2019

Report of the Fraser River Panel to the Pacific Salmon Commission on the 2019 Fraser River Sockeye and Pink Salmon Fishing Season

Prepared by the

Pacific Salmon Commission

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Pacific Salmon Commission
600-1155 Robson Street
Vancouver, B.C.
V6E 1B5
(604) 684-8081
www.psc.org

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Contact Information

Please email any inquiries to info@psc.org.

REPORT OF THE
FRASER RIVER PANEL
TO THE PACIFIC SALMON COMMISSION
ON THE 2019 FRASER RIVER SOCKEYE AND PINK SALMON FISHING SEASON

2019 PANEL MEMBERS AND ALTERNATES

CANADA

J. Nener, Chair
Fisheries and Oceans Canada

C. Ashton
Purse seine fisher

M. Griswold
Troll fisher

K. Malloway
First Nations

R. Morley
Salmon processing industry

J. Murray
Gillnet fisher

L. Jantz (Alternate)
Fisheries and Oceans Canada

S. Hollingsworth (Alternate)
Sport fisher

T. Roberts Jr. (Alternate)
First Nations

L. Rombough (Alternate)
Gillnet fisher

P. Sakich (Alternate)
Troll fisher

M. Shepert (Alternate)
First Nations

UNITED STATES

L. Loomis, Vice-Chair
Treaty Indian tribes

K. Hughes
Washington Department of Fish and Wildlife

B. Kehoe
Commercial salmon fishing industry

J. Dixon
National Marine Fisheries Service

A. Dufault (Alternate)
Washington Department of Fish and Wildlife

R. Charles (Alternate)
Treaty Indian tribes

J. Giard (Alternate)
Reefnet fisher

P. Mundy (Alternate)
National Marine Fisheries Service

Prepared by

FISHERIES MANAGEMENT DIVISION

of the

PACIFIC SALMON COMMISSION

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I. EXECUTIVE SUMMARY

The 2019 season saw a record low number of sockeye return to the Fraser River. The final in-season run size estimate of 571,000 sockeye was 88% less than the median forecast (4,795,000) and 86% below the cycle line average. While lower 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 that was discovered at the start of the season on June 23, 2019. The landslide impacted the stocks with spawning grounds above Big Bar which amounted to 81% of the total Fraser sockeye run. The landslide created a physical barrier that impeded upstream migration, especially early in the season when water discharge levels were too high to allow natural migration past the slide. The overall low run size in combination with the Big Bar migration challenges resulted in the smallest spawning escapement in the Fraser River since 1943. Unlike the sockeye return, the Fraser River pink salmon return in 2019 was 76% above the median forecast (5,018,600). The impact of the slide on pink salmon was much smaller than for sockeye given the low proportion of pinks that traditionally spawn above Big Bar, the lack of stream fidelity and the later timing of the pink salmon run when discharge levels were lower. The following paragraphs describe the planning of the 2019 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. At the time of pre-season planning, there had been no knowledge that a landslide had occurred at Big Bar and therefore the impact of Big Bar had not been taken into account in any pre-season planning.
2. Pre-season, the median run size forecast (p50 level, Appendix B) was 4,795,000 Fraser River sockeye salmon and according to the quantitative forecast there was a one in two chance that the run size would be between 2,891,000 and 8,676,000. Given the recent declines in productivity, it was however emphasised that there was a high likelihood that expected returns would be lower than the median forecast and likely fall between 2,891,000 and 4,795,000 sockeye. The median Fraser River pink run size forecast was 5,018,600 (p50 level, Appendix B) with a one in two chance that the run size would be between 3,577,000 and 7,513,000.
3. Pre-season expectations of migration parameters included a 69% diversion rate for Fraser River sockeye and a 50% diversion rate for Fraser River pink salmon through Johnstone Strait. The Panel adopted the following Area 20 50% migration dates: July 5 for Early Stuart, July 30 for Early Summer, August 10 for Summer, August 18 for Late-run sockeye, and August 28 for pink salmon.
4. At median (p50) forecast abundance levels, pre-season spawning escapement goals were 41,000 Early Stuart, 186,000 Early Summer, 1,572,000 Summer and 336,600 Late-run sockeye for a total of 2,135,600 sockeye salmon and 4,483,000 pink salmon (Table 1). The goals for Fraser River pink salmon and for each sockeye management group were established by applying Canada's Spawning Escapement Plan (Appendix B) to their median forecasted run sizes.
5. Management Adjustments (MAs) of 28,300 Early Stuart, 83,700 Early Summer, 141,500 Summer-run and 188,500 Late-run sockeye were added to the spawning escapement targets to increase the likelihood of achieving the targets (Appendix F, Table F 3).
6. The projected Total Allowable Catch (TAC) of Fraser River sockeye salmon based on the median forecasted abundances and agreed deductions was 2,011,000 sockeye (Table 1), of which 16.5% (331,800 sockeye) were allocated to the United States (U.S.). The projected TAC of Fraser River pink salmon was 528,400 fish, of which 25.7% (135,800 pinks) were allocated to the U.S.
7. Pre-season model runs indicated it was unlikely the Summer-run TAC could be fully harvested due to fisheries constraints required to achieve spawning escapement targets for co-

migrating Early Summer and Late-run stocks, however, the model runs for pink salmon indicated that the TAC could be fully harvested.

8. The Panel adopted the 2019 Management Plan Principles and Constraints and Regulations, and (Appendices C, D).

In-season Management Considerations

9. The in-season marine migration timing (Figure 3) was later than pre-season expectations for all sockeye management groups except the Early Summer run: 3 days for Early Stuart run, 1 day earlier for Early Summer-run, 9 days for Summer run and 1 day for Late run. Pink salmon timing which was 11 days earlier than the expected timing (Figure 4) caused sockeye and pink salmon migrations to overlap more than expected pre-season.
10. The overall Johnstone Strait diversion rate (Figure 5) for Fraser River sockeye was 84% compared to the pre-season forecast of 69%. The Fraser River pink salmon diversion rate was 11%, which was a record low, instead of 50% which was used in pre-season modelling.
11. Returns for Fraser sockeye salmon were substantially below median pre-season forecasts unlike Fraser River pink salmon which returned substantially above the median pre-season forecast. Early Stuart run: 36% below median forecast, Early Summer run: 79% below median forecast, Summer run: 89% below median forecast, Late run: 93% below median forecast and pink salmon run: 76% above median forecast. The number of returning Early Stuart sockeye fell between the p10 and p25 run size forecast, but for Early Summer, Summer and Late-run, the number of returning sockeye were lower than the p10 run size forecasts. The pink salmon return exceeded the p75 run size forecast.
12. 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 below historical average and river temperatures were above historical average in July and through mid-August and near record highs in early September (Figure 8).

Implications of the Big Bar landslide

13. The Big Bar landslide (Figure 6), discovered on June 23, created a five-meter waterfall on the Fraser River that formed an upstream migration barrier for salmon with spawning grounds above Big Bar. The slide impacted 100% of the Early Stuart, 60% of the Early Summer run, and 90% of the Summer run. None of the Late run population spawn above Big Bar. The proportion of pink salmon stocks spawning above Big Bar was expected to be low. The extent that the landslide impeded natural upstream migration was dependant on water velocity which was higher earlier in the season. Big Bar therefore had a larger impact on early migrating stocks, in particular Early Stuart sockeye.
14. 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 to the slide in the summer of 2019 included: the partial creation of a natural fishway through rock-manipulations, radio tagging, sonar monitoring, fish transport by helicopter and truck and the collection of Early Stuart broodstock for emergency enhancement (Figure 7).
15. As discharge levels decreased over the summer and water levels declined, an increasing proportion of the run was able to make it past the slide naturally.
16. Of the stocks above Big Bar, the following proportions made it to the spawning grounds: 0.34% of the Early Stuart Run, 43% of the Early Summer run stocks and 81% of the Summer run stocks.
17. Post-season, additional remediation work included breaking up and removing rocks to improve natural fish passage and the construction and deployment of a natural fishway and flexible, pressurised fish transport tube.

Run Size, Catch, Escapement and Migration patterns

18. Returns of adult Fraser sockeye totalled 571,000 fish (Tables 8 and 9) which was 72% below the escapement of 2,006,000 fish in the primary brood year (2015). This return was the smallest since records started in 1893. Divided into management groups, adult returns totalled 26,100 Early Stuart, 99,900 Early Summer-run, 418,500 Summer-run and 26,400 Late-run sockeye.
19. Due to the very poor sockeye return, all sockeye management groups were managed using a low abundance exploitation rate (LAER); 10% for Early Stuart and 20% for the other management groups.
20. Catches of Fraser River sockeye salmon in all fisheries totalled 94,400 fish, including 9,860 fish caught by Canada, 78,110 fish caught by the U.S. and 6,400 fish caught by test fisheries (Table 8). Almost all the Canadian catch was from unsanctioned catch (9,770 fish) and almost all the U.S. catch occurred in Alaska (77,640 fish). In Washington, catches were in recreational and ceremonial Treaty Indian fisheries. The overall harvest rate was 17% of the run (Figure 10).
21. DFO's near-final estimates of spawning escapements to streams in the Fraser River watershed totalled 302,000 adult sockeye (Tables 8 and 9). This was 75% less than the brood year escapement of 1,189,000 adults and the lowest escapement on this cycle since 1943. By management group and for this cycle line, spawning escapements in 2019 were the lowest on record for Early Stuart, the third smallest for Early Summer-run, below the cycle line average for Summer run and the lowest on record for Late run (Figure 12). There were 146,500 effective female spawners in the Fraser watershed, representing an overall spawning success of 98%.
22. The total run-size estimate of Fraser River pink salmon was 8,858,600 (Figure 13). Catches totalled 550,800 fish, with 300,300 caught by Canada, 233,300 caught by the U.S. and 17,200 caught in test fisheries (Table 8). This catch represents an exploitation rate of 6% (Table 7 and 8), which is the third lowest exploitation rate since records began in 1959 (Figure 13).
23. Since 2009, estimates of pink salmon passage have been obtained through the hydroacoustics program at Mission. In 2019, the run size of Fraser River pink salmon was calculated by adding the total catch of pink salmon below Mission (292,700 fish) to the Mission passage estimate (8,566,000 fish, Table 7), while the spawner abundance (8,307,800 fish) was calculated by subtracting the total catch from the run size.

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, the spawning escapement targets for all management groups equalled their run sizes, and there was no need for the Panel to adopt MA estimates. 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 (on target), Early Summer-run (3% under), Summer-run (8% under) and Late-run sockeye (10% over) (Table 12).
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 2019, spawning escapement targets could not be met for any management group. Additionally, the Big Bar landslide also meant further reductions in escapement to upper river spawning areas, and this was a dominant factor for some populations (e.g. Early Stuart).
27. Spawning ground estimates of Fraser sockeye abundance totalled 302,000 adults, which is 47% below the post-season target. Spawner abundance was severely below target for Early Stuart sockeye (100% under), below target for Early Summer-run (55% under), below target for Summer-run (41% under) and below target for Late-run sockeye (59% under) (Table 13).

The exploitation rates for all management groups were less than their respective LAERs (Table 8).

28. There was no International TAC (Total Allowable Catch) of Fraser sockeye (Table 14), based on the calculation method set out in Annex IV, Chapter 4 of the Pacific Salmon Treaty. The Washington catch of 470 Fraser sockeye therefore exceeded the U.S. share. The total Canadian catch of 9,860 Fraser sockeye consisted almost entirely of unsanctioned catch in addition to the 80 fish in the Charter test fisheries (Albion and Area 12 Chum). This Canadian catch was 100% more fish than the Canadian share of TAC + AFE. In these calculations, the TAC is based on the TAC on the date of the last in-season Panel meeting (September 12, 2019), while catches are post-season estimates.
29. In terms of domestic U.S. allocation objectives for Fraser sockeye, Treaty Indian fishers were 470 fish above their share of the U.S. TAC (Table 15).
30. For Fraser River pink salmon, there was a TAC of 2,882,760 salmon (Table 14) based on the calculation method set out in Annex IV, Chapter 4 of the Pacific Salmon Treaty.
31. Access to pink salmon TAC was limited as all sockeye management groups were in a LAER, and the run size for pink salmon was only increased from 5.0 to 8.9 million on September 12 when most of these fish had already passed through U.S. waters and most commercial fishing areas in Canada. As a result, the spawning escapement for Fraser River pink salmon was greater than the post-season target (38% over; Table 13), and the exploitation rate was very low at 6% (Table 8).
32. The Washington catch of 233,200 Fraser pink salmon was less than their 25.7% share of the international TAC and the Canadian catch of 300,300 was 1,841,600 fish less than their allowable catch.
33. Regarding domestic U.S. allocation objectives for Fraser pink salmon, both Treaty Indian and All Citizen fishers were below their shares of the U.S. TAC (Table 16), 210,800 fish and 297,000 fish, respectively.
34. There was no by-catch of non-Fraser sockeye salmon, but there was a by-catch of 69,620 non-Fraser pink salmon in commercial net fisheries regulated by the Fraser River Panel (Table 17). Catches of other Fraser and non-Fraser salmon species included 5,720 Chinook, 190 coho, and 10 chum.

Allocation Status

35. By Panel agreement there is a U.S. payback of 470 Fraser River sockeye to be carried forward to 2020 (Table 18). There was no payback owed for Fraser River pink salmon (Table 18).

II. FRASER RIVER PANEL

In 2019, 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 that occur 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.

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

[1] Pacific Salmon Treaty as modified through January 2019.

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 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.

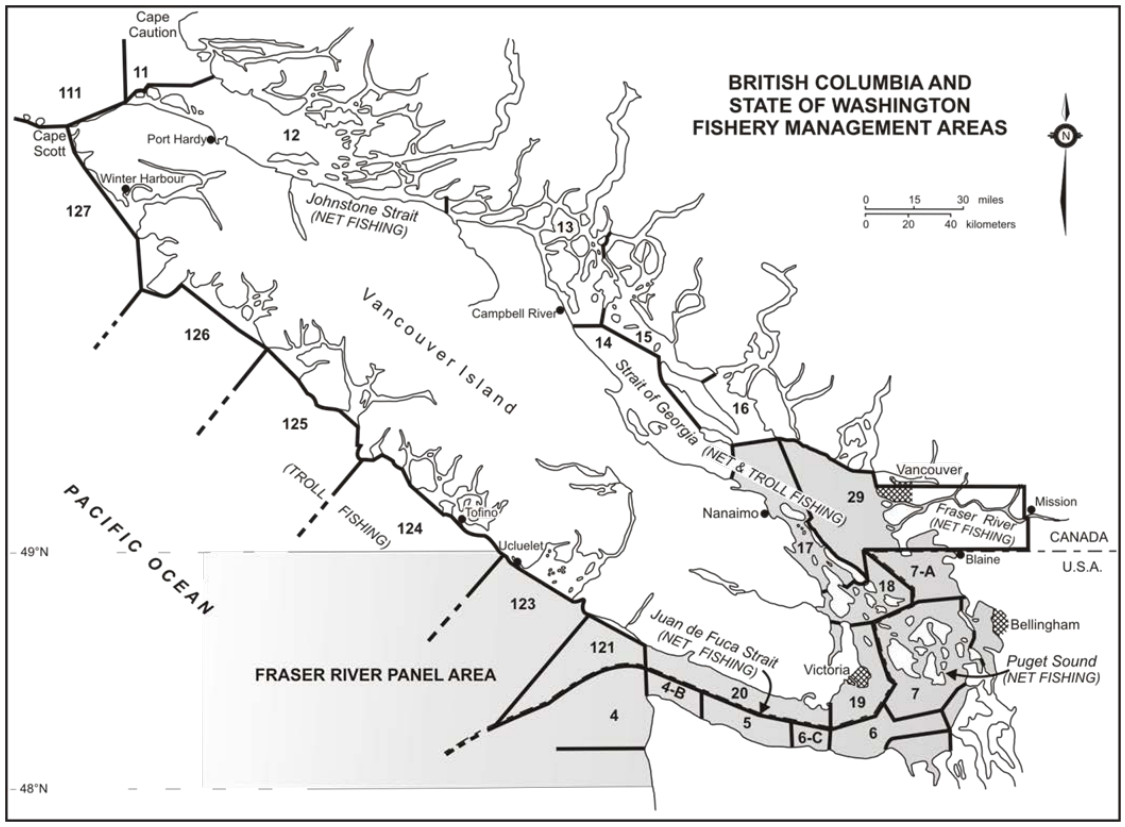

Figure 1. Fishery management areas in the Fraser River Panel Area and south coast waters.

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 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 objectives for spawning escapement and catch allocation and test fishery deductions.

Both countries evaluated fishing plans directed at catching Fraser River sockeye and pink salmon. The fisheries primarily targeted Summer-run sockeye and pink salmon, with some additional harvest of Early Summer and Late-run stocks. Assuming median run size estimates (p50 or 50th percentile) for both Fraser sockeye and pink salmon, the planned US fisheries were within a few hundred fish of their allocated TAC while Canada's ability to achieve their sockeye salmon total allowable catch (TAC) was constrained by a 10% low abundance exploitation rate (LAER) assigned to the Early Stuart management group, and a 20% LAER assigned to the Late-run management group. The LAER is applied to accommodate "small but acceptable" amounts of by-catch for management groups with little or no TAC[3]. Canada was able to achieve their full pink salmon TAC, but this was largely a function of a fixed catch assigned to pink salmon purse seine fisheries in the Strait of Georgia, a fishery not dynamically included in the model simulation framework. During pre-season modelling, fishing induced mortalities (FIMs) for sockeye salmon captured and released during pink-directed fisheries were included in estimates of exploitation rate, but excluded from total catch estimates (i.e. not counted against the TAC). Alternative model runs explored the sensitivity of fishing plans to sockeye salmon run size. The p25 (25th percentile) sockeye salmon run size scenario further constrained Canada's catches, as an additional 20% LAER came into effect for the Early Summer run management group due to these low abundances. At the p25 sockeye abundance scenario, only FSC fisheries were modelled in Canada as there was no International TAC at these run sizes.

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

[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 Commission. January 2019. Pacific Salmon Treaty.

until the 2012 brood year (2013 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%) (Appendix B, Table B1). The median forecast (50th percentile, or p50) represented an equal chance (i.e., a one in two chance) that the return would fall above or below the forecast value assuming long term average productivity. However, based on both freshwater and ocean conditions experienced by sockeye returning in 2019, it was predicted the number of returning sockeye would fall between the 25% and 50% probability level[5]. For planning purposes, the Panel used the median (i.e., p50) run size forecast of 4.8 million Fraser River sockeye salmon and 5.0 million pink salmon as the "base case" scenario. The Panel also explored an alternative model, assuming a sockeye salmon run size corresponding to the 25th percentile of the distribution of the forecasted run size (p25: 2.9 million). In this scenario, no discretionary catches were taken by the test fishery due to the low abundances and associated fishing constraints.

Canada used the "Fraser River Sockeye Spawning Initiative" (FRSSI) model in combination with pre-season stakeholder consultations to establish escapement goals for 2019. These are documented in the Pacific Region Integrated Fisheries Management Plan (IFMP). The spawning escapement plan released by Canada to the Panel (Appendix B, Table B2) relies on the application of a Total Allowable Mortality (TAM) rule, defined by a Lower Fishery Reference Point, an Upper Fishery Reference Point, a TAM cap and a Low Abundance Exploitation rate (LAER). The resulting pre-season escapement targets for sockeye at the p50 run size levels by management group were: Early Stuart – 41,000; Early Summer run – 186,000; Summer run– 1,572,000; and Late run – 336,600[6]. At these abundance levels, the Early Stuart and Late-run run sizes were too low to allow directed harvest. These management group were instead managed under a 10% and 20% LAER respectively. The pre-season escapement target for pink salmon at the p50 run size level was 4,483,000.

Pre-season fisheries management planning was based on assumptions about the proportions of Fraser River sockeye and pink salmon 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). The pre-season Fraser River sockeye diversion rate of 69% was derived by DFO using a combination of current velocities and sea surface temperatures[7]. Although the diversion rate of Harrison fish through the south is historically higher than for other co-migrating sockeye salmon, given the low contribution of Harrison to the forecast, the Harrison diversion was also modelled as 69%. The Panel adopted and used a Fraser River pink salmon diversion rate of 50% for pre-season planning based on historical data, as the DFO forecast based on environmental data (53%) was not available until August 18.

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. DFOs oceanographic models[7] generated timing forecasts of July 5 for the Early Stuart run and August 10 for the Chilko run. The Fraser River Panel adopted the DFO forecast for Early Stuart. Area 20 timing for all other component stocks in the model were based on historical medians for all years excluding the 2016 cycle line years, with the exception of the Nadina group (Nadina, Bowron, Gates, Nahatlatch, Taseko) and the Chilliwack-Pitt group, which assumed all-year historical medians. Similarly, the timing of Fraser River pink salmon was based on the median of the entire time series. The timing of the Early Summer, Summer and Late-run

[4] Hawkshaw, M. Xu, Y., and Davis, B. 2020. Pre-season run size forecasts for Fraser River Sockeye (*Oncorhynchus nerka*) and Pink (Oncorhynchus gorbuscha) Salmon in 2019. Can. Tech.Rep. Fish. Aquat. Sci. 3391: vi + 52 p.

[5] MacDonald, B.L., Grant, S.C.H., Patterson, D.A., Robinson, K. A.., Boldt, J.L., Benner, K., King, J., Pon, L., Selbie, D.T., Neville, C.E.M., and J.A. Tadey. 2019. State of the Salmon: Informing the survival of Fraser sockeye returning in 2019 through life cycle observations. Can. Tech. Rep. Fish. Aquat. Sci. 3336: V + 60 p.

[6] DFO. 2019. Pacific Region Final Integrated Fisheries Management Plan June 1, 2019 – May 31, 2020, Salmon Southern BC.

[7] Folkes, M.J.P., Thomson, R.E., and Hourston, R.A.S. 2018. Evaluating Models to Forecast Return Timing and Diversion Rate of Fraser Sockeye Salmon. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/021. vi + 220 p.

management groups were derived based on the aggregated daily abundances of component stocks assuming normal run timing distributions. The Panel adopted the resulting marine timing of July 30 for the Early Summer run, August 10 for the Summer run, August 18 for the Late run, and August 28 for pink salmon. Figures 3 and 4 illustrate the distribution of daily abundances by management group given the pre-season assumptions of Area 20 timing and total run size.

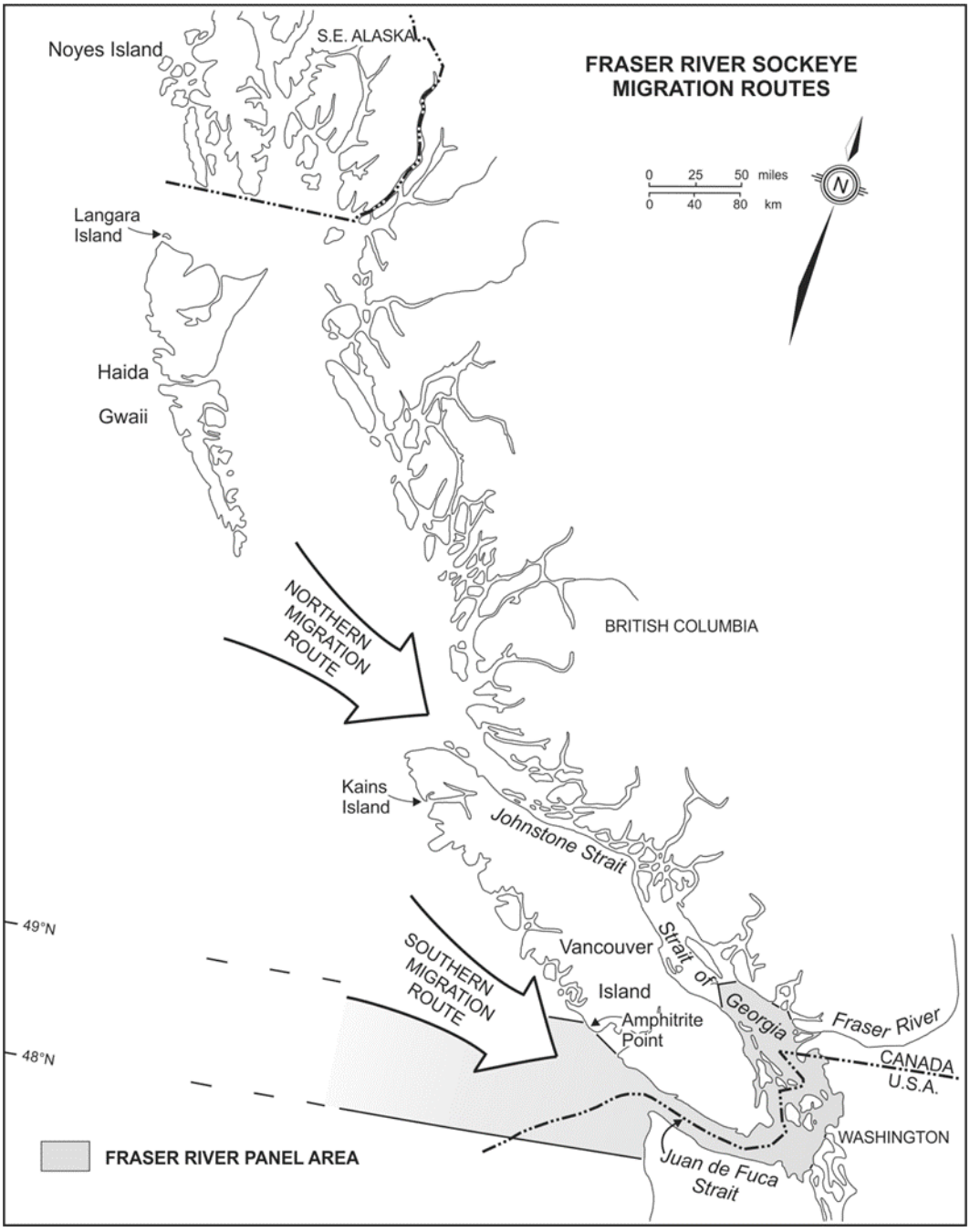

Figure 2. The northern (Johnstone Strait) and southern (Juan de Fuca Strait) routes for sockeye and pink salmon migration to the Fraser River.

