

# **Joint US and CA Juan de Fuca Chum Sampling Program 2020**

Progress Report to Southern Endowment Fund: Project SF-2020-SP-4

Pieter Van Will, John Candy, Carmen McConnell, Lee Kearey

Department of Fisheries and Oceans  
3190 Hammond Bay Road  
Nanaimo, B. C.  
V9T 6N7

and

Bill Patton

Northwest Indian Fisheries Commission  
6730 Martin Way E.  
Olympia WA 98516-5540

Contact Phone: 250-230-0048

Email: [Pieter.VanWill@dfo-mpo.gc.ca](mailto:Pieter.VanWill@dfo-mpo.gc.ca)

## **Abstract**

The project plan for 2020, the fifth year of the project, 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 1<sup>st</sup> week of October 2020. 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 September 29<sup>th</sup> and ran until November 6<sup>th</sup>. A total of 129 sets were completed (70 in Canadian waters and 59 in US waters). A total of 4,302 Chum were encountered and 1,794 were sampled for stock id and other biologicals. The Catch per Unit Effort (CPUE) was stronger in general on the Canadian side, similar to what was seen in 2017 and 2018. The catch information demonstrated a peak timing on the Canadian side of the Strait during week 43. Timing on the US side is problematic in 2020 as scheduling and weather issues during week 43 on the US side resulted in insufficient sampling. Over the

period of the program, Chum CPUE was always 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.

Weekly target sample sizes were generally achieved in Canadian waters up until the last week of the program when Chum CPUEs dropped off. In US waters lower CPUE was encountered throughout the season and weekly sample targets were only achieved in weeks 41 and 42. It is hoped that with additional years of Chum CPUE data from this Southern approach (through Juan de Fuca) it will help to improve the existing relationship between Chum CPUE and abundance that exists for the Northern Approach (through Johnstone Strait).

## **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.

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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<sup>2</sup>, and a volume of 417 km<sup>3</sup> (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: Baseline of 400 sample sites/populations by regional genetic groups used to estimate stock composition of Chum salmon from southern British Columbia and Washington State in 2020 fisheries (bcm-SNP\_coastwide\_v2.0.0\_2020-04-05)

Repunit/Conservation Unit	CU Number	Region	Population	N
Korea	KOR-01	Korea	Namdae_R	96
Honshu_Japan_Sea	JPN-03	Japan	Gakko_R	35
			Hayatsuki_R	70
			Kawabukuro_R	92
			Miomote_R	93
			Uono_R	79
Honshu_Pacific_Coast	JPN-04	Japan	Koizumi_R	79
			Sakari_R	75
			Tsugaruishi_R	54
Hokkaido_eastern	JPN-07	Japan	Kushiro_R	34
			Tokachi_R	109
Nemuro_Strait	JPN-05	Japan	Nishibetsu_R	77

Repunit/Conservation Unit	CU Number	Region	Population	N
Hokkaido_Sea_of_Okhotsk	JPN-01	Japan	Shibetsu_R	106
			Abashiri_R	129
			Horonai_R	50
			Shari_R	77
			Tokoro_R	116
			Tokushibetsu_R	108
Hokkaido_western	JPN-06	Japan	Shikiu_R	80
			Shiriuchi_R	91
			Shizunai_R	80
			Yurappu_R	77
			Chitose_R	91
Hokkaido_Japan_Sea	JPN-02	Japan	Teshio_R	73
			Toshibetsu_R	56
			Avakumovka_R	33
Primorye	RU-07	Russia	Ryazanovka_R	45
Sakhalin	RU-03	Russia	Kalininka_R	45
			Naiba_R	124
			Tym_R	47
			Udarnitsa_R	49
Amur	RU-06	Russia	Amur_R	146
Magadan	RU-05	Russia	Suifen_R	21
			Magadan_R	67
			Okhota_R	85
			Ola_R	111
			Tauy_R	52
Northern_Sea_of_Okhotsk			Tugur_R	98
			Oklan_R	70
			Penzhina_R	35
West_coast_Kamchatka	RU-01	Russia	Bolshaya_R	97
			Hairusova_R	93
			Kikhchik_R	86
			Kol_R	80
			Plotnikova_R	72
			Pymta_R	88
			Utka_R	36
			Vorovskaya_R	151
			Apuka_R	48
			Dranka_R	48
East_coast_Kamchatka	RU-02	Russia	Ivashka_R	43
			Kamchatka_R	66
			Karaga_R	42
			Nerpichye_Lake	40
			Olyutorsky_Bay	51

Repunit/Conservation Unit	CU Number	Region	Population	N
North_east_Russia	RU-04	Russia	Ossora_R	89
			Zhupanova_R	38
			Anadyr_R	91
			Impuka_R	29
			Kanchalan_R	76
Kotzebue	AK-02	Western Alaska (excluding Yukon River)	Agiapuk_R	93
			Inmachuk_R	93
			Kelly_Lake	95
			Kobuk_R	92
			Koyuk_R	43
			Noatak_R	25
Norton_Sound_north	AK-05	Western Alaska (excluding Yukon River)	Eldorado_R	93
			Kwiniuk_R	79
			Niukluk_R	86
			Nome_R	117
			Pikmiktalik_R	132
			Pilgrim_R	95
			Shaktoolik_R	94
			Snake_R	89
			Unalakleet_R	93
			Ungalik_R	50
Kuskokwim_Bay_River	AK-08	Western Alaska (excluding Yukon River)	Aniak_R	93
			Big_R_Kusko	88
			George_R	104
			Goodnews_R	113
			Holokuk_R	62
			Kanektok_R	150
			Kasigluk_R	42
			Kogruklu_R	125
			Kuskokwim_R_South_Fork	141
			Kwethluk_R	107
			Nunsatuk_R	74
			Salmon_R_WAlaska	89
			Takotna_R	99
			Tatlawiksuk_R	101
			Tuluksak_R	94
North_east_Bristol	AK-09	Western Alaska (excluding Yukon River)	Alagnak_R	81
			Naknek_R	56
			Togiak_R	77

Repunit/Conservation Unit	CU Number	Region	Population	N
Nushagak_summer	AK-14	Western Alaska (excluding Yukon River)	Mulchatna_R Stuyahok_R	69 43
South_west_Bristol	AK-07	Western Alaska (excluding Yukon River)	Egegik_Bay Gertrude_Cr Pumice_Cr	75 88 94
North_Peninsula	AK-03	Western Alaska (excluding Yukon River)	Frosty_Cr Joshua_Green_R Moller_Bay	94 98 92
Tanana_summer	AK-15	Yukon River - US	Chena_R_Early Chena_R_Late Salcha_R_Early Salcha_R_Late	94 67 44 32
Tanana_fall	AK-16	Yukon River - US	Delta_R Kantishna_R Toklat_R	79 101 100
Upper_Alaska_fall	AK-11	Yukon River - US	Big_Salt_R Black_R Chandalar_R Sheenjek_R	36 97 45 132
Lower_river_summer	AK-10	Yukon River - US	Andreafsky_R Anvik_R California_Cr Chulinak_R Gisasa_R Henshaw_Cr Jim_R Koyukuk_R_Middle_Fork Koyukuk_R_South_Fork_Late Melozitna_R Nulato_R Tozitna_R	88 96 46 67 42 100 95 96 57 141 95 86
Teslin	CU-38	Yukon River - Canada	Teslin_R	102
Middle Yukon River	CU-42	Yukon River - Canada	Big_Cr Pelly_R Tatchun_R Yukon_R@Minto	120 64 83 78
Donjek-Kluane-White	CU-44-45	Yukon River - Canada	Donjek_R Kluane_Lake	69 103
North Yukon River	CU-43	Yukon River - Canada	Chandindu_R	85
Porcupine River	CU-46	Yukon River - Canada	Fishing_Branch_R Porcupine_R	85 48

Repunit/Conservation Unit	CU Number	Region	Population	N
South_west_Peninsula	AK-13	Central Alaska	Coleman_Cr	72
			Delta_Cr	74
			Volcano_Bay	106
			Westward_Cr	77
South_east_Peninsula	AK-06	Central Alaska	Alagogshak_Cr	93
			Big_R	89
			Stepovak_Bay	86
			American_R	92
Kodiak	AK-04	Central Alaska	Sturgeon_R	70
			Uganik_R	81
			Constantine_Cr	43
			Keta_Cr	84
Prince_William_Sound	AK-12	Central Alaska	Olsen_Bay_Cr	71
			Wells_R	95
			Dipac_Hatchery	147
			Gambier_Bay	60
SE_Alaska	AK-01.2	Southeast Alaska	Greens_Cr	45
			Herman_Cr	54
			Kennel_Cr	36
			Sawmill_Cr	32
Taku	CU-36	North and Central BC	Wells_Bridge	49
			Taku_R	55
			Tuskwa_Cr	62
			Crow_Lagoon_Cr	81
Portland Inlet Region	CU-26_30-32_AK-01.1	North and Central BC	Disappearance_Cr	77
			Ensheshese_R	103
			Fish_Cr	96
			Kateen_R	94
			Ksemamaith_Cr	66
			Kshwan_R	92
			Lachmach_R	137
			Lagoon_Cr	75
			Lizard_Cr	57
			Nakat_Inlet	108
			Neets_Bay_Hatchery_Early	78
			Neets_Bay_Hatchery_Late	99
			Stagoo_Cr	58
			Stumaun_Cr	49
			Toon_R	63
			Tseax_R	75
Middle Skeena	CU-28	North and Central BC	Wilauks_Cr	50
			Date_Cr	137

Repunit/Conservation Unit	CU Number	Region	Population	N
Lower Skeena	CU-27	North and Central BC	Kispiox_R	59
			Kitwanga_R	98
			McCully_Cr	55
			Nangeese_R	104
			Andesite_Cr	123
			Dog_Tag_Cr	104
			Ecstall_R	96
			Kitsumkalum_R	74
			Whitebottom_Cr	75
			Zymagotitz_R	73
North Haida Gwaii-Stanley Creek	CU-25	North and Central BC	Stanley_Cr	108
North Haida Gwaii	CU-24	North and Central BC	Ain_R	45
			Awun_R	95
West Haida Gwaii	CU-23	North and Central BC	Naden_R	66
			Botany_Inlet_Cr_Head	44
			Clapp_Basin	94
			Dawson_Inlet_Cr	92
			Fairfax_Inlet_Cr_Outer	42
			Gold_Harbour_Cr	67
			Goski_Bay_Cr	58
			Kano_Inlet_Cr	98
			Mace_Cr	73
			Mountain_Cr	96
			Seal_Inlet_Cr	116
			Security_Inlet_Cr_LH	84
			Steel_Cr	137
			Buck_Channel_Cr_#2	95
			Deena_R	94
			Honna_R	80
			Lagins_Cr	121
Skidegate	CU-22	North and Central BC	North_Arm_Cr_RH	48
			Slatechuck_Cr	54
			Tarundl_Cr	99
			Bag_Harbour_Cr	154
			Dana_Cr	88
			Hutton_Cr_Head	37
			Lagoon_Inlet	95
			Little_Goose_Cr	98
			Pacofi_Cr	111
			Pallant_Cr	104
			Salmon_R_Area2E	69
			Sedgwick_Cr	76
East HG	CU-21	North and Central BC		

Repunit/Conservation Unit	CU Number	Region	Population	N
Douglas-Gardner-Mussel-Kynoch	CU-19-20	North and Central BC	Sedmond_Cr	112
			Surprise_Cr	40
			Thorsen	95
			Bish_Cr	61
			Foch_R	71
			Gilttoyes_Cr	74
			Green_R	67
			Kainet_Cr	76
			Kemano_R	85
			Khutze_R	42
			Kiltuish_R	93
			Kitimat_R	94
			Lard_Cr	61
			Quaal_R	86
Hecate Lowlands	CU-18	North and Central BC	Arnoup_Cr	128
			Barnard_Cr	99
			Blackrock_Cr	52
			Duthie_Cr	69
			East_Arm_Cr	88
			Flux_Cr	130
			Gil_Cr	45
			Kitasoo_Cr	134
			Markle_Inlet_Cr	41
			Nias_Cr	76
			Pa-aat_R	44
			Salmon_Bay_Cr	41
			Stewart_Cr	59
			Tyler_Cr	83
			West_Arm_Cr	95
			Wilson_Cr	31
Bella Coola-Dean_all	CU-16-17	North and Central BC	Bella_Coola_R	52
			Kimsquit_R	37
			Nooseseck_R	22
			Skowquiltz_R	76
			Snootli_Cr	47
Spiller-Fitz Hugh-Burke	CU-15	North and Central BC	Bella_Bella	96
			Bullock_Channel_Cr	46
			Cheenis_Lake_Cr	62
			Cooper_Inlet_#1_Cr	63
			Deer_Pass_Cr	71
			Frenchman_Cr	49
			Hook_Nose_Cr	48



Repunit/Conservation Unit	CU Number	Region	Population	N
Rivers Inlet	CU-13	North and Central BC	Jenny_Bay_Cr	56
			Kwakusdis_R	55
			Martin_R	44
			McLoughlin_Cr	95
			Neekas_Cr	72
			Quartcha_Cr	27
			Clyak_R	50
Smith Inlet	CU-12	North and Central BC	MacNair_Cr	104
			Draney_Cr	72
			Lockhart_Gordon_Cr	81
Northwest Vancouver Island	CU-11	Southern BC	Nekite_R	117
			Walkum_Cr	57
			Cayeghle_R	86
			Colonial_Cr	90
			Goodspeed_R	21
Southwest Vancouver Island	CU-10	Southern BC	Pegattem_Cr	53
			Bedwell_R	51
			Black_Cr_WCVI	25
			Burman_R	29
			Canton_Cr	97
			Conuma_R	108
			Hoiss_Cr	27
			Kaouk_R	47
			Little_Toquart_Cr	69
			Lord_Cr	29
			Nahmint_R	121
			Nitinat_R	119
			Park_R	25
			Salmon_Cr_WCVI	50
			Sarita_R	22
			Sucwoa_R	106
			Sugsaw_Cr	92
			Tlupana_R	104
			Tranquil_Cr	69
			Warn_Bay_Cr	39
Upper Knight	CU-09	Southern BC	Ahnuhati_R	128
Southern Coastal Streams	CU-08	Southern BC	Klinaklini_R	95
			Mackenzie_Sound_Cr	20
			Taaltz_Cr	24
			Viner_Scott_Cove	107
Bute Inlet	CU-07	Southern BC	Viner_Sound	129
			Algard_Cr	63
			Homathko_R	94

Repunit/Conservation Unit	CU Number	Region	Population	N
Loughborough	CU-06	Southern BC	Orford_R	88
			Southgate_R	59
			Glendale_Cr	75
			Heydon_Cr	150
			Phillips_R	146
Northeast Vancouver Island Georgia Strait	CU-05	Southern BC	Nimkish_R	103
			Campbell_R	184
	CU-04	Southern BC	Chemainus_R	59
			Cold_Cr	20
			Cowichan_R	108
			Demamiel_Cr	50
			Englishman_R	131
			Goldstream_R	184
			Lang_Cr	64
			Lit_Qualicum_R	190
			Myrtle_Cr	27
			Nanaimo_R	85
			Okeover_Cr	82
			Puntledge_R	193
			Qualicum_R	178
			Sliammon_Cr	59
			Snake_Bay_Cr	89
			Theodosia_R	90
			Tzoonie_R	85
Howe Sound-Burrard Inlet	CU-03	Southern BC	Cheakamus_R	75
			Indian_R	113
			Mamquam_R	98
			Mashiter_Cr	45
			Shovelnose_Cr	80
			Squamish_R	69
Lower Fraser	CU-02	Southern BC	Alouette_N	54
			Alouette_R	37
			Barnes_Cr	32
			Blaney_Cr	59
			Chehalis_R	97
			Chilliwack_R	148
			Chilqua_Cr	103
			Harrison_R	75
			Harrison_R_Late	97
			Hicks_Cr	68
			Hopedale_Cr	111
			Hunter_Cr_FR	73
			Inch_Cr	91

Repunit/Conservation Unit	CU Number	Region	Population	N
North_Puget_Sound	WA-02	Washington	Kanaka_Cr	83
			Kawkawa_Cr	54
			Lillooet_R_Lower	55
			MacIntyre_Cr	51
			Norrish_Worth_Cr	79
			Peach_Cr	159
			Railroad_Cr	65
			Serpentine_R	32
			Silverdale_Cr	99
			Silverhope_Cr	60
			Squawkum_Cr	123
			Stave_R	112
			Street_Cr	178
			Sweltzer_R	62
			Vedder_R	67
			Wahleach_Cr	50
			Whonnock	65
			Widgeon_Cr	88
			Worth_Cr	54
			County_Line_Cr_Fall	60
			Grant_Cr_Fall	49
			Nooksack_R	60
			Sauk_R	39
			Siberia_Cr_Fall	36
			Skagit_R	46
			Skykomish_R	85
			Snohomish_R	76
Central_Sound	WA-07	Washington	Stillaguamish_R	76
South_Puget_Sound	WA-01	Washington	Chico_Grovers_Hatch	140
			Green_R_Keta_Hatchery	92
Hood Canal Region-Fall	WA-03.1-04_06	Washington	Kennedy_Cr	95
			Mill_Cr	56
			Minter_Cr	93
			Nisqually_R	96
			Nisqually_R_Winter	89
			Puyallup_R	82
			Skookum_Cr_Fall	56
			Big_Beef_Cr_Fall	75
			Big_Mission_Cr	26
			Elwha_R_Fall	61
			Enetai_Cr_Fall	90
			Hoodsport_Fall	94
			Lilliwaup_Cr	100

Repunit/Conservation Unit	CU Number	Region	Population	N
Hood Canal-Summer	WA-03.2	Washington	McKernan_Hatch_Fall	69
			Spencer_Cr	30
			Tulalip	80
			Big_Quilcene_R_Summer	72
			Jimmycomelately_Cr	23
Coastal_Washington	WA-05	Washington	Salmon_Cr_HOOD	95
			Bitter_Cr	87
			Ellsworth_Cr	56
			Quinault_R	81
			Satsop_R_Fall	84

## Appendix D: 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 24 days between September 29<sup>th</sup> and November 6<sup>th</sup>, 2020, targeting the peak migration periods. Weekly trips were typically two days of fishing in US waters and 2 days fishing in Canadian waters. We targeted a sample rate of 100 Chum per day, to a maximum of 400 per week over the course of each 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 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 was 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 wheelhouse 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 they 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.

