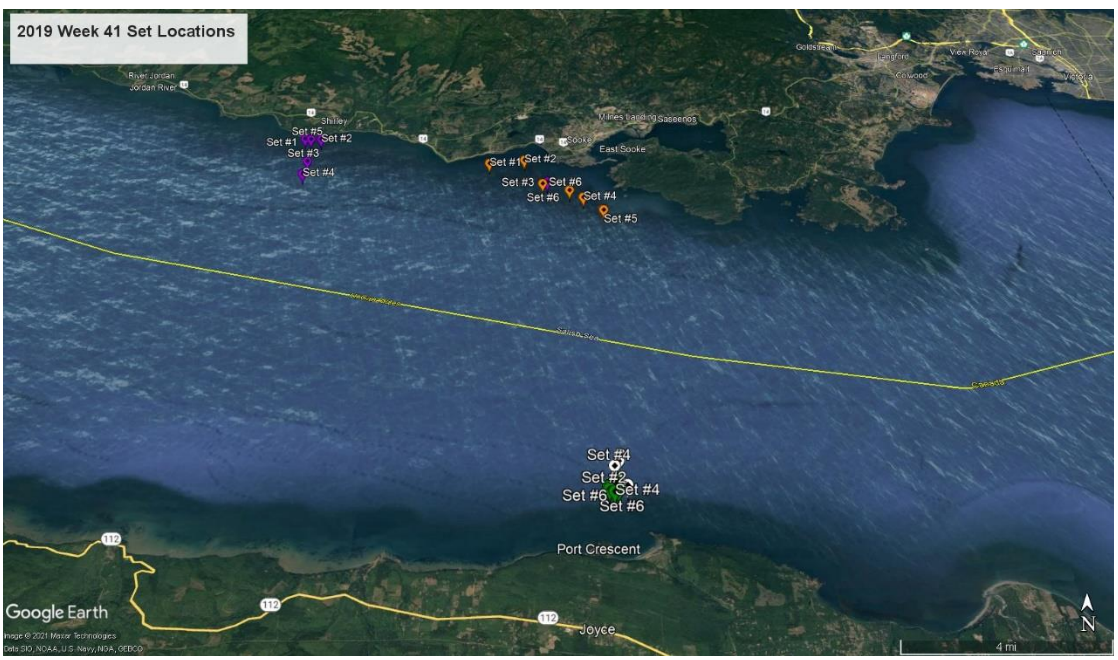


Figure 4. Set locations Week 41 (October 8-14)

Figure 5. Set locations Week 42 (October 15-21)

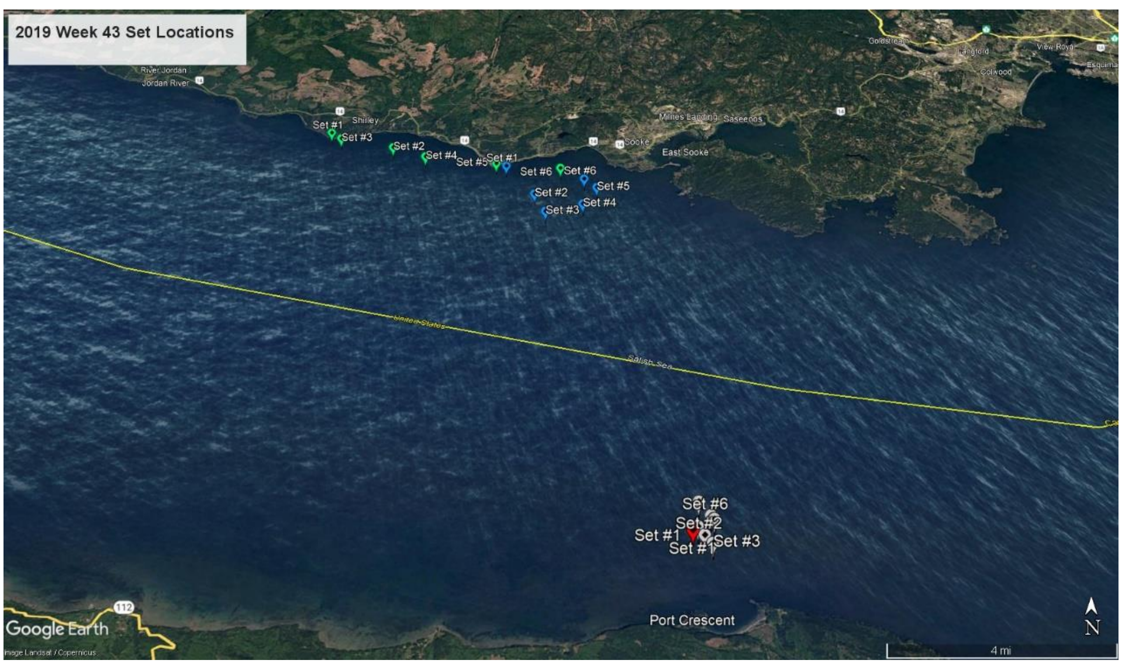


Figure 6. Set locations Week 43 (October 22-28)

Figure 7. Set locations Week 44 (October 29-November 4)

Figure 8. Set locations Week 45 (November 5-11)

