2020

Report of the Fraser River Panel to the Pacific Salmon Commission on the 2020 Fraser River Sockeye Salmon Fishing Season

Prepared by the

Pacific Salmon Commission

April 2022

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REPORT OF THE
FRASER RIVER PANEL
TO THE PACIFIC SALMON COMMISSION
ON THE 2020 FRASER RIVER SOCKEYE
SALMON FISHING SEASON

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April 2022

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Appendix F

I. EXECUTIVE SUMMARY

The 2020 season saw a record low number of sockeye salmon return to the Fraser River. The previous lowest returns occurred in 2016 and 2019, making this the third record low in the last five years. The final 2020 in-season run size estimate of 365,200 sockeye was 61% less than the median forecast (941,000) and 88% below the cycle line average (3,100,000). While low survival rates similar to previous years were expected, there is no clear explanation why survival rates turned out to be the lowest on record. This very low run size was further impacted by the Big Bar landslide of 2019, most notably early in the season when discharge levels were high and migration issues were prevalent from Hells Gate to the Big Bar Slide. The overall low run size in combination with the migration challenges resulted in the smallest spawning escapement in the Fraser River since the 1940's. While the corona virus pandemic and related COVID-19 disease prompted a number of local, provincial/state/tribal, and federal government restrictions on the movement of people and the conduct of business, the impact on the implementation of Chapter 4 of the Treaty in 2020 was minor and mainly restricted to reduced shipping services to transport samples. The following paragraphs describe the planning of the 2020 season and the Panel management actions, including those taken in response to the low sockeye salmon run size and the Big Bar landslide.

Pre-season Planning

1. During the 2019/20 winter/spring season, substantial mitigation work had been undertaken to alleviate the impact of the Big Bar rockslide (Figures 5 and 6). The remediation work included breaking up and removing rock at the site to improve natural fish passage and the construction and deployment of alternative fish passage options including a concrete fishway and the Whooshh^{TM} system, a flexible, pressurized fish transport tube.
2. Pre-season, the median run size forecast (p50 level, Appendix B) was 941,000 Fraser River sockeye salmon and according to the quantitative forecast there was a one in two chance that the run size would be between 488,000 and 1,913,000.
3. Based on the forecast, Big Bar was expected to impact 100% of the Early Stuart run, 34% of the Early Summer run, 63% of the Summer run and none of the Late run stocks.
4. Pre-season expectations of migration parameters included a 35% diversion rate for Fraser River sockeye through Johnstone Strait. The Panel adopted the following Area 20 50% migration dates: July 4 for Early Stuart, July 24 for Early Summer, July 31 for Summer, and August 6 for Late-run sockeye.
5. At median (p50) forecast abundance levels, pre-season spawning escapement goals were 13,000 Early Stuart, 150,300 Early Summer, 611,000 Summer and 99,000 Late-run sockeye for a total of 873,300 sockeye salmon (Table 1). The goals for each sockeye management group were established by applying Canada's Spawning Escapement Plan to their median forecasted run sizes (Appendix B).
6. Management Adjustments (MAs) of 9,000 Early Stuart, 78,200 Early Summer, 97,800 Summer-run and 40,600 Late-run sockeye were added to the spawning escapement targets to increase the likelihood of achieving the targets (Appendix B, Table B2). These MA estimates did not include predicted impacts of Big Bar given the unknown impacts of the remediation work done prior to the 2020 season.
7. There was no projected Total Allowable Catch (TAC) of Fraser River sockeye salmon based on the median forecasted abundances and agreed deductions.
8. Pre-season model runs at the p75 also projected no international TAC; however, Canada was able to model some Food, Social, Ceremonial fisheries targeting Early Summer run.
9. The Panel adopted the 2020 Management Plan Principles and Constraints and Regulations, the 2020 Regulations, and the 2020 Pre-season Agreement on Test Fishing Deductions (Appendix C).

In-season Management Considerations

10. The in-season marine migration timing (Figure 3) was earlier than pre-season expectations for all sockeye management groups except for Early Stuart: 2 days later for Early Stuart run, 9 days earlier for Early Summer-run, 3 days earlier for Summer run and 4 days earlier for Late run.
11. The overall Johnstone Strait diversion rate for Fraser River sockeye was 25% compared to the pre-season forecast of 35% (Figure 4).
12. Returns for Fraser sockeye salmon were substantially below median pre-season forecasts with the exception of Early Stuart sockeye salmon. Early Stuart run: 29% above median forecast, Early Summer run: 59% below median forecast, Summer run: 60% below median forecast, Late run: 83% below median forecast. The number of returning Early Stuart sockeye fell between the p50 and p75 run size forecast, but for Early Summer, Summer and Late run, the number of returning sockeye were lower than the p25 run size forecasts.
13. The very low number of sockeye returning to the Fraser River resulted in the spawning escapement target to be equal to the run size for all management groups. Therefore, the adoption of management adjustments (MAs) for all run timing groups was unnecessary, as it would not impact achievement of the targets. Fraser River discharge was above historical average and river temperatures were below historical average in July and were near average through August and early September (Figure 7).

Implications of the Big Bar landslide

14. A Unified Command Incident Management Team, a collaboration between First Nations, Federal and Provincial governments, continued to lead the remediation response for the 2020 season which included: the natural fishway, radio tagging, sonar monitoring, fish transport by Whooshh™ and truck and the collection of Early Stuart and Bowron broodstock for emergency enhancement (Figure 5).
15. Despite the mitigation work, the Big Bar landslide continued to create migration challenges for salmon spawning above Big Bar (Figure 6), in particular for early migrating stocks like Early Stuart and Bowron sockeye that experienced well above average discharge levels.
16. As discharge levels decreased over the summer and water levels declined, an increasing proportion of the run (primarily Summer-run fish and later timed Early Summer-run stocks) was able to make it past the slide naturally.
17. Of the stocks above Big Bar, the following proportions made it to the spawning grounds: 0.2% of the Early Stuart run, 147% of the Early Summer run and 94% of the Summer run stocks.
18. Post-season, additional remediation work was focused on the construction of permanent fishways.

Run Size, Catch, Escapement and Migration patterns

19. Returns of adult Fraser sockeye totalled 363,800 fish (Table 7) which was 59% below the return of 890,000 fish in the primary brood year (2016). This return was the smallest since records started in 1893. Divided into management groups, adult returns totalled 16,800 Early Stuart, 88,900 Early Summer-run, 241,500 Summer-run and 16,600 Late-run sockeye.
20. Due to the very poor sockeye return, all sockeye management groups were managed using a 10% low abundance exploitation rate (LAER).
21. Catches of Fraser River sockeye salmon in all fisheries totalled 25,300 fish, including 11,400 fish caught by Canada, 9,300 fish caught by the U.S. and 4,600 fish caught by test fisheries (Table 6). Almost all the Canadian catch was unsanctioned (11,300 fish). All of the catch by the U.S. was from pink directed fisheries in Alaska. The overall harvest rate was 7% of the run (Figure 9, Table 7).
22. DFO's near-final estimates of spawning escapements to streams in the Fraser River watershed totalled 272,800 adult sockeye (Tables 6 and 7). This was 43% less than the brood year escapement of 484,500 adults and the lowest escapement on this cycle since the 1940's. By management group and for this cycle line, spawning escapements in 2020 were the lowest on

record for Early Stuart and Late run, the second lowest for Summer run and for Early Summer run, the lowest since the mid-1970s (Figure 11). There were 157,300 effective female spawners in the Fraser watershed, with an overall spawning success of 97%.

23. There was considerable evidence that the number of fish returning deviated from the accounted catch and escapement estimates, as the difference between estimates (DBEs) accounted for 18% of the run size estimate. The DBEs, which are the differences between spawning escapements and potential spawning escapements (Mission escapement minus any in-river catch above Mission) will eventually be replaced by run size adjustments (RSAs) following further evaluations of the differences and associated en route losses within the RSA process.

Achievement of Objectives

24. In order of descending priority, the goals of the Panel are to achieve the targets for spawning escapement, international sharing of the TAC, and domestic catch allocation.
25. In-season management decisions are based on targets for spawning escapement, which are represented in-season by potential spawning escapement targets (i.e., spawning escapement targets plus MAs). Due to the extremely low return in 2020, the spawning escapement targets for all management groups equalled their run sizes, and there was no need for the Panel to adopt MA estimates (Table 8). Also, with the very low catches, the potential escapements (i.e., Mission escapement minus all catch above Mission) for each management group were very similar to the spawning escapement target: Early Stuart sockeye (6% above), Early Summer-run (4% under), Summer-run (9% under) and Late-run sockeye (14% over).
26. For all management groups, the spawning escapement target equalled the run size, so the escapement target could only be obtained in the absence of catches *and* any difference between estimates. Thus even with the rigorous management approach that was applied in 2020, spawning escapement targets could not be met for any management group. Additionally, early season high discharge levels from Hells Gate to the Big Bar landslide resulted in further reductions in escapement to upper river spawning areas for early migrating stocks like Early Stuart and Bowron.
27. Spawning ground estimates of Fraser sockeye abundance totalled 272,800 adults, which is 25% below the post-season target (Table 9). Spawner abundance was severely below target for Early Stuart sockeye (98% under), below target for Early Summer-run (10% under), below target for Summer-run (23% under) and below target for Late-run sockeye (62% under). The exploitation rates for all management groups were less than their respective LAERs.
28. There was no International TAC (Total Allowable Catch) of Fraser sockeye, based on the calculation method set out in Annex IV, Chapter 4 of the Pacific Salmon Treaty (Table 10). There was no sockeye catch in Washington. The total Canadian catch of 11,400 Fraser sockeye consisted almost entirely of unsanctioned catch in addition to 50 fish caught in the Charter test fishery (Albion). This Canadian catch exceeded the allowable harvest by 100%. In these calculations, the TAC is based on the TAC on the date of the last adopted run size in an in-season Panel meeting (September 1, 2020), while catches are post-season estimates.
29. There was no by-catch of non-Fraser sockeye salmon as there were no commercial marine fisheries in 2020.

Allocation Status

30. No payback was generated in 2020, but by Panel agreement there is still a U.S. payback of 470 Fraser River sockeye from the 2019 season that will be carried forward to 2021 (Table 11).

II. FRASER RIVER PANEL

In 2020, the Panel operated under the terms of Annex IV, Chapter 4 of the Pacific Salmon Treaty between Canada and the United States (U.S.)[1]. The Fraser River Panel was responsible for in-season management of fisheries that target Fraser River sockeye and pink salmon within the Panel Area (Figure 1), including net fisheries in both countries and the Canadian troll fishery in the Strait of Georgia. Fisheries directed at Fraser River sockeye and pink salmon outside of the Panel area are coordinated with those in the Panel area, but are the responsibility of the appropriate agencies (largely Canada's Department of Fisheries and Oceans (DFO)). Coordination of directed harvest of other salmon species (coho and chum) intercepted in south coast areas is the responsibility of the Southern Panel and the Pacific Salmon Commission (PSC). Regulation of Southern Panel related fisheries is the responsibility of the appropriate agencies in each country.

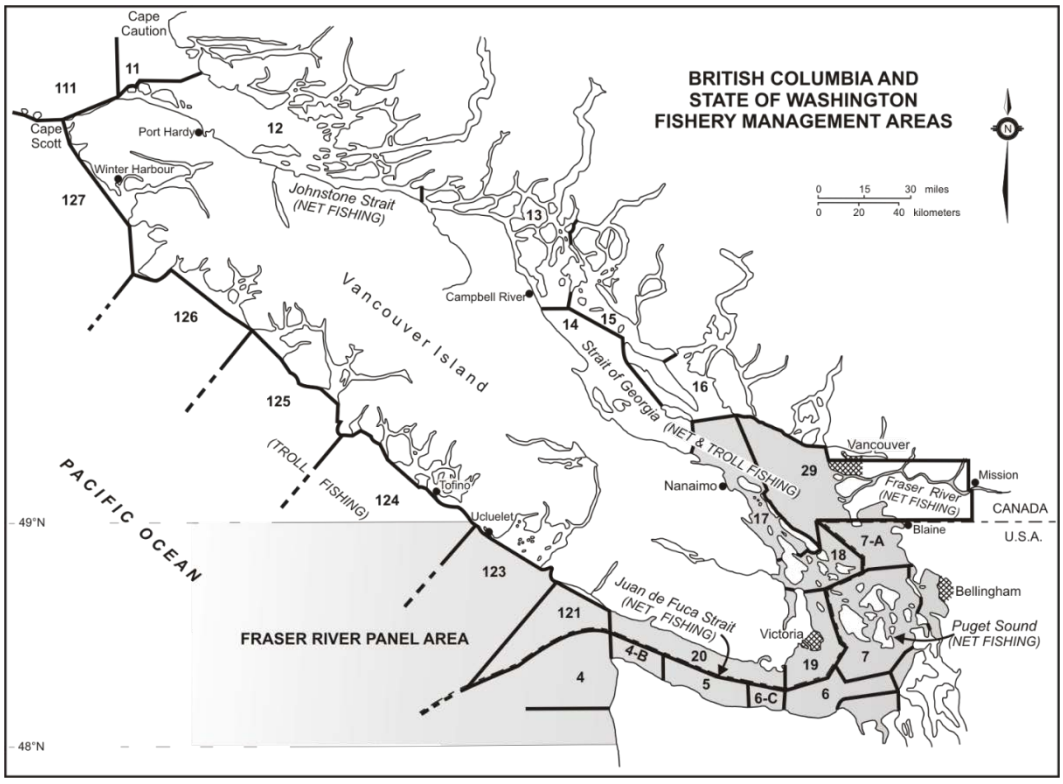

Figure 1. Fishery management areas in the Fraser River Panel Area and south coast waters.

Prior to the fishing season, the Fraser River Panel recommends a fishery regime for Panel Area fisheries to the Pacific Salmon Commission (PSC). The recommendation is based on: (1) abundance, timing and migration route forecasts and escapement targets for Fraser River sockeye and pink salmon provided by Canada's Department of Fisheries and Oceans (DFO); (2) international catch allocation goals set by the Treaty; (3) domestic catch allocation goals established by each country; (4) management concerns for other stocks and species also identified by each country; and (5) historical patterns in migration and fisheries dynamics. In descending priority, the objectives that guide the Panel's decision-making are to: (1) achieve the spawning escapement targets, (2) meet international catch allocation goals, and (3) meet domestic catch allocation objectives. Conservation concerns for other species and stocks that may occur as by-catch in fisheries directed at Fraser sockeye and pink salmon are generally addressed domestically with some international coordination. While not under Panel regulatory control, management of

[1] Pacific Salmon Treaty as modified through January 2020.

Canadian non-Panel area fisheries directed at Fraser River sockeye and pink salmon is based on the same in-season information and hierarchy of objectives.

The Panel's regulatory authority is implemented based on the principle that all Panel-regulated fisheries are to remain closed (Appendix D) unless opened by specific order (Appendix E). The pre-season plan identifies the approximate pattern of fishery openings required to achieve the Panel objectives given pre-season expectations. However, the Panel typically determines the actual pattern of fishery openings based on in-season assessments by PSC staff (Appendix I) of Fraser sockeye and pink salmon run size, migration timing and route, in-river migration abundance (i.e., Mission escapement) and Management Adjustments. Thus, the Panel responds to deviations from pre-season expectations in their weekly fishing plans and most substantive fishery decisions are based on in-season rather than pre-season assessments. The Fraser River Technical Committee (Appendix H) works in conjunction with Staff to facilitate Panel activities by providing their respective National sections of the Panel with technical advice and ensuring timely exchange of data between Staff and the Parties.

III. PANEL MANAGEMENT ACTIVITIES

Information used for Panel management can be divided into three general categories: (1) pre-season forecasts and expectations, on which planning activities such as the pre-season management plan are based; (2) in-season estimates that change over the course of the season, on which in-season fishery decisions are based; and (3) post-season estimates derived from information that was unavailable during the season, such as spawning ground estimates of escapement, more complete catch estimates, and adjustments to estimates that with hindsight appear to have been biased or incorrect. Post-season estimates impact Panel management in two ways: (a) they can affect the data used to inform pre-season assumptions in future years (e.g. abundance, timing and management adjustments) and (b) some elements (e.g. spawning escapements, catches) impact post-season evaluation of the achievement of management objective (see Section VI below for more details). Key information in the first two categories is discussed in the following sections.

A. Pre-season Planning

Pre-season fisheries management plans for Panel Area fisheries were developed by the Panel using the Fishery Planning Model[2], which allows for the evaluation of the impacts of alternative fishery options on the achievement of management objectives. Model inputs include: forecasts of run size, migration timing, diversion rate, migration delays in the Strait of Georgia, and management adjustments (MAs), as well as test fishery deductions and objectives for spawning escapement and catch allocation.

The pre-season median run-size forecast did not allow for any fisheries directed at Fraser River sockeye salmon. Alternative model runs using the p75 (75th percentile) and p90 (90th percentile) of the forecast explored the sensitivity of fishing plans to larger sockeye salmon run sizes. At the p75 run size forecast scenario there was still no international Total Allowable Catch (TAC) available and only Canadian FSC fisheries were able to target Early Summer-run sockeye. The allowable exploitation rates for Early Stuart, Summer run, and Late run corresponded to their Low Abundance Exploitation Rates (LAERs) of 10%, 10% and 20% respectively. The LAER is applied to accommodate small amounts of by-catch for management groups with little or no TAC, as detailed in paragraph 3 (e), amended Annex IV, Chapter 4 of the 2020 Pacific Salmon Treaty[3].

[2] Cave, J.D. and W.J. Gazey. 1994. A pre-season simulation model for fisheries on Fraser River sockeye salmon (*Oncorhynchus nerka*). Can. J. Fish. Aquat. Sci. 51(7): 1535-1549.
[3] Pacific Salmon Treaty as modified through January 2020.

Due to constraints imposed by the LAERs, the model indicated Canada's total catch was limited to 148,600 sockeye of the 249,800 available for harvest. Under the p90 run size forecast scenario, sockeye directed fisheries were planned for both countries. At this run size, the Early Stuart and Late run were to be managed under their corresponding LAERs. Constraints on fishing opportunities imposed by these management groups impacted fishing opportunities on the Early Summer and Summer runs. The U.S. fishing plan resulted in a modelled sockeye catch of 122,900, or 98% of their 125,200 allocation. The Canadian fishing plan resulted in a modelled sockeye catch of 862,700, or 83% of the 1,033,700 remaining available for harvest.

The preliminary run-size forecast for Fraser River sockeye salmon was produced by Canada using a variety of stock-recruit models similar to those used in previous years and with data up until the 2016 brood year (2017 brood year for Harrison)[4] . Canada presented the Panel with a sockeye salmon run-size forecast corresponding to five probability levels (10%, 25%, 50%, 75% and 90%) that the return would be below, or at, the specified abundance (Appendix B, Table B1). In 2020, the Panel used the median (i.e., p50) run size forecast of 941,000 Fraser River sockeye salmon as the "base case" scenario for planning purposes. The Panel also explored two alternative models, assuming a sockeye salmon run size corresponding to the 75th percentile of the distribution of the forecasted run size (p75: 1.9 million) and a sockeye salmon run size corresponding to the 90th percentile of the distribution of the forecasted run size (p90: 3.9 million).

Canada used the "Fraser River Sockeye Spawning Initiative" (FRSSI) model and pre-season consultations on the Pacific Region Integrated Fisheries Management Plan (IFMP)[5] to establish escapement goals for the 2020 management season. The spawning escapement plan released by Canada to the Panel (Appendix B, Table B2) was based on FRSSI guidelines with stakeholder input through a domestic consultation process. Pre-season escapement targets for sockeye at the p50 run size levels by management group were: Early Stuart – 13,000; Early Summer run – 150,300; Summer run– 610,700; and Late run – 99,000[3]. At this abundance level, the Early Stuart, Early Summer, Summer, and Late runs were managed to a 10% LAER instead of the associated escapement targets.

Pre-season fisheries management planning was based on assumptions about the proportions of Fraser River sockeye migrating through Johnstone Strait instead of Juan de Fuca Strait (i.e. Johnstone Strait diversion rate, Figure 2) as well as marine timing (i.e. Juan de Fuca or Area 20 50% migration dates). Area 20 dates are indices of marine migration timing and represent the date when 50% of the total run would have entered Juan de Fuca Strait (Canadian Area 20) if the entire run had migrated via that route. Covid-19 affected timelines for the retrieval of oceanographic data used for the forecast of the timing and diversion rate[6]. Therefore, DFO provided forecasts of Area 20 timing based on recent year medians. These timing forecasts did not include environmental or oceanographic covariates. The Fraser River Panel adopted the all-years historical median for Early Stuart of July 4. Area 20 timing for all other component stocks in the model were based on historical cycle-line medians with the exception of the Nadina group (Nadina, Bowron, Gates, Nahatlatch, Taseko) and the Chilliwack-Pitt group, which assumed all-year historical medians. The timing of the Early Summer, Summer and Late-run management groups were derived based on the aggregated daily abundances of component stocks assuming normal run timing distributions. The Panel adopted a timing of July 24 for the Early Summer run, July 31 for the Summer run, and August 6 for the Late run.

[4] Hawkshaw, M., Xu, Y., and Davis, B. 2020. Pre-season Run Size Forecasts for Fraser River Sockeye (*Oncorhynchus nerka*) Salmon in 2020. Can. Tech. Rep. Fish. Aquat. Sci. In Press.
[5] DFO. 2020. Pacific Region Final Integrated Fisheries Management Plan June 1, 2020 - May 31, 2021, Salmon Southern BC.
[6] Hourston, R. 2018. Evaluating Models To Forecast Fraser Sockeye Return Timing And Diversion Rate. Can. Sci. Advis. Sec. Res. Doc.

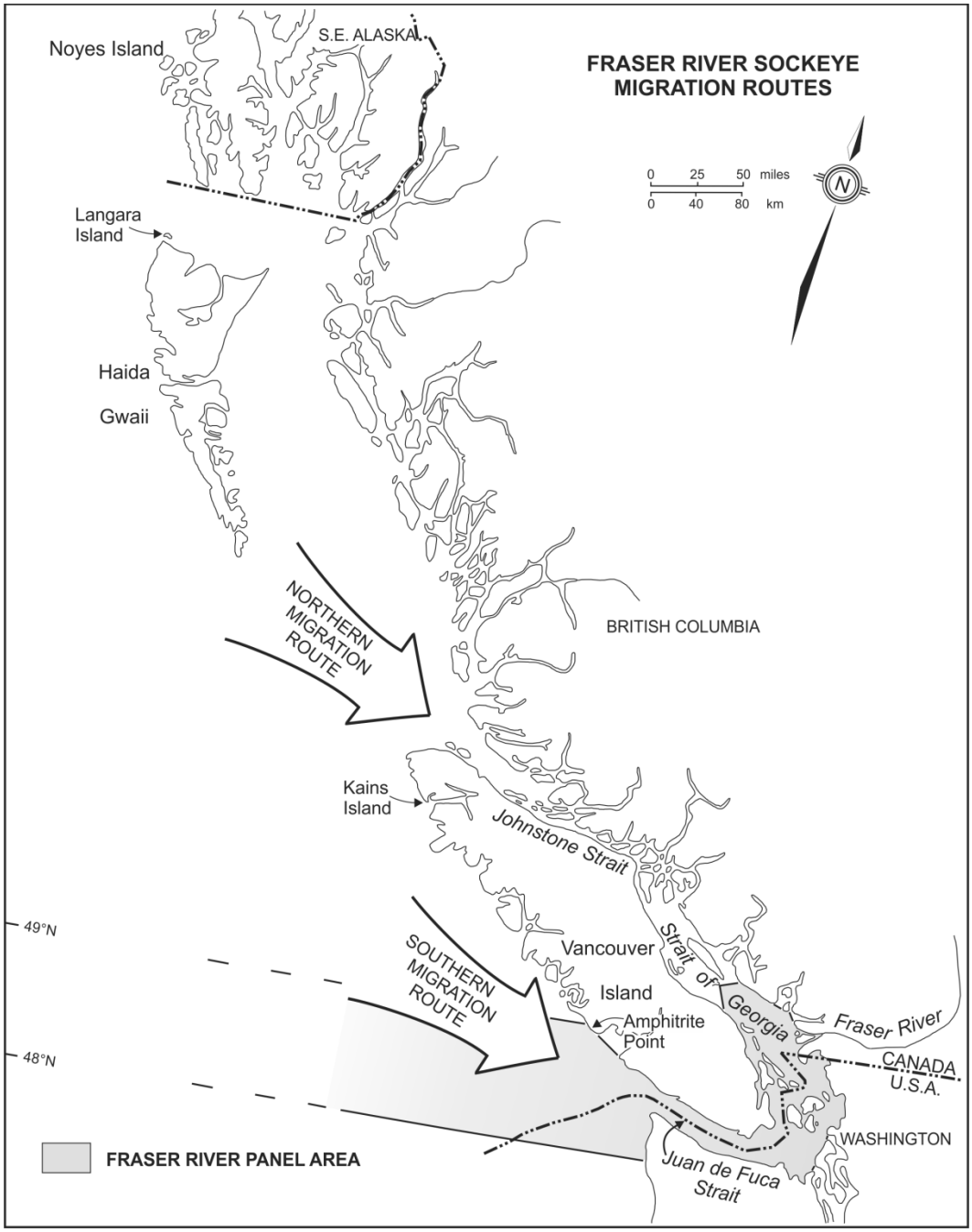

Figure 2. The northern (Johnstone Strait) and southern (Juan de Fuca Strait) routes for sockeye and pink salmon migration to the Fraser River.

Without the oceanographic data needed to provide diversion rate forecasts based on oceanographic models, DFO forecasted a 63% diversion rate for Fraser River sockeye salmon through Johnstone Strait using the historical median since 1998. An additional forecast was produced using historical diversion data limited to the 2020 cycle-line years. This cycle-line forecast produced various model estimates between 32 and 40%, depending on the number of historical data points used. The Panel adopted a Johnstone Strait diversion rate of 35%, calculated using the average daily diversion rates from the last 5 years on the cycle line. Harrison sockeye salmon diversion rate was modelled as 24% based on the historical relationship between Harrison sockeye salmon diversion and total sockeye diversion. Figure 3 illustrates the distribution of daily

abundances by management group given the pre-season assumptions of Area 20 timing and total run size.

The Panel adopted a management approach that assumed effectively zero migration delay of the Late-run and Summer-run management groups into the Fraser River. The non-Birkenhead Late-run group delay component was not estimated due to the low forecasted abundances and a lack of historical evidence for delay on the 2016 cycle line. The model also assumed no delay of Harrison sockeye salmon in the Strait of Georgia.

DFO's Environmental Watch (E-Watch) Program provided the Panel with long-range (3-month) projections of Fraser River temperature and discharge conditions. Fraser River watershed snowpack was 116% of normal in early spring (April 1, BC Fraser Basin Snow Water Index). Although high temperatures on May 9th and 10th resulted in significant snow melt across much of coastal B.C., the areas that contribute to most of Fraser River flow (roughly two-thirds) had above average snowpack on June 1[7]. The long-range forecast was for above average discharge and above average water temperature in the Fraser River. Staff used the environmental forecasts in Management Adjustment (MA) models developed jointly by DFO and the PSC to forecast the proportional difference between estimates (pDBEs) (see Table F3) to predict how many additional sockeye should be allowed to escape to increase the probability of achieving spawning escapement objectives (see references in the MA section of the Management Information chapter). Due to the high forecasted relative abundances of Pitt and Chilliwack fish in the Early Summer-run aggregate, Harrison fish in the Summer-run aggregate, and Birkenhead in the Late-run aggregate the weighted pDBE approach was used for these three management groups. Given the low forecasted run sizes and the impacts of the Big Bar landslide, management adjustments (MAs) were not expected to impact fishery management decisions. For planning purposes, the Panel agreed to a pMA for the Early Stuart run (pMA=0.69; pDBE=-0.41; MA=9,000 fish), Early Summer run aggregate (pMA=0.52; pDBE=-0.34; MA=78,200 fish), Summer run aggregate (pMA=0.16; pDBE=-0.14; MA=97,700 fish) and Late run aggregate (pMA=0.41; pDBE=-0.29; MA=40,600 fish) (Table 4). For more details about how the MAs were estimated see the "Management Adjustment and DBE" section in Appendix F.