Markers were obtained from several sources, including the University of Washington (UW) GTseq panel (Oke\_GTseq350; n = 198 markers), the Washington Department of Fish and Wildlife (WDFW) marker panel (n = 163 markers), two collections of additional markers provided by UW (Jim Seeb, pers. comm; n = 200 and n = 113 markers), as well as markers from the DFO Molecular Genetics Lab including species identification markers (MGL; n = 11 markers). These datasets were all collected using the code repository `fasta_SNP_extraction` (see Data Availability). Collectively, this resulted in a total of 685 target SNPs for development. Two markers from UW were screened out as they were insertion/deletions rather than SNPs, leaving a total of 683 markers in this amplicon panel.

For the 683 input markers, the available sequence data typically derived from RADseq data (often less than 200 bp) were collected into a fasta file and aligned against a contig-level chum salmon reference genome produced by the University of Victoria (B. Koop, pers. comm.), using BLAST (Altschul et al. 1990) with an e-value cutoff of  $1e-30$ . To avoid primer designs in repetitive regions of the genome, only those markers that aligned four or fewer times were retained for further analysis, which resulted in dropping 86 markers. Using the `fasta_SNP_extraction` pipeline, a total of 400 bp of flanking sequence was taken from the reference genome to optimally obtain 200 bp on either side of the targeted variant. The two alleles for the variant were inserted into the 400 bp fragment, and this was submitted to Thermo Fisher for design of an AmpliSeq panel, as previously conducted (Sutherland et al. 2020). The Thermo Fisher design team was able to design all primers for the panel, as per manufacturers' methods, except for six markers that were dropped from the panel due to design issues. For full details on this method, see Sutherland et al. (2020) and the `fasta_SNP_extraction` pipeline (see Data Availability).

DNA from each fish was normalized to 40 ng/μl, barcoded and amplified according to the AgriSeq panel protocol using the chum v.1.0 primers, as per manufacturers' instructions, using the available 768 barcodes (Thermo Fisher), as previously described (Beacham et al. 2017). Pools of barcoded 768 individuals were collected and sequenced on an Ion Torrent PI chip using the Ion Chef to prepare sets of two chips for sequencing on a single run of the Ion Torrent. Sequenced samples were de-multiplexed, the total number of reads per chip assessed for quality of the overall chip, and variants called per sample using a hotspots file and the Torrent Suite software (TS v.5.10.1; variantCaller v.5.6.0.4; Thermo Fisher).

### Baseline Populations

The Pacific Rim SNP baseline of 400 sampling locations from Japan to coastal Washington including Russia, Alaska, and Yukon River was used for the Genetic Stock Identification of the Chum salmon from the Area 20 test fishery (Appendix C: Baseline of 400 sample sites/populations by regional genetic groups used to estimate stock composition of Chum salmon from southern British Columbia and Washington State in 2020 fisheries (bcm-SNP\_coastwide\_v2.0.0\_2020-04-05)). Of the 68 reporting regions 16 regional groupings of populations from southern British Columbia and Washington 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

SNP GSI analysis was conducted with RUBIAS (Moran and Anderson, 2019), with the population posterior means file the basic file used for subsequent analyses. This file contained the probability of assignment of the individual to each of the 398 populations in the baseline, with the version of the baseline used for analysis being MGL SNP coastwide baseline v.3.0.0. A total of 25,000 iterations was run, with the first 5,000 iterations set as burn-in. The last 5,000 iterations from the Monte Carlo Markov Chain from RUBIAS were used to estimate the origin of individuals and stock composition, with the mean allocation to each population and reporting unit in the baseline. Standard deviations of estimated stock compositions were also determined from the last 5,000 iterations from the Monte Carlo Markov Chain. This approach allowed estimation of uncertainty from sources of variance from both the sample size and the genetic assignments.

## Results and Discussion

The program initiated as planned on September 29<sup>th</sup> and ran until November 6<sup>th</sup>. Data has been stratified over each week and by fishing area (see Table 1 for the week assignments). A total of 129 sets were completed (70 in Canadian fishing areas and 59 in US fishing areas). A total of 4,302 (compared to 1,471 in 2016, 9,577 in 2017 and 8,688 in 2018 and 762 in 2019) Chum were encountered and 1,794 were sampled for stock id and other biologicals. Most fish in 2020 were caught in quadrants A on the Canadian side and D on the United States 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 fifth 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 (Figure 2). Set locations were collected on the data sheets as well as through VMS. The GPS coordinates of each of these set locations (Appendix C: Baseline of 400 sample sites/populations by regional genetic groups used to estimate stock composition of Chum salmon from southern British Columbia and Washington State in 2020 fisheries (bcm-SNP\_coastwide\_v2.0.0\_2020-04-05))

Repunit/Conservation Unit	CU Number	Region	Population	N
Korea	KOR-01	Korea	Namdae_R	96
Honshu_Japan_Sea	JPN-03	Japan	Gakko_R	35
			Hayatsuki_R	70
			Kawabukuro_R	92
			Miomote_R	93
			Uono_R	79
Honshu_Pacific_Coast	JPN-04	Japan	Koizumi_R	79

Repunit/Conservation Unit	CU Number	Region	Population	N
Hokkaido_eastern	JPN-07	Japan	Sakari_R	75
			Tsugaruishi_R	54
			Kushiro_R	34
			Tokachi_R	109
Nemuro_Strait	JPN-05	Japan	Nishibetsu_R	77
			Shibetsu_R	106
Hokkaido_Sea_of_Okhotsk	JPN-01	Japan	Abashiri_R	129
			Horonai_R	50
			Shari_R	77
			Tokoro_R	116
Hokkaido_western	JPN-06	Japan	Tokushibetsu_R	108
			Shikui_R	80
			Shiriuchi_R	91
			Shizunai_R	80
Hokkaido_Japan_Sea	JPN-02	Japan	Yurappu_R	77
			Chitose_R	91
			Teshio_R	73
			Toshibetsu_R	56
Primorye	RU-07	Russia	Avakumovka_R	33
Sakhalin	RU-03	Russia	Ryazanovka_R	45
			Kalininka_R	45
			Naiba_R	124
			Tym_R	47
Amur	RU-06	Russia	Udarnitsa_R	49
			Amur_R	146
Magadan	RU-05	Russia	Suifen_R	21
			Magadan_R	67
			Okhota_R	85
			Ola_R	111
Northern_Sea_of_Okhotsk			Tauy_R	52
			Tugur_R	98
			Oklan_R	70
			Penzhina_R	35
West_coast_Kamchatka	RU-01	Russia	Bolshaya_R	97
			Hairusova_R	93
			Kikhchik_R	86
			Kol_R	80
			Plotnikova_R	72
			Pymta_R	88
			Utka_R	36
			Vorovskaya_R	151
East_coast_Kamchatka	RU-02	Russia	Apuka_R	48
			Dranka_R	48

Repunit/Conservation Unit	CU Number	Region	Population	N
North_east_Russia	RU-04	Russia	Ivashka_R	43
			Kamchatka_R	66
			Karaga_R	42
			Nerpichye_Lake	40
			Olyutorsky_Bay	51
			Ossora_R	89
			Zhupanova_R	38
			Anadyr_R	91
			Impuka_R	29
			Kanchalan_R	76
Kotzebue	AK-02	Western Alaska (excluding Yukon River)	Agiapuk_R	93
			Inmachuk_R	93
			Kelly_Lake	95
			Kobuk_R	92
			Koyuk_R	43
			Noatak_R	25
Norton_Sound_north	AK-05	Western Alaska (excluding Yukon River)	Eldorado_R	93
			Kwiniuk_R	79
			Niukluk_R	86
			Nome_R	117
			Pikmiktalik_R	132
			Pilgrim_R	95
			Shaktoolik_R	94
			Snake_R	89
			Unalakleet_R	93
			Ungalik_R	50
Kuskokwim_Bay_River	AK-08	Western Alaska (excluding Yukon River)	Aniak_R	93
			Big_R_Kusko	88
			George_R	104
			Goodnews_R	113
			Holokuk_R	62
			Kanektok_R	150
			Kasigluk_R	42
			Kogruklu_R	125
			Kuskokwim_R_South_Fork	141
			Kwethluk_R	107
			Nunsatuk_R	74
			Salmon_R_WAlaska	89
			Takotna_R	99
			Tatlawiksuk_R	101
			Tuluksak_R	94

Repunit/Conservation Unit	CU Number	Region	Population	N
North_east_Bristol	AK-09	Western Alaska (excluding Yukon River)	Alagnak_R Naknek_R Togiak_R	81 56 77
Nushagak_summer	AK-14	Western Alaska (excluding Yukon River)	Mulchatna_R Stuyahok_R	69 43
South_west_Bristol	AK-07	Western Alaska (excluding Yukon River)	Egegik_Bay Gertrude_Cr Pumice_Cr	75 88 94
North_Peninsula	AK-03	Western Alaska (excluding Yukon River)	Frosty_Cr Joshua_Green_R Moller_Bay	94 98 92
Tanana_summer	AK-15	Yukon River - US	Chena_R_Early Chena_R_Late Salcha_R_Early Salcha_R_Late	94 67 44 32
Tanana_fall	AK-16	Yukon River - US	Delta_R Kantishna_R Toklat_R	79 101 100
Upper_Alaska_fall	AK-11	Yukon River - US	Big_Salt_R Black_R Chandalar_R Sheenjek_R	36 97 45 132
Lower_river_summer	AK-10	Yukon River - US	Andreafsky_R Anvik_R California_Cr Chulinak_R Gisasa_R Henshaw_Cr Jim_R Koyukuk_R_Middle_Fork Koyukuk_R_South_Fork_Late Meložitna_R Nulato_R Tožitna_R	88 96 46 67 42 100 95 96 57 141 95 86
Teslin	CU-38	Yukon River - Canada	Teslin_R	102
Middle Yukon River	CU-42	Yukon River - Canada	Big_Cr Pelly_R Tatchun_R Yukon_R@Minto	120 64 83 78
Donjek-Kluane-White	CU-44-45	Yukon River - Canada	Donjek_R	69

Repunit/Conservation Unit	CU Number	Region	Population	N
North Yukon River	CU-43	Yukon River - Canada	Kluane_Lake	103
			Chandindu_R	85
Porcupine River	CU-46	Yukon River - Canada	Fishing_Branch_R	85
			Porcupine_R	48
South_west_Peninsula	AK-13	Central Alaska	Coleman_Cr	72
			Delta_Cr	74
			Volcano_Bay	106
			Westward_Cr	77
South_east_Peninsula	AK-06	Central Alaska	Alagogshak_Cr	93
			Big_R	89
			Stepovak_Bay	86
			American_R	92
Kodiak	AK-04	Central Alaska	Sturgeon_R	70
			Uganik_R	81
			Constantine_Cr	43
			Keta_Cr	84
Prince_William_Sound	AK-12	Central Alaska	Olsen_Bay_Cr	71
			Wells_R	95
			Dipac_Hatchery	147
			Gambier_Bay	60
SE_Alaska	AK-01.2	Southeast Alaska	Greens_Cr	45
			Herman_Cr	54
			Kennel_Cr	36
			Sawmill_Cr	32
			Wells_Bridge	49
			Taku_R	55
			Tuskwa_Cr	62
			Crow_Lagoon_Cr	81
			Disappearance_Cr	77
			Ensheshese_R	103
Taku	CU-36	North and Central BC	Fish_Cr	96
			Kateen_R	94
			Ksemamaith_Cr	66
			Kshwan_R	92
			Lachmach_R	137
			Lagoon_Cr	75
			Lizard_Cr	57
			Nakat_Inlet	108
			Neets_Bay_Hatchery_Early	78
			Neets_Bay_Hatchery_Late	99
Portland Inlet Region	CU-26_30-32_AK-01.1	North and Central BC	Stagoo_Cr	58
			Stumaun_Cr	49



Repunit/Conservation Unit	CU Number	Region	Population	N
Middle Skeena	CU-28	North and Central BC	Toon_R	63
			Tseax_R	75
			Wilauks_Cr	50
			Date_Cr	137
			Kispiox_R	59
			Kitwanga_R	98
			McCully_Cr	55
Lower Skeena	CU-27	North and Central BC	Nangeese_R	104
			Andesite_Cr	123
			Dog_Tag_Cr	104
			Ecstall_R	96
			Kitsumkalum_R	74
			Whitebottom_Cr	75
			Zymagotitz_R	73
North Haida Gwaii-Stanley Creek	CU-25	North and Central BC	Stanley_Cr	108
North Haida Gwaii	CU-24	North and Central BC	Ain_R	45
			Awun_R	95
			Naden_R	66
West Haida Gwaii	CU-23	North and Central BC	Botany_Inlet_Cr_Head	44
			Clapp_Basin	94
			Dawson_Inlet_Cr	92
			Fairfax_Inlet_Cr_Outer	42
			Gold_Harbour_Cr	67
			Goski_Bay_Cr	58
			Kano_Inlet_Cr	98
			Mace_Cr	73
			Mountain_Cr	96
			Seal_Inlet_Cr	116
			Security_Inlet_Cr_LH	84
			Steel_Cr	137
			Buck_Channel_Cr_#2	95
			Deena_R	94
			Honna_R	80
Skidegate	CU-22	North and Central BC	Lagins_Cr	121
			North_Arm_Cr_RH	48
			Slatechuck_Cr	54
			Tarundl_Cr	99
			Bag_Harbour_Cr	154
			Dana_Cr	88
			Hutton_Cr_Head	37
East HG	CU-21	North and Central BC	Lagoon_Inlet	95
			Little_Goose_Cr	98

Repunit/Conservation Unit	CU Number	Region	Population	N
Douglas-Gardner-Mussel-Kynoch	CU-19-20	North and Central BC	Pacofi_Cr	111
			Pallant_Cr	104
			Salmon_R_Area2E	69
			Sedgwick_Cr	76
			Sedmond_Cr	112
			Surprise_Cr	40
			Thorsen	95
			Bish_Cr	61
			Foch_R	71
			Gilttoyeses_Cr	74
			Green_R	67
			Kainet_Cr	76
			Kemano_R	85
			Khutze_R	42
Hecate Lowlands	CU-18	North and Central BC	Kiltuish_R	93
			Kitimat_R	94
			Lard_Cr	61
			Quaal_R	86
			Arnoup_Cr	128
			Barnard_Cr	99
			Blackrock_Cr	52
			Duthie_Cr	69
			East_Arm_Cr	88
			Flux_Cr	130
			Gil_Cr	45
			Kitasoo_Cr	134
			Markle_Inlet_Cr	41
			Nias_Cr	76
Bella Coola-Dean_all	CU-16-17	North and Central BC	Pa-aat_R	44
			Salmon_Bay_Cr	41
			Stewart_Cr	59
			Tyler_Cr	83
			West_Arm_Cr	95
			Wilson_Cr	31
			Bella_Coola_R	52
			Kimsquit_R	37
			Nooseseck_R	22
			Skowquiltz_R	76
			Snootli_Cr	47
			Bella_Bella	96
			Bullock_Channel_Cr	46
			Cheenis_Lake_Cr	62
Spiller-Fitz Hugh-Burke	CU-15	North and Central BC		