Pre-season, the Panel assumed a component of the Late-run and Summer-run management groups would delay their migration into the Fraser River. The proportion of the run that delays and the number of days delayed are higher on years of the dominant cycle line compared to other years. For planning purposes, the model assumed 35% of the non-Birkenhead Late-run group would delay in the Strait of Georgia and would migrate upstream around September 12. For the overall Late run group, this resulted in 50% of the run migrating upstream by August 30 and corresponded to a 5-day migration delay compared to the migration speed of other management groups. The model also assumed 37% of Harrison sockeye salmon would delay in the Strait of Georgia prior to migrating upstream around September 10. For the entire Harrison stock group, this resulted in an August 21 Mission 50% date and assumed 6-days of migration delay.

DFO's Environmental Watch (E-Watch) Program provided the Panel with long-range (3-month) forecasts of Fraser River temperature and discharge conditions. In early Spring, the snowpack in the Fraser River watershed was 20% below average (April 1, BC Fraser Basin Snow Water Index). Due to warm temperatures and rapid snow melt in May, snow basin indices dropped significantly by June 1. This occurred 1-3 weeks earlier than normal in most areas and increased the likelihood of low flow conditions in the summer. Low flows would reduce the water temperature buffering capacity of the watershed to hot and cool air temperatures. The long-range forecast predicted below 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). From this, a prediction can be made as to how many additional sockeye should be allowed to escape to achieve spawning escapement objectives (see references in the MA section of the Management Information chapter). The Panel chose to adopt the proportional management adjustments (pMAs) based on historical medians (see Table F4) for all four management groups. For the Early Summer and Summer run, the weighted pDBE approach had almost no impact on the aggregate pDBE or SET given the low forecasted relative abundances of Pitt, Chilliwack and Harrison fish. The relative abundances of Birkenhead in the Late-run aggregate however had an impact on the weighted pDBE and resulting SET for that management group. As a result, the Panel agreed to forego the weighted pDBE approach for the Early Summer- and Summer-run aggregate but use the weighted pDBE approach for the Late-run aggregate for 2019 (with possible review in-season if component proportions were different than the pre-season forecast). The Panel adopted a pMA for the Early Stuart run (pMA=0.69; MA=28,300 fish), Early Summer run aggregate (pMA=0.45; MA=83,700 fish), Summer run aggregate (pMA=0.09; MA=141,500 fish) and Late run aggregate (pMA=0.56; MA=188,500 fish) (Table 6). 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 with conservation concerns 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 except the Summers 4-1's, 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, and the Southern Resident Killer whale population.

Pre-season test fishing plans did not include the Naka Creek or Gulf troll test fisheries, but did include the Area 4B,5 gillnet test fishery, and a reduced Area 7 reef net test fishery (Table 4). To cover the cost of the proposed test fisheries ($1,401,000), it was anticipated a total of 67,000 sockeye salmon and 20,000 pink salmon (7,200 Fraser and 12,800 non-Fraser) would need to be caught and retained by the test fishing program. The distribution between stocks was determined using a pre-season test fishing model with the anticipated fishing schedule and no planned pink directed pay fish periods due to concerns about FIMs for Late-run sockeye salmon. The

distribution of the test fishing deduction across management groups was based on historical catches for the non-discretionary component (i.e. gill net test fisheries and scientific samples) and based on the harvestable surplus for the discretionary component (i.e. additional fish landed in the purse seine test fisheries to cover operational costs).

The total non-discretionary catch (40,700) for sockeye salmon was estimated as the average non-discretionary catch over the previous three cycle years and was scaled based on the pre-season run-size forecast abundance relative to the average run-size abundances in the previous three cycle years. The distribution of this catch across management groups was based on the proportions of the non-discretionary catch observed in 2015. Usually, proportions based on a 3-year cycle average are applied, but stock proportions from the 2019 pre-season run size forecast aligned better with those observed in 2015, compared to 2007 or 2011. The sockeye salmon discretionary catch was then calculated by subtracting the total non-discretionary catch from the total deduction, and distributed across management groups based on the percent harvestable surplus assigned to each group in 2019. In the pre-season plan, pay fish retention was modelled to occur between August 10 and August 12 in purse seine test fisheries. Because there was no harvestable surplus for Early Stuart, the test fishing deduction was equivalent to the non-discretionary catch. When assuming a sockeye salmon run size corresponding to the 25th percentile of the forecast, the test fishing deduction was reduced to only include non-discretionary catches.

For Fraser River pink salmon, the total non-discretionary catch (5,500) was based on the average non-discretionary catch over the previous three return years. Although, there were no pink directed retention periods planned for the purse seine test fisheries, 1,700 Fraser River pink salmon were estimated to be caught during the sockeye payfish retention window between August 10 and August 12. In addition, the test fisheries were also expected to catch 12,800 non-Fraser pink salmon based on historical proportions of Fraser and non-Fraser pink salmon catches.

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 (Appendix C). The pre-season sockeye salmon TAC for international sharing was 2,011,000 (Table 1), of which 16.5% or 331,800 fish was the U.S. (Washington) share. Treaty Indian fisheries were allocated 71.4% of the U.S. TAC and All Citizen fisheries the remaining 28.6%. Adding the remaining balance to Canada to the 400,000 Aboriginal Fishery Exemption (AFE) resulted in 2,079,200 sockeye salmon available for harvest by Canada. Commercial pre-season catch targets in Canada totalled 945,200 sockeye salmon; Canadian non-commercial sockeye salmon catch targets totalled 1,137,800, including 795,400 fish for in-river First Nations and 292,300 fish for marine First Nations, plus projected recreational catches of 40,000 fish in the Fraser River and 10,100 fish in marine areas. In Canadian commercial fisheries, Area B purse seine was allocated 48.5% of the sockeye salmon commercial TAC, Area D gill net was allocated 21.6%, Area E gill net was allocated 25.1%, and Area H troll was allocated 4.8%.

For pink salmon, the pre-season TAC for international sharing was 528,400 (Table 1). The U.S. share was 25.7% of the TAC or 135,800 fish, divided equally between Tribal Indian and All Citizen fisheries. The balance to Canada was 74.3% or 392,600 fish. Canadian pre-season non-commercial catch targets totalled 205,700 fish, including 126,800 fish for in-river First Nations and 10,000 fish for marine First Nations, plus projected recreational catches of 20,000 fish in the river and 10,000 fish in marine areas. In Canadian commercial fisheries, Area B purse seine was allocated 82.5% of the pink salmon commercial TAC, Area D gill net was allocated 4.0%, Area E gill net was allocated 3.0%, Area G troll was allocated 0.5%, and Area H troll was allocated 10.0%.

Pre-season, the Fraser River Panel considered two alternative planning scenarios that included variations in assumed sockeye salmon run sizes (median forecast and p25 forecast) and adopted a Base Case Planning Model assuming median run size forecasts for both Fraser River sockeye and pink salmon. Canada and the U.S. developed a pre-season management plan under the “base case” conditions which included the “2019 Management Plan Principles and Constraints” and “2019

Regulations" (Appendices C & D). In the pre-season plan, marine FSC fisheries were the first potential fisheries directed at Fraser River sockeye on July 22. The first scheduled Canadian commercial fishery in marine waters was planned for August 8 in the Johnstone Strait gill net fishery. The first scheduled Canadian fishery in the river was an FSC opening starting on July 26. The first sockeye salmon directed fishery in U.S. Panel-Area waters was planned for July 30 in Areas 4B,5,6C. Only three days of directed pink salmon fisheries, commencing on August 28, were modelled in U.S. fisheries. Canadian catches directed at pink salmon were entered as fixed inputs. Sockeye salmon fishing induced mortalities (FIMs) in the Canadian Area 29B pink-directed purse seine fishery were also entered as fixed inputs, equivalent to 10% of the pink catch and assigned entirely to the Late-run management group. Fishing induced mortalities were calculated for sockeye salmon encountered in All Citizen U.S. pink directed fisheries with an assumed FIM rate of 25%. Given the timing of the U.S. fisheries, the FIMs were distributed across both the Summer and Late-run management groups but zero FIMs were produced for earlier timed components of the Fraser sockeye return. For pre-season planning, fishery openings at the start of the season were constrained by a 10% LAER for Early Stuart and a 4-week moving window closure for fisheries directed at Early Stuart and the weaker early-timed stocks of the Early Summer run (e.g. Bowron, Taseko). In addition, a 20% LAER for Late-run constrained catches on more abundant co-migrating Summer-run and pink salmon later in the season.

The planning model indicated that the U.S. was likely able to harvest most of their TAC, assuming a small but acceptable overage of Early Summer-run and Late-run fish. Due to the limited TAC available for co-migrating Early Summer-run and Late-run stocks, Canada was unable to harvest their total TAC, primarily allocated to the more abundant Summer-run group. The pre-season plan modelled both countries as achieving their pink salmon TAC. For Canada this was however attributed to the fact that Canadian pink salmon catch was primarily modelled as a fixed input.

B. In-season Management

In 2019, all sockeye salmon management groups returned well below the median pre-season forecasts, and later than forecast (Figure 3). Pink salmon returns however were well above forecast, and the marine timing was much earlier than forecast (Figure 4).

The Fraser River Panel convened 22 times between July 9, 2019 and September 17, 2019 to discuss run status and enact in-season orders (Appendix E) to regulate fisheries directed at Fraser River sockeye and pink 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, Mission escapement to date and 50% migration dates. The main events that transpired each week of the season are summarized below with a focus on Staff assessments and Panel decisions.

Just prior to the start of the season, on June 23, 2019, a significant landslide was discovered in a narrow section of the Fraser River near Big Bar, north of Lillooet, B.C. The landslide created a five-meter waterfall that some of the Fraser River salmon stocks needed to migrate past in order to reach their spawning grounds. For Fraser River sockeye, the affected stocks included Early Stuart, Nadina, Bowron, Taseko, Chilko, Quesnel, Late Stuart and Stellako sockeye. In 2019, these stocks represented 77% of the expected Fraser River sockeye run. The landslide was expected to impact 100% of the Early Stuart run, 32% of the Early Summer run and 89% of the Summer run. None of the Late-run stocks were impacted by the landslide. For Fraser River pink salmon, the majority of the spawning grounds are located downstream of the landslide and less than 5% of the Fraser River pink salmon were expected to be impacted by the landslide. Given

the lack of spawning ground enumerations for pink salmon in recent years, this estimate was however very uncertain (see Big Bar Landslide section under Management Information for further information).

Table 1. Pre-season and in-season updates of run size, spawning escapement targets and other TAC-related values for Fraser River sockeye in 2019. 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	41,000	41,000	0.69	28,300	500	3,600	41,000	0	0	0	0
	Early Summer	465,000	186,000	0.45	83,700	9,500	48,200	327,400	137,600	195,300	0	0
	Summer	3,930,000	1,572,000	0.09	141,500	53,000	290,100	2,056,600	1,873,400	2,216,500	0	0
	Late	359,000	336,600	0.56	188,500	4,000	58,100	359,000	0	0	0	0
	Sockeye	**4,795,000**	**2,135,600**		**442,000**	**67,000**	**400,000**	**2,784,000**	**2,011,000**	**2,411,800**	**0**	**0**
	Pink	**5,018,600**	**4,483,000**			**7,200**		**4,490,200**	**528,400**	**535,600**	**0**	**0**
July 9 In-season	Early Stuart	41,000	41,000	0.69	28,300	500	3,600	41,000	0	0	3	14,292
	Early Summer	465,000	186,000	0.45	83,700	9,500	48,200	327,400	137,600	195,300	1	2,858
	Summer	3,930,000	1,572,000	0.09	141,500	53,000	290,100	2,056,600	1,873,400	2,216,500	0	0
	Late	359,000	336,600	0.56	188,500	4,000	58,100	359,000	0	0	0	0
	Sockeye	**4,795,000**	**2,135,600**		**442,000**	**67,000**	**400,000**	**2,784,000**	**2,011,000**	**2,411,800**	**4**	**17,150**
	Pink	**5,018,600**	**4,483,000**			**7,200**		**4,490,200**	**528,400**	**535,600**	**0**	**0**
July 12 In-season	Early Stuart	41,000	41,000	0.69	28,300	500	3,600	41,000	0	0	28	20,000
	Early Summer	465,000	186,000	0.45	83,700	9,500	48,200	327,400	137,600	195,300	5	3,431
	Summer	3,930,000	1,572,000	0.09	141,500	53,000	290,100	2,056,600	1,873,400	2,216,500	0	0
	Late	359,000	336,600	0.56	188,500	4,000	58,100	359,000	0	0	0	0
	Sockeye	**4,795,000**	**2,135,600**		**442,000**	**67,000**	**400,000**	**2,784,000**	**2,011,000**	**2,411,800**	**33**	**23,431**
	Pink	**5,018,600**	**4,483,000**			**7,200**		**4,490,200**	**528,400**	**535,600**	**0**	**0**
July 16 In-season	Early Stuart	41,000	41,000	0.69	28,300	500	3,600	41,000	0	0	22	18,155
	Early Summer	465,000	186,000	0.45	83,700	9,500	48,200	327,400	137,600	195,300	43	10,876
	Summer	3,930,000	1,572,000	0.09	141,500	53,000	290,100	2,056,600	1,873,400	2,216,500	7	1,367
	Late	359,000	336,600	0.56	188,500	4,000	58,100	359,000	0	0	0	0
	Sockeye	**4,795,000**	**2,135,600**		**442,000**	**67,000**	**400,000**	**2,784,000**	**2,011,000**	**2,411,800**	**72**	**30,398**
	Pink	**5,018,600**	**4,483,000**			**7,200**		**4,490,200**	**528,400**	**535,600**	**0**	**0**
July 19 In-season	Early Stuart	27,000	27,000	0.69	18,600	500	3,600	27,000	0	0	59	20,243
	Early Summer	465,000	186,000	0.45	83,700	9,500	48,200	327,400	137,600	195,300	77	9,875
	Summer	3,930,000	1,572,000	0.09	141,500	53,000	290,100	2,056,600	1,873,400	2,216,500	3	1,294
	Late	359,000	336,600	0.56	188,500	4,000	58,100	359,000	0	0	0	0
	Sockeye	**4,781,000**	**2,121,600**		**432,300**	**67,000**	**400,000**	**2,770,000**	**2,011,000**	**2,411,800**	**139**	**31,412**
	Pink	**5,018,600**	**4,483,000**			**7,200**		**4,490,200**	**528,400**	**535,600**	**0**	**0**
July 23 In-season	Early Stuart	27,000	27,000	0.69	18,600	500	3,600	27,000	0	0	44	24,393
	Early Summer	465,000	186,000	0.45	83,700	9,500	48,200	327,400	137,600	195,300	90	16,729
	Summer	3,930,000	1,572,000	0.09	141,500	53,000	290,100	2,056,600	1,873,400	2,216,500	13	1,658
	Late	359,000	336,600	0.56	188,500	4,000	58,100	359,000	0	0	0	0
	Sockeye	**4,781,000**	**2,121,600**		**432,300**	**67,000**	**400,000**	**2,770,000**	**2,011,000**	**2,411,800**	**147**	**42,780**
	Pink	**5,018,600**	**4,483,000**			**7,200**		**4,490,200**	**528,400**	**535,600**	**0**	**0**
July 26 In-season	Early Stuart	27,000	27,000	0.69	18,600	500	3,600	27,000	0	0	45	25,918
	Early Summer	465,000	186,000	0.45	83,700	9,500	48,200	327,400	137,600	195,300	154	25,094
	Summer	3,930,000	1,572,000	0.09	141,500	53,000	290,100	2,056,600	1,873,400	2,216,500	27	3,364
	Late	359,000	336,600	0.56	188,500	4,000	58,100	359,000	0	0	0	0
	Sockeye	**4,781,000**	**2,121,600**		**432,300**	**67,000**	**400,000**	**2,770,000**	**2,011,000**	**2,411,800**	**226**	**54,376**
	Pink	**5,018,600**	**4,483,000**			**7,200**		**4,490,200**	**528,400**	**535,600**	**17**	**0**
July 30 In-season	Early Stuart	27,000	27,000	0.69	18,600	500	3,600	27,000	0	0	44	25,641
	Early Summer	465,000	186,000	0.45	83,700	9,500	48,200	327,400	137,600	195,300	348	37,869
	Summer	3,930,000	1,572,000	0.09	141,500	53,000	290,100	2,056,600	1,873,400	2,216,500	225	4,904
	Late	359,000	336,600	0.56	188,500	4,000	58,100	359,000	0	0	7	0
	Sockeye	**4,781,000**	**2,121,600**		**432,300**	**67,000**	**400,000**	**2,770,000**	**2,011,000**	**2,411,800**	**624**	**68,414**
	Pink	**5,018,600**	**4,483,000**			**7,200**		**4,490,200**	**528,400**	**535,600**	**56**	**0**
August 2 In-season	Early Stuart	27,000	27,000	0.69	18,600	500	2,200	27,000	0	0	45	25,794
	Early Summer	221,000	167,000	0.45	75,200	9,500	48,300	221,000	0	0	476	42,633
	Summer	3,930,000	1,572,000	0.09	141,500	53,000	291,200	2,057,700	1,872,300	2,216,500	378	7,619
	Late	359,000	336,600	0.56	188,500	4,000	58,300	359,000	0	0	24	393
	Sockeye	**4,537,000**	**2,102,600**		**423,800**	**67,000**	**400,000**	**2,664,700**	**1,872,300**	**2,216,500**	**923**	**76,439**
	Pink	**5,018,600**	**4,483,000**			**7,200**		**4,490,200**	**528,400**	**535,600**	**101**	**0**

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 Passage to date
August 6	In-season	Early Stuart	27,000	27,000	0.69	18,600	100	2,200	27,000	0	0	45	25,914
		Early Summer	221,000	167,000	0.45	75,200	2,000	48,300	221,000	0	0	605	51,179
		Summer	3,930,000	1,572,000	0.09	141,500	53,000	291,200	2,057,700	1,872,300	2,216,500	785	15,530
		Late	359,000	336,600	0.56	188,500	4,000	58,300	359,000	0	0	34	873
		Sockeye	**4,537,000**	**2,102,600**		**423,800**	**59,100**	**400,000**	**2,664,700**	**1,872,300**	**2,216,500**	**1,469**	**93,496**
		Pink	**5,018,600**	**4,483,000**			**7,200**		**4,490,200**	**528,400**	**535,600**	**186**	**0**
August 9	In-season	Early Stuart	27,000	27,000	0.69	18,600	100	2,200	27,000	0	0	45	25,895
		Early Summer	112,000	112,000	0.45	50,400	2,000	48,300	112,000	0	0	656	56,939
		Summer	3,930,000	1,572,000	0.09	141,500	29,600	291,200	2,034,300	1,895,700	2,216,500	1,103	27,779
		Late	359,000	336,600	0.56	188,500	3,200	58,300	359,000	0	0	48	1,113
		Sockeye	**4,428,000**	**2,047,600**		**399,000**	**34,900**	**400,000**	**2,532,300**	**1,895,700**	**2,216,500**	**1,852**	**111,726**
		Pink	**5,018,600**	**4,483,000**			**7,200**		**4,490,200**	**528,400**	**535,600**	**253**	**8,297**
August 13	In-season	Early Stuart	27,000	27,000	0.69	18,600	100	2,600	27,000	0	0	46	25,908
		Early Summer	112,000	112,000	0.45	50,400	2,000	9,200	112,000	0	0	773	65,524
		Summer	1,065,000	1,065,000	0.09	95,900	7,600	76,900	1,065,000	0	0	1,799	48,792
		Late	359,000	336,600	0.56	188,500	3,200	32,700	359,000	0	0	90	2,440
		Sockeye	**1,563,000**	**1,540,600**		**353,400**	**12,900**	**121,400**	**1,563,000**	**0**	**0**	**2,708**	**142,664**
		Pink	**5,018,600**	**4,483,000**			**5,500**		**4,488,500**	**530,100**	**535,600**	**642**	**15,608**
August 16	In-season	Early Stuart	27,000	27,000	0.69	18,600	100	2,600	27,000	0	0	46	25,908
		Early Summer	85,000	85,000	0.45	38,300	2,000	6,500	85,000	0	0	835	71,634
		Summer	224,000	224,000	0.09	20,200	7,600	14,800	224,000	0	0	2,387	71,490
		Late	111,000	111,000	0.56	62,200	3,200	7,900	111,000	0	0	108	3,510
		Sockeye	**447,000**	**447,000**		**139,300**	**12,900**	**31,800**	**447,000**	**0**	**0**	**3,376**	**172,542**
		Pink	**5,018,600**	**4,483,000**			**5,500**		**4,488,500**	**530,100**	**535,600**	**1,163**	**28,010**
August 20	In-season	Early Stuart	27,000	27,000	0.69	18,600	100	2,600	27,000	0	0	46	25,908
		Early Summer	90,000	90,000	0.45	40,500	1,500	7,500	90,000	0	0	887	80,307
		Summer	400,000	400,000	0.09	36,000	5,000	35,000	400,000	0	0	3,170	111,089
		Late	111,000	111,000	0.56	62,200	2,000	9,100	111,000	0	0	137	4,885
		Sockeye	**628,000**	**628,000**		**157,300**	**8,600**	**54,200**	**628,000**	**0**	**0**	**4,240**	**222,189**
		Pink	**5,018,600**	**4,483,000**			**23,500**		**4,506,500**	**512,100**	**535,600**	**1,598**	**51,213**
August 23	In-season	Early Stuart	27,000	27,000	0.69	18,600	100	2,600	27,000	0	0	46	25,908
		Early Summer	90,000	90,000	0.45	40,500	1,500	7,500	90,000	0	0	967	84,670
		Summer	400,000	400,000	0.09	36,000	5,000	35,000	400,000	0	0	3,880	135,155
		Late	40,000	40,000	0.56	22,400	2,000	9,100	40,000	0	0	233	6,355
		Sockeye	**557,000**	**557,000**		**117,500**	**8,600**	**54,200**	**557,000**	**0**	**0**	**5,126**	**252,088**
		Pink	**7,400,000**	**6,000,000**			**23,500**		**6,023,500**	**1,376,500**	**1,400,000**	**123,348**	**167,105**
August 27	In-season	Early Stuart	27,000	27,000	0.69	18,600	100	2,600	27,000	0	0	46	25,908
		Early Summer	90,000	90,000	0.45	40,500	1,500	7,500	90,000	0	0	1,001	87,852
		Summer	400,000	400,000	0.09	36,000	5,000	35,000	400,000	0	0	4,540	197,724
		Late	40,000	40,000	0.56	22,400	2,000	9,100	40,000	0	0	327	8,439
		Sockeye	**557,000**	**557,000**		**117,500**	**8,600**	**54,200**	**557,000**	**0**	**0**	**5,914**	**319,923**
		Pink	**7,400,000**	**6,000,000**			**23,500**		**6,023,500**	**1,376,500**	**1,400,000**	**226,645**	**297,401**
August 30	In-season	Early Stuart	27,000	27,000	0.69	18,600	100	2,600	27,000	0	0	46	25,908
		Early Summer	90,000	90,000	0.45	40,500	1,500	7,500	90,000	0	0	1,010	89,830
		Summer	400,000	400,000	0.09	36,000	5,000	35,000	400,000	0	0	4,857	265,503
		Late	40,000	40,000	0.56	22,400	750	9,100	40,000	0	0	323	9,955
		Sockeye	**557,000**	**557,000**		**117,500**	**7,350**	**54,200**	**557,000**	**0**	**0**	**6,236**	**391,196**
		Pink	**5,000,000**	**4,468,800**			**23,500**		**4,492,300**	**507,700**	**531,200**	**248,082**	**461,357**
September 3	In-season	Early Stuart	27,000	27,000	0.69	18,600	100	2,600	27,000	0	0	46	25,908
		Early Summer	90,000	90,000	0.45	40,500	1,500	7,500	90,000	0	0	1,009	91,129
		Summer	400,000	400,000	0.09	36,000	5,000	35,000	400,000	0	0	4,945	297,840
		Late	40,000	40,000	0.56	22,400	750	9,100	40,000	0	0	329	13,385
		Sockeye	**557,000**	**557,000**		**117,500**	**7,350**	**54,200**	**557,000**	**0**	**0**	**6,329**	**428,262**
		Pink	**5,000,000**	**4,468,800**			**23,500**		**4,492,300**	**507,700**	**531,200**	**249,556**	**1,149,120**