During the pre-season planning process, both countries identified salmon stocks for which they had conservation concerns and that could influence management decisions for fisheries directed at Fraser River sockeye salmon. Canada identified Early Stuart sockeye salmon, Cultus Lake sockeye salmon, Nimpkish sockeye salmon, Sakinaw sockeye salmon, interior Fraser River coho salmon, Strait of Georgia coho salmon, interior Fraser steelhead salmon, all Fraser River Chinook salmon, west coast Vancouver Island and Strait of Georgia Chinook salmon, various rockfish species, and the Southern Resident Killer whale population. The U.S. highlighted concerns for Puget Sound Chinook salmon, Puget Sound and coastal Washington coho salmon, Puget Sound steelhead salmon, Hood Canal summer chum salmon, Lake Washington sockeye, Baker Lake sockeye, Upper Columbia River sockeye, and the Southern Resident Killer whale population.

Pre-season test fishing plans did not include the Naka Creek, Gulf troll test fisheries, or Area 4B,5 gillnet test fishery. A reduced Area 7 reef net test fishery was tentatively planned but would depend on in-season circumstances. The cost of the proposed test fishing program ($585,000) was not expected to be covered through the sale of test fish. It was expected that the program would retain a total of 8,300 Fraser River sockeye. These sockeye only included those retained for sampling purposes and those caught in gillnet test fisheries. Additional sockeye retention for the purposes of program cost-neutrality was not considered for the 2020 season due to the low run size.

The total predicted non-discretionary catch (8,300) of sockeye salmon and the distribution of this catch across management groups was based on the proportions of the non-discretionary catch observed in the three cycle years prior (i.e. 2008, 2012, and 2016). The distribution of the test

[7] River Forecast Center. Snow Survey and Water Supply Bulletin. July 1, 2020.

fishing deduction across management groups was based on average historical catches for the non-discretionary component (i.e. gill net test fisheries and scientific samples). The sockeye salmon discretionary catch component was zero as there was no harvestable surplus available in the forecast. At the p75 and p90 sockeye salmon run sizes, the test fishing deduction remained solely comprised of non-discretionary catches. The Panel reserved the ability to authorize the retention of discretionary "payfish" if in-season abundances were sufficient.

Calculations of TACs and international harvest shares for Fraser sockeye and pink salmon were based on Annex IV, Chapter 4 of the Pacific Salmon Treaty. There was no available TAC for international sharing at the p50 forecast abundance (Table 1). With no balance remaining to Canada, Canadian catch was limited to the Aboriginal Fishery Exemption (AFE) of 85,800. This sockeye catch was not a target, but would be used as an allowance for incidental mortalities in non-sockeye directed fisheries.

The Fraser River Panel considered three alternative planning scenarios at the June meeting that included variations in assumed sockeye salmon run sizes (median forecast, p75 forecast, and p90 forecast) and adopted a Base Case Planning Model assuming the median run size forecast for Fraser River sockeye. Canada and the U.S. developed a pre-season management plan under the "base case" conditions which included the "2020 Management Plan Principles and Constraints" and "2020 Regulations" (Appendices C and D). In the pre-season plan, there were no potential fisheries directed at Fraser River sockeye salmon in either the U.S. or Canada. For pre-season planning, a 10% LAER for all sockeye management groups, a moving window closure for fisheries occurring during the peak timing of Early Stuart sockeye salmon, as well as area closures to protect Nimpkish sockeye and gear and timing restrictions to protect Sakinaw sockeye salmon, constrained potential fishery openings for the entirety of the fishing season.

B. In-season Management

In 2020, all sockeye salmon management groups returned well below the median pre-season forecasts, and earlier than forecast, with the exception of Early Stuart sockeye (Figure 3).

The Fraser River Panel convened 14 times between July 10, 2020 and September 1, 2020 to discuss run status and enact in-season orders (Appendix E) to regulate fisheries directed at Fraser River sockeye salmon in Panel Areas. Table 1 summarizes pre-season and in-season data by management group and by meeting date, including estimates of run size and the various deductions that result in the calculated TAC (ie., spawning escapement target, MA, projected test fishery catch and Aboriginal Fishery Exemption, AFE). Also shown are estimates of available harvest (run size minus spawning escapement target and MA), catch to date, and Mission escapement to date. The main events that transpired each week of the season are summarized below with a focus on Staff assessments and Panel decisions.

During the 2020 winter/spring season, substantial mitigation work had been undertaken to alleviate the impact of the 2019 Big Bar rockslide that reduced successful upstream migration of sockeye stocks with spawning grounds north of Lillooet, B.C. The affected sockeye stocks included Early Stuart, Nadina, Bowron, Taseko, Chilko, Quesnel, Late Stuart and Stellako sockeye. In 2020, these stocks represented 50% of the expected Fraser River sockeye returns: 100% of the Early Stuart run, 34% of the Early Summer run, 63% of the Summer run and none of the Late run stocks. Despite the mitigation efforts that had been undertaken, the impact of these efforts was still unknown pre-season and there remained a serious risk that Fraser River sockeye would have trouble passing the area naturally if discharge levels were high. It was anticipated that early migrating stocks like Early Stuart and some Early Summer run stocks would be impacted more due to higher water discharge earlier in the season compared to later timed Summer-run stocks that were expected to pass the slide area when discharge levels would have decreased.

Table 1. Pre-season and in-season updates of run size, spawning escapement targets and other TAC-related values for Fraser River sockeye salmon in 2020. The available harvest (run size minus spawning escapement target and management adjustment), catch to date, Mission escapement to date and migration timing are also shown.

				TAC*									
Date	Management Group	Total Abundance	Spawning Escapement Target	pMA	Manage-ment Adjust.	Test Fishing	Aboriginal Fishery Exemption	Total Deductions	Total Allowable Catch	Available Harvest **	Catch to date	Mission Escape. to date
June Pre-season***	Early Stuart	13,000	13,000	0.69	9,000	200	1,100	13,000	0	0	0	0
	Early Summer	218,000	150,300	0.52	78,200	2,400	19,400	218,000	0	0	0	0
	Summer	611,000	611,000	0.16	97,800	5,100	56,000	611,000	0	0	0	0
	Late	99,000	99,000	0.41	40,600	600	9,300	99,000	0	0	0	0
	Sockeye	**941,000**	**873,300**		**225,600**	**8,300**	**85,800**	**941,000**	**0**	**0**	**0**	**0**
July 10 In-season	Early Stuart	13,000	13,000	0.69	9,000	200	1,100	13,000	0	0	3	1,054
	Early Summer	218,000	150,300	0.52	78,200	2,400	19,400	218,000	0	0	8	1,054
	Summer	611,000	611,000	0.16	97,800	5,100	56,000	611,000	0	0	0	0
	Late	99,000	99,000	0.41	40,600	600	9,300	99,000	0	0	0	0
	Sockeye	**941,000**	**873,300**		**225,600**	**8,300**	**85,800**	**941,000**	**0**	**0**	**11**	**2,107**
July 14 In-season	Early Stuart	13,000	13,000	0.69	9,000	200	1,100	13,000	0	0	33	9,430
	Early Summer	218,000	150,300	0.52	78,200	2,400	19,400	218,000	0	0	148	5,657
	Summer	611,000	611,000	0.16	97,800	5,100	56,000	611,000	0	0	0	0
	Late	99,000	99,000	0.41	40,600	600	9,300	99,000	0	0	0	0
	Sockeye	**941,000**	**873,300**		**225,600**	**8,300**	**85,800**	**941,000**	**0**	**0**	**181**	**15,088**
July 17 In-season	Early Stuart	13,000	13,000	0.69	9,000	200	1,100	13,000	0	0	34	8,542
	Early Summer	218,000	150,300	0.52	78,200	2,400	19,400	218,000	0	0	566	13,781
	Summer	611,000	611,000	0.16	97,800	5,100	56,000	611,000	0	0	225	393
	Late	99,000	99,000	0.41	40,600	600	9,300	99,000	0	0	0	0
	Sockeye	**941,000**	**873,300**		**225,600**	**8,300**	**85,800**	**941,000**	**0**	**0**	**824**	**22,716**
July 21 In-season	Early Stuart	13,000	13,000	0.69	9,000	200	1,100	13,000	0	0	67	12,369
	Early Summer	218,000	150,300	0.52	78,200	2,400	19,400	218,000	0	0	619	26,754
	Summer	611,000	611,000	0.16	97,800	5,100	56,000	611,000	0	0	382	5,861
	Late	99,000	99,000	0.41	40,600	600	9,300	99,000	0	0	9	49
	Sockeye	**941,000**	**873,300**		**225,600**	**8,300**	**85,800**	**941,000**	**0**	**0**	**1,077**	**45,034**
July 24 In-season	Early Stuart	13,000	13,000	0.69	9,000	200	1,100	13,000	0	0	73	13,373
	Early Summer	218,000	150,300	0.52	78,200	2,400	19,400	218,000	0	0	774	39,103
	Summer	611,000	611,000	0.16	97,800	5,100	56,000	611,000	0	0	905	8,963
	Late	99,000	99,000	0.41	40,600	600	9,300	99,000	0	0	18	54
	Sockeye	**941,000**	**873,300**		**225,600**	**8,300**	**85,800**	**941,000**	**0**	**0**	**1,769**	**61,494**
July 28 In-season	Early Stuart	14,000	14,000	0.69	9,700	200	1,100	14,000	0	0	72	13,647
	Early Summer	218,000	150,300	0.52	78,200	2,400	19,400	218,000	0	0	956	44,994
	Summer	611,000	611,000	0.16	97,800	5,100	56,000	611,000	0	0	1,425	20,403
	Late	99,000	99,000	0.41	40,600	600	9,300	99,000	0	0	44	243
	Sockeye	**942,000**	**874,300**		**226,300**	**8,300**	**85,800**	**942,000**	**0**	**0**	**2,497**	**79,287**
July 31 In-season	Early Stuart	14,000	14,000	0.69	9,700	200	1,100	14,000	0	0	73	13,325
	Early Summer	218,000	150,300	0.52	78,200	2,400	19,400	218,000	0	0	1,074	47,655
	Summer	611,000	611,000	0.16	97,800	5,100	56,000	611,000	0	0	1,964	36,793
	Late	99,000	99,000	0.41	40,600	600	9,300	99,000	0	0	66	341
	Sockeye	**942,000**	**874,300**		**226,300**	**8,300**	**85,800**	**942,000**	**0**	**0**	**3,176**	**98,115**
August 4 In-season	Early Stuart	14,000	14,000	0.69	9,700	110	1,290	14,000	0	0	72	13,274
	Early Summer	72,000	72,000	0.52	37,400	1,500	5,750	72,000	0	0	1,070	51,753
	Summer	311,000	311,000	0.16	49,800	3,000	28,130	311,000	0	0	2,180	55,832
	Late	99,000	99,000	0.41	40,600	590	9,310	99,000	0	0	99	1,931
	Sockeye	**496,000**	**496,000**		**137,500**	**5,200**	**44,480**	**496,000**	**0**	**0**	**3,421**	**122,791**
August 7 In-season	Early Stuart	14,000	14,000	0.69	9,700	110	1,290	14,000	0	0	72	13,271
	Early Summer	72,000	72,000	0.52	37,400	1,500	5,700	72,000	0	0	1,090	54,589
	Summer	169,000	169,000	0.16	27,000	3,000	13,900	169,000	0	0	2,330	72,527
	Late	28,000	28,000	0.41	11,500	590	2,210	28,000	0	0	108	2,464
	Sockeye	**283,000**	**283,000**		**85,600**	**5,200**	**23,100**	**283,000**	**0**	**0**	**3,600**	**142,851**
August 11 In-season	Early Stuart	14,000	14,000	0.69	9,700	110	1,290	14,000	0	0	72	13,271
	Early Summer	72,000	72,000	0.52	37,400	1,500	5,700	72,000	0	0	1,090	56,876
	Summer	169,000	169,000	0.16	27,000	3,000	13,900	169,000	0	0	2,343	91,475
	Late	28,000	28,000	0.41	11,500	590	2,210	28,000	0	0	114	4,773
	Sockeye	**283,000**	**283,000**		**85,600**	**5,200**	**23,100**	**283,000**	**0**	**0**	**3,619**	**166,395**
August 14 In-season	Early Stuart	14,000	14,000	0.69	9,700	110	1,290	14,000	0	0	72	13,271
	Early Summer	72,000	72,000	0.52	37,400	1,400	5,700	72,000	0	0	1,093	59,124
	Summer	169,000	169,000	0.16	27,000	3,000	13,900	169,000	0	0	2,375	105,957
	Late	28,000	28,000	0.41	11,500	290	2,210	28,000	0	0	117	6,440
	Sockeye	**283,000**	**283,000**		**85,600**	**4,800**	**23,100**	**283,000**	**0**	**0**	**3,657**	**184,792**
August 18 In-season	Early Stuart	14,000	14,000	0.69	9,700	110	1,290	14,000	0	0	72	13,271
	Early Summer	72,000	72,000	0.52	37,400	1,400	5,700	72,000	0	0	1,092	58,131
	Summer	169,000	169,000	0.16	27,000	3,000	13,900	169,000	0	0	2,414	130,750
	Late	28,000	28,000	0.41	11,500	290	2,210	28,000	0	0	120	7,990
	Sockeye	**283,000**	**283,000**		**85,600**	**4,800**	**23,100**	**283,000**	**0**	**0**	**3,698**	**210,142**

Table 1, continued on next page

Table 1, continued.

Date		Management Group	Total Abundance	TAC* Spawning Escapement Target	pMA	Manage-ment Adjust.	Test Fishing	Aboriginal Fishery Exemption***	Total Deductions	Total Allowable Catch	Available Harvest **	Catch to date	Mission Escape. to date
August 25	In-season	Early Stuart	14,000	14,000	0.69	9,700	110	1,290	14,000	0	0	72	15,850
		Early Summer	72,000	72,000	0.52	37,400	1,400	5,700	72,000	0	0	1,092	68,164
		Summer	169,000	169,000	0.16	27,000	3,000	13,900	169,000	0	0	2,441	175,870
		Late	28,000	28,000	0.41	11,500	290	2,210	28,000	0	0	116	6,013
		Sockeye	**283,000**	**283,000**		**85,600**	**4,800**	**23,100**	**283,000**	**0**	**0**	**3,721**	**265,898**
September 1	In-season	Early Stuart	16,000	16,000	0.69	11,000	110	1,290	16,000	0	0	72	15,850
		Early Summer	72,000	72,000	0.52	37,400	1,300	5,700	72,000	0	0	1,094	68,164
		Summer	191,000	191,000	0.16	30,600	3,200	13,900	191,000	0	0	2,453	183,924
		Late	14,000	14,000	0.41	5,700	150	2,210	14,000	0	0	122	13,433
		Sockeye	**293,000**	**293,000**		**84,700**	**4,760**	**23,100**	**293,000**	**0**	**0**	**3,742**	**281,371**
September 23	Post-season	Early Stuart	16,000	16,000	0.69	11,000	110	1,290	16,000	0	0	73	15,850
		Early Summer	72,000	72,000	0.52	37,400	1,300	5,700	72,000	0	0	1,097	68,164
		Summer	191,000	191,000	0.16	30,600	3,200	13,900	191,000	0	0	2,455	184,427
		Late	14,000	14,000	0.41	5,700	150	2,210	14,000	0	0	124	15,877
		Sockeye	**293,000**	**293,000**		**84,700**	**4,760**	**23,100**	**293,000**	**0**	**0**	**3,749**	**284,318**

* The TAC is determined by the run sizes and TAC deductions (spawning escapement targets, management adjustments, projected test fishing catches and AFE Exemptions) that were in effect when Panel had the last in-season meeting (Sept. 17).

** Available Harvest = Total abundance minus spawning escapement target and Management Adjustment. Management groups that meet the criteria of Low Abundance Exploitation Rate (LAER) are assumed to have no Available Harvest (ie. 0) because a LAER is not intended to provide direct harvest

*** Pre-season values reflect those adopted by the Panel in effect on the date shown. In some cases there may be slight differences between these values and those used in the base case planning model that was completed earlier during pre-season planning.

July 5 - 11, 2020:

The first in-season Panel meeting took place on Friday, July 10. A larger than average snowpack, combined with extremely wet conditions during the early summer in the Upper Fraser region resulted in historic high river discharge conditions across the Fraser River watershed. The high discharge and debris within the Fraser River however seemed to have slowed down the upstream migration Hydroacoustic estimates commenced July 5 at Mission and in-season abundance estimates for Early Stuart sockeye indicated returns below the median run size forecast (13,000 sockeye) or possibly delayed migration due to the very high discharge in the Fraser River. The Fraser River water discharge at Hope was about 9,407 $m^3 \cdot s^{-1}$, which is approximately 63% greater than average for this date while the temperature was 1.9ºC lower than average at 13.8ºC. Sockeye stocks with spawning grounds above the rockslide need about 10 days to migrate from the Lower Fraser River to the rockslide location. On July 10, no sockeye had yet been observed at the Big Bar rockslide area.

July 12 – 18, 2020:

Approximately 8,500 Early Stuart sockeye had passed by Mission to date and Early Stuart migration through marine approach areas was winding down. Associated run size estimates were similar to the median forecast of 13,000 sockeye. At this point, there was no information regarding the expected success of Early Stuart sockeye migration past the Big Bar landslide but the high discharge levels, both within the slide area as well as in the rest of the Fraser River watershed, were expected to negatively impact the survival of Early Stuart sockeye. On July 16, the Fraser River water discharge at Hope was about 8,072 $m^3 \cdot s^{-1}$, which is approximately 51% greater than average for this date and historically has been associated with large differences between Mission abundance and spawners on the spawning grounds. The temperature of the Fraser River at Qualark on July 16 was 14.8ºC, which is 1.7ºC lower than average for this date.

July 19 – 25, 2020:

Approximately 13,400 Early Stuart sockeye had passed by Mission to date and this estimate was similar to the median forecast of 13,000 sockeye. The estimated escapement of Early Summer-run sockeye past Mission through July 23 was 39,100 fish and the run was tracking near the p25 forecast of 116,000. Current data suggested the run was likely to be later and/or smaller than expected pre-season. The marine gillnet test fisheries were extended in Area 12 and 20 to July 28 and July 30, respectively. Total catch plus escapement to date equalled 63,400 sockeye which was below the expected median forecast for this date.

Discharge remained very high throughout the watershed. On July 23, the Fraser River water discharge at Hope was about 7,832 $m^3 \cdot s^{-1}$, which is approximately 62% greater than average for this date and historically has been associated with large differences between Mission abundance and spawners on the spawning grounds. The temperature of the Fraser River at Qualark on July 23 was 15.7ºC, which is 1.6ºC lower than average for this date. For Early Stuart, the 19-day model predicted an expected Difference Between Estimates (DBE) of -80% assuming a timing of July 6 compared to pre-season expectations of -41%; however, this estimate did not account for the environmental conditions at Big Bar rock slide. This high DBE indicated that the majority of Early Stuart sockeye would not reach the spawning grounds due to the high discharge throughout the watershed. As of July 24 a small number of sockeye had been observed by sonar stations downstream of the slide and on July 25, the first sockeye were observed in the fishway that feeds the Whooshh™ system but no sockeye had made it past the slide yet. On July 25, the first sockeye had been caught in the fishwheel but beach seining to radio tag sockeye remained unsuccessful.

July 26 – August 1, 2020:

Approximately 13,300 Early Stuart sockeye had passed by Mission to date and this estimate was similar to the median forecast of 13,000 sockeye. At the meeting on Tuesday, the Panel adopted an Early Stuart run size estimate of 14,000 with an associated Area 20 timing of July 7 which was 3 days later than the pre-season forecast. The estimated catch and escapement of Early Summer-run sockeye past Mission through July 30 was 48,800 fish and the run was tracking below the p25 forecast of 116,000. Current data suggested the Early Summer run was smaller than expected pre-season. The marine gillnet test fisheries ended in Area 12 and 20 on July 28 and July 30, respectively while purse seine test fisheries continued in Areas 12 and 20. Summer-run sockeye were increasing in marine areas and catch and Mission passage as of July 30 was 38,800. Based on relative smolt abundance estimates observed in 2018 and in-season run size estimates for Chilliwack, Nadina and Bowron, it was possible to produce an early estimate of the Summer run of 444,000, assuming Harrison would return as forecast. This estimate was below the median preseason forecast of 611,000 sockeye and was not approved by the Fraser Panel. The timing of the Summer run would need to be later than preseason expectation to be able to reach the forecasted run size. The diversion rate was 31% which was similar to pre-season expectations. Total catch plus escapement to date equalled 101,400 sockeye which was below the expected median forecast for this date.

Discharge remained high throughout the watershed. On July 30, the Fraser River water discharge at Hope was about 6,412 $m^3 \cdot s^{-1}$, which is approximately 46% greater than average for this date. The temperature of the Fraser River at Qualark on July 30 was 17.1ºC, which is 0.9ºC lower than average for this date.

As of July 30, 6,672 salmon had been observed at the Alfalfa sonar site, 10 km downstream of the slide. Based on hydroacoustic length data and fishwheel catches, about 25% of these salmon were expected to be sockeye. No evidence of milling had been observed below the slide. As of July 30, 31 sockeye had been radio-tagged below Big Bar. A total of 921 salmon (both sockeye and Chinook) had been transported through the Whooshh™ system, including 30 tagged Chinook. No radio tagged sockeye had yet been detected upstream of the slide. A total of 176 salmon had been counted at the Churn Creek Sonar site, 40km upstream of the slide. The natural fishway remained submerged due to high discharge levels and unable to support natural salmon passage.

August 2 – August 8, 2020:

The Early Stuart run was complete with an estimated catch plus escapement of 13,400, just below the adopted in-season run size of 14,000. The estimated escapement of Early Summer-run sockeye past Mission through August 6 was 54,600 fish and the run continued to track below the p10 forecast. At the meeting on Tuesday, the Panel adopted an Early Summer-run run size estimate of 72,000 with an associated Area 20 timing of July 17 which was 7 days earlier than the pre-season forecast.

The Summer run was tracking below the p50 forecast of 611,000 sockeye. The presence of the Chilko stock group, which was expected to contribute close to half of the Summer run return this year, had increased in catch samples but associated abundances remained low. At the meeting on Tuesday, the Panel adopted the p25 forecast of 311,000 Summer-run sockeye with an associated Area 20 50% timing of August 7 which was 8 days later than forecast. Observations in the marine area continued to decline, especially for Chilko fish and at the meeting on Friday the Panel further reduced the Summer-run run size to 169,000 with an associated marine timing in Area 20 July 27 which was 10 days earlier than forecast.

Similarly, Late run abundances were very low in marine test fishing catches and tracking lower than abundances associated with the p10 forecast. At Friday's meeting, the Panel also adopted a Late-run run size of 28,000 with an associated marine timing in Area 20 of August 15 which was 9 days later than the pre-season forecast. This reduced the in-season Fraser sockeye run size to 283,000, making it the lowest run size on record. This officially placed all management groups in a low abundance exploitation rate (LAER) scenario.

The five-day average sockeye diversion rate through Johnstone Strait had increased to 54% by the end of the week. Due to the low catches in the marine Areas the Panel did not see a need to further extend the Area 12 and Area 20 purse seine test fisheries so the last dates for these test fisheries were August 5 and August 6, respectively.

Discharge remained high throughout the watershed for the time of year. On August 6, the Fraser River water discharge at Hope was about 5,439 $m^3 \cdot s^{-1}$, which is approximately 38% greater than average for this date. The temperature of the Fraser River at Qualark on August 6 was 18.4ºC, which is 0.4ºC greater than average for this date.

As of August 4, a total of 27,459 salmon had been observed 10 km below the Big Bar slide but so far these salmon were dominated by Chinook. Thus far a total of 2,176 salmon were observed at Churn Creek, 40 km upstream of the slide, the majority being Chinook salmon based on length observations. Some sockeye had passed the slide area with the assistance of the Whooshh™ system. Three tagged sockeye salmon were observed passing Churn Creek representing less than 10% of the tagged sockeye currently within the slide area.

August 09-15, 2020:

The total accounted run to date was 188,500 sockeye salmon, consisting of 13,400 Early Stuart, 60,200 Early Summer-, 108,400 Summer- and 6,500 Late-run sockeye. With a total run size of 283,000, this still left 94,000 left to come in order to achieve the run size. This included 36,000 Harrison which were expected to delay their migration into the river, despite the fact that substantial delay had not previously been observed on this cycle line. No further changes to run size were made given that all management groups were in a low abundance exploitation rate (LAER) scenario.

Throughout the Fraser River watershed, discharge levels continued to decrease. On August 13, the Fraser River water discharge at Hope was about 4,013 cms, which is approximately 15% greater than average for this date. The temperature of the Fraser River at Qualark on August 13 was 16.6ºC, which is 1.4ºC less than average for this date.

The number of sockeye reaching the Big Bar slide area had been increasing. As of August 13, a total of 71,823 salmon had been observed 10 km below the slide but so far these salmon had been dominated by Chinook. Following the decrease in water discharge levels, both sockeye and Chinook salmon were able to pass above the slide area using the natural fish way. A total of 48,301 salmon had been observed at Churn Creek, 40 km upstream of the slide. The proportion of sockeye among these salmon had been increasing and was 60% on August 12. In addition to using the natural fish way, 5,597 salmon had been transported through the Whooshh™ system while

1,527 salmon had been transported by truck. A total of 238 Early Stuart fish had been collected for brood stock and taken to the Cultus Lake hatchery.

August 16 – 22, 2020:

The total accounted run to date was 213,900 sockeye salmon, consisting of 13,400 Early Stuart, 59,200 Early Summer-, 133,200 Summer- and 8,100 Late-run sockeye. No further run size adjustments were made given that all management groups were in a low abundance exploitation rate (LAER) scenario.

Throughout the Fraser River watershed, discharge levels continued to decrease. On August 17, the Fraser River water discharge at Hope was about 3,538 cms, which is approximately 10% greater than average for this date. The temperature of the Fraser River at Qualark on August 17 was 17.7ºC, which is 0.4ºC less than average for this date.

The number of sockeye reaching the Big Bar slide area had been increasing. As of August 17, a total of 91,701 salmon had been observed 10 km below the slide but so far these salmon had been dominated by Chinook. Following the decrease in water discharge levels, both sockeye and Chinook salmon were able to pass above the slide area using the natural fish way. A total of 77,249 salmon had been observed at Churn Creek, 40 km upstream of the slide and preliminary estimates suggested 18,815 sockeye had past the slide as of August 14. In addition to using the natural fish way, 5,883 salmon had been transported through the Whooshh™ system.

August 23 – 29, 2020:

The total accounted run to date was 269,700 sockeye salmon, consisting of 16,000 Early Stuart, 69,300 Early Summer-, 178,300 Summer- and 6,100 Late-run sockeye. No further run size adjustments were made given that all management groups were in a low abundance exploitation rate (LAER) scenario.

The Mission hydroacoustics program revised estimates for different periods throughout the season. High water levels early in the season affected the initial deployment of the usual hydroacoustic system configuration, so instead of the split-beam system being deployed on the left-bank, an ARIS system was deployed which tended to underestimate salmon. As a result, estimates based on the left-bank ARIS system during time periods between July 4-August 4 and August 11-24 were updated with a correction factor resulting in an increase in total salmon passage by approximately 10% and total sockeye passage by 14%.

Throughout the Fraser River watershed, discharge levels continued to decrease. On August 24, the Fraser River water discharge at Hope was about 3,410 cms, which was approximately 20% greater than average for this date. The temperature of the Fraser River at Qualark on August 24 was 17.6ºC, which is average for this date.

The number of sockeye reaching the Big Bar slide continued to increase. Counts were a couple of days behind due to trouble with sonars but as of August 24, a total of 118,791 salmon had been observed 10 km below the slide. Estimates of species composition indicated it was predominately sockeye with the occasional Chinook being observed. A total of 103,166 salmon had been observed at Churn Creek, 40 km upstream of the slide. In addition to using the natural fish way, 7,374 salmon had been transported through the Whooshh™ system. Sockeye were also observed spawning in tributaries between the slide and Lillooet.

