Fisheries and Oceans Pêches et Océans

MEMORANDUM NOTE DE SERVICE

To
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First Nations Chiefs, Councillors and Fisheries Representatives;
Sport Fishing Advisory Board;
Commercial Salmon Advisory Board;
Marine Conservation Caucus

From
De

Pacific Region
Fisheries and Oceans Canada

Security Classification - Classification de sécurité
UNCLASSIFIED
Our file - Notre référence
Your File - Votre référence
Date
06-12-2021

Subject
Object

Fraser Chinook Fishery Mortality Index Summary, 2014 - 2020

Introduction

This memo compiles information to support Southern BC Chinook harvest planning and specifically fisheries that impact Fraser River Chinook Managment Units (MUs). The results presented in this note represent the work of biologists from across the Pacific Region and include updated data and results to that which was presented at previous meetings in 2020 and early 2021. Many of the results presented rely on monitoring programs that are implemented in partnership with First Nations and stakeholders (e.g. the 'Avid Angler' program).

Fraser Chinook Management Objectives (2019-2020)

Spring 4_2, Spring 5_2, and Summer 5_2 Chinook:

- Manage Canadian fisheries in a highly precautionary manner to allow as many fish to pass through to the spawning grounds as possible.
- Note: Fishery impacts are expected to include incidental Chinook mortalities in Fraser River Chinook and Sockeye test fisheries, Chinook retention or bycatch retention in First Nation FSC fisheries, release mortalities, and incidental mortalities during Chinook-directed fisheries in mixed stock fisheries.

Summer 4_1 Chinook:

- No biological management objective outlined for the aggregate in the IFMP. Precautionary reduction in marine fishery mortalities by at least 25% compared to the 2013-2016 average to support increased availability of Summer 4_1 Chinook for Chinook-directed First Nations FSC

fisheries. Lower Shuswap River indicator stock to reach the Pacfic Salmon Treaty (PST) biologically-based escapement goal of 12,300 spawners.

Fall 4_1 Chinook:

- Harrison River indicator stock to reach the Pacfic Salmon Treaty (PST) biologically-based escapement goal of 75,100 spawners. To achieve this goal, the Department aimed to reduce Canadian fishery mortalities by at least 25%.

What management actions were taken in 2019 and 2020 to meet objectives?

General overview of management measures (See maps in Appendix 1 for detailed measures by Pacific Fisheries Management Area):

Recreational fisheries:

- Chinook restrictions were implemented in most South Coast areas to address conservation concerns for Fraser River Chinook salmon.
- Chinook non-retention beginning April 19 (2019)/April 1 (2020) in most South Coast waters with exception of WCVI waters inside 1nm from the surfline;
- No fishing for Chinook beginning April 19 (2019)/April 1 (2020) in marine approaches to Fraser River; and,
- No fishing for salmon at mouth of Fraser and within Fraser in effect beginning January 1

Commercial troll fisheries:

- Area F (Northern BC) – Chinook non-retention until August 20 (2019)/August 15 (2020); (additional objective to pass additional Summer 4_1 Chinook to Fraser River)
- Area G (WCVI) – Delayed start until August 1

First Nations fisheries:

- Fraser River First Nations FSC fisheries opportunities were limited to unplanned events or first fish ceremonies into July, followed by opportunities to target healthy Summer 4_1 Chinook, primarily in August. Limited directed opportunities on stream-type Chinook in terminal areas without access to abundant Chinook stocks.
- South Coast FSC fisheries opportunities for mixed Chinook stocks were permitted in marine areas, with the exception of the approaches to the Fraser River.
- Five Nations (Ahousaht, Ehattesaht, Hesquiaht, Mowachaht/Muchalaht, and Tla-o-qui-aht) rights-based commercial fishery in 2020 was delayed until July 15 in areas seaward of 1 nautical mile from the surfline on the West Coast of Vancouver Island. A maximum 80 cm size limit was in effect from July 16 to July 31.

Evaluation of Management Objectives

The Department utilizes information from coded-wire tag (CWT) Chinook indicator populations to assess the distribution of fishery mortalities in Canadian and United States salmon fisheries. However, there are no current CWT indicators for the Fraser Spring 5_2 and Summer 5_2 MUs, and an alternative methodology is required to reconstruct fishery mortalities for these groups. The run-reconstruction-plus-genetic-stock-ID

("RR+GSI") fishing mortality index (FMI) approach to evaluating the above management objectives was derived from the methodology developed for reviewing the Fraser Chinook management approach established in 2012, which was reviewed through the Canadian Science Advisory Secretariat (CSAS) in 2020 (Dobson et al. - "A Technical Review of the Management Approach for Stream-Type Fraser River Chinook" - https://publications.gc.ca/collections/collection_2020/mpo-dfo/fs70-5/Fs70-5-2020-027-eng.pdf).

In general, this approach estimates a FMI for each Fraser Chinook Management Unit by combining mortality data from the Fraser River Chinook Run Reconstruction model with genetic stock identification (GSI, or DNA) and catch estimates from marine fisheries. Results presented include information that is generated annually through monitoring programs to support stock assessments and harvest management using standard methods and procedures. These results include:

- Fraser Chinook spawner abundance (excludes jacks);
- Estimated mortality impacts at the Big Bar landslide site (i.e. fish that are projected to have reached Big Bar but did not reach upstream spawning areas in 2019);
- Fraser River Chinook Terminal Run Size estimates (i.e. number of Chinook projected to have returned to the mouth of the Fraser River); and,
- Fraser River Chinook catch estimates for indexed Canadian fisheries in mixed-stock areas.

This approach is also compared with the Chinook Technical Committee's Exploitation Rate Analysis, which assesses fishery mortalities for Chinook indicator stocks under the Pacific Salmon Treaty using CWTs recovered from CDN and US fisheries, and incorporates incidental mortalities. The main gap in this approach, and one of the main reasons the RR+GSI method was developed, is the lack of current CWT indicators for Spring 5_2 and Summer 5_2 Chinook.

Known uncertainties with analyses

There are several known sources of uncertainty with the data used in the analyses that affect the mortality estimates. These are outlined in Dobson et al. (2020), which includes detailed discussion of the following sources of uncertainty:

- Biological data: Length-at-age and age composition data are only available for a limited number of stocks, and there are potential errors in scale analysis.
- CWT recoveries and expansions: If sampling rates or the contribution of the CWT indicator stock to the fishery are low, estimates of CWT recoveries are imprecise; therefore, CWT samples may not represent landed catch well. CWT catch samples from landed catch may not represent the stock composition of released catch when there are selective regulations for retaining catch.
- Estimates of smolt-to-age-2 (or 3) survival rate: Based on a single stock; indicator stocks may not adequately represent survival rate of non-indicator stocks if there is significant variation in survival rates among populations within a MU. Variability in the tag loss and/or tagging mortality contribute to uncertainty in the survival rates.
- Limits and uncertainties with genetic stock identification (GSI): Limited baseline data to represent stock production, poor stock ID accuracy due to stock transfers (introgression), imprecise estimates of stock composition when sampling rates are low, small stocks more likely to be missed when sample rates low, infilling required for several fisheries leads to greater uncertainty and potential

bias. GSI catch samples from landed catch do not represent the stock composition of released catch when there are selective regulations for retaining catch.

- Escapement estimates: Methods that generate estimates of relative abundance (e.g. visual surveys) instead of methods that generate true abundance (e.g. mark-recapture).
- Incorrect or missing input data (escapement, kept and released catch) and methods for infilling. A key assumption of infilling is that the proportion of aggregate MU-level escapement attributed to a single stock is constant among years. Accuracy and precision of catch estimates affected by survey effort, ability to correctly identify species, variability of fishing effort and CPUE, and illegal and unreported fishing activity, and infilling for fisheries where catch was not estimated.
- Catch in all Canadian mixed-stock salmon-directed fisheries that intercept Fraser Chinook is included in the analysis. Southern British Columbia (SBC) Marine First Nations Food, Social, and Ceremonial (FN FSC) fisheries data may be incomplete; DNA analysis to discern the proportion of the catch that is Fraser-origin in SBC FN FSC fisheries has only been conducted in 2020. Catch in Fraser River tributaries is also included. For all fisheries except SBC Marine Recreational, only the landed catch is included (i.e. does not include release mortalities or drop-out mortalities). Catch in Central Coast fisheries are not included, as these fisheries are assumed to minorly impact Fraser stocks based on limited GSI samples and the areas fished and CWT data (see maps in Appendix 1). Catch in USA fisheries is not included. US and Central Coast fishery mortliaties are included in the CWT-based mortality estimates. Impacts from midwater groundfish trawl fisheries are also not included, as work is ongoing to discern the proportion of the bycatch that is Fraser-origin.
- Potential violation of critical run reconstruction model assumptions: run timing, vulnerability to fisheries, pre-spawn or en-route mortalities, migration rates, and interannual variation in migration behaviour.

Sensitivity analyses presented in Dobson et al. (2020) of the impact of systematic biases in data inputs and model assumptions showed that, given the range of scenarios considered, estimated annual harvest impacts were most sensitive to assumptions of equal fishery vulnerability of all MUs within the RR model, the peak spawning date used within the RR model, the abundance ratio used to split Spring 5_2 and Summer 5_2 catch composition estimates for Northern BC recreational and commercial fisheries, consistent biases in escapement data, and high en-route mortality in a single year (2018). In comparison, sensitivity scenarios that represented systematic biases in relatively low impact fisheries, such as biases in stock composition estimates for JDF or total mortality estimates from Fraser River recreational fisheries, had negligible effects on annual harvest impacts.