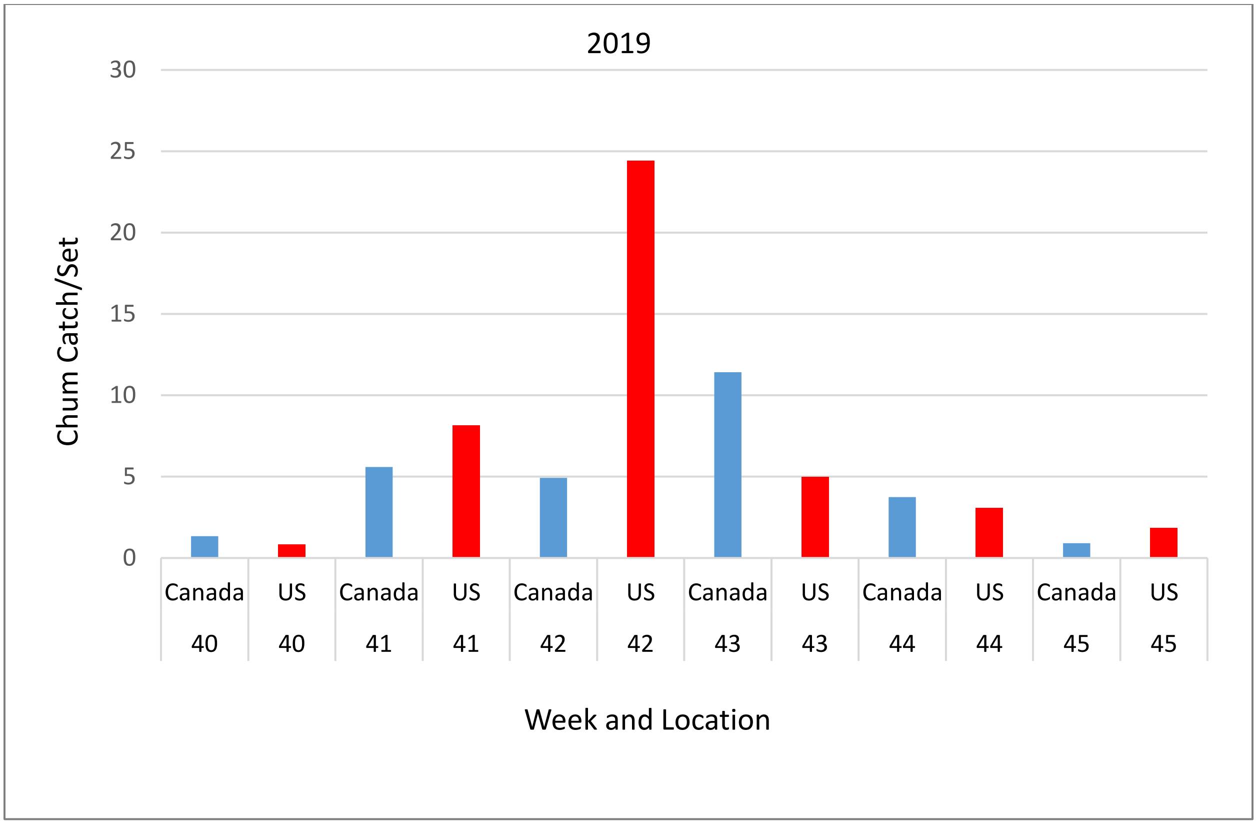
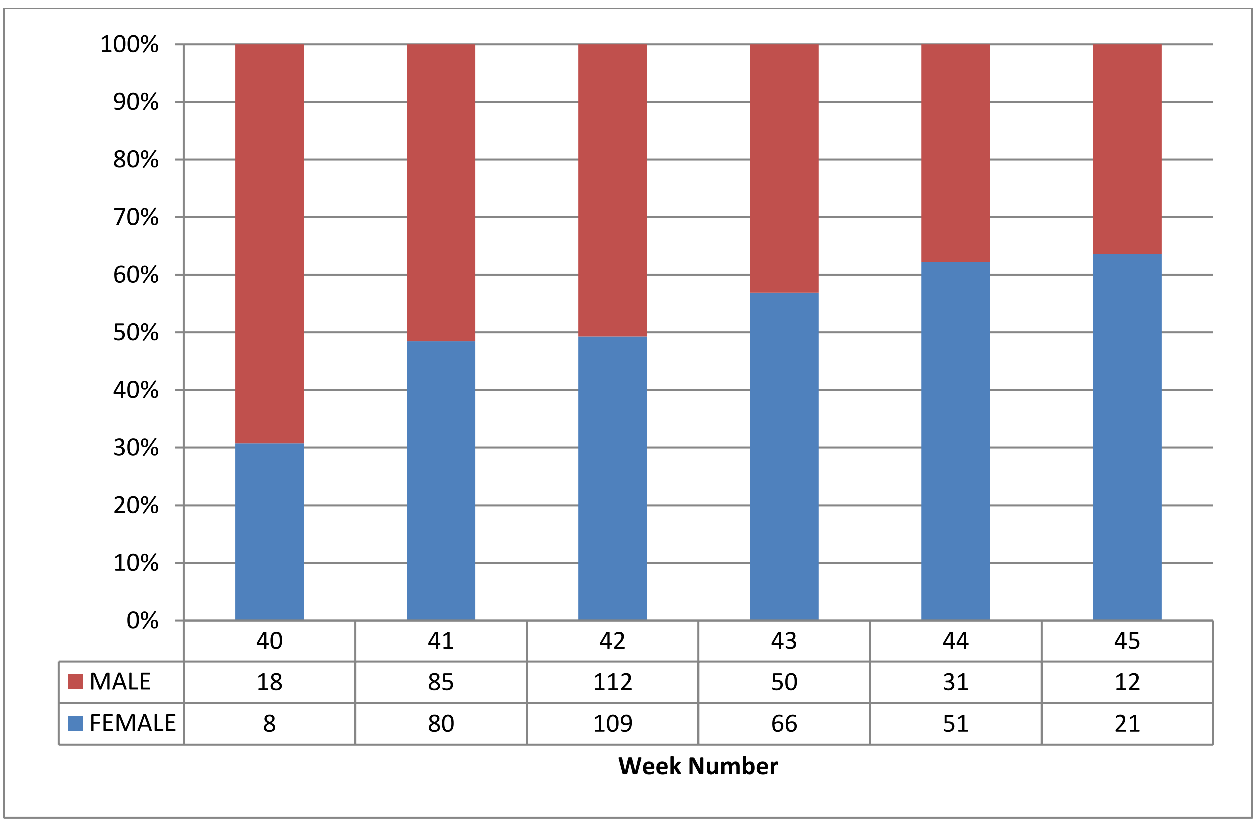


Figure 9. CPUE by time and area



	40	41	42	43	44	45
MALE	18	85	112	50	31	12
FEMALE	8	80	109	66	51	21

Figure 10. Chum salmon sex composition over time (sample size below week #)