August 30 – September 4, 2020:

The total accounted run to date was 285,200 sockeye salmon, consisting of 16,000 Early Stuart, 69,300 Early Summer-, 186,400 Summer- and 13,500 Late-run sockeye. At the final in-season meeting on Tuesday, the Panel adopted an Early Stuart run size of 16,000, a Summer-run run size estimate of 191,000 and a Late-run run size of 14,000. They also updated the associated

Area 20 timings for all four management groups to July 6, July 15, July 28 and August 2 for Early Stuart, Early Summer run, Summer run and Late run, respectively, which were all earlier than the pre-season forecast timing with the exception of Early Stuart which was two days later.

On August 31, the Fraser River water discharge at Hope was about 2,757 cms, which was approximately 9% greater than average for this date. The temperature of the Fraser River at Qualark on August 31 was 16.4ºC, which was 0.5ºC below average for this date.

The number of sockeye reaching the Big Bar slide continued to increase. As of August 31, a total of 125,576 salmon had been observed at Churn Creek, 40 km upstream of the slide. Counts were still missing for August 22, 23, 30 and 31. In addition to using the natural fish way, 8,266 salmon had been transported through the Whooshh™ system. At the Cultus Lake lab, 400,000 Early Stuart eggs and 20,000 Bowron eggs had been collected.

On October 3, Panel control of the last U.S. Panel Area was relinquished, in accordance with the pre-season regulations. The TAC calculation was based on the last in-season run size estimate adopted by the Panel (September 1) as per amended Treaty language for Chapter 4, Annex IV. The achievement of in-season catch objectives was assessed through a comparison with post-season catch estimates in the Achievement of Objectives section of this report.

There were no commercial fisheries for Fraser River sockeye salmon.

IV. MANAGEMENT INFORMATION

To facilitate decision making, the Panel requires information about the abundance, timing, migration route and expected catch levels of Fraser River sockeye (by management group) and pink salmon. Pre-season, these quantities are provided by DFO in the form of forecasts that are augmented by PSC Staff through analysis of historical data. Staff update these estimates in-season through various assessment programs (Appendix F). Stock monitoring programs collect information about abundance at various points along the migration route using test fisheries, hydroacoustics and observers. The locations and schedule for these Staff and DFO programs are listed in Table 2. These data are augmented with catch information from commercial, First Nations, recreational and other fisheries that are provided by the two countries. Stock identification programs collect and analyze biological samples (e.g., DNA, scales) from various fisheries, which are used to apportion the total abundance of sockeye into component stock groups. Table 3 shows the sockeye stock resolution that was reported in 2020.

Stock assessment activities conducted by Staff use the data described above to provide estimates of daily catch, daily abundance, Mission escapement, migration timing and diversion rate, which are the basis for estimating total abundances, escapement targets and catch allocations for the different sockeye management groups. Staff also provide estimates of Management Adjustments (MAs), which are a measure of how many additional fish should be allowed to escape past Mission to increase the likelihood of achieving sockeye spawning escapement targets, given historical discrepancies, current year migration timing and observed and forecasted river conditions from DFO's Environmental Watch program. These data are compiled and analysed by Staff and the results provided to the Panel. The section "In-season Management" above summarized how these estimates changed each week as data from the programs accumulated. The following sections provide a summary of the end-of-season results.

Table 2. Panel-approved stock monitoring operations (test fishery, hydroacoustic and observer) conducted during the 2020 fishing season.

Area	Location	Gear	Dates	Operated by
Canadian Panel Areas				
20	Juan de Fuca Str.	Gillnet	July 11 - July 30	PSC
20	Juan de Fuca Str.	Purse Seine	July 21 - August 6	PSC
29-14	Fraser R. (Cottonwood)	Gillnet	July 8 - August 4	PSC
29-16	Fraser R. (Whonnock)	Gillnet	June 23 - September 8	PSC
29-16	Fraser R. (Mission)	Hydroacoustic	July 5 - August 31	PSC
Canadian non-Panel Areas				
12	Queen Charlotte Str. (Round Is.)	Gillnet	July 9 - July 28	DFO
12	Johnstone Str. (Blinkhorn)	Purse Seine	July 20 - August 5	DFO
	Fraser R. (Hells Gate)	Observer	July 2 - August 27	PSC
	Fraser R. (Qualark)	Gillnet	July 11 - September 4	DFO
	Fraser R. (Qualark)	Hydroacoustic	July 10 - September 5	DFO

Table 3. Individual stocks included in the Fraser River sockeye stock groups used in 2020.

Stock Group	Component Stocks
Early Stuart	
Early Stuart	Early Stuart stocks
Early Summer	
Chilliwack	Chilliwack Lake, Upper Chilliwack River
Nadina/ Bowron/Gates/ Nahatlatch/ Taseko	Nadina, Bowron, Gates, Nahatlatch, Taseko
Pitt/ Alouette/ Coquitlam	Pitt, Alouette, Coquitlam
Early South Thompson	Scotch, Seymour, early Eagle, Cayenne, Upper Adams
North Barriere	Upper Barriere
Summer	
Raft/N.Thompson	Raft, North Thompson main stem
Chilko	Chilko River, south end Chilko Lake, north end Chilko Lake
Horsefly/McKinley	Horsefly, McKinley
Mitchell/Lake Tributaries	Mitchell, Roaring, Wasko, Blue Lead
Late Stuart/Stellako	Stellako, Tachie, Middle, Pinchi, Kuzkwa
Harrison/ Widgeon	Harrison, Widgeon
Late	
Birkenhead/Big Silver	Birkenhead, Big Silver
Late Shuswap/Portage	Lower Adams, Portage, Lower Shuswap, Middle Shuswap, late Eagle, Little River
Weaver/Cultus	Weaver, Cultus

A. Abundance

The final in-season run size estimate adopted by the Panel was 293,000 Fraser River sockeye salmon (Table 1). This much lower-than-forecasted abundance of sockeye salmon constrained fishing opportunities in both countries. The post-season abundance estimate for sockeye salmon (365,200 fish, Tables 6 and 7) based on spawning ground enumerations, accounted catches and

differences between estimates is 20% more than the end-of-season estimate, and only 39% of the pre-season median forecast (941,000).

B. Migration Timing and Diversion Rate

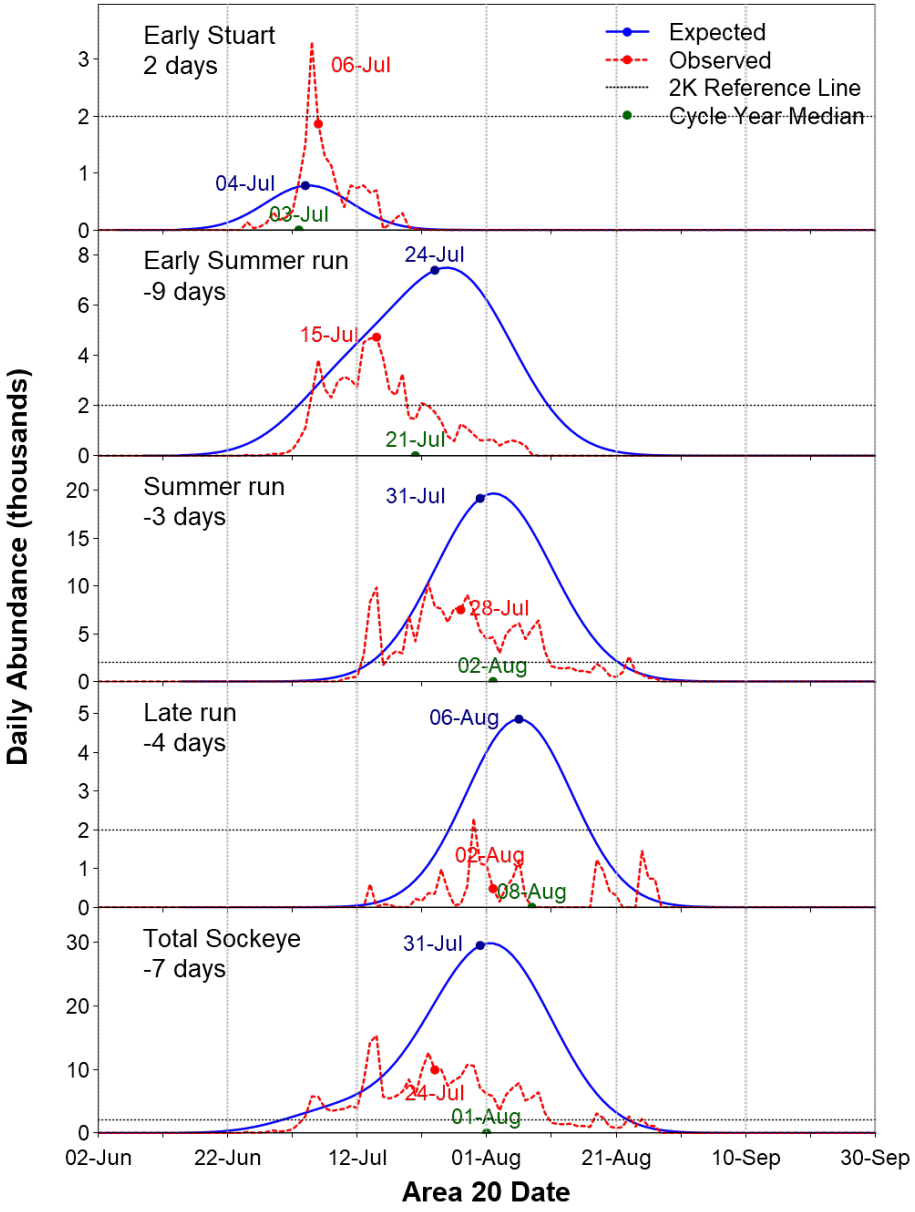

Figure 3. Pre-season expectations and post-season reconstructions of daily Fraser River sockeye salmon abundance by management group in 2020 (Area 20 date), including the observed 50% dates and number of days difference with pre-season expectations.

Figure 3 shows the forecasted and observed daily migrations, and Area 20 50% migration dates for each Fraser sockeye management group. The end-of-season estimates of marine migration timing in 2020 were later than pre-season expectations for Early Stuart (July 6, 2 days

later) but earlier than expected for Early Summer-run (July 15, 9 days earlier), Summer-run (July 28, 3 days earlier) and Late-run (August 2, 4 days earlier) groups.

The Fraser sockeye diversion rate in 2020 was lower than forecast. The observed annual diversion through Johnstone Strait was 25% of the Fraser sockeye return, compared to the initial DFO forecast of 63% and the Panel approved estimate of 35% used for pre-season planning (Figure 4).

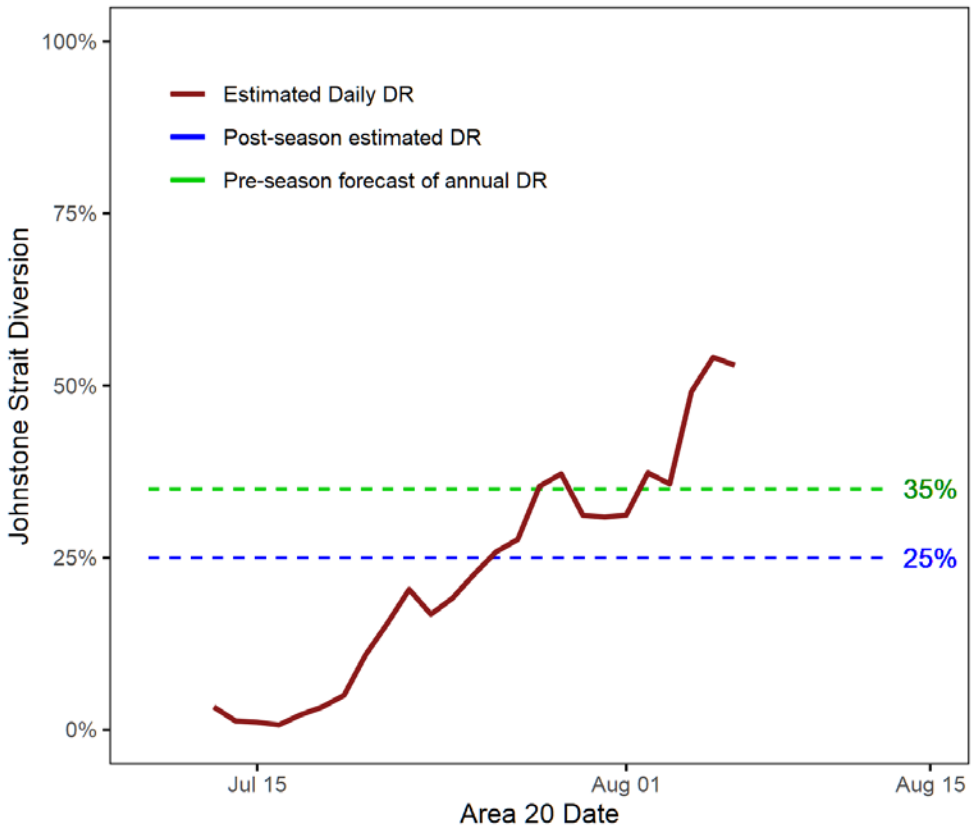

Figure 4. Pre-season forecast of annual Johnstone Strait diversion rate (DR) for Fraser sockeye salmon, compared to post-season estimates of daily and annual rates for 2020.

C. Big Bar Landslide

On, June 23, 2019, the Big Bar landslide was discovered along the Fraser River north of Lillooet, close to the Big Bar Ferry (Figure 5). Over 85,000 cubic metres of rock had sheared off a 125-metre-high cliff and had fallen into an already narrow portion of the Fraser River. The rockslide created a five-metre waterfall that formed an upstream migration barrier for salmon with spawning grounds above Big Bar (Figure 6). A Unified Command Incident Management Team was set up in response to the slide which involved collaboration between First Nations, Federal and Provincial governments. The response both immediate and on-going was to improve site safety, improve natural and assisted passage through or over the slide and monitor successful passage and fish condition of the Fraser River salmon spawning above Big Bar.

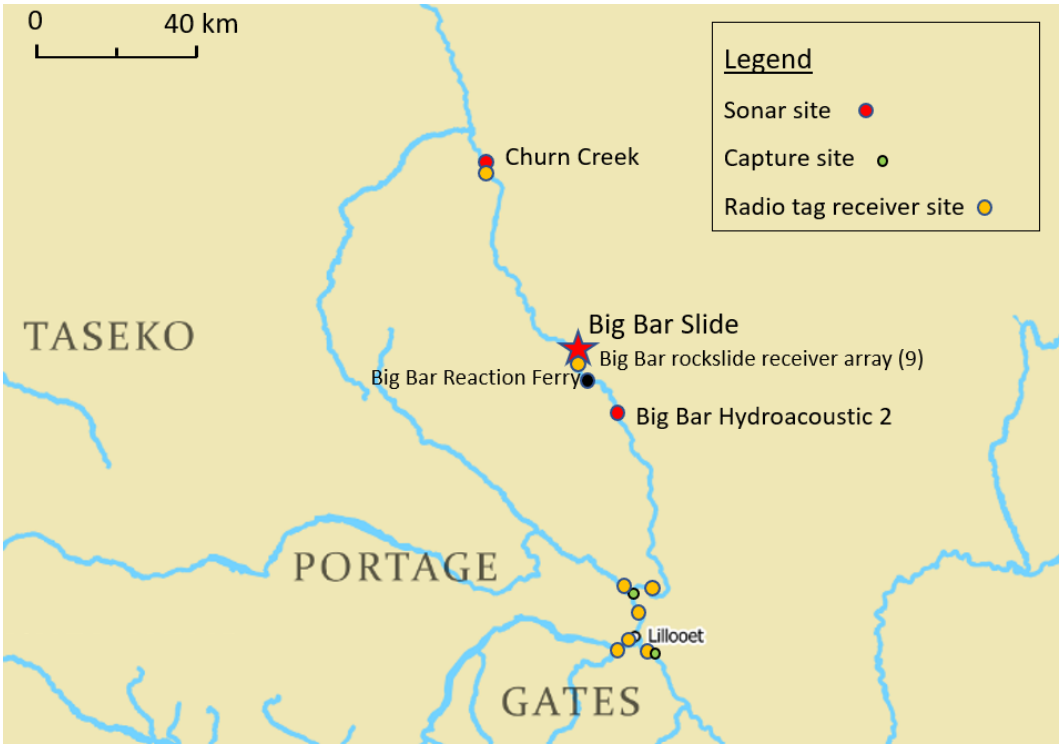

Figure 5. Map of sonar, salmon capture and radio tag receiver locations on the Fraser River near the Big Bar landslide in 2020.

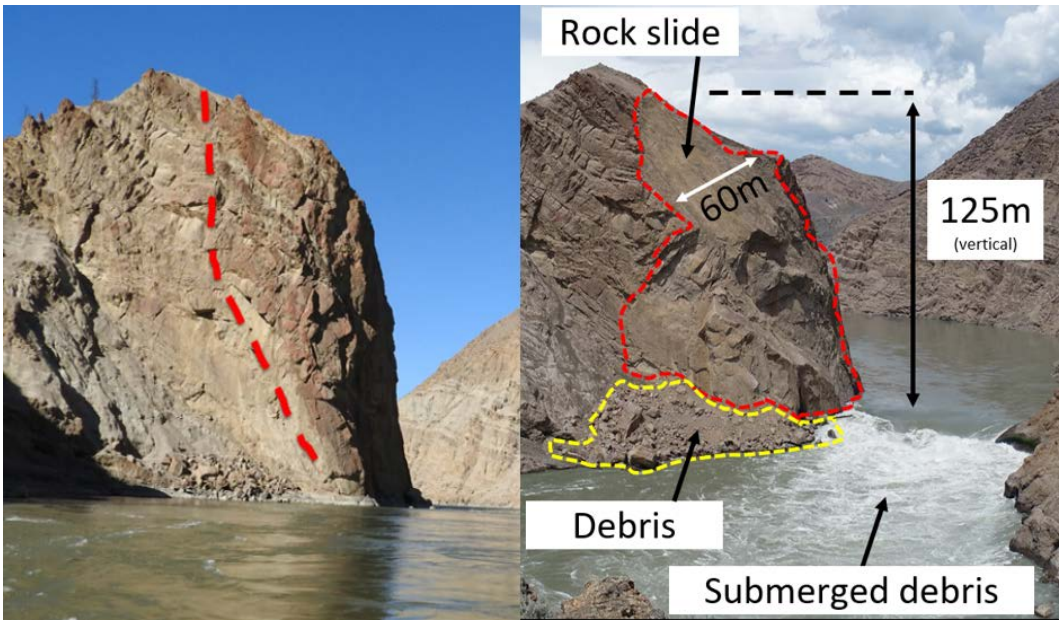

Figure 6. Big Bar Site before (A) and after (B) the slide. (A) The red line depicts what part of the cliff fell into the Fraser River. (B) Rock and debris 125 m in height and 60 m in width fell onto the banks and into the Fraser River.

In the winter of 2019/2020 remediation work on the slide site continued. This work included the completion of a “nature-like” fishway, blasting of rock outcrops, creation of an overland access road and the building of the infrastructure required to install a pneumatic fish pump system (Whooshh^{TM}).

In May 2020, understanding fish migration and movement, health and run size became the focus. To provide in-season feedback to managers to inform them about natural passage success of all salmon, hydroacoustic fish monitoring stations were set up downstream and upstream of the slide and fish were radio tagged to track the behaviour and quantity of fish traveling through the slide site. Radio tag receivers were set up along the Fraser River and in tributaries which also informed the DFO Stock Monitoring group on fish behavior associated with barriers and salmon condition.

In-season, Fraser River discharge remained well above the historical average for the duration of the season. Although remediation work had been done to increase the discharge threshold for salmon at Big Bar, there was a significant barrier to migration of sockeye at 2,800 m^3/s and higher. It was evident that the in-river work had improved fish passage, however the historically high discharge levels contributed to salmon passage challenges. When discharge levels impeded natural migration through the slide site, the efficacy of the fish transport by the Whooshh™ system was evaluated and determined to have had limited success at transporting salmon over the slide site. During periods of very high discharge early in the season, the operation of the Whooshh™ system however had to be interrupted. Post-season analysis of tagging data also revealed that most of the salmon transported through the Whooshh™ did not continue their upstream migration after exiting the transport tubes and instead fell back below the slide. Following the observed challenges migrating past Big Bar early in the season, a total of 409 early migrating sockeye had been taken as broodstock for enhancement after being identified as Early Stuart (365) and Bowron (44) sockeye through DNA analyses.

Of the stocks that spawn above Big Bar, the following proportions made it to the spawning grounds based on observed DBE estimates: 0.2% of the Early Stuart Run, 147% of the Early Summer run stocks and 94% of the Summer run stocks. For Early Summer run, the spawning escapement was larger than the potential spawning escapement, hence the estimate is larger than 100%. The Big Bar rockslide had a major impact on early migrating stocks that are negatively impacted by high discharge levels, such as Early Stuart and the earlier timed Early Summer run stocks such as Bowron.

Post season, the process for technical consultation continued and future work included geotechnical investigation, preliminary design and hydraulic modelling. The proposed target was for unimpeded salmon passage at discharge levels between 500 and 550 m^3/s.

Additional information regarding both the remediation work, salmon transport and enhancement efforts can be found on Government of Canada's Big Bar landslide response site[8].

D. Management Adjustments and DBEs

In 2020, the run size estimates for all sockeye management groups were smaller than the escapement targets and therefore it was unnecessary for fisheries management purposes to increase the spawning escapement targets with additional salmon to increase the probability of reaching this target, i.e. there was no need to adopt Management Adjustments (MA) as they would not increase the ability to achieve targets. All four management groups were managed based on a Low Abundance Exploitation Rate (LAER) and Management Adjustments had no management implications. Despite this, the data that inform the MAs as well as the actual DBE observations are useful for management purposes and are therefore described here.

[8] https://www.pac.dfo-mpo.gc.ca/pacific-smon-pacifique/big-bar-landslide-eboulement/index-eng.html

MAs are based on statistical models [9,10,11,12] that consider the historical differences between in-season projections of spawning escapement (i.e., Mission escapement minus catch above Mission, or "potential spawning escapement") and post-season estimates (i.e., spawning ground estimates). For Early Stuart, Early Summer-run and Summer-run stocks, the models relate historical escapement differences (difference between estimates, or DBEs) to river conditions measured near Hope, BC in the Fraser River. When discharge levels or temperatures are above average, DBEs also tend to be high. In addition, for Early Stuart and Early Summer runs, in-season estimates are consistently higher than spawning ground estimates even when migration conditions are within normal ranges, and this tendency is also captured by the MA models. For Late-run sockeye, historical DBEs are related to the date when half the run has migrated past Mission (i.e., Mission 50% date), which captures the impact of the early migration behaviour observed since the mid-1990s on the migration success of these stocks.

Pre-season MA predictions and DBEs are based on median values from historical datasets for each management group or are based on models using long-range forecasts of river conditions and in-river migration timing. In-season values are generated using updated migration timing estimates and observed and/or short-range forecasts of lower river discharge and temperature in combination with other considerations such as watershed-wide environmental conditions, and evidence of migratory distress (i.e. carcasses, fish holding, fish straying). In contrast, post-season values are calculated independently of any environmental data using post-season predictions of potential spawning and observed spawning ground escapements.

In 2020, the Fraser River basin watershed snow basin index was 116% of normal in early spring (April 1, BC Fraser Basin Snow Water Index). Due to limited snowpack melt at higher elevations with several storms in May, the overall snow basin index was 90% of normal in June. In early June, the Environmental Watch program (E-Watch) generated a long-range forecast of lower Fraser River summer temperature and flow conditions using relationships between winter snowpack accumulation, summer air temperatures and river environmental conditions. The long-range forecast was for above average to average discharge and average to above average water temperature in the Fraser River. In-season, Fraser River discharge remained well above the historical average for the duration of the season while river temperatures remained below average until August. River temperature peaked at 18.8°C on August 5 and decreased again to well below average in the second week of August. Although river temperature did increase again, river temperature continued to be moderated with higher-than-average river discharge due to continued rain events (Figure 7). Early in the season, observed discharge at Hells Gate exceeded the discharge thresholds for Early Stuart[13] (8,000 m^3/s) and Early Summer[14] run (6,500 m^3/s) (Figure 7).

[9] Hague, M.J., and Patterson, D.A. 2007. Quantifying the sensitivity of Fraser River sockeye salmon (*Oncorhynchus nerka*) Management Adjustment models to uncertainties in run timing, run shape and run profile. Can. Tech. Rep. Fish. Aquat. Sci. 2776 : vii + 55p.

[10] Macdonald, J.S., Patterson, D.A., Guthrie, I., Lapointe, M. 2008. Improvements to environmental Management Adjustment models: SEF final report.

[11] Macdonald, J.S., Patterson, D.A., Hague, M.J., Guthrie, I.C. 2010. Modeling the Influence of Environmental Factors on Spawning Migration Mortality for Sockeye Salmon Fisheries Management in the Fraser River, British Columbia. Transactions of the American Fisheries Society 139:768-782.

[12] Cummings, J.W., Hague, M.J., Patterson, D.A., and Peterman, R.M. 2011. The impact of different performance measures on model selection for Fraser River sockeye salmon. N. Am. J. Fish. Aquat. Sci. 31: 323-334.

[13] Macdonald, J.S., Foreman, M.G.G., Farrell, T., Williams, I.V., Grout, J., Cass, A., Woodey, J.C., Enzenhofer, H., Clarke, W.C., Houtman, R., Donaldson, E.M. and Barnes, D. 2000. The influence of extreme water temperatures on migrating Fraser River sockeye salmon (Oncorhynchus nerka) during the 1998 spawning season. Canadian Technical Report of Fisheries and Aquatic Sciences 2326.

[14] Macdonald, J.S., Patterson, D.A., Hague, M.J., Guthrie, I.C. 2011 Modeling the influence of environmental factors on spawning migration mortality for sockeye salmon fisheries management in the Fraser River, B.C. Transactions of the American Fisheries Society 139:3.

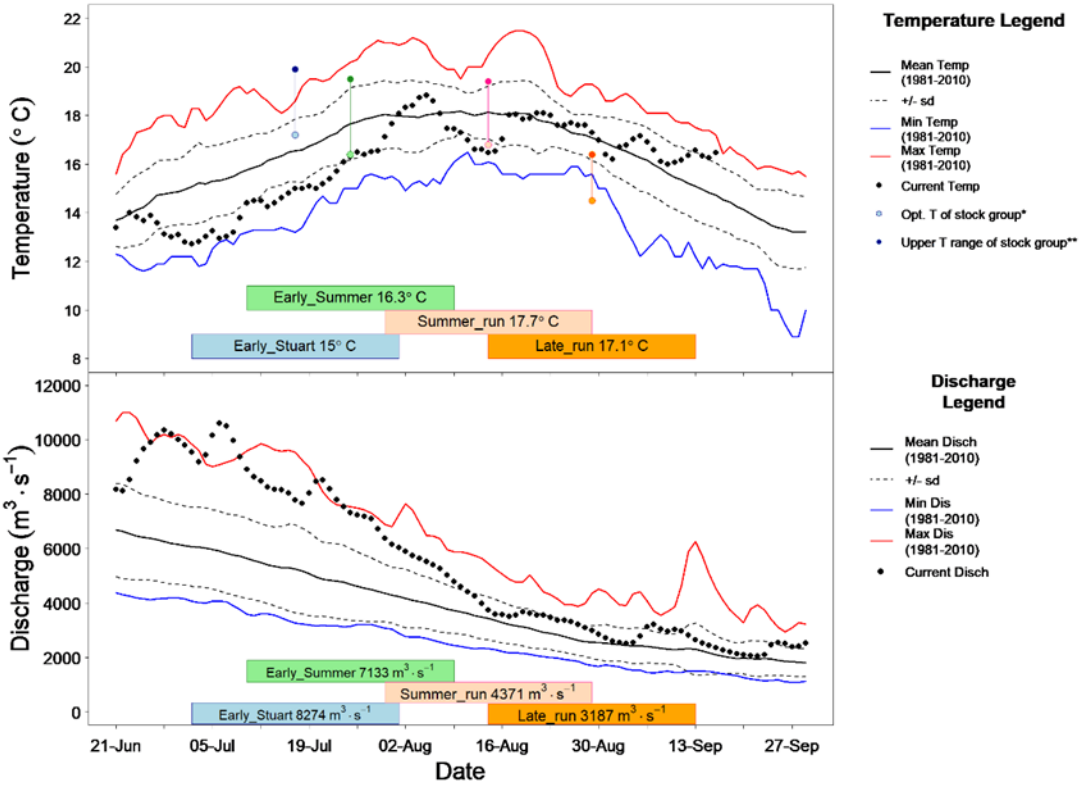

Figure 7. Fraser River temperature and discharge measured near Hope in 2020. Also shown are run timing bars that represent a 31 day spread of the run centred around the Hells Gate date and the mean temperature and discharge for the 31 day spread.