More successful passage of Chinook Salmon through the Big Bar Landslide occurred at higher flow levels in 2020 compared to 2019; however, there were prolonged high water levels that delayed passage in 2020. A preliminary estimate of mortality at the landslide in 2019 was based on the ratio of successful spawners above/below the landslide site, which resulted in an estimate of 89% mortality for Spring 5_2 Chinook and 51% mortality for Summer 5_2 Chinook. An alternative analysis combining radio tagging and sonar monitoring is currently in progress. Radio tags were applied throughout the migration period in both 2019 and 2020 using a variety of gear types. Tag arrival to the slide was monitored by an array of radio receivers, and an array of radio receivers above the slide were able to detect successful passage of fish with radio tags. The survival of radio-tagged salmon was estimated based on the number of tags that successfully passed the slide compared to those that failed to pass.

Preliminary estimates of Big Bar mortality are available for 2019 and 2020:

		Big Bar Mortality	
Management Unit	**Conservation Unit(s)**	**2019**	**2020**
Spring 5_2	CK-10/CK-12	0.9	0.31
Summer 5_2	CK-11	0.5	0.19

The 2019 estimates align well with the results of the spawner ratio method, however it is important to note that both estimates are uncertain. The 2019 and 2020 radio tag mortality estimates have not yet been incorporated into the FMI analysis. The results will increase the current run size estimates for those MUs in 2020, so the RR+GSI FMI for these Management Units may be over-estimated. Further work incorporating the 2019 and 2020 Big Bar mortality estimates will be forthcoming from DFO Stock Assessment in early 2022.

COVID-19 impacts to assessment programs, particularly in 2020, add to the uncertainty of this analysis. It is apparent that COVID-19 reduced recreational fishing effort in 2020, so not all the reduced fishery impact can be attributed to management actions. Further, COVID-19 affected monitoring and assessment operations, reducing sample size and thereby increasing uncertainty in results.

Results

A summary of the RR+GSI FMI estimates for the base period (2014-2018), 2019, and 2020 is provided in the tables on the following pages, including a comparison with the Exploitation Rate Analysis (ERA) FMI. Note that these results are preliminary and subject to change.

Key observations from these tables:

Overall:

- Run size of all Fraser Chinook MUs was lower than average in 2020, with the exception of the Summer 4_1 MU that returned at an above-average amount.
- There have been five consecutive years (2016-2020) of lower-than-average escapements to the three Fraser MUs with yearling smolt life history (Spring 4_2, Spring 5_2, and Summer 5_2) and are therefore a continuing conservation concern. The Harrison (Fall 4_1) Chinook are a stock of concern experiencing a downward trend in escapement, and the escapement goal has not been met in the last six years.
- The RR+GSI FMI for all Fraser Chinook MUs decreased in 2019 compared to the base period, and for most MUs (except Fall 4_1) the FMI was further reduced in 2020. Summary of reductions relative to the base period FMI (see next page):

Management Unit	Base Period FMI (2014-2018)	2019 FMI	2019 % change	2020 FMI	2020 % change
Spring 4_2	24.9%	6.0%	-75.8%	4.5%	-81.9%
Spring 5_2	23.8%	6.6%	-72.3%	2.6%	-89.0%
Summer 5_2	25.2%	14.9%	-40.9%	12.8%	-49.0%
Summer 4_1	43.0%	32.3%	-24.8%	23.9%	-44.5%
Fall 4_1	23.6%	18.3%	-22.4%	19.4%	-17.8%

- Results from the RR+GSI method differ from the ERA, both in magnitude and trend in each MU across years. This is similar to the findings in Dobson et al. (2020), however in both cases it appears there has been an overall decrease of fishery mortalities within each MU compared to the base period. It is important to note that the mortality distribution percentages developed from the ERA and the RR+GSI are different measures, produced from different methods, and are not intended to be directly compared. More discussion on some of the differences between these methods, particularly for the Spring 4_2 MU, is in Appendix 2.

Recreational fisheries:

- Impacts to stream-type Fraser Chinook (Spring 4_2, Spring 5_2, Summer 5_2) decreased in 2019 compared to the base period, and decreased further in 2020 (both in-river and marine)
    - Note: Summer 5_2 in-river mortalities in 2019 (1.1%) and 2020 (2.4%) were in tributary systems where fisheries targetted hatchery stocks (Chilliwack River and Chehalis River). These stocks include Chilliwack and Chehalis Summer Chinook, both of which originated as transplants from many Fraser River tributaries (e.g. Bowron, Finn, Upper Pitt, etc.) and are supplemented by hatchery production with a goal of contributing to harvest. Fisheries are conducted to ensure the hatcheries obtain target broodstock amounts. The Department is discussing and seeking feedback on whether these impacts should be included in this analysis of the effectiveness of management actions; however, separating these impacts may not be straight-forward given the contribution of these stocks to CWT/GSI data as well.
- Impacts to Summer 4_1 Chinook from marine recreational fisheries decreased substantially, from 16.3% in 2019 to 5.3% in 2020.
- The impacts to Summer 4_1 and Fall 4_1 Chinook from in-river recreational fisheries in 2019 and 2020 occurred in terminal systems, as mainstem Fraser River fishing for Chinook was closed both years.
- As in the base period, the vast majority of fishing mortality on Fall 4_1 Chinook occurs in recreational fisheries, primarily those in marine waters. Some reduction in FMI relative to the base period occurred in 2019 but the FMI increased to near base period levels in 2020. Impacts to Fall 4_1 Chinook decreased slightly in 2019 but increased in 2020 (still below base period levels).

Commercial/EO/Test fisheries:

- Impacts to all Fraser Chinook Management Units in these fisheries were reduced in 2019 and further so in 2020.
- Of particular note is the substantial decrease in impacts to Summer 4_1 Chinook (down from 16.9% in the base period to 3.0% in 2019 and 2.7% in 2020). This decrease was driven by a delayed start to the Area F troll fishery that was designed to pass additional Chinook to the Fraser River to support First Nations Food, Social and Ceremonial (FSC) fishery access.

First Nations FSC fisheries:

- Impacts to Spring 4_2 and Spring 5_2 Chinook decreased substantially in 2019 compared to the base period and remained low in 2020
- Impacts to Summer 5_2 Chinook decreased slightly in 2019 but increased in 2020 (still below base period levels)
- Impacts to Summer 4_1 Chinook increased in 2019 compared to the base period and increased slightly further in 2020, as intended given the objective to pass more Summer 4_1 Chinook from marine fisheries (particularly Area F troll) to the Fraser River and to provide directed harvest opportunities targeting this MU in First Nations FSC fisheries in the Fraser.

Conclusion

Based on the RR+GSI method, management actions appear to have successfully resulted in decreasing fishery mortalities on Spring 4_2 and Spring 5_2 Chinook to low levels, less than 5% in 2020. While substantial reductions in fishery impacts on Summer 5_2 Chinook were achieved in 2019 with some additional redution in 2020, the impact of Canadian fisheries on this MU remain higher than the impact on the Spring 4_2 and Spring 5_2 MUs. This is likely due to the later run timing of the Summer 5_2 MU that coincides with Chinook retention opportunities targeting Summer 4_1 Chinook in August and September.

The management objective to shift the harvest distribution of Summer 4_1 from marine, particularly Area F troll, fisheries to Fraser River FN FSC fisheries appears to have been achieved, as there was a large shift in the proportion of Summer 4_1 Chinook caught by each fishing group and a greater proportion of the overall Fraser Chinook catch was comprised of Summer 4_1 Chinook; approximately 60% of the harvest of this MU occurred in First Nations FSC fisheries in the Fraser River in 2020 (compared to 18% in the base period). In addition, the Lower Shuswap escapement objective was met in both 2019 and 2020.

For the Fall 4_1 MU, while Canadian fishery mortalities were reduced in 2019 and 2020, the Harrison River indicator stock did not meet the escapement goal in either year. Threats likely contributing most to this (by decreasing smolt-to-adult survival rates) include climate change, ecosystem modifications, pollution, fishing, and competition with hatchery fish (see comments specific to DU2 in DFO 2020).

A similar analysis of the 2021 fisheries will occur in 2022 when data are compiled, including completion of the Fraser River run reconstruction and DNA lab analysis of samples. Discussion of the impact of this analysis on 2022 fisheries management measures will occur during winter and spring consultation meetings with First Nations and stakeholders.

References

DFO. 2020. Recovery Potential Assessment for 11 Designatable Units of Fraser River Chinook Salmon, *Oncorhynchus tshawytscha*, Part 1: Elements 1 to 11. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/023.

Dobson, D., Holt, K. and Davis, B. 2020. A Technical Review of the Management Approach for Stream-Type Fraser River Chinook. DFO Can. Sci. Advis. Sec. Res. Doc. 2020/027. x + 280 p.

Table 1. Catch amounts used to calculate Fishing Mortality Index for the run reconstruction plus GSI method (RR+GSI). Exploitation Rate Analysis (ERA) results provided for comparison (note: methods are different and results not expected to align precisely). Results are preliminary.