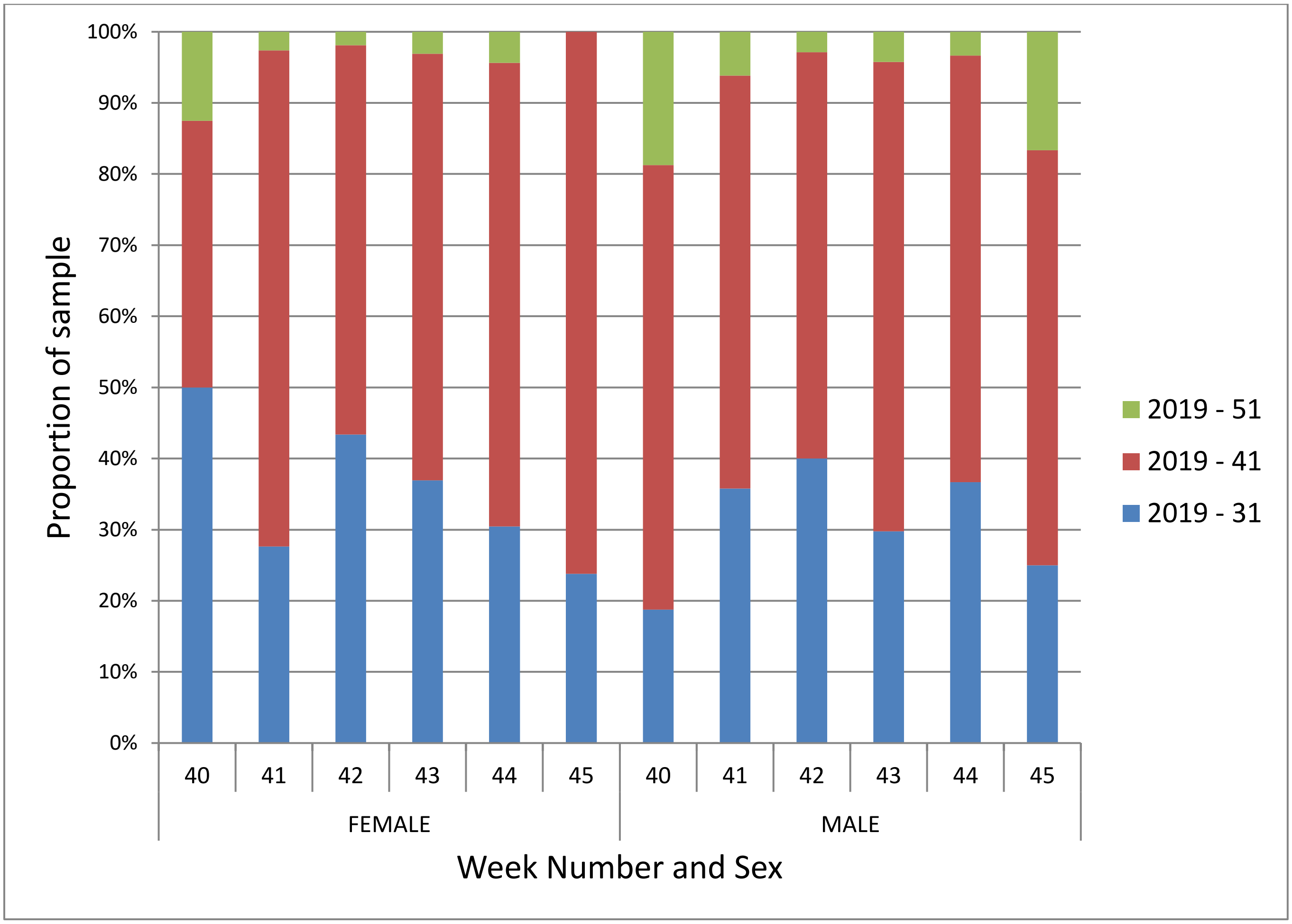


Figure 11. Chum salmon age composition over time

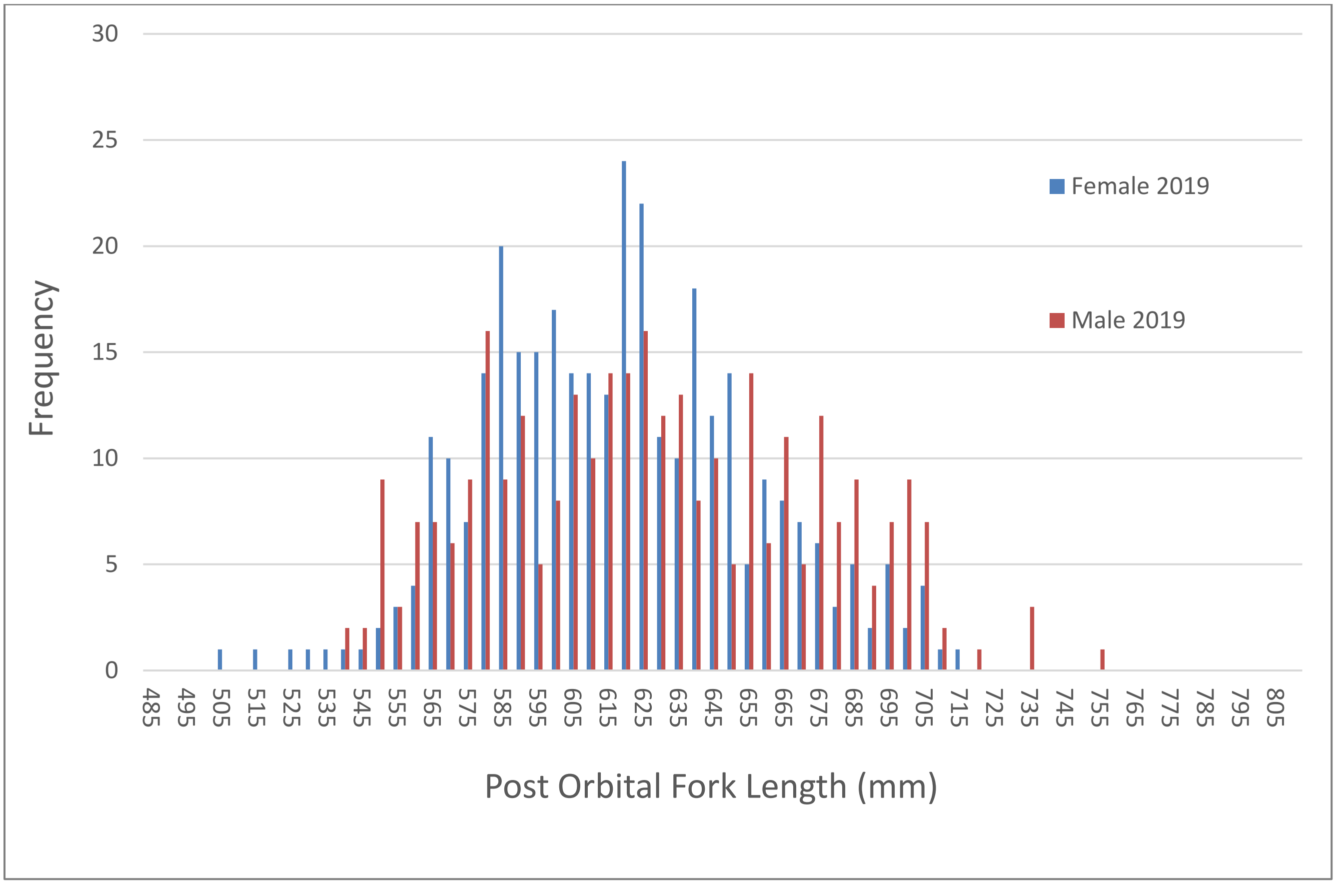


Figure 12. Length distribution of chum sampled in 2019

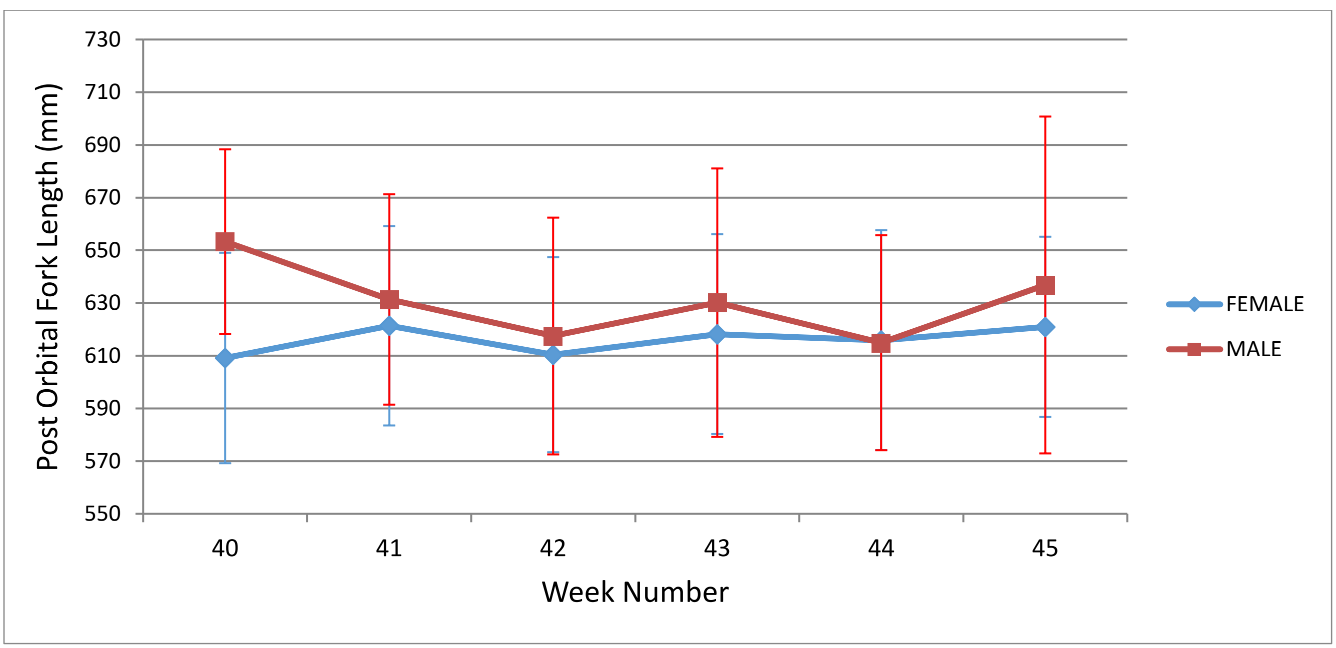


Figure 13. Chum salmon length by sex over time (error bars= 1 S.D.)