In recent years, MA estimates for some management groups have been estimated based on the weighted average of component abundances and their respective %DBEs depending on the forecasted relative abundance of the component to the entire management group. Due to the high forecasted relative abundances of Pitt and Chilliwack fish in the Early Summer-run aggregate, Harrison fish in the Summer-run aggregate and Birkenhead in the Late-run aggregate, the weighted pDBE approach had been used for pre-season planning for all three management groups.

A summary of the pre-season and in-season MA models used during 2020 are provided in the "Management Adjustment and DBE" section in Appendix F. The pMAs and the final observed DBEs derived from near final spawning ground escapement estimates are shown in Table 4 for comparison purposes. In-season predictions of proportional difference between estimates (pDBEs) (Table F3) derived from environmental MA models were presented to the Panel for the Early Stuart, Early Summer- and Summer-run sockeye. Due to the higher-than-average discharge levels in the Fraser River, both the Early Stuart and Early Summer run sockeye experienced 31-day mean discharge levels that were greater than their discharge threshold of 8,000 m^3/s and 6,500 m^3/s, respectively. For Early Stuart and Early Summer-run sockeye the Panel was also presented pDBE estimates that included the impact of the Big Bar landslide on stocks that spawn above the slide. Despite the remediation work to improve fish passage past the slide, the high discharge levels early in-season were expected to negatively impact migration past the slide for these management units. Flows decreased towards the end of July and migration conditions improved for the later timed Summer-run sockeye. In-season MA models predicted substantially higher (more negative) pDBEs for the Early Stuart and Early Summer run sockeye (Table F3). For Late-run sockeye the final in-season Mission 50% date based on Mission passage, was August 25. Based on the predicted pDBE (Table F3) from the run-timing model, the early observed Mission timing for the Late run would greatly impact their survival.

Table 4. Pre-season, in-season and post-season estimates of DBEs (differences between estimates) and pMAs (proportional management adjustments). Pre-season and in-season adopted values reflect the final values adopted by the Panel either prior to the season or for in-season management. Observed DBEs are calculated from final in-season estimates of potential spawning escapement and post-season estimates of spawning populations based on field enumeration programs conducted by DFO. (See Appendix A: Glossary of terms and abbreviations for DBE definition; and footnotes and Appendix F for more details on the methodologies and data sets used for each aggregate).

Description	Early Stuart		Early Summer		Summer		Late	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Pre-season adopted	-41%	0.69	-34%	0.52	-14%	0.16	-29%	0.41
In-season adopted	-41%	0.69	-34%	0.52	-14%	0.16	-29%	0.41
Observed [1]	-98%	40.65	16%	-0.14	7%	-0.07	-62%	1.65

1 Derived from DFO's near-final spawning escapement estimates.

Post-season, the observed %DBEs for Early Stuart and Late-run sockeye were higher than those predicted pre-season (Table 4). However, the observed %DBEs for Early Summer- and Summer-run sockeye were positive, due to more sockeye encountered on the spawning ground than predicted based on estimates at Mission. Remediation work at the Big Bar landslide did improve natural fish passage at the slide; however, record high discharge was observed early in the season and natural fish passage was impeded. Discharge decreased by August 11th, but this decrease occurred too late to allow natural upstream migration for Early Stuart but did benefit Summer-run stocks. The final observed %DBE for Early Stuart was -99.7%. This estimate does not include the 365 Early Stuart sockeye that were taken as brood stock from below the Big Bar landslide. Migration at Big Bar was impeded for the Early Summer-run sockeye with earlier migration timings (e.g., Bowron); however, as discharge decreased to 2,700 m^3/s at the slide site, more natural sockeye passage was observed. This drop in passage benefitted both the later timed Early Summer-run stocks and the Summer-run stocks that spawn above the Big Bar landslide. Overall, spawning ground estimates for the Early Summer-run stocks exceeded in-season abundance predictions and the observed %DBE was 16%. For Summer run, spawning ground estimates exceeded in-season abundance predictions and the observed %DBE for Summer run was 7%. Late-run sockeye do not spawn above the Big Bar landslide; however, the early observed Mission timing would have impacted their survival. The observed %DBE was larger (more negative) than predicted at -60%.

D. Mission Passage

The upstream passage estimate of Fraser sockeye at Mission was 287,700, consisting of 16,700 Early Stuart, 69,600 Early Summer-run, 185,500 Summer-run, and 15,900 Late-run sockeye (Table 5). Sockeye passage estimates were derived using the hydroacoustics monitoring facility at Mission from July 5 to August 31. Official estimates began on July 5, although extrapolated passage estimates were derived from left bank and offshore systems at Mission from July 1 to July 4 for the Early Stuart run.

Salmon passage was estimated by the Mission hydroacoustics program using a stratified sampling configuration by combining passage estimates from a vessel-based mobile split-beam system, a shore-based split-beam system on the left bank, and shore-based Adaptive Resolution Imaging Sonar (ARIS) systems on both the left and right banks. Detailed descriptions of the hydroacoustics estimation methodology for 2020 are provided in Appendix F.

Table 5. Fraser River sockeye salmon passage at Mission in 2020.

Management Group	Mission Escapement	
Stock Group	fish	%
Early Stuart	**16,700**	**6%**
Early Summer	**69,600**	**24%**
Chilliwack	25,900	9%
Early Miscellaneous	30,700	11%
Early South Thompson	800	0%
North Barriere/Taseko	3,400	1%
Pitt[1]	8,800	3%
Summer	**185,500**	**64%**
Raft/N.Thompson	4,000	1%
Chilko	68,000	24%
Quesnel	900	0%
Late Stuart/Stellako	54,400	19%
Harrison	58,200	20%
Late	**15,900**	**6%**
Birkenhead	11,500	4%
Late Shuswap/Portage	100	0%
Weaver/Cultus	4,300	1%
Total Sockeye	**287,700**	**100%**

1 Pitt River sockeye do not migrate past Mission, but are shown here as if they did to provide a complete accounting of Fraser sockeye

V. RUN SIZE, CATCH AND ESCAPEMENT

A. Sockeye Salmon

The total abundance of sockeye salmon in 2020 was 365,200 fish (Tables 6 and 7), which is 61% smaller than the median forecast of 941,000 fish and 26% below the total adult return in 2016 (493,200). The 2020 return is the smallest run size since records began in 1893 (Figure 8). While the 2020 Fraser Sockeye Science Integration Workshop predicted that the survival would fall below average and between the 25th percentile and the median forecast[15], actual returns were below the 25th percentile.

The causes of the small return are unknown. Freshwater and marine conditions experienced by sockeye returning in 2020 were expected to be below average. The forecast included a large return of four year olds (86%), predominantly Chilko fish, 27%. In-season, the return of age 4 Chilko fish (28,000) was 88% lower than forecast (243,000), which is consistent with the low run size observed in-season. This apparent poorer than expected survival of Chilko four-year-olds, coupled with the poor returns relative to forecast of several other Fraser sockeye stock groups (see below), suggests that a marine mechanism may have caused the poor productivity observed in 2020. While it is tempting to blame the low return on the anomalously warm ocean temperatures

[15] MacDonald, B.L., Grant, S.C.H., Wilson, N., Patterson, D.A., Robinson, K.A., Boldt, J.L., King, J. Anderson, E., Decker, S., Leaf, B., Pon, L., Xu, Y., Davis, B., & Selbie, D.T. 2020. State of the Salmon: Informing the survival of Fraser Sockeye returning in 2020 through life cycle observations. Can. Tech. Rep. Fish. Aquat. Sci. 3398: v + 76 p.

in the Gulf of Alaska, the lack of a consistent response among sockeye populations, suggests a more complicated causal mechanism.

Table 6. Catch, escapement, difference between estimates and run size for Fraser River sockeye (by management group) in 2020.

	Fraser Sockeye					
	Early Stuart	Early Summer	Summer	Late	Total	% of Run
CANADIAN CATCH	**30**	**400**	**11,000**	**10**	**11,400**	**3%**
Commercial Catch	**0**	**0**	**0**	**0**	**0**	0%
Panel Area	0	0	0	0	0	0%
Non-Panel Areas	0	0	0	0	0	0%
First Nations Catch	**0**	**0**	**0**	**0**	**0**	0%
Marine FSC	0	0	0	0	0	0%
Fraser River FSC	0	0	0	0	0	0%
Economic Opportunity	0	0	0	0	0	0%
Non-commercial Catch	**0**	**10**	**40**	**10**	**70**	0%
Marine Recreational	0	0	10	10	20	0%
Fraser Recreational	0	0	0	0	0	0%
Charter (Albion & Area 12 Chum)	0	10	30	0	50	0%
ESSR	0	0	0	0	0	0%
Unsanctioned Catch* **	30	400	10,900	0	11,300	3%
UNITED STATES CATCH	**30**	**1,000**	**7,700**	**600**	**9,300**	**3%**
Washington Total	**0**	**0**	**0**	**0**	**0**	**0%**
Commercial catch	**0**	**0**	**0**	**0**	**0**	0%
Treaty Indian	0	0	0	0	0	0%
All Citizen	0	0	0	0	0	0%
Non-commercial Catch	**0**	**0**	**0**	**0**	**0**	0%
Ceremonial	0	0	0	0	0	0%
Recreational	0	0	0	0	0	0%
Alaska	30	1,000	7,700	600	9,300	3%
TEST FISHING CATCH	**100**	**1,300**	**3,100**	**100**	**4,600**	**1%**
PSC (Panel Areas)	**60**	**800**	**1,700**	**80**	**2,700**	**1%**
Canada	60	800	1,700	80	2,700	1%
United States	0	0	0	0	0	0%
Canada (non-Panel Areas)	**50**	**400**	**1,400**	**40**	**1,900**	**1%**
TOTAL RUN	**16,800**	**89,200**	**242,500**	**16,700**	**365,200**	**100%**
Total Catch in All Fisheries	200	2,600	21,800	700	25,300	7%
Adult Spawning Escapement *	400	80,100	185,900	6,400	272,800	75%
Jack Spawning Escapement	0	200	1,000	200	1,500	0%
Difference Between Estimates**	16,300	6,200	33,800	9,400	65,700	18%
Percentage of Total Run	**100%**	**100%**	**100%**	**100%**	**100%**	
Total Catch in All Fisheries	1%	3%	9%	4%	7%	
Spawning Escapement	2%	90%	77%	39%	75%	
Difference Between Estimates	97%	7%	14%	56%	18%	

* Spawning escapement estimates for Early Stuart, Bowron, and Cultus sockeye include 365, 44, and 101, respectively, individuals captured as brood stock.

** Difference between estimates as at the time of the final spawning ground estimates. Also, consistent with Panel advice, positiveDBEs were set to zero for all components of management groups.

*** Largely resulting from unsanctioned food fisheries by two communities in the mid-river area, with small amounts from other food fisheries and recreational fisheries that were directed at other species in 2020

Table 7. Catch, escapement, difference between estimates, run size and exploitation rate for Fraser River sockeye (by stock group) salmon in 2020.

Management Group / Stock Group	Catch	Adult Spawning Escapement	Difference Between Estimates[3]	Abundance			Portion of Run	Adult Exploitation Rate
				Adult	Jack [1]	Total		
Fraser Sockeye Salmon								
Early Stuart	**200**	**400**	**16,300**	**16,800**	**0**	**16,800**	**5%**	**1%**
Early Summer-run	**2,600**	**80,100**	**6,200**	**88,900**	**200**	**89,100**	**24%**	**3%**
Chilliwack	300	31,700	0	31,900	0	31,900	9%	1%
Early Miscellaneous	1,800	38,000	1,900	41,700	200	41,900	11%	4%
Early South Thompson	100	2,600	0	2,700	30	2,700	1%	4%
North Barriere/Taseko	200	1,000	2,300	3,500	0	3,500	1%	6%
Pitt	200	6,800	2,100	9,000	0	9,000	2%	2%
Summer-run	**21,800**	**185,900**	**33,800**	**241,500**	**1,000**	**242,500**	**66%**	**9%**
Raft/N.Thompson	200	5,600	0	5,800	0	5,800	2%	3%
Chilko	13,400	54,600	6,700	74,700	1,000	75,700	21%	18%
Quesnel	200	800	600	1,600	10	1,600	0%	13%
Late Stuart/Stellako	7,100	49,100	26,500	82,800	60	82,800	23%	9%
Harrison/Widgeon	900	75,800	0	76,600	0	76,600	21%	1%
Late-run	**700**	**6,500**	**9,400**	**16,600**	**200**	**16,800**	**5%**	**4%**
Birkenhead/BigSilver	400	6,100	5,300	11,800	200	12,000	3%	3%
Late Shuswap/Portage	300	30	100	400	0	400	0%	75%
Weaver/Cultus	20	300 [2]	4,000	4,300	20	4,300	1%	0%
Total	**25,300**	**272,800**	**65,700**	**363,800**	**1,500**	**365,200**	**100%**	**7%**
Portion of Total Run	7%	75%	18%	100%	0%	100%		

1 Jack ratios were not estimated for fisheries; estimates include only those jacks that were actually sampled and are therefore underestimates.

2 Spawning escapement estimates of Early Stuart and Cultus sockeye include 365 and 101, respectively, individuals captured as brood stock.

3 Difference between estimates as at the time of the final spawning ground estimates. Also, consistent with Panel advice, positive DBEs were set to zero for all componenets of management groups.

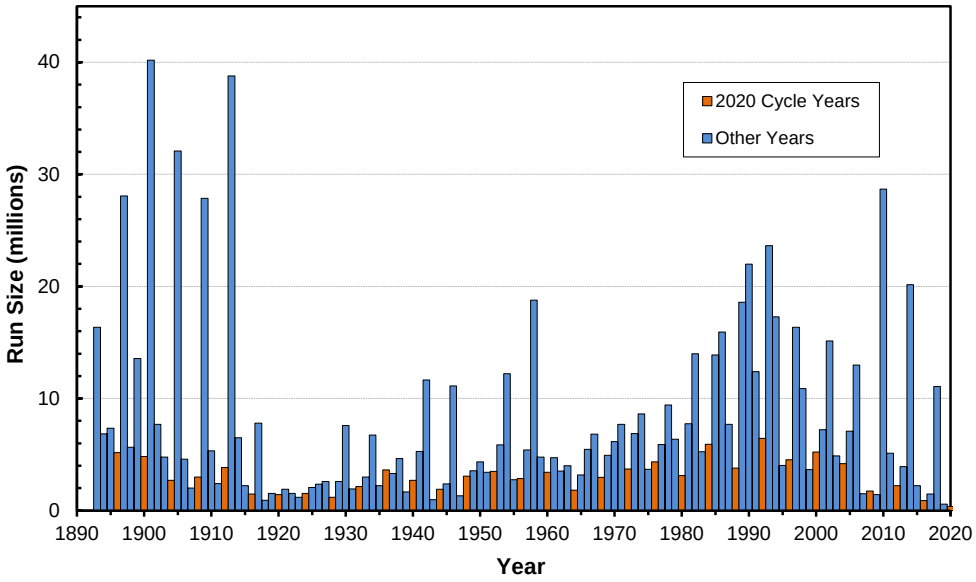

Figure 8. Total run size of Fraser River sockeye salmon from 1893-2020. Returns on the 2020 cycle are emphasized.

All management groups returned at lower abundances than their median (50p level) pre-season forecast, with the exception of Early Stuart. The total return of Early Stuart sockeye was 16,800 adults (Table 7), 29% greater than the median forecast. Early Summer-run sockeye returns totalled 88,900 adults, only 65% of the median forecast level. The abundances of Earl Summer run were dominated by Chilliwack (31,900 adults) and Early Miscellaneous (41,700 adults). The abundance of Summer-run sockeye was 241,500 adults, only 40% of the median forecast level. The abundance of Summer-run fish were dominated by Chilko (74,700 adults), Late Stuart/Stellako (82,800 adults) and Harrison/Widgeon (76,600 adults). Returns to all Late-run components were very poor relative to their median forecasts resulting in an aggregate Late-run return of 16,600 adults that was only 17% of the group's median pre-season forecast. Components

The total sockeye catch of 25,300 fish represented about 7% of the total return (Tables 6 and 7) and includes sockeye catches in pink directed fisheries in Alaska. This exploitation rate is tied with 2017 for the lowest since records began in 1893 (Figure 9). Of the total sockeye catch, 11,400 fish were caught in Canada, 9,300 fish in the U.S. and 4,600 fish in test fisheries (Table 6). Virtually all of the Canadian catch was from unsanctioned catch (11,300 fish) resulting predominantly from food fisheries by two communities in the mid-river area, with small amounts from other food fisheries and recreational fisheries that were directed at other species in 2020. There was some Charter catch, 50 fish, and no commercial sockeye catch in Canada. There was no sockeye catch in Washington State. The Alaska catch of Fraser sockeye during pink salmon directed fisheries was 9,300 fish.

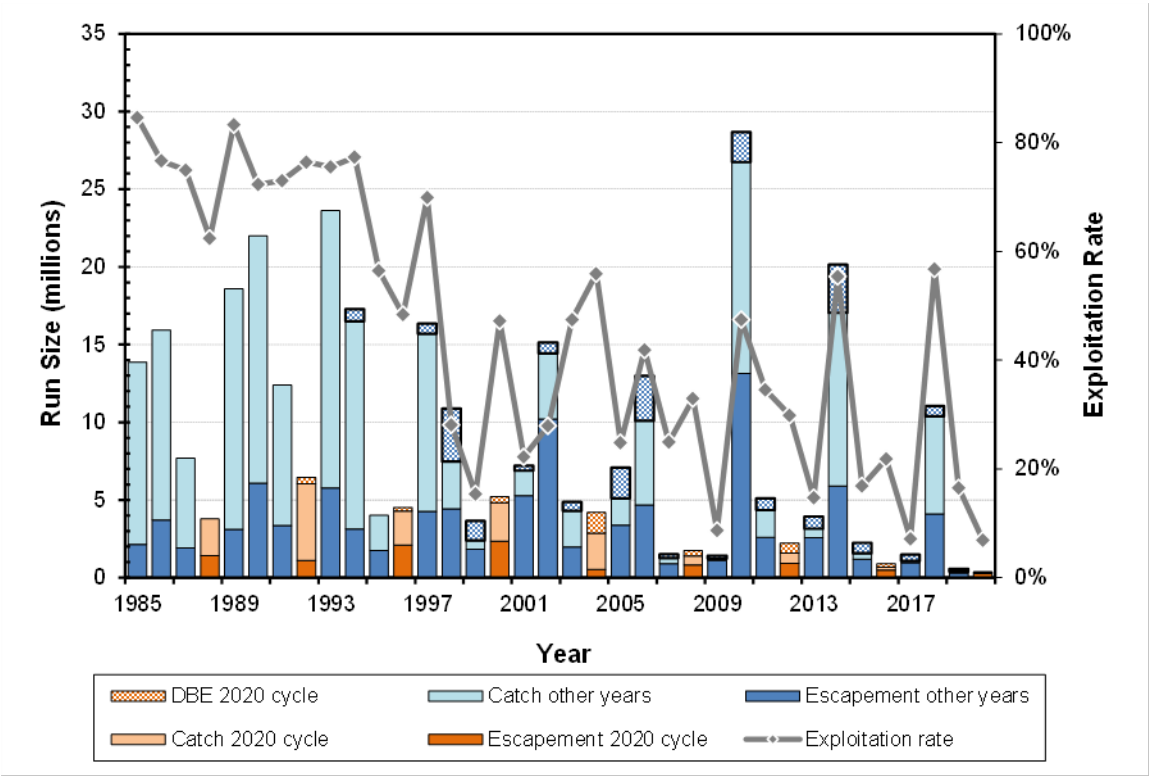

Figure 9. Total catch, escapement, difference between estimates, run size and exploitation rate for Fraser River sockeye salmon in 1985-2020, with returns on the 2020 cycle emphasized.

DFO annually assesses the spawning ground abundance of sockeye populations in the Fraser watershed (Figure 10). In 2020, the near-final estimate of adult spawners (primarily age 4 and age 5 fish) totalled 272,800 fish, or 75% of the total run (Table 9). This escapement was 44% lower than the brood year (2016) escapement of 484,500 adults.

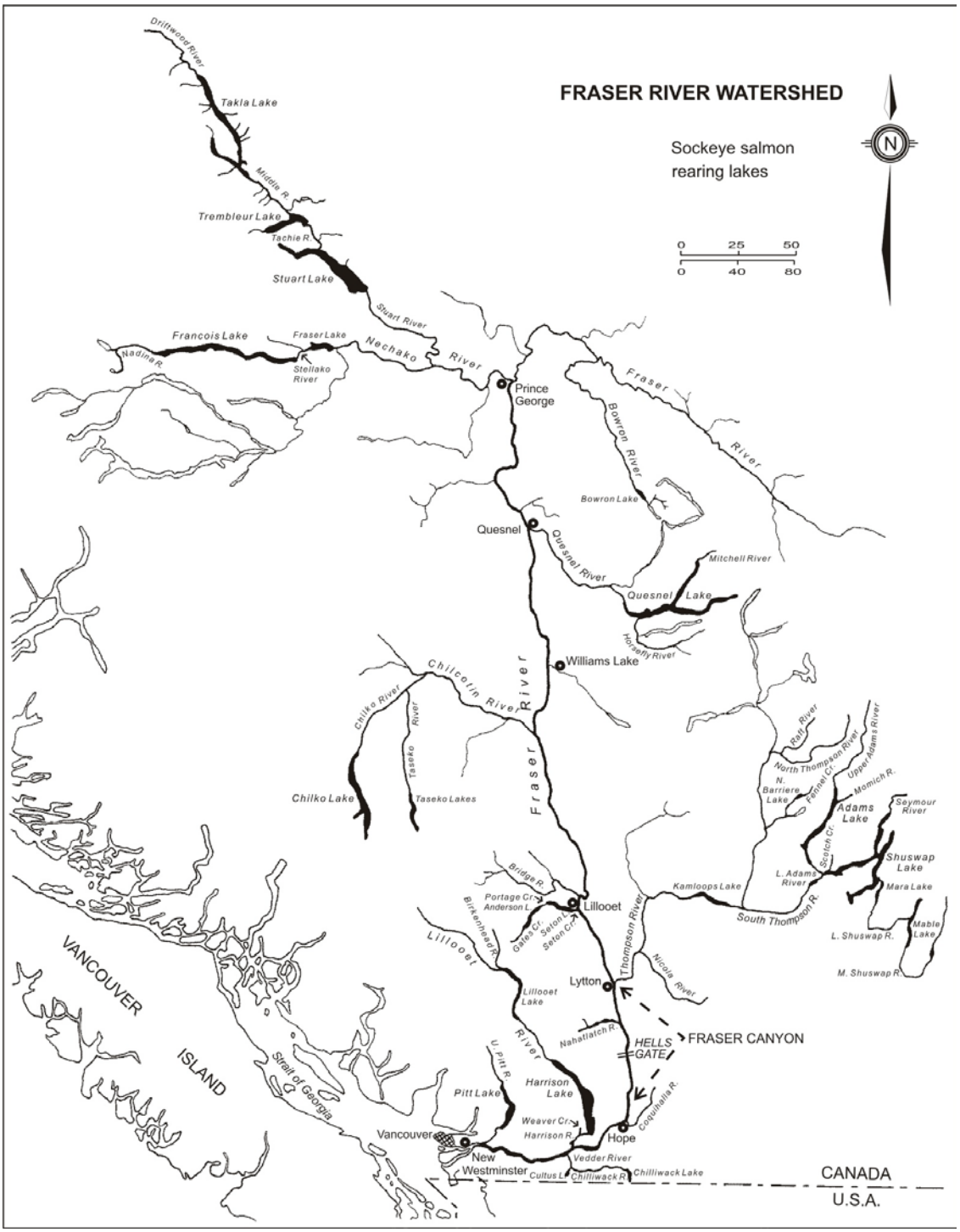

Figure 10. Sockeye salmon spawning areas in the Fraser River watershed.

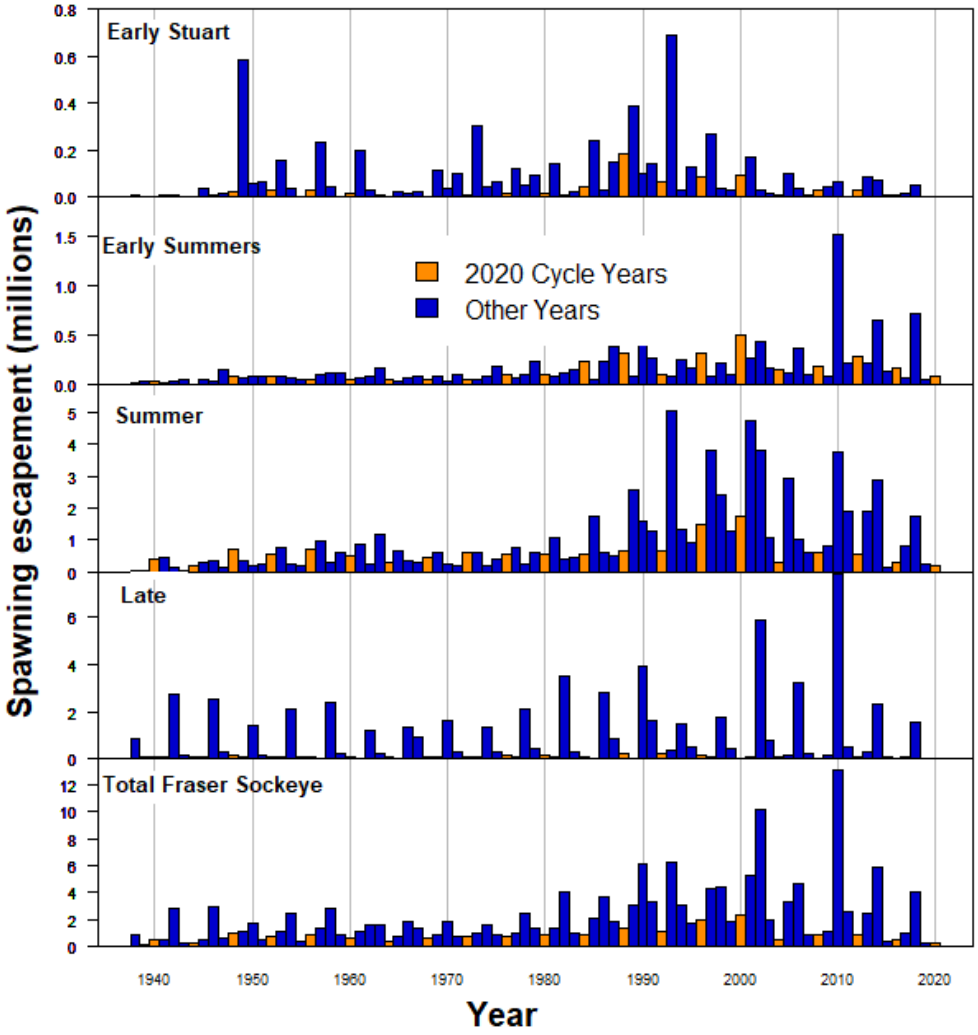

Figure 11. Annual adult spawning escapement of Fraser River sockeye salmon for each management group, and total Fraser sockeye, in 1938-2020, with escapements on the 2020 cycle emphasized.

Spawner abundances for most management groups were much less than those observed in the brood year (2016, Figure 11). By management group, spawning escapements in 2020 were the lowest on record for the Early Stuart system, the lowest observed since 1972 on this cycle line for Early Summer run, the second lowest observed for this cycle line for Summer run, and the lowest cycle year escapement on record for the Late run and the third consecutive decline on the 2020 cycle line for four year olds. The very low escapements relative to the brood year are attributed primarily to the combination of low productivity (recruits/spawner), the above normal discharge in the Fraser River prior to mid-August and the additional mortality of early migrating stocks located above Big Bar.