	STOCK MANAGEMENT UNIT																	
	Spring 4_2			Spring 5_2			Summer 5_2			Summer 4_1			Fall 4_1			Total		
	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020
Spawners	10,721	6,154	8,764	20,824	5,275	20,507	21,529	15,038	21,780	107,282	173,431	169,160	91,198	120,634	83,420	251,554	320,532	303,631
Big Bar Mortality	n/a	n/a	n/a	n/a	17,872	*TBD*	n/a	5,090	*TBD*	n/a	n/a	n/a	n/a	n/a	n/a	0	22,962	0
Fraser First Nations FSC	2,489	116	303	3,004	461	324	2,065	1,297	1,793	9,471	26,642	29,943	1,102	480	255	18,131	28,996	32,618
Fraser Recreational	62	0	0	208	0	1	719	255[3]	593[3]	6,337	3,715	3,615	5,054	7,735	5,469	12,380	11,705	9,678
Fraser Commercial/EO/Test	125	110	72	259	92	201	417	194	315	4,956	2,935	2,361	583	640	291	6,340	3,971	3,240
Total In-River Fishing Mortality	2,676	226	375	3,471	553	526	3,201	1,746	2,701	20,764	33,292	35,919	6,739	8,855	6,015	36,851	44,672	45,536
Total Return to River	**13,397**	**6,380**	**9,139**	**24,295**	**23,700**	**21,033**	**24,730**	**21,874**	**24,481**	**128,046**	**206,723**	**205,079**	**97,937**	**129,489**	**89,435**	**288,405**	**388,166**	**349,167**
NBC Troll [1,5]	132	0	0	948	96	0	981	40	16	23,626	3,613	1,487	341	81	16	26,028	3,830	1,519
NBC Net [1]	4	0	0	29	0	0	30	0	0	714	0	0	10	0	0	787	0	0
NBC Recreational [1,5,6]	72	15	1	307	67	12	307	420	8	7,725	10,865	1,592	73	282	63	8,484	11,649	1,676
NBC First Nations [1]	13	1	1	95	13	11	98	9	7	2,358	1,192	988	34	71	59	2,598	1,286	1,066
WCVI Troll [2]	217	90	0	237	98	0	207	86	0	2,577	1,067	2,135	1,795	743	104	5,033	2,084	2,239
WCVI First Nations [2]	0	0	0	0	0	0	179	121	0	2,685	1,821	741	179	121	0	3,043	2,063	741
SBC Recreational [8]	437	63	37	1,412	806	3	2,245	1,096	475	20,409	30,910	10,141	19,066	16,945	13,852	43,569	49,820	24,508
Total CDN Marine Fishing Mortality [4,7]	**875**	**169**	**39**	**3,028**	**1,080**	**26**	**4,047**	**1,772**	**506**	**60,094**	**49,468**	**17,084**	**21,498**	**18,243**	**14,094**	**89,542**	**70,732**	**31,749**
Total CDN Fishing Mortality	**3,551**	**395**	**414**	**6,499**	**1,633**	**552**	**7,248**	**3,518**	**3,207**	**80,858**	**82,760**	**53,003**	**28,237**	**27,098**	**20,109**	**126,393**	**115,404**	**77,285**
Run Size Index	**14,272**	**6,549**	**9,178**	**27,323**	**24,780**	**21,059**	**28,777**	**23,646**	**24,987**	**188,140**	**256,191**	**222,163**	**119,435**	**147,732**	**103,529**	**377,947**	**458,898**	**380,916**
RR+GSI Fishing Mortality Index	**24.9%**	**6.0%**	**4.5%**	**24%**	**6.6%**	**2.6%**	**25%**	**14.9%**	**12.8%**	**43%**	**32%**	**24%**	**24%**	**18%**	**19%**	**33%**	**25%**	**20%**
Exploitation Rate Analysis Fishing Mortality Index*	18.2%	**3.5%**	**23.1%**	n/a	n/a	n/a	n/a	n/a	n/a	27.6%	**13.5%**	**13.8%**	**22.5% (HAR) 25.8% (CHI)**	**22.2% (HAR) 19.6% (CHI)**	**14.9% (HAR) 32.5% (CHI)**	*CDN ONLY		

[1] NBC GSI in base period is uncertain; based on microsatellite data from Area 1-5 Troll fisheries. Re-analysis with single-nucleotide polymorphisms (SNPs) is a planned in future.

[2] WCVI GSI in base period is uncertain; using 2019 WCVI GSI as a proxy; Some data available but not for all years, needs further work.

[3] Fraser recreational catch of Summer 5(2) Chinook in 2019 and 2020 was all terminal catch in Chilliwack and Chehalis rivers.

[4] Central BC catch is assumed to not impact Fraser stocks based on limited GSI samples and area fished, so is not included here.

[5] 2019 and 2020 GSI for NBC troll and sport updated to use info from SNP analysis.

[6] Area 3-5 recreational catch is newly added to total NBC Recreational catch (was not included when analysis first done in 2020).

[7] Does not include inside marine SBC First Nations catch (Only 2020 impacts available: 6 Fraser Sp 4(2), 23 Fraser Su 5(2), 371 Fraser Su 4(1), 1171 Fraser Fall).

[8] Recreational fishery impacts are infilled for May-Sep using iREC; Oct-Apr is catch info without infilling.

Table 2. Fishing Mortality Index by fishery for the run reconstruction plus GSI method (RR+GSI). Exploitation Rate Analysis (ERA) results provided for comparison (note: methods are different and results not expected to align precisely). Results are preliminary.

	STOCK MANAGEMENT UNIT																	
	Spring 4_2			Spring 5_2			Summer 5_2			Summer 4_1			Fall 4_1			Total		
	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020
Spawners	75.1%	94.0%	95.5%	76.2%	21.3%	97.4%	74.8%	63.6%	87.2%	57.0%	67.7%	76.1%	76.4%	81.7%	80.6%	66.6%	69.8%	79.7%
Big Bar Mortality	n/a	n/a	n/a	n/a	72.1%	TBD	n/a	21.5%	TBD	n/a	n/a	n/a	n/a	n/a	n/a	0.0%	5.0%	0.0%
Fraser First Nations FSC	17.4%	1.8%	3.3%	11.0%	1.9%	1.5%	7.2%	5.5%	7.2%	5.0%	10.4%	13.5%	0.9%	0.3%	0.2%	4.8%	6.3%	8.6%
Fraser Recreational	0.4%	0.0%	0.0%	0.8%	0.0%	0.0%	2.5%	1.1%	2.4%	3.4%	1.5%	1.6%	4.2%	5.2%	5.3%	3.3%	2.6%	2.5%
Fraser Commercial/EO/Test	0.9%	1.7%	0.8%	0.9%	0.4%	1.0%	1.4%	0.8%	1.3%	2.6%	1.1%	1.1%	0.5%	0.4%	0.3%	1.7%	0.9%	0.9%
Total In-River Fishing Mortality Index	**18.8%**	**3.5%**	**4.1%**	**12.7%**	**2.2%**	**2.5%**	**11.1%**	**7.4%**	**10.8%**	**11.0%**	**13.0%**	**16.2%**	**5.6%**	**6.0%**	**5.8%**	**9.8%**	**9.7%**	**12.0%**
NBC Troll	0.9%	0.0%	0.0%	3.5%	0.4%	0.0%	3.4%	0.2%	0.1%	12.6%	1.4%	0.7%	0.3%	0.1%	0.0%	6.9%	0.8%	0.4%
NBC Net	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%
NBC Recreational	0.5%	0.2%	0.0%	1.1%	0.3%	0.1%	1.1%	1.8%	0.0%	4.1%	4.2%	0.7%	0.1%	0.2%	0.1%	2.2%	2.5%	0.4%
NBC First Nations	0.1%	0.0%	0.0%	0.3%	0.1%	0.1%	0.3%	0.0%	0.0%	1.3%	0.5%	0.4%	0.0%	0.0%	0.1%	0.7%	0.3%	0.3%
WCVI Troll	1.5%	1.4%	0.0%	0.9%	0.4%	0.0%	0.7%	0.4%	0.0%	1.4%	0.4%	1.0%	1.5%	0.5%	0.1%	1.3%	0.5%	0.6%
WCVI First Nations	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.5%	0.0%	1.4%	0.7%	0.3%	0.1%	0.1%	0.0%	0.8%	0.4%	0.2%
SBC Recreational	3.1%	1.0%	0.4%	5.2%	3.3%	0.0%	7.8%	4.6%	1.9%	10.8%	12.1%	4.6%	16.0%	11.5%	13.4%	11.5%	10.9%	6.4%
Total CDN Marine Fishing Mortality	**6.1%**	**2.6%**	**0.4%**	**11.1%**	**4.4%**	**0.1%**	**14.1%**	**7.5%**	**2.0%**	**31.9%**	**19.3%**	**7.7%**	**18.0%**	**12.3%**	**13.6%**	**23.7%**	**15.4%**	**8.3%**
RR+GSI Fishing Mortality Index	**24.9%**	**6.0%**	**4.5%**	**23.8%**	**6.6%**	**2.6%**	**25.2%**	**14.9%**	**12.8%**	**43.0%**	**32.3%**	**23.9%**	**23.6%**	**18.3%**	**19.4%**	**33.4%**	**25.1%**	**20.3%**
Exploitation Rate Analysis Fishing Mortality Index*	18.2%	**3.5%**	**23.1%**	n/a	n/a	n/a	n/a	n/a	n/a	27.6%	**13.5%**	**13.8%**	**22.5% (HAR) 25.8% (CHI)**	**22.2% (HAR) 19.6% (CHI)**	**14.9% (HAR) 32.5% (CHI)**	*CDN ONLY		

See notes/caveats with Table 1.

Table 3. Summary of Fishing Mortality Index by fishing group for the run reconstruction plus GSI method (RR+GSI). Results are preliminary. See notes/caveats with Table 1.