Repunit/Conservation Unit	CU Number	Region	Population	N
Rivers Inlet	CU-13	North and Central BC	Cooper_Inlet_#1_Cr	63
			Deer_Pass_Cr	71
			Frenchman_Cr	49
			Hook_Nose_Cr	48
			Jenny_Bay_Cr	56
			Kwakusdis_R	55
			Martin_R	44
			McLoughlin_Cr	95
			Neekas_Cr	72
			Quartcha_Cr	27
Smith Inlet	CU-12	North and Central BC	Clyak_R	50
			MacNair_Cr	104
			Draney_Cr	72
Northwest Vancouver Island	CU-11	Southern BC	Lockhart_Gordon_Cr	81
			Nekite_R	117
			Walkum_Cr	57
			Cayeghle_R	86
			Colonial_Cr	90
Southwest Vancouver Island	CU-10	Southern BC	Goodspeed_R	21
			Pegattem_Cr	53
			Bedwell_R	51
			Black_Cr_WCVI	25
			Burman_R	29
			Canton_Cr	97
			Conuma_R	108
			Hoiss_Cr	27
			Kaouk_R	47
			Little_Toquart_Cr	69
			Lord_Cr	29
			Nahmint_R	121
			Nitinat_R	119
			Park_R	25
			Salmon_Cr_WCVI	50
			Sarita_R	22
			Sucwoa_R	106
			Sugsaw_Cr	92
			Tlupana_R	104
			Tranquil_Cr	69
Upper Knight	CU-09	Southern BC	Warn_Bay_Cr	39
			Ahnuhati_R	128
Southern Coastal Streams	CU-08	Southern BC	Klinaklini_R	95
			Mackenzie_Sound_Cr	20
			Taaltz_Cr	24

Repunit/Conservation Unit	CU Number	Region	Population	N
Bute Inlet	CU-07	Southern BC	Viner_Scott_Cove	107
			Viner_Sound	129
			Algard_Cr	63
			Homathko_R	94
			Orford_R	88
Loughborough	CU-06	Southern BC	Southgate_R	59
			Glendale_Cr	75
			Heydon_Cr	150
			Phillips_R	146
			Nimpkish_R	103
Northeast Vancouver Island Georgia Strait	CU-05	Southern BC	Campbell_R	184
	CU-04	Southern BC	Chemainus_R	59
			Cold_Cr	20
			Cowichan_R	108
			Demamiel_Cr	50
			Englishman_R	131
			Goldstream_R	184
			Lang_Cr	64
			Lit_Qualicum_R	190
			Myrtle_Cr	27
			Nanaimo_R	85
			Okeover_Cr	82
			Puntledge_R	193
			Qualicum_R	178
			Slammon_Cr	59
			Snake_Bay_Cr	89
			Theodosia_R	90
			Tzoonie_R	85
Howe Sound-Burrard Inlet	CU-03	Southern BC	Cheakamus_R	75
			Indian_R	113
			Mamquam_R	98
			Mashiter_Cr	45
			Shovelnose_Cr	80
Lower Fraser	CU-02	Southern BC	Squamish_R	69
			Alouette_N	54
			Alouette_R	37
			Barnes_Cr	32
			Blaney_Cr	59
			Chehalis_R	97
			Chilliwack_R	148
			Chilqua_Cr	103
			Harrison_R	75
			Harrison_R_Late	97

Repunit/Conservation Unit	CU Number	Region	Population	N
North_Puget_Sound	WA-02	Washington	Hicks_Cr	68
			Hopedale_Cr	111
			Hunter_Cr_FR	73
			Inch_Cr	91
			Kanaka_Cr	83
			Kawkawa_Cr	54
			Lillooet_R_Lower	55
			MacIntyre_Cr	51
			Norrish_Worth_Cr	79
			Peach_Cr	159
			Railroad_Cr	65
			Serpentine_R	32
			Silverdale_Cr	99
			Silverhope_Cr	60
			Squawkum_Cr	123
			Stave_R	112
			Street_Cr	178
			Sweltzer_R	62
			Vedder_R	67
			Wahleach_Cr	50
			Whonnock	65
			Widgeon_Cr	88
			Worth_Cr	54
			County_Line_Cr_Fall	60
			Grant_Cr_Fall	49
			Nooksack_R	60
			Sauk_R	39
			Siberia_Cr_Fall	36
			Skagit_R	46
			Skykomish_R	85
			Snohomish_R	76
			Stillaguamish_R	76
Central_Sound	WA-07	Washington	Chico_Grovers_Hatch	140
South_Puget_Sound	WA-01	Washington	Green_R_Keta_Hatchery	92
			Kennedy_Cr	95
			Mill_Cr	56
			Minter_Cr	93
			Nisqually_R	96
			Nisqually_R_Winter	89
			Puyallup_R	82
			Skookum_Cr_Fall	56
Hood Canal Region-Fall	WA-03.1-04_06	Washington	Big_Beef_Cr_Fall	75
			Big_Mission_Cr	26

Repunit/Conservation Unit	CU Number	Region	Population	N
Hood Canal-Summer	WA-03.2	Washington	Elwha_R_Fall	61
			Enetai_Cr_Fall	90
			Hoodsport_Fall	94
			Lilliwaup_Cr	100
			McKernan_Hatch_Fall	69
			Spencer_Cr	30
			Tulalip	80
			Big_Quilcene_R_Summer	72
			Jimmycomelately_Cr	23
			Salmon_Cr_HOOD	95
Coastal_Washington	WA-05	Washington	Bitter_Cr	87
			Ellsworth_Cr	56
			Quinault_R	81
			Satsop_R_Fall	84

Appendix D: 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 129 sets conducted in 2020 were deemed good sets and were included in the analysis. For the 129 assessment sets 54% were within the Canadian fishing areas and 46% 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, coverage in Week 43 was not achieved in the US waters.

### *Catch and Effort information*

Catch and effort data is provided in Table 2 for the program. A total of 4,302 Chum, 119 adult Coho and 1 jack Coho were encountered during the program. Of the catch only 1,794 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 (Keep in mind there was no coverage in US waters in week 43). Unlike 2019 where the Chum CPUE tended to dominate in the US waters, the CPUE was higher through most of the season in the

Canadian waters similar to 2017 and 2018 (

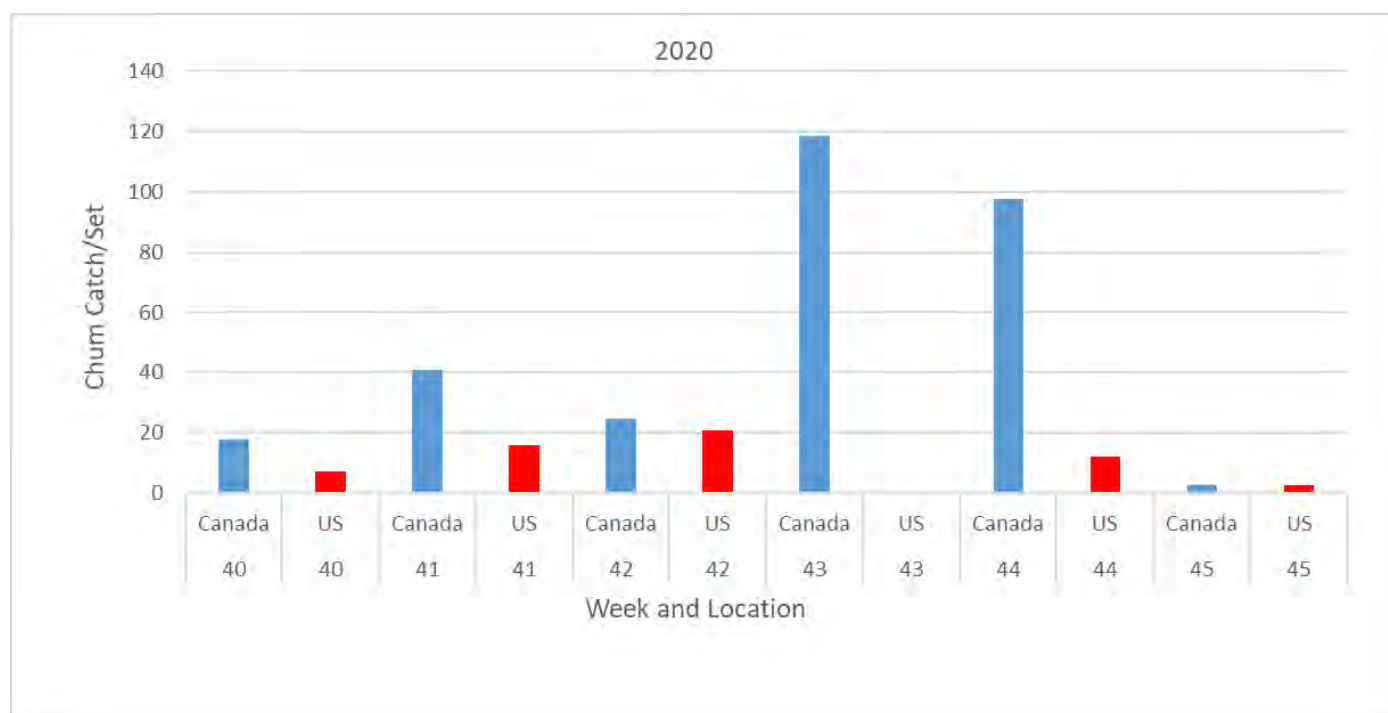


Figure 9). With only five years of data associated with this type of sampling it is difficult to draw any conclusions as to what the CPUE encountered reflects on abundance of Chum salmon moving through this area over the time but it is hoped additional years of this program will support this analysis.

### *Biological Information*

All Chum retained during the project were sampled for a variety of biologicals and 1,794 Chum were sampled over the duration of the project.

### **Sex composition**

The sex composition varied across weeks (Table 3). Male Chum dominated in the first weeks with female Chum composition increasing through the weeks and then dominating in



week 42 (

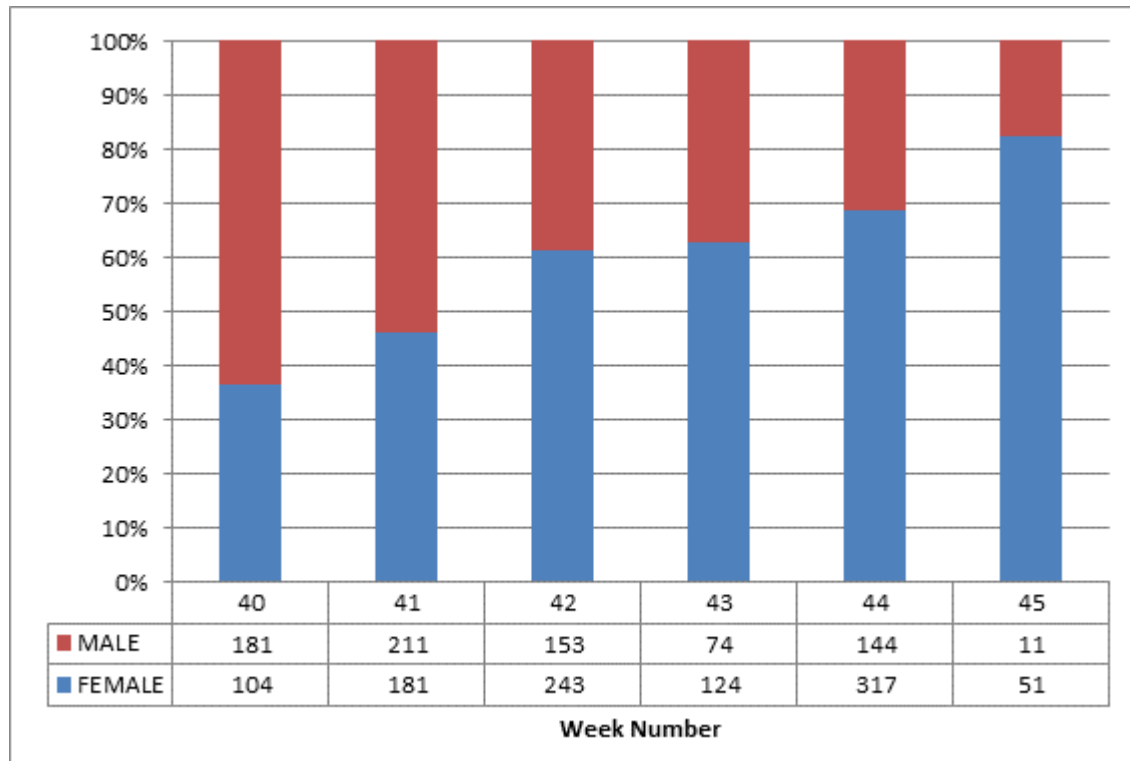


Figure 10) till the end of the sampling program. This pattern is indicative of chum migration seen in other areas such as the Johnstone Strait Test fishery.

### Age composition

Age composition was dominated by 4<sub>1</sub> Chum of the duration of the program (Table 4). The Age 5 composition was virtually nonexistent which agrees with the extremely low 4-year-old return in 2019. Age 3<sub>1</sub> and 4<sub>1</sub> females dominated the composition from week 42 through 45 (Figure 11). These results are like what was encountered in the 2020 Johnstone Strait test fishery samples for chum moving through the Northern approach.

### Length data

Fish size range from 486mm to 743mm with the average Male Chum = 633mm and females = 619mm (Table 5). 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<sub>1</sub> and 4<sub>1</sub> 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 6 and Table 7 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 very small US contributions to the catch. (Table 6). This is unlike previous year where we would see the US composition increase in Canadian waters as the season progressed. 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 7). 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 4 years. Temporally, US stocks increased their prevalence throughout October and into November in US fishing areas (Figure 14).

Regarding Canadian composition, Southern BC populations tended to dominate spatially in Canadian waters over the duration of the program. Fraser populations tended to show slightly higher contribution to the catch in US waters relative to the composition seen in the Canadian waters (Figure 14) through the first 3 weeks of sampling. The Southern BC populations were made up primarily of Strait of Georgia West, West Coast Vancouver Island and Fraser stocks through most of the season. Only a small contribution of the Strait of Georgia East stock was encountered, later supported by the very poor escapement to that area (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.

The composition of US stocks saw Hood Canal Fall Chum typically dominating in many weeks in both Canadian and US waters (Figure 16) with Central Puget Sound and South Puget Sound stocks also contributing to all areas and weeks. Juan de Fuca Falls, Puget Sound North and Coastal Washington Fall Chum did not contribute much to the samples and appeared more sporadic across time and space.

## **Conclusion**

The program in 2020 continued to be an effective platform to sample Chum migration moving through the Strait of Juan de Fuca similar to the previous 4 years (Van Will et al., 2017; Smith-Belliveau et al, 2018, Van Will et al., 2020 and Watkins et al. 2022). The program collected valuable stock specific information on spatial distribution and migration timing. The CPUE in 2020 was the third highest lower than 2017 and 2018 and well above 2016 and 2019 (Figure 17) with a similar peak to 2017 in week 43. 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 as seen over all five years of the program.

## **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 4 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. 2020 Date ranges and assigned week numbers*

<b>Date Range</b>	<b>Week Number</b>
September 26 - October 2	40
October 3 - October 9	41
October 10 - October 16	42
October 17 - October 23	43
October 24 - October 30	44
October 31 - November 6	45

*Table 2. Catch and Effort information for the program in 2020*

<b>Week Number/ Fishing Area</b>	<b>Number of Sets</b>	<b>Chum Kept</b>	<b>Chum Released</b>	<b>Coho adult released</b>	<b>Coho Jack released</b>
40					
Canada	12	200	15	41	0
US	12	85	0	19	0
41					
Canada	12	200	292	18	0
US	12	192	0	19	0
42					
Canada	8	196	0	13	0
US	10	200	8	9	1
43					
Canada	8	198	750	0	0
US	1	0	0	0	0
44					
Canada	18	316	1443	0	0
US	12	144	0	0	0
45					
Canada	12	32	0	0	0
US	12	31	0	0	0
<b>Grand Total</b>	<b>129</b>	<b>1794</b>	<b>2508</b>	<b>119</b>	<b>1</b>

Table 3. Chum Salmon sex composition over time

Week #	Female	Male	Sample Size
40	36%	64%	285
41	46%	54%	392
42	61%	39%	396
43	63%	37%	198
44	69%	31%	461
45	82%	18%	62
<b>Combined</b>	<b>57%</b>	<b>43%</b>	<b>1794</b>

Table 4. Chum Salmon age composition by sex over time

Sex/ Week #	Female				Male			
	Age 3	Age 4	Age 5	Total	Age 3	Age 4	Age 5	Total
40	4%	33%	0%	37%	9%	54%	0%	63%
41	8%	37%	0%	45%	15%	40%	0%	55%
42	13%	48%	0%	61%	11%	27%	1%	39%
43	12%	50%	0%	62%	3%	35%	0%	38%
44	17%	51%	0%	68%	8%	24%	0%	32%
45	25%	60%	0%	85%	0%	15%	0%	15%
<b>Combined</b>	<b>12%</b>	<b>45%</b>	<b>0%</b>	<b>57%</b>	<b>10%</b>	<b>34%</b>	<b>0%</b>	<b>43%</b>

Table 5. Chum salmon length by sex over time

Sex/ Week#	Average Length (mm)	Standard deviation (mm)	Maximum (mm)	Minimum (mm)	Sample Size
<b>Female</b>	<b>619</b>	<b>34</b>	<b>723</b>	<b>486</b>	<b>1020</b>
40	636	27	715	565	104
41	624	33	695	528	181
42	622	31	723	547	243
43	623	33	700	530	124
44	609	35	701	486	317
45	609	39	697	535	51
<b>Male</b>	<b>633</b>	<b>34</b>	<b>743</b>	<b>508</b>	<b>774</b>
40	641	30	710	537	181
41	632	29	705	555	211
42	631	36	726	515	153
43	634	31	705	547	74
44	627	40	743	508	144
45	650	39	717	600	11
<b>Combined</b>	<b>625</b>	<b>34</b>	<b>743</b>	<b>486</b>	<b>1794</b>