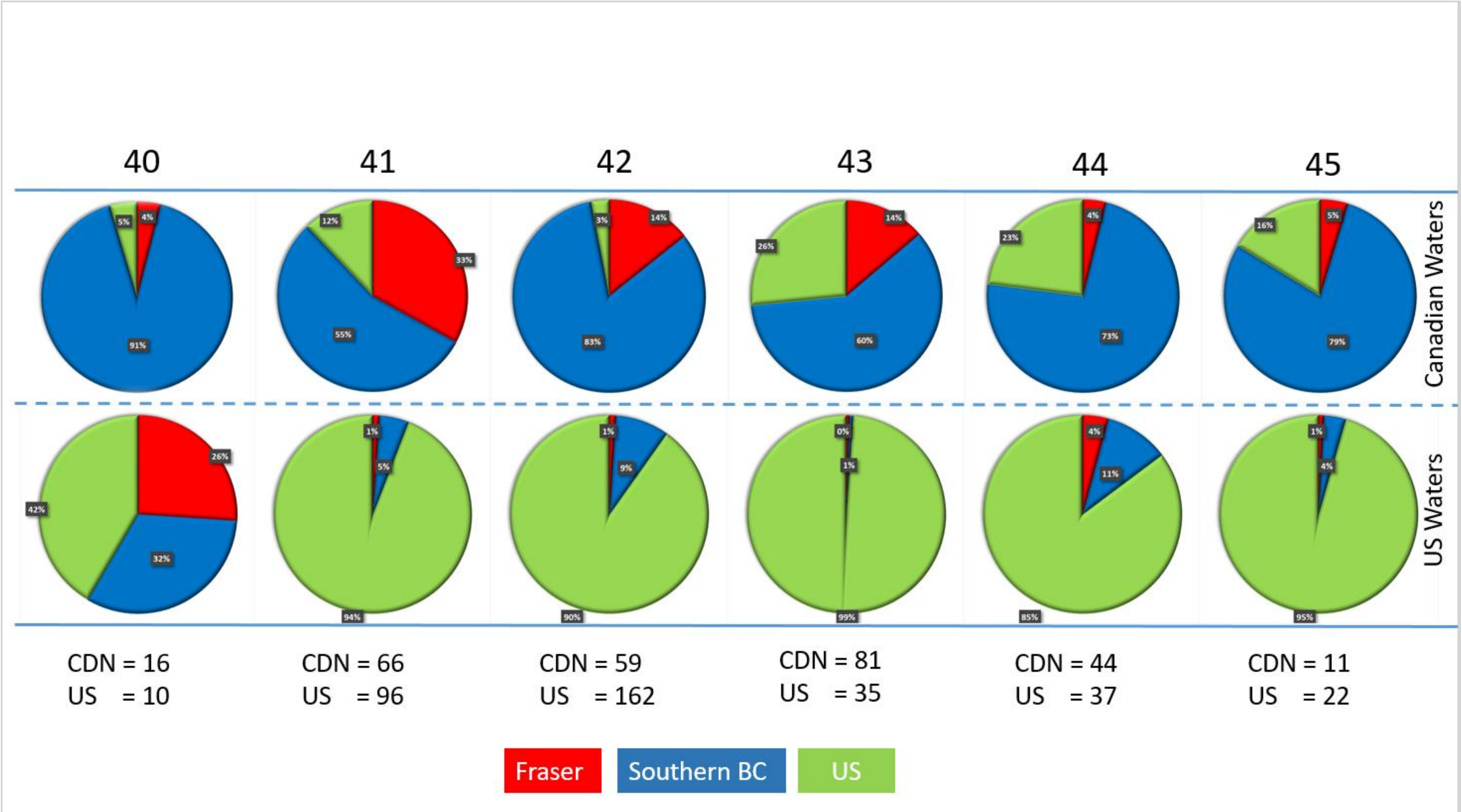


Figure 14. Fraser, Southern BC and US Composition of samples across time and between in US and Canadian waters (Sample size is provided below the pie graphs for each week). Week 40 = Oct.1 - Oct. 7