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 Passage to date
September 6	In-season	Early Stuart	27,000	27,000	0.69	18,600	100	2,600	27,000	0	0	46	25,908
		Early Summer	90,000	90,000	0.45	40,500	1,500	7,500	90,000	0	0	1,012	92,423
		Summer	400,000	400,000	0.09	36,000	5,000	35,000	400,000	0	0	4,977	312,005
		Late	40,000	40,000	0.56	22,400	750	9,100	40,000	0	0	324	11,536
		Sockeye	**557,000**	**557,000**		**117,500**	**7,350**	**54,200**	**557,000**	**0**	**0**	**6,358**	**441,872**
		Pink	**5,000,000**	**4,468,800**			**23,500**		**4,492,300**	**507,700**	**531,200**	**253,033**	**2,957,841**
September 10	In-season	Early Stuart	27,000	27,000	0.69	18,600	100	2,600	27,000	0	0	46	25,908
		Early Summer	90,000	90,000	0.45	40,500	1,500	7,500	90,000	0	0	1,012	92,381
		Summer	400,000	400,000	0.09	36,000	5,000	35,000	400,000	0	0	5,004	324,129
		Late	40,000	40,000	0.56	22,400	750	9,100	40,000	0	0	326	12,729
		Sockeye	**557,000**	**557,000**		**117,500**	**7,350**	**54,200**	**557,000**	**0**	**0**	**6,388**	**455,147**
		Pink	**5,000,000**	**4,468,800**			**23,500**		**4,492,300**	**507,700**	**531,200**	**256,870**	**4,631,498**
September 12	In-season	Early Stuart	26,000	26,000	0.69	17,900	100	2,500	26,000	0	0	46	25,908
		Early Summer	94,000	94,000	0.45	42,300	1,100	8,300	94,000	0	0	1,012	92,381
		Summer	360,000	360,000	0.09	32,400	5,000	31,000	360,000	0	0	5,031	336,362
		Late	20,000	20,000	0.56	11,200	500	1,500	20,000	0	0	329	13,946
		Sockeye	**500,000**	**500,000**		**103,800**	**6,700**	**43,300**	**500,000**	**0**	**0**	**6,417**	**468,597**
		Pink	**8,900,000**	**6,000,000**			**23,500**		**6,023,500**	**2,876,500**	**2,900,000**	**262,316**	**6,878,744**
September 13	In-season	Early Stuart	26,000	26,000	0.69	17,900	100	2,500	26,000	0	0	46	25,908
		Early Summer	94,000	94,000	0.45	42,300	1,100	8,300	94,000	0	0	1,012	92,381
		Summer	360,000	360,000	0.09	32,400	5,000	31,000	360,000	0	0	5,026	335,440
		Late	20,000	20,000	0.56	11,200	500	1,500	20,000	0	0	342	20,268
		Sockeye	**500,000**	**500,000**		**103,800**	**6,700**	**43,300**	**500,000**	**0**	**0**	**6,426**	**473,997**
		Pink	**8,900,000**	**6,000,000**			**23,500**		**6,023,500**	**2,876,500**	**2,900,000**	**262,602**	**7,726,883**
September 17	End-of-season	Early Stuart	26,000	26,000	0.69	17,900	100	2,500	26,000	0	0	46	25,908
		Early Summer	94,000	94,000	0.45	42,300	1,100	8,300	94,000	0	0	1,012	92,514
		Summer	360,000	360,000	0.09	32,400	5,000	31,000	360,000	0	0	5,035	338,645
		Late	20,000	20,000	0.56	11,200	500	1,500	20,000	0	0	344	21,740
		Sockeye	**500,000**	**500,000**		**103,800**	**6,700**	**43,300**	**500,000**	**0**	**0**	**6,437**	**478,807**
		Pink	**8,900,000**	**6,000,000**			**23,500**		**6,023,500**	**2,876,500**	**2,900,000**	**263,283**	**8,375,007**

* 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 opportunities.

*** 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 07 - 13, 2019:

The first in-season Panel meeting took place on Tuesday, July 09. Due to favourable conditions the Mission hydroacoustics program was operational on July 04, four days earlier than expected. Only a very small number of sockeye, predominantly Early Stuart, had been caught in the in-river test fishery at Whonnock. By July 12, approximately 23,400 sockeye were estimated to have passed by Mission. Fraser River water temperature at Qualark was 17.6ºC which was 1.7ºC above average and the discharge was 4,371 $m^3 \cdot s^{-1}$ which was 22% below average.

At the Big Bar landslide location, hydroacoustic fish monitoring stations had been established both upstream and downstream of the site to evaluate the impact of the slide on the upstream migration of salmon. High water levels and substantial buildup of debris from flooding in the Chilcotin River however created challenges in the collection of hydroacoustic data. Radio tagging to track the fish travelling through the slide area was scheduled to commence as soon as possible. In addition, potential options were being explored to physically move fish upstream from the obstruction. Sockeye stocks with spawning grounds above the landslide were expected to need about 10 days to migrate from the Lower Fraser River to the landslide location. Based on pre-season forecasts, the peak migration of Early Stuart was expected at the landslide around July 21. Also, close to 4,000 Early Stuart sockeye were expected to have reached the slide location by July 7

but the large amounts of sediments and debris within the Fraser River seemed to have slowed down the upstream migration substantially. At this point, no information was available regarding the expected success of Early Stuart sockeye migration past the landslide.

July 14 – 20, 2019:

Approximately 20,200 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 below the median forecast of 41,000 and after review the Panel adopted the p25 forecast level of 27,000 sockeye with a 50% marine timing of July 8. On July 18, the Fraser River water temperature at Qualark was 18.0ºC which was 1.4ºC above average and the discharge was 4,465 $m^3 \cdot s^{-1}$ which was 14% below average. Given the lack of management implications, no changes were made to the Management Adjustment for Early Stuart sockeye.

With the low abundance in marine areas, the start of several marine test fisheries was delayed. The Area 5 test fishery was scheduled to start on July 17 but was delayed until further notice. The purse seine test fisheries in Area 12,13 and 20 were delayed by one day to July 24, 26, and 25, respectively.

The landslide at Big Bar continued to be a major source of concern for the Panel. Several options were still under consideration for fish transport past this site which included moving fish by helicopter or truck as well as potentially moving fish using the WHOOSHH Fish Transport System, also known as a 'salmon cannon'. Fish monitoring plans included hydroacoustics above and below the slide, radio tagging and PIT tagging, blood sampling and the installation of a camera. Due to high water levels over the past week it had not been possible to use the hydroacoustics systems but conditions were improving. There was no information to date on the migration success of Early Stuart sockeye past the landslide site.

July 21 – 27, 2019:

Approximately 25,900 Early Stuart sockeye had passed by Mission to date. No changes were made to the Early Stuart run size which remained at 27,000 sockeye with a 50% marine timing through Area 20 of July 8. Most of the Early Summer-run fish detected in test fisheries and migrating past Mission were Nadina sockeye. The estimated escapement of Early Summer-run sockeye past Mission through July 25 was 25,300 fish and the run was tracking below the p25 forecast of 221,000. Current data suggested the run was likely to be later and/or smaller than expected pre-season. The diversion rate had been fluctuating substantially due to the low test fishing catches and reached 47% on July 25.

Both flow levels and water temperatures remained relatively stable. The Fraser River water temperature at Qualark and the discharge at Hope were both close to average at 18.2°C and 4,200$m^3 \cdot s^1$.

At the Big Bar landslide, controlled blasting operations had been successful in removing dangerous overhanging rock on the face of the landslide and rock scaling crews had begun manipulating rocks to create a natural fish passage. Fish transport via helicopters started earlier this week and a total of 120 sockeye and 86 Chinook had been transported. Fish monitoring using hydroacoustic stations below and above the landslide location had resumed. Despite improved river conditions, the hydroacoustic station above the landslide did not detect any fish, likely due to the high-water velocity at the landslide site. Downstream of the site, salmon were captured for radio tagging by seining and onshore angling. By July 25, a total of 129 salmon had been radio tagged (28 sockeye and 101 Chinook) and tagging was expected to continue at a rate of 100 radio tags per week. A total of 10 radio stations had been placed near the landslide to monitor successful migration past the partial blockage. Thus far, no radio tagged salmon had been detected upstream of the landslide. Tagged salmon were also being moved upstream using helicopter transport to evaluate the success of their continued migration.

July 28 – August 3, 2019:

As of August 1, the Early Stuart run was near completion with an estimated escapement of 25,800. The estimated escapement of Early Summer-run sockeye past Mission through August 1 was 42,600 fish and the run was tracking slightly above the p10 forecast (112,000). To date, most of the Early Summer run was comprised of Nadina sockeye. As of August 1, the estimated escapement of Early Thompson totalled 2,000 sockeye and another 2,000 sockeye were expected to reach the river in the next six days. It was however anticipated that there would be more Early Thompson sockeye seaward of the marine test fisheries. As a result, the Panel adopted an Early Summer-run run size of 221,000 (p25 forecast) with an associated 50% marine timing in Area 20 of August 8. At this run size there was no available International Allowable Catch for Early Summer-run sockeye. Summer-run sockeye were increasing in marine areas but few Chilko sockeye were present within the catch sample which was unexpected as they comprised 70% of the Summer run management group run size forecast. The diversion rate was 59% which was similar to pre-season expectations for the time of year.

Both flow levels and water temperatures remained relatively stable and close to average. The Fraser River water temperature at Qualark and the discharge at Hope were at 18.2°C and 4,011$m^3 \cdot s^1$.

At the Big Bar landslide, controlled blasting continued in order to increase the amount of material available for moving boulders into the river to change the flow of water and allow for easier migration for salmon. A prefabricated fish ladder was on site but had not been deployed. Radio tagging continued as did bio sampling for stress testing. Assembly of a fish-wheel was underway which would aid with the capture of salmon for transport. The number of salmon counted by the Big Bar acoustic monitoring equipment continued to increase daily and on August 3, the number of salmon transported by helicopter totalled 3,600 sockeye and Chinook. Since July 12, approximately 40,000 sockeye and Chinook salmon had been accounted for at the hydroacoustics site downstream of the slide. Excluding the salmon transported by helicopter, none of the radio tagged salmon released below the slide had been detected above the Big Bar slide. Also, the hydroacoustic site upstream of the slide had not yet detected any upstream migration since water levels decreased following the flooding of the Chilcotin River.

August 04-10, 2019:

The Early Stuart run was complete with an estimated catch plus escapement of 25,900. The estimated escapement of Early Summer-run sockeye past Mission through August 8 was 56,900 fish and the run continued to track below the p10 forecast (112,000). Thus far the Early Summer-run groups had mainly consisted of Nadina and only a limited number of Early Thompson sockeye had been detected in the catch samples. Given the limited number of Early Thompson sockeye observed thus far and the lack of management implications, the Panel adopted the Early Summer-run p10 run-size forecast of 112,000 with an associated 50% marine timing in Area 20 of August 2.

The catch plus escapement estimate for Summer-run stocks reached 28,900 sockeye on August 8. The Summer run was tracking below the p10 forecast of 1.6 million sockeye. The presence of the Chilko stock group, which was expected to contribute more than half of the total Fraser sockeye return this year had increased in catch samples but associated abundances remained low. Given the Summer-run abundance accounted for to date and the on-going fish passage issues due to the Big Bar landslide, the Panel was not considering sockeye directed fishery openings. The five-day average sockeye diversion rate through Johnstone Strait had increased to 90% by the end of the week.

The Fraser River pink salmon marine catches appeared to be tracking near the historic cycle average. In-river estimates of pink salmon were generated by the Mission hydroacoustics program, and as of August 8, 8,600 were estimated in catch and escapement past the Mission site. The pink salmon diversion rate was 25% which was below the cycle average of 50%.

The Fraser River water temperature at Qualark of 19.1°C was 1°C higher than average for this date but was expected to decrease slightly to 18.8°C and the discharge was close to average at 3,921$m^3 \cdot s^1$ and was expected to decrease to average values.

On August 8, it was estimated that about 59,000 sockeye should have reached the Big Bar site based on abundances observed at Mission. High water levels at the landslide site due to heavy rainfall in the northern part of the watershed delayed the rock manipulations required for the completion of the natural fish way. As of August 4, a total of 144 salmon had been radio tagged to monitor their upstream movement. Thus far, only two radio tagged salmon had made it to the northern portion of the watershed and both had been transported by helicopter. A total of approximately 5,200 sockeye had been transported upstream from the slide via helicopter.

August 11 – 17, 2019:

The estimated escapement and catch of Early Summer-run sockeye past Mission through August 15 was 72,400 fish and the run continued to track below the p10 forecast (112,000). Early Summer-run groups had mainly consisted of Nadina and only a limited number of Early Thompson sockeye had been detected in the catch samples. Given the limited number of Early Thompson sockeye observed and the lack of management implications, the Panel adopted the Early Summer-run run size of 85,000 with an associated 50% marine timing of July 26.
The catch plus escapement estimate for Summer-run stocks reached 73,900 sockeye on August 15. The Summer run was tracking below the p10 forecast of 1.6 million sockeye. Chilko dominated the catch samples but associated abundances remained low. Given the Summer-run abundance accounted for to date and the on-going fish passage issues due to the Big Bar landslide, the Panel adopted an in-season Summer-run run size of 224,000 with an associated 50% marine timing of August 17.

On August 15, the catch plus escapement estimate past Mission for Late-run stocks was 3,600 sockeye. The current data were insufficient to generate an in-season run size estimate but daily Late-run abundances were tracking below the p10 forecast of 111,000. Pre-season, Birkenhead was expected to contribute 64% of the returning Late run sockeye but currently was returning in very small numbers. For the other Late-run stocks, there was no evidence of Late-run delay. The Panel adopted a p10 run size forecast of 111,000 with an associated 50% marine timing of August 25. These adopted run sizes brought the total adopted in-season run size to 447,000 which, if materialized, would be the lowest run size observed since records began in 1893. Each management group was in a low abundance exploitation rate (LAER) scenario, but with a further reduction to run size there was a large change in the sockeye allowable mortality for each group from 310,000 to just under 87,000. This was particularly important as any future pink salmon directed fisheries would need to take the total allowable mortality into consideration. The sockeye diversion rate through Johnstone Strait had decreased slightly to 86% by the end of the week. The Fraser River pink salmon daily abundances appeared to be tracking well above the median forecast of 5,018,600. In-river estimates of pink salmon were generated by the Mission hydroacoustics program, and as of August 15, 29,200 were estimated in catch and escapement past the Mission site. The pink salmon diversion rate was 7% which was well below the pre-season forecast of 50%.

The Fraser River water temperature at Qualark of 19.2°C was 1.2°C higher then average for this date but was expected to decrease slightly to 18.9°C and the discharge was close to average at 3,237$m^3 \cdot s^1$ and was expected to remain in this range. For Early Summer run, the 19-day model predicted an expected Difference Between Estimates (DBE) of -27% assuming a timing of August

2 compared to pre-season expectations of -31%; however, this estimate did account for the environmental conditions at Big Bar landslide. DFO provided an escapement estimate of 3.3% past Big Bar site which based on an updated calculation of the DBE translated into a DBE of -63. It was noted that this DBE did not account for the biological issues these fish would be confronting (e.g., depleted energy reserves to try to migrate past site). The Panel did not adopt either one of these DBEs as there was no impact on management for this management group.

On August 15, it was estimated that about 76,000 sockeye should have reached the Big Bar site based on abundances observed at Mission and thus far, approximately 9,500 sockeye had been transported upstream from the slide via helicopter. As of August 9, a total of 185 salmon had been radio tagged to monitor their upstream movement. Excluding the salmon transported by helicopter, none of the radio tagged salmon released below the slide had been detected above the Big Bar slide thus far. Water levels at the landslide site were decreasing.

August 18 – 24, 2019:

The estimated escapement and catch of Early Summer-run sockeye past Mission through August 22 was 85,700 fish. Recent catches in the marine areas indicated the return of a few of the later timed Early Summer run stocks (Gates, Nahatlatch, Early Thompson). At the meeting on Tuesday, the Panel adopted an in-season run size of 90,000 which was slightly higher than the previously adopted run size of 85,000 with a 50% marine timing in Area 20 of July 27.
The catch plus escapement estimate for Summer-run stocks reached 139,100 sockeye on August 22. Although the run was tracking well below the adopted run size of 224,000 there were still indications of Chilko fish returning in the marine areas. The Panel adopted an in-season Summer-run run size of 400,000 with an associated 50% marine timing of August 21. On August 22, the catch plus escapement estimate past Mission for Late-run stocks was 6,400 sockeye. Daily Late run abundances were tracking well below the p10 forecast of 111,000. Birkenhead continued to return in very small numbers. For the other Late-run stocks, there was no evidence of Late-run delay. The Panel adopted a run-size of 40,000 with an associated 50% marine timing of August 26.

Despite the small increase in the Early Summer and Summer-run run size, the reduction in the Late-run run size still meant that these adopted run sizes brought the total adopted in-season run size to 557,000. Each management group was in a low abundance exploitation rate (LAER) scenario.

The Fraser River pink salmon daily abundances appeared to be tracking well above the median forecast of 5,018,600 as well as the p75 forecast of 7.5 million. These daily abundance estimates had however been derived based on the historic catchability estimates and the Fraser River Panel expressed concerns regarding the very high marine survival rates these estimates would imply given that the out-migrating fry abundance in 2018 (192 million) had been the lowest number observed since the method for enumerating out-migrating fry had been standardised in 1968. At the Tuesday meeting, DFO provided pre-season estimates of timing and diversion for Fraser River pink salmon. The timing forecast of August 25 was three days earlier than the long-term average and the timing assumed prior to the start of the season. The updated diversion rate forecast of 53% was similar to the 50% assumed pre-season. Thus far, in-season diversion rates for pink salmon had however been much lower at less than 10%. At Tuesday's meeting, the Panel approved a U.S. pink directed fishery based on the median preseason forecast, but efforts were to be made to release sockeye alive. Due to better than expected catches, the U.S. closed the pink directed fishery on Friday morning following concerns they would exceed their Total Allowable Catch (TAC). The total Fraser River pink catch associated with this fishery opening totalled 116,500 pink salmon which did not exceed the available US TAC of 131,500 pinks. Daily abundance estimates derived from the U.S. CPUE data averaged 335,000 pink salmon per day and confirmed daily abundances generated from test fishery data.

As of August 22, 167,100 pink salmon had been estimated by the Mission hydroacoutics program and an additional 123,300 Fraser River pink salmon had been caught in the test fisheries and the US fishery, bringing the total number of pinks observed in catch and escapement to 290,500. At Friday's meeting the Panel adopted a pink salmon run size of 7.4 million with a 50% marine timing in Area 20 of August 20. This run size assumed a 3.8% survival rate while the survival rate associated with the preseason forecast was 2.6% and the average survival rate was 3%. With the increased run size there was more available pink salmon TAC for both countries. The catch remaining for the U.S. was 237,300 pinks while Canada still had the total pink salmon TAC of 1,022,700 pinks available. The Panel approved another pink salmon directed fishery in the U.S.; however, there was no sockeye retention for either the Treaty Indian or All Citizens fishery.

The Fraser River water temperature at Qualark of 18.1°C was 1.4°C higher than average for this date but was expected to decrease slightly to 16.7°C and the discharge was close to average at 3,265$m^3 \cdot s^1$ and was expected to increase to decrease to 2,934 $m^3 \cdot s^1$. For Early Summer run, the 31-day model predicted an expected Difference Between Estimates (DBE) of -30% assuming a timing of July 27 compared to pre-season expectations of -31%; however, this estimate did account for the environmental conditions at Big Bar landslide. It was noted that this DBE did not account for the biological issues these fish would be confronting (e.g., depleted energy reserves to try to migrate past site).

On August 22, it was estimated that about 117,600 sockeye should have reached the Big Bar site based on abundances observed at Mission and approximately 25,108 sockeye had been transported upstream from the slide via helicopter. As of August 22, a total of 378 salmon had been radio tagged to monitor their upstream movement. There was evidence of restricted natural passage of Chinook salmon through the slide area but there was no evidence that sockeye were able to migrate through. Water levels at the landslide site had decreased to similar levels compared to when the landslide had first been detected and this was assumed to aid the natural passage of Chinook salmon.

August 25 – 31, 2019:

Mission passage estimates for Fraser sockeye on August 29 for Early Stuart, Early Summer-, Summer- and Late-run groups were 25,900, 89,800, 265,500 and 10,000, respectively. The pink salmon estimate past Mission was 461,400. Test fishing catches remained low for sockeye and had also substantially declined for pink salmon in the marine areas. Following the decline in marine pink salmon catches and lower than expected All Citizen catches in U.S. Area 7 fisheries, resulting run size estimates were tracking closer to 5.0 million compared to the adopted run size of 7.4 million.

Overall, there was considerable uncertainty regarding the pink salmon run size. At the meeting on August 27, the Panel agreed to manage the pink run size to the median forecast (5,018,600) for management purposes. Later in the week, the different pink salmon run size estimation methods were reviewed: a reconstruction based run size model using marine catch per unit effort (CPUE) data in combination with historical expansion lines, a time-density model using marine test fishing data, a reconstruction based run size model using marine catch per unit effort data in combination with an in-season Area 20 expansion line based on U.S. Area 7 fishery data, and finally a regression model that uses four days of CPUE data prior to the historical peak marine migration date to predict the run size. The reconstruction-based run size model using an in-season expansion line derived from U.S. Area 7 data performed best across historical years and produced a run size estimate of 5 million for 2019. With the exception of the reconstruction-based run size model using historical expansion lines, all models indicated that the pink salmon run size was near or below 5.0 million. The Panel therefore adopted a pink salmon run size estimate of 5.0 million with a 50% marine timing in Area 20 of August 17. As a result of the reduction in run size there was no available total allowable catch (TAC) for the U.S. In-season diversion rates for pink salmon had increased substantially over the last week to 59% which was near the pre-season forecast of 50%. The Panel decided to terminate the Area 12 and 20 purse seine test fisheries a

week earlier than planned given the decline in pink salmon test fishing catches, the lack of U.S. TAC and the high cost of this test fishery.

The Fraser River water temperature at Qualark of 17.6°C was 0.5°C higher than average for this date but was expected to decrease slightly to 18.2°C and the discharge was close to average at 2,829 $m^3 \cdot s^1$ and was expected to decrease to 2,543 $m^3 \cdot s^1$. For Summer run, the 19-day model produced an expected Difference Between Estimates (DBE) of -5% when assuming a timing of August 21, pre-season a difference of -8% was expected. Neither estimate accounted for the migration conditions at Big Bar landslide, nor for the biological issues these fish would be confronting (e.g. depleted energy reserves to try to migrate past site).