*Table 6. Estimated percentage stock composition of Chum salmon caught in the Juan de Fuca sampling program by week and Area (CDN: Canadian waters) in 2020. Stock compositions were estimated using the SNPs baseline outlined in Appendix C (bcm-SNP\_coastwide\_v2.0.0\_2020-04-05). 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 also provided.*

Year	2020		2020		2020		2020		2020		2020	
Julian Date	273-274		280-281		287-288		292-293		299-303		310-311	
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	Sept 29-Sept 30		Oct06-Oct07		Oct13-Oct14		Oct18-Oct19		Oct25-Oct29		Nov05-Nov06	
Sample Size	197 (1)		198(2)		193(2)		193(5)		314(1)		31(0)	
Region	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Fraser	5.3%	1.7%	7.8%	2.0%	12.3%	2.4%	0.6%	0.6%	6.1%	1.4%	7.6%	4.9%
Johnstone Strait	1.0%	1.9%	0.2%	0.6%	0.3%	1.1%	12.0%	3.1%	1.1%	0.9%	0.1%	1.1%
Strait of Georgia East	2.3%	1.3%	1.1%	1.1%	5.2%	2.2%	3.3%	2.0%	1.1%	1.4%	0.3%	2.0%
Strait of Georgia West	62.4%	4.3%	65.1%	4.0%	63.4%	4.3%	62.3%	4.6%	72.9%	3.2%	70.3%	9.1%
West Coast Vancouver Island	23.0%	3.5%	23.7%	3.5%	14.4%	3.0%	21.8%	3.7%	17.2%	2.6%	18.3%	7.4%
Puget Sound-North	0.0%	0.1%	0.0%	0.1%	0.3%	0.6%	0.0%	0.1%	0.0%	0.1%	0.2%	1.1%
Puget Sound-Central	3.1%	1.2%	0.0%	0.0%	0.8%	0.9%	0.0%	0.0%	0.9%	0.5%	0.0%	0.2%
Puget Sound-South	1.2%	0.8%	0.0%	0.1%	0.8%	0.9%	0.0%	0.1%	0.0%	0.0%	0.0%	0.3%
Puget Sound-Lates	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
Nooksack	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
JdF/Hood Canal Summer	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
Tulalip/Hood Canal Falls	1.8%	1.0%	2.0%	1.0%	2.6%	1.1%	0.0%	0.1%	0.7%	0.5%	3.2%	3.1%
Washington Coastal	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.4%
Country												
Canada	94.0%	1.7%	98.0%	1.1%	95.6%	1.6%	100.0%	0.5%	98.4%	0.8%	96.6%	4.1%
US	6.0%	1.7%	2.0%	1.0%	4.4%	1.5%	0.0%	0.2%	1.6%	0.7%	3.4%	3.3%

*Table 7. Estimated percentage stock composition of Chum salmon caught in the Juan de Fuca sampling program by week and Area (US: United States waters) in 2020. Stock compositions were estimated using the SNPs baseline outlined in Appendix C (bcm-SNP\_coastwide\_v2.0.0\_2020-04-05). 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 also provided.*

Year	2020		2020		2020		2020		2020	
Julian Date	275-276		282-283		289-290		300-301		308-309	
Gear	seine		seine		seine		seine		seine	
Area	JdF_TF_US		JdF_TF_US		JdF_TF_US		JdF_TF_US		JdF_TF_US	
Week #	Week40		Week41		Week42		Week44		Week45	
Sample Dates	Oct01-Oct02		Oct08-Oct09		Oct15-Oct16		Oct 26-Oct 27		Nov03-Nov04	
Sample Size	85(0)		182(10)		197(3)		142(2)		30(0)	
Region	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Fraser	8.7%	3.2%	12.0%	2.5%	13.5%	2.5%	1.4%	1.0%	3.3%	3.2%
Johnstone Strait	0.8%	1.6%	0.0%	0.2%	0.0%	0.2%	0.0%	0.2%	0.0%	0.7%
Strait of Georgia East	0.0%	0.4%	1.9%	1.1%	0.0%	0.2%	0.0%	0.2%	2.5%	4.1%
Strait of Georgia West	12.1%	3.8%	11.5%	2.6%	22.0%	3.0%	9.0%	2.4%	14.5%	7.1%
West Coast Vancouver Island	8.4%	3.0%	3.9%	1.6%	0.5%	0.5%	0.1%	0.3%	0.0%	0.7%
Puget Sound-North	2.8%	1.9%	1.8%	1.1%	0.5%	0.6%	0.0%	0.1%	0.0%	0.5%
Puget Sound-Central	13.0%	4.1%	17.3%	3.1%	17.5%	2.8%	20.3%	3.6%	7.7%	6.5%
Puget Sound-South	24.2%	5.0%	13.5%	2.8%	16.8%	2.7%	30.5%	4.1%	37.2%	8.8%
Puget Sound-Lates	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	3.4%	3.2%
Nooksack	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.9%	3.1%
JdF/Hood Canal Summer	2.0%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.3%
Tulalip/Hood Canal Falls	26.7%	4.8%	35.8%	3.6%	29.3%	3.2%	38.7%	4.1%	28.6%	8.6%
Washington Coastal	1.2%	1.2%	2.3%	1.1%	0.0%	0.1%	0.0%	0.1%	0.0%	0.3%
Country										
Canada	30.1%	4.9%	29.3%	3.4%	36.0%	3.4%	10.6%	2.6%	20.3%	7.2%
US	69.9%	5.0%	70.7%	3.4%	64.0%	3.4%	89.4%	2.6%	79.7%	7.5%

## Figures

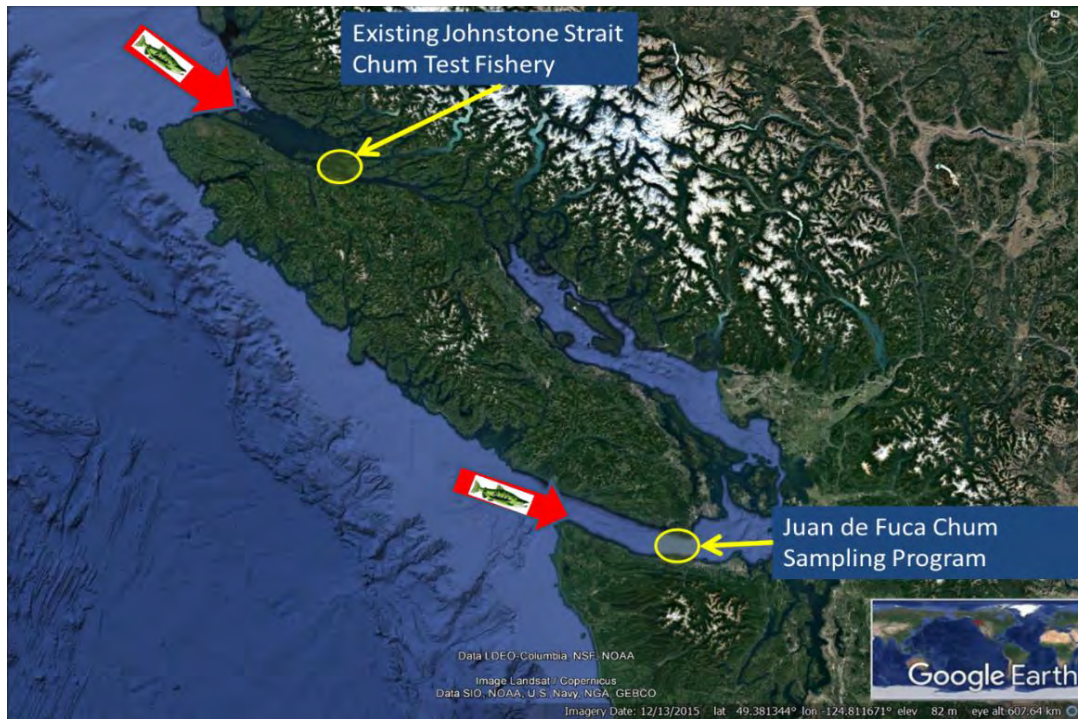


Figure 1. Map of migration pathways for Fall Chum returning to Southern BC and Washington State

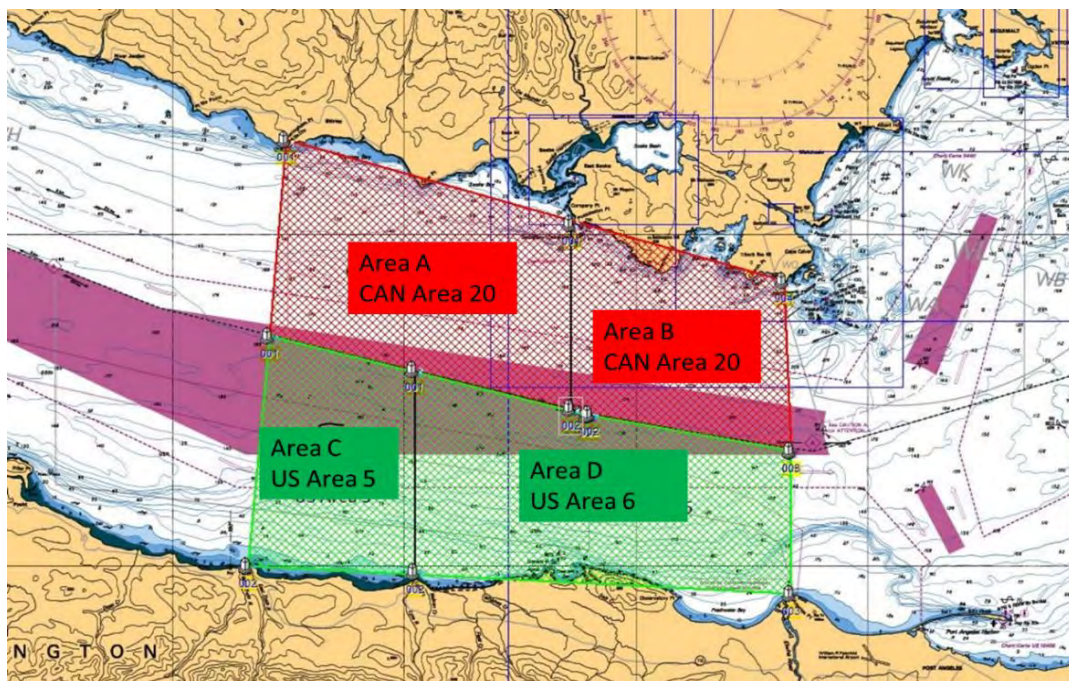


Figure 2. Map of fishing quadrants in Juan de Fuca Strait





Figure 3. Set locations Week 40 (September 21-October 3)

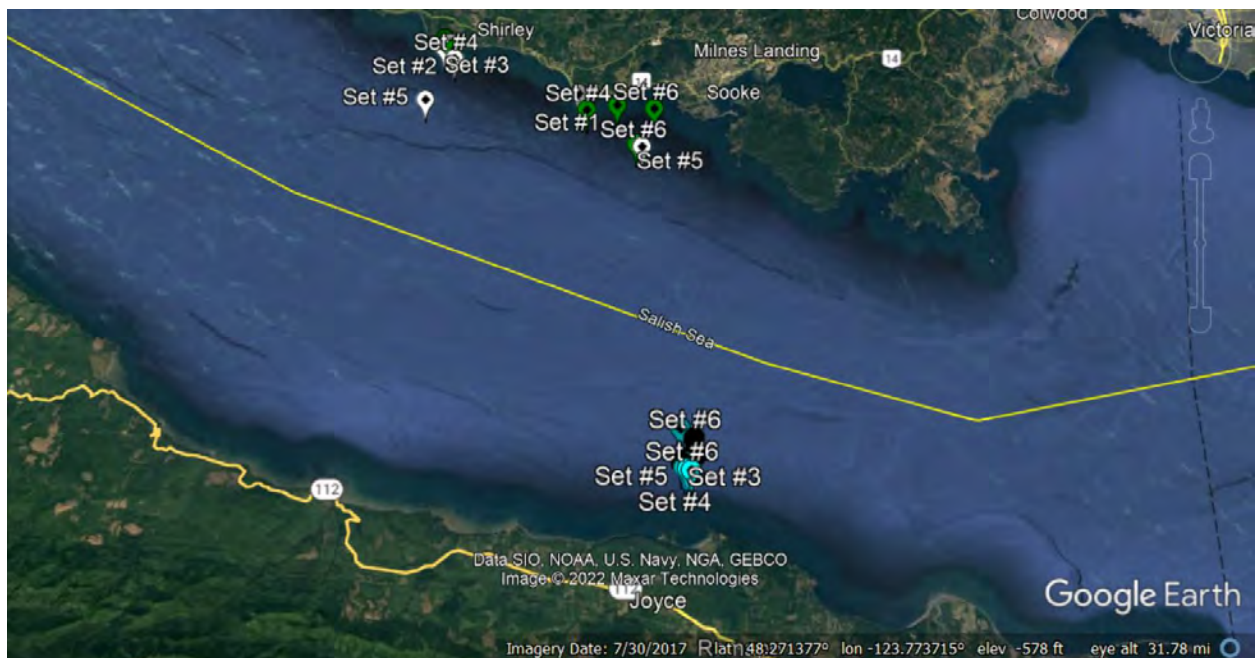


Figure 4. Set locations Week 41 (October 4-10)

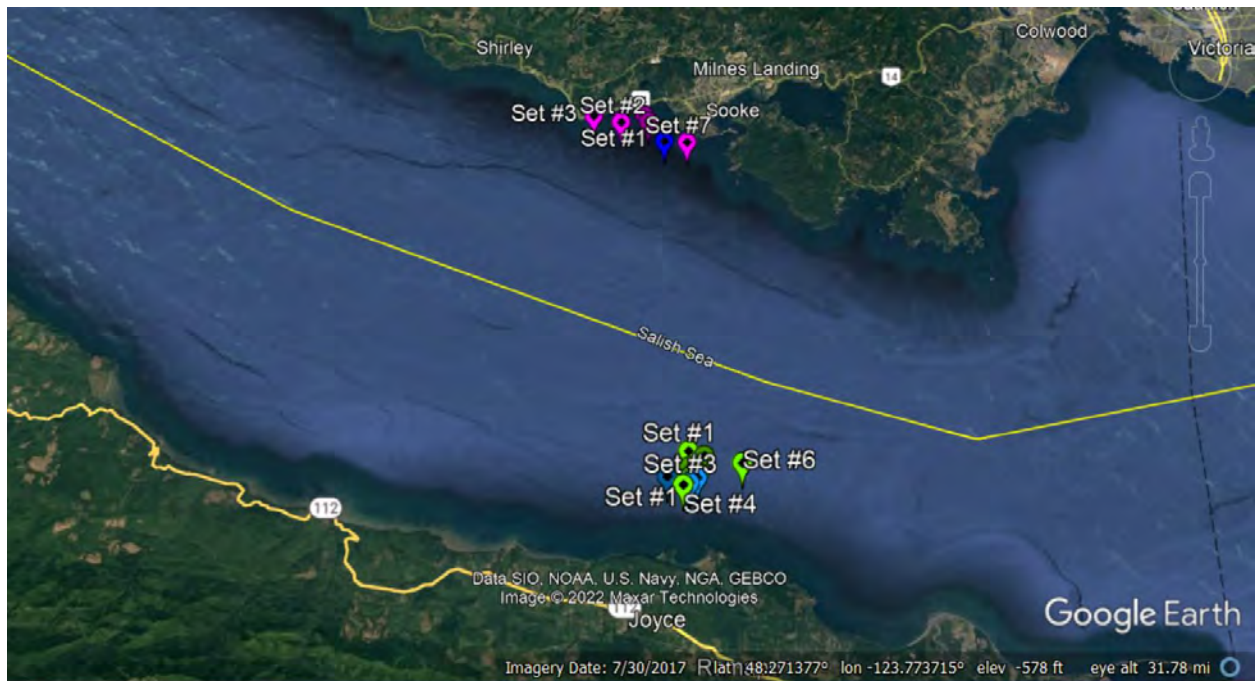


Figure 5. Set locations Week 42 (October 11-17)