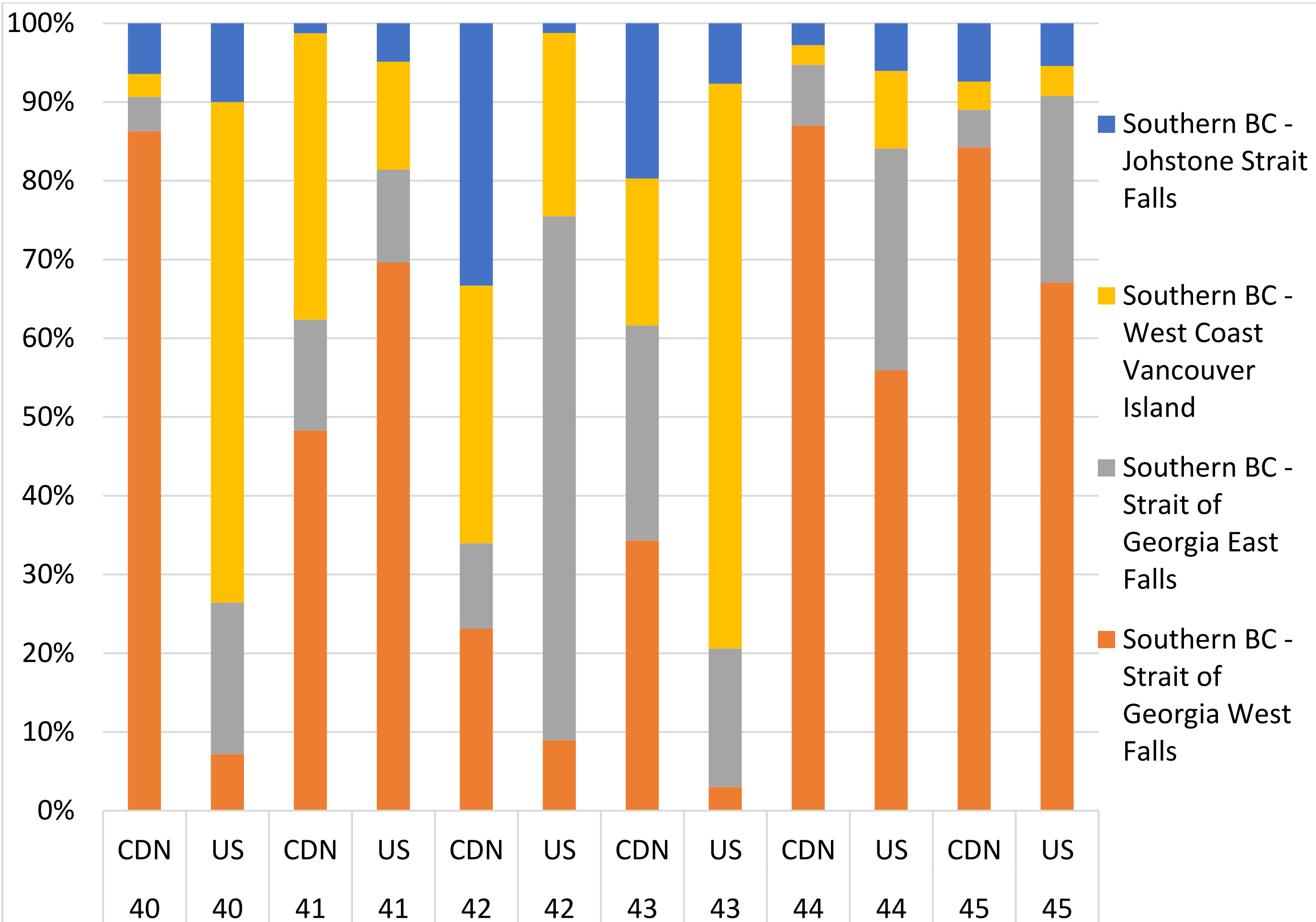


Figure 15. Stock composition of the Southern BC (SBC) component in the samples by area and week

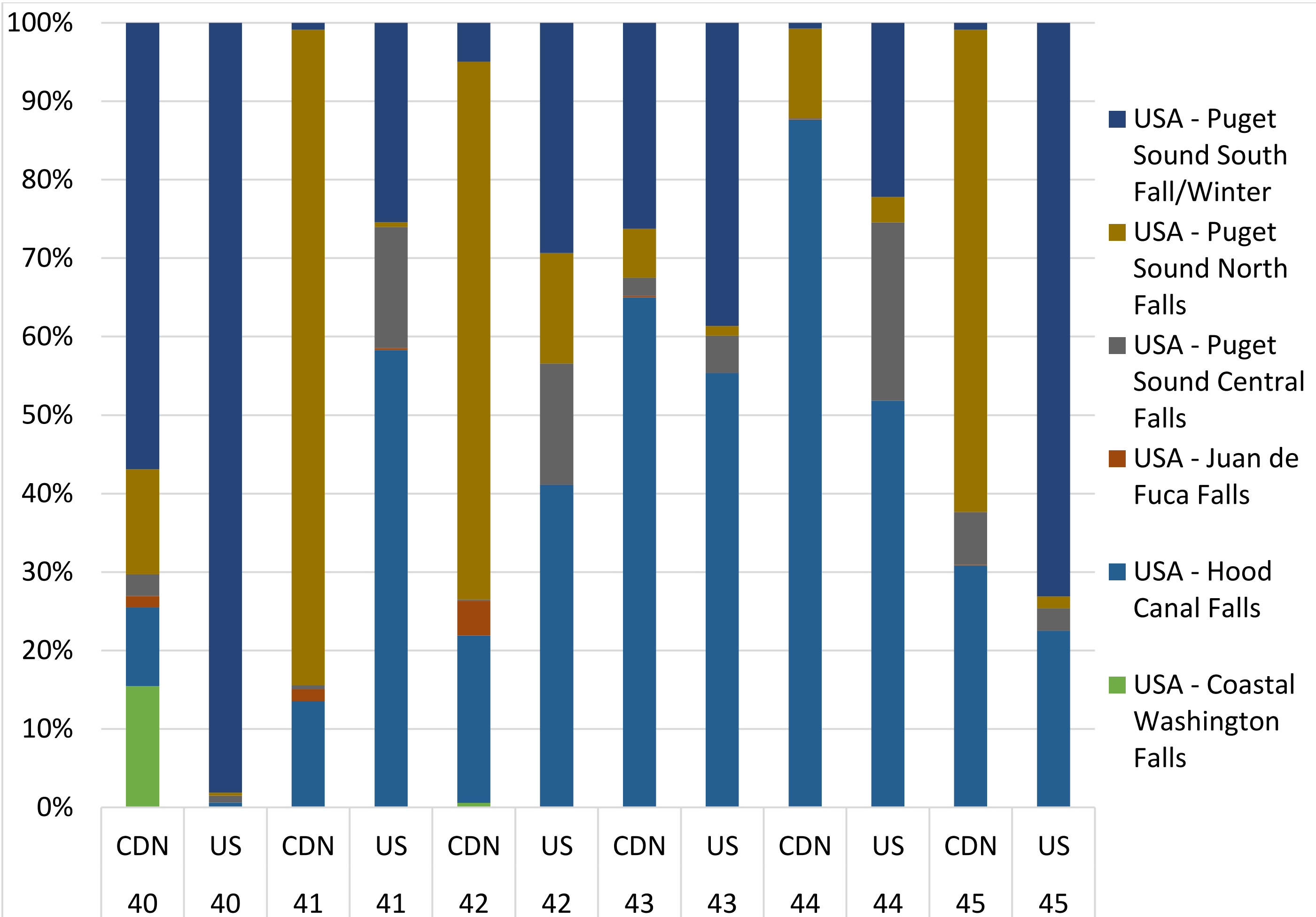
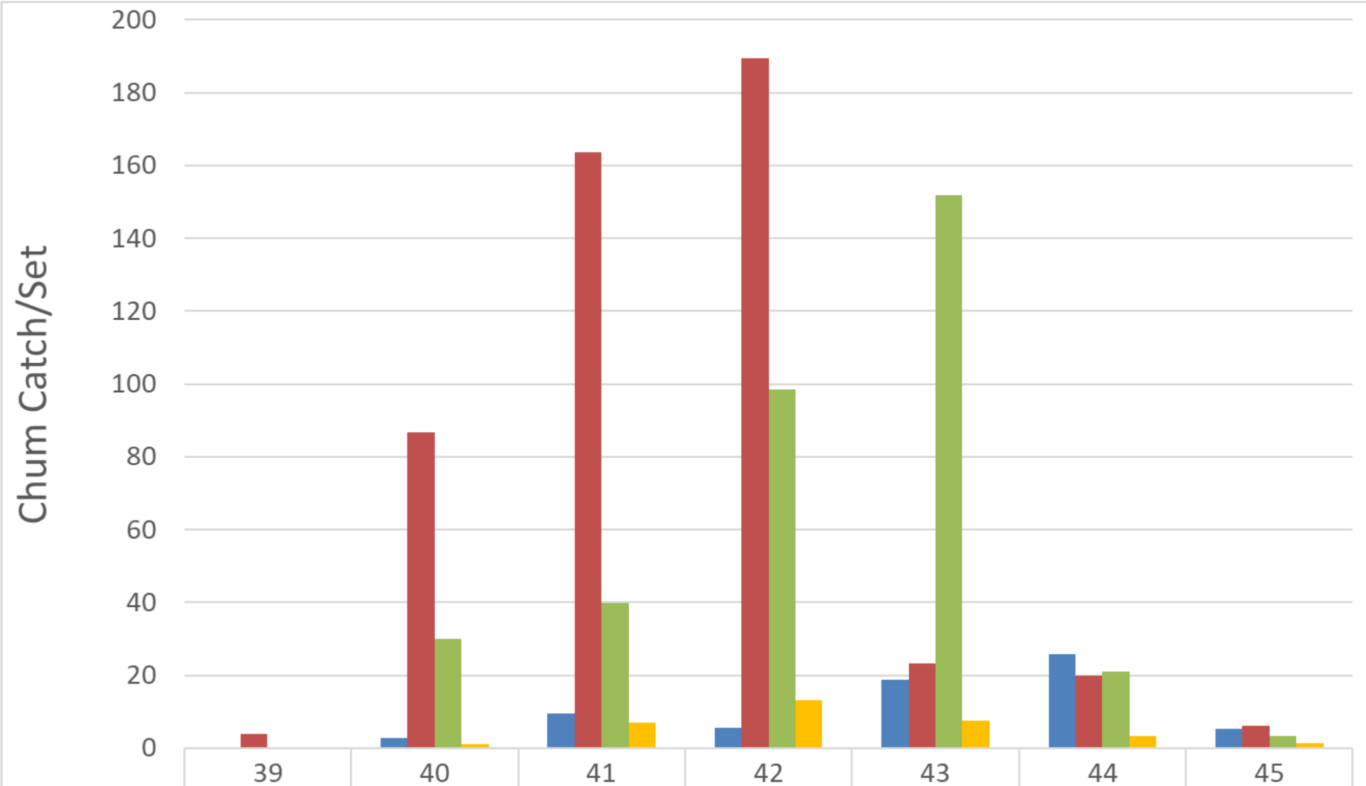