The overall spawning success of adult female sockeye in the Fraser watershed was 97%. The effective female spawning population in 2020 totalled 153,300 fish, which was 33% less than the

number of effective females in 2016. The DBE[16] estimate was 65,700 fish, or 18% of the total return (Tables 6 and 7). As a percentage of run size for each management group, Early Stuart had the largest DBE at 97%, while the DBEs for Early Summer and Summer run were less than 15%. The Late run had a DBE of 56%. Note that these DBE estimate differ from the DBE estimates mentioned in previous sections as they include Alaska catches which are only available post-season.

Further details regarding sockeye salmon abundances, catches and spawning escapements including comparisons with the previous four-cycle years can be found in Appendix G (Tables G1 and G2).

VI. ACHIEVEMENT OF OBJECTIVES

The mandate of the Fraser River Panel is to manage commercial fisheries in Panel Area waters to achieve a hierarchy of objectives. In order of importance, the objectives are to: (1) achieve spawning escapement targets for Fraser River sockeye and pink salmon as determined by the schedule provided by Canada; (2) achieve harvest targets for international sharing of the TAC as defined in the Treaty; and (3) achieve domestic allocation goals within each country. In addition, the Treaty instructs the Panel to plan and manage its fisheries consistent with the provisions of other chapters of Annex IV to ensure that the conservation needs and management requirements for other species and other sockeye and pink salmon stocks are taken into account. Panel management is evaluated after each season to determine whether the goals were achieved and to identify potential improvements in data collection programs, assessment methods and management techniques. While not formally under Panel control, management of Canadian non-Panel fisheries directed at Fraser River sockeye and pink salmon is based on the same in-season information and hierarchy of objectives, with priority given first to conservation, and then to First Nations Food, Social and Ceremonial (FSC) harvest within Canada's allocation.

A. Escapement

The Panel's first task is to achieve spawning escapement targets by stock or stock grouping. Spawning escapement targets were determined by applying Canada's spawning escapement plan to abundance estimates for each management group. In 2020, the run size estimates for all sockeye management groups were smaller than the Lower Fishery reference points, so all management groups were in a LAER approach and catches were a result of fisheries directed at other co-migrating stocks or unsanctioned catches. In addition, the escapement targets equalled the total run size.

In-season monitoring of the progress toward spawning escapement targets is not directly measurable because in most cases spawner abundance cannot be assessed on the spawning grounds until well after the fishing season has ended. In-season management is therefore based on targets for potential spawning escapement (i.e., PSE target = in-season spawning escapement target + MA). Progress towards these targets is monitored by comparison with in-season PSE estimates (i.e., Mission escapement to-date - catch above Mission). Final in-season PSE estimates indicate the in-season PSE targets were not reached except for Early Stuart and Late run (Table 8):

[16] Based on in estimates of total return but including Alaska catches. Difference Between Estimates (DBEs) will eventually be replaced by Run-size Adjustments (RSAs) which are revisions to the total run size in cases when there is evidence that more fish returned than were accounted for in catch and escapement, e.g., evidence of en route mortality, evidence of biased or incomplete estimates of catch, Mission escapement or spawning escapement. The focus of RSAs is on providing the best assessments of total returns, i.e., recruitment. Models that relate recruitment and spawning stock are used to develop both pre-season abundance forecasts and escapement policy. The methods used to estimate RSAs are currently under review by PSC and DFO staff and members of the Fraser River Panel Technical Committee.

Early Stuart (6% over), Early Summer run (4% under), Summer run (9% under) and Late run (14% over).

Table 8. Comparison of in-season targets and in-season estimates of potential spawning escapement (PSE) for adult Fraser River sockeye salmon in 2020.

Management Group	Final In-season Abundance Estimate	Potential Spawning Escapement (PSE)					
		Spawning Escapement Target	Management Adjustment *	In-season PSE ** Target	PSE *** Estimate	Difference Fish	Difference %
Adult sockeye	**293,000**	**293,000**	**84,700**	**293,000**	**276,000**	**-17,000**	**-6%**
Early Stuart	16,000	16,000	11,000	16,000	17,000	1,000	6%
Early Summer	72,000	72,000	37,400	72,000	69,000	-3,000	-4%
Summer	191,000	191,000	30,600	191,000	174,000	-17,000	-9%
Late	14,000	14,000	5,700	14,000	16,000	2,000	14%

* Adjustment of spawning escapement targets to achieve spawning escapement goals.

** Spawning escapement target + MA. If the spawning escapement target + MA exceeds the total abundance, then the target equals the total abundance.

*** Mission passage minus all catch above Mission.

Table 9. Comparison of post-season spawning escapement targets and escapement estimates for adult Fraser River sockeye salmon in 2020. Post-season estimates of sockeye escapement are from spawning ground enumeration programs (DFO). Post-season estimate of pink escapement based on Mission hydroacoustics.

Management Group	Post-season Run-size Estimate	Spawning Escapement			
		Post-season Target	Adult Estimate	Difference Fish	Difference %
Sockeye salmon	**365,200**	**365,200**	**272,800 ***	**-92,400**	**-25%**
Early Stuart	16,800	16,800	400	-16,400	-98%
Early Summer	89,200	89,200	80,100	-9,100	-10%
Summer	242,500	242,500	185,900	-56,600	-23%
Late	16,700	16,700	6,400	-10,300	-62%

* Includes 365, 44, and 101 Early Stuart, Bowron, and Cultus adults, respectively, kept for broodstock

In terms of the achievement of post-season objectives, the total spawning ground escapement estimate of Fraser sockeye was 25% below the target (Table 9). The spawning escapement targets for all sockeye management groups equalled their in-season run sizes and escapement targets were unattainable given the predicted en route losses. Those losses were especially severe early in the season, when discharge was higher than average in the Fraser River and natural migration passage past Big Bar was obstructed. Only 30 Early Stuart sockeye were estimated on the spawning grounds (98% below target), but 365 fish were collected for broodstock as part of a broader conservation enhancement initiative to mitigate the impacts of Big Bar landslide. Similarly, 44 Bowron sockeye from the Early Summer run were also collected for enhancement purposes. The Big Bar impact was in addition to the regular en route losses as in-season estimates for Early Stuart are consistently higher than spawning ground estimates even when migration conditions are within normal range. Spawning ground escapement estimates were below target by 10%, 23% and 62% for Early Summer, Summer and Late run, respectively (Table 9). The harvest of Fraser sockeye only contributed to a limited extent to this discrepancy as the exploitation rate for all management groups was less than the 10% LAER: Early Stuart (1%), Early Summer run (3%), Summer run (9%) and Late run (4%, Table 7).

The low sockeye returns in 2020 reflect a continuing trend of declining productivity that is a growing concern[17]. Currently the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) considers eight Fraser River sockeye stocks as endangered (Early Stuart, Bowron, Taseko, Late Stuart, Quesnel, Portage, Weaver, Cultus) and two as threatened (Upper Barriere, Widgeon)[18]. Of these stocks, Early Stuart, Bowron, Taseko, Quesnel and Late Stuart all have spawning grounds above Big Bar.

B. International Allocation

The Panel's second priority is to achieve the goals for international allocation of the TACs for Fraser sockeye salmon. In accordance with Annex IV, Chapter 4 of the Pacific Salmon Treaty, the TAC calculations are based on the run sizes, spawning escapement targets and MAs in effect when the Panel last adopted a run size in-season (September 1), which is based on a new agreement reached by the Panel February 14, 2019. This agreement is reflected in the amended 2020 Chapter 4, Annex IV of the Pacific Salmon Treaty. The test fishing catch and Aboriginal Fisheries Exemption deductions are the post-season estimates, however.

Given the low run sizes in 2020, there was no International TAC for Fraser River sockeye (Table 10). Due to the catch of 470 sockeye in Washington in pink salmon directed fisheries in 2019, the United States had a payback of 470 sockeye (Table 10); however, as there were no sockeye directed fisheries in 2020, it was agreed by the Panel that this payback would be carried forward to the 2021 season. Canada's catch of 11,400 Fraser sockeye was largely from unsanctioned catch (11,300) and exceeded the available harvest by 100%. A detailed version of the TAC calculations by management group is presented in Appendix G, Table G3.

C. Domestic Allocation

The third priority of the Panel is to achieve domestic allocation goals as specified by the Parties. While the Panel manages all commercial fisheries directed at Fraser River sockeye and pink salmon in Panel Area waters (Figure 1), Canada has sole responsibility for regulating fisheries including commercial net and troll fisheries in non-Panel areas such as Johnstone Strait, and First Nations and recreational fisheries in all fishing areas.

In the US, there was no Washington catch of sockeye salmon (Tables 10 and 11).

In Canada, unsanctioned sockeye catch accounted for 11,300 fish. An additional 50 Fraser River sockeye were caught in domestic, Chinook and chum test fisheries.

D. Conservation of Other Stocks and Species

Non-target stocks and species are caught in Panel Area fisheries directed at Fraser River sockeye and pink salmon. The conservation needs and management requirements for these stocks and species caught incidentally in fisheries regulated by the Fraser Panel are taken into account through a variety of bilateral and domestic processes associated with the implementation of Chapter 4 (Fraser River sockeye and pink salmon) and other Chapters of Annex IV. A comprehensive summary of all the methods in which by-catch impacts are taken into account is beyond the scope of this report, but we provide a few examples below. In the United States, the

[17] DFO. 2020. Recovery Potential Assessment for Fraser River Sockeye Salmon (*Oncorhynchus nerka*) – Nine Designatable Units – Part 1: Probability of Achieving Recovery Targets. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/012.

[18] COSEWIC. 2017. COSEWIC assessment and status report on the Sockeye Salmon *Oncorhynchus nerka*, 24 Designatable Units in the Fraser River Drainage Basin, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xli + 179 pp.

Pacific Fishery Management Council[19] takes into account modelled by-catch of Chinook and coho salmon in Fraser Panel regulated sockeye and pink-directed fisheries to ensure consistency with Chapters 3 (Chinook) and 5 (coho) of Annex IV. Similarly, Canada, through its Integrated Fisheries Management Plan[20] for South Coast salmon fisheries, specifies closure windows for sockeye and pink-directed fisheries in the Fraser River and these closures are regularly implemented to protect Chinook and coho salmon. As there was no directed commercial Fraser sockeye fisheries, there was no by-catch of non-Fraser sockeye salmon or non-Fraser pink salmon or other salmon species.

Table 10. Total allowable catch (TAC) and achievement of international catch shares for Fraser River sockeye salmon in 2020. TAC calculations use the in-season estimates of run size, spawning escapement target and management adjustment at the time of the last adopted run size at an in-season Panel meeting (September 1), in accordance with the revised Annex IV, Chapter 4 of the Treaty agreed to January 2020.

		Sockeye	
TOTAL ALLOWABLE CATCH			
In-season Total Run Size		**293,000**	
Deductions		**382,400**	
In-season Spawning Escapement Target		293,000	
In-season Management Adjustment		84,800	
Aboriginal Fishery Exemption (AFE)		0	
Post-season Test Fishing Catch		4,600	
Total Allowable Catch	*1, 2*	**0**	
UNITED STATES			
Washington Total Share	*3*	**-470**	
Washington Share of TAC	*1*	0	16.5%
Payback		-470	
Washington Catch		**0**	
Deviation		**-470**	
In-season Alaska Catch Estimate		0	
CANADA			
Canadian Share of TAC + U.S. Payback + AFE		**0**	
Canadian Catch (includes Charter, excludes ESSR)		**11,400**	
Unsanctioned Catch	*4*	11,300	
Deviation		**-11,400**	

1 TAC and Washington sockeye share according to Annex IV, Chapter 4 of the Pacific Salmon Treaty.

2 TAC may not equal the total run minus total deductions shown due to adjustments required when the run size of individual management groups is less than the nominal deductions. A more detailed TAC calculation showing these intermediate calculations is shown in the Appendix.

3 United States share according to revised Annex IV of the Pacific Salmon Treaty:
Sockeye: 16.5% of the TAC - payback (maximum 5% of share).
Pink: 25.7% of the TAC - payback (maximum 5% of share).

4 Largely resulting from unsanctioned food fisheries by two communities in the mid-river area, with small amounts from other food fisheries and recreational fisheries that were directed at other species in 2020

[19] https://www.pcouncil.org/managed_fishery/salmon/

[20] https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/index-eng.html

VII. ALLOCATION STATUS

Annex IV, Chapter 4, (paragraph 8 (c)(iv)) specifies that *the US share will not be adjusted for an overage resulting from TAC reductions after the scheduling of the last Fraser River Panel approved U.S. fishery of the season.* The resulting calculations indicate that while there was no sockeye catch in 2020 there still remained a payback of 470 sockeye resulting from the pink directed fisheries in 2019 (Table 11). As there were no directed commercial fisheries in the 2020 season, the Panel agreed that the 470 landed in Panel regulated fisheries directed at Fraser River pink salmon in 2019 would be carried over as payback to 2021.

Table 11. Allocation status for Fraser River sockeye salmon in 2016-2020.

	2016 (Aug 02)	2017 (Oct 7)	2018 (Aug 23)	2019 (Sep 13)	2020 (Sep 1)
TOTAL ALLOWABLE CATCH					
Total Run Size	2,110,000	1,487,000	14,022,000	500,000	293,000
Escapement and other deductions	1,542,700	1,487,000	7,822,400	500,000	293,000
Total Allowable Catch:	567,300	0	6,199,600	0	0
UNITED STATES					
Washington Catch	1,700	1,500	993,500	470	0
Washington Share (excldes payback) *	93,600	0	1,020,300	0	0
Deviation:	-91,900	1,500	-26,800	470	0
Cumulative Allocation Status:	**900****	**2400****	**0****	**470****	**470****
CANADA					
Catch	149,200	71,900	4,731,500	9,860	11,360
Share + Aboriginal Exemption	622,100	71,700	5,251,000	9,710	11,290
Deviation:	-472,900	200	-519,500	150	70

* From 2008 - 2018, United States allocation status follows either Commission guidance or Chapter 4 (paragraph 8, c, iv). This language states "The U.S share will not be adjusted for an overage resulting from TAC reductions after the scheduling of the last Fraser River Panel approved U.S fishery of the season". Thus, in circumstances which satisfy the above conditions, the TAC's used to determine allocation status may be different than the TAC based on input data used in post-season calculations. The dates in each year used to calculate run sizes and other deductions for this allocation status table are noted in parathenses under each year. Exceptions to the language in paragraph 8, c, iv are noted below. Washinton shares during this period were calculated according to Annex IV of the Pacific Salmon Treaty: Shall not exceed 16.5% for Fraser River sockeye and 25.7% for Fraser River pink salmon.

** Washington share of the TAC according to Annex IV of the Pacific Salmon Treaty:

2016: No payback was generated in 2016, but by Panel agreement 900 sockeye were carried forward from the 2015 season.

2017: By Panel agreement 900 sockeye were carried forward from the 2015 season as well as the 1,500 sockeye overage generated from the 2017 season. U.S. pink salmon allocation status is based on TAC share in effect on Aug 31, when the last U.S. fishery was scheduled.

2018: Shall not exceed 16.5% for Fraser sockeye and 25.7% for Fraser pinks. Allocation status based on TAC when Panel made it's last decision about U.S. fisheries in 2018 (Aug. 23), because TAC decreased between date of last U.S. fishery decision (Aug 23) and when Panel control of last U.S. fishery areas was relinquished (Oct 6).

2019: Shall not exceed 16.5% for Fraser sockeye and 25.7% for Fraser pinks. Allocation status based on TAC when Panel made its last decision about U.S. fisheries in 2019 (Sep 13). As there was no TAC for sockeye salmon, any sockeye caught in pink directed fisheries was considered an overage.

2020: Shall not exceed 16.5% for Fraser sockeye and 25.7% for Fraser pinks. As there was no TAC for sockeye salmon, the payback of 470 sockeye was carried forward from the 2019 season.

VIII. APPENDICES

APPENDIX A: GLOSSARY OF TERMS AND ABBREVIATIONS

Bayesian Methods and Models: Statistical models which allow pre-season forecasts of run size, diversion rate, and migration timing to be used as priors and then combined with in-season observations as data accumulates over the course of the season. Early in the season, estimates are heavily dependent on these pre-season priors, but this dependence shifts to the collected data as the season progresses. Uncertainty in the in-season estimates of run size, migration timing and diversion rate decreases as more data become available. The name "Bayesian" comes from the frequent use of Bayes' theorem in the inference process which specifies how the prior and in-season data interact in the generation of estimates.

CPUE: Catch per unit of effort. Typically associated with data obtained from test fisheries (e.g., number of fish caught per 100 fathom minutes (a measure of net size and soak time)).

Cycle line: A series of years associated with a cohort of Fraser sockeye assuming spawners are 4 years old. A cycle line of a particular year includes every 4th year (e.g., 2008, 2012, 2016).

Demonstration fishery: A Canadian commercial fishery designed to test particular gear configurations or explore the feasibility of harvests either in non-traditional areas or by non-traditional gear. A limited number of licenses are typically granted to permit the conduct of such fisheries.

Difference between estimates (DBE): Difference between estimates of spawning escapement (PSE) and potential spawning escapement (SE) (DBE=SE-PSE). The potential spawning escapement is defined as Mission escapement minus any in-river catch that occurs between Mission and the spawning areas. Sources for DBEs include en route mortality and errors (bias and imprecision) introduced through the estimates of Mission escapement, spawning ground escapement, First Nations and recreational catches above Mission, and stock composition. Historical DBE values are used to generate Management Adjustment (MA) models, which use estimates of migration timing and river conditions to predict the DBEs likely to be observed in the current year. The proportional DBE (pDBE) is estimated by dividing the difference between estimates by the potential spawning escapement (pDBE = DBE/PSE) and is often shown as a percentage, such that %DBE = 100 * pDBE. The formulas pDBE = (1/(1+pMA))-1, and pMA= (1/(1+pDBE)-1 can be used to convert between pDBEs and pMAs.

Northern Diversion rate: Proportion of the salmon run that migrates through Johnstone Strait (northern approach) as opposed to Juan de Fuca Strait (southern approach). Estimates may be in time steps of a week or a few days, or a value for the entire migration on an annual basis.

Economic Opportunity (EO) fishery: Commercial Fraser River First Nations fishery in the Lower Fraser area.

Effective Female Spawners: The total number of female spawners multiplied by a measure of spawning success that relates to the fraction of females subsampled in a population that either died with all of their eggs (0% spawning), none of their eggs (100% spawning success) or with an intermediate fraction of their eggs (50% spawning success). Carcass surveys conducted on the spawning grounds endeavour to representatively sample a portion of the available carcasses and assign them to one of the above three categories.

ESSR: Terminal harvest of salmon that are "Excess Salmon to Spawning Requirements". This term is usually associated with fish that are surplus to those needed to completely seed an artificial spawning channel and in the Fraser are most frequently associated with sockeye and the spawning channel at Weaver Creek.

Fishery-induced Mortality (FIM) or Release Mortality: In fisheries where some component of the catch is released (e.g., non-retention), some proportion of the released fish are expected to die

due to the stress of capture and handling. These mortalities are referred to as fishery-induced mortality or release mortality.

Fishery Planning Model: A pre-season model that allows the Panel to evaluate the impacts of various fishery options on the achievement of management objectives, given pre-season expectations such as abundance, stock composition, migration timing, diversion rate, spawning escapement targets, management adjustments and catch objectives.

Food, Social and Ceremonial (FSC) fishery: Non-commercial First Nations fishery.

Low Abundance Exploitation Rate (LAER): The purpose of managing a sockeye management group in a LAER situation is to permit by-catch of that stock group in fisheries directed at other management groups or species with available surpluses (e.g., Summer-run sockeye, pink salmon). The application of a LAER for a management group has the effect of limiting the exploitation rate (ER) of that group to a small amount (e.g., 10% or 20% of a run timing group). The need to implement a LAER for a particular sockeye management group can be caused by one of the following:

- When the run size is below the lower fisheries reference point as defined by Canada's Spawning Escapement Plan.
- When the escapement goal plus the management adjustment (MA) is greater than the run size.
- When the escapement goal plus the MA is less than the run size but the resulting ER is less than the % LAER.

Management Adjustment (MA): Additional fish added to an escapement target for the purpose of increasing the likelihood of achieving the escapement target. Pre-season, MAs are typically calculated based on historical discrepancies or long-range forecasts of river conditions. In-season the MAs for Early Stuart, Early Summer-run and Summer-run sockeye stocks are calculated using models that relate historical discrepancies to river conditions. Estimates of migration timing and river conditions in the current year are then used to predict the proportional management adjustments (pMA) that are applied to spawning escapement targets. For Late-run stocks, MAs are often calculated based on models that relate historical discrepancies to upstream timing. The pMAs are multiplied by the spawning escapement targets to calculate numerical MAs. MAs are calculated pre-season as inputs for pre-season planning, and at regular intervals during the fishing season based on in-season estimates of migration timing and observed and forecasted river conditions.

Management group or Run-timing group: Aggregates of sockeye salmon stocks that are used in Fraser Panel management, i.e., Early Stuart, Early Summer-run, Summer-run, and Late-run groups.

Migration date or 50% date: Dates when half (50%) of the total run would have passed a certain geographical location if it is assumed that all fish migrated via that route.

Area 20 date: An index of marine migration timing, assuming the entire run migrated through Canadian fishery management Area 20 in Juan de Fuca Strait.

Mission date: An index of in-river migration timing, defined by when half the total Mission escapement (usually identified by individual stock or stock group) is estimated to have passed Mission.

Reconstructed Mission date: An index of in-river migration timing based on when half of the total reconstructed run to Mission (Mission escapements plus catches seaward of Mission) is estimated to have been available to pass Mission. Reconstructed Mission dates are generally not available for Late-run stocks for which a portion of the run is expected to delay prior to entering the Fraser River.

Mission Escapement or Mission Passage: PSC estimates of the daily number of fish that migrate upstream past the hydroacoustic field station at Mission, B.C. Mission passage is primarily

estimated by hydroacoustic methods, but at times (usually early and late in the season) is estimated by dividing the CPUE by catchability using data from in-river test fisheries.

Non-retention: In fisheries where one species is targeted but by-catch of a second species is expected, regulations may specify that the fish of the second species be released. For example, sockeye salmon were expected to be caught in some pink-directed fisheries in 2015 but there was minimal TAC for Late-run Fraser sockeye remaining, so some fisheries were opened for pink salmon harvest, but under conditions of either mandatory or voluntary non-retention for sockeye. Non-target species that are released are assigned gear-specific fishing induced mortality rates (FIMs; see above), that are accounted for along with landed catches in estimates of total exploitation rates.

Potential Spawning Escapement (PSE)

> **Potential spawning escapement target**: In-season target for PSE by management group, where the PSE is the sum of the spawning escapement target plus the Management Adjustment (MA). May also be called the "Adjusted Spawning Escapement target". The management objective is to achieve the PSE target in-season as measured by the potential spawning escapement.
>
> **Potential spawning escapement**: Mission escapement estimate minus in-river catch upstream of Mission. If there were no en route mortalities or estimation errors in Mission escapement, up-river catch, spawning escapement or stock identification, the potential spawning escapement would in theory equal the number of fish estimated to have reached the spawning areas.

Run size: Total abundance or total return of a stock, management group or entire population of Fraser River sockeye or pink salmon.

Run-size Adjustment (RSA): Adjustments to the total return in cases when there is evidence that the number of fish returning deviate from that accounted for in catch and escapement, e.g., evidence of en route mortality, evidence of biased or incomplete estimates of catch, Mission escapement or spawning escapement.

Spawning Escapement (SE)

> **Spawning escapement or Net escapement**: Spawning escapement of adult male and female spawners and jack spawners (precocious age 3 males) as estimated through assessment programs conducted on the spawning grounds, or projected from other data when such programs are not conducted in all areas (e.g., a portion of Quesnel spawners was not assessed on the spawning grounds in 2002). Such escapement numbers include losses from pre-spawn mortality on the spawning grounds, however, pre-spawn mortality (fraction of females which die but retain some portion of their eggs) is accounted for in estimates of effective female spawners.
>
> **Spawning escapement target**: Target for total adult spawning escapement for each spawning population as defined each year by Canada's Spawning Escapement Plan.

Total Allowable Mortality rule (TAM rule): For each Fraser sockeye management group at different run sizes, Canada's Spawning Escapement Plan specifies the total allowable mortality from all sources, including fishery removals (catch) and en route mortality (represented by the Management Adjustment).

List of abbreviations:

ADFG: Alaska Department of Fish and Game	JS: Johnstone Strait
AFE: Aboriginal Fishery Exemption	LAER: Low Abundance Exploitation Rate
ARIS: Adaptive Resolution Imaging Sonar	LGL: A biological consulting company
BC: Province of British Columbia	MA: Management Adjustment
CPUE: Catch per Unit of Effort	MLP: Mandatory Landing Program
DBE: Difference Between Estimates	M-R: Mark-Recapture
DFO: Fisheries and Oceans Canada	pMA: Proportional Management Adjustment
DIDSON: Dual-frequency IDentification SONar	PSC: Pacific Salmon Commission
	PSE: Potential Spawning Escapement
EO: Economic Opportunity	RSA: Run Size Adjustment
ESSR: Excess Salmon to Spawning Requirements	SE: Spawning Escapement
	SET: Spawning Escapement Target
FRP: Fraser River Panel	TAC: Total Allowable Catch
FRPTC: Fraser River Panel Technical Committee	TAM: Total Allowable Mortality
	WDFW: Washington Department of Fish and Wildlife
FRSSI: Fraser River Sockeye Spawning Initiative	
FSC: “Food, Social and Ceremonial”	

APPENDIX B: 2020 PRE-SEASON FORECASTS AND SPAWNING ESCAPEMENT TARGETS FOR FRASER RIVER SOCKEYE SALMON

Table B1. Pre-season forecasts for Fraser River sockeye salmon in 2020. (Provided to the Panel by Fisheries and Oceans Canada)[20]. Post-season the 2020 forecast was slightly revised to a median total forecast of 924,000[21].