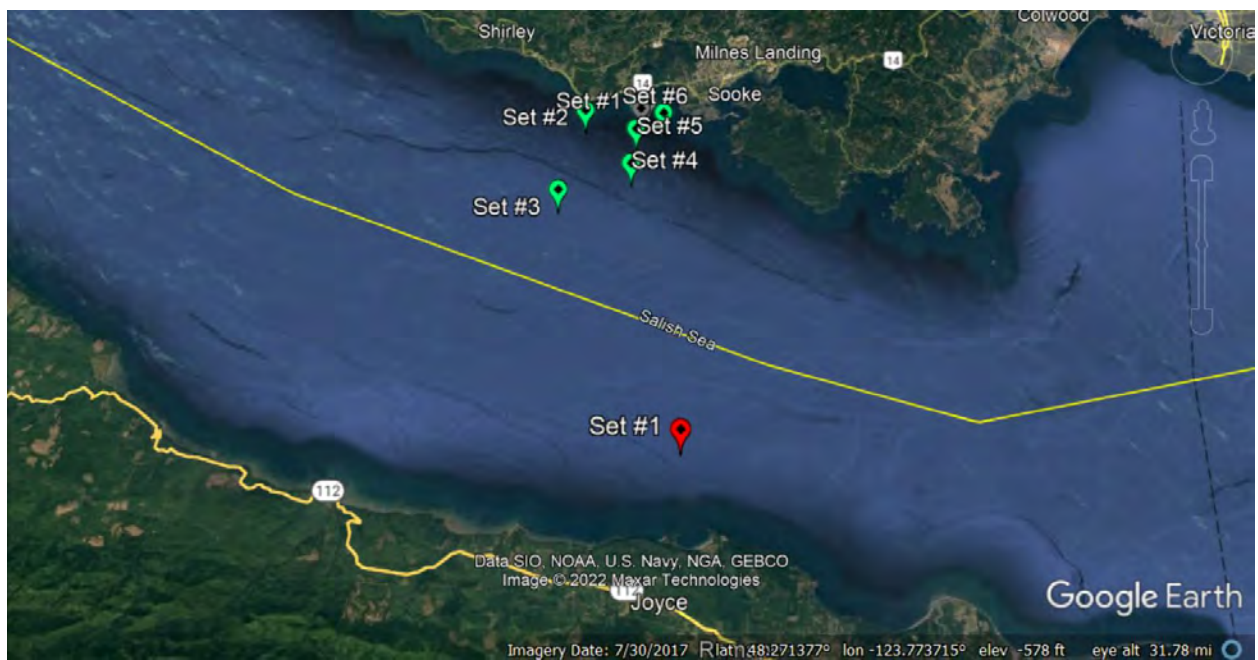


Figure 6. Set locations Week 43 (October 18-24)



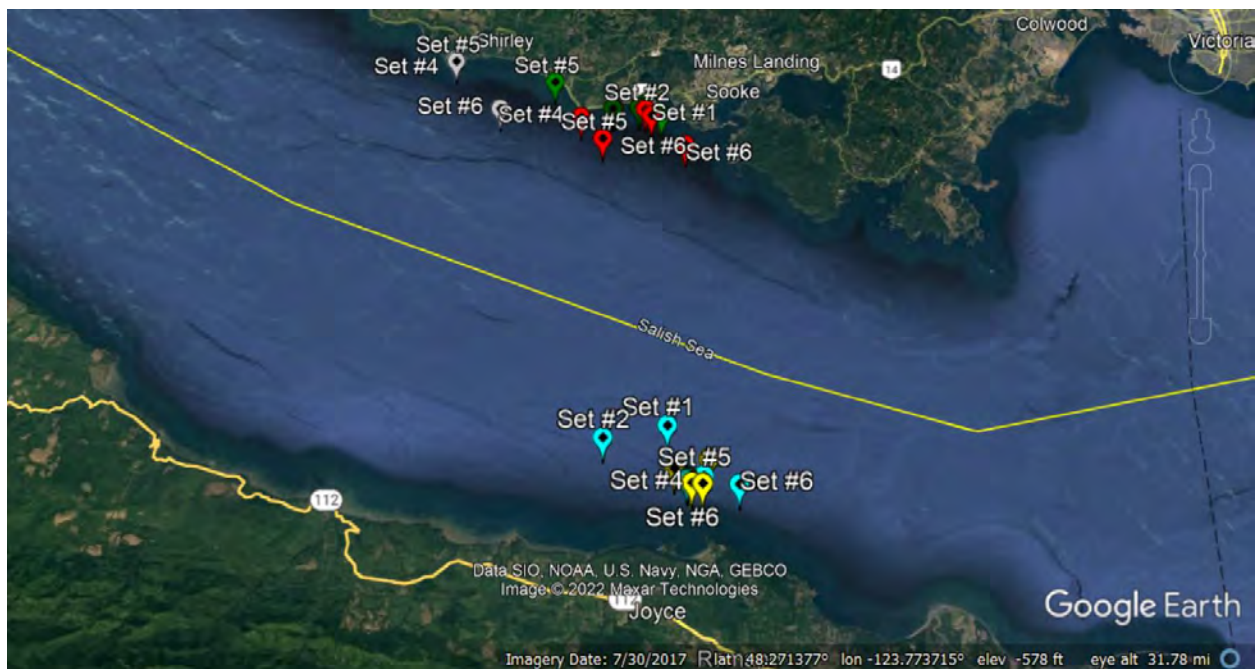


Figure 7. Set locations Week 44 (October 25-31)

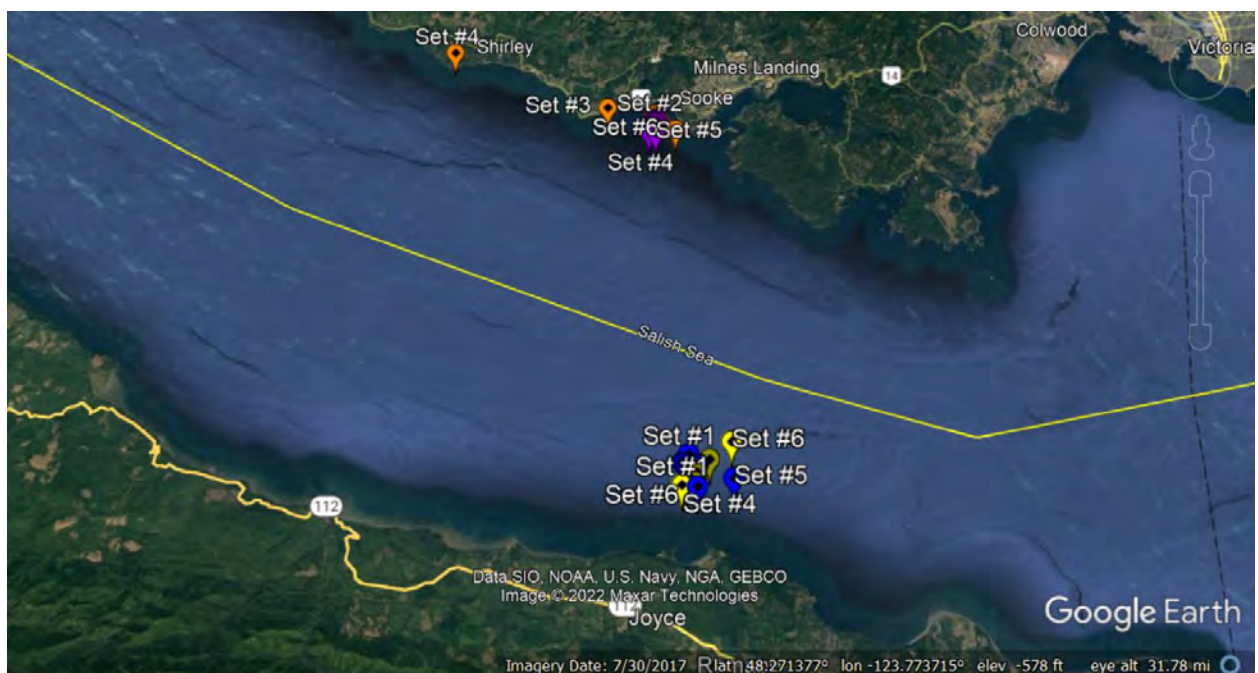


Figure 8. Set locations Week 45 (November 1-7)

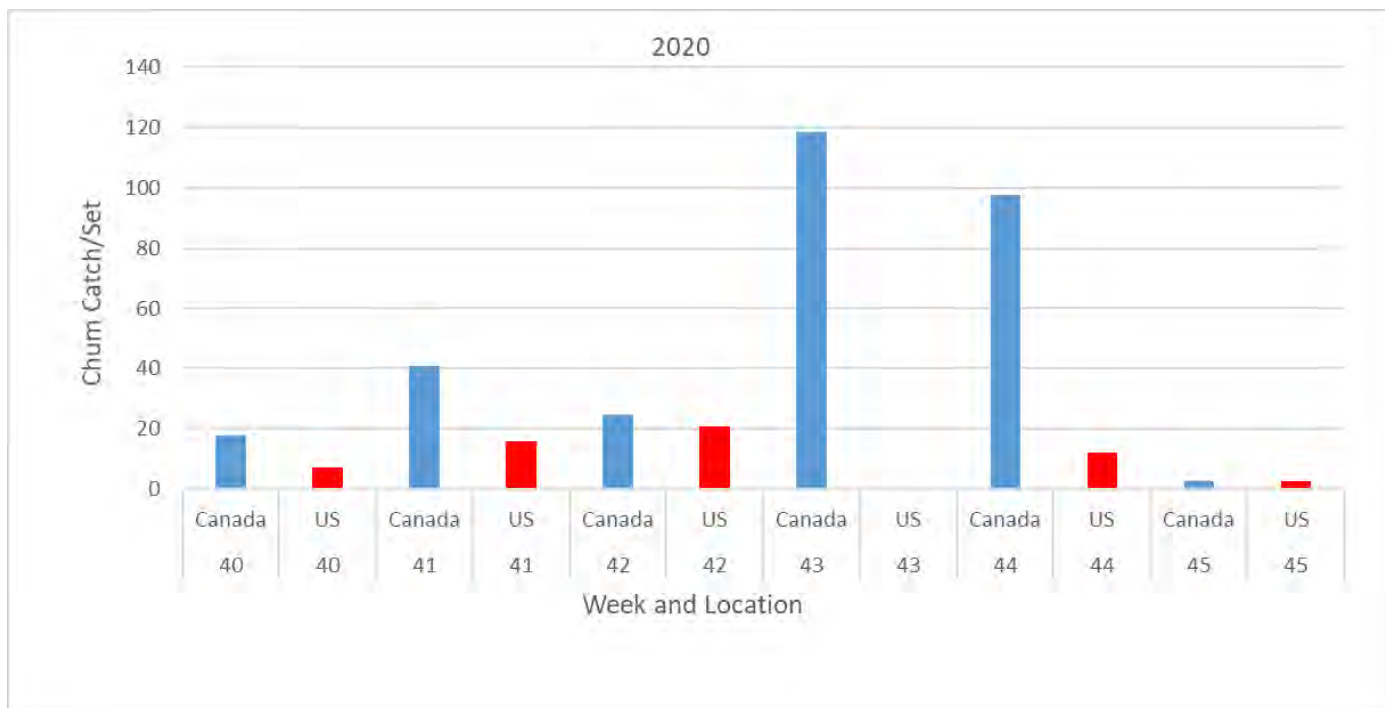


Figure 9. Chum CPUE by time and area

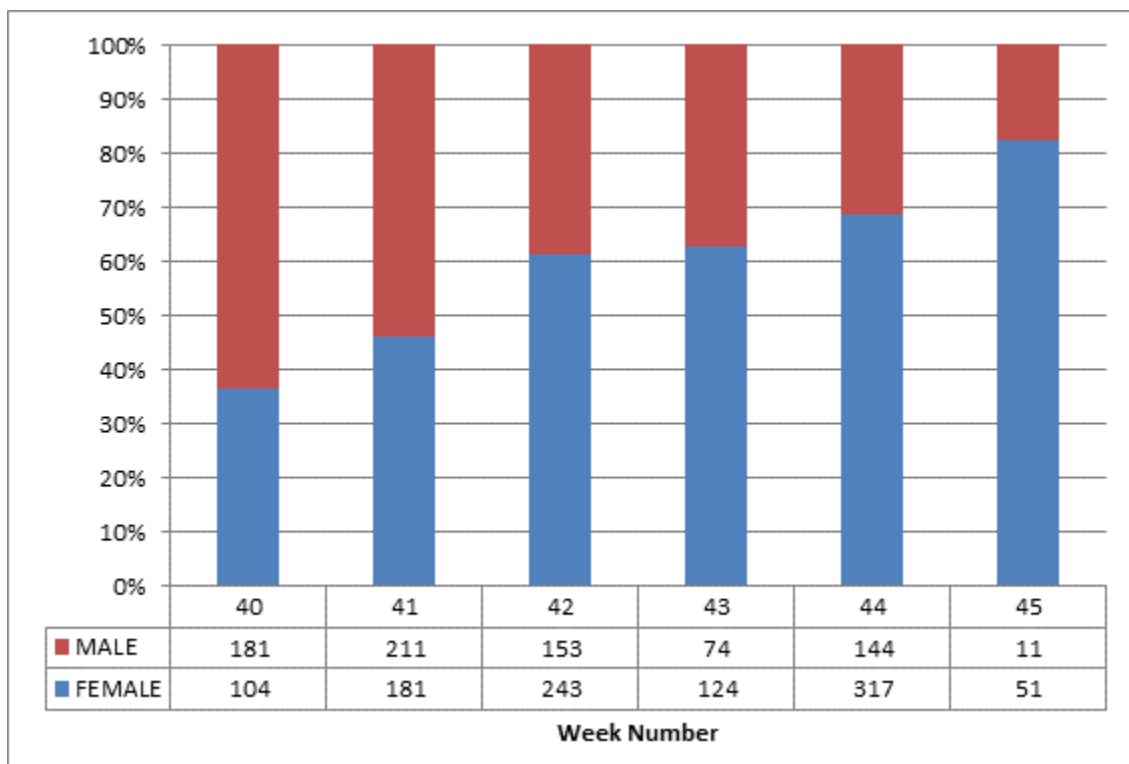


Figure 10. Chum salmon sex composition over time (sample size below week #)