Figure 16. Stock composition of the US component in the samples by area and week



	39	40	41	42	43	44	45
2016		2.8	9.4	5.5	18.8	25.7	5.3
2017	3.9	86.6	163.5	189.5	23.1	19.9	6.2
2018		29.9	39.9	98.3	151.9	21.0	3.4
2019		1.1	6.9	13.0	7.6	3.4	1.4

Figure 17. Comparison between 2016-2019 CPUE

Appendices

Appendix A: Set log example

Chum Seine Test Fishery — Juan de Fuca Strait Area 20 — Date (dd/mmm/yyyy): ______/__________/ ________ — Page______of______

Mark Recalma MV "Qualicum Producer" — Blinkhorn - Vessel # 2 — Observer: — FOS Trip ID (office use only):

Set #	Location Name	Time (PST 1845) Start	Close	Tide	Weather		Sockeye (118) Adult	Jack	Coho (115) Adult	Jack/Juv	Pink (108)	Chum (112)	Chinook (124) Adult	Jack	Stlhd (128)	Other (specify)	Set Cond.	Set Type	Bio Data & Set Comments (# of jumpers and finners, problems with set, ect…)
					Rain: 0 1 2 3	Kept													Book # Scale # to
					% Overcast:														Book # Scale # to
					Wind (Dir/kn):	Rel													DNA Sheet # DNA # to
					Sea Cond:														Water Temp °C
					Rain: 0 1 2 3	Kept													Book # Scale # to
					% Cloud:														Book # Scale # to
					Wind (Dir/kn):	Rel													DNA Sheet # DNA # to
					Sea Cond:														Water Temp °C
					Rain: 0 1 2 3	Kept													Book # Scale # to
					% Cloud:														Book # Scale # to
					Wind (Dir/kn):	Rel													DNA Sheet # DNA # to
					Sea Cond:														Water Temp °C
					Rain: 0 1 2 3	Kept													Book # Scale # to
					% Cloud:														Book # Scale # to
					Wind (Dir/kn):	Rel													DNA Sheet # DNA # to
					Sea Cond:														Water Temp °C
					Rain: 0 1 2 3	Kept													Book # Scale # to
					% Cloud:														Book # Scale # to
					Wind (Dir/kn):	Rel													DNA Sheet # DNA # to
					Sea Cond:														Water Temp °C
					Rain: 0 1 2 3	Kept													Book # Scale # to
					% Cloud:														Book # Scale # to
					Wind (Dir/kn):	Rel													DNA Sheet # DNA # to
					Sea Cond:														Water Temp °C

DAILY & SET COMMENTS	**Assessment Total (set cond 1 & 2 and/or set type 1)**										**Set Condition:**
	Non-Assessment Total (set cond 0 and/or set type 2)										0 - Bad set or catch not representative
											1 - Problem with set but did not affect catch
											2 - Good set no problems
											Set Type:
											1 - Assessment
											2 - Non-Assessment
											Weather Codes:
											Overcast: 0%, 25%, 50%, 75%, 100%
Total Daily Samples -											Rain: 0 - none 1 - light 2 - medium 3 - heavy
											Sea Cond: calm rippled chop rough

Appendix B: Biosample form example

CHUM BIOSAMPLE FORM:

Vessel: Area Sampled by: Date:_____/______/ _________

SET #	LOCATION NAME or LAT/LONG	FISH #	SCALE BOOK#	SCALE #	DNA #	LENGTH POF mm	SEX circle one	SKIN COLOR circle one	COMMENTS fish condition
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	
							M / F	B / S / D	