(a) Catch summary

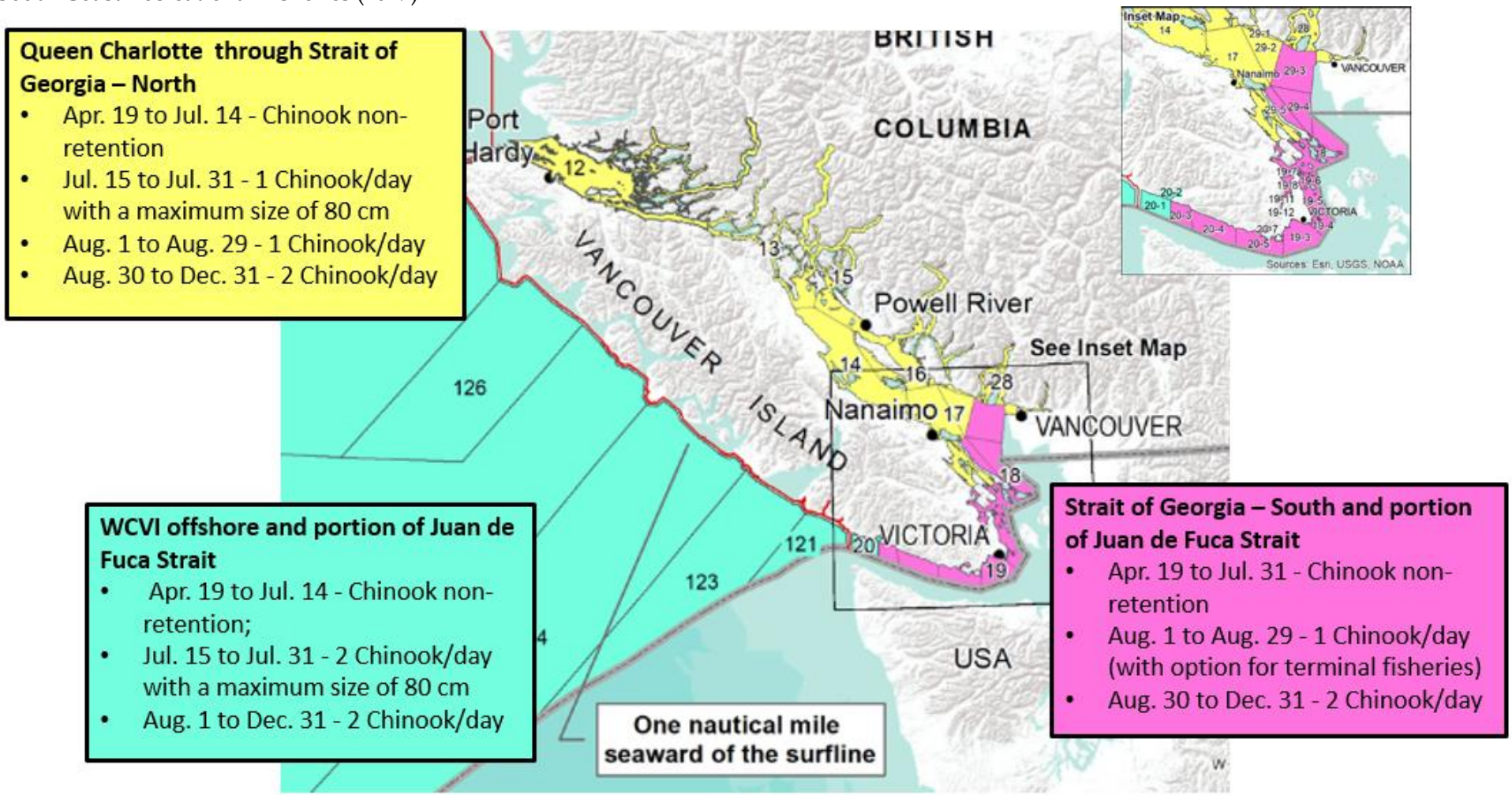
	STOCK MANAGEMENT UNIT																	
	Spring 4_2			Spring 5_2			Summer 5_2			Summer 4_1			Fall 4_1			Total		
	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020
RECREATIONAL																		
In-river	62	0	0	208	0	1	719	255	593	6,337	3,715	3,615	5,054	7,735	5,469	12,380	11,705	9,678
Marine	509	78	38	1,719	873	15	2,552	1,516	483	28,134	41,775	11,733	19,139	17,227	13,915	52,053	61,469	26,184
Total	**571**	**78**	**38**	**1,927**	**873**	**16**	**3,271**	**1,771**	**1,076**	**34,471**	**45,490**	**15,348**	**24,193**	**24,962**	**19,384**	**64,433**	**73,174**	**35,862**
COMMERCIAL/EO/TEST																		
In-river	125	110	72	259	92	201	417	194	315	4,956	2,935	2,361	583	640	291	6,340	3,971	3,240
Marine	353	90	0	1,214	194	0	1,218	126	16	26,917	4,680	3,622	2,146	824	120	31,848	5,914	3,758
Total	**478**	**200**	**72**	**1,473**	**286**	**201**	**1,635**	**320**	**331**	**31,873**	**7,615**	**5,983**	**2,729**	**1,464**	**411**	**38,188**	**9,885**	**6,998**
FIRST NATIONS																		
In-river	2,489	116	303	3,004	461	324	2,065	1,297	1,793	9,471	26,642	29,943	1,102	480	255	18,131	28,996	32,618
Marine	13	1	1	95	13	11	277	130	7	5043	3013	1729	213	192	59	5641	3349	1807
Total	**2,502**	**117**	**304**	**3,099**	**474**	**335**	**2,342**	**1,427**	**1,800**	**14,514**	**29,655**	**31,672**	**1,315**	**672**	**314**	**23,772**	**32,345**	**34,425**
Total CDN Fishing Mortality	**3,551**	**395**	**414**	**6,499**	**1,633**	**552**	**7,248**	**3,518**	**3,207**	**80,858**	**82,760**	**53,003**	**28,237**	**27,098**	**20,109**	**126,393**	**115,404**	**77,285**
Run Size Index	**14,272**	**6,549**	**9,178**	**27,323**	**24,780**	**21,059**	**28,777**	**23,646**	**24,987**	**188,140**	**256,191**	**222,163**	**119,435**	**147,732**	**103,529**	**377,947**	**458,898**	**380,916**

(b) Percentage mortality summary

	STOCK MANAGEMENT UNIT																	
	Spring 4_2			Spring 5_2			Summer 5_2			Summer 4_1			Fall 4_1			Total		
	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020	AVERAGE 2014-2018	2019	2020
RECREATIONAL																		
In-river	0.4%	0.0%	0.0%	0.8%	0.0%	0.0%	2.5%	1.1%	2.4%	3.4%	1.5%	1.6%	4.2%	5.2%	5.3%	3.3%	2.6%	2.5%
Marine	3.6%	1.2%	0.4%	6.3%	3.5%	0.1%	8.9%	6.4%	1.9%	15.0%	16.3%	5.3%	16.0%	11.7%	13.4%	13.8%	13.4%	6.9%
Total	**4.0%**	**1.2%**	**0.4%**	**7.1%**	**3.5%**	**0.1%**	**11.4%**	**7.5%**	**4.3%**	**18.3%**	**17.8%**	**6.9%**	**20.3%**	**16.9%**	**18.7%**	**17.0%**	**15.9%**	**9.4%**
COMMERCIAL/EO/TEST																		
In-river	0.9%	1.7%	0.8%	0.9%	0.4%	1.0%	1.4%	0.8%	1.3%	2.6%	1.1%	1.1%	0.5%	0.4%	0.3%	1.7%	0.9%	0.9%
Marine	2.5%	1.4%	0.0%	4.4%	0.8%	0.0%	4.2%	0.5%	0.1%	14.3%	1.8%	1.6%	1.8%	0.6%	0.1%	8.4%	1.3%	1.0%
Total	**3.3%**	**3.1%**	**0.8%**	**5.4%**	**1.2%**	**1.0%**	**5.7%**	**1.4%**	**1.3%**	**16.9%**	**3.0%**	**2.7%**	**2.3%**	**1.0%**	**0.4%**	**10.1%**	**2.2%**	**1.8%**
FIRST NATIONS																		
In-river	17.4%	1.8%	3.3%	11.0%	1.9%	1.5%	7.2%	5.5%	7.2%	5.0%	10.4%	13.5%	0.9%	0.3%	0.2%	4.8%	6.3%	8.6%
Marine	0.1%	0.0%	0.0%	0.3%	0.1%	0.1%	1.0%	0.5%	0.0%	2.7%	1.2%	0.8%	0.2%	0.1%	0.1%	1.5%	0.7%	0.5%
Total	**17.5%**	**1.8%**	**3.3%**	**11.3%**	**1.9%**	**1.6%**	**8.1%**	**6.0%**	**7.2%**	**7.7%**	**11.6%**	**14.3%**	**1.1%**	**0.5%**	**0.3%**	**6.3%**	**7.0%**	**9.0%**
Total CDN Fishing Mortality Index (RR+GSI method)	**24.9%**	**6.0%**	**4.5%**	**23.8%**	**6.6%**	**2.6%**	**25.2%**	**14.9%**	**12.8%**	**43.0%**	**32.3%**	**23.9%**	**23.6%**	**18.3%**	**19.4%**	**33.4%**	**25.1%**	**20.3%**

Appendix 1. Detailed Maps of Fisheries Management Measures in 2019 and 2020.