On August 29, it was estimated that about 180,100 sockeye should have reached the Big Bar site based on abundances observed at Mission and also some pink salmon were reported to have arrived at Big Bar. As of August 29, 41,347 sockeye and 30 pink salmon had been transported upstream from the slide via helicopter. Based on radio telemetry, 56% of the helicopter-transported salmon were able to successfully resume their upstream migration. A total of 305 sockeye and 5 pink salmon had been radio-tagged to monitor their upstream movement. There was evidence of restricted natural passage of Chinook and sockeye salmon through the slide area as 17 radio-tagged Chinook and 2 radio-tagged sockeye had successfully migrated through the slide area as of August 26.

September 1 – September 7, 2019:

Mission passage estimates for Fraser sockeye on September 5 were 25,900, 92,400, 312,000 and 11,500 for Early Stuart, Early Summer-, Summer- and Late-run groups respectively. The pink salmon estimate past Mission was 2,957,800. In-river test fishing catches remained low for sockeye but had increased substantially for pink salmon.

The Fraser River water temperature at Qualark of 18.2°C was 1.9°C higher than average for this date but was expected to decrease to 17.3°C and the discharge was close to average at 2,279 $m^3 \cdot s^1$ and was expected to decrease to 2,073 $m^3 \cdot s^1$.

On September 6, it was estimated that about 285,000 sockeye should have reached the Big Bar site based on abundances observed at Mission. Approximately 51,449 sockeye and 372 pink salmon had been transported upstream from the slide via helicopter. However, helicopter transport was temporarily ceased due to the increase in successful natural migration of Chinook, sockeye and pink salmon through the slide area. Prior to August 28, the percent successful passage past Big Bar with helicopter assistance and through natural passage was 19%. After August 28, the percent successful passage past Big Bar increased to 64%, bringing the overall success rate to 43%.

September 8 - 14, 2019:

Mission passage estimates on September 13 for Early Stuart, Early Summer-, Summer- and Late-run groups were 25,900, 92,400, 335,400 and 20,300 fish, respectively. While in-river test fishing catches remained low for sockeye, they were still very high for pink salmon. The pink salmon estimate past Mission was 7,726,900.

At the meeting on Thursday September 12, the Panel increased the pink salmon run size to 8.9 million based on the marine CPUE data and the historic expansion line which was also more consistent with the current escapement estimate. The associated Area 20 timing remained August 17. The Panel also adopted in-season run sizes for Early Stuart, Early Summer-, Summer- and Late-run groups of 26,000, 94,000, 360,000, and 20,000, respectively, with associated Area 20 timing estimates of July 29 for Early Summer run, and August 19 for both Summer- and Late run .

At the new adopted pink salmon run size of 8.9 million the U.S. and Canada both had catch remaining: 505,000 and 2.1 million pink salmon respectively and opened pink salmon fisheries with non-retention of sockeye salmon.

The Fraser River water temperature at Qualark of 17.6°C was 2.4°C higher than average for this date but was expected to decrease to 16.0°C and the discharge was close to average at 2,163 $m^3 \cdot s^1$ and was expected to decrease to 1,968 $m^3 \cdot s^1$.

On September 12, it was estimated that about 356,000 sockeye should have reached the Big Bar site based on abundances observed at Mission. Based on radio-tagging information it was estimated that at least 64% of actively migrating sockeye and 57% of actively migrating pink salmon were able to successfully pass the landslide. Including the salmon transported by helicopter earlier in the season, a total of 200,000 salmon had been accounted for at the hydroacoustic station at Churn Creek above the Big Bar slide. This included Chinook as well as sockeye and pink salmon. Despite the increased migration success, pink salmon spawning activity has been observed in the main stem of the Fraser River below the Big Bar site.

September 15 - 21, 2019:

Mission passage estimates on September 17 for Early Stuart, Early Summer-, Summer- and Late-run groups were 25,900, 92,500, 338,600 and 21,700 fish, respectively. In-river test fishing catches remained low for sockeye, pink salmon catches had decreased substantially as well. The pink salmon estimate past Mission was 8,375,000.

The Fraser River water temperature at Qualark of 16.2°C was 1.5°C higher than average for this date but was expected to decrease slightly to 15.0°C and the discharge was above average at 2,411$m^3 \cdot s^1$ and was expected to increase to 2,768$m^3 \cdot s^1$. For Summer run, the 31-day model predicted an expected Difference Between Estimates (DBE) of -37% assuming a timing of August 19 compared to pre-season expectations of -8%; however, this estimate did not account for the environmental conditions at Big Bar landslide. It was noted that this DBE did not account for the biological issues these fish would be confronting (e.g., depleted energy reserves to try to migrate past site).

On September 16, 366,000 sockeye were expected to have reached the Big Bar site based on abundances observed at Mission. Based on radio-tagging information it was estimated that at least 53% of actively migrating sockeye and 36% of actively migrating pink salmon were able to successfully pass the landslide. Including the salmon transported by helicopter earlier in the season, a total of 234,000 salmon had been accounted for at the hydroacoustic station at Churn Creek above the Big Bar slide. This included Chinook as well as sockeye and pink salmon. Sonar operators at the Big Bar sonar site observed smaller salmon digging in the river bottom on the sonar video files.

On October 5, 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 12) as per revised 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.

Overviews of pink salmon directed commercial fisheries openings in U.S. and Canadian Panel Areas are contained in Table 2 and 3. There were no commercial fisheries for sockeye salmon.

Table 2. Number of days when major Canadian commercial fisheries in the Fraser River Panel Area were open for directed harvest of Fraser River pink salmon in 2019. Regulatory control of Canadian Panel Areas was relinquished by the Panel on September 21 For Area 20, September 28 for Areas 17 and 18, and October 12 for Area 29, in accordance with pre-season regulations (Appendix D).

	Panel Areas					Non-Panel Areas			
	20		29		18, 29	11-16			
Date	Purse Seine	Gillnet	Purse Seine	Gillnet	Troll	Purse Seine	Gillnet	Troll H	Troll G
Jun.16-Aug.3									
Aug.4-Aug.10									
Aug.11-Aug.17									
Aug.18-Aug.24									
Aug.25-Aug.31									
Sep.1-Sep.7									
Sep.8-Sep.14			1		1				
Sep.15-Sep.21			3		3				
Sep.22-Sep.28									
Sep.29-Oct.5									
Oct.6-Oct.12									
Total	0	0	4	0	4	0	0	0	0

Table 3. Number of days when major U.S. net fisheries in the Fraser River Panel Area were open for directed harvest of Fraser River pink salmon in 2019. Regulatory control of U.S. Panel Areas was relinquished by the Panel on September 17 for Areas 4b, 5, 6, 6c, and 7 by in-season order; September 21 for portions of Areas 7a (excluding the Apex) by in-season order and October 5 for the remaining portions of Area 7a, in accordance with pre-season regulations (Appendix D).

	Treaty Indian		All Citizen		
	Areas	Areas	Areas 7 and 7A		
Date	4B, 5, 6C	6, 7, 7A	Purse Seine	Gillnet	Reefnet
Jun.16-Aug.3					
Aug.4-Aug.10					
Aug.11-Aug.17					
Aug.18-Aug.24	4	3		1	1
Aug.25-Aug.31	4	2		1	1
Sep.1-Sep.7					
Sep.8-Sep.14		2	1	2	2
Sep.15-Sep.21	2	2			
Sep.22-Sep.28					
Sep.29-Oct.5					
Total	10	9	1	4	4

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 4. 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 5 shows the sockeye stock resolution that was reported in 2019.

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 4. Panel-approved stock monitoring operations (test fishery, hydroacoustic and observer) conducted during the 2019 fishing season.

Area	Location	Gear	Dates	Operated by
Canadian Panel Areas				
20	Juan de Fuca Str.	Gillnet	July 10 - August 13	PSC
20	Juan de Fuca Str.	Purse Seine	July 26 - August 30	PSC
29-14	Fraser R. (Cottonwood)	Gillnet	July 12 - September 16	PSC
29-16	Fraser R. (Whonnock)	Gillnet	June 24 - September 28	PSC
29-16	Fraser R. (Mission)	Hydroacoustic	July 4 - September 23	PSC
Canadian non-Panel Areas				
12	Queen Charlotte Str. (Round Is.)[1]	Gillnet	July 11 - August 11	DFO
12	Johnstone Str. (Blinkhorn)	Purse Seine	July 25 - August 30	DFO
13	Lower Johnstone Str.	Purse Seine	August 10 - August 23	DFO
	Fraser R. (Hells Gate)	Observer	July 3 - September 29	PSC
	Fraser R. (Qualark)	Gillnet	July 2 - September 29	DFO
	Fraser R. (Qualark)	Hydroacoustic	July 1 - September 30	DFO
United States Panel Areas				
7	San Juan Islands	Reefnet	August 17 - September 12	PSC

[1] An additional test fishing vessel funded by the Southern Endowment Fund was operated to assess the use of an Alaska Twist gillnet from July 16, 2019 to August 9, 2019.

Table 5. Individual stocks included in the Fraser River sockeye stock groups used in 2019.

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 estimates adopted by the Panel were 500,000 Fraser River sockeye and 8,900,000 pink 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 (571,000 fish, Tables 8 and 9) based on spawning ground enumerations, accounted catches and differences between estimates is slightly more than the end-of-season estimate, and only 12% of the pre-season median forecast (4,795,000).

Ongoing research at Mission[8,9] has produced hydroacoustic methods that provide reliable daily estimates of pink salmon passage. The post season run-size estimate of 8,858,600 fish (Table 8) was calculated by adding the estimated catch below Mission (292,700 fish) to the Mission passage estimate (8,565,900 fish, Table 7). This estimate is 76% greater than the median pre-season forecast (5,018,600).

B. Migration Timing and Diversion Rate

Figures 3 and 4 show the forecasted and observed daily abundances, and Area 20 50% migration dates for each sockeye management group and for total Fraser River sockeye and pink salmon. The end-of-season estimates of marine migration timing in 2019 were later than pre-

[8] Xie, Y., F.J.Martens, and J.L.Nelitz. 2012. Implementation of stationary sub-sampling systems to estimate salmon passage in the Lower Fraser River: Year 1 of 2011 and 2012 project report to Southern boundary restoration and enhancement fund. Pacific Salmon Commission, Vancouver, British Columbia. May, 2012.
[9] Martens, F.J. and Y.Xie. 2014. Estimation of near-shore salmon passage using stratified vertical sampling by DIDSON sonar: A final project report to the southern boundary restoration and enhancement fund. Pacific Salmon Commission. June, 2014.

season expectations for the Early Stuart (3 days later), Summer-run (9 days later) and Late-run (1 day later) groups but earlier than expected for Early Summer-run (1 day earlier) and pink salmon (11 days earlier). With the exception of the Summer run, the timing of the sockeye stocks was similar to the cycle line average for the sockeye management groups. The timing for pink salmon was much earlier than the historical median and also two days earlier than the timing of Summer- and Late-run sockeye.

The diversion rate in 2019 was higher than forecast for Fraser sockeye, but much lower than forecast for pink salmon. For Fraser sockeye the observed annual diversion through Johnstone Strait was 84% of the Fraser sockeye return, compared to the initial forecast of 69% used for pre-season planning (Figure 5). For Fraser River pink salmon, the Johnstone Strait diversion rate was 11%, a record low, instead of the 50% that was used in planning and the forecasted value of 53%.

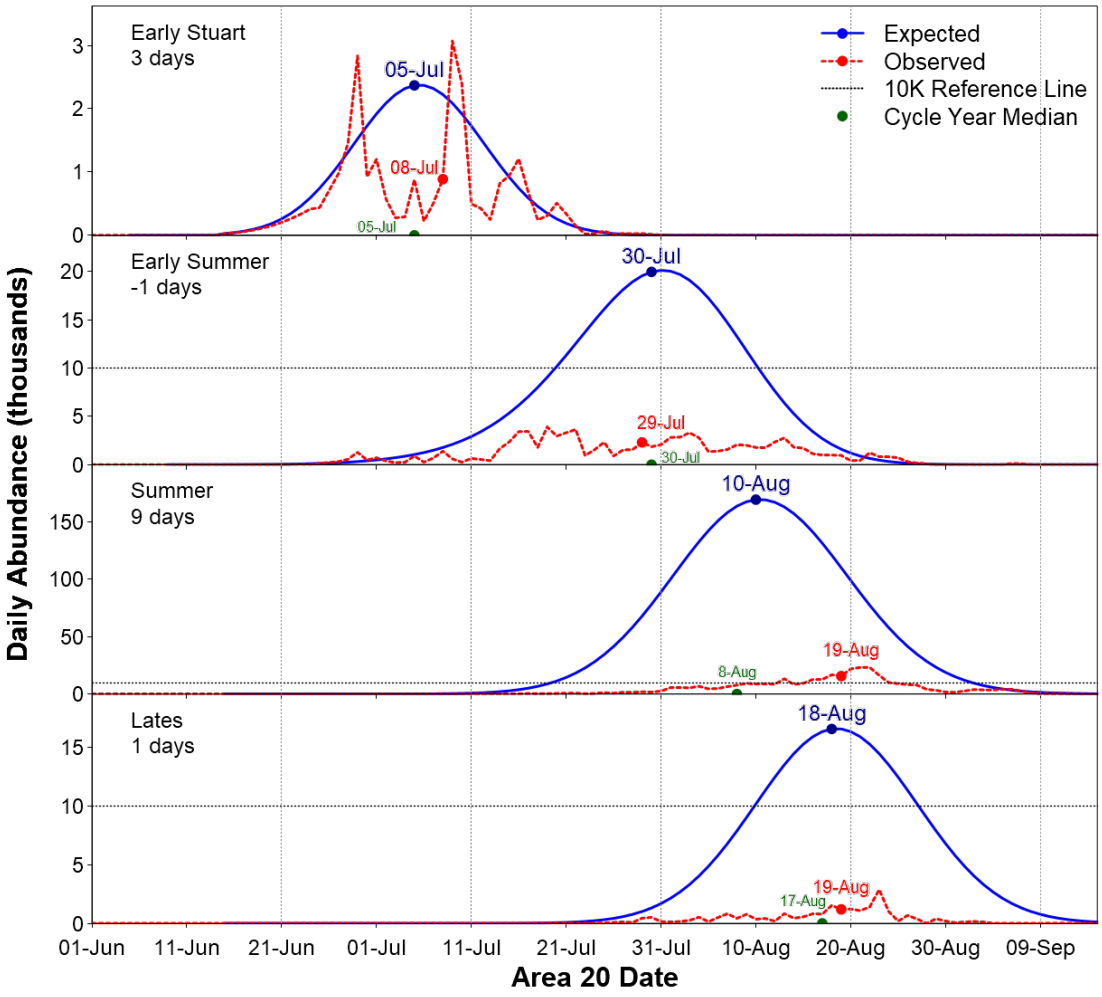

Figure 3. Pre-season expectations and post-season reconstructions of daily Fraser River sockeye salmon abundance by management group in 2019 (Area 20 date), including the observed 50% dates and number of days difference with pre-season expectations.

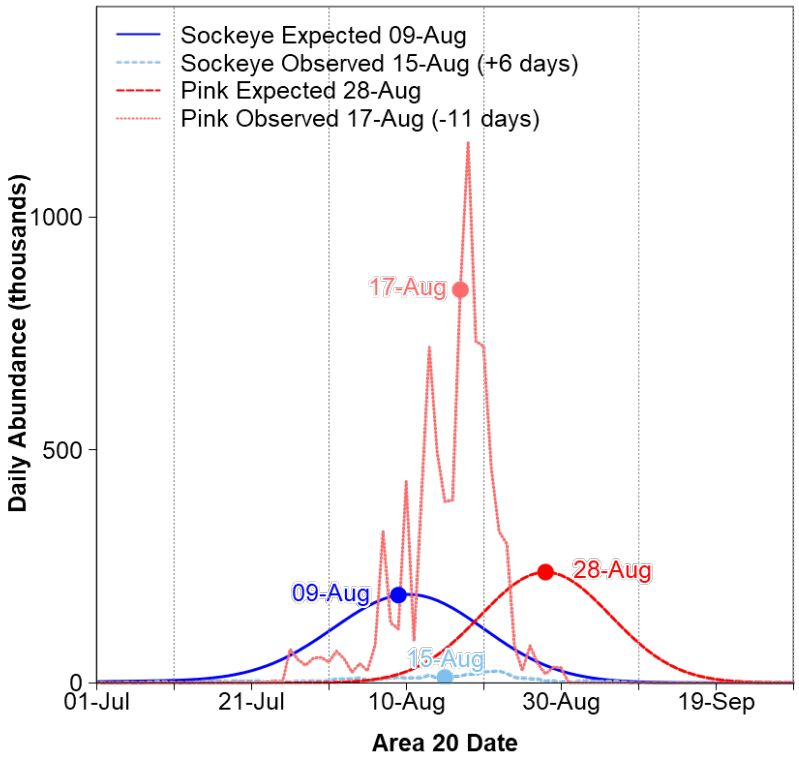

Figure 4. Pre-season projections and post-season reconstructions of daily Fraser River sockeye and pink salmon abundance in 2019 (Area 20 date), including the observed 50% dates and number of days difference with pre-season expectations.

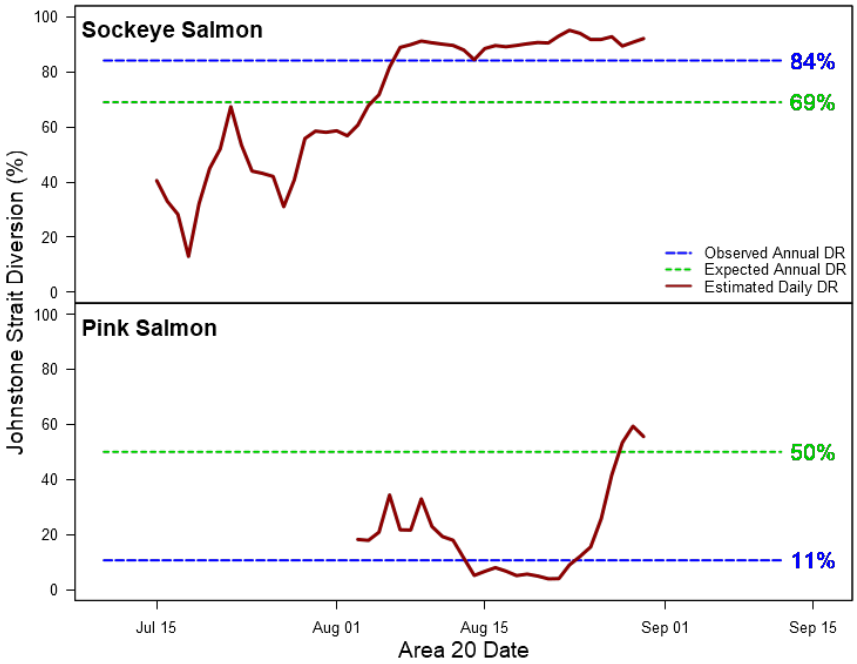

Figure 5. Pre-season forecast of annual Johnstone Strait diversion rate (DR) for Fraser sockeye salmon, compared to post-season estimates of daily and annual rates for 2019.

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. 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 (Figure 6). The landslide created a five-metre waterfall that formed an upstream migration barrier for salmon with spawning grounds above Big Bar. The slide impacted 81% of the total Fraser River sockeye run, 100% of the Early Stuart, 60% of the Early Summers run, and 90% of the Summer run. More specifically, the affected stocks included Early Stuart, Nadina, Bowron, Taseko, Chilko, Quesnel, Late Stuart and Stellako. The proportion of pink salmon stocks spawning above Big Bar was expected to be low. Of the sockeye stocks above Big Bar, five are currently considered endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Early Stuart, Bowron, Taseko, Late Stuart and Quesnel[10].

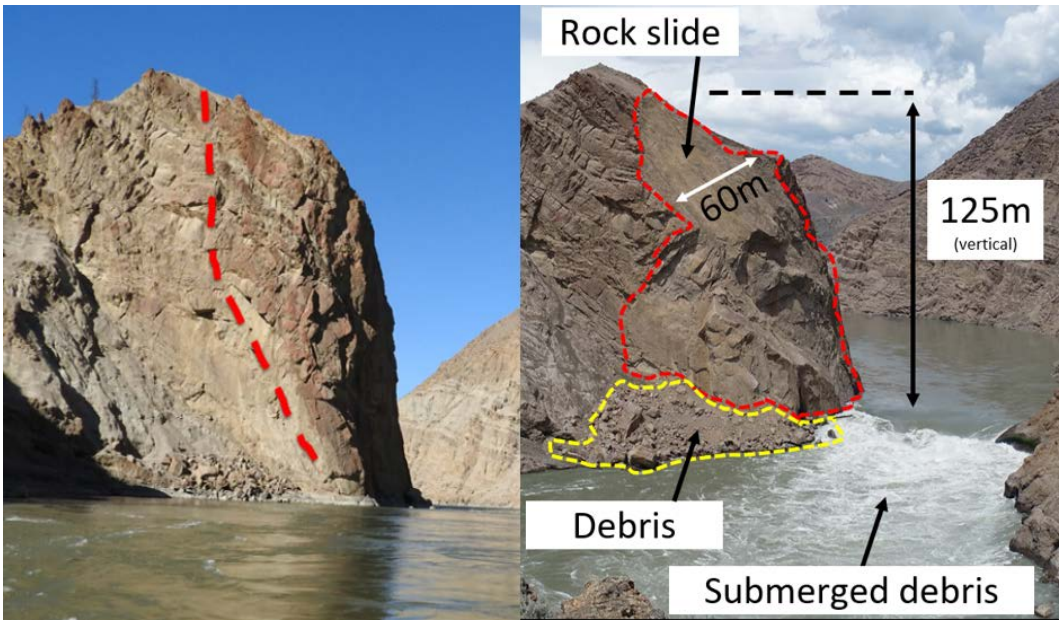

Figure 6. Big Bar Site before (A) and after (B) the slide. (A) The red line depicts what part of the cliff fell into the Fraser River. (B) Rock and debris 125 m in height and 60 m in width fell onto the banks and into the Fraser River.

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 to the slide included rock work within the slide area, salmon monitoring, transport and the collection of Early Stuart broodstock for emergency enhancement. The rock work consisted of rock scaling to improve site safety and the partial creation of a natural fishway through rock-manipulations. Helicopters were used to transport salmon across the slide. To provide in-season feedback to managers and inform them about the level of successful natural passage, hydroacoustic fish monitoring stations were set up downstream and upstream of the slide and fish were radio tagged to track the fish traveling through the slide site. Radio tag receivers were set up along the Fraser River and in tributaries which also informed managers about alternative migration behavior (Figure 7).

[10] 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.

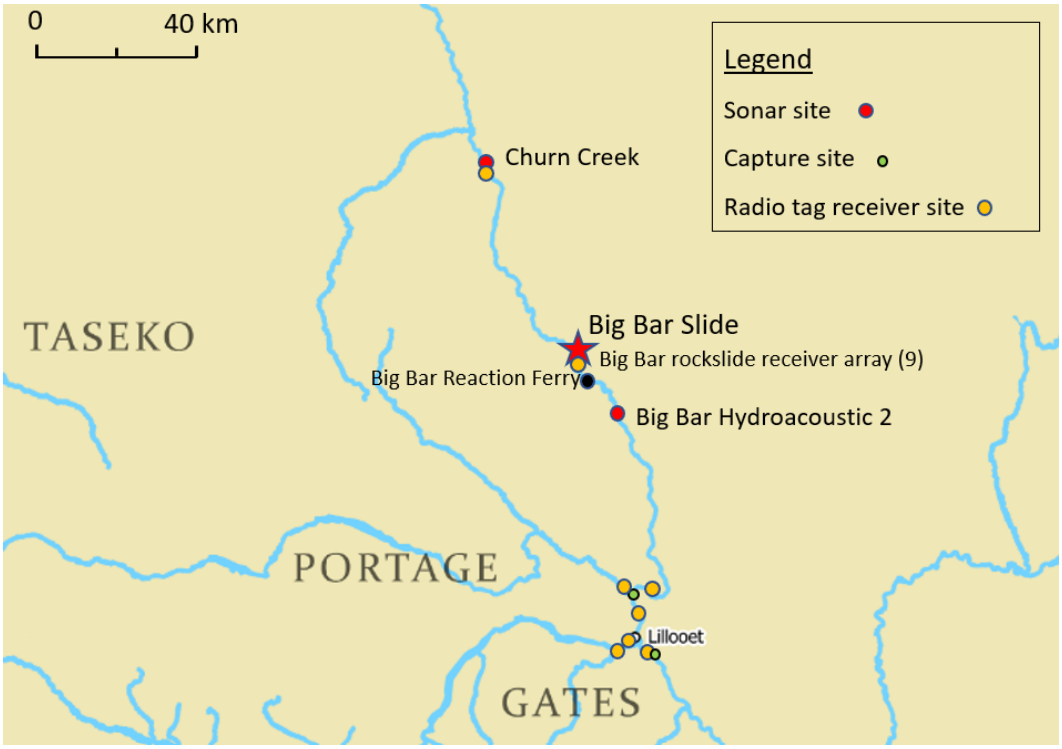

Figure 7. Map of sonar, salmon capture and radio tag receiver locations on the Fraser River near the Big Bar landslide in 2019.