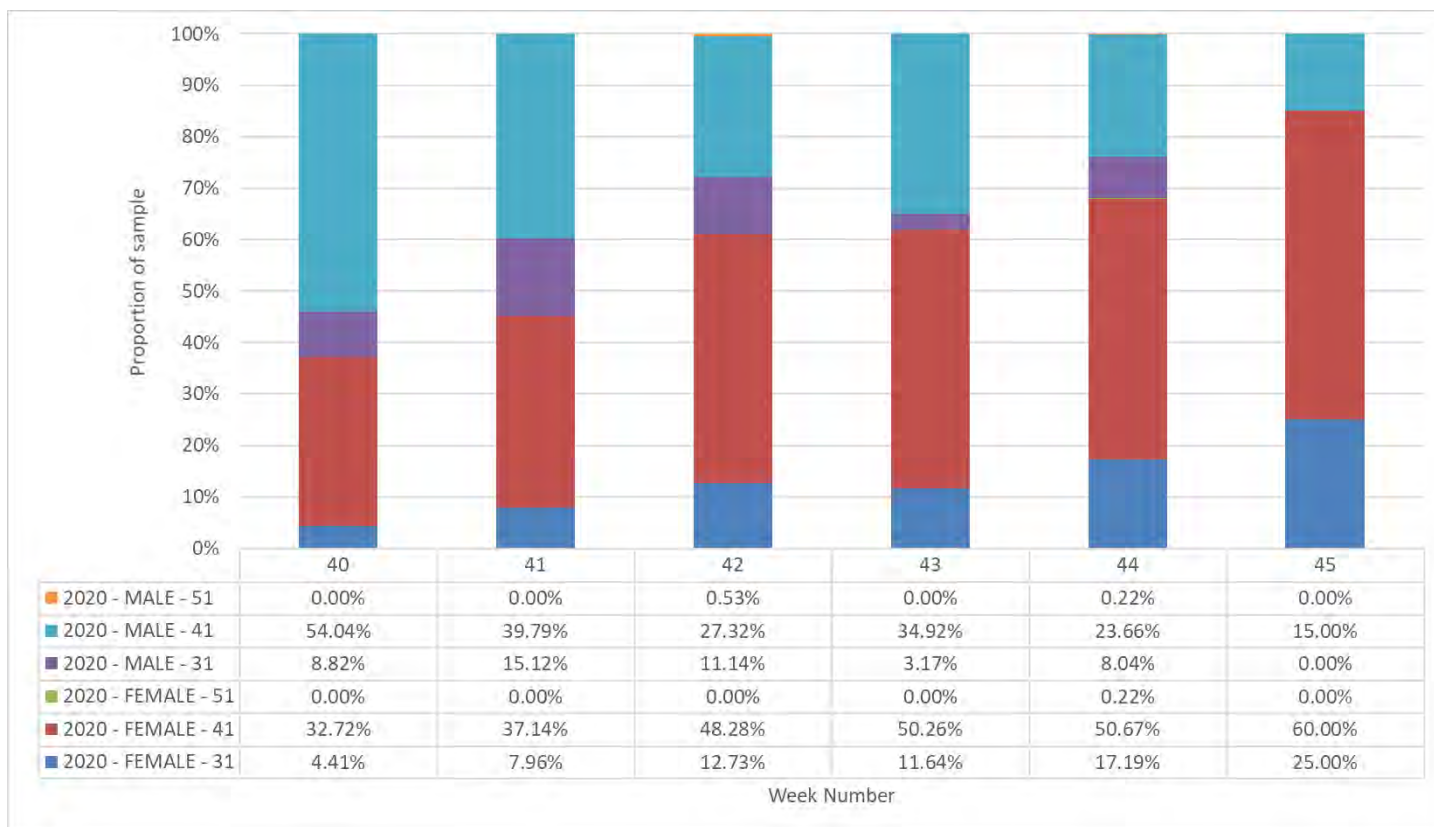


Figure 11. Chum salmon sex and age composition over time



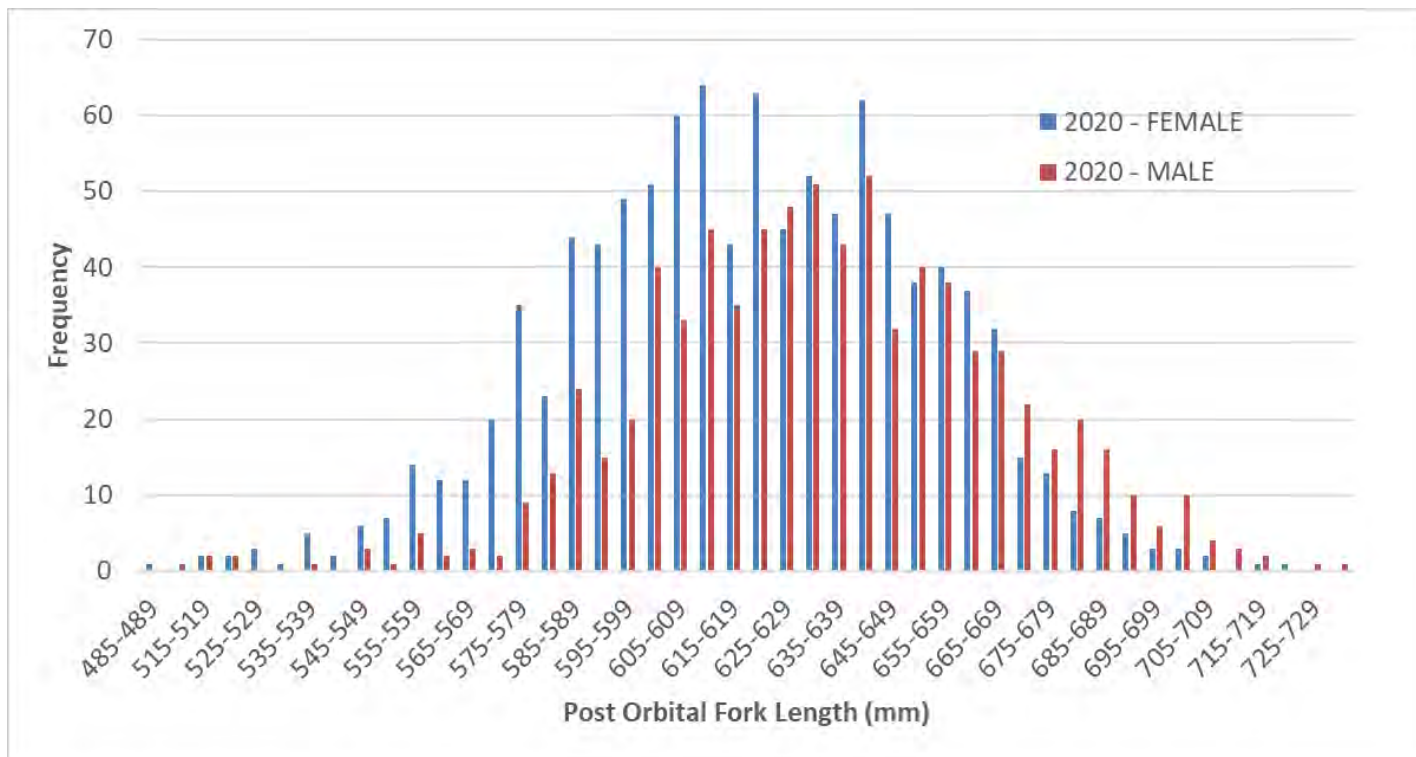


Figure 12. Length distribution of chum sampled in 2019

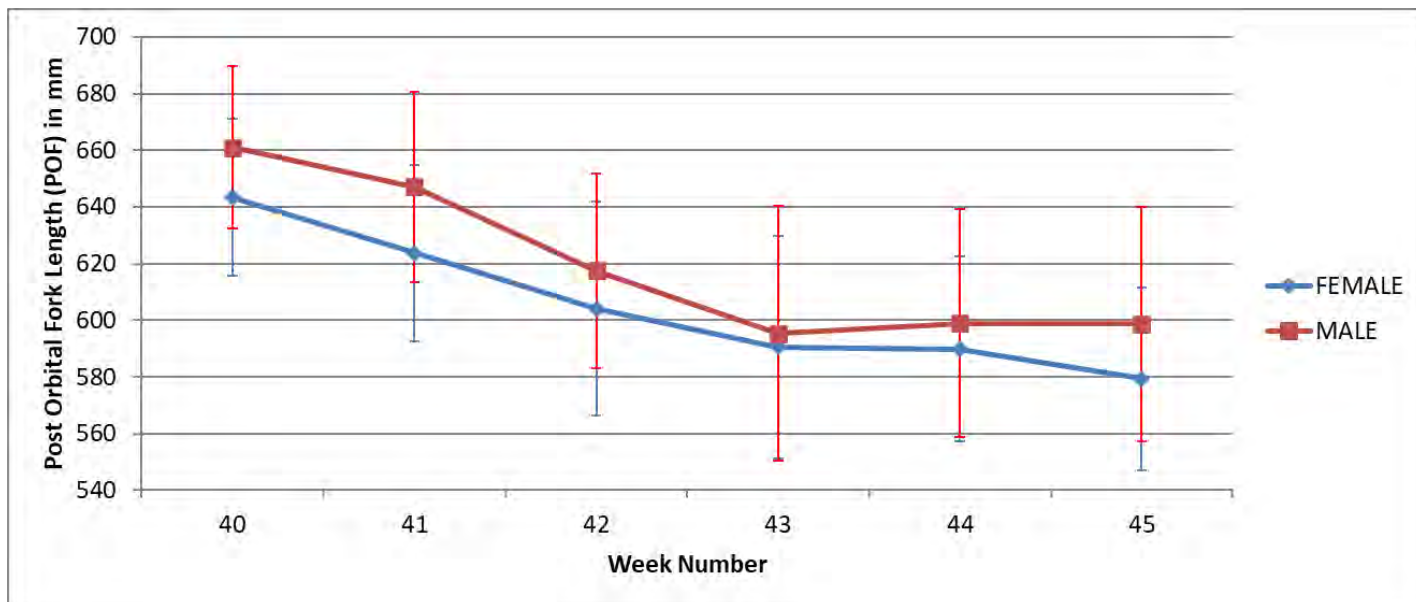


Figure 13. Chum salmon length by sex over time (error bars= 1 S.D.)

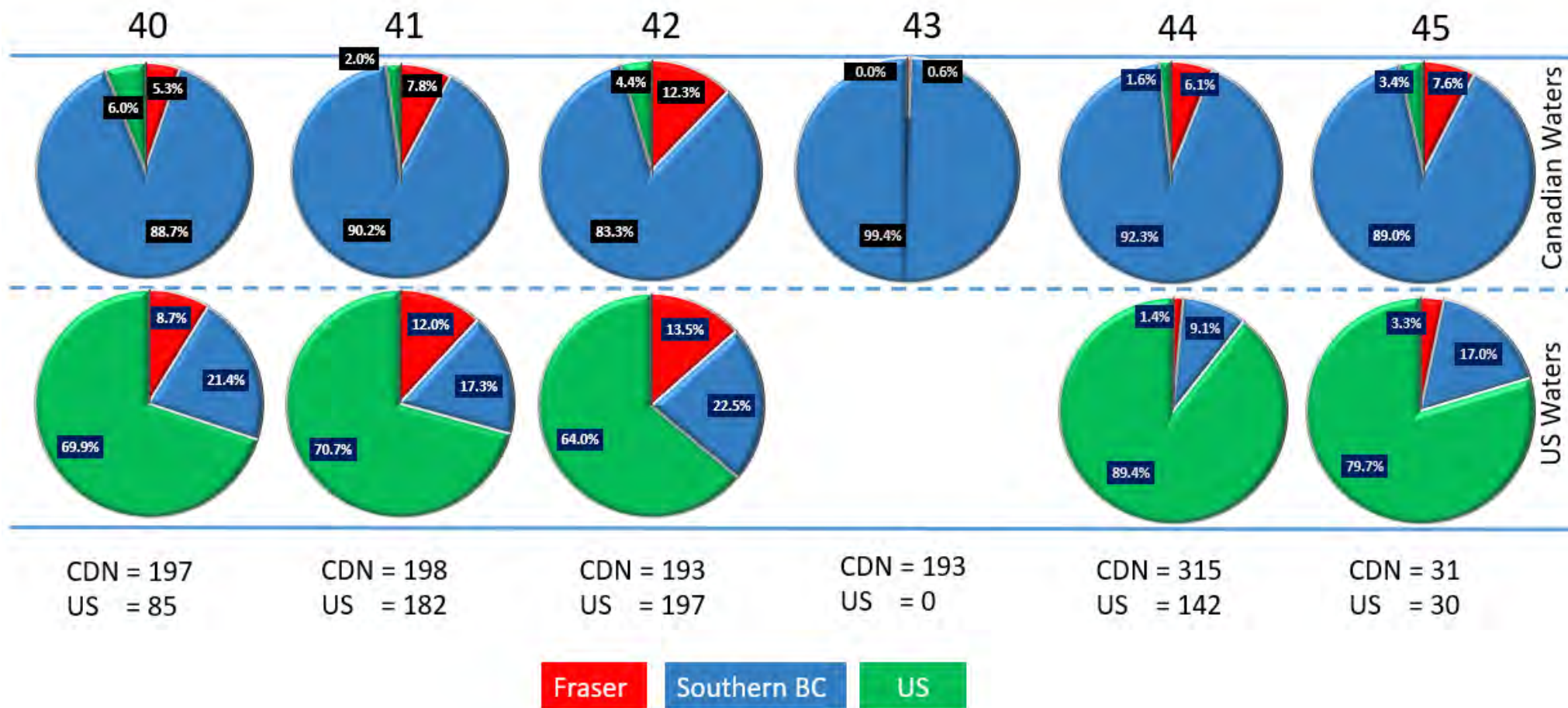
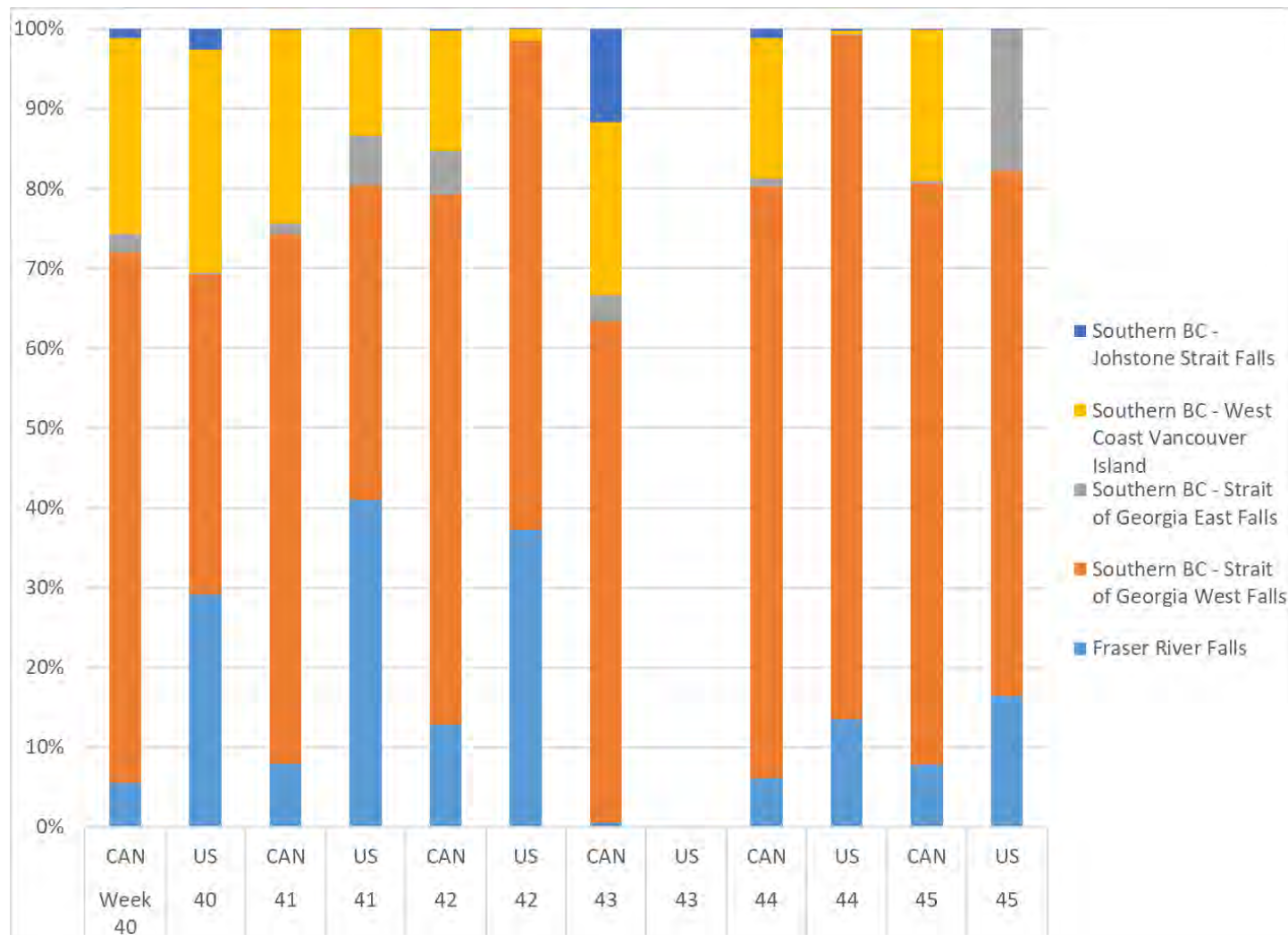


Figure 14. Fraser, Southern BC and US Composition of samples across time and between in US and Canadian waters (Sample size is provided below the pie graphs for each week). Week 40 = Oct. 1 - Oct. 7