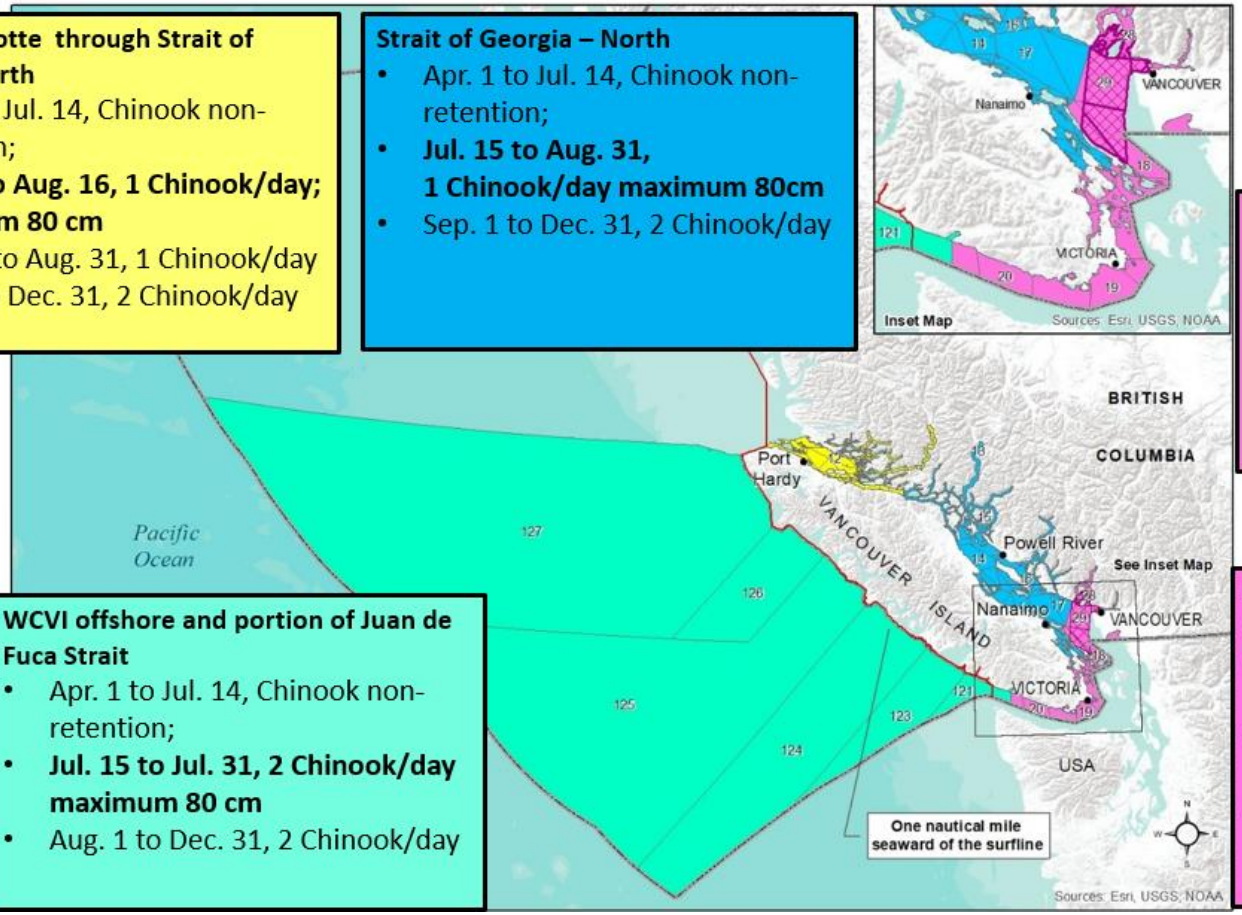
South Coast Recreational Fisheries (2019)



Fraser River tidal waters and non-tidal waters

- Fraser Mouth (29-6, -7, -9 and -10) – Jan. 1 to Dec. 31, fishing for salmon not permitted
- Fraser Tidal waters – Jan. 1 to Sep. 13, fishing for salmon not permitted
- Fraser non-tidal – Region 2: Jan. 1 to Nov. 2, fishing for salmon not permitted
- Some opportunities to harvest Chinook in tributary areas (e.g. to target Summer 4_1 Chinook)

South Coast Recreational Fisheries (2020)



Queen Charlotte through Strait of Georgia – North

- Apr. 1 to Jul. 14, Chinook non-retention;
- **Jul. 15 to Aug. 16, 1 Chinook/day; maximum 80 cm**
- Aug. 17 to Aug. 31, 1 Chinook/day
- Sep. 1 to Dec. 31, 2 Chinook/day

Strait of Georgia – North

- Apr. 1 to Jul. 14, Chinook non-retention;
- **Jul. 15 to Aug. 31, 1 Chinook/day maximum 80cm**
- Sep. 1 to Dec. 31, 2 Chinook/day

Portions of Southern Strait of Georgia, Howe Sound and Burrard Inlet (hatched area)

- **April 1 to August 31: No fishing for Chinook**
- September 1 to December 31: 2 Chinook per day.

WCVI offshore and portion of Juan de Fuca Strait

- Apr. 1 to Jul. 14, Chinook non-retention;
- **Jul. 15 to Jul. 31, 2 Chinook/day maximum 80 cm**
- Aug. 1 to Dec. 31, 2 Chinook/day

Strait of Georgia – South and portion of Juan de Fuca Strait

- Apr. 1 to Jul. 31, Chinook non-retention;
- **Aug. 1 to Aug. 31, 1 Chinook/day maximum 80cm**
- Sep. 1 to Dec. 31, 2 Chinook/day

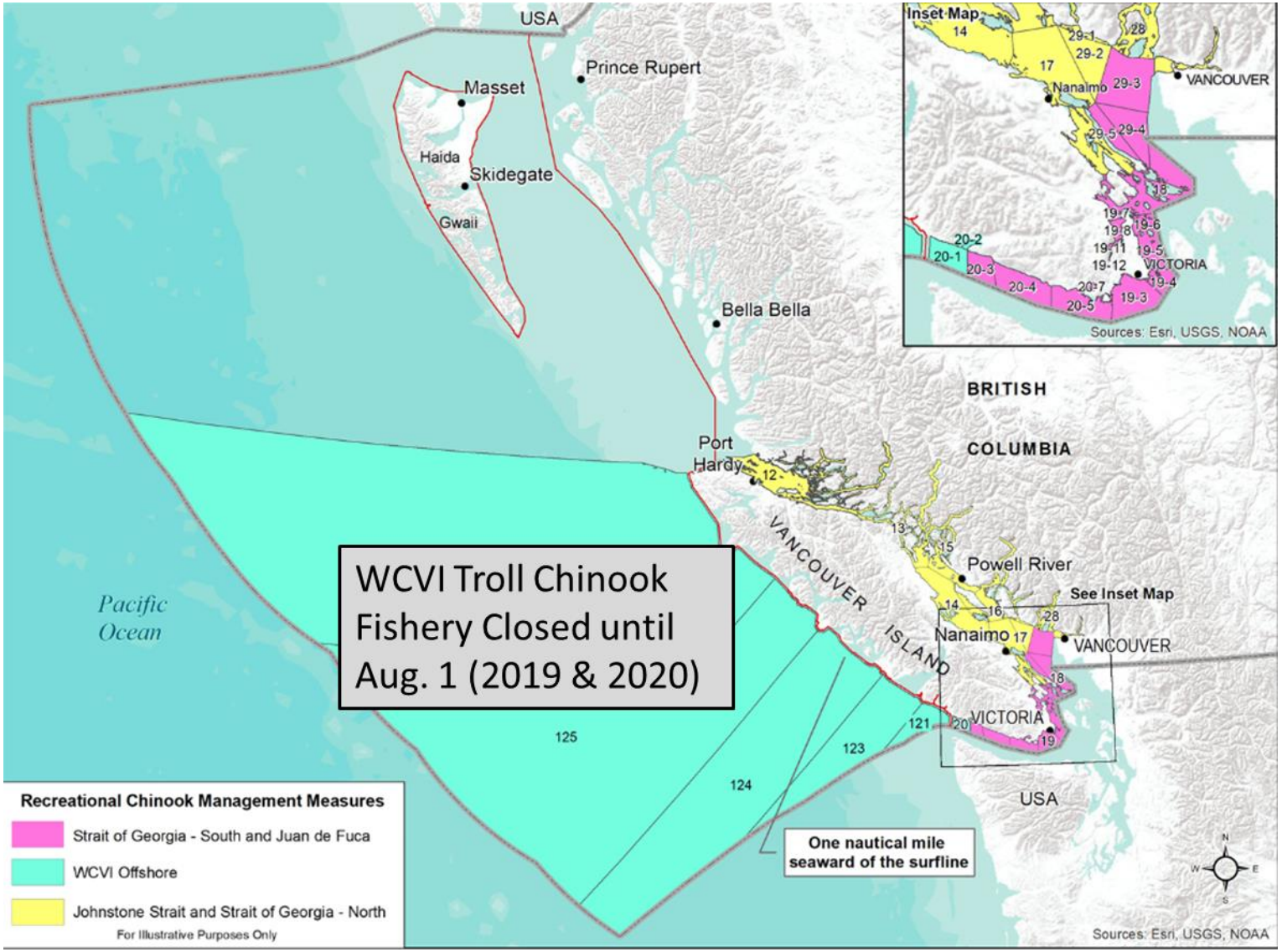
Approaches to Fraser River - Subareas 29-6, 29-7, 29-9 to 29-17 and the non-tidal waters of the Fraser River from Mission Bridge to the confluence with Sawmill Creek:

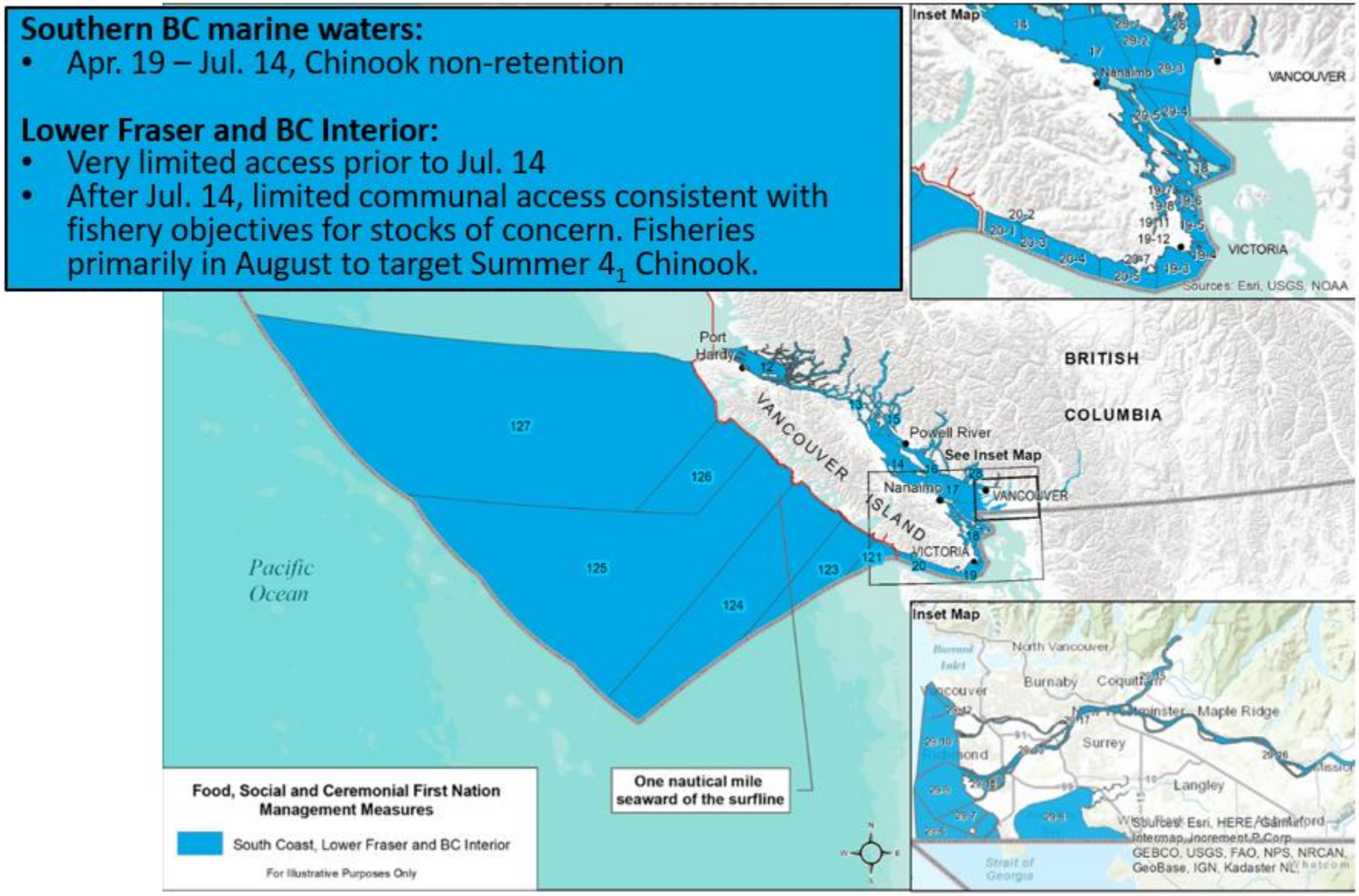
- Jan. 1 to Nov. 1: No fishing for salmon
- (Fishing opportunities for specific salmon stocks may be considered)

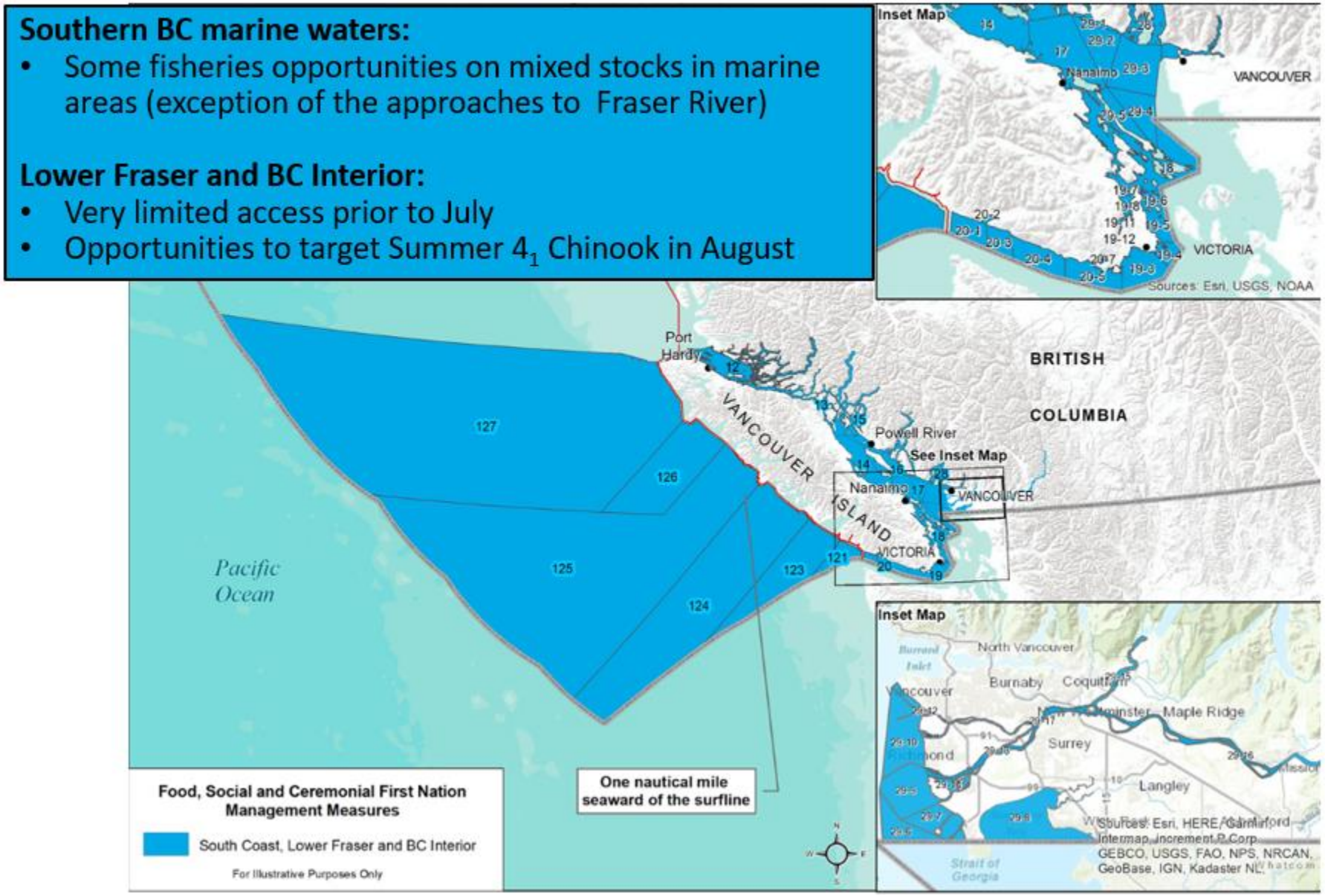
Freshwater Regions 3, 5, 7 & 8 - Year round:

- Closed to fishing for salmon
- (Fishing opportunities for specific salmon stocks may be considered)

South Coast Commercial Fisheries (2019/2020)

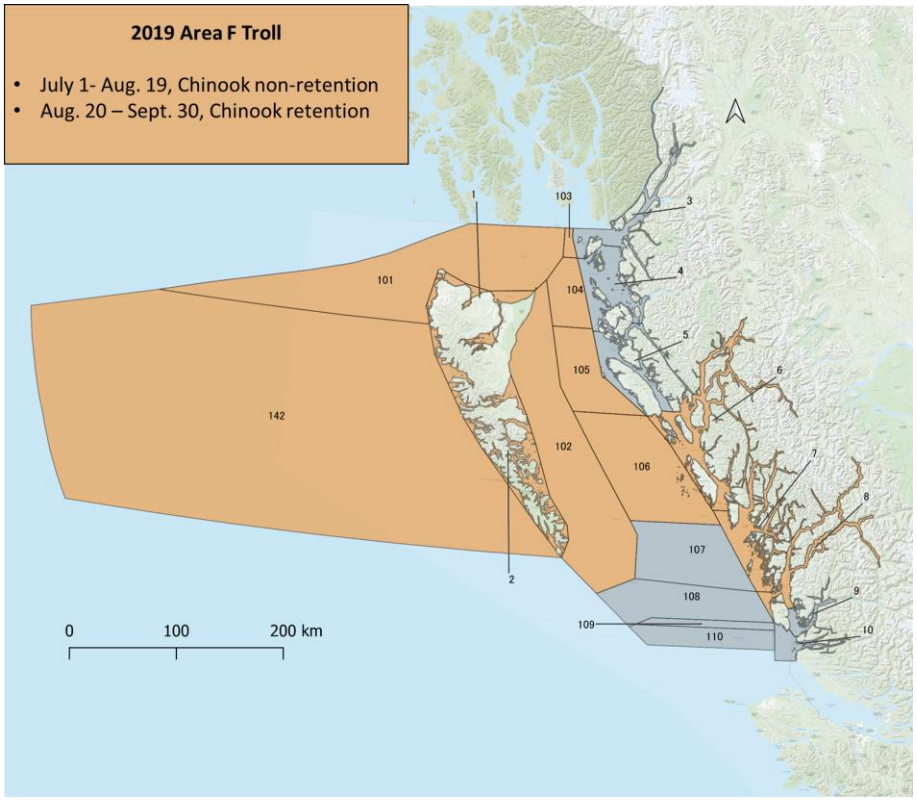



Southern BC marine waters:
• Apr. 19 – Jul. 14, Chinook non-retention
Lower Fraser and BC Interior:
• Very limited access prior to Jul. 14
• After Jul. 14, limited communal access consistent with fishery objectives for stocks of concern. Fisheries primarily in August to target Summer 4$_1$ Chinook.
Inset Map
VANCOUVER
VICTORIA
Sources: Esri, USGS, NOAA
Port Hardy
BRITISH
COLUMBIA
Powell River
See Inset Map
Nanaimo
VANCOUVER
ISLAND
VICTORIA
127
126
125
124
123
121
Pacific Ocean
Inset Map
North Vancouver
Burnaby
Coquitlam
Maple Ridge
Surrey
Langley
Sources: Esri, HERE, Garmin, Intermap, increment P Corp, GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL,
Strait of Georgia
Food, Social and Ceremonial First Nation Management Measures
South Coast, Lower Fraser and BC Interior
For Illustrative Purposes Only
One nautical mile seaward of the surfline