Natural upstream migration was dependent on water velocity which was higher earlier in the season. Big Bar therefore had a larger impact on early migrating stocks, in particular Early Stuart sockeye. As discharge levels decreased over the summer and water levels declined, limited natural passage through the slide was observed starting on August 26. The discharge threshold for natural sockeye salmon passage through the slide area was 1800 m^3/s. When discharge levels were at or below this level, sockeye were observed passing through the slide site.

The Big Bar landslide had a major impact on early migrating stocks, such as Early Stuart and Early Summer run stocks, that were negatively impacted by high discharge levels. Of the stocks that spawn above Big Bar, the following proportions made it to the spawning grounds: 0.34% of the Early Stuart Run, 43% of the Early Summer run stocks and 81% of the Summer run stocks.

Post-season, remediation work continued at the landslide. The work included breaking up and removing massive rocks from the river and the east toe to improve natural fish passage, the construction of a concrete fishway and the deployment of a flexible, pressurized fish transport tube.

D. Management Adjustments and DBEs

In 2019, the run size estimates for all sockeye management groups were smaller than the escapement targets and therefore it was unnecessary 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. No Management Adjustments are applied to Fraser River pink salmon.

Management Adjustments (MAs) are based on statistical models [11,12,13,14] 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 recent years, pre-season MA estimates for some management groups have been estimated based on the weighted average of component abundances and their respective %DBEs. Due to the low relative abundances of Pitt, Chilliwack and Harrison fish in 2019, no weighted approach was used for the Early Summer- and Summer-run group. The weighted pDBE approach was used for Birkenhead and the remainder of the Late-run aggregate. 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 estimates of potential spawning and spawning ground escapements.

In 2019, Fraser River watershed snowpack was 80% of normal in early spring (April 1, BC Fraser Basin Snow Water Index). Due to warm temperatures and rapid snow melt in May, snow basin indices dropped significantly by June 1. The low June 1 snowpack was attributed to snow melt that was 1-3 weeks ahead of normal for most areas. The diminished snowpack increased the likelihood of low flow conditions in the summer. The long-range forecast predicted below average discharge and above average water temperature in the Fraser River. Low flows increase the impact of the weather on water temperatures. In-season, flow and temperature were mitigated by regular precipitation throughout the watershed. Fraser River discharge at Hope did drop below the minus one standard deviation in June through early July. Flow increased in mid-July to just below the mean and increased further by end of July and stayed close to the mean for the rest of the season. Water temperature fluctuated and for a few days, reached the Maximum Temperature for the 1981-2010 time period. With rain events and lower than average air temperatures, water temperatures only remained high for a few days and then would drop again. In September water temperature stayed at the Maximum Temperature for more than a week. Observed temperatures

[11] 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.

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

[13] 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.

[14] 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.

exceeded the upper range of the optimum temperature for aerobic swimming for Early Summer-run and Late-run sockeye during their 31-day migration period centered on the 50% Hells Gate date[15] (Figure 8).

Table 6. 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[1,2]		Early Summer Aggregate[2]		Summer Aggregate[2]		Late Aggregate[2]	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Pre-season adopted	-41%	0.69	-31%	0.45	-8%	0.09	-36%	0.56
In-season adopted[3]	NA	NA	NA	NA	NA	NA	NA	NA
Observed[4]	-99.7%	288.59	-51%	1.04	-25%	0.34	-51%	1.04

1 Pre-season, given the pre-season forecast of abundances, fisheries decisions that could impact the Early Stuart sockeye management group were based on a Low Abundance Exploitation Rate (LAER) limit.
2 In-season, given the 2019 in-season adopted run size , fisheries decisions that could impact the Early Stuart, Early Summer-, Summer- and Late-run sockeye management groups, were based on a LAER limit.
3 In-season, given that Management Adjustments had no management implications and given the uncertainty of the impact of the Big Bar rockslide on fish passage, the Panel did not adopt in-season management adjustments for any of the management groups.
4 Derived from Near Final escapement estimates.

An overview of the pre-season and in-season MA models used during 2019 management season is provided in the "Management Adjustment and DBE" section in Appendix F. A comparison of proportional management adjustment (pMA) estimates adopted pre-season, in-season and post-season is shown in Table 6. Predictions from in-season environmental MA models of proportional difference between estimates (pDBEs) (Table F3) were presented to the Panel for the Early Stuart, Early Summer- and Summer-run sockeye. Environmental conditions in-season were similar to those predicted pre-season and the in-season Temperature and Discharge MA models predicted similar, but slightly lower (more positive) pDBEs for these run timing groups. For Late-run sockeye the final in-season Mission 50% Date based on Mission passage, was September 8, which meant a delay of 12 days. Based on this timing, the run-timing MA model predicted a pDBE for the Late-run excluding Birkenhead (BiBS) that was virtually the same as that adopted pre-season (Table F3). For Early Stuart, Early Summer and Summer run, these MA estimates however did not take into account the impact of the Big Bar landslide.

The observed %DBEs for all four management groups were higher than those predicted pre-season (see Table 6). In addition to the traditional factors that impact MAs, the migration of the Early Stuart and portions of the Early Summer and the Summer run sockeye were impacted by the Big Bar Slide. It is however difficult to differentiate the impact of the slide versus regular sources of DBEs on the final 2019 estimates. For Early Stuart fish, there was no natural passage past the slide. Approximately 2,500 Early Stuart sockeye were heli-transported above the slide, but survival to the spawning grounds of these transported fish was low. The observed %DBE for Early Stuart was 99.7%. Later in the season, as discharge decreased to 1800 m^3/s at the slide site, more

[15] Elliason, E.J., Clark, T.D., Hague, M.J., Hanson, L.M., Gallagher, Z.S., Jeffries, K.M., Gale, M.K., Patterson, D.A., Hinch, S.G., and Farrell, A.P. 2011. Differences in Thermal Tolerance Among Sockeye Salmon Populations. Science 332:109-112.

natural sockeye passage was observed. For Early Summer run, there was some natural passage observed and fish were also heli-transported above the slide. The observed %DBE for the Early Summer run stocks above the slide was -57%, while the observed %DBE for those stocks that have spawning grounds below Big Bar was lower at -42%. Although 90% of the Summer run sockeye estimated at Mission spawn above the Big Bar landslide, the observed %DBE for those stocks spawning above the slide was only -19%.

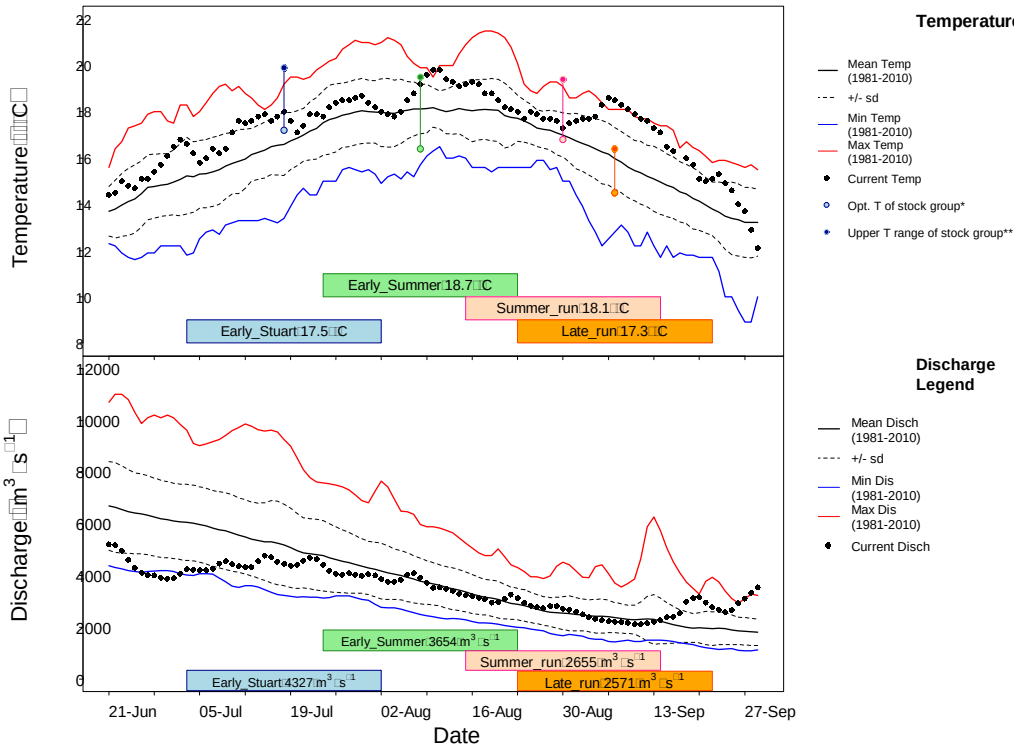

Figure 8. Fraser River temperature and discharge measured near Hope in 2019. Also shown are run timing bars that represent a 31 day spread of the run centred around the Hells Gate date and the mean temperature and discharge for the 31 day spread.

D. Mission Passage

The upstream passage of Fraser River sockeye at Mission was estimated to be 479,400, consisting of 25,900 Early Stuart, 92,500 Early Summer-run (including Pitt), 339,100 Summer-run, and 21,900 Late-run sockeye (Table 7). The total upstream passage of Fraser River pink salmon at Mission was estimated to be 8,566,000.

Sockeye passage estimates were derived by the hydroacoustics monitoring facility at Mission during the period of peak migration from July 4 to August 19. From August 20 to September 28, daily sockeye passages were estimated by using the catch per unit effort (CPUE) estimates from the Whonnock gill net test fishery in combination with an in-season catchability estimate. Prior to July 4, Whonnock CPUE estimates were used in combination with a catchability estimate based on past years. Pink salmon passage was estimated using hydroacoustics throughout their entire migration period except from September 24 to September 28, when Whonnock CPUE data were used in combination with an in-season catchability estimate.

The Mission hydroacoustics program implemented a sampling method similar to previous years that consisted of a vessel-based, downward-looking split-beam for the offshore area, a

stationary, side-looking split-beam for the left bank, and an Adaptive Resolution Imaging Sonar (ARIS) on both the left and right banks. Detailed descriptions of the hydroacoustic methods used to estimate salmon passage in 2019 are provided in Appendix F.

Table 7. Fraser River sockeye and pink salmon passage at Mission in 2019.

Management Group	Mission Escapement	
Stock Group	fish	%
Early Stuart	**25,900**	**5%**
Early Summer	**92,500**	**19%**
Chilliwack	6,500	1%
Early Miscellaneous	68,300	14%
Early South Thompson	10,000	2%
North Barriere/Taseko	1,500	0%
Pitt[1]	6,300	1%
Summer	**339,100**	**71%**
Raft/N.Thompson	1,900	0%
Chilko	202,800	42%
Quesnel	39,700	8%
Late Stuart/Stellako	63,900	13%
Harrison	30,800	6%
Late	**21,900**	**5%**
Birkenhead	3,700	1%
Late Shuswap/Portage	14,600	3%
Weaver/Cultus	3,600	1%
Total Sockeye	**479,400**	**100%**
Pink Salmon	**8,566,000**	**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 2019 was 571,000 fish (Tables 8 and 9), which is 88% smaller than the median forecast of 4,795,000 fish and 71% below the total adult return in 2015 (2,000,000). The 2019 return is the smallest run size since records began in 1893 (Figure 9). While the 2019 Fraser Sockeye Science Integration Workshop predicted that the survival would

fall below average and between the 25th percentile and the median forecast[16], actual returns were below the 10th percentile.

Table 8. Catch, escapement, difference between estimates and run size for Fraser River sockeye (by management group) and pink salmon in 2019.

	Fraser Sockeye						Fraser Pinks	
	Early Stuart	Early Summer	Summer	Late	Total	% of Run	Total	% of Run
CANADIAN CATCH	**120**	**1,530**	**8,180**	**30**	**9,860**	**2%**	**300,300**	**3%**
Commercial Catch	**0**	**0**	**0**	**0**	**0**	0%	**5**	**0%**
Panel Area	0	0	0	0	0	0%	5	0%
Non-Panel Areas	0	0	0	0	0	0%	0	0%
First Nations Catch	**0**	**0**	**0**	**0**	**0**	0%	**263,600**	**3%**
Marine FSC	0	0	0	0	0	0%	5,400	0%
Fraser River FSC	0	0	0	0	0	0%	37,200	0%
Economic Opportunity	0	0	0	0	0	0%	220,900	2%
Non-commercial Catch	**0**	**10**	**70**	**0**	**80**	0%	**36,700**	**0%**
Marine Recreational	0	0	0	0	0	0%	30,200	0%
Fraser Recreational	0	0	0	0	0	0%	5,700	0%
Charter (Albion & Area 12 Chum)	0	10	70	0	80	0%	700	0%
ESSR	0	0	0	0	0	0%	0	0%
Unsanctioned Catch*	**120**	**1,520**	**8,110**	**30**	**9,770**	**2%**	0	0%
UNITED STATES CATCH	**120**	**6,820**	**66,980**	**4,190**	**78,100**	**14%**	**233,300**	**3%**
Washington Total	**0**	**50**	**330**	**90**	**470**	**0%**	**233,300**	**3%**
Commercial catch	**0**	**0**	**0**	**0**	**0**	0%	**233,200**	**3%**
Treaty Indian	0	0	0	0	0	0%	159,600	2%
All Citizen	0	0	0	0	0	0%	73,500	1%
Non-commercial Catch	**0**	**50**	**330**	**90**	**470**	0%	**100**	**0%**
Ceremonial	0	50	330	90	470	0%	100	0%
Recreational	0	0	0	0	0	0%	0	0%
Alaska	**100**	**6,800**	**66,600**	**4,100**	**77,600**	14%	0	0%
TEST FISHING CATCH	**80**	**1,100**	**5,000**	**300**	**6,400**	**1%**	**17,200**	**0%**
PSC (Panel Areas)	**30**	**300**	**1,100**	**50**	**1,500**	**0%**	**14,600**	**0%**
Canada	30	300	1,100	50	1,500	0%	14,400	0%
United States	0	0	0	0	0	0%	200	0%
Canada (non-Panel Areas)	**40**	**800**	**3,900**	**200**	**4,900**	**1%**	**2,700**	**0%**
TOTAL RUN	**26,100**	**99,900**	**418,500**	**26,400**	**571,000**	**100%**	**8,858,600**	**100%**
Total Catch in All Fisheries	300	9,400	80,100	4,500	94,400	17%	550,800	6%
Adult Spawning Escapement **	90	44,600	246,500	10,700	302,000	53%	8,307,800	94%
Jack Spawning Escapement	0	500	300	100	900	0%	0	0%
Difference Between Estimates***	25,700	45,400	91,500	11,100	173,700	30%	0	0%
Percentage of Total Run	**100%**	**100%**	**100%**	**100%**	**100%**		**100%**	
Total Catch in All Fisheries	1%	9%	19%	17%	17%		6%	
Spawning Escapement	0%	45%	59%	41%	53%		94%	
Difference Between Estimates	98%	45%	22%	42%	30%		0%	

* 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 2019

** Spawning escapement estimate for Cultus sockeye include 45 individuals captured as brood stock.

*** 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.

[16] 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.

The causes of the small return are unknown. Freshwater and marine conditions experienced by sockeye returning in 2019 appeared similar to those experienced by the salmon that returned in 2017 and 2018. Freshwater smolt information from Chilko indicates high freshwater survival given that an estimated 71 million smolts left Chilko Lake in 2017, which was more than twice the cycle average. Four-year-old Chilko sockeye were expected to contribute more than 50% of the median pre-season forecast for the Summer-run group. In-season, the return of age four Chilko fish was much lower than its median forecast. 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 2019. Returns of all other Fraser River sockeye stocks were also uniformly poor. However, returns of Fraser River pink salmon which shared at least part of their ocean residence with Fraser River sockeye exceeded the forecast by 76%. Ocean distribution is likely different between Fraser sockeye and pink salmon however it is probable that there is some overlap in distribution. Thus, while it is tempting to blame the low return on the anomalously warm ocean temperatures in the Gulf of Alaska where age 4 Fraser River sockeye that returned in 2019 reared from late fall of 2017 through the spring of 2019, the lack of consistent response among species, suggests a more complicated causal mechanism.

Table 9. Catch, escapement, difference between estimates, run size and exploitation rate for Fraser River sockeye (by stock group) salmon in 2019.

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	**300**	**90**	**25,700**	**26,100**	**0**	**26,100**	**5%**	**1%**
Early Summer-run	**9,400**	**44,600**	**45,400**	**99,500**	**500**	**99,900**	**17%**	**9%**
Chilliwack	30	1,300	5,100	6,500	90	6,600	1%	0%
Early Miscellaneous	6,200	34,100	32,700	72,900	400	73,300	13%	9%
Early South Thompson	2,900	5,200	4,800	12,800	0	12,800	2%	23%
North Barriere/Taseko	70	500	200	800	0	800	0%	9%
Pitt	300	3,500	2,700	6,500	0	6,500	1%	5%
Summer-run	**80,100**	**246,500**	**91,500**	**418,200**	**300**	**418,500**	**73%**	**19%**
Raft/N.Thompson	2,000	1,000	1,000	4,000	0	4,000	1%	50%
Chilko	53,400	168,200	29,100	250,700	200	250,900	44%	21%
Quesnel	13,900	21,600	17,200	52,700	0	52,700	9%	26%
Late Stuart/Stellako	10,400	51,700	17,000	79,100	100	79,200	14%	13%
Harrison/Widgeon	500	4,000	27,200	31,700	10	31,700	6%	2%
Late-run	**4,500**	**10,700**	**11,100**	**26,300**	**100**	**26,400**	**5%**	**17%**
Birkenhead/BigSilver	700	3,100	600	4,400	60	4,500	1%	16%
Late Shuswap/Portage	3,800	5,800	8,700	18,300	0	18,300	3%	21%
Weaver/Cultus	40	1,900 [2]	1,700	3,600	80	3,700	1%	1%
Total	**94,400**	**302,000**	**173,700**	**570,000**	**900**	**571,000**	**100%**	**17%**
Portion of Total Run	17%	53%	30%	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 Cultus sockeye include 45 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.

All management groups returned at lower abundances than their median (50p level) pre-season forecast. The total return of Early Stuart sockeye was 26,000 adults (Table 9), 37% less than the median forecast. Early Summer-run sockeye returns were dominated by Nadina/Bowron

sockeye and totalled 99,900 fish, 79% less than the median forecast level. The abundance of Summer-run sockeye was 418,500 adults, only 11% of the median forecast level. Most Summer-run fish were Chilko salmon, which saw only 7% of the forecast return to the Fraser River. Returns to all Late-run components were very poor relative to their median forecasts resulting in an aggregate Late-run return (26,400 adults) that was only 7% of the group's median pre-season forecast.

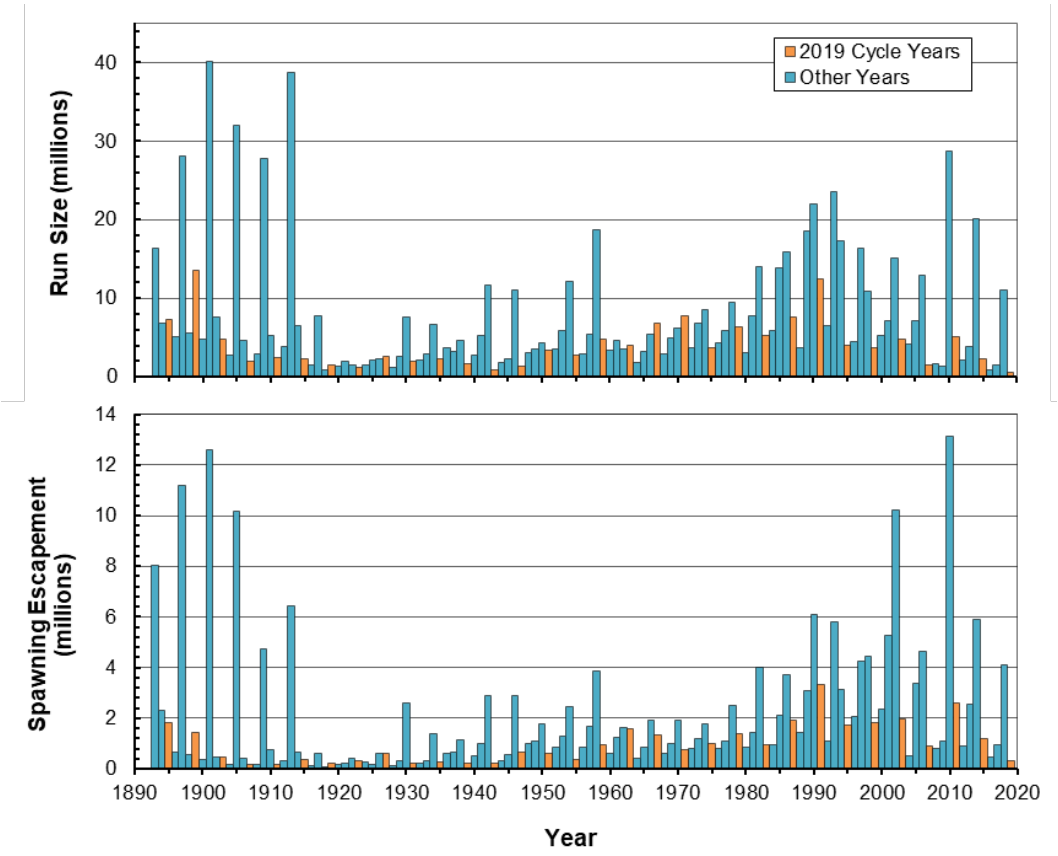

Figure 9. Total run size and spawning escapement of Fraser River sockeye salmon from 1893-2019. Returns on the 2019 cycle are emphasized.

The total sockeye catch of 94,400 fish represented about 17% of the total return (Tables 8 and 9). This exploitation rate which includes Alaska catch was 17% (Figure 10). Of the total sockeye catch, 9,860 fish were caught in Canada, 78,100 fish in the U.S. and 6,400 fish in test fisheries (Table 8). Virtually all of the Canadian catch was from unsanctioned catch (9,770 fish) resulting 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 2019. There was some Charter catch, 80 fish, and no commercial catch in Canada. In Washington State there was no commercial catch taken but 470 sockeye were caught in Treaty Indian Ceremonial and Subsistence fisheries directed at Fraser River pink salmon. The Alaska catch of Fraser sockeye was 77,600 fish.

DFO annually assesses the spawning ground abundance of sockeye populations in the Fraser watershed (Figure 11). In 2019, the near-final estimate of adult spawners (primarily age 4 and age 5 fish) totalled 302,000 fish, or 53% of the total run. This escapement was 85% lower than the brood year (2015) escapement of 2,000,000 adults.