Appendix C: Set coordinates and time

Latitude	Longitude	Set #	Date and time BEGIN	Date and Time END
48^{o}22.2N	123^{o}55.3W	1	10/01/2019 09:42:00	10/01/2019 10:12:00
48^{o}20.53N	123^{o}55.3W	2	10/01/2019 10:50:00	10/01/2019 11:17:00
48^{o}19.28N	123^{o}54.79W	3	10/01/2019 11:49:00	10/01/2019 12:18:00
48^{o}17.6N	123^{o}46.31W	4	10/01/2019 13:45:00	10/01/2019 14:15:00
48^{o}18.51N	123^{o}44.93W	5	10/01/2019 14:43:00	10/01/2019 15:10:00
48^{o}20.65N	123^{o}45.92W	6	10/01/2019 15:45:00	10/01/2019 16:10:00
48^{o}22.21N	123^{o}55.02W	1	10/02/2019 09:05:00	10/02/2019 09:37:00
48^{o}20.56N	123^{o}55.11W	2	10/02/2019 10:12:00	10/02/2019 10:40:00
48^{o}19.33N	123^{o}55.04W	3	10/02/2019 11:12:00	10/02/2019 11:37:00
48^{o}19.66N	123^{o}49.47W	4	10/02/2019 12:45:00	10/02/2019 13:20:00
48^{o}20.84N	123^{o}48.7W	5	10/02/2019 14:00:00	10/02/2019 14:28:00
48^{o}20.9N	123^{o}46.06W	6	10/02/2019 15:00:00	10/02/2019 15:29:00
48^{o}11.08N	123^{o}43.13W	1	10/03/2019 09:00:00	10/03/2019 09:30:00
48^{o}10.84N	123^{o}43.13W	2	10/03/2019 09:51:00	10/03/2019 10:20:00
48^{o}11.26N	123^{o}43.54W	3	10/03/2019 10:41:00	10/03/2019 11:20:00
48^{o}11.41N	123^{o}43.71W	4	10/03/2019 11:34:00	10/03/2019 11:55:00
48^{o}11.1N	123^{o}43.35W	5	10/03/2019 12:25:00	10/03/2019 12:54:00
48^{o}10.82N	123^{o}43.29W	6	10/03/2019 13:20:00	10/03/2019 13:51:00
48^{o}10.86N	123^{o}43.71W	1	10/04/2019 07:20:00	10/04/2019 07:49:00
48^{o}10.71N	123^{o}43.62W	2	10/04/2019 08:24:00	10/04/2019 08:51:00
48^{o}10.93N	123^{o}42.97W	3	10/04/2019 09:12:00	10/04/2019 09:38:00
48^{o}11.44N	123^{o}43.34W	4	10/04/2019 10:04:00	10/04/2019 10:30:00
48^{o}11.31N	123^{o}43.61W	5	10/04/2019 10:52:00	10/04/2019 11:20:00
48^{o}11.0N	123^{o}43.84W	6	10/04/2019 11:38:00	10/04/2019 12:06:00
48^{o}20.89N	123^{o}47.66W	1	10/08/2019 09:10:00	10/08/2019 09:41:00
48^{o}21.03N	123^{o}46.31W	2	10/08/2019 09:52:00	10/08/2019 10:23:00
48^{o}20.01N	123^{o}45.58W	3	10/08/2019 10:49:00	10/08/2019 11:17:00
48^{o}19.44N	123^{o}44.06W	4	10/08/2019 11:33:00	10/08/2019 12:05:00
48^{o}18.93N	123^{o}43.33W	5	10/08/2019 12:22:00	10/08/2019 12:57:00
48^{o}19.73N	123^{o}44.57W	6	10/08/2019 13:33:00	10/08/2019 14:05:00
48^{o}22.04N	123^{o}55.14W	1	10/09/2019 09:18:00	10/09/2019 09:53:00
48^{o}22.01N	123^{o}54.49W	2	10/09/2019 10:10:00	10/09/2019 10:45:00
48^{o}21.01N	123^{o}54.77W	3	10/09/2019 11:07:00	10/09/2019 11:40:00
48^{o}20.46N	123^{o}54.8W	4	10/09/2019 12:09:00	10/09/2019 12:42:00
48^{o}22.02N	123^{o}54.9W	5	10/09/2019 13:00:00	10/09/2019 13:27:00
48^{o}20.07N	123^{o}45.41W	6	10/09/2019 14:30:00	10/09/2019 15:02:00
48^{o}10.81N	123^{o}43.49W	1	10/10/2019 09:19:00	10/10/2019 09:52:00
48^{o}11.29N	123^{o}43.32W	2	10/10/2019 10:12:00	10/10/2019 10:43:00
48^{o}11.45N	123^{o}43.28W	3	10/10/2019 10:55:00	10/10/2019 11:23:00
48^{o}11.18N	123^{o}43.44W	4	10/10/2019 11:40:00	10/10/2019 12:09:00

48°10.85N	123°43.34W	5	10/10/2019 12:22:00	10/10/2019 12:53:00
48°10.74N	123°43.11W	6	10/10/2019 13:14:00	10/10/2019 13:46:00
48°10.71N	123°43.64W	1	10/11/2019 07:16:00	10/11/2019 07:49:00
48°10.66N	123°43.61W	2	10/11/2019 08:12:00	10/11/2019 08:41:00
48°10.91N	123°43.33W	3	10/11/2019 09:06:00	10/11/2019 09:47:00
48°10.6N	123°43.47W	4	10/11/2019 09:54:00	10/11/2019 10:37:00
48°10.78N	123°43.39W	5	10/11/2019 10:37:00	10/11/2019 11:07:00
48°10.62N	123°43.36W	6	10/11/2019 11:14:00	10/11/2019 11:45:00
48°22.29N	123°55.21W	1	10/15/2019 09:42:00	10/15/2019 10:12:00
48°22.05N	123°54.88W	2	10/15/2019 10:30:00	10/15/2019 10:57:00
48°20.78N	123°55.12W	3	10/15/2019 11:28:00	10/15/2019 12:03:00
48°20.35N	123°56.29W	4	10/15/2019 12:12:00	10/15/2019 12:34:00
48°19.32N	123°55.17W	5	10/15/2019 12:58:00	10/15/2019 13:29:00
48°22.23N	123°55.02W	6	10/15/2019 13:59:00	10/15/2019 14:27:00
48°19.99N	123°44.18W	1	10/16/2019 08:22:00	10/16/2019 08:53:00
48°19.48N	123°45.3W	2	10/16/2019 09:09:00	10/16/2019 09:35:00
48°19.32N	123°46.7W	3	10/16/2019 09:45:00	10/16/2019 10:14:00
48°18.43N	123°47.52W	4	10/16/2019 10:27:00	10/16/2019 10:55:00
48°21.81N	123°53.56W	5	10/16/2019 11:40:00	10/16/2019 12:09:00
48°22.28N	123°55.13W	6	10/16/2019 12:34:00	10/16/2019 13:07:00
48°10.65N	123°43.29W	1	10/17/2019 08:50:00	10/17/2019 09:22:00
48°10.78N	123°43.22W	2	10/17/2019 09:56:00	10/17/2019 09:56:00
48°10.61N	123°43.36W	3	10/17/2019 10:12:00	10/17/2019 10:38:00
48°11.2N	123°43.62W	4	10/17/2019 10:45:00	10/17/2019 11:18:00
48°11.44N	123°43.69W	5	10/17/2019 11:30:00	10/17/2019 12:04:00
48°11.54N	123°43.63W	6	10/17/2019 12:20:00	10/17/2019 12:52:00
48°11.05N	123°43.28W	1	10/18/2019 07:36:00	10/18/2019 08:07:00
48°10.9N	123°42.78W	2	10/18/2019 08:20:00	10/18/2019 08:53:00
48°10.77N	123°43.26W	3	10/18/2019 09:02:00	10/18/2019 09:34:00
48°11.2N	123°43.66W	4	10/18/2019 10:20:00	10/18/2019 10:51:00
48°11.36N	123°43.32W	5	10/18/2019 11:04:00	10/18/2019 11:34:00
48°10.96N	123°43.41W	6	10/18/2019 11:04:00	10/18/2019 11:34:00
48°21.01N	123°48.84W	1	10/22/2019 09:03:00	10/22/2019 09:33:00
48°19.93N	123°47.82W	2	10/22/2019 10:15:00	10/22/2019 10:47:00
48°19.29N	123°47.44W	3	10/22/2019 11:09:00	10/22/2019 11:54:00
48°19.56N	123°46.19W	4	10/22/2019 12:00:00	10/22/2019 12:34:00
48°20.17N	123°45.7W	5	10/22/2019 12:51:00	10/22/2019 13:20:00
48°20.5N	123°46.12W	6	10/22/2019 13:46:00	10/22/2019 14:18:00
48°22.4N	123°55.33W	1	10/23/2019 09:30:00	10/23/2019 10:30:00
48°21.77N	123°52.96W	2	10/23/2019 11:12:00	10/23/2019 11:42:00
48°22.15N	123°54.92W	3	10/23/2019 12:10:00	10/23/2019 12:41:00
48°21.39N	123°51.74W	4	10/23/2019 13:07:00	10/23/2019 13:40:00
48°21.11N	123°49.2W	5	10/23/2019 13:56:00	10/23/2019 14:28:00