Southern BC marine waters:
• Some fisheries opportunities on mixed stocks in marine areas (exception of the approaches to Fraser River)
Lower Fraser and BC Interior:
• Very limited access prior to July
• Opportunities to target Summer 4$_1$ Chinook in August
Inset Map
VANCOUVER
VICTORIA
Sources: Esri, USGS, NOAA
Port Hardy
BRITISH
COLUMBIA
VANCOUVER ISLAND
Powell River
See Inset Map
Nanaimo
VICTORIA
Pacific Ocean
127
126
125
124
123
121
Inset Map
North Vancouver
Burnaby
Coquitlam
Maple Ridge
Surrey
Langley
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL,
Strait of Georgia
Food, Social and Ceremonial First Nation Management Measures
South Coast, Lower Fraser and BC Interior
For Illustrative Purposes Only
One nautical mile seaward of the surfline

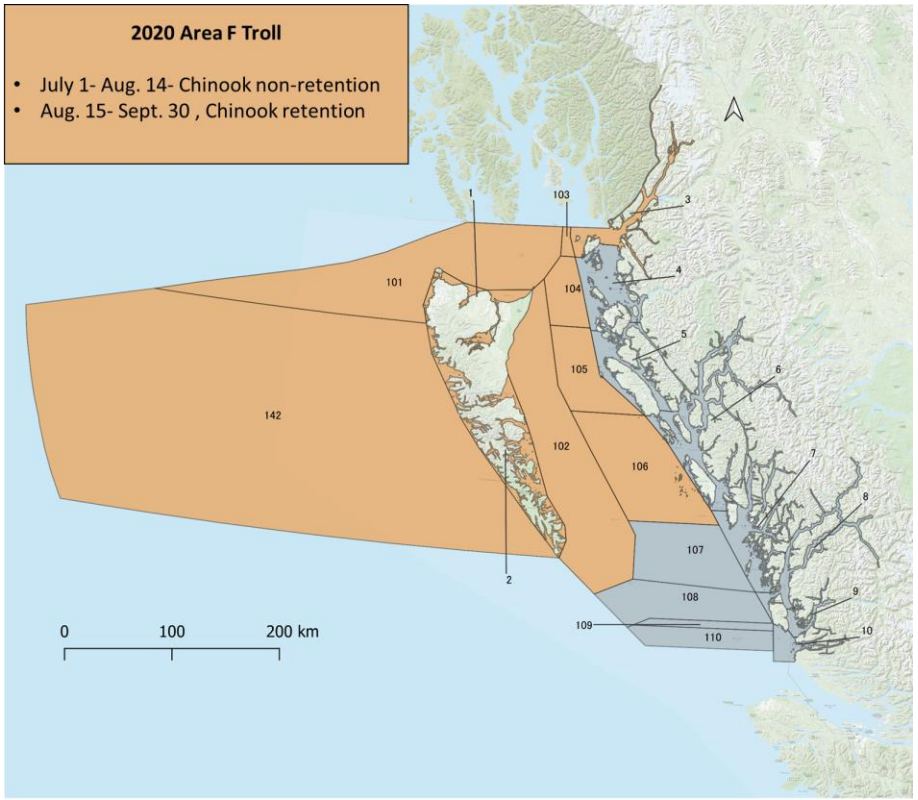
North and Central Coast Area F Troll (2019)

Grey polygons represent areas of inactivity in the region.



North and Central Coast Area F Troll (2020)

Grey polygons represent areas of inactivity in the region.



North Coast Fisheries (2019)

In all areas there was Chinook retention for First Nation FSC. Reductions in the daily limit for Chinook were driven by low abundance of Sockeye salmon thus requiring the reallocation of Chinook for in-river FSC fisheries to compensate. Grey polygons represent areas of inactivity in the region.

Area 1 and 2
Recreational: Apr 1- Mar 31, 2 Chinook/day

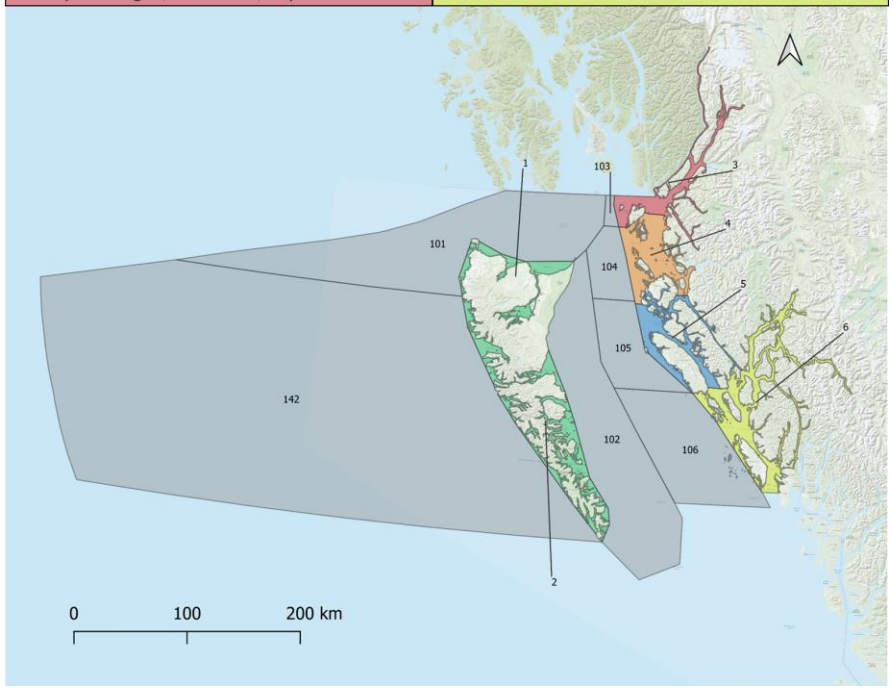
Area 3
Gillnet Fishery: June 17 – July 16, Chinook non-retention
Seine Fishery: July 9-22, Chinook non-retention

Recreational:
- Apr.1 –July 26; Aug. 6 – Mar. 31, 2 Chinook/day
- July 27- Aug. 5, 1 Chinook/day

Area 4
Recreational:
- Apr.1 –July 26; Aug. 6 – Mar. 31, 2 Chinook/day
- July 27- Aug. 5, 1 Chinook/day

Area 5
Recreational:
- Apr.1 –July 26; Aug. 6 – Mar. 31, 2 Chinook/day
- July 27- Aug. 5, 1 Chinook/day

Area 6
Recreational: Apr 1- Mar 31, 2 Chinook/day



North Coast Fisheries (2020)

In all areas there was Chinook retention for First Nation FSC. Reductions in the daily limit for Chinook were driven by pre-season conservation decisions outlined in the Integrated Fisheries Management Plan. Grey polygons represent areas of inactivity in the region.

Area 1 and 2
Seine Fishery: Aug. 24-31 , Chinook non-retention

Recreational: Apr 1- Mar 31, 2 Chinook/day

Area 3
Seine Fishery: July 6, Chinook non-retention

Recreational:
- Apr. 1 – May 31; July 15 – Mar. 31, 2 Chinook/day
- June 1 – July 14, 1 Chinook/day

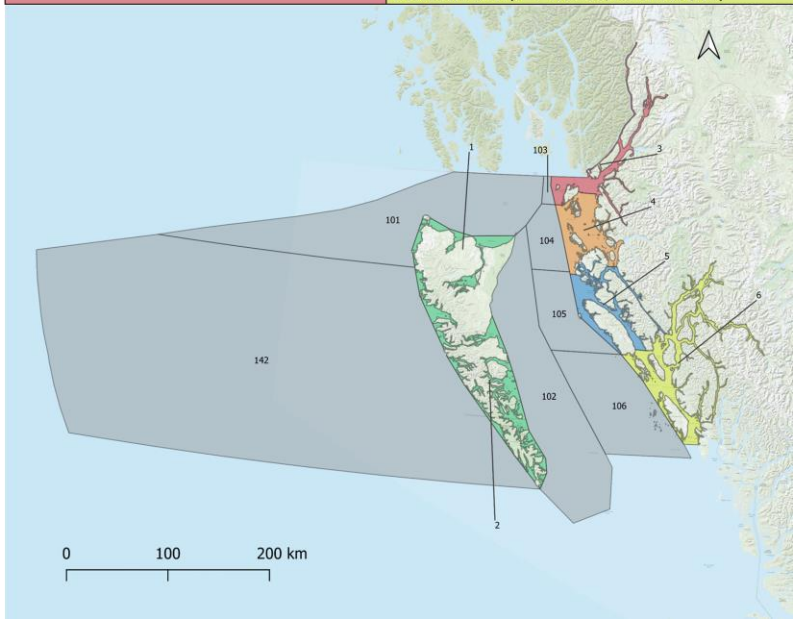
Area 4
Gillnet Fishery: Aug. 6-7, Chinook non-retention

Recreational:
- Apr. 1 – May 31; July 15 – Mar. 31, 2 Chinook/day
- June 1 – July 14, 1 Chinook/day

Area 5
Recreational:
- Apr. 1 – May 31; July 15 – Mar. 31, 2 Chinook/day
- June 1 – July 14, 1 Chinook/day