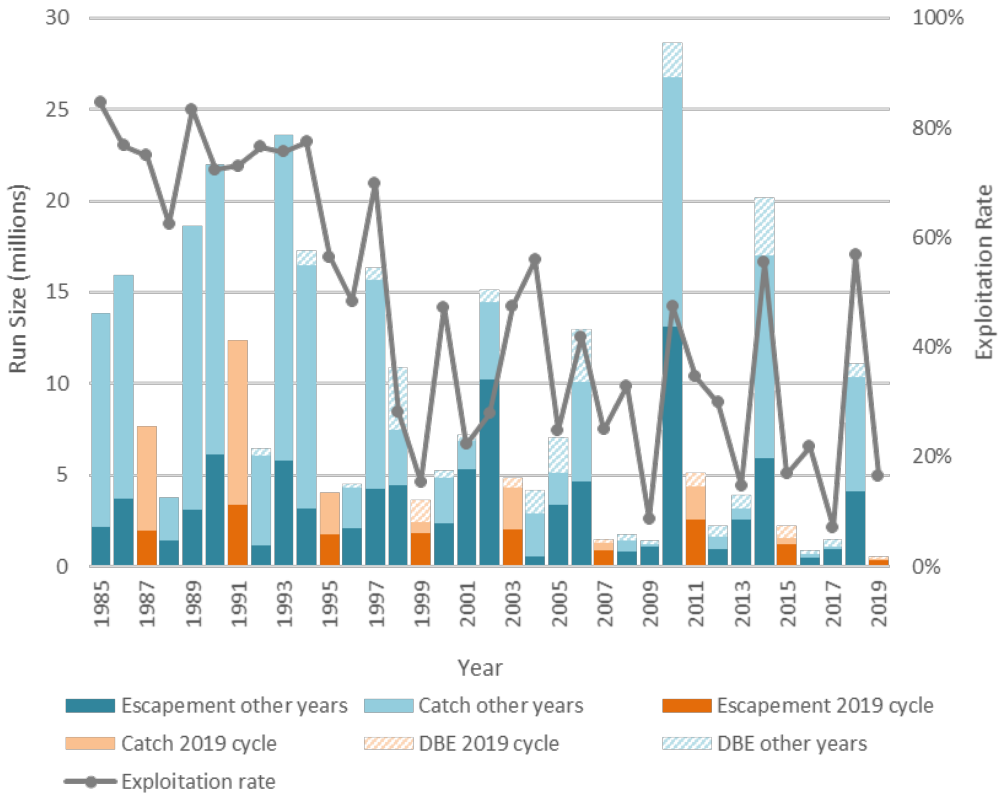

Figure 10. Total catch, escapement, difference between estimates, run size and exploitation rate for Fraser River sockeye salmon in 1985-2019, with returns on the 2019 cycle emphasized.

Spawner abundances for most management groups were much less than those observed in the brood year (2015, Figure 12). By management group, spawning escapements in 2019 were the lowest on record for the Early Stuart system, the third lowest on this cycle line for Early Summer run, 50% less than the brood and cycle average for Summer run, and the lowest cycle year escapement on record for the Late run. The very low escapements relative to those in the brood year are attributed primarily to the combination of low overall survival and the additional mortality Fraser River sockeye stocks located above Big Bar experienced during their upstream migration in 2019.

The overall spawning success of adult female sockeye in the Fraser watershed was 98%. The effective female spawning population in 2019 totalled 146,500 fish, which was only 21% of the number of effective females in 2015. The DBE[17] estimate was 173,700 fish, or 30% of the total return. As a percentage of run size for each management group, Early Stuart had the largest DBE at 98%, while the DBEs for Early Summer and Late run were about 45%. The Summer run had a DBE of 22% (Tables 8 and 9).

[17] In estimates of total return, 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.

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 G3).

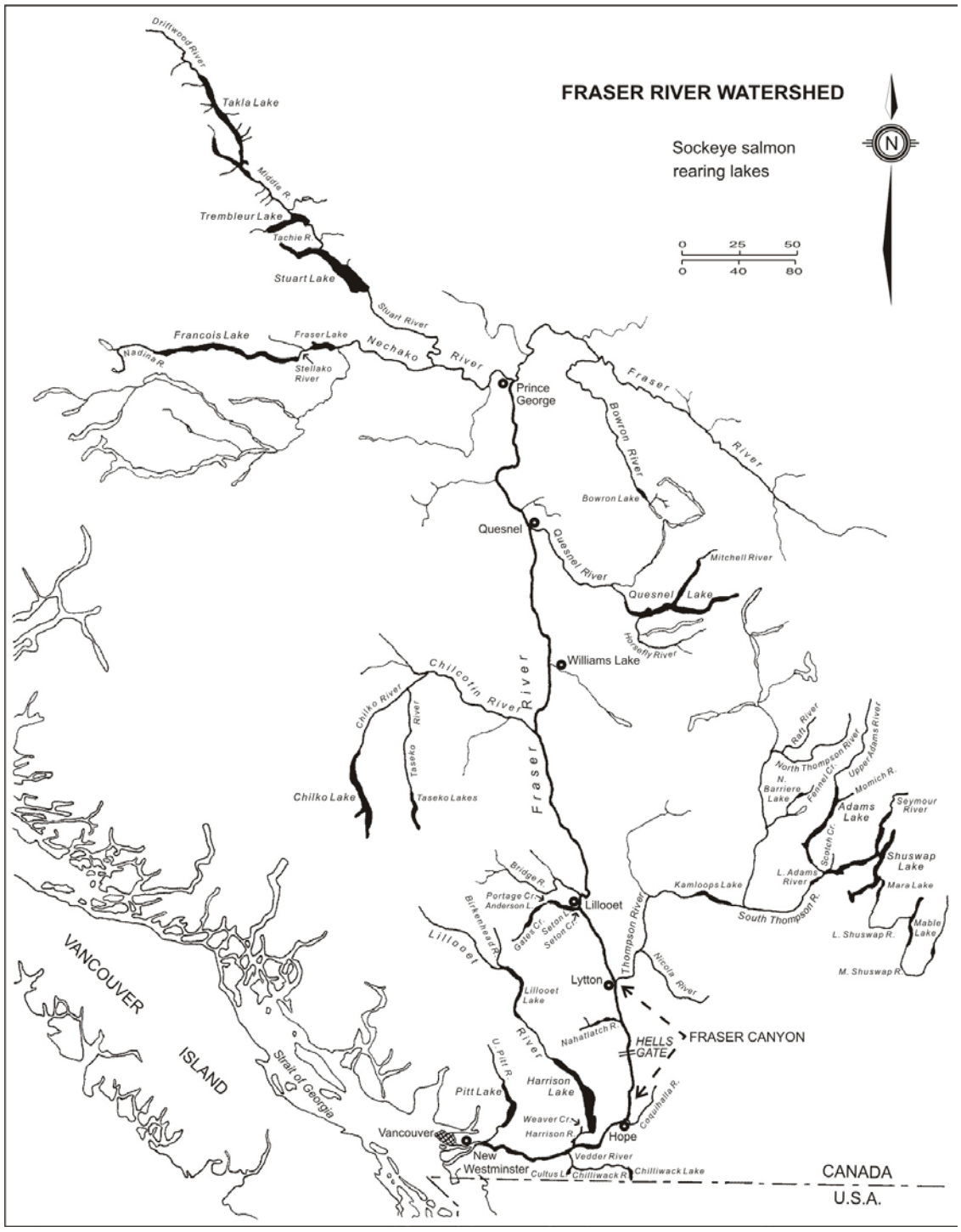

Figure 11. Sockeye salmon spawning areas in the Fraser River watershed.

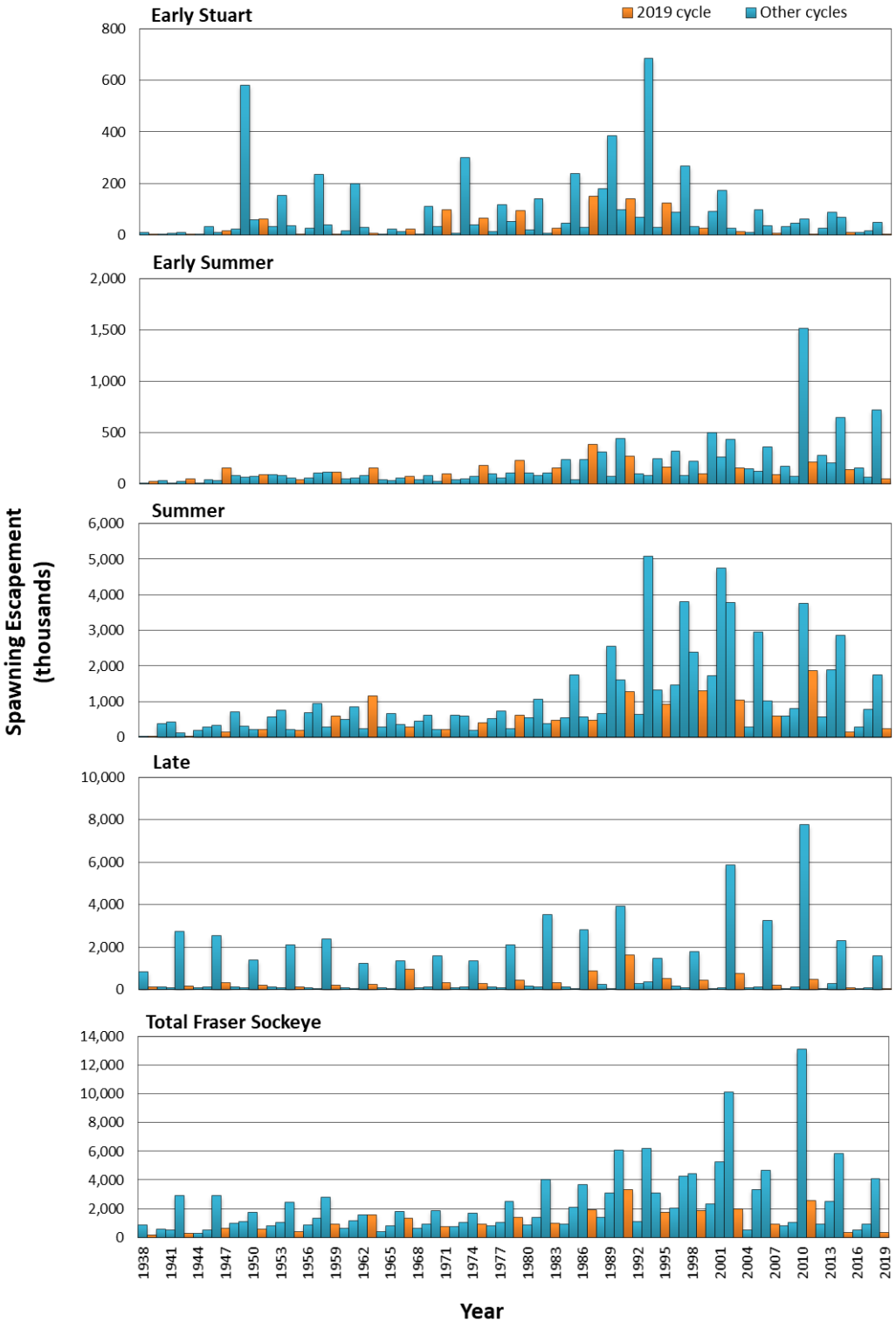

Figure 12. Annual adult spawning escapement of Fraser River sockeye salmon for each management group and for total sockeye in 1938-2019, with escapements on the 2019 cycle emphasized.

B. Pink Salmon

The in-season run-size estimate of 8,900,000 fish is greater than the median pre-season forecast of 5,018,600 fish (Table 1). Hydroacoustic research has provided Staff with the ability to estimate pink salmon passage at Mission. Summing this passage estimate (8,565,900) with the catch below Mission (292,700) provided the in-season estimate of total abundance noted above.

The 2019 return was more than double the return in the brood year (Figure 13), but less than average. Returns of Fraser pink salmon (Figure 13) have shown large variation over the years, as 2017 was the lowest return since 1965 (3,549,000 fish), while 2003 was one of the highest returns (26,000,000 fish) since records began in 1959.

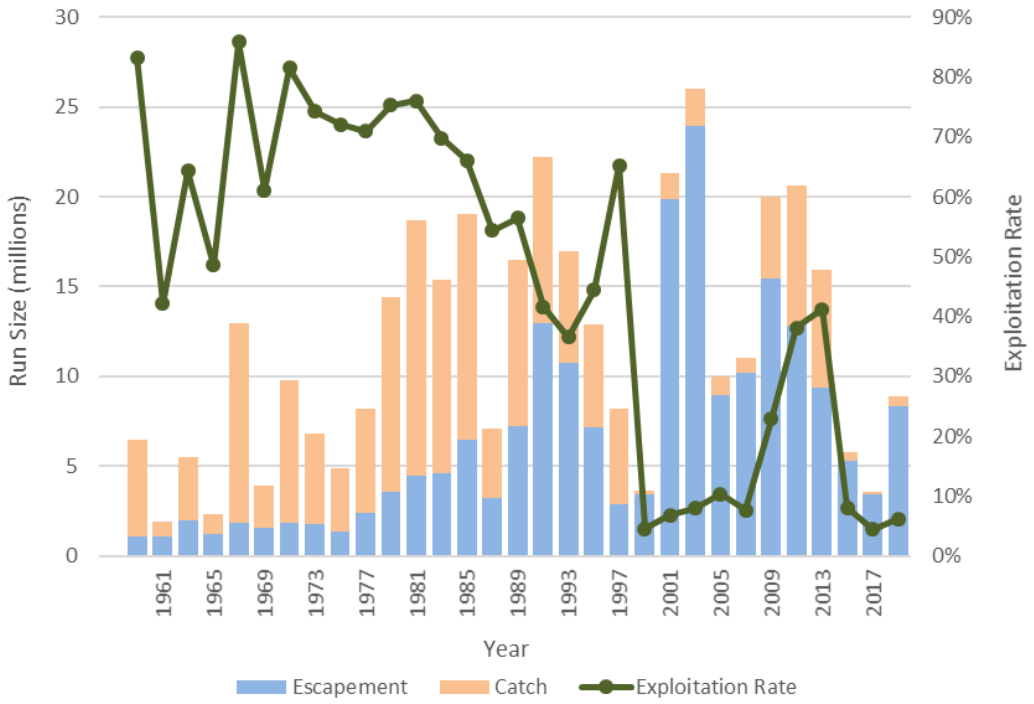

Figure 13. Total catch, escapement, run size and exploitation rate for Fraser River pink salmon in 1959-2019.

The exploitation rate of Fraser River pink salmon in 2019 was 6%, similar to the low exploitation rates (5-10%) observed in 1999-2007, 2015 and 2017, and much smaller than the 1959-1989 average exploitation rate of 68% (Figure 13). The low exploitation rates observed in the 1999-2007 period were largely a result of conservation concerns for Late-run sockeye that co-migrate with pink salmon. These low harvest levels have resulted in substantial spawning escapements of Fraser pinks in recent years. In 2019, the low run size return for sockeye in combination with the uncertainty regarding the pink salmon run size until September 12 were the primary factors constraining pink-directed fisheries in both countries. Overall, the pink salmon return in 2019 was the third smallest since 1999.

Of the total Fraser River pink salmon catch, 300,300 were caught in Canada, 233,300 in the U.S. and 17,200 in test fisheries (Table 8). There was little Canadian commercial catch (less than 10, Table 10) but there was a First Nations catch of 263,600 and a Charter catch of 700. The U.S. catch included a commercial catch of 233,200, of which 159,600 were caught in Treaty Indian fisheries and 73,500 in All Citizen fisheries (Table 11). There was a small catch of 100 fish in a U.S. Ceremonial and Subsistence fishery.

Further details on Fraser River pink salmon abundances, catches and spawning escapements including historical production data can be found in Appendix G (Tables G2 and G4).

Table 10. Canadian commercial catches of Fraser River pink salmon by gear type, license designation and statistical area in 2019. Grey areas indicate fishery areas are not part of the license-area designation.

Fishery	Purse Seine		Gillnet			Troll			
Areas	Area A	Area B	Area C	Area D	Area E	Area F	Area G	Area H	Total
Commercial	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**5**
Panel Areas	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**5**
20		0			0		0		0
17, 18, 29		5			0			0	5
121-124 *		0		0			0		0
Non-Panel Area	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
1-10	0		0			0			0
11-16		0		0	0		0	0	0
124-127 *		0		0			0		0
First Nations Economic Opportunity and Demo Fisheries									**220,900**
Total Catch									**220,905**

* Catch in Area 124 is divided between Panel and Non-Panel Areas.

Table 11. U.S. commercial catches of Fraser River pink salmon by user group, gear type and statistical area in 2019.

Areas	Purse Seine	Gillnet	Reefnet	Total
Panel Area (Washington)	**200,900**	**200**	**32,100**	**233,200**
Treaty Indian *	**158,000**	**200**	**1,400**	**159,600**
4B, 5 and 6C	0	0	0	0
6 and 7	83,500	0	1,400	84,900
7A	74,500	200	0	74,700
Non-Indian **	**42,900**	**0**	**30,600**	**73,500**
7	42,000	0	30,600	72,600
7A	900	0	0	900
Non-Panel Area				**0**
United States Total				**233,200**

* Estimates for Treaty-Indian fisheries are from the "TOCAS" database.

** Estimates for All Citizen fisheries are from the WDFW "LIFT" database.

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 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 or to the total return in the case of Fraser River pink salmon. In 2019, 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 and catches were a result of fisheries directed at other co-migrating stocks. 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: Early Stuart (on target), Early Summer run (3% under), Summer run (8% under) and Late run (10% over) (Table 12). Pre-season, only Early Stuart and Late-run sockeye had been constrained by a Low Abundance Exploitation Rate (LAER), 10% and 20%, respectively. In-season, the lower than forecasted abundances also triggered a 20% LAER for the Early Summer and Summer run (Figure 14).

Table 12. Comparison of in-season targets and in-season estimates of potential spawning escapement (PSE) for adult Fraser River sockeye salmon in 2019.

	Final	Potential Spawning Escapement (PSE)					
Management Group	In-season Abundance Estimate	Spawning Escapement Target	Management Adjustment *	In-season PSE ** Target	PSE *** Estimate	Difference Fish	Difference %
Adult sockeye	**500,000**	**500,000**	**103,800**	**500,000**	**469,000**	**-30,000**	**-6%**
Early Stuart	26,000	26,000	17,900	26,000	26,000	0	0%
Early Summer	94,000	94,000	42,300	94,000	91,000	-3,000	-3%
Summer	360,000	360,000	32,400	360,000	331,000	-29,000	-8%
Late	20,000	20,000	11,200	20,000	22,000	2,000	10%

* 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.

In terms of the achievement of post-season objectives, the total spawning ground escapement estimate of Fraser sockeye was 47% below the target, while the estimated escapement of Fraser

River pink salmon was 38% larger than its target (Table 13). 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 natural migration passage past Big Bar was obstructed. Less than 100 sockeye were estimated to have made it to the Early Stuart spawning ground (100% below target). 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 55%, 41% and 59% for Early Summer, Summer and Late run, respectively (Table 13). 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 LAER: Early Stuart (1%), Early Summer run (9%), Summer run (19%) and Late run (17%) The LAER was 10% for Early Stuart, and 20% for the 3 other management groups.

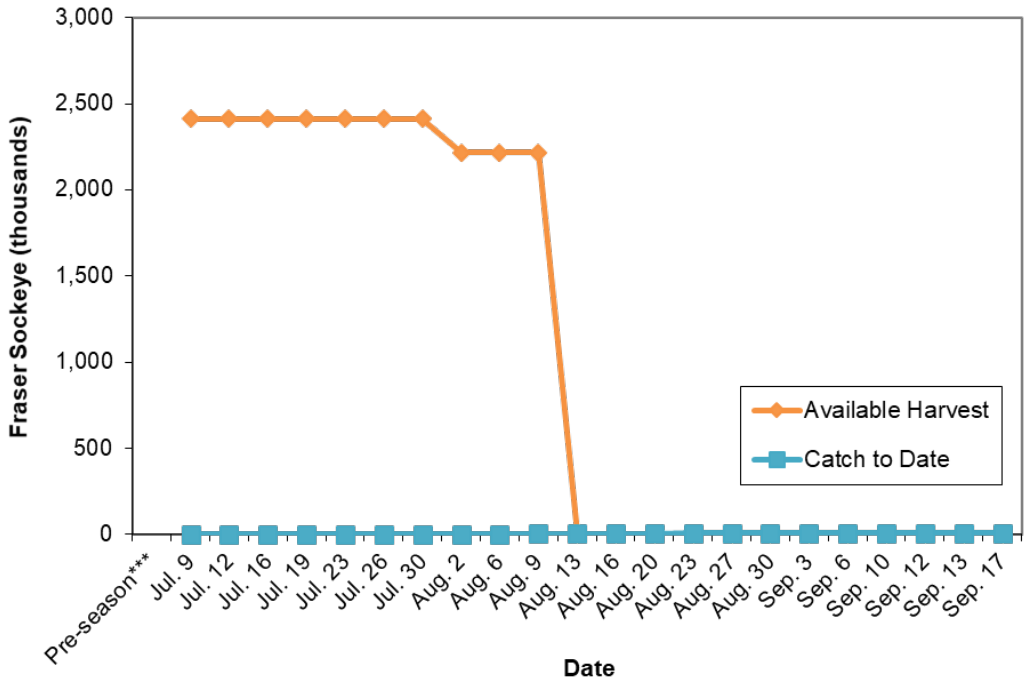

Figure 14. Available harvest of Fraser sockeye compared to catch to date in all fisheries in 2019. The available harvest is calculated as run size minus spawning escapement target and management adjustment and represents fish that are available for catch in all commercial, recreational, First Nations and test fisheries.

The low sockeye returns in 2019 reflect a continuing trend of declining productivity that is a growing concern[18]. 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,

[18] 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.

Widgeon)[19]. Of these stocks, Early Stuart, Bowron, Taseko, Quesnel and Late Stuart all have spawning grounds above Big Bar.

For Fraser River pink salmon, the spawning escapement estimate was 38% above the target (Table 13) and the exploitation rate was very low at 6% (Table 8). This was due to the fact that access to pink salmon TAC had been restricted as all sockeye management groups were in a LAER situation. In addition, the run size for pink salmon was only increased from 5.0 to 8.9 million on September 12 when most of these fish had already escaped marine fisheries.

Table 13. Comparison of post-season spawning escapement targets and escapement estimates for adult Fraser River sockeye and pink salmon in 2019. 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	**571,000**	**571,000**	**302,000**	**-269,000**	**-47%**
Early Stuart	26,100	26,100	100	-26,000	-100%
Early Summer	99,900	99,900	44,600	-55,300	-55%
Summer	418,500	418,500	246,500	-172,000	-41%
Late	26,400	26,400	10,700 *	-15,700	-59%
Pink salmon	**8,858,600**	**6,000,000**	**8,307,800**	**2,307,800**	**38%**

* Late-run escapement estimate includes 168 Cultus fish kept for broodstock.

B. International Allocation

The Panel's second priority is to achieve the goals for international allocation of the TACs for Fraser sockeye and pink 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 12), which is based on a new agreement reached by the Panel February 14, 2019. This agreement is reflected in the revised 2020 Chapter 4, Annex IV of the Pacific Salmon Treaty and retroactively modifies the TAC calculation for 2019. The test fishing catch and Aboriginal Fisheries Exemption deductions are the post-season estimates, however.

Given the low run sizes in 2019, there was no International TAC for Fraser River sockeye (Table 14). Due to the catch of 470 fish in Washington in pink salmon directed fisheries, the United States exceeded its share by 470 fish (Table 14). Canada's catch of 9,860 Fraser sockeye was largely from unsanctioned catch (9,770) and exceeded their share by 100%. A detailed version of the TAC calculations by management group is presented in Appendix G, Table G5.

The TAC for Fraser pink salmon was 2,882,760 fish, with a U.S. share of 740,870 fish (25.7%) and Canadian allowable harvest of 2,141,890 fish (Table 14). Both the U.S. and Canada caught less than their share 507,580 and 1,841,630 under, respectively. Access to pink salmon TAC had been restricted due to all sockeye management groups being in a LAER and the fact that

[19] 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.

pink salmon run size was increased from 5 to 8.9 million when most of the salmon had already exited marine fishing areas.

Table 14. Total allowable catch (TAC) and achievement of international catch shares for Fraser River sockeye and pink salmon in 2019. 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 12), in accordance with the revised Annex IV, Chapter 4 of the Treaty agreed to January 2020.

		Sockeye		Pink
TOTAL ALLOWABLE CATCH				
In-season Total Run Size		**500,000**		**8,900,000**
Deductions		**610,250**		**6,017,240**
In-season Spawning Escapement Target		500,000		6,000,000
In-season Management Adjustment		103,840		n/a
Aboriginal Fishery Exemption (AFE)		n/a		n/a
Post-season Test Fishing Catch		6,410		17,240
Total Allowable Catch	*1, 2*	**0**		**2,882,760**
UNITED STATES				
Washington Total Share	*3*	**0**		**740,870**
Washington Share of TAC	*1*	0	16.5%	740,870
Payback		0		0
Washington Catch		**470**		**233,290**
Deviation		**-470**		**507,580**
In-season Alaska Catch Estimate		0		0
CANADA				
Canadian Share of TAC + U.S. Payback + AFE		**0**		**2,141,890**
Unsanctioned Catch	*4*	**9,770**		
Canadian Catch excluding ESSR Catch		**9,860**		**300,260**
Deviation		**-9,860**		**1,841,630**

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 2019.