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

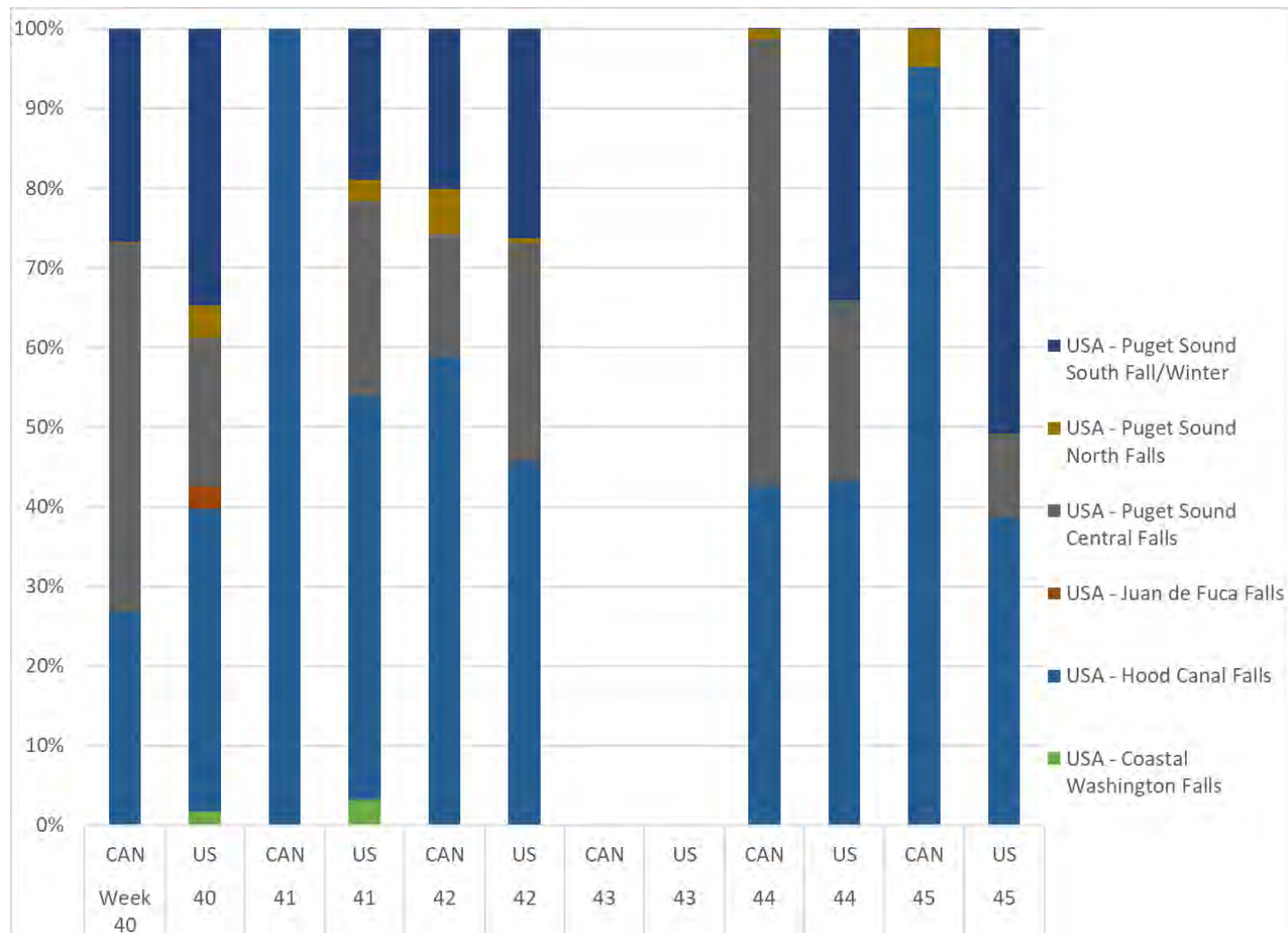
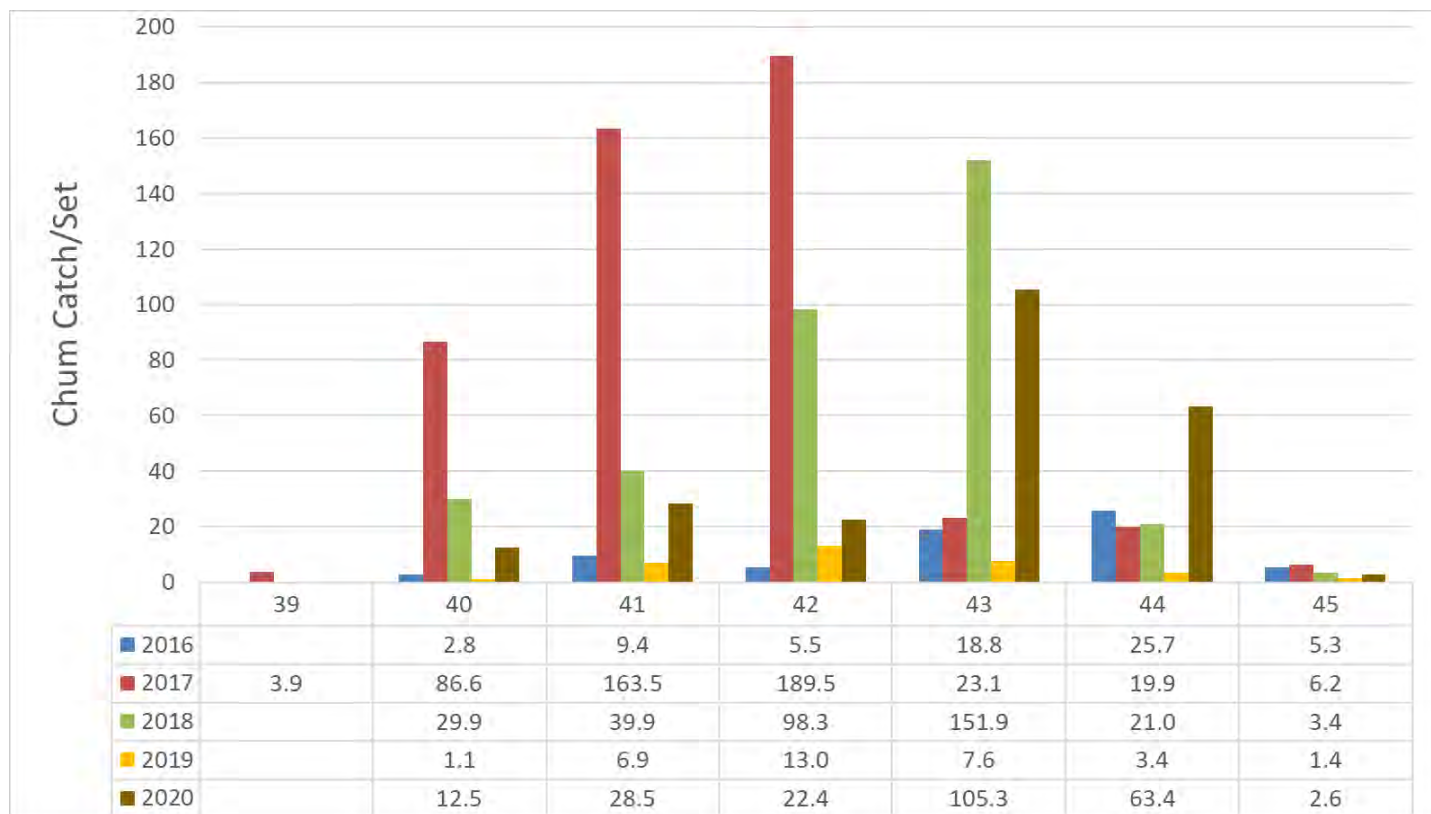


Figure 16. Stock composition of the US component in the samples by area and week





*Figure 17. Comparison between 2016-2020 Chum Catch per Unit Effort (CPUE)*

## *Appendices*

## Appendix A: Set log example

Chum Seine Test Fishery					Juan de Fuca Strait Area 20					Date (dd/mm/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	Kept	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 (Dirkn):	Rel										DNA Sheet #	DNA #	to	
					Sea Cond:											Water Temp °C			
					Rain: 0 1 2 3	Kept										Book #	Scale #	to	
					% Cloud:											Book #	Scale #	to	
					Wind (Dirkn):	Rel										DNA Sheet #	DNA #	to	
					Sea Cond:											Water Temp °C			
					Rain: 0 1 2 3	Kept										Book #	Scale #	to	
					% Cloud:											Book #	Scale #	to	
					Wind (Dirkn):	Rel										DNA Sheet #	DNA #	to	
					Sea Cond:											Water Temp °C			
					Rain: 0 1 2 3	Kept										Book #	Scale #	to	
					% Cloud:											Book #	Scale #	to	
					Wind (Dirkn):	Rel										DNA Sheet #	DNA #	to	
					Sea Cond:											Water Temp °C			
					Rain: 0 1 2 3	Kept										Book #	Scale #	to	
					% Cloud:											Book #	Scale #	to	
					Wind (Dirkn):	Rel										DNA Sheet #	DNA #	to	
					Sea Cond:											Water Temp °C			
<b>DAILY &amp; SET COMMENTS</b>		<b>Assessment Total (set cond 1 &amp; 2 and/or set type 1)</b>														<b>Set Condition:</b>			
		<b>Non-Assessment Total (set cond 0 and/or set type 2)</b>														0 - Bad set or catch not representative			
																1 - Problem with set but did not affect catch			
																2 - Good set no problems			
																<b>Set Type:</b>			
																1 - Assessment			
																2 - Non-Assessment			
																<b>Weather Codes:</b>			
																Overcast: 0%, 25%, 50%, 75%, 100%			
																Rain: 0 - none 1 - light 2 - medium 3 - heavy			
																Sea Cond: calm rippled chop rough			
Total Daily Samples -																			

**CHUM BIOSAMPLE FORM:**

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

[illegible]



*Appendix C: Baseline of 400 sample sites/populations by regional genetic groups used to estimate stock composition of Chum salmon from southern British Columbia and Washington State in 2020 fisheries (bcm-SNP\_coastwide v2.0.0 2020-04-05)*

Repunit/Conservation Unit	CU Number	Region	Population	N
Korea	KOR-01	Korea	Namdae_R	96
Honshu_Japan_Sea	JPN-03	Japan	Gakko_R	35
			Hayatsuki_R	70
			Kawabukuro_R	92
			Miomote_R	93
			Uono_R	79
Honshu_Pacific_Coast	JPN-04	Japan	Koizumi_R	79
			Sakari_R	75
			Tsugaruishi_R	54
Hokkaido_eastern	JPN-07	Japan	Kushiro_R	34
			Tokachi_R	109
Nemuro_Strait	JPN-05	Japan	Nishibetsu_R	77
			Shibetsu_R	106
Hokkaido_Sea_of_Okhotsk	JPN-01	Japan	Abashiri_R	129
			Horonai_R	50
			Shari_R	77
			Tokoro_R	116
			Tokushibetsu_R	108
Hokkaido_western	JPN-06	Japan	Shikiu_R	80
			Shiriuchi_R	91
			Shizunai_R	80
			Yurappu_R	77
Hokkaido_Japan_Sea	JPN-02	Japan	Chitose_R	91
			Teshio_R	73
			Toshibetsu_R	56
Primorye	RU-07	Russia	Avakumovka_R	33
			Ryazanovka_R	45
Sakhalin	RU-03	Russia	Kalininka_R	45
			Naiba_R	124
			Tym_R	47
			Udarnitsa_R	49
Amur	RU-06	Russia	Amur_R	146
			Suifen_R	21
Magadan	RU-05	Russia	Magadan_R	67
			Okhota_R	85
			Ola_R	111
			Tauy_R	52
			Tugur_R	98
Northern_Sea_of_Okhotsk			Oklan_R	70
			Penzhina_R	35
West_coast_Kamchatka	RU-01	Russia	Bolshaya_R	97

Repunit/Conservation Unit	CU Number	Region	Population	N
East_coast_Kamchatka	RU-02	Russia	Hairusova_R	93
			Kikhchik_R	86
			Kol_R	80
			Plotnikova_R	72
			Pymta_R	88
			Utka_R	36
			Vorovskaya_R	151
			Apuka_R	48
			Dranka_R	48
			Ivashka_R	43
			Kamchatka_R	66
			Karaga_R	42
			Nerpichye_Lake	40
			Olyutorsky_Bay	51
			Ossora_R	89
			Zhupanova_R	38
North_east_Russia	RU-04	Russia	Anadyr_R	91
			Impuka_R	29
			Kanchalan_R	76
Kotzebue	AK-02	Western Alaska (excluding Yukon River)	Agiapuk_R	93
			Inmachuk_R	93
			Kelly_Lake	95
			Kobuk_R	92
			Koyuk_R	43
			Noatak_R	25
Norton_Sound_north	AK-05	Western Alaska (excluding Yukon River)	Eldorado_R	93
			Kwiniuk_R	79
			Niukluk_R	86
			Nome_R	117
			Pikmiktalik_R	132
			Pilgrim_R	95
			Shaktoolik_R	94
			Snake_R	89
			Unalakleet_R	93
			Ungalik_R	50
Kuskokwim_Bay_River	AK-08	Western Alaska (excluding Yukon River)	Aniak_R	93
			Big_R_Kusko	88
			George_R	104
			Goodnews_R	113
			Holokuk_R	62
			Kanektok_R	150

Repunit/Conservation Unit	CU Number	Region	Population	N
North_east_Bristol	AK-09	Western Alaska (excluding Yukon River)	Kasigluk_R	42
			Kogrukluk_R	125
			Kuskokwim_R_South_Fork	141
			Kwethluk_R	107
			Nunsatuk_R	74
			Salmon_R_WAlaska	89
			Takotna_R	99
			Tatlawiksuk_R	101
			Tuluksak_R	94
			Alagnak_R	81
Nushagak_summer	AK-14	Western Alaska (excluding Yukon River)	Naknek_R	56
			Togiak_R	77
South_west_Bristol	AK-07	Western Alaska (excluding Yukon River)	Mulchatna_R	69
			Stuyahok_R	43
			Egegik_Bay	75
North_Peninsula	AK-03	Western Alaska (excluding Yukon River)	Gertrude_Cr	88
			Pumice_Cr	94
			Frosty_Cr	94
Tanana_summer	AK-15	Yukon River - US	Joshua_Green_R	98
			Moller_Bay	92
			Chena_R_Early	94
			Chena_R_Late	67
Tanana_fall	AK-16	Yukon River - US	Salcha_R_Early	44
			Salcha_R_Late	32
			Delta_R	79
			Kantishna_R	101
Upper_Alaska_fall	AK-11	Yukon River - US	Toklat_R	100
			Big_Salt_R	36
			Black_R	97
			Chandalar_R	45
Lower_river_summer	AK-10	Yukon River - US	Sheenjok_R	132
			Andreafsky_R	88
			Anvik_R	96
			California_Cr	46
			Chulinak_R	67
			Gisasa_R	42
			Henshaw_Cr	100
			Jim_R	95
			Koyukuk_R_Middle_Fork	96
			Koyukuk_R_South_Fork_Late	57

Repunit/Conservation Unit	CU Number	Region	Population	N
Teslin Middle Yukon River	CU-38	Yukon River - Canada	Melozitna_R	141
			Nulato_R	95
	CU-42	Yukon River - Canada	Tozitna_R	86
			Teslin_R	102
			Big_Cr	120
Donjek-Kluane-White	CU-44-45	Yukon River - Canada	Pelly_R	64
			Tatchun_R	83
			Yukon_R@Minto	78
			Donjek_R	69
			Kluane_Lake	103
North Yukon River	CU-43	Yukon River - Canada	Chandindu_R	85
Porcupine River	CU-46	Yukon River - Canada	Fishing_Branch_R	85
South_west_Peninsula	AK-13	Central Alaska	Porcupine_R	48
			Coleman_Cr	72
			Delta_Cr	74
			Volcano_Bay	106
South_east_Peninsula	AK-06	Central Alaska	Westward_Cr	77
			Alagogshak_Cr	93
			Big_R	89
Kodiak	AK-04	Central Alaska	Stepovak_Bay	86
			American_R	92
			Sturgeon_R	70
Prince_William_Sound	AK-12	Central Alaska	Uganik_R	81
			Constantine_Cr	43
			Keta_Cr	84
			Olsen_Bay_Cr	71
SE_Alaska	AK-01.2	Southeast Alaska	Wells_R	95
			Dipac_Hatchery	147
			Gambier_Bay	60
			Greens_Cr	45
			Herman_Cr	54
			Kennel_Cr	36
			Sawmill_Cr	32
			Wells_Bridge	49
			Taku_R	55
Taku	CU-36	North and Central BC	Tuskwa_Cr	62
Portland Inlet Region	CU-26_30-32_AK-01.1	North and Central BC	Crow_Lagoon_Cr	81
			Disappearance_Cr	77
			Ensheshese_R	103
			Fish_Cr	96
			Kateen_R	94
			Ksemamaith_Cr	66
			Kshwan_R	92

Repunit/Conservation Unit	CU Number	Region	Population	N
Middle Skeena	CU-28	North and Central BC	Lachmach_R	137
			Lagoon_Cr	75
			Lizard_Cr	57
			Nakat_Inlet	108
			Neets_Bay_Hatchery_Early	78
			Neets_Bay_Hatchery_Late	99
			Stagoo_Cr	58
			Stumaun_Cr	49
			Toon_R	63
			Tseax_R	75
			Wilauks_Cr	50
			Date_Cr	137
			Kispiox_R	59
			Kitwanga_R	98
Lower Skeena	CU-27	North and Central BC	McCully_Cr	55
			Nangeese_R	104
			Andesite_Cr	123
			Dog_Tag_Cr	104
			Ecstall_R	96
			Kitsumkalum_R	74
			Whitebottom_Cr	75
North Haida Gwaii-Stanley Creek	CU-25	North and Central BC	Zymagotitz_R	73
			Stanley_Cr	108
North Haida Gwaii	CU-24	North and Central BC	Ain_R	45
			Awun_R	95
			Naden_R	66
			Botany_Inlet_Cr_Head	44
West Haida Gwaii	CU-23	North and Central BC	Clapp_Basin	94
			Dawson_Inlet_Cr	92
			Fairfax_Inlet_Cr_Outer	42
			Gold_Harbour_Cr	67
			Goski_Bay_Cr	58
			Kano_Inlet_Cr	98
			Mace_Cr	73
			Mountain_Cr	96
			Seal_Inlet_Cr	116
			Security_Inlet_Cr_LH	84
			Steel_Cr	137
			Buck_Channel_Cr_#2	95
			Deena_R	94
			Honna_R	80
Skidegate	CU-22	North and Central BC	Lagins_Cr	121
			North_Arm_Cr_RH	48

Repunit/Conservation Unit	CU Number	Region	Population	N
East HG	CU-21	North and Central BC	Slatechuck_Cr	54
			Tarundl_Cr	99
			Bag_Harbour_Cr	154
			Dana_Cr	88
			Hutton_Cr_Head	37
			Lagoon_Inlet	95
			Little_Goose_Cr	98
			Pacofi_Cr	111
			Pallant_Cr	104
			Salmon_R_Area2E	69
			Sedgwick_Cr	76
			Sedmond_Cr	112
			Surprise_Cr	40
			Thorsen	95
Douglas-Gardner-Mussel-Kynoch	CU-19-20	North and Central BC	Bish_Cr	61
			Foch_R	71
			Gilttoyes_Cr	74
			Green_R	67
			Kainet_Cr	76
			Kemano_R	85
			Khutze_R	42
			Kiltuish_R	93
			Kitimat_R	94
			Lard_Cr	61
			Quaal_R	86
Hecate Lowlands	CU-18	North and Central BC	Arnoup_Cr	128
			Barnard_Cr	99
			Blackrock_Cr	52
			Duthie_Cr	69
			East_Arm_Cr	88
			Flux_Cr	130
			Gil_Cr	45
			Kitasoo_Cr	134
			Markle_Inlet_Cr	41
			Nias_Cr	76
			Pa-aat_R	44
			Salmon_Bay_Cr	41
			Stewart_Cr	59
			Tyler_Cr	83
			West_Arm_Cr	95
Bella Coola-Dean_all	CU-16-17	North and Central BC	Wilson_Cr	31
			Bella_Coola_R	52
			Kimsquit_R	37