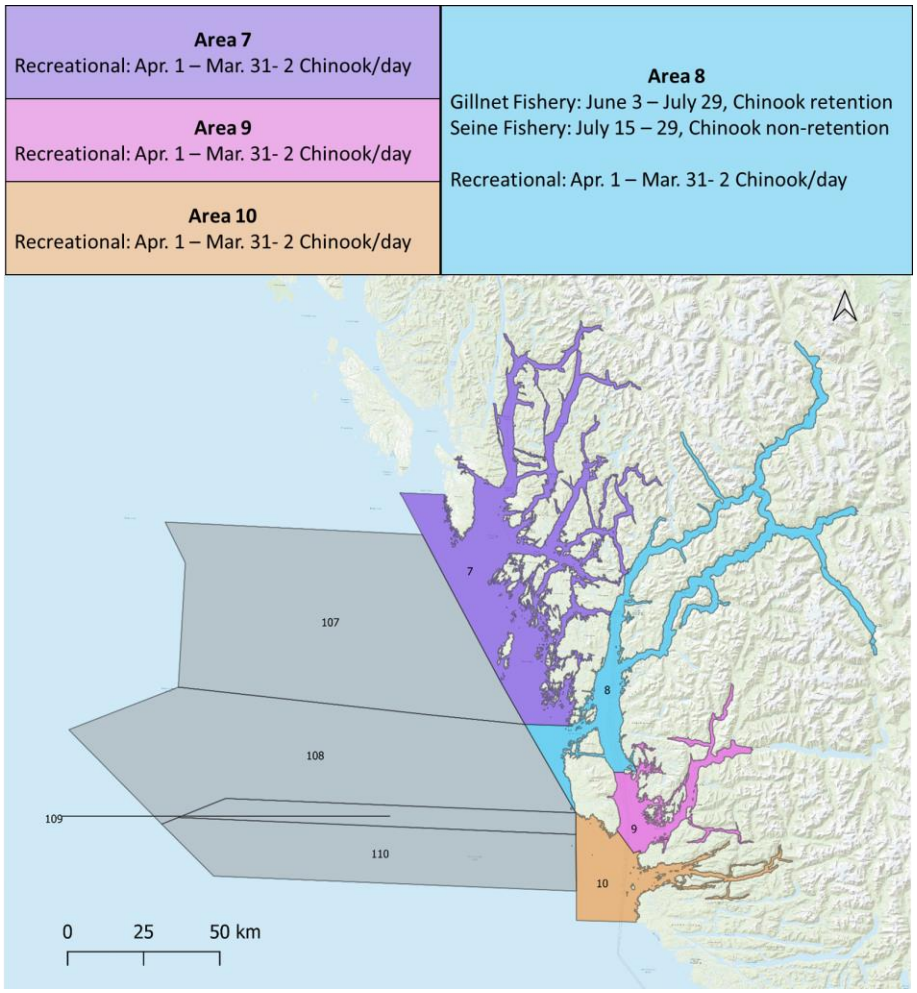
Area 6
Area 6 Seine Fishery: July 29- Aug .10, Chinook non-retention

Recreational: Apr 1- Mar 31, 2 Chinook/day



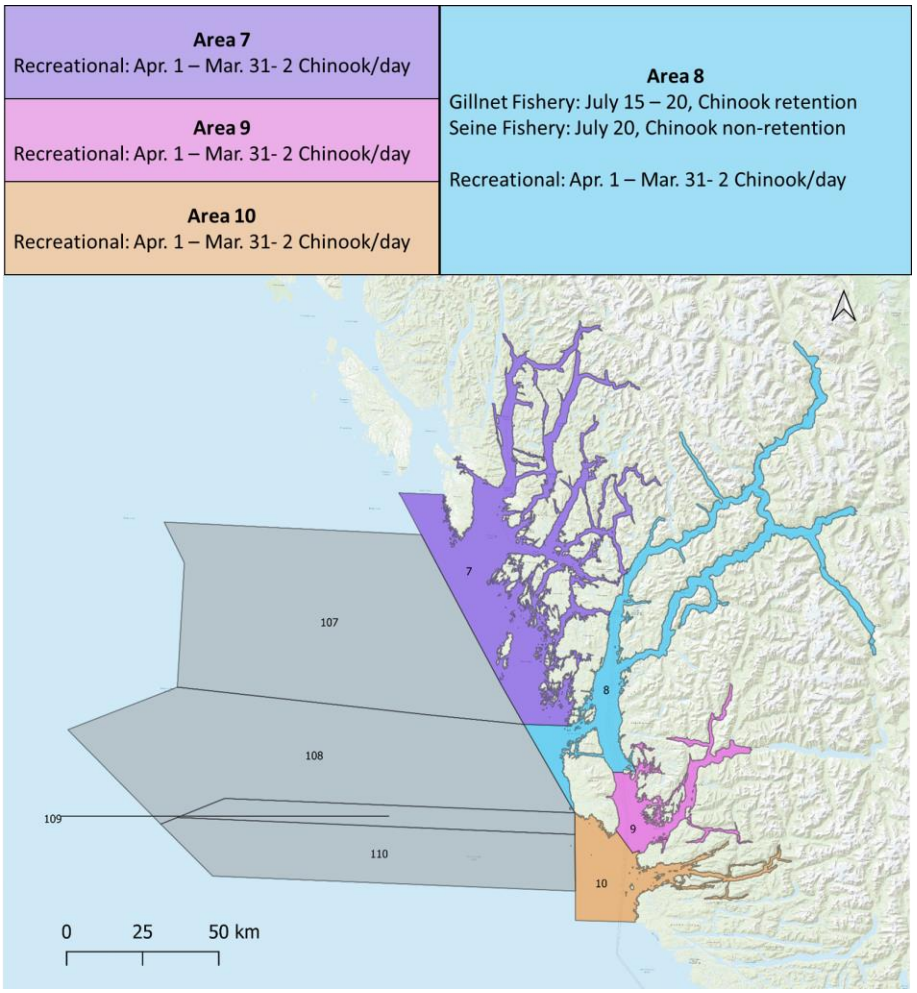
Central Coast Fisheries (2019)

In all areas there is Chinook retention for First Nation FSC. Grey polygons represent areas of inactivity in the region.



Central Coast Fisheries (2020)

In all areas there is Chinook retention for First Nation FSC. Grey polygons represent areas of inactivity in the region.



Appendix 2. Discussion around some of the differences in results between the run reconstruction plus genetic stock ID method and exploitation rate analysis method, focused on the 2020 Spring 4_2 results.

The magnitude and trend of the fishing mortality index differs between the run reconstruction plus genetic stock ID (RR+GSI) and exploitation rate analysis (ERA), especially for the Spring 4_2 Chinook in 2020. While both methods can be used to estimate a fishery mortality index on Fraser Chinook, they are not intended to be the same or directly compared. Differences in the results can occur for several reasons outlined below, some of which are specific to the Spring 4_2 Chinook estimate generated for 2020:

- Run reconstruction assumes fish have the same migration timing and rate in each section of the river each year, but for 2020 the high water events may have changed fish behaviour (signs there may have been delayed migration) and this is not accounted for in the run reconstruction model. We know from more detailed investigations of other Fraser River salmon that high water migration conditions influence the rate that salmon migrate upstream and the frequency that they can rest at creek and river confluences.
- There were also observations of fish overshooting the Thompson River in 2020 (recoveries upstream near the Stein River confluence), and Nicola fish are assumed to not go beyond the Thompson River in the run reconstruction, which is similar to the assumptions used in the run reconstruction model for other stocks.
- The run reconstruction model can have inconsistent application of kept catch versus total mortality, depending on the information available for each fishery. The ERA method attempts to standardize to total mortality in each fishery.
- The run reconstruction method is a model that relies on several assumptions being the same each year (e.g. the size distribution of stocks, migration rates and residence times, fishery vulnerability, migration timing, en-route and other types of non-fishing mortality), whereas the ERA method relies on estimating the catch and escapement and sampling fisheries for CWTs; Therefore, variation and timing, vulnerability, age and size composition, etc. will be represented to the extent that the catch estimation and CWT sampling represent the characteristics of the actual fishery.
- The run reconstruction model uses only kept catch and escapement data obtained from the Fraser River in the denominator, thus the percentage value represents a harvest rate. In comparison, the ERA method uses CWT data obtained from all salmon fisheries along the coast and the Fraser River in the denominator, thus the percentage value represents an exploitation rate. Adding on catch by stock from the marine fisheries to the run reconstruction values attempts to close the gap on this issue, but not all marine fisheries have genetic samples available to assign the catch to stock groups. In many cases, a reasonable proxy in time/area is used.
- All CWT exploitation rate estimates have uncertainty due to uncertainty in catch estimates and are further impacted by low CWT sample rates; In 2020, sample rates in the Fraser River FSC fisheries were very low, at an average of 3.5%. Typically the goal is for at least 20% sampling rate within the fishery.
- CWT recoveries in a fishery stratum (e.g. month and fishing area) rely on estimates of the catch of adipose fin clipped (AFC) Chinook and CWT samples collected from the kept AFC Chinook. The CWT recoveries are estimated from the CWT sample and the CWT sample rate (total CWT sample divided by the sample rate), and the uncertainty in the estimated CWT recoveries increases as the sample rate decreases. Another component of the uncertainty arises from the uncertainty in the AFC catch estimate, which generally depends on the uncertainty in the estimated fishing effort and the variability in the catch per unit effort, as well as the number of catch estimation strata that are used to represent the

fishing gear characteristics (e.g. set nets, drift nets, dip nets, rod and reel, gaff, etc.). Note that different methods can be used to estimate catch, thus there are different sources of uncertainty (e.g. surveys, log book diaries, phone-based fishing reports, etc.). When the AFC catch is not directly estimated as part of the catch estimation study design, the catch estimate is multiplied by the percentage of the catch that was observed to be AFC, called the mark rate. The mark rate can be developed from different sources where the catch is observed in the fishery stratum. Also, when the CWT sample is small, then the CWT sample composition can be developed from different sources in the fishery stratum.

It is difficult to reconcile these differences, so it is expected that the actual impacts to Spring 4_2 Chinook likely lie somewhere between the two estimates.