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, Treaty Indian fishers caught more than their share of the sockeye salmon TAC, 470 fish (Table 15). For Fraser River pink salmon, Treaty Indian and All Citizen fishers caught less than their share of the pink salmon TAC, 210,800 and 297,000 under, respectively (Table 16).

In Canada, unsanctioned sockeye catch accounted for 9,770 fish. First Nations FSC fisheries were the only fisheries directed towards Fraser pink salmon and harvested 263,600 fish which was less than Canada's share (Tables 8, 14). Marine and in-river recreational pink catch accounted for 30,200 and 5,700 fish, respectively. An additional 80 Fraser River sockeye and 700 Fraser River pink salmon were caught in domestic, Chinook and chum test fisheries.

Table 15. Achievement of domestic catch goals in Washington for Fraser River sockeye salmon in 2019.

User Category	Actual Catch		Share of TAC		Deviation
	Fish	%	Fish	%	
Washington Total	**470**	**100.0%**	**0**	**100.0%**	**470**
Treaty Indian *	470	100.0%	0	67.7%	470
All Citizen **	0	0.0%	0	32.3%	0

* Treaty Indian catch includes commercial and ceremonial catches.

** All Citizen catch includes commercial and recreational catches.

Table 16. Achievement of domestic catch goals in Washington for Fraser River pink salmon in 2019.

User Category	Actual Catch		Share of TAC		Deviation
	Fish	%	Fish	%	
Washington Total	**233,200**	**100.0%**	**740,900**	**100.0%**	**-507,700**
Treaty Indian *	159,700	68.5%	370,500	50.0%	-210,800
All Citizen **	73,500	31.5%	370,500	50.0%	-297,000

* Treaty Indian catch includes commercial and ceremonial catches.

** All Citizen catch includes commercial and recreational catches.

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 Pacific Fishery Management Council 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 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. There was no by-catch of non-Fraser sockeye salmon, but there was a by-catch of 69,620 non-Fraser pink salmon in commercial net fisheries regulated by the Fraser River Panel. Catches of other Fraser and non-Fraser salmon species included 5,720 Chinook, 190 coho, and 10 chum (Table 17).

Table 17. Catches of non-Fraser sockeye and pink salmon and catches of other salmon species in commercial fisheries regulated by the Fraser River Panel in 2019.

Area and Gear	Non-Fraser		Fraser and Non-Fraser			
	Sockeye	Pink	Chinook	Coho	Chum	Steelhead
United States *	**0**	**69,620**	**5,720**	**190**	**10**	**0**
Areas 4B, 5 and 6C Net	0	0	0	0	0	0
Areas 6, 7 and 7A Net	0	69,620	5,720	190	10	0
Canada **	**0**	**0**	**0**	**0**	**0**	**0**
Area 20 Net	0	0	0	0	0	0
Area 29 Net	0	0	0	0	0	0
Total	**0**	**69,620**	**5,720**	**190**	**10**	**0**

* Estimates for All Citizen fisheries are from the WDFW "LIFT" database, while estimates for Treaty-Indian fisheries are from the "TOCAS" database.

** Estimates are from DFO in-season hail program.

VII. ALLOCATION STATUS

Annex IV, Chapter 4, (paragragh 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 there was an overage for Fraser River sockeye in 2019 (Table 18). The Panel agreed post-season that the 470 sockeye landed in Panel regulated fisheries directed at Fraser River pink salmon in 2019 would be carried over as payback to 2020. The sockeye caught in the Treaty Indian fishery (470) were not sold but retained by US tribes for ceremonial and subsistence purposes. The resulting calculations also indicate there was no payback due for Fraser River pink salmon in 2019 (Table 18).

Table 18. Allocation status for Fraser River sockeye and pink salmon in 2014-2019.

	2014 (Oct 04)	2015 (Aug 07)	2016 (Aug 02)	2017 (Oct 7)	2018 (Aug 23)	2019 (Sep 13)
TOTAL ALLOWABLE CATCH						
Total Run Size	19,883,500	6,367,000	2,110,000	1,487,000	14,022,000	500,000
Escapement and other deductions	8,688,600	3,758,100	1,542,700	1,487,000	7,822,400	500,000
Total Allowable Catch:	11,194,900	2,608,900	567,300	0	6,199,600	0
UNITED STATES						
Washington Catch	701,600	46,200	1,700	1,500	993,500	470
Washington Share (excldes payback) *	1,847,100	430,500	93,600	0	1,020,300	0
Deviation:	-1,145,500	-384,300	-91,900	1,500	-26,800	470
Cumulative Allocation Status:	**0**	**900****	**900****	**2400****	**0****	**470****
CANADA						
Catch	10,122,800	187,900	149,200	71,900	4,731,500	9,860
Share + Aboriginal Exemption	9,747,800	2,365,600	622,100	71,700	5,251,000	9,710
Deviation:	375,000	-2,177,700	-472,900	200	-519,500	150

	2015 (Aug 31)	2017 (Aug 31)	2019 (Sep 13)
TOTAL ALLOWABLE CATCH			
Total Run Size	14,455,000	4,800,000	8,900,000
Escapement and other deductions	6,210,900	4,388,100	6,017,240
Total Allowable Catch:	8,244,100	411,900	2,882,760
UNITED STATES			
Washington Catch	330,900	102,200	233,290
Washington Share *	2,118,700	105,900	740,870
Deviation:	-1,787,800	-3,700	-507,580
Cumulative Allocation Status:	**0**	**0**	**0**
CANADA			
Catch	116,500	37,200	300,260
Share	6,125,400	306,000	2,141,890
Deviation:	-6,008,900	-268,800	-1,841,630

* 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:

2015: By Panel agreement, any U.S. catch of Fraser sockeye after August 7, when the last U.S. sockeye-directed fishery was scheduled, is considered an overage.

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 adopted last in-season run size (Oct 12).

2019: By Panel agreement, the 470 sockeye caught during the pink salmon directed opening generated a payback as there was no available TAC for sockeye salmon.

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
EO: Economic Opportunity	PSE: Potential Spawning Escapement
ESSR: Excess Salmon to Spawning Requirements	RSA: Run Size Adjustment
FRP: Fraser River Panel	SE: Spawning Escapement
FRPTC: Fraser River Panel Technical Committee	SET: Spawning Escapement Target
FRSSI: Fraser River Sockeye Spawning Initiative	TAC: Total Allowable Catch
FSC: "Food, Social and Ceremonial"	TAM: Total Allowable Mortality
	WDFW: Washington Department of Fish and Wildlife

APPENDIX B: 2019 PRE-SEASON FORECASTS AND SPAWNING ESCAPEMENT TARGETS FOR FRASER RIVER SOCKEYE AND PINK SALMON

Table B1. Pre-season forecasts for Fraser River sockeye and pink salmon in 2019. (Provided to the Panel by Fisheries and Oceans Canada).

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 (Ei)*	18,000	27,000	41,000	61,000	92,000
Early Summer		112,000	221,000	465,000	898,000	1,753,000
(total excluding miscellaneous)		76,000	140,000	277,000	557,000	1,059,000
Bowron	*Ricker (Pi)*	6,000	9,000	15,000	24,000	39,000
Upper Barriere (Fennell)	*PowerAge4 /SiblingAge5*	3,000	5,000	10,000	19,000	32,000
Gates	*Larkin*	12,000	22,000	41,000	81,000	152,000
Nadina	*MRJ*	29,000	59,000	129,000	283,000	576,000
Pitt	*LarkinAge4 /SiblingAge5*	13,000	20,000	34,000	57,000	90,000
Scotch	*LarkinAge4 /SiblingAge5*	4,000	9,000	19,000	38,000	75,000
Seymour	*LarkinAge4 /SiblingAge5*	9,000	16,000	29,000	55,000	95,000
Misc (EShu) [b]	*R/S*	30,000	68,000	156,000	253,000	448,000
Misc (Taseko) [c]	*R/S*	1,000	2,000	3,000	6,000	9,000
Misc (Chilliwack)	*Ricker*	2,000	5,000	17,000	59,000	195,000
Misc (Nahatlatch) [d]	*R/S*	3,000	6,000	12,000	23,000	42,000
Summer		1,553,000	2,454,000	3,930,000	7,048,000	11,187,000
(total excluding miscellaneous)		1,526,000	2,398,000	3,835,000	6,852,000	10,789,000
Chilko	*Power Juv (Pi)*	1,151,000	1,773,000	2,750,000	4,761,000	7,143,000
Late Stuart	*R1C*	6,000	14,000	39,000	105,000	256,000
Quesnel	*Ricker (Ei)Age4 /SiblingAge5*	100,000	177,000	333,000	687,000	1,207,000
Stellako	*Larkin*	175,000	261,000	368,000	572,000	848,000
Harrison [e]	*Ricker/Odd(Ei)*	71,000	140,000	293,000	646,000	1,205,000
Raft [e]	*Ricker(PDO)*	23,000	33,000	52,000	81,000	130,000
Misc (N. Thomp. Tribs) [e & f]	*R/S*	1,000	3,000	5,000	10,000	20,000
Misc (N. Thomp River) [e & f]	*R/S*	26,000	53,000	89,000	185,000	375,000
Misc (Widgeon) [g]	*R/S*	0	0	1,000	1,000	3,000
Late		111,000	189,000	359,000	669,000	1,265,000
(total excluding miscellaneous)		100,000	169,000	320,000	596,000	1,138,000
Cultus	*PowerJuv (Pi)*	0	0	1,000	2,000	3,000
Late Shuswap	*RickerCycAge4 /SiblingAge5*	11,000	26,000	61,000	140,000	325,000
Portage	*Larkin*	0	0	2,000	8,000	29,000
Weaver	*Ricker(PDO)Age4 /SiblingAge5*	7,000	13,000	27,000	55,000	116,000
Birkenhead	*Ricker (Ei)*	82,000	130,000	229,000	391,000	665,000
Misc Harrison/Lillooet [g]	*R/S*	11,000	20,000	39,000	73,000	127,000
TOTAL SOCKEYE SALMON		1,794,000	2,891,000	4,795,000	8,676,000	14,297,000
(TOTAL excluding miscellaneous)		1,720,000	2,734,000	4,473,000	8,066,000	13,078,000
TOTAL PINK SALMON	*Power(fry) SSS*	2,530,000	3,577,000	5,018,600	7,513,000	10,610,000

a. See Table 4 for model descriptions
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

Table B2. Spawning escapement plan for Fraser River sockeye and pink salmon in 2019. (Provided to the Panel by Fisheries and Oceans Canada and based on Fraser River Sockeye Spawning Initiative (FRSSI) guidelines with input from domestic consultations).

Management Unit		Pre-season Forecast Return				
		p10	p25	**p50**	p75	p90
Early Stuart	forecast	18,000	27,000	**41,000**	61,000	92,000
	TAM Rule (%)	0%	0%	**0%**	0%	0%
	Escapement Target	18,000	27,000	**41,000**	61,000	92,000
	MA	12,400	18,600	**28,300**	42,100	63,500
	Esc. Target + MA	30,400	45,600	**69,300**	103,100	155,500
	LAER	10%	10%	**10%**	10%	10%
	Available ER at Return	0%	0%	**0%**	0%	0%
	Allowable ER	10%	10%	**10%**	10%	10%
	Allowable Harvest	1,800	2,700	**4,100**	6,100	9,200
	2019 Performance					
	Projected S (after MA)	9,600	14,300	**21,800**	32,400	48,900
	BY Spawners	10,096	10,096	**10,096**	10,096	10,096
	Proj. S as % BY S	95%	142%	**216%**	321%	484%
	cycle avg S	44,409	44,409	**44,409**	44,409	44,409
	Proj. S as % cycle S	22%	32%	**49%**	73%	110%

Management Unit		Pre-season Forecast Return				
		p10	p25	**p50**	p75	p90
Early Summer (w/o RNT)	*lower ref. pt. (w misc)*	147,400	157,900	**167,900**	161,200	165,500
	upper ref. pt. (w misc)	368,400	394,600	**419,700**	403,100	413,800
	forecast (incl. misc)	112,000	221,000	**465,000**	898,000	1,753,000
	TAM Rule (%)	0%	29%	**60%**	60%	60%
	Escapement Target	112,000	157,900	**186,000**	359,200	701,200
	MA	50,400	71,100	**83,700**	161,600	315,500
	Esc. Target + MA	162,400	229,000	**269,700**	520,800	1,016,700
	LAER	20%	20%	**20%**	20%	20%
	Available ER at Return	0%	0%	**42%**	42%	42%
	Allowable ER	20%	20%	**42%**	42%	42%
	Allowable Harvest	22,400	44,200	**195,300**	377,200	736,300
	2019 Performance					
	Projected S (after MA)	61,800	122,000	**186,100**	359,400	701,500
	BY Spawners	137,845	137,845	**137,845**	137,845	137,845
	Proj. S as % BY S	45%	89%	**135%**	261%	509%
	cycle avg S	144,830	144,830	**144,830**	144,830	144,830
	Proj. S as % cycle S	43%	84%	**128%**	248%	484%

Table B2, continued on next page

Table B2, continued.

Management Unit		Pre-season Forecast Return				
		p10	p25	**p50**	p75	p90
Summer (w. RNT & Har)	*lower ref. pt. (w misc)*	1,109,500	1,109,500	**1,109,500**	1,109,500	1,109,500
	upper ref. pt. (w misc)	2,773,900	2,773,900	**2,773,900**	2,773,900	2,773,900
	forecast	1,553,000	2,454,000	**3,930,000**	7,048,000	11,187,000
	TAM Rule (%)	29%	55%	**60%**	60%	60%
	Escapement Target	1,109,500	1,109,500	**1,572,000**	2,819,200	4,474,800
	MA	99,900	99,900	**141,500**	253,700	402,700
	Esc. Target + MA	1,209,400	1,209,400	**1,713,500**	3,072,900	4,877,500
	LAER	20%	20%	**20%**	20%	20%
	Available ER at Return	22%	51%	**56%**	56%	56%
	Allowable ER	22%	51%	**56%**	56%	56%
	Allowable Harvest	343,600	1,244,600	**2,216,500**	3,975,100	6,309,500
	2019 Performance					
	Projected S (after MA)	1,112,600	1,112,600	**1,576,400**	2,827,100	4,487,300
	BY Spawners	977,005	977,005	**977,005**	977,005	977,005
	Proj. S as % BY S	114%	114%	**161%**	289%	459%
	cycle avg S	651,121	651,121	**651,121**	651,121	651,121
	Proj. S as % cycle S	171%	171%	**242%**	434%	689%

Management Unit		Pre-season Forecast Return				
		p10	p25	**p50**	p75	p90
Late (w/o Har)	*lower ref. pt. (w misc)*	336,600	336,600	**336,600**	336,600	336,600
	upper ref. pt. (w misc)	841,400	841,400	**841,400**	841,400	841,400
	forecast	111,000	189,000	**359,000**	669,000	1,265,000
	TAM Rule (%)	0%	0%	**6%**	50%	60%
	Escapement Target	111,000	189,000	**336,600**	336,600	506,000
	MA	54,400	98,300	**188,500**	198,600	323,800
	Esc. Target + MA	165,400	287,300	**525,100**	535,200	829,800
	LAER	20%	20%	**20%**	20%	20%
	Available ER at Return	0%	0%	**0%**	20%	34%
	Allowable ER	20%	20%	**20%**	20%	34%
	Allowable Harvest	22,200	37,800	**71,800**	133,800	435,200
	2019 Performance					
	Projected S (after MA)	59,600	99,500	**184,900**	336,100	504,400
	BY Spawners	68,022	68,022	**68,022**	68,022	68,022
	Proj. S as % BY S	88%	146%	**272%**	494%	742%
	cycle avg S	465,982	465,982	**465,982**	465,982	465,982
	Proj. S as % cycle S	13%	21%	**40%**	72%	108%
Allowable Harvest (TF, US, CDN)		390,000	1,329,300	**2,487,700**	4,492,200	7,490,200
Total projected spawners		1,243,600	1,348,400	**1,969,200**	3,555,000	5,742,100

2019 Fraser Pink Escapement Plan

Run Size	**Escapement Plan**
Less than 7.059M	Exploitation rate increases linearly from 0% at run size =0 to 15% at run size = 7.059M
Between 7.059M-20M	Fixed Escapement. Escapement goal = 6,000,000
Greater than 20M	Exploitation Rate Cap = 70%

	2019 Pre-season Forecast Return				
	p10	p25	**p50**	p75	p90
forecast	2,530,000	3,577,000	**5,018,600**	7,513,000	10,610,000
escapement target	2,394,000	3,305,000	**4,483,000**	6,000,000	6,000,000
allowable ER	5%	8%	**11%**	20%	43%

APPENDIX C: 2019 FRASER RIVER PANEL MANAGEMENT PLAN PRINCIPLES AND CONSTRAINTS (agreed July 9, 2019)

1. Fisheries and Oceans Canada (DFO) has provided the Panel with run-size forecasts for Fraser River sockeye and pink salmon. It is broadly understood that the sockeye and pink 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 outmigrating fry) and observation error in the associated data. The median forecast for the total Fraser sockeye return is 4,795,000 fish, and there is a one in four chance that the actual number of returning sockeye will be at or below 2,891,000 fish and there is a one in four chance that the actual number of returning sockeye will be at or larger than 8,676,000 fish. The median forecasts for the four different management groups are 41,000 Early Stuart, 465,000 Early Summer-run, 3,930,000 Summer-run, and 359,000 Late-run sockeye. Of note, the Chilko sockeye represent 57% of the total Fraser sockeye return and 70 % of the Summer-run return at the median forecast, further adding to the uncertainty. The median forecast for Fraser River pink salmon is 5,018,600 fish, and there is a one in four chance that the actual number of returning pink salmon will be below 3,577,000, and a one in four chance that the return will be larger than 7,513,000. The median or 50% probability level forecasts for Fraser River sockeye and pink salmon were used for pre-season planning purposes. When sufficient information is available in-season, the Panel will update run size estimates of Fraser River sockeye and pink 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. The US anticipates harvesting their full total allowable catch (TAC) for Fraser River sockeye salmon. Canadian fisheries are constrained by the total allowable exploitation rate of Early Summer and Late Run which limits Canada's ability to harvest their sockeye salmon TAC. However, depending upon sockeye and coho constraints, both Canada and the United States anticipate harvesting the full pink salmon TAC if Fraser River pink salmon returns in 2019 correspond to the median forecast.

3. TAC and international shares are calculated according to the 2014 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 and 25.7% of the international TAC of Fraser River pink salmon. For 2019, 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. At the median forecasts, the LAERs are set at 10% for Early Stuart, 20% for Early Summer, Summer-run sockeye and Late-run sockeye. 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. The Panel has adopted a similar management approach for Late-run sockeye that presumes that similar to recent years, Late-run sockeye will enter the Fraser River earlier than the long-term average, and some proportion will not survive to spawn.

5. Given pre-season assumptions about Late-run sockeye marine migration timing and recent delay behavior, the Panel has agreed to use a proportional Management Adjustment (pMA) factor for Late-run sockeye of 0.56. If in-season information suggests the upstream timing of Late-run, excluding Birkenhead-Big Silver, is later than September 8th, the Panel will consider adjusting the pMA based on predictions from the timing model fit to all years. At the median forecast, no directed harvest of Late-run sockeye is planned. However, some limited by-catch of Late-run sockeye may occur in fisheries directed at other co-migrating Fraser River sockeye management groups with harvestable surpluses and Fraser River pink salmon.

Regulations

i) If in-season conditions are consistent with pre-season expectations, low impact fisheries would be expected to commence in late-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 2019 management season.

APPENDIX D: 2019 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 13, 2019.

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 30th day of June 2019, to the 21st day of September 2019, 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 30th day of June 2019, to the 21st day of September 2019, 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 30th day of June 2019 to the 28th day of September 2019, 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 30th day of June 2019, to the 28th day of September 2019, 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 30th day of June 2019, to the 12th day of October 2019, both dates inclusive. b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 29 from the 30th day of June 2019, to the 12th day of October 2019, 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.

During the 2019 season, the Fraser River Panel will adopt orders establishing open fishing periods based on a 2019 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 30th day of June 2019 to the 21st day of September 2019, 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 30th day of June 2019, to the 28th day of September 2019, 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 29th day of September 2019, to the 5th day of October 2019, 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 30th day of June 2019, to the 21st day of September 2019, 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 30th day of June 2019, to the 28th day of September 2019, 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 29th day of September 2019, to the 5th day of October 2019, 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 2019 season, the Fraser River Panel will adopt orders establishing open fishing periods based on a 2019 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: 2019 FRASER RIVER PANEL IN-SEASON ORDERS

To 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, the Fraser River Panel formulated the following orders to regulate Panel Area fisheries.

August 20, 2019

United States

Treaty Indian

Areas 4B, 5 and 6C

Open to drift gillnets from 12:00 p.m. (noon), Wednesday, August 21, 2019 through 12:00 p.m. (noon) Friday, August 23, 2019. All efforts must be made to release sockeye alive.

Areas 6, 7 and 7A

Open for reef net, drift gillnet, and purse seine fishing from 5 a.m., Wednesday, August 21, 2019, through 9 a.m., Friday August 23, 2019. All efforts must be made to release sockeye alive.

All Citizen

Areas 7 and 7A

Open to purse seine fishing, with non-retention of sockeye, 5:00 a.m. to 9:00 p.m., Friday, August 23, 2019.

Areas 7 and 7A

Open to drift gillnet fishing, with non-retention of sockeye, 8:00 a.m. to 11:59 p.m., Friday, August 23, 2019.

August 23, 2019

United States

All Citizen

Areas 7 and 7A

The purse seine fishery previously scheduled for 5 a.m. to 9 p.m., Friday, August 23, 2019, is rescinded.

Areas 7 and 7A

The drift gillnet fishery previously scheduled for 8 a.m. to 11:59 p.m., Friday, August 23, 2019, is rescinded.

August 23, 2019

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Open to drift gillnets from 12:00 p.m. (noon), Saturday, August 24, 2019 to 12:00 p.m. (noon) Wednesday, August 28, 2019. Sockeye non-retention.

Area 7

Open to reef net fishing, from 5:00 a.m. to 9:00 p.m., Sunday, August 25, 2019 Monday, August 26, 2019. Sockeye non-retention.

All Citizen

Area 7

Open to reef net fishing, from 5:00 a.m. to 9:00 p.m., Sunday, August 25, 2019, and from 5:00 a.m. to 9:00 p.m. Monday, August 26, 2019. Must release all sockeye, unmarked Chinook, unmarked coho, and all chum salmon.

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Areas 7 and 7A, excluding the Apex

Open to purse seine fishing from 5:00 a.m. to 9:00 p.m., Saturday, August 24, 2019, and from 5:00 a.m. to 9:00 p.m., Sunday, August 25, 2019. Pink salmon retention only.

Areas 7 and 7A, excluding the Apex

Open to drift gillnet fishing, from 8:00 a.m. to 11:59 p.m., Saturday, August 24, 2019, and Sunday, August 25, 2019. Non-retention of sockeye.

September 12, 2019

United States

Treaty Indian Fishery

Areas 4B, 5, 6, 6C, 7 and 7A

Open for reef net, drift gillnet, and purse seine fishing with non-retention of sockeye from 5:00 a.m. Sunday, September 15, 2019, through 9:00 p.m. Monday, September 16, 2019.

Area 7

Open to reef net with non-retention of sockeye 5:00 a.m. – 9:00 p.m. Friday, September 13, 2019, and 5:00 a.m. – 1:00 p.m. Saturday, September 14, 2019.

All Citizen

Area 7

Open to reef net fishing from 5:00 a.m. through 9:00 p.m., Friday, September 13, 2019, and from 5 a.m. through 1 p.m., Saturday, September 14, 2019. Must release all sockeye, unmarked Chinook salmon, unmarked coho, and all chum salmon.

Area 7

Open to purse seine fishing from 5 a.m. through 9 p.m., Friday, September 13, 2019. Pink salmon retention only.

Area 7

Open to drift gillnet fishing from 8 a.m. through 11:59 p.m. (midnight), Friday, September 13, 2019. Non-retention of sockeye.

Area 7A

Open to purse seine fishing from 5 a.m. through 9 p.m., Friday, September 13, 2019, and from 5 a.m. through 1 p.m., Saturday, September 14, 2019. Pink salmon retention only.