Repunit/Conservation Unit	CU Number	Region	Population	N
Spiller-Fitz Hugh-Burke	CU-15	North and Central BC	Nooseseck_R	22
			Skowquiltz_R	76
			Snootli_Cr	47
			Bella_Bella	96
			Bullock_Channel_Cr	46
			Cheenis_Lake_Cr	62
			Cooper_Inlet_#1_Cr	63
			Deer_Pass_Cr	71
			Frenchman_Cr	49
			Hook_Nose_Cr	48
			Jenny_Bay_Cr	56
			Kwakusdis_R	55
			Martin_R	44
			McLoughlin_Cr	95
			Neekas_Cr	72
Rivers Inlet	CU-13	North and Central BC	Quartcha_Cr	27
			Clyak_R	50
Smith Inlet	CU-12	North and Central BC	MacNair_Cr	104
			Draney_Cr	72
			Lockhart_Gordon_Cr	81
Northwest Vancouver Island	CU-11	Southern BC	Nekite_R	117
			Walkum_Cr	57
			Cayeghle_R	86
			Colonial_Cr	90
			Goodspeed_R	21
Southwest Vancouver Island	CU-10	Southern BC	Pegattem_Cr	53
			Bedwell_R	51
			Black_Cr_WCVI	25
			Burman_R	29
			Canton_Cr	97
			Conuma_R	108
			Hoiss_Cr	27
			Kaouk_R	47
			Little_Toquart_Cr	69
			Lord_Cr	29
			Nahmint_R	121
			Nitinat_R	119
			Park_R	25
			Salmon_Cr_WCVI	50
			Sarita_R	22
			Sucwoa_R	106
			Sugsaw_Cr	92
			Tlupana_R	104
			Tranquil_Cr	69

Repunit/Conservation Unit	CU Number	Region	Population	N
Upper Knight	CU-09	Southern BC	Warn_Bay_Cr	39
			Ahnuhati_R	128
			Klinaklini_R	95
Southern Coastal Streams	CU-08	Southern BC	Mackenzie_Sound_Cr	20
			Taaltz_Cr	24
			Viner_Scott_Cove	107
			Viner_Sound	129
Bute Inlet	CU-07	Southern BC	Algard_Cr	63
			Homathko_R	94
			Orford_R	88
			Southgate_R	59
Loughborough	CU-06	Southern BC	Glendale_Cr	75
			Heydon_Cr	150
			Phillips_R	146
Northeast Vancouver Island	CU-05	Southern BC	Nimpkish_R	103
Georgia Strait	CU-04	Southern BC	Campbell_R	184
			Chemainus_R	59
			Cold_Cr	20
			Cowichan_R	108
			Demamiel_Cr	50
			Englishman_R	131
			Goldstream_R	184
			Lang_Cr	64
			Lit_Qualicum_R	190
			Myrtle_Cr	27
			Nanaimo_R	85
			Okeover_Cr	82
			Puntledge_R	193
			Qualicum_R	178
			Slammon_Cr	59
			Snake_Bay_Cr	89
			Theodosia_R	90
			Tzoonie_R	85
Howe Sound-Burrard Inlet	CU-03	Southern BC	Cheakamus_R	75
			Indian_R	113
			Mamquam_R	98
			Mashiter_Cr	45
			Shovelnose_Cr	80
			Squamish_R	69
Lower Fraser	CU-02	Southern BC	Alouette_N	54
			Alouette_R	37
			Barnes_Cr	32
			Blaney_Cr	59
			Chehalis_R	97



Repunit/Conservation Unit	CU Number	Region	Population	N
North_Puget_Sound	WA-02	Washington	Chilliwack_R	148
			Chilqua_Cr	103
			Harrison_R	75
			Harrison_R_Late	97
			Hicks_Cr	68
			Hopedale_Cr	111
			Hunter_Cr_FR	73
			Inch_Cr	91
			Kanaka_Cr	83
			Kawkawa_Cr	54
			Lillooet_R_Lower	55
			MacIntyre_Cr	51
			Norrish_Worth_Cr	79
			Peach_Cr	159
			Railroad_Cr	65
			Serpentine_R	32
			Silverdale_Cr	99
			Silverhope_Cr	60
			Squawkum_Cr	123
			Stave_R	112
			Street_Cr	178
			Sweltzer_R	62
			Vedder_R	67
			Wahleach_Cr	50
			Whonnock	65
			Widgeon_Cr	88
			Worth_Cr	54
			County_Line_Cr_Fall	60
			Grant_Cr_Fall	49
			Nooksack_R	60
			Sauk_R	39
			Siberia_Cr_Fall	36
			Skagit_R	46
			Skykomish_R	85
			Snohomish_R	76
			Stillaguamish_R	76
Central_Sound	WA-07	Washington	Chico_Grovers_Hatch	140
South_Puget_Sound	WA-01	Washington	Green_R_Keta_Hatchery	92
			Kennedy_Cr	95
			Mill_Cr	56
			Minter_Cr	93
			Nisqually_R	96
			Nisqually_R_Winter	89
			Puyallup_R	82

Repunit/Conservation Unit	CU Number	Region	Population	N
Hood Canal Region-Fall	WA-03.1-04_06	Washington	Skookum_Cr_Fall	56
			Big_Beef_Cr_Fall	75
			Big_Mission_Cr	26
			Elwha_R_Fall	61
			Enetai_Cr_Fall	90
			Hoodsport_Fall	94
			Lilliwaup_Cr	100
			McKernan_Hatch_Fall	69
			Spencer_Cr	30
			Tulalip	80
Hood Canal-Summer	WA-03.2	Washington	Big_Quilcene_R_Summer	72
			Jimmycomelately_Cr	23
			Salmon_Cr_HOOD	95
Coastal_Washington	WA-05	Washington	Bitter_Cr	87
			Ellsworth_Cr	56
			Quinault_R	81
			Satsop_R_Fall	84

*Appendix D: Set coordinates and time*

<b>Latitude</b>	<b>Longitude</b>	<b>Set #</b>	<b>Date and time BEGIN</b>	<b>Date and Time END</b>
48°21.92	123°54.94	1	09/29/2020 11:25:00	09/29/2020 11:55:00
48°21.51	123°55.13	2	09/29/2020 12:20:00	09/29/2020 12:52:00
48°20.87	123°54.96	3	09/29/2020 13:10:00	09/29/2020 13:42:00
48°20.29	123°54.67	4	09/29/2020 14:10:00	09/29/2020 14:41:00
48°22.3	123°54.94	5	09/29/2020 15:12:00	09/29/2020 15:35:00
48°22.1	123°55.11	6	09/29/2020 15:50:00	09/29/2020 16:30:00
48°22.16	123°55.44	1	09/30/2020 09:00:00	09/30/2020 09:31:00
48°22.09	123°55.18	2	09/30/2020 09:53:00	09/30/2020 10:25:00
48°21.89	123°55.26	3	09/30/2020 10:35:00	09/30/2020 11:08:00
48°20.81	123°54.47	4	09/30/2020 12:03:00	09/30/2020 12:27:00
48°18.82	123°48.65	5	09/30/2020 13:20:00	09/30/2020 13:50:00
48°18.48	123°49.54	6	09/30/2020 14:08:00	09/30/2020 14:38:00
48°11.13	123°43.41	1	10/01/2020 09:20:00	10/01/2020 09:50:00
48°10.74	123°43.59	2	10/01/2020 10:07:00	10/01/2020 10:36:00
48°10.74	123°43.8	3	10/01/2020 10:46:00	10/01/2020 11:20:00
48°10.69	123°44.01	4	10/01/2020 11:35:00	10/01/2020 12:06:00
48°10.99	123°44.1	5	10/01/2020 12:20:00	10/01/2020 12:50:00
48°11.21	123°43.55	6	10/01/2020 13:10:00	10/01/2020 13:40:00
48°10.65	123°43.06	1	10/02/2020 07:00:00	10/02/2020 07:30:00
48°10.78	123°43.17	2	10/02/2020 07:42:00	10/02/2020 08:13:00
48°10.86	123°43.42	3	10/02/2020 08:22:00	10/02/2020 08:52:00
48°10.84	123°43.24	4	10/02/2020 09:11:00	10/02/2020 09:42:00
48°10.86	123°43.16	5	10/02/2020 09:54:00	10/02/2020 10:26:00
48°11.0	123°43.0	6	10/02/2020 10:41:00	10/02/2020 11:13:00
48°20.92	123°49.38	1	10/06/2020 08:40:00	10/06/2020 09:11:00
48°22.13	123°55.18	2	10/06/2020 09:57:00	10/06/2020 10:27:00
48°21.94	123°55.41	3	10/06/2020 10:51:00	10/06/2020 11:20:00
48°21.64	123°54.89	4	10/06/2020 11:30:00	10/06/2020 12:00:00
48°20.26	123°55.8	5	10/06/2020 12:19:00	10/06/2020 12:50:00
48°19.49	123°46.45	6	10/06/2020 13:53:00	10/06/2020 14:24:00
48°20.68	123°47.69	1	10/07/2020 08:30:00	10/07/2020 08:59:00
48°21.93	123°55.0	2	10/07/2020 10:05:00	10/07/2020 10:36:00
48°22.27	123°55.46	3	10/07/2020 10:46:00	10/07/2020 11:17:00
48°20.44	123°48.95	4	10/07/2020 12:15:00	10/07/2020 12:46:00
48°19.56	123°46.7	5	10/07/2020 13:21:00	10/07/2020 13:50:00
48°20.69	123°46.12	6	10/07/2020 14:02:00	10/07/2020 14:31:00
48°11.78	123°43.74	1	10/08/2020 09:16:00	10/08/2020 09:45:00
48°10.94	123°43.38	2	10/08/2020 09:55:00	10/08/2020 10:26:00
48°10.78	123°43.34	3	10/08/2020 10:40:00	10/08/2020 11:16:00
48°10.81	123°43.46	4	10/08/2020 11:21:00	10/08/2020 11:56:00
48°10.8	123°43.36	5	10/08/2020 12:11:00	10/08/2020 12:43:00
48°10.76	123°43.19	6	10/08/2020 12:56:00	10/08/2020 13:25:00
48°10.91	123°43.58	1	10/09/2020 07:18:00	10/09/2020 07:45:00
48°10.98	123°43.43	2	10/09/2020 07:58:00	10/09/2020 08:29:00

48°10.87	123°43.26	3	10/09/2020 08:46:00	10/09/2020 09:17:00
48°11.23	123°43.12	4	10/09/2020 09:36:00	10/09/2020 10:08:00
48°11.16	123°43.04	5	10/09/2020 10:20:00	10/09/2020 10:51:00
48°11.57	123°43.19	6	10/09/2020 11:10:00	10/09/2020 11:41:00
48°20.28	123°45.6	1	10/13/2020 08:00:00	10/13/2020 08:30:00
48°20.83	123°46.36	1	10/14/2020 08:04:00	10/14/2020 08:35:00
48°20.73	123°47.5	2	10/14/2020 08:47:00	10/14/2020 09:18:00
48°20.84	123°48.68	3	10/14/2020 09:35:00	10/14/2020 10:06:00
48°21.02	123°46.56	4	10/14/2020 10:25:00	10/14/2020 10:57:00
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48°10.84	123°43.48	4	10/15/2020 12:55:00	10/15/2020 13:24:00
48°11.17	123°42.94	5	10/15/2020 13:48:00	10/15/2020 14:20:00
48°11.55	123°41.32	6	10/15/2020 14:34:00	10/15/2020 15:03:00
48°11.62	123°42.78	7	10/15/2020 15:30:00	10/15/2020 16:01:00
48°11.05	123°42.98	1	10/16/2020 07:23:00	10/16/2020 07:52:00
48°11.01	123°44.11	2	10/16/2020 08:10:00	10/16/2020 08:41:00
48°10.91	123°43.25	3	10/16/2020 08:52:00	10/16/2020 09:23:00
48°20.84	123°46.85	1	10/18/2020 08:15:00	10/18/2020 08:46:00
48°20.48	123°49.06	2	10/18/2020 09:40:00	10/18/2020 10:19:00
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48°19.01	123°46.88	4	10/18/2020 11:40:00	10/18/2020 12:11:00
48°20.07	123°46.84	5	10/18/2020 12:30:00	10/18/2020 13:01:00
48°20.64	123°45.77	6	10/18/2020 13:20:00	10/18/2020 13:50:00
48°20.93	123°46.48	1	10/19/2020 08:01:00	10/19/2020 08:32:00
48°20.71	123°46.74	2	10/19/2020 09:00:00	10/19/2020 09:29:00
48°11.8	123°43.79	1	10/24/2020 09:15:00	10/24/2020 09:46:00
48°21.02	123°46.81	1	10/25/2020 08:18:00	10/25/2020 08:49:00
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48°21.56	123°50.49	5	10/25/2020 11:53:00	10/25/2020 12:22:00
48°20.85	123°45.81	6	10/25/2020 13:00:00	10/25/2020 13:31:00
48°11.03	123°43.86	1	10/26/2020 09:20:00	10/26/2020 09:50:00
48°11.35	123°42.58	2	10/26/2020 10:07:00	10/26/2020 10:38:00
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48°10.72	123°43.15	6	10/26/2020 13:20:00	10/26/2020 13:51:00
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48°11.1	123°43.51	4	10/27/2020 11:57:00	10/27/2020 12:26:00

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48°10.81	123°41.36	6	10/27/2020 13:20:00	10/27/2020 13:51:00
48°21.09	123°46.38	1	10/28/2020 08:18:00	10/28/2020 08:50:00
48°21.16	123°47.87	2	10/28/2020 09:05:00	10/28/2020 09:36:00
48°21.09	123°47.89	3	10/28/2020 09:45:00	10/28/2020 10:14:00
48°21.97	123°54.9	4	10/28/2020 11:30:00	10/28/2020 12:01:00
48°21.91	123°54.85	5	10/28/2020 12:23:00	10/28/2020 12:54:00
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48°20.81	123°46.24	1	10/29/2020 08:04:00	10/29/2020 08:35:00
48°20.98	123°46.52	2	10/29/2020 08:45:00	10/29/2020 09:11:00
48°20.91	123°47.85	3	10/29/2020 09:30:00	10/29/2020 10:02:00
48°20.54	123°49.18	4	10/29/2020 10:30:00	10/29/2020 11:01:00
48°19.95	123°48.16	5	10/29/2020 11:15:00	10/29/2020 11:46:00
48°20.0	123°44.69	6	10/29/2020 12:08:00	10/29/2020 12:40:00
48°11.58	123°43.39	1	11/03/2020 09:25:00	11/03/2020 09:56:00
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48°10.86	123°43.41	4	11/03/2020 11:51:00	11/03/2020 12:22:00
48°11.1	123°41.6	5	11/03/2020 12:45:00	11/03/2020 13:17:00
48°10.79	123°42.94	6	11/03/2020 13:40:00	11/03/2020 14:11:00
48°10.79	123°43.54	1	11/04/2020 09:00:00	11/04/2020 09:29:00
48°10.9	123°43.08	2	11/04/2020 09:42:00	11/04/2020 10:14:00
48°11.15	123°43.01	3	11/04/2020 10:25:00	11/04/2020 10:56:00
48°10.8	123°43.5	4	11/04/2020 11:06:00	11/04/2020 11:37:00
48°11.51	123°42.58	5	11/04/2020 11:55:00	11/04/2020 12:25:00
48°12.02	123°41.8	6	11/04/2020 12:51:00	11/04/2020 13:22:00
48°20.91	123°45.89	1	11/05/2020 08:10:00	11/05/2020 08:41:00
48°20.9	123°46.03	2	11/05/2020 08:53:00	11/05/2020 09:24:00
48°21.1	123°48.15	3	11/05/2020 09:50:00	11/05/2020 10:21:00
48°22.37	123°55.0	4	11/05/2020 11:00:00	11/05/2020 11:31:00
48°21.06	123°46.17	5	11/05/2020 12:34:00	11/05/2020 13:07:00
48°20.63	123°45.19	6	11/05/2020 13:33:00	11/05/2020 14:06:00
48°20.8	123°46.03	1	11/06/2020 07:30:00	11/06/2020 08:01:00
48°20.88	123°45.97	2	11/06/2020 08:13:00	11/06/2020 08:45:00
48°20.87	123°46.13	3	11/06/2020 08:56:00	11/06/2020 09:27:00
48°20.5	123°46.29	4	11/06/2020 09:40:00	11/06/2020 10:10:00
48°20.47	123°46.01	5	11/06/2020 10:25:00	11/06/2020 10:55:00
48°20.91	123°45.85	6	11/06/2020 11:12:00	11/06/2020 11:42:00