Run timing group / Stocks	Forecast Model [a]	Probability that Return will be at/or Below Specified Run Size				
		10%	25%	50%	75%	90%
Early Stuart	*Ricker(Pi)4/Sibling5*	5,000	8,000	13,000	23,000	33,000
Early Summer		72,000	116,000	218,000	469,000	1,098,000
(total excluding miscellaneous)		64,000	93,000	145,000	249,000	435,000
Bowron	*Ricker(Pi)*	500	900	2,000	3,000	8,000
Upper Barriere (Fennell)	*Power4/Sibling5*	3,000	5,000	8,000	14,000	25,000
Gates	*Larkin4/Sibling5*	6,000	9,000	15,000	28,000	47,000
Nadina	*PowerJuvFRDpeak4 /Sibling5*	26,000	42,000	72,000	133,000	245,000
Pitt	*Larkin4/Sibling5*	27,000	32,000	41,000	57,000	83,000
Scotch	*Larkin*	1,000	2,000	4,000	8,000	16,000
Seymour	*Larkin*	800	2,000	3,000	6,000	11,000
Misc (EShu) [b]	*R/S*	1,000	3,000	7,000	13,000	22,000
Misc (Taseko) [c]	*R/S*	200	500	900	2,000	2,000
Misc (Chilliwack)	*Ricker*	5,000	16,000	57,000	191,000	611,000
Misc (Nahatlatch) [d]	*R/S*	2,000	4,000	8,000	14,000	28,000
Summer		169,000	311,000	611,000	1,231,000	2,376,000
(total excluding miscellaneous)		161,000	290,000	572,000	1,148,000	2,192,000
Chilko	*Larkin4/Sibling5*	94,000	152,000	256,000	439,000	722,000
Late Stuart	*RickerFRDMn4/Sibling5*	6,000	14,000	35,000	83,000	178,000
Quesnel	*Ricker(Ej)4/Sibling5*	800	1,000	2,000	4,000	7,000
Stellako	*Larkin4/Sibling5*	29,000	50,000	93,000	171,000	308,000
Harrison [e]	*Ricker(Ej)Even3 /Sibling4*	26,000	64,000	168,000	419,000	924,000
Raft [e]	*Ricker(PDO)4/Sibling5*	5,000	9,000	18,000	32,000	53,000
Misc (N. Thomp Tribs) [e & f]	*R/S*	500	1,000	2,000	5,000	11,000
Misc (N. Thomp River) [e & f]	*R/S*	8,000	20,000	36,000	77,000	171,000
Misc (Widgeon) [g]	*R/S*	90	300	700	1,000	2,000
Late		28,000	53,000	99,000	190,000	374,000
(total excluding miscellaneous)		24,000	40,000	71,000	138,000	280,000
Cultus	*PowerJuv(Pi)4/Sibling5*	500	700	1,000	2,000	4,000
Late Shuswap	*RickerCyc4/Sibling5*	200	300	600	1,000	2,000
Portage	*Larkin*	80	200	400	800	2,000
Weaver	*Ricker(PDO)4/Sibling5*	400	600	1,000	3,000	6,000
Birkenhead	*Ricker(Ej)4/Sibling5*	23,000	38,000	68,000	131,000	266,000
Misc Harrison/Lillooet [g]	*R/S*	4,000	13,000	28,000	52,000	94,000
TOTAL SOCKEYE SALMON		274,000	488,000	941,000	1,913,000	3,881,000
(TOTAL excluding miscellaneous)		254,000	431,000	801,000	1,558,000	2,940,000

b. Misc. Early Shuswap uses Scotch & Seymour R/EFS
c. Misc. Taseko uses Chilko R/EFS
d. Misc. Nahatlach uses Early summer-run stocks R/EFS
e. Raft, Harrison, Misc. North Thompson stocks moved to Summer run-timing group
f. Misc. North Thompson stocks use Raft & Fennel R/EFS
g. Misc. Late Run stocks (Harrison Lake down-stream migrants including Big Silver, Cogburn, etc.), and river-type Widgeon use Birkenhead R/EFS

[21] https://publications.gc.ca/collections/collection_2020/mpo-dfo/Fs97-6-3392-eng.pdf

Table B2. Spawning escapement plan for Fraser River sockeye and pink salmon in 2020. (Provided to the Panel by Fisheries and Oceans Canada and based on Fraser River Sockeye Spawning Initiative (FRSSI) guidelines with input from domestic consultations)[20].

Management Unit		Pre-season Forecast Return				
		p10	p25	**p50**	p75	p90
	lower ref. pt. (w misc)	108,000	108,000	**108,000**	108,000	108,000
	upper ref. pt. (w misc)	216,000	216,000	**216,000**	216,000	216,000
Early Stuart	forecast	5,000	8,000	13,000	23,000	33,000
	TAM Rule (%)	0%	0%	**0%**	0%	0%
	Escapement Target	5,000	8,000	**13,000**	23,000	33,000
	MA	3,500	5,500	**9,000**	15,900	22,800
	Esc. Target + MA	8,500	13,500	**22,000**	38,900	55,800
	LAER	10%	10%	**10%**	10%	10%
	Available ER at Return	0%	0%	**0%**	0%	0%
	Allowable ER	10%	10%	**10%**	10%	10%
	Allowable Harvest	500	800	**1,300**	2,300	3,300
	2020 Performance					
	Projected S (after MA)	2,700	4,200	**6,900**	12,200	17,500
	BY Spawners	8,612	8,612	**8,612**	8,612	8,612
	Proj. S as % BY S	31%	49%	**80%**	142%	203%
	cycle avg S	35,354	35,354	**35,354**	35,354	35,354
	Proj. S as % cycle S	8%	12%	**20%**	35%	49%

Management Unit		Pre-season Forecast Return				
		p10	p25	**p50**	p75	p90
Early Summer (w/o RNT)	*lower ref. pt. (w misc)*	112,800	125,300	**150,300**	188,400	252,400
	upper ref. pt. (w misc)	225,500	250,600	**300,600**	376,700	504,800
	forecast (incl. misc)	72,500	116,400	**217,900**	469,000	1,098,000
	TAM Rule (%)	0%	0%	**31%**	50%	50%
	Escapement Target	72,500	116,400	**150,300**	234,500	549,000
	MA	29,700	52,400	**78,200**	131,300	334,900
	Esc. Target + MA	102,200	168,800	**228,500**	365,800	883,900
	LAER	10%	10%	**10%**	10%	10%
	Available ER at Return	0%	0%	**0%**	22%	19%
	Allowable ER	10%	10%	**10%**	22%	19%
	Allowable Harvest	7,300	11,600	**21,800**	103,200	214,100
	2020 Performance					
	Projected S (after MA)	46,600	72,300	**130,200**	234,500	550,200
	BY Spawners	156,520	156,520	**156,520**	156,520	156,520
	Proj. S as % BY S	30%	46%	**83%**	150%	352%
	cycle avg S	155,761	155,761	**155,761**	155,761	155,761
	Proj. S as % cycle S	30%	46%	**84%**	151%	353%

Table B2, continued on next page

Table B2, continued.

Management Unit		Pre-season Forecast Return				
		p10	p25	**p50**	p75	p90
Summer	*lower ref. pt. (w misc)*	**804,200**	**881,600**	**967,400**	**1,080,700**	**1,199,200**
(w. RNT & Har)	*upper ref. pt. (w misc)*	**1,608,500**	**1,763,100**	**1,934,900**	**2,161,400**	**2,398,500**
	forecast	169,390	311,300	**610,700**	1,231,000	2,376,000
	TAM Rule (%)	0%	0%	**0%**	12%	50%
	Escapement Target	169,390	311,300	**610,700**	1,080,700	1,199,200
	MA	20,300	43,600	**91,600**	172,900	215,900
	Esc. Target + MA	189,690	354,900	**702,300**	1,253,600	1,415,100
	LAER	10%	10%	**10%**	10%	10%
	Available ER at Return	0%	0%	**0%**	0%	40%
	Allowable ER	10%	10%	**10%**	10%	40%
	Allowable Harvest	16,939	31,130	**61,070**	123,100	960,900
	2020 Performance					
	Projected S (after MA)	135,800	246,800	**476,800**	947,400	1,197,100
	BY Spawners	277,805	277,805	**277,805**	277,805	277,805
	Proj. S as % BY S	49%	89%	**172%**	341%	431%
	cycle avg S	653,758	653,758	**653,758**	653,758	653,758
	Proj. S as % cycle S	21%	38%	**73%**	145%	183%

Management Unit		Pre-season Forecast Return				
		p10	p25	**p50**	p75	p90
Late	*lower ref. pt. (w misc)*	349,600	398,000	**418,300**	413,200	400,700
(w/o Har)	*upper ref. pt. (w misc)*	699,300	796,000	**836,600**	826,400	801,400
	forecast	28,180	52,800	**99,000**	189,800	374,000
	TAM Rule (%)	0%	0%	**0%**	0%	0%
	Escapement Target	28,180	52,800	**99,000**	189,800	374,000
	MA	12,700	22,700	**42,600**	81,600	160,800
	Esc. Target + MA	40,880	75,500	**141,600**	271,400	534,800
	LAER	10%	10%	**10%**	20%	20%
	Available ER at Return	0%	0%	**0%**	0%	0%
	Allowable ER	10%	10%	**10%**	20%	20%
	Allowable Harvest	2,818	5,280	**9,900**	37,960	74,800
	2020 Performance					
	Projected S (after MA)	17,600	33,200	**62,400**	105,800	208,300
	BY Spawners	45,091	45,091	**45,091**	45,091	45,091
	Proj. S as % BY S	39%	74%	**138%**	235%	462%
	cycle avg S	435,329	435,329	**435,329**	435,329	435,329
	Proj. S as % cycle S	4%	8%	**14%**	24%	48%
Allowable Harvest (TF, US, CDN)		27,557	48,810	**94,070**	266,560	1,253,100
Total projected spawners		202,700	356,500	**676,300**	1,299,900	1,973,100

APPENDIX C: 2020 FRASER RIVER PANEL MANAGEMENT PLAN PRINCIPLES AND CONSTRAINTS (agreed July 10, 2020)

1. Fisheries and Oceans Canada (DFO) has provided the Panel with run-size forecasts for Fraser River sockeye salmon. It is broadly understood that the sockeye run-size forecasts are uncertain due to high variability in annual salmon productivity (e.g. the number of returning recruits per spawner, the number of returning recruits per out-migrating fry) and observation error in the associated data. The median forecast for the total Fraser sockeye return is 941,000 fish, and there is a one in four chance that the actual number of returning sockeye will be at or below 488,000 fish and there is a one in four chance that the actual number of returning sockeye will be at or larger than 1,913,000 fish. The median forecasts for the four different management groups are 13,000 Early Stuart, 218,000 Early Summer-run, 611,000 Summer-run, and 99,000 Late-run sockeye. Of note, the Chilko and Harrison stock groups represent 45% of the total Fraser sockeye return and 69% of the Summer-run return at the median forecast, further adding to the uncertainty. The median or 50% probability level forecast for Fraser River sockeye salmon was used for pre-season planning purposes. When sufficient information is available in-season, the Panel will update run size estimates of Fraser River sockeye salmon as appropriate.

2. The Panel's first priority is to attain spawning escapement goals by management group. A coordinated approach to management has been developed that reflects both Parties sharing the burden of conservation. As a result of the pre-season planning and with consideration of the current and expected adverse environmental conditions for fish survival and productivity, as well as the extremely low forecast and the lingering impact of the Big Bar landslide, neither Canada nor the US anticipates any available TAC at the median forecast.

3. TAC and international shares are calculated according to the 2020 revised Annex IV, Chapter 4, of the Pacific Salmon Treaty, which limits the United States harvest (in Washington State) to 16.5% of the international TAC of Fraser River sockeye salmon. For 2020, the Fraser River Panel agreed to pre-season Fraser River Aboriginal Exemptions as determined by the process outlined in paragraph 3d for the purposes of computing Fraser River sockeye TAC by management group. The Panel will implement low abundance exploitation rates (LAER) for a management group when the allowable harvest for that group, according to Total Allowable Mortality rules as defined in Canada's escapement plan, is less than the LAER, in order to allow access to available TAC for other co-migrating Fraser River sockeye salmon management groups or other salmon species. At the median forecasts, the LAERs are set at 10% for all management groups. If in-season run sizes increase to the p75 level or higher, the LAER for Late-run sockeye will be increased to 20%. LAER's are not intended to create directed harvest opportunities in mixed stock areas, do not contribute to International TAC's, and represent maximum allowable fishing-related impacts (including test fisheries and release mortalities). Calculated International TAC's that fall below the LAER amount will contribute to the International share.

4. At the median forecast, no directed harvest of sockeye is planned. At forecasted median abundance levels and given current escapement objectives, the Panel anticipates managing all management groups with a LAER approach.

Regulations

i) If in-season abundance and environmental conditions are better than pre-season expectations, low impact fisheries would be expected to commence in mid-July in Panel Waters. The actual start dates and duration of fisheries will depend on in-season estimates of timing, abundance, diversion, and agreed management adjustments.

ii) The Parties' conservation concerns for other species and stocks will be taken into account throughout the 2020 management season.

APPENDIX D: 2020 REGULATIONS

The Fraser River Panel approved regulations for the management of the Fraser River sockeye salmon fishery in Panel Area waters and submitted these to the Pacific Salmon Commission. The Commission approved the Fishery Regime and Regulations and submitted these to the respective national governments for approval on June 12, 2020.

Canadian Fraser River Panel Area

In accordance with Article VI, Paragraph 5 of the Pacific Salmon Treaty, the Commission recommends Canada adopt the following fishing regime developed by the Fraser River Panel, namely:

1. a) No person shall commercially fish for sockeye or pink salmon in Pacific Fishery Management Area 20-1, 3 and 4 with nets from the 28th day of June 2020, to the 5th day of September 2020, both dates inclusive.

   b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 20-1, 3 and 4 from the 28th day of June 2020, to the 5th day of September 2020, both dates inclusive.

2. a) No person shall commercially fish for sockeye or pink salmon in Pacific Fishery Management Areas 17 and 18 with nets from the 28th day of June 2020 to the 3rd day of October 2020, both dates inclusive.

   b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 18-1, 4 and 11 from the 28th day of June 2020, to the 3rd day of October 2020, both dates inclusive.

3. a) No person shall commercially fish for sockeye or pink salmon with nets in Pacific Fishery Management Area 29 from the 28th day of June 2020, to the 10th day of October 2020, both dates inclusive.

   b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 29 from the 28th day of June 2020, to the 10th day of October 2020, both dates inclusive.

4. The following Fraser River Panel Area waters are excluded:

   a) High Seas westerly of the Bonilla Point-Tatoosh Island Lighthouse Line.
   b) Pacific Fishery Management Area 19, Area 20-2 and 5 to 7 and Area 29-8.
   c) Commercial troll fishing in Pacific Fishery Management Area 17, Area 18-2, 3 and 5 to 10.
   d) The Fraser River and the tributary streams and lakes above the train bridge at Mission.

During the 2020 season, the Fraser River Panel will adopt orders establishing open fishing periods based on a 2020 management plan adopted by the Panel. This plan will be designed to achieve Pacific Salmon Treaty-mandated conservation objectives, international allocations of the catch, and domestic goals of the Parties.

United States Fraser River Panel Area

In accordance with Article VI, Paragraph 5 of the Pacific Salmon Treaty, the Commission recommends the United States adopt the following fishing regime developed by the Fraser River Panel, namely:

Treaty Indian Fisheries:

1. No Treaty Indian shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 4B, 5 and 6C with drift gillnets or purse seines from the 28th day of June 2020 to the 5th day of September 2020, both dates inclusive.

2. No Treaty Indian shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 6A, 7 and 7A with nets from the 28th day of June 2020, to the 12th day of September 2020, both dates inclusive.

3. No Treaty Indian shall commercially fish for sockeye or pink salmon with nets in that portion of Puget Sound Salmon Management and Catch Reporting Area 7A lying westerly of a straight line drawn from the low water range marker in Boundary Bay on the International Boundary through the east tip of Point Roberts in the State of Washington to the East Point Light on Saturna Island in the Province of British Columbia from the 13th day of September 2020, to the 3rd day of October 2020, both dates inclusive.

All-Citizen Fisheries:

1. No person shall fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 4B, 5, and 6C with nets from the 28th day of June 2020, to the 5th day of September 2020, both dates inclusive.

2. No person shall fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 6A, 7 and 7A with nets from the 28th day of June 2020, to the 12th day of September 2020, both dates inclusive.

3. No person shall fish for sockeye or pink salmon with nets in that portion of Puget Sound Salmon Management and Catch Reporting Area 7A lying westerly of a straight line drawn from the low water range marker in Boundary Bay on the International Boundary through the east tip of Point Roberts in the State of Washington to the East Point Light on Saturna Island in the Province of British Columbia from the 13th day of September 2020, to the 3rd day of October 2020, both dates inclusive.

The following Fraser River Panel Area waters and fisheries are excluded:

Treaty Indian and All-Citizen Fisheries:

1. High Seas westerly of the Bonilla Point-Tatoosh Island Lighthouse Line.

2. Puget Sound Salmon Management and Catch Reporting Areas 6B, 6D, 7B, 7C, 7D and 7E.

During the 2020 season, the Fraser River Panel will adopt orders establishing open fishing periods based on a 2020 management plan adopted by the Panel. This plan will be designed to achieve Pacific Salmon Treaty-mandated conservation objectives, international allocations of the catch, and domestic goals of the Parties.

APPENDIX E: 2020 FRASER RIVER PANEL IN-SEASON ORDERS

The Fraser River Panel formulates orders to regulate Panel Area fisheries; however, there were no fishery openings in 2020. Typically, these orders provide for adequate escapement of the various stocks of Fraser River sockeye salmon and for the prescribed allocation of catch: (a) internationally, between the United States and Canada and (b) domestically, among the commercial user groups in Canada and the United States.

Fraser River Panel control of Canadian Panel Areas was relinquished in accordance with the pre-season Regulations (Appendix D) as follows: Area 20 on September 5; Areas 17 and 18 on October 5; and Area 29 on October 10. Panel control of United States Panel Areas were relinquished in accordance with the pre-season Regulations as follows; Areas 4B, 5, and 6C on September 5, Areas 6, 6A, 7 and 7A on September 12 and the remaining portions of Area 7A on October 3.

APPENDIX F: PSC STAFF ACTIVITIES: STOCK MONITORING, IDENTIFICATION AND ASSESSMENT, AND MANAGEMENT ADJUSTMENTS

Stock Monitoring

Stock monitoring programs assess the abundance and migration timing of Fraser River sockeye and pink salmon at different points along their migration routes. The Stock Monitoring Group uses test fishery data from marine and freshwater areas, hydroacoustic abundance estimates collected in the Fraser River at Mission, B.C., and visual observations at Hells Gate. In addition to providing estimates of daily and cumulative passage in marine areas and at Mission, stock monitoring analyses provide projections of the number of fish migrating between marine areas and Mission, and estimates of diversion rates through Johnstone Strait. Stock composition information from the Stock Identification Group is used to apportion total estimates to sockeye stocks or stock groups and Fraser and non-Fraser origin pink salmon. This information is required for the development of fishing plans that aid in meeting spawning escapement and catch allocation objectives.

A. Test Fishing

Test fisheries provide much of the data used to assess the migration of Fraser River sockeye and pink salmon, including catch per unit effort (CPUE) to estimate abundance and biological samples used to estimate stock and species composition. Table 2 in the main body of the report summarizes the locations and operational timing of Panel-approved test fisheries. Table F1 summarizes more detailed information about the gear used and sampling methods employed.

Table F1. Sampling details for Panel-approved test fisheries conducted in 2020.

			2020						
Area	Name	Gear	Number of Vessels	Net Length (m)	Net Depth (meshes)	Mesh Size (mm)	Mesh Size (in)	Number of Sets	Set Duration (minutes)
Canadian Panel Areas									
20	Juan de Fuca Str.	Gillnet	2	549	90	130	5 1/8	2	300
20	Juan de Fuca Str.	Purse Seine	1	549	875	95	3 3/4	6	20
29-14	Fraser R. (Cottonwood)	Gillnet	1	220	Variable	Variable		2	20
29-16	Fraser R. (Whonnock)	Gillnet	1	320	Variable	Variable		2	20
Canadian Non-Panel Areas									
12	Queen Charlotte Str. (Round Is.)	Gillnet	1	366	60	130	5 1/8	3	100
12	Johnstone Str. (Blinkhorn)	Purse Seine	1	397	575	95	3 3/4	6	20
	Fraser R. (Qualark)	Gillnet	1	30	Variable	Variable		6	5

Information pertaining to the migration of Fraser River sockeye and pink salmon through marine areas are primarily obtained from the test fisheries in Area 20 (Juan de Fuca Strait) and Area 12 (upper Johnstone Strait), but may be augmented by test fisheries in Area 13 (lower Johnstone Strait), U.S. Area 5 (Juan de Fuca Strait), and U.S. Area 7 (San Juan Islands). Test fisheries in Area 29 (lower Fraser River) are used to assess in-river species and stock composition for application to Mission passage estimates. When the Mission hydroacoustics program is not in operation, test fisheries in Area 29 provide passage estimates for sockeye salmon using CPUE models. The Qualark (Fraser River canyon) gillnet test fishery provides information on salmon species composition for the Qualark hydroacoustics program.

In 2020, the Fraser River Panel tried to minimize the financial costs of Panel-approved test fisheries as well as the impacts on successful escapement of sockeye salmon to spawning grounds within the Fraser River watershed. The Area 4B,5 gillnet, Area 29 gulf troll, Area 12 (Naka Creek)

gillnet, and Area 13 purse seine test fisheries were not scheduled for this year. The Area 7 reefnet test fishery was planned to operate prior to U.S. commercial fisheries, but did not operate due to the lack of fishing opportunities. Half of the cost of the Qualark gillnet test fishery was paid from the bilateral Test Fishing Revolving Fund while the remainder was paid for by Canada. The Area 12 and Area 20 gillnet test fisheries did not begin until July 9 and July 11, respectively. These dates were after most of the Early Stuart sockeye were expected to have migrated past the test fishery locations. The number of Area 20 gillnet test fishing vessels remained at two, with both vessels fishing contemporaneously for safety purposes. The Panel decided to extend both the Area 12 and 20 gillnet test fisheries by four days in-season. Due to the low expected return for Fraser River sockeye, a reduced number of fishing days were scheduled for the Area 12 and Area 20 purse seines. Both purse seine test fisheries were extended by one day in-season.

The Fraser River Panel agreed to end the Cottonwood gillnet test fishery in Area 29 on August 4, 21 days earlier than scheduled, due to extremely low daily sockeye catches. The Whonnock gillnet test fishery in Area 29 also ended two days earlier than scheduled, on September 8, due to declines in daily sockeye catches. To improve worker safety at Hells Gate, counters were scheduled to work together at all times resulting in counts only being performed five days per week, Sunday through to Thursday. To reduce the potential for transmission of Covid-19, observers were not permitted onboard vessels in Area 20 as the duration of fishing each day did not allow them to remain outdoors at all times. Test fishers performed onboard observation duties and observers sampled from the dock. Other precautions, including the administration of personal protective equipment and restriction of public access to the dock, were also taken. Precautions were taken for river test fisheries, such as the administration of personal protective equipment and having the observers remain outside for the duration of test fishing.

Early in the season, marine gillnet daily catches of sockeye in Area 12 and Area 20 were consistently low compared to both brood year catches and the cycle-year average. Later in the season, marine purse seine daily catches of sockeye in Area 20 and Area 12 were also low compared to the brood year and the cycle-year average. Record-low sockeye catches occurred in the Cottonwood test fishery with only 26 sockeye caught over the course of the season. Due to high water levels in the Fraser River, the Whonnock test fishery conducted sets at Glen Valley Bar well into the season. Once water levels decreased, the test fishing vessel performed drifts at Whonnock Channel and supplemental sets were continued at the Glen Valley Bar to obtain additional sockeye samples. Despite these efforts to increase catches, sockeye catches remained low likely due to the high water levels and low abundance of sockeye.

Due to the low total abundance of Fraser River sockeye, the number of salmon retained from all Panel-approved test fisheries was less than expected pre-season. Only sockeye that could not be released alive or those required for scientific samples were retained in the test fisheries. Fish sales were unable to offset program costs. The 2020 program deficit of $427,000 was paid for by the Test Fish Revolving fund. The 2020 season was the second year of a four-year Southern Endowment Fund (SEF) project to evaluate the transition from a multistrand nylon gillnet to a more modern and readily available Alaska Twist gillnet in the Area 12 gillnet test fishery[22]. The experimental program ran for 20 days and was fully-funded by the SEF. The experimental program will continue in 2021 and 2022.

B. Mission Hydroacoustics

A hydroacoustics monitoring facility is operated by PSC staff upstream of the Mission Railway Bridge throughout the summer to provide a daily estimate of sockeye escapement through the lower Fraser River. Since the 2011 season, staff have implemented a stratified sampling

[22] Labelle, M. and Van Will, P. 2021. Comparison of Sockeye Salmon catch and catch rates of two test-fishing gill nets used at Round Island in 2020. SEF Final Report.

method to estimate daily salmon passage using a combination of split-beam and imaging sonars[23, 24]. The sonar systems operate 24 hours a day to collect information on the density, direction of travel, speed, and size distributions of fish targets. In the 2020 monitoring season, daily salmon passage from July 05 – Aug 04 was estimated using a side-looking Adaptive Resolution Imaging Sonar (ARIS) on the left bank of the river, a downward-looking split-beam sonar mounted on a vessel transecting the river, and an ARIS sonar on the right bank of the river. Daily passage from Aug 05- Aug 31 was estimated by adding a left-bank, side-looking split-beam sonar to the above sampling configuration (Figure F1).

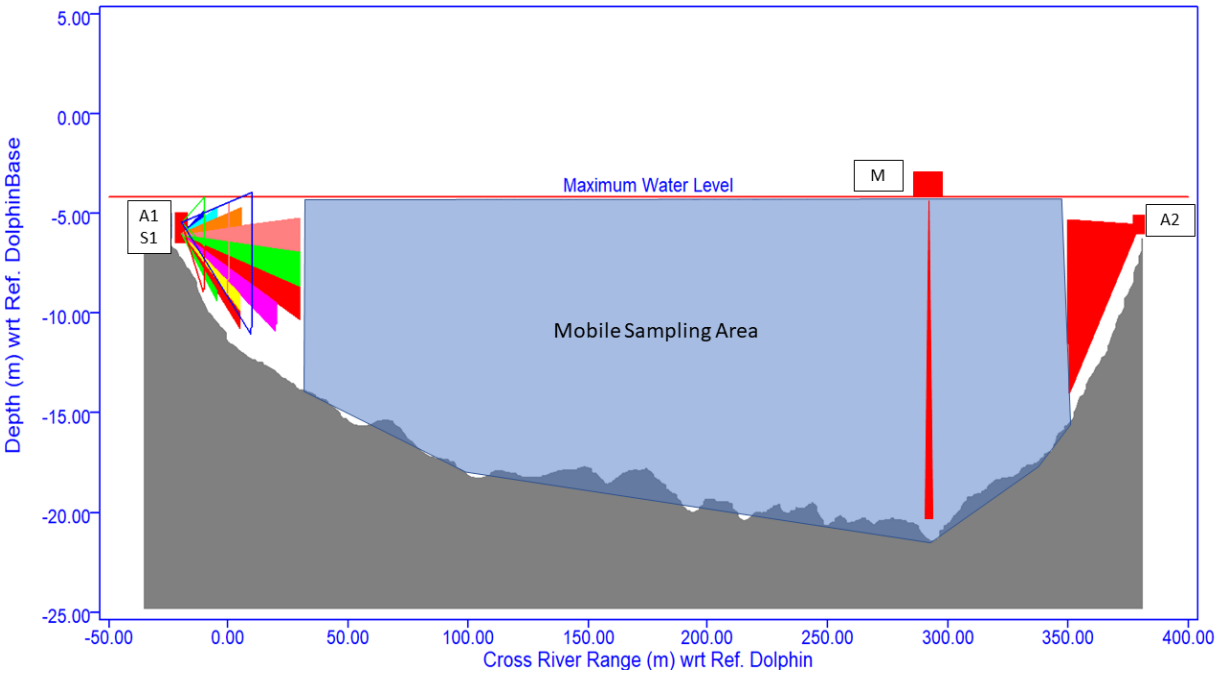

Figure F1. Cross-river view of the sampling geometry of the sonar systems operated at the Mission hydroacoustics site from Aug 05 – Aug 31, 2020. The four systems shown are the left bank split-beam (S1), the left bank ARIS (A1), the mobile split-beam (M), and the right bank ARIS (A2). The beam geometries of left bank ARIS (A1) are represented by the hollow triangles and overlap with the S1 beam geometries which are represented by the filled coloured triangles. The blue filled offshore area represents the cross-river region sampled by the mobile split-beam. The gray filled area represents the river bottom. Note that the cross-river range scale on the x-axis is compressed relative to the vertical depth scale on the y-axis.

The left bank split-beam (S1) consists of a side-looking transducer with an elliptical beam-width of 2°x 10° manufactured by Hydroacoustics Technology Incorporated. The transducer was attached to a SIDUS SS250 rotator to control its pan and tilt, allowing stratified sampling of the water column by the narrow vertical beam. The hourly stratified sampling design consisted of 10 aims of non-overlapping, 2-deg vertical apertures with each aim sampling for 6 minutes each hour up to a range of 50 metres. The aim and orientation of the transducer were monitored and verified using an ImpactSubsea-ISD 4000. The split-beam system was deployed towards the far end of an extendable fish-deflection weir, which prevented fish from swimming behind or too close to the

[23] Xie, Y., A. P. Gray, F. J. Martens, and J. D. Cave. 2007. Development of a shore-based hydroacoustics system on the right bank of the Lower Fraser River to monitor salmon passages: A project report to Southern boundary restoration and enhancement fund. Pacific Salmon Commission, Vancouver, British Columbia. April, 2007.