48^{o}20.92N	123^{o}46.94W	6	10/23/2019 14:45:00	10/23/2019 15:17:00
48^{o}11.08N	123^{o}43.62W	1	10/24/2019 09:03:00	10/24/2019 09:35:00
48^{o}10.92N	123^{o}43.48W	2	10/24/2019 09:42:00	10/24/2019 10:13:00
48^{o}10.77N	123^{o}43.31W	3	10/24/2019 10:24:00	10/24/2019 10:54:00
48^{o}11.22N	123^{o}43.2W	4	10/24/2019 11:11:00	10/24/2019 11:43:00
48^{o}11.56N	123^{o}43.53W	5	10/24/2019 12:10:00	10/24/2019 12:41:00
48^{o}11.29N	123^{o}43.27W	6	10/24/2019 12:57:00	10/24/2019 13:29:00
48^{o}11.01N	123^{o}43.75W	1	10/25/2019 07:20:00	10/25/2019 07:53:00
48^{o}20.04N	123^{o}44.9W	1	10/29/2019 08:45:00	10/29/2019 09:16:00
48^{o}20.33N	123^{o}47.62W	2	10/29/2019 09:41:00	10/29/2019 10:13:00
48^{o}20.47N	123^{o}49.35W	3	10/29/2019 10:20:00	10/29/2019 10:53:00
48^{o}21.75N	123^{o}52.61W	4	10/29/2019 11:44:00	10/29/2019 12:16:00
48^{o}22.13N	123^{o}55.37W	5	10/29/2019 12:30:00	10/29/2019 13:05:00
48^{o}20.35N	123^{o}45.62W	6	10/29/2019 14:12:00	10/29/2019 14:43:00
48^{o}19.99N	123^{o}44.22W	1	10/30/2019 08:32:00	10/30/2019 09:10:00
48^{o}19.47N	123^{o}44.67W	2	10/30/2019 09:18:00	10/30/2019 09:47:00
48^{o}20.25N	123^{o}46.53W	3	10/30/2019 10:00:00	10/30/2019 10:29:00
48^{o}20.64N	123^{o}47.99W	4	10/30/2019 10:40:00	10/30/2019 11:11:00
48^{o}20.35N	123^{o}45.92W	5	10/30/2019 11:45:00	10/30/2019 12:16:00
48^{o}19.93N	123^{o}44.36W	6	10/30/2019 12:47:00	10/30/2019 13:19:00
48^{o}11.14N	123^{o}43.41W	1	10/31/2019 12:15:00	10/31/2019 12:46:00
48^{o}10.96N	123^{o}43.41W	2	10/31/2019 13:00:00	10/31/2019 13:30:00
48^{o}11.42N	123^{o}43.4W	3	10/31/2019 13:45:00	10/31/2019 14:14:00
48^{o}11.72N	123^{o}42.94W	4	10/31/2019 14:30:00	10/31/2019 15:01:00
48^{o}11.12N	123^{o}43.15W	5	10/31/2019 15:25:00	10/31/2019 15:56:00
48^{o}10.89N	123^{o}43.25W	6	10/31/2019 16:17:00	10/31/2019 16:49:00
48^{o}10.75N	123^{o}43.38W	1	11/01/2019 07:34:00	11/01/2019 08:03:00
48^{o}10.96N	123^{o}43.28W	2	11/01/2019 08:27:00	11/01/2019 09:00:00
48^{o}11.28N	123^{o}43.75W	3	11/01/2019 09:18:00	11/01/2019 09:50:00
48^{o}10.83N	123^{o}43.49W	4	11/01/2019 10:01:00	11/01/2019 10:32:00
48^{o}10.67N	123^{o}43.83W	5	11/01/2019 10:40:00	11/01/2019 11:11:00
48^{o}10.72N	123^{o}43.92W	6	11/01/2019 11:20:00	11/01/2019 11:51:00
48^{o}22.32N	123^{o}55.2W	1	11/05/2019 09:29:00	11/05/2019 10:01:00
48^{o}21.57N	123^{o}54.35W	2	11/05/2019 10:10:00	11/05/2019 10:40:00
48^{o}20.94N	123^{o}49.27W	3	11/05/2019 11:10:00	11/05/2019 11:41:00
48^{o}19.38N	123^{o}48.59W	4	11/05/2019 11:54:00	11/05/2019 12:26:00
48^{o}20.03N	123^{o}45.07W	5	11/05/2019 13:00:00	11/05/2019 13:31:00
48^{o}19.92N	123^{o}44.6W	6	11/05/2019 13:41:00	11/05/2019 14:14:00
48^{o}20.21N	123^{o}45.14W	1	11/06/2019 08:35:00	11/06/2019 09:07:00
48^{o}19.65N	123^{o}44.61W	2	11/06/2019 09:16:00	11/06/2019 09:47:00
48^{o}19.1N	123^{o}44.53W	3	11/06/2019 10:00:00	11/06/2019 10:30:00
48^{o}18.23N	123^{o}44.96W	4	11/06/2019 10:45:00	11/06/2019 11:16:00
48^{o}17.45N	123^{o}44.62W	5	11/06/2019 11:25:00	11/06/2019 11:56:00

48°17.24N	123°44.46W	6	11/06/2019 12:07:00	11/06/2019 12:37:00
48°11.14N	123°43.42W	1	11/07/2019 08:28:00	11/07/2019 09:00:00
48°10.96N	123°43.42W	2	11/07/2019 09:13:00	11/07/2019 09:44:00
48°10.7N	123°43.23W	3	11/07/2019 10:00:00	11/07/2019 10:27:00
48°11.28N	123°43.28W	4	11/07/2019 10:41:00	11/07/2019 11:09:00
48°11.46N	123°43.24W	5	11/07/2019 11:32:00	11/07/2019 12:00:00
48°11.36N	123°43.52W	6	11/07/2019 12:22:00	11/07/2019 12:53:00
48°11.0N	123°43.68W	1	11/08/2019 07:01:00	11/08/2019 07:32:00
48°11.41N	123°43.57W	2	11/08/2019 07:42:00	11/08/2019 08:13:00
48°11.83N	123°43.98W	3	11/08/2019 08:23:00	11/08/2019 08:55:00
48°11.82N	123°43.04W	4	11/08/2019 09:06:00	11/08/2019 09:34:00
48°11.41N	123°43.24W	5	11/08/2019 09:52:00	11/08/2019 10:24:00
48°12.29N	123°43.49W	6	11/08/2019 10:47:00	11/08/2019 11:16:00