[24] Xie, Y., F. J. Martens, C. G. Michielsens, J. D. Cave. 2013. Implementation of Stationary Hydroacoustic Sampling Systems to Estimate Salmon Passage in the Lower Fraser River: A final project report to the southern boundary restoration and enhancement fund. Pacific Salmon Commission, Vancouver, British Columbia. May, 2013.

transducer. Due to the abnormally high water in July, the S1 system could not be deployed until August 5 when the system was implemented and started monitoring fish off the left bank. Fish count data from S1 was used for official estimates of daily fish passage between August 5 and August 31.

An ARIS system (A1) was also operated on the left bank. As with the S1 system, the high water and fast flows prevented the deployment of the fish deflection weir; therefore, the A1 system was deployed on an AR2 rotator secured to a tripod on July 1. The rotator allowed the A1 to cycle through multiple vertical aims for full sampling coverage of the water column up to 30m. On July 31, the A1 tripod was moved approximately 15m upstream to accommodate the deployment of the deflection fish weir; the A1 continued to collect data from the upstream location. On August 11 the A1 was moved to the fish deflection weir, adjacent to the S1 transducer. The A1 collected data throughout program operations and was used for official estimates of salmon passage between July 5 to August 4, and August 11 to August 31st. During the first period, the A1 was used to officially estimate salmon passage in the nearshore area between 0 and 30m. During the latter period, the A1 was used to officially estimate salmon passage in the nearshore area between 0 and 10m. The primary reason for using the ARIS during the latter period was due to the very low daily salmon passage (seen in 2020) in the presence of a relatively large number of resident fish in the 0-10m nearshore range area that could not be accurately excluded by the split-beam system while image-based A1 data allowed the user to reject small resident fish. The A1 system was used throughout the program operations to obtain fish counts as well as measurements of fish fork lengths. These lengths were input into a mixture model to estimate the salmon passage and to provide species composition estimates of Chinook and sockeye salmon in the nearshore areas of both banks.

The offshore region of the site was sampled by a vessel-based split-beam system (M) using a downward-looking, 6-deg circular beam transducer manufactured by Biosonics Incorporated. The transducer was towed by the vessel transecting the width of the river to obtain cross-river fish density data in offshore areas. In the early part of the season, debris and high flows prevented the transecting with normal speeds. Transect time increased from a normal time of 5 min to approximately 7-8 minutes per transect, and night transects were eliminated during periods of high debris for safety concerns. The deployment of the on-board imaging sonar DIDSON was also eliminated during stationaries until flows diminished to reduced strain on the DIDSON pole mount. Night transects resumed on July 16 and DIDSON deployment during stationaries resumed on July 27. An average of 97 transects were carried out each day between July 5 and July 15; as flows decreased, an average of 172 transects were carried out each day between July 16 and August 31. Information on the direction of travel and speed of fish targets cannot be readily obtained from a moving transducer, so behavioural statistics observed from the left bank were applied to the vessel-based density data to estimate offshore fish passage[25]. To monitor offshore fish behaviour, the on-board DIDSON was deployed from anchored positions approximately 50 meters offshore from the left or right bank. During these anchored deployments, the DIDSON was aimed towards offshore water with a 20-m sounding range from the vessel. Anchored deployments of the DIDSON were carried out six times per day (three times from each side of the river) for an hour each time. In 2020, a verbal agreement was reached between the PSC, DFO, and Sumas First Nation as part of a Memorandum of Understanding (MOU) related to Food, Social and Ceremonial fishery openings in the Mission area. In adherence to the agreement, the transecting vessel was docked during fishery openings and no data collection occurred offshore. As part of the MOU, alternative Mission passage estimates for fishing days are being explored.

The right bank area was sampled by the ARIS system (A2) deployed at the end of a telescopic fish-deflection weir. The A2 system used a single vertical aim to sample the entire water column up to 30 metres in range from the sonar. High water levels prevented the deployment of the weir

[25] Xie, Y., A. P. Gray, F. J. Martens, J. L. Boffey and J. D. Cave. 2005. Use of dual-frequency identification sonar to verify salmon flux and to examine fish behaviour in the Fraser River. Pacific Salmon Comm. Tech. Rep. No. 16: 58 p. Vancouver, B.C.

with the right-bank site's concrete platform being submerged until late-July. Between July 5 and July 30, salmon passage was estimated by deploying the A2 for a 3-hour period from 1100 – 1400 hours, 3 days a week, from a vessel anchored at the right bank site. The A2 daily passage was extrapolated using the daily A1 passage as a benchmark. This was implemented by calculating the ratio of A2/A1 during the 3-hour A2 monitoring period. The ratio was then applied to the concurrent A1 daily passage to estimate the A2 passage over the entire 24-hour period. On days where no sampling occurred on the right bank, the A2 passage was calculated by applying the most recent A2/A1 ratio to A1 passage from the current day. Fork lengths were measured to estimate proportions of salmon sized passage and assist with species composition. For low-sample size periods as encountered often in early July, a sliding window was used to combine measurements taken during the current and previous 3 collection days to perform the length-based model runs. The length based model proportions from the previous data collection day were applied to interpolated days. On July 31, the fish deflection weir was deployed and the A2 was fully operational until August 31. A2 passage estimate was included in the official estimate from July 5 to August 31.

The data collected by the ARIS systems was manually counted by trained technicians to estimate salmon passage within the sampled areas. Technicians counted the number of fish targets and their direction of travel for a 5-min subset of the data from each hour. These counts were then expanded to estimate the hourly passage of fish in both the upstream and downstream directions. Both ARIS systems deployed at the site can sample up to a range of 40 meters, however, the sampling area was divided into 10-meter range bins and each stratum was counted separately for improved count accuracy. Only range bins from 0-30 meters were included in official estimate for the assurance of data quality in terms of identification of fish images. To remove small, non-salmonid species from the estimates of upstream salmon passage, fork length measurements were taken on a subset of fish in the ARIS data. A normally distributed mixture model with a set of priors from lower-river test fishery catches was then applied to determine the proportion of adult salmon based on length frequencies, and this proportion was applied to the counts to obtain salmon passage estimates.

To determine salmon passage using data collected by the split-beam systems, acoustic echoes were tracked using an alpha-beta tracker[26] and then classified as fish or noise (e.g. debris, air bubbles) by a discriminate function analysis[27]. The integrity of statistically identified fish tracks was further verified by trained staff that reviewed the echogram data with editing software to remove misclassified targets. This data review and editing procedure was performed each day for the data collected from both the left bank and vessel-based split-beam systems to provide information on the density and position of fish targets.

Salmon passage estimates from the left bank split-beam, the vessel-based split-beam, the left bank ARIS and the right bank ARIS were combined to obtain the daily total salmon passage. Overlapping sampling areas between the vessel-based split-beam and the shore-based systems were identified using GPS and passage estimates from the shore-based systems were preferentially adopted. The vessel-based split-beam estimates were excluded where possible because they are the least precise due to lower sampling intensity and prone to negative bias due to avoidance behaviour[28]. On the left bank, passage was estimated by A1 from July 5 to August 4, by S1 from August 5 to August 10, and by a combination of A1 and S1 from August 11 to August 31, using A1 for the first 10m and S1 for 10-50m. Over the entire monitoring period from July 5 to August

[26] Blackman, S. S. and R. Popoli. Design and Analysis of Modern Tracking Systems. Artech House, Boston, 1999.
[27] Xie, Y., C.G.J. Michielsens, and F.J. Martens. 2012. Classification of fish and non-fish acoustic tracks using discriminant function analysis. – ICES Journal of Marine Science, doi:10.1093/icesjms/fsr198.
[28] Xie, Y., C. G. J. Michielsens, A. P. Gray, F. J. Martens, and J. L. Boffey. 2008. Observations of avoidance reactions of migrating salmon to a mobile survey vessel in a riverine environment. Can. J. Fish. Aquat. Sci. 65: 2178-2190.

31, the ARIS and split beam left bank systems saw a combined 67% of total salmon passage, the right bank ARIS observed 17% of passage, and the offshore system observed 16% of passage.

Salmon passage at Mission was estimated using a stratified model. Passage for the shore-based systems was calculated using one of 2 length-based models: unweighted and weighted (by hourly abundances) models. Both models estimate salmon passage by removing the resident size targets from the estimate. Due to low passage numbers, the unweighted model was used from July 5 to August 16, and the weighted model was implemented on August 17 after passage had increased sufficiently (see sub-report "B6f_Length-based model"). The offshore passage was calculated using species proportions from Whonnock gill net test fisheries. Salmon passage estimates were further apportioned among salmon species using information from multiple sources that included daily catch-per-unit effort (CPUE) and species proportions (both uncorrected and catchability corrected estimates[29]) from the Whonnock and Albion gill net test fisheries, modelled forecasts of daily Chinook salmon abundance provided by DFO, and length-based model estimates based on the frequency distributions of fork lengths measured from the ARIS data. Due to very low catches at the Whonnock test fishery, estimates of sockeye species composition from July 5 through August 23 were calculated using total salmon passage estimates minus the daily Chinook passage as calculated by the unweighted length-based mixture model. Due to changes in catch at the Whonnock and Albion test fisheries and passage at Mission, for a period of 3 days from August 24 to August 26, sockeye passage was estimated using total salmon passage estimates minus the daily Chinook passage as calculated by Albion CPUE times the Expansion Line . Finally, from August 27 to September 8, sockeye passage was calculated as the Whonnock CPUE times the Expansion Line.

Stock Identification

A. Sockeye Salmon

Stock identification methods for sockeye salmon relied on DNA[30] (using the program CBAYES[31]) and scale pattern analyses[32]. Both techniques involve comparing the attributes of individuals in mixture samples (e.g., from mixed-stock fisheries) to the attributes of pure samples obtained from the spawning grounds of each of the named stocks (i.e., "standards" or "baselines"). Samples from test fishery catches were analyzed daily, beginning in late June and continuing to early September. Due to COVID-19, shipping services in 2020 remained reduced compared to normal, causing Area 20 and Whonnock genetic stock identification data to be one day less up to date than in other years. Interim results for the missing day of data were provided using scale pattern analyses or through model projections. DFO provided samples from test fisheries in Johnstone Strait and from in-river test fisheries at Albion and Qualark. Alaska's Department of Fish and Game collected samples for the PSC from District 104 purse seine landings in Ketchikan and Petersburg. Because there were no sockeye-directed fishery openings in 2020 (due to low abundance and impacts of the Big Bar slide), no samples were available from Canadian commercial fisheries and Food, Social, and Ceremonial (FSC) fisheries in 2020. For over a

[29] Walters, C. 2015, Comparison of Mission and Qualark hydroacoustic facilities for providing escapement information for management of Fraser River sockeye and pink fisheries. October 10, 2015 a Review Report to Fraser Strategic Review Committee.
[30] Beacham, T.D., M. Lapointe, J.R. Candy, B. McIntosh, C. MacConnachie, A. Tabata, K. Kaukinen, L. Deng, K.M. Miller and R.E. Withler. 2004. Stock identification of Fraser River sockeye salmon using microsatellites and major histocompatibility complex variation. Trans. Am. Fish. Soc. 133: 1117-1137.
[31] Neaves, P.I., C.G. Wallace, J.R. Candy, and T.D. Beacham. 2005. CBAYES: Computer program for mixed stock analysis of allelic data, v5.01. Department of Fisheries and Oceans (Canada). Available: http://www.pac.dfo-mpo.gc.ca/science/facilities-installations/pbs-sbp/mgl-lgm/apps/index-eng.htm (January 2012).
[32] Gable, J. and S. Cox-Rogers. 1993. Stock identification of Fraser River sockeye salmon: methodology and management application. PSC Tech. Rep. No. 5.

decade, Langara Fishing Adventures has provided samples from recreational catches near Haida Gwaii, but COVID-19 precluded these opportunistic samples.

Each year during the management season, DNA estimates, scale measurements (including age), sex, and length information are collected from Fraser Panel test fisheries and other local fisheries, and these are compiled at the individual level to assist interpretations and assess possible sampling issues. Table F2 summarizes the age composition (based on scale readings by PSC Staff) of sockeye catches compared to the pre-season forecast. Sample sizes were insufficient for several stocks due to low sockeye returns and poor catches. The age-four forecast for returning Early Stuart sockeye was similar to the frequency of age-four fish in test fishery samples. Test fishery samples of Early Summer-run sockeye were predominantly age-four fish, and age-4 proportions surpassed the forecast. Of note, a much higher proportion of age-five fish were forecast for Pitt than was observed in test fishery samples. The forecast for the Summer-run predicted a higher proportion of age-four sockeye than was observed. A significant deviation from the forecast was observed for Chilko sockeye; the estimate from fishery samples was only 41% age-four fish compared to a forecast of 95%. Fishery samples of Late-run sockeye consisted predominantly of age-four fish and, overall, this was similar to the forecast proportion.

Table F2: Summary of the 2020 forecast and in-season age composition estimates of sockeye sampled from purse seine and in-river test fisheries. Scale-based ages of individuals with probabilities of origin greater than 50% (determined via genetic stock identification) to a stock aggregate are included here. Inconsistencies between this table and the forecast table (Table B1, resulted in a post-season revision of the 2020 forecast to a total median forecast of 924,000 sockeye[21].

Sockeye stock/timing group	2020 Fraser Sockeye Forecasts			2020 In-season	
	Median Age-4 Forecast	Total Median Forecast	% Age-4	Sample size	% Age-4
Early Stuart	**12,500**	**13,000**	**96%**	**30**	**90%**
Early Summer	**170920**	**217,900**	**78%**	**311**	**90%**
Chilliwack	55,300	57,000	97%	64	98%
Pitt	15,000	41,000	37%	29	66%
Nadina	71,920	72,000	100%	77	97%
Bowron	300	2,000	15%	8	100%
Nahatlatch	5,000	8,000	63%	9	78%
Gates	12,000	15,000	80%	84	92%
Taseko	600	900	67%	11	18%
North Barriere	6,000	8,000	75%	11	100%
Early S. Thompson	4800	14,000	34%	18	94%
Summer	**539,600**	**610,700**	**88%**	**1107**	**66%**
Harrison	138,000	168,000	82%	217	87%
Widgeon	500	700	71%	0	NA
Late Stuart/Stellako	126,800	128,000	99%	409	81%
Chilko	243,000	256,000	95%	426	41%
Quesnel	1,100	2,000	55%	5	40%
Raft/North Thompson	30,200	56,000	54%	50	74%
Late	**67,770**	**99,000**	**68%**	**80**	**81%**
Birkenhead	56,000	68,000	82%	56	86%
Misc. Lillooet-Harrison	10,000	28,000	36%	2	0%
Late Shuswap/Portage	470	1000	47%	3	100%
Weaver	600	1,000	60%	15	67%
Cultus	700	1,000	70%	4	100%
Total	**915,000**	**1,067,000**	**86%**	**1,528**	**70%**

Catches in District 104 totaled 144,000 sockeye. Extracted DNA of fish putatively originating from southern stocks (as determined by examination of Single Nucleotide Polymorphisms[33] by the US National Oceanic and Atmospheric Administration laboratory in Auke Bay, Alaska) was obtained and analyzed with methods consistent with other DNA results reported here and to the Fraser Panel. The preliminary catch of Fraser River sockeye in Alaska was estimated to be 9,300, which was 6% of the sockeye catch in District 104 and approximately 3% of the accounted Fraser River return in-season. The primary Fraser sockeye stocks caught in Alaska were Chilko, Late Stuart/Stellako, and Gates. Stock proportions differed from the relative abundance of stocks returning to the Fraser Panel Area. For example, 65% of the Fraser sockeye caught in Alaska were estimated to be from Chilko Lake versus 24% during in-season accounting, and Harrison sockeye were estimated to not contribute to the Fraser sockeye catch in Alaska but were the second most frequent Fraser stock during in-season estimation (20% of the accounted Fraser return in-season). The age-4 proportion of Chilko sockeye caught in Alaska was 44%, which was similar to the age-4 proportion of Chilko fish observed returning to the Fraser River (Table F2). Sample sizes of matching stock and age were too small in Alaska to permit useful comparisons for other Fraser stocks in 2020.

Other than accounting for return-by-age as usual for Fraser River sockeye stocks, work continued on methods for using stock compositions to predict run size. The Smolt Method for Updating Run Figures[34] (called SMURFing) was applied in 2020 to provide an independent estimate of the Summer-run return. Ratios of Summer-run stocks (excluding Harrison and Widgeon populations) to the earliest Early Summer-run stocks (Chilliwack, Nadina, and Bowron) were examined among samples of outmigrant juveniles collected in the lower Fraser River[35], and Georgia and Johnstone straits[36,8] in 2018. Unlike early and late Shuswap stocks, for which SMURFing is considered relatively robust due to similarity among the juveniles, the early stocks and later stocks scrutinized for the 2020 return rear in different lakes and differ in size, timing, and possibly other characteristics that could affect their ratios in samples of the outmigration. Furthermore, these differences could cause knock-on effects regarding age at maturity and survival to maturity. The SMURF technique assumes age at maturity and marine survival to be equal (or similar, at least) for early-returning and late-returning stocks, such that the ratio among juveniles is the same as the ratio among the returning adults. (Note that results may be quite robust to violations of these assumptions.) In contrast to SMURFing for Shuswap stocks on the 2018 cycle, age compositions are more complex on the 2020 cycle, and the ratio is only applied to age 4_2 sockeye returns (returns of other ages are updated based on age compositions observed among returning adults).

The average ratio of non-Harrison Summer-run stocks to Chilliwack, Nadina, and Bowron stocks across all the outmigrant juvenile programs in 2018 was 4.15:1, which was applied to the age 4_2 in-season run size estimate of the earlier stocks to generate an estimate of age 4_2 Summer-run return. This estimate was independent of the reconstruction-based run size estimate. The first

[33] Guthrie III, C.M., Nguyen, H. and J.R. Guyon. Northern Boundary Area Sockeye Salmon Genetic Stock Identification For Year 2015 District 101 Gillnet and District 104 Purse Seine Fisheries. A project report to Northern boundary restoration and enhancement fund. Pacific Salmon Commission, Vancouver, British Columbia. April 10, 2017.

[34] Latham, S., C. Michielsens, C. Wallace, T. Whitehouse, J. Tadey, C. Neville, M. Trudel. (2015, May 17). Stock identification of Fraser sockeye smolt samples provides marine fisheries managers with more timely and accurate estimates of adult run size. North Pacific Anadromous Fish Commission. Retrieved from https://npafc.org/wp-content/uploads/Poster-42-Latham-et-al.pdf.

[35] Mahoney, J.E., Tadey, J.A., Whitehouse, T.R., Neville, C., and Kalyn, S.M. 2013. Evaluation of Timing, Size, Abundance and Stock Composition of Downstream Migrating Juvenile Sockeye Salmon in the Lower Fraser River – A Report to the Pacific Salmon Commission. Fisheries and Oceans Canada, Delta, BC. 2013.

[36] Neville, C., Trudel, M., Beamish, R.J., Johnson, S.C. 2013. The Early Marine Distribution of Juvenile Sockeye Salmon Produced from the Extreme Low Return in 2009 and the Extreme High Return in 2010. North Pacific Anadromous Fish Commission, Technical Report No. 9: 65-68.

[8] Hakai Institute, Juvenile Salmon Program, see https://goose.hakai.org/shiny/JSP/

in-season SMURFing estimate for the non-Harrison Summer run was reported to the Panel on July 31. At that time, the estimate of the combined Chilliwack, Nadina, and Bowron return was approximately 41,500 age 4_2 sockeye. Applying the ratio yielded 172,000 age 4_2 Summer-run sockeye. With 63% of the Summer run being estimated to be age 4_2, the total run size for non-Harrison Summer-run sockeye was 275,000 (80% PI: 230,000 – 331,000). On August 4, the estimate of early stock 4_2 sockeye was 37,000, leading to an estimate of 154,000 age 4_2 Summer-run sockeye, and 251,000 total non-Harrison Summer-run sockeye (80% PI: 217,000 – 291,000). Because the assessments of the return of the early stocks and the relevant age compositions were quite steady between the two dates, the SMURFing estimates were also quite similar.

The final in-season ratio of non-Harrison Summer-run to Chilliwack, Nadina, and Bowron 4_2 sockeye was only 1.72:1. The final in-season estimate of non-Harrison Summer-run sockeye was 128,000, considerably less than even the 20th percentile of the predictions generated by SMURFing and reported to the Panel. Putting this into perspective, the pre-season forecast of the non-Harrison Summer run was 442,000, so the update based on stock composition ratios among smolts may have been useful. Still, it is troubling that the final estimate was so far outside the prediction interval. Sample sizes for outmigrating juveniles were relatively small in 2018 ($n = 639$ for the relevant stocks), with significant differences in the stock compositions (and SMURFing ratios) estimated from samples collected in various programs ($p < 0.01$). The quality of the SMURFing estimate may have been diminished by severe dissimilarities among the stocks being compared, or by unrepresentative sampling of the outmigrating juveniles in time and space as described to the Fraser River Technical Committee on July 30.

Finally, stock composition observations contributed to the Fraser Panel's understanding of unusual migration patterns in 2020. Based on previous years' experience, sockeye migration time between Mission and Qualark is generally assumed to be between two and three days. Stock proportions can be compared between the two locations by removing stocks in Mission estimates that do not migrate past Qualark, and these projections are often similar to observations at Qualark two to three days later (see Fraser River Panel Annual Report 2012, for example). A similar approach was used to align Mission and Qualark projections to observations at Lillooet. In 2020, stock proportion trends at Qualark and Lillooet appeared relatively delayed (Figure F2). Early in the season, Fraser River discharge and velocity were anomalously high (see section IV. Management Information), and fish were observed to have difficulty swimming upstream at the Mission Hydroacoustics sonar site (Fraser River Panel presentation, January 2021). Such unusually high discharge levels likely contributed to slower migration speeds as the sockeye travelled from Mission to Qualark and Lillooet. Sample sizes were also low in 2020, increasing uncertainty in stock composition estimates, but the apparent delay is consistent with (or slightly greater than) the effect on travel time based on hydroacoustic abundances.

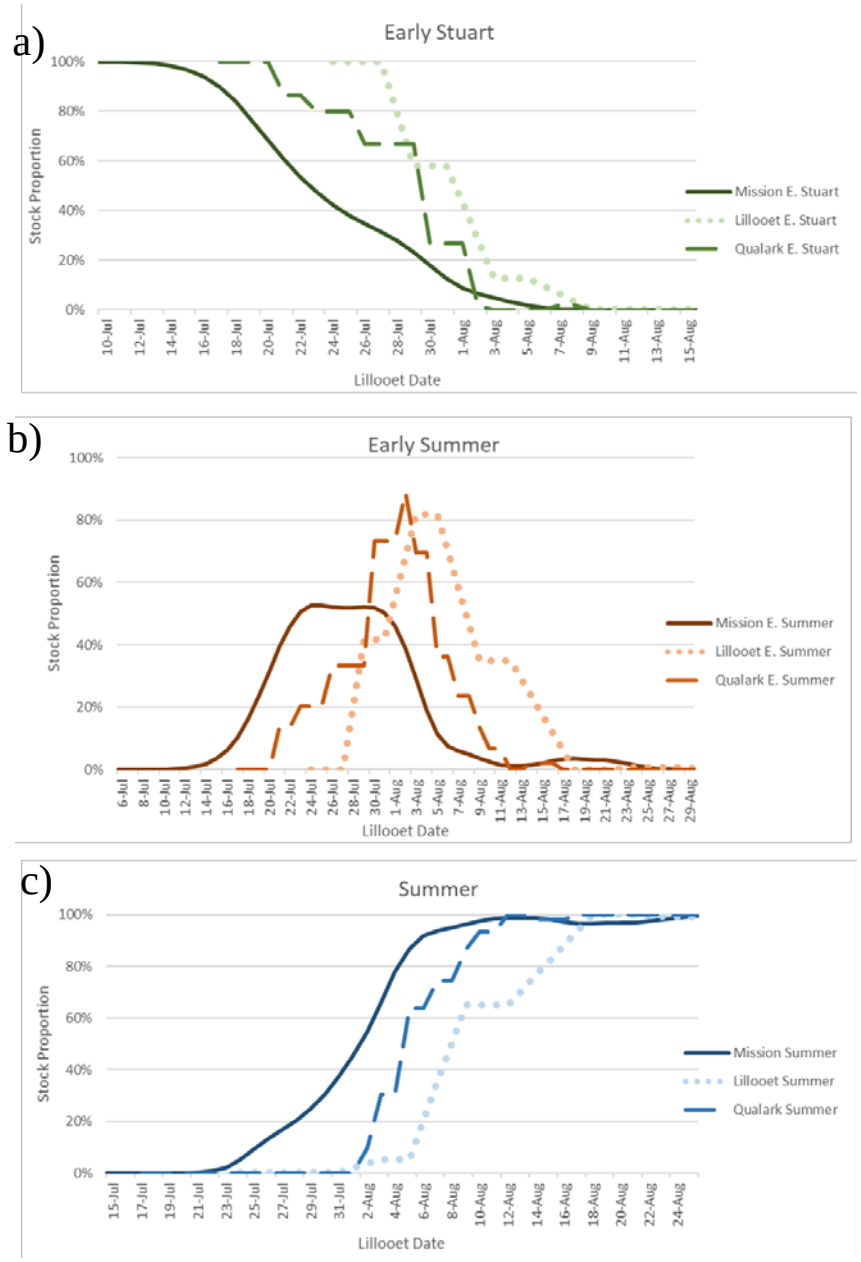

Figure F2. Estimated stock proportions at Mission, Qualark, and Lillooet, aligned to "Lillooet date" by historical sockeye travel times among the locations (i.e., 3 days for Mission to Qualark, and 6 days for Qualark to Lillooet). The estimates for a) Early Stuart, b) Early Summer, and c) Summer-run management groups represent expectations only for those stocks that migrate upstream of each site (proportions for stocks that spawn in downstream locations were subtracted to allow the locations to be compared). This figure shows that stock compositions were observed in Qualark samples later than expected. That is, the dashed lines representing Qualark follow a similar shape to the projected Mission proportions at Qualark but are shifted to the right (delayed); this delayed arrival was also apparent at Lillooet.

Stock Assessment

Assessment of Fraser River sockeye abundance by stock group is primarily based on catch, effort, escapement and stock composition data. Since there were no commercial fisheries in 2020, stock assessment methods to estimate run size relied solely on catch and catch per unit effort (CPUE) data from test fishing vessels in addition to reconstructed marine daily abundance estimates derived from in-river hydro-acoustic data. The CPUE data was converted into daily abundance estimates using a catchability estimate derived using a hierarchical analysis of historical data (Area 12 purse seine catchability: 5.6×10^{-3}, Area 20 purse seine catchability: 2.5×10^{-3}). The marine abundance estimates derived from in-river hydro-acoustic data and marine test fishery data were analysed using Bayesian stock assessment models[37]. These models compare the reconstructed daily migration pattern to ideal run-timing curves, assuming the run is normally distributed. By assuming the run follows this idealized pattern, the run size can be estimated once the 50% migration date (i.e., the date 50% of the run has migrated past the reference location, which corresponds to the peak of the normal distribution) has been identified, by doubling the abundance up to that date. Prior to observing the peak of the run, there is considerable uncertainty about the run size. Based on initial observations before the peak of the run, the estimates can indicate the run to be earlier and smaller than forecast, or later and larger than forecast.

The uncertainty about the actual size of the run is estimated using Bayesian methodology. The Bayesian version of the cumulative normal model relies on additional information (pre-season forecasts of run size based on historic stock-recruit data and timing based on sea-surface temperature (SST) and eastward current speed index in the Gulf of Alaska, expected duration of the run, average historical expansion line estimates and pre-season forecasts of diversion rate based on SST) to reduce the uncertainty and keep the run size estimates within realistic bounds. Naïve forecasts of timing and diversion informed the priors in 2020 due to data shortfalls as a result of the Covid-19 pandemic. This prior information is incorporated within the Bayesian model through the use of prior probability distributions (priors). These priors indicate a range of values that are assumed plausible for the various model parameters and depending on the shape of the prior probability distribution indicate which parameter values are assumed more plausible than others. Theoretically the Bayesian version of the cumulative normal model should provide more stable estimates since it relies on both in-season data as well as historical data. Retrospective analyses have confirmed that incorporating prior knowledge is especially advantageous before the 50% migration date is known. Bayesian stock assessment models are especially useful around the 50% migration date of the run as well as immediately after. After this period, when the run size will depend on the remainder of the run still to come, the run size can be estimated by adding the Bayesian estimate of the tail of the normal distribution to the accounted run-to-date.

Figures F3 a, b, c, and d provide an overview of the run size estimates from the stock assessment model and the accounted run size at various dates during the season (median and 80% probability interval). These estimates can be compared against the Panel adopted in-season run size estimates used for management purposes and against the final in-season estimates of the accounted run-to-date. In 2020, pre-season forecasts overestimated the run size for all management groups except Early Stuart sockeye. The timing of the sockeye run was earlier than expected for all management groups except Early Stuart sockeye.

[37] Michielsens, C.G.J. and Cave, J.D. 2019. In-season assessment and management of salmon stocks using a Bayesian time-density model. Can. J. Fish. Aquat. Sci. 76: 1073-1085.

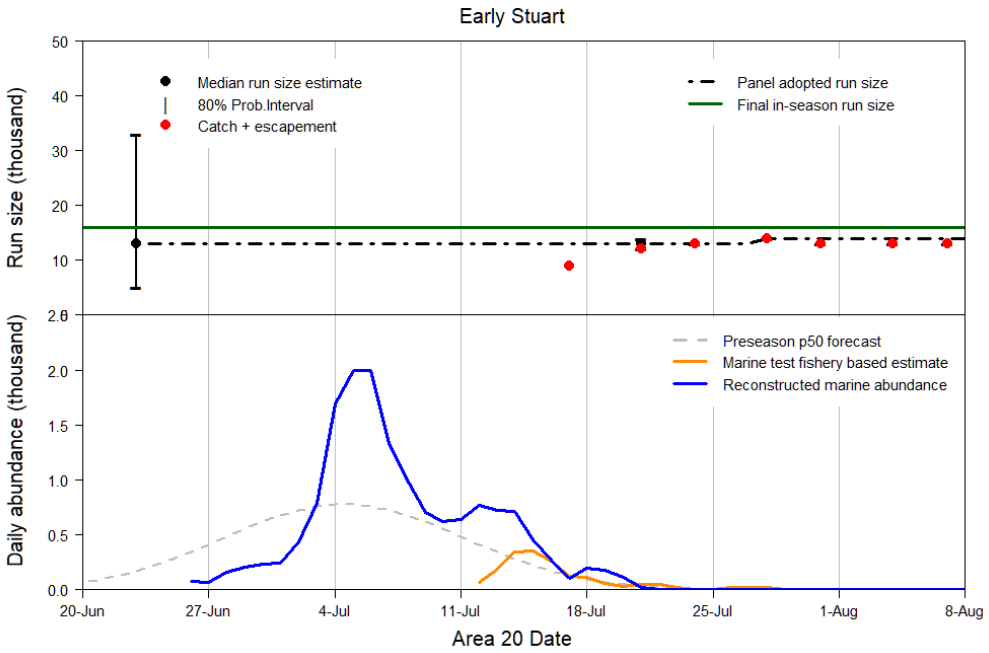

Figure F3a: Daily reconstructed abundance estimates for Early Stuart and corresponding run size estimates at different times during the season.

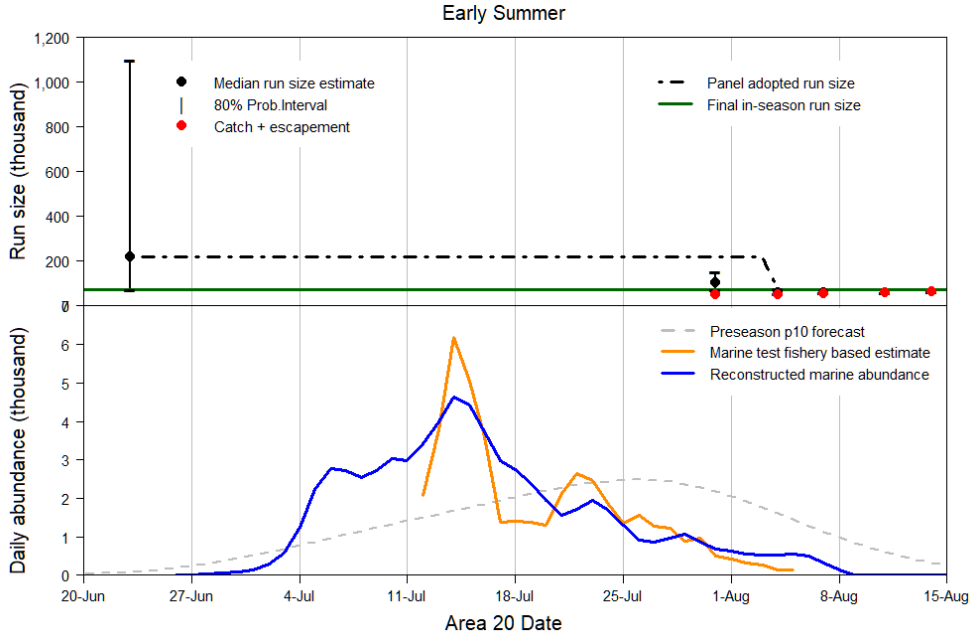

Figure F3b: Daily reconstructed abundance estimates for Early Summer-run salmon and corresponding run size estimates at different times during the season.

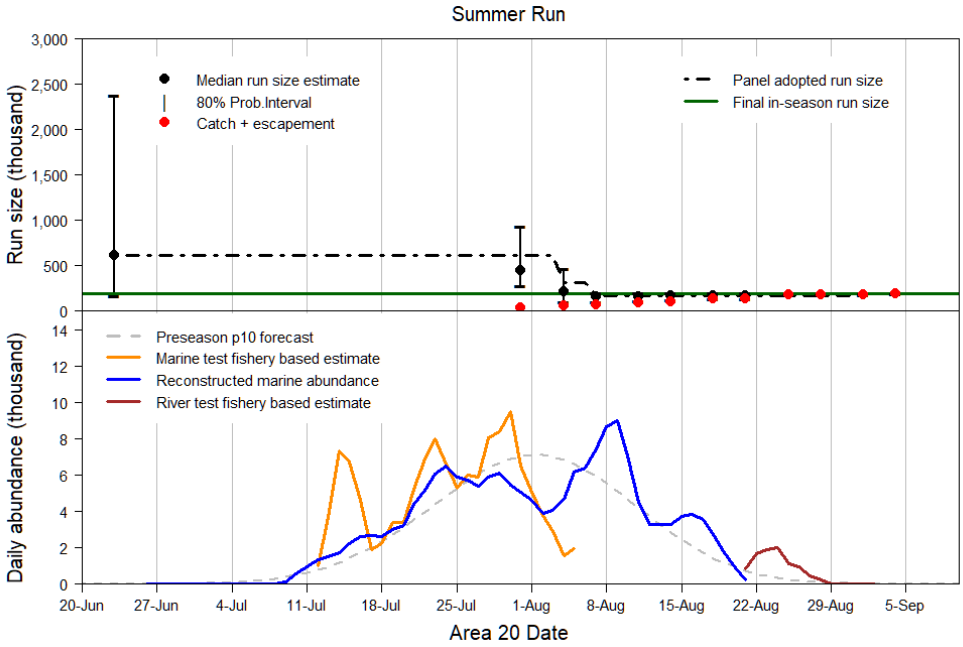

Figure F3c: Daily reconstructed abundance estimates for Summer-run salmon and corresponding run size estimates at different times during the season.

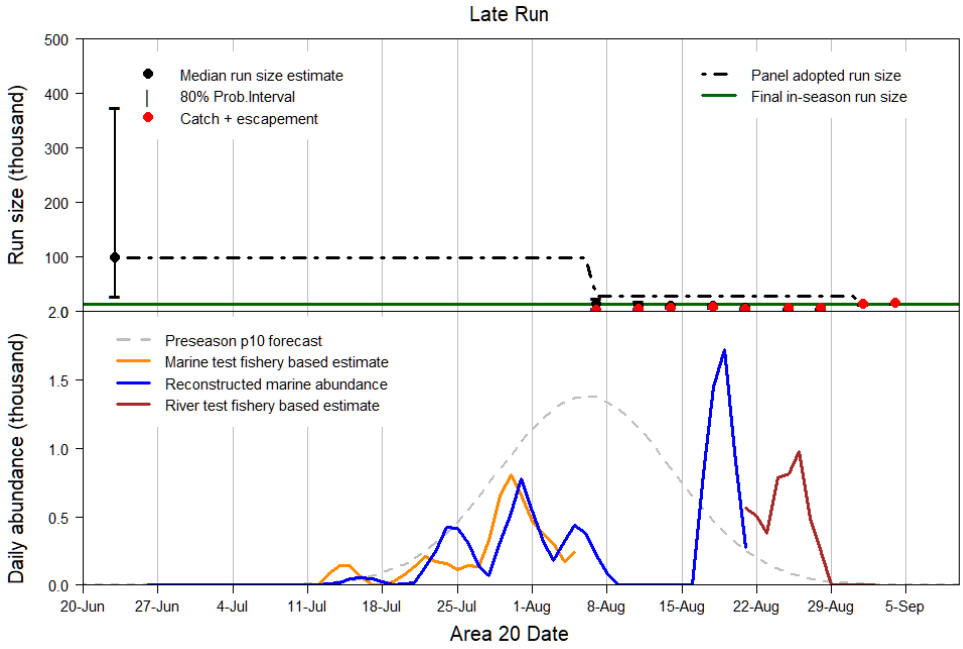

Figure F3d: Daily reconstructed abundance estimates for Late-run salmon and corresponding run size estimates at different times during the season.

Management Adjustment and DBE

For pre-season planning, the Environmental Watch program at Fisheries and Oceans Canada presented a long-range forecast of Fraser River environmental conditions. The Fraser River basin watershed snow basin index was 116% of normal in early spring (April 1, BC Fraser Basin Snow Water Index). Due to limited snowpack melt at higher elevations with several storms in May, the overall snow basin index was 90% of normal in June. The long-range forecast was for above average to average discharge and average to above average water temperature in the Fraser River. Staff used the environmental forecasts in Management Adjustment (MA) models developed jointly by DFO and the PSC to predict how many additional sockeye should be allowed to escape to increase the probability of achieving spawning escapement objectives (see references in the MA section of the Management Information section).

For pre-season planning purposes Management Adjustments (MAs) 9,000 Early Stuart, 78,200 Early Summer, 97,800 Summer and 40,600 Late-run sockeye were added to the spawning escapement targets (SET). However, the SET was already the entire run size for Early Stuart, Summer and Late-run sockeye. At pre-season forecast of abundances all four management groups would be in a low abundance exploitation rate situation. Since MAs would not impact fishery management decisions, no MAs were adopted for pre-season planning purposes only.

In-season predictions from environmental MA model estimates (Table F3) were presented to the Panel for Early Stuart, Early Summer and Summer run. For Early Stuart and Early Summer run sockeye the Panel was also presented a pDBE estimate that included the impact of the Big Bar Slide on those stocks that spawn above the slide. Fraser River discharge remained well above the historical average for the duration of the season while river temperatures remained below average until August. River temperature peaked at 18.8°C on August 5 and dropped again to well below average in the second week of August. Although river temperature did increase again, river temperature continued to be moderated by higher than average river discharge due to continued rain events (Figure 7). Observed discharge exceeded the discharge threshold of 8,000 cms for Early Stuart run[38] and the 6,500 cms discharge threshold for Early Summer run[39] during their 31-day migration period centered on the 50% Hells Gate date (Figure 7). In-season MA models predicted substantially higher (more negative) pDBEs for the Early Stuart and Early Summer run sockeye. For Late-run sockeye the final in-season Mission 50% Date based on Mission passage was August 25. Based on the predicted pDBE (Table F3) from the run-timing model, the early observed Mission timing for the Late run would greatly impact their survival. Additionally, the high discharge levels impacted successful passage at the Hells Gate and the Big Bar Slide site. Despite remediation work to improve fish past the slide, the high observed discharge levels in the Fraser River once again blocked passage at the slide early in the season. As flows decreased towards the end of July, sockeye were finally observed migrating in the fish ladder. Early Stuart and early timed Early Summer-run sockeye migration were impacted while migration conditions had improved for the later timed Early Summer-run and Summer-run sockeye. The repercussions of the Big Bar slide on sockeye passage were not accounted for by the MA models. Instead, the DBE due to the Big Bar slide was in addition to the regular DBE.

[1] Macdonald, J.S., Patterson, D.A., Hague, M.J., Guthrie, I.C. 2010 Modeling the influence of environmental factors on spawning migration mortality for sockeye salmon fisheries management in the Fraser River, B.C. Transactions of the American Fisheries Society 139:3.

[39] Macdonald, J.S., Foreman, M.G.G., Farrell, T., Williams, I.V., Grout, J., Cass, A., Woodey, J.C., Enzenhofer, H., Clarke, W.C., Houtman, R., Donaldson, E.M. and Barnes, D. 2000. The influence of extreme water temperatures on migrating Fraser River sockeye salmon (Oncorhynchus nerka) during the 1998 spawning season. Canadian Technical Report of Fisheries and Aquatic Sciences 2326.

Table F3: Pre-season and in-season MA models and assumptions used for each Fraser sockeye management group in 2020. In-season timing refers to the final updated date for each group. Details regarding assumptions for pre-season timing can be found in the pre-season planning section (under Panel Management activities) of the report.

Description	Early Stuart[1]		Early Summer Aggregate[2]		Summer Aggregate[3]		Lates Aggregate[4]	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Pre-season 31-day MA Model %DBE Predictions	-96%	24.00	-44%	0.79	-18%	0.22	NA	NA
In-season 19-day MA Model %DBE Predictions	-98%	49.00	-54%	1.17	-10%	0.11	NA	NA
Post-season 31-day MA Model %DBE Predictions	-98%	49.00	-53%	1.13	-9%	0.10	NA	NA
In-season run-timing Model Predictions	NA	NA	NA	NA	NA	NA	-84%	5.20

1 %DBE predictions include an estimate of the impact of Big Bar.
2 %DBE predictions are the weighted average of the MA model prediction for Early Summer run excluding Chilliwack and Pitt and the %DBE estimate for Chilliwack and Pitt. The %DBE prediction also includes an estimate of the impact of Big Bar on those stocks that spawn above the slide.
3 %DBE predicitons are the weighted average of the MA model prediction for Summer run excluding Harrison and the %DBE estimate for Harrison.
4 The %DBE prediction is the weighted average of the run timing model (using a Mission 50% date of Sept. 17th) prediction for Late run excluding Birkenhead/Big Silver and the %DBE estimate for Birkenhead/Big Silver.

Spawning ground estimates of Fraser sockeye abundance totalled 272,800 sockeye, which means a total post-season %DBE of (-25%) was observed in 2020 (Table 9). None of the sockeye management groups achieved their post-season spawning escapement targets (SETs). Poor escapement in 2020 was due to low returns and in the case of Early Stuart sockeye, the Big Bar Landslide.

See Table F4 for a detailed summary of the Management Adjustment approaches by stock group.

Table F4: DBEs and pMAs adopted pre-season and in-season to generate weighted pMA values for Early Summer, Summer and Late-run groups.

Management Group	Pre-season Predictor Variables	In-season Predictor Variables	Cycle lines Used	Excluded Years
Early Stuart	Historical Median	19-day temp and discharge[1]	All	1977, 1980, 1982, 1984, 1986, 2006, 2012, 2015, 2016, 2017, 2018,2019
Early Summer run w/o Chilliwack and Pitt	Historical Median	19-day temp and discharge[1]	Dominant and Subdominant Cycle (2018 & 2019)	1993, 2006,2019
Chilliwack	Historical Dom/Subdom Cycle Median	Historical Dom/Subdom Cycle Median	2016 & 2017	years with DNA n<30 fish identified as Chilliwack
Pitt	Historical Median, using inseason data for 1998, 2000-2004	Historical Median, using inseason data for 1998, 2000-2004	All	1982, 1983, 1999, 2005, 2006
Summer run w/o Harrison	Historical Median	19-day temp and discharge[1]	All	2002, 2006,2019
Harrison	Historical Median 2004-2019	Historical Median 2004-2019	All	2006
Late run w/o Birkenhead	Historical 2020 Cycle Line Median since 1996	NA	2020 Cycle	NA
Birkenhead	Median of all years	Median of all years	All	1979, 2002, 2006

[1] $\ln(DBE) = a + b_1T + b_2T^2 + b_3Q + b_4Q^2$ where T = 19-day (3-days before and 15-days after the Hells Gate 50% date) temperature and Q = 19-day (3-days before and 15-days after the Hells Gate 50% date) discharge.

[2] $\ln(DBE) = a + bR$ where R is Mission timinig

APPENDIX G: HISTORICAL CATCH, ESCAPEMENT AND PRODUCTION DATA

Table G 1. Catch by user group, spawning escapement, difference between estimates and run size of Fraser River sockeye salmon for cycle years 2008-2020.

	Fraser Sockeye Salmon			
	2008	2012	2016	2020
CANADIAN CATCH	**481,100**	**510,300**	**149,200**	**11,400**
Commercial Catch	**16,200**	**0**	**0**	**0**
Panel Area	11,600	0	0	0
Non-Panel Areas	4,640	0	0	0
First Nations Catch	**447,300**	**508,100**	**148,400**	**0**
Marine FSC	31,900	53,200	32,300	0
Fraser River FSC	415,400	454,900	116,100	0
Economic Opportunity	0	0	0	0
Non-commercial Catch	**17,600**	**2,250**	**820**	**70**
Marine Recreational	120	0	0	20
Fraser Recreational	16,400	0	0	0
Charter	1,170	2,250	820	50
ESSR	0	0	0	0
Unsanctioned Catch*	**0**	**0**	**0**	**11,290**
UNITED STATES CATCH	**51,000**	**118,100**	**37,100**	**9,270**
Washington Total	**49,400**	**111,300**	**1,670**	**0**
Commercial catch	**48,000**	**105,200**	**830**	**0**
Treaty Indian	39,000	72,800	830	0
Non-Indian	8,970	32,300	0	0
Non-commercial Catch	**1,430**	**6,140**	**840**	**0**
Ceremonial	1,430	6,140	840	0
Recreational	0	0	0	0
Alaska	**1,550**	**6,780**	**35,400**	**9,270**
TEST FISHING CATCH	**41,300**	**33,900**	**8,840**	**4,610**
PSC (Panel Areas)	**36,200**	**26,200**	**6,400**	**2,690**
Canada	26,900	17,000	6,400	2,690
United States	9,310	9,180	0	0
Canada (non-Panel Areas)	**5,080**	**7,680**	**2,440**	**1,920**
TOTAL RUN	**1,741,100**	**2,219,200**	**893,700**	**365,300**
Total Catch in All Fisheries	573,400	662,300	195,200	25,300
Adult Spawning Escapement	815,600	920,400	484,500	274,000
Jack Spawning Escapement	1,550	4,330	2,350	1,450
Difference between estimates	350,500	632,100	211,700	64,600
Percentage of Total Run	**100%**	**100%**	**100%**	**100%**
Total Catch in All Fisheries	33%	30%	22%	7%
Adult Spawning Escapement	47%	41%	54%	75%
Jack Spawning Escapement	0%	0%	0%	0%
Difference between estimates	20%	28%	24%	18%

* Largely resulting from unsanctioned food fisheries by two communities in the mid-river area, with small amounts from other food fisheries and recreational fisheries that were directed at other species in 2020

Table G 2. Escapements of sockeye salmon to Fraser River spawning areas for cycle years 2008-2020*

DISTRICT / Stock Group / Stream/Lake	Year 2008	2012	2016	2020	
NORTHEAST					
Upper Bowron R.	1,005	59	143	388	
STUART					
Early Stuart					
Driftwood R.	683	234	38	0	
Takla L. Streams	5,476	4,218	1,203	2	
Middle R. Streams	17,330	18,020	6,060	22	
Trembleur L. Streams	6,378	3,758	1,269	6	
Miscellaneous	0	0	38	365	
Late Stuart					
Kazchek Cr.	194	241	43	11	
Kuzkwa Cr.	7,268	5,630	1,147	1,339	
Middle R.	5,616	13,147	2,071	891	
Tachie R.	122,929	68,557	5,197	1,776	
Miscellaneous	10,562	5,544	949	0	
NECHAKO					
Nadina R. (Late)	32,724	22,840	16,671	13,438	
Nadina Channel	33,251	8,102	9,961	15,907	
Stellako R.	159,737	137,992	30,119	44,371	
QUESNEL					
Horsefly R.	5,324	536	519	703	
Horsefly Channel	0	0	0	0	
McKinley Cr.	77	0	0	0	
Mitchell R.	1,564	58	264	58	
Miscellaneous	126	11	132	1,011	
CHILCOTIN					
Chilko R. & L.	249,863	245,522	154,918	54,513	
Chilko Channel	0	0	0	0	
Taseko L.	60	100	164	60	
SETON-ANDERSON					
Gates Cr.	5,420	12,600	4,914	6,151	
Gates Channel	9,418	15,884	3,674	0	
Portage Cr.	97	25	41	20	
NORTH THOMPSON					
North Thompson R.	3,879	1,096	6,437	223	
Raft R.	10,406	10,003	8,147	5,099	
Fennell Cr.	2,270	1,967	1,152	981	
SOUTH THOMPSON					
Early Summer-run					
Scotch Cr.	654	2,005	961	1,410	
Seymour R.	1,350	822	374	920	
Upper Adams / Momich / Cayenne	1,257	256	42	27	
Miscellaneous	1,727	411	159	202	
Late-run					
Adams R.	149	0	36	22	
Little R.	2	2	2	2	
Lower Shuswap R.	11	9	7	0	
Miscellaneous	2	1	4	1	
HARRISON-LILLOOET					
Birkenhead R.	19,500	55,321	36,404	5,308	
Big Silver Cr. & misc. Birk. types	2,763	3,722	4,640	146	
Harrison R.	6,717	70,904	65,758	75,537	
Weaver Cr.	1,309	345	15	37	
Weaver Channel	1,447	573	259	47	*1*
LOWER FRASER					
Nahatlatch R. & L.	573	4,065	1,896	2,096	
Cultus L.	491 *1*	1,088 *1*	2,583 *1*	312 *1*	
Upper Pitt R.	16,921	78,038	58,241	3,976	
Chilliwack L./Chilliwack R., upper	67,822	126,164	57,928	31,770	
MISCELLANEOUS *2*	1,271	551	301	3,666	
ADULTS	815,623	920,421	484,881	272,814	*3*
JACKS	1,674	12,056	5,588	1,450	
TOTAL NET ESCAPEMENT	817,297	932,477	490,469	274,264	

* Estimates are from DFO.

1 Cultus estimates include 340 adults in 2008, 835 adults in 2012, 2,387 adults in 2016, and 101 adults in 2020.

2 'Miscellaneous' category includes fish from small stocks throughout the Fraser watershed.

3 Includes 365 Early Stuart and 44 Bowron adults kept for broodstock

Table G 3. Detailed calculation of total allowable catch (TAC) and achievement of international catch shares for Fraser sockeye (by management group) salmon in 2020. Calculations are based on the in-season estimates of abundance, spawning escapement target and Management Adjustment at the time the Panel adopted the last in-season run size (September 1), in accordance with Annex IV, Chapter 4 of the Pacific Salmon Treaty.

	Fraser Sockeye					
	Early Stuart	Early Summer	Summer	Late	Total	
RUN STATUS, ESCAPEMENT NEEDS & AVAILABLE SURPLUS						
In-season Abundance Estimate	**16,000**	**72,000**	**191,000**	**14,000**	**293,000**	
Adjusted Spawning Escapement Target *	**16,000**	**72,000**	**191,000**	**14,000**	**293,000**	
Spawning Escapement Target (SET)	16,000	72,000	191,000	14,000	293,000	
%SET from TAM rules	*100%*	*100%*	*100%*	*100%*		
Management Adjustment (MA)	11,000	37,400	30,600	5,700	84,800	
Proportional MA (pMA)	*0.52*	*0.52*	*0.16*	*0.41*		
Test Fishing Catch (TF, post-seas. est.)	100	1,300	3,100	100	4,600	
Surplus above Adjusted SET & TF *	**0**	**0**	**0**	**0**	**0**	
DEDUCTIONS & TAC FOR INTERNATIONAL SHARING						
Aboriginal Fishery Exemption (AFE)	**0**	**0**	**0**	**0**	**0**	
Total Deductions (Adj.SET + TF + AFE)	27,200	110,700	224,700	19,900	382,400	
Available TAC (Abundance - Deductions)	**0**	**0**	**0**	**0**	**0**	
UNITED STATES (Washington) TAC						
Propor. distrib. TAC - Payback	**0**	**0**	**0**	**0**	**0**	
Proportionally distributed TAC **	0	0	0	0	0	16.5%
U.S. Payback	0	0	0	0	-470	
Washington Catch	0	0	0	0	0	
Deviation from TAC - Payback	**0**	**0**	**0**	**0**	**0**	
CANADIAN TAC						
Propor. distrib. TAC + Payback + AFE	**0**	**0**	**0**	**0**	**0**	
Propor. distrib. TAC + U.S. Payback	0	0	0	0	0	83.5%
AFE	0	0	0	0	0	
Unsanctioned Catch***	0	400	10,900	0	11,300	
Canadian Catch excluding ESSR Catch	0	400	11,000	0	11,400	
Deviation from TAC + Payback + AFE	**0**	**-400**	**-11,000**	**0**	**-11,400**	
TOTAL						
Available TAC + U.S. Payback + AFE	**0**	**0**	**0**	**0**	**0**	
Total Catch excluding ESSR Catch	0	400	11,000	0	11,400	
Deviation from TAC + U.S. Payback + AFE	**0**	**-400**	**-11,000**	**0**	**-11,400**	

* The surplus cannot exceed the estimated abundance.

** Washington sockeye and pink shares according to Annex IV, Chapter 4 of the Pacific Salmon Treaty.

*** Largely resulting from unsanctione food fisheries by two communities in the mid-river area, with small amounts from other food fisheries and recreational fisheries that were directed at other species in 2020

APPENDIX H: MEMBERS OF THE FRASER RIVER PANEL TECHNICAL COMMITTEE IN 2020

Canada	United States
J. Scroggie, Co-Chair *Fisheries and Oceans Canada*	R. Conrad, Co-Chair *Northwest Indian Fisheries Commission*
M. Mortimer *Fisheries and Oceans Canada*	M. Agha *Washington Department of Fish and Wildlife*
M. Staley *First Nations Advisor*	P. Mundy *National Marine Fisheries Service*
K. Campbell *First Nations Advisor*	

APPENDIX I: STAFF OF THE PACIFIC SALMON COMMISSION IN 2020

EXECUTIVE OFFICE

John Field, Executive Secretary

John Son, Information Technology Manager

Julie Ehrmantraut, Administrative Assistant

Kim Bartlett, Meeting Planner

Teri Tarita, Librarian, Archivist, and Records Manager

FINANCE AND ADMINISTRATION

Ilinca Manisali, Director of Finance

Witty Lam, Senior Accountant

Koey Lu, Accountant

Tom Alpe, Manager, Restoration & Enhancement Funds

Victor Keong, Program Assistant, Restoration & Enhancement Funds

Christina Langlois, Administrative Assistant, Restoration & Enhancement Funds

FISHERIES MANAGEMENT DIVISION STAFF

Fiona Martens, Chief Biologist Programs

Catherine Michielsens, Chief Biologist Science

Stock Assessment Group

Merran Hague, Quantitative Fisheries Biologist

Eric Taylor, Quantitative Biologist

Jessica Gill, Stock Assessment Assistant

Mark McMillan, Database Manager

Stock Identification Group

Maxine Forrest, Manager, Scale Lab

Steve Latham, Manager, Stock Identification

Julie Sellars, Senior Scale Analyst

Catherine Ball, Scale Lab Technician

Angela Phung, Stock Identification Biologist

Dejan Brkic, Salmon Technician

Stock Monitoring Group

Erica Jenkins, Director of Stock Monitoring

Benia Nowak, Manager, Test Fishing Operations

Yunbo Xie, Hydroacoustic Scientist

Rachael Hornsby, Manager, Hydroacoustic Operations

Jacqueline Nelitz, Hydroacoustic Technician

Mike Bartel Sawatzky, Hydroacoustic Technician