Area 7A

Open to drift gillnet fishing from 8 a.m. through 11:59 p.m. (midnight), Friday, September 13, 2019, and from 8 a.m. through 4 pm., Saturday, September 14, 2019. Non-retention of sockeye.

September 13, 2019

Canada

Areas 29-6, 7, 9

Open to Area B purse seine ITQ from 7:00 a.m. to 8:00 p.m. daily from Saturday, September 14, 2019 until Friday, September 20, 2019 (Please refer to DFO Fishery Notice for further details)

Areas 29-1 to 6

Open to Area H troll ITQ fishery from 12:01 a.m. (midnight) Saturday, September 14, 2019 until 11:59 p.m. Saturday, September 21, 2019 (Please refer to DFO Fishery Notice for further details)

United States

Treaty Indian Fishery

Areas 4B, 5, and 6C

Open for drift gillnet fishing from 5:00 a.m. Sunday, September 15, 2019, through 9:00 p.m. Monday, September 16, 2019. Non-retention of sockeye. This supersedes the net fisheries previously scheduled in these areas for Sunday, September 15, 2019, and Monday, September 16, 2019.

Areas 6, 7 and 7A

Open for drift gillnet, and purse seine fishing from 5:00 a.m. Sunday, September 15, 2019, through 9:00 p.m. Monday, September 16, 2019. Non-retention of sockeye. This supersedes the net fisheries previously scheduled in these areas for Sunday, September 15, 2019, and Monday, September 16, 2019.

Area 7

Open to reef net fishing from 12 p.m. to 8 p.m., Saturday, September 14, 2019. Sockeye non-retention. This supersedes the reef net fishery previously scheduled in this area for Saturday, September 14, 2019.

All Citizen

Area 7

Open to reef net fishing from 12 p.m. to 8 p.m., Saturday, September 14, 2019. Must release all sockeye, unmarked Chinook salmon, unmarked coho, and all chum salmon. This supersedes the reef net fishery previously scheduled for this area on Saturday, September 14, 2019.

September 17, 2019

Canada

Areas 29-6, 29-7 and 29- 9

Area B seine ITQ fishery for pink salmon will close at 20:00 hours Tuesday, September 17. (Please refer to DFO Fishery Notice for further details).

Areas 29-1 to 29-6

Area H troll ITQ fishery for Pink Salmon will close at 23:59 Tuesday, September 17, 2019. (Please refer to DFO Fishery Notice for further details).

United States

Treaty Indian and All Citizen Fishery

Areas 4B, 5, 6, 6C and 7

Relinquish regulatory control effective 23:59 p.m., Tuesday, September 17, 2019.

Area 7A, excluding the Apex

Relinquish regulatory control effective 23:59 p.m., Saturday, September 21, 2019.

Apex

Relinquish regulatory control effective 23:59 p.m., Saturday, October 5, 2019, as originally scheduled.

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 21; Areas 17 and 18 on September 28; and Area 29 on October 12. Panel control of United States Panel Areas were relinquished as follows; Areas 4B, 5, 6, 6C and 7 on September 17 by in-season order; Area 7A excluding the Apex on September 21 by in-season order, and the remaining portions of Area 7A on October 5 in accordance with the pre-season Regulations.

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 sockeye and pink salmon, including abundance-related data such as catch-per-unit-effort (CPUE) and biological samples from which stock composition estimates are obtained. While Table 4 in the main body of the report summarizes the locations and temporal patterns of Panel-approved test fisheries, Table F1 summarizes more detailed information about the nets and sampling strategies employed.

Table F 1. Sampling details for Panel-approved test fisheries conducted in 2019.

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
United States Panel Areas									
7	San Juan Islands	Reefnet [1]	2	n/a	n/a	n/a		n/a	n/a
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
13	Lower Johnstone Str.	Purse Seine	1	397	575	95	3 3/4	6	20
	Fraser R. (Qualark)	Gillnet	1	30	Variable	Variable		3	5

1 Reefnet observations are made during periods of favorable tides. Fish are counted as they swim through the gear but are not harvested.

Information pertaining to the migration of Fraser River sockeye and pink salmon through marine areas is provided primarily by test fisheries in Area 20 (Juan de Fuca Strait) and Areas 12 (upper Johnstone Strait) but is 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 the Fraser River (Area 29) are used to assess species and stock composition for application to Mission passage estimates. When the Mission hydroacoustic program is not active, lower river (Area 29) test fisheries provide passage estimates for sockeye salmon through the use of CPUE models. In

the Fraser River canyon, the Qualark gillnet test fishery provides information on salmon species composition for the Qualark hydroacoustics program and was funded by the PSC test fishing revolving fund.

In 2019, the Fraser River Panel tried to minimize the cost of Panel-approved test fisheries as well as their impact on the successful escapement of salmon to spawning grounds throughout the Fraser River watershed. As a result of the low forecast for Early Stuart sockeye (p50: 41,000 sockeye), the Area 20 gillnet test fishery began on July 10, after which most of the Early Stuart sockeye were thought to have migrated past the test fishery site. For safety purposes, two gill net vessels were used in Area 20. To minimize costs, the Area 12 Naka Creek gillnet and Area 29 Gulf Troll test fisheries were not scheduled and the reefnet observation program was limited to operate only prior to potential U.S. commercial fishery openings. Due to the low in-season returns of Fraser River sockeye, the U.S. Area 5 gillnet test fishery was cancelled and there was a reduction to the number of days of operation of the Area 20, 12, and 13 purse seine programs. Finally, due to the low returns of Fraser sockeye and concerns for salmon migration success past the Big Bar landslide, the Qualark gillnet test fishery reduced fishing effort from 6 to 3 sets per day.

Early in the season, daily marine gillnet sockeye catches in Area 20 and Area 12 were low compared to brood year catches as well as the cycle-year average. Later in the season, purse seine test fishery catches of sockeye in Area 20, Area 12, and Area 13 were also low compared to the brood year as well as the cycle-year average. Catches of pink salmon in the Area 20 purse seine test fishery were higher than the brood year and cycle-year average up until August 18 but dropped off very soon after. Pink salmon catches in the Area 12 and Area 13 purse seine test fisheries were low compared to brood year catches as well as the cycle-year average. In the Fraser River, test fishing catches of sockeye were low compared to the brood year and cycle-year average at both the Cottonwood and Whonnock gillnet test fisheries. Both the Cottonwood and Whonnock gillnet test fisheries had much higher pink salmon catches than the brood year and cycle year average. The condensed peak of the pink salmon migration through the lower Fraser River in early September resulted in large daily catches of pink salmon in the Cottonwood and Whonnock gillnet test fisheries. During this period, Cottonwood had high daily catches of pink salmon while catches at Whonnock surpassed the previous daily catch records with record catches of 737 and 676 pink salmon on September 5 and 9, respectively. The U.S. Area 7 reefnet observation test fishery was deployed for two separate pink salmon observation periods for a total of 5 days of observations. Both observation periods were followed by commercial openings for pink salmon in U.S. waters. Pink salmon were retained in the marine purse seines for a period of time with the goal of reducing the potential deficit of the program in 2019. Only sockeye that could not be released alive or those required for scientific samples were retained in the test fisheries. Due to the low total abundance of Fraser River sockeye the number of sockeye retained from all Panel-approved test fisheries was well below what was planned for pre-season. The high abundance of Fraser River pink salmon allowed for a short period of pink salmon retention in the purse seine test fisheries. This retention window was constrained due to concerns for sockeye fisheries induced mortalities. Due to restricted retention of sockeye and pink salmon in the test fisheries, fish sales were unable to offset the costs of the program. The 2019 program deficit of $837,000 was paid for by the Test Fish Revolving fund.

The 2019 season was the first 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[20]. The experimental program ran for 20 days and was funded fully by the SEF. The experimental program will continue in 2020, 2021, and 2022.

[20] Labelle, M. and Van Will, P. 2020. Comparison of Sockeye Salmon catch and catch rates of two test-fishing gill nets used at Round Island in 2019. SEF Final Report.

B. Mission Hydroacoustics

Every summer, Pacific Salmon Commission staff operate a hydroacoustics monitoring facility upstream of the Mission Railway Bridge, approximately 80km from the mouth of the Fraser River. The purpose of the site is to provide accurate and timely estimates of sockeye and pink salmon passage through the lower Fraser River.

The Mission hydroacoustics site has applied a consistent sampling method to enumerate salmon passage since 2011 using a combination of split-beam and imaging sonars[21,22]. For 2019, daily salmon passage was estimated using a side-looking split-beam sonar and an Adaptive Resolution Imaging Sonar (ARIS) for the left bank of the river, a downward-looking split-beam sonar deployed on a vessel for the offshore portion of the river, and an ARIS imaging sonar for the right bank of the river (Figure F1). The sonar systems operate 24 hours a day to collect information on the density, direction of travel, speed, and size distributions of fish targets.

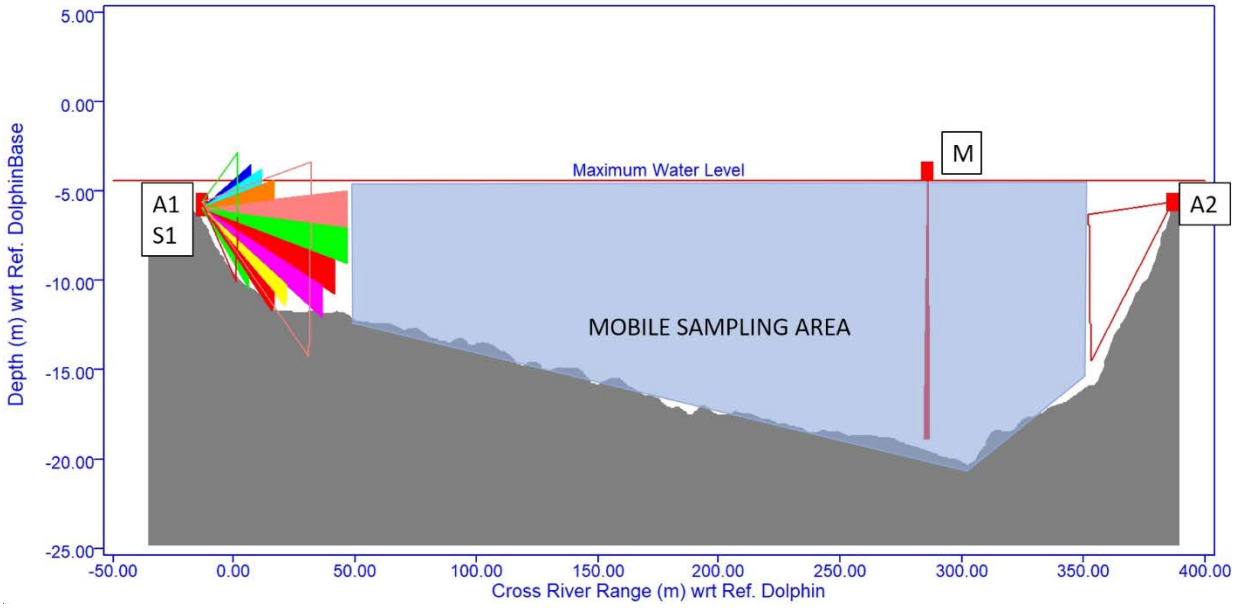

Figure F 1. Cross-river view of the sampling geometry of the sonar systems operated at the Mission hydroacoustics site. The four systems shown are the left bank split-beam (S1), the left bank ARIS (A1), the mobile split-beam (M), and the right bank ARIS (A2). The beam geometries of left bank ARIS (A1) 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.

[21] 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.

[22] 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.

The left bank split-beam (S1) consists of a side-looking transducer with an elliptical beam width of 2°×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 ten aims of non-overlapping, 2° vertical apertures with each aim sampling for 6 minutes each hour up to a range of 60 metres. The aim and orientation of the transducer were monitored using an Impact Subsea ISD4000 motion reference unit. 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 transducer. The system was operated for the full duration of the hydroacoustics program from July 4 to September 23.

An ARIS system (A1) was also operated on the left bank from a location adjacent to the split-beam at the end of the fish-deflection weir. The ARIS system was deployed on an AR2 rotator that allowed it to cycle through multiple vertical aims for full sampling coverage of the water column up to a range of 45 metres. The ARIS collected data throughout program operations, however, it was only used for official estimates of salmon passage within the nearshore area (up to 25m range) from August 27 to September 23. The primary reason for using the ARIS during this period was due to the high density of pink salmon that could not be accurately tracked by the split-beam system. The ARIS system was also used throughout August for obtaining measurements of fish fork lengths. These lengths were input into a length-based model to estimate the relative proportions of sockeye and pink salmon migrating past the site.

The offshore region of the site was sampled by a vessel-based split-beam system (M) using a downward-looking, 6° circular beam transducer manufactured by Biosonics Incorporated. The transducer was towed along transects perpendicular to the river flow to obtain cross-river fish density data in offshore areas. Each transect took approximately five minutes from one bank of the river to the other and an average of 170 transects were carried out each day throughout the full duration of the hydroacoustics program. Information on the direction of travel and speed of fish targets cannot be obtained from a moving transducer, so behavioural statistics observed from the left bank split-beam were applied to the vessel-based density data to estimate offshore fish passage[23]. To monitor offshore fish behaviour, the vessel also deployed a DIDSON imaging sonar from anchored positions approximately 50 meters offshore from the left or right bank. During these anchored deployments, the DIDSON was aimed offshore for sampling of fish passage up to a range of 20 metres from the vessel. Anchored deployment of the DIDSON occurred six times per day (three times from each side of the river) for an hour each time.

The right bank area was sampled by an ARIS system (A2) deployed at the end of a telescopic fish-deflection weir. This system commenced data collection on July 9 and was included in subsequent daily estimates of salmon passage up to September 20. The A2 system used a single vertical aim to sample the entire water column up to 40 metres range from the sonar.

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 five-minute 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. To remove small, non-salmonid fish populations from the estimates of upstream salmon passage, fork length measurements were taken on a subset of fish in the ARIS data. A normally distributed length-based model was then applied to determine the proportion of

[23] 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.

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[24] and then classified as fish or noise (e.g., debris, air bubbles) by a discriminate function analysis[25]. This treatment also removed most small, non-salmonid fish targets from the estimation data by filtering out echoes that were too weak to represent adult salmon. 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[26]. On the left bank area, the split-beam was used for the entire sampling area except during the period of pink migration when the ARIS was used to estimate salmon passage in the nearshore area up to 25 meters range. Over the entire monitoring period from July 4 to September 23, the ARIS and split-beam left bank systems saw a combined 81% of total salmon passage, the right bank ARIS observed 15% of passage, and the offshore system observed 4% of passage.

Salmon passage estimates were apportioned among Pacific salmon species using information from multiple sources that included daily catch-per-unit effort (CPUE) and species proportions from the Whonnock and Albion gill net test fisheries, modelled forecasts of daily Chinook salmon abundance, and mixture 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 throughout July were calculated using total salmon passage estimates minus the forecasted daily Chinook passage. Once sockeye passage increased in August and pinks began to co-migrate in the river, species proportions were estimated using a stratified method based on catch from the Whonnock test fishery and length-based model estimates of fish length frequencies from ARIS data[27]. This stratified method was applied to the total daily salmon estimate to determine pink and sockeye passage from August 1 to August 19. From August 20 and onward, salmon passage at Mission was dominated by pink salmon, reducing the reliability of length-based model estimates of sockeye and pink salmon proportions. Therefore, daily sockeye abundance during this period was estimated by expanding Whonnock CPUE estimates using a catchability coefficient. Pink salmon passage was then estimated as total salmon passage minus sockeye and Chinook passage estimates.

[24] Blackman, S. S. and R. Popoli. Design and Analysis of Modern Tracking Systems. Artech House, Boston, 1999.
[25] 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.
[26] 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.
[27] Grant, S., M. Townsend, B. White, and M. Lapointe. 2014. Fraser River Pink Salmon (Oncorhynchus gorbuscha) Data Review: Inputs for Biological Status and Escapement Goals. Report prepared for Pacific Salmon Commission. May, 2014.

Stock Identification

PSC staff conduct sampling programs designed to identify stock proportions of Fraser River sockeye and pink salmon in commercial, test, First Nations and recreational catches. Coupled with abundance indices from stock monitoring programs, these data provide information on the abundance and timing of sockeye and pink salmon stocks as they migrate to their natal rivers in the Fraser watershed. Stock identification data are also used to account for Fraser sockeye and pink salmon wherever they are caught, and to apportion the daily estimates of sockeye escapement past Mission into discrete stock groups. Stock identification methods for sockeye salmon in 2019 used DNA and scale pattern analyses from fish caught in marine and in-river fisheries. Pink salmon stock identification for 2019 relied on DNA analyses of marine test fisheries and commercial catches. For sockeye salmon, continuing a practice developed in recent years, a multinomial extrapolation procedure was used for predicting stock composition estimates in catches that had not yet occurred or had not yet been analyzed. For pink salmon, extrapolations used stock composition estimates from previous years and the current year (2019) to estimate overall projections in a Bayesian framework.

A. Sockeye Salmon

Stock identification methods for sockeye salmon relied on DNA[28] (using the program CBAYES[29]) and scale pattern analyses[30]. 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 early July and continuing to mid-September. PSC staff sampled sockeye from test fishery catches from Port Renfrew and the Lower Fraser River in British Columbia. 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, Alaska, and Langara Fishing Adventures provided samples from recreational catches near Haida Gwaii, British Columbia. DFO also provided a DNA sample from fish seized by conservation officers.

[28] 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.

[29] 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.html (January 2012).

[30] Gable, J. and S. Cox-Rogers. 1993. Stock identification of Fraser River sockeye salmon: methodology and management application. PSC Tech. Rep. No. 5.

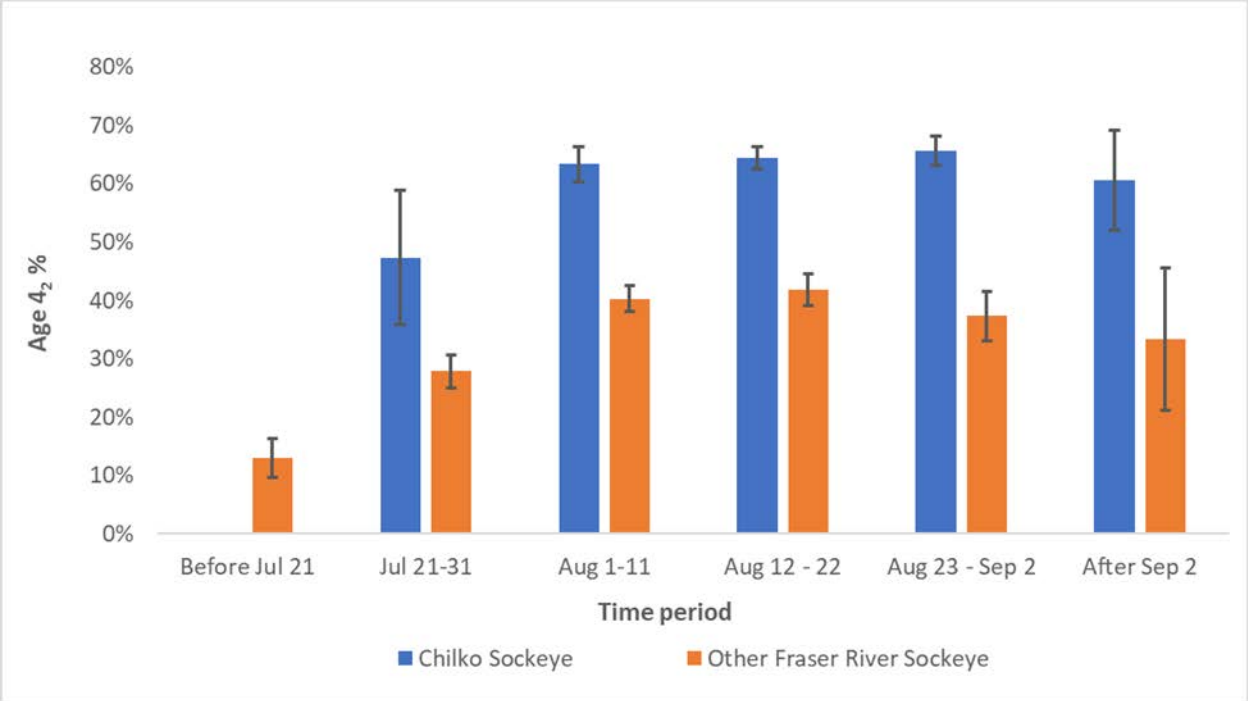

Figure F 2: Age 4_2 proportion of in-season Fraser River sockeye caught in Area 12, Area 20, and Area 29 test fisheries over approximately 10-day catch periods. Results are presented for sockeye that reared in Chilko Lake (representing approximately half of the forecast return) and other Fraser River sockeye excluding Harrison Rapids and Widgeon Slough sockeye. Bars are standard deviations.

Estimation of age is the first step in the interpretation of scales for stock identification, but age estimates of returning sockeye are also informative regarding expected abundances – observations of lower-than-expected age 4_2 proportions portend poor Fraser sockeye returns. Age composition estimates from test fishing catches were reported frequently in 2019, particularly early in the season when other information about the run was scarce. The value of this information for setting expectations regarding abundance relies to some extent on the ability to predict age compositions from early samples. Figure F2 illustrates the estimated age 4_2 proportions for Chilko and non-Chilko Fraser sockeye salmon (based on scale readings by PSC Staff) in six in-season time periods. Harrison Rapids and Widgeon Slough sockeye were excluded here because of their distinct life histories and age structures. There were no Chilko sockeye detected until the July 21 – 31 period. Age 4_2 proportions generally increased over time until mid-August; the Chilko 4_2 proportion was higher (by at least 20%) than the aggregate of other stock groups during each comparable period.

Table F2 summarizes age compositions of caught sockeye (excluding District 104) compared to the pre-season forecast. Both Early Stuart and Early Summer-run sockeye age 4 proportions were substantially lower than were forecast. Nadina sockeye, with a very low in-season age 4 proportion (5%), was a major contributor to the Early Summer run, resulting in a lower-than-expected age 4 proportion for the management group. In-season age 4 proportions were also lower than were forecast for most other component stocks in the Early Summer-run. The Summer-run forecast included a large return of four-year-olds, particularly for Chilko. The in-season age 4 proportion observed for this stock was 64% compared to a forecast of 88%. For Summer-run stocks, Late Stuart/Stellako was the only stock that exhibited a higher age 4 proportion than expected. The forecast age 4 proportion for Late-run sockeye was 57% because of expected

strength in the Birkenhead and Big Silver stock group (which had high age 4 forecast proportions relative to other Late-run stocks). Partly because of the poor return of Birkenhead and Big Silver sockeye, the in-season age 4 proportion for the Late run management group was only 27%.

Table F 2: Summary of the 2019 forecast and in-season age composition estimates of sockeye sampled from fisheries. Scale-based ages of individuals with probabilities of origin greater than 66% (as determined by genetic stock identification) to a stock aggregate are included here.

Sockeye stock/timing group	2019 Fraser Sockeye Forecasts			2019 In-season	
	Median Age-4 Forecast	TOTAL Median Forecast	FOUR YEAR OLD PROPORTION	Sample size	% Age -4
Early Stuart	**27,000**	**41,000**	**66%**	**35**	**11%**
Early Summer	**274,000**	**469,000**	**58%**	**528**	**29%**
Bowron	9000	15,000	60%	6	33%
Upper Barriere	8,000	10,000	80%	3	67%
Gates	34,000	41,000	83%	76	96%
Nadina	83,000	129,000	64%	306	5%
Pitt	9,000	34,000	26%	37	30%
Early S. Thompson	103,000	204,000	50%	67	54%
Taseko	3,000	3,000	99%	5	60%
Chilliwack	17,000	21,000	83%	16	56%
Nahatlatch	8,000	12,000	65%	12	25%
Summer	**3,123,300**	**3,929,780**	**79%**	**2,128**	**56%**
Chilko	2,426,000	2,750,000	88%	1301	64%
Quesnel	207,000	333,000	62%	229	12%
Late Stuart/Stellako	224,000	407,000	55%	428	61%
Harrison	167,000	293,000	6%	150	35%
Raft / N. Thompson	99,000	146,000	68%	19	26%
Widgeon	300	780	38%	1	0%
Late	**203,000**	**359,000**	**57%**	**71**	**27%**
Cultus	1,000	1,000	100%	0	NA
Late Shuswap/ Portage	20,000	63,000	33%	33	15%
Weaver	11,000	27,000	41%	15	67%
Birkenhead	144,000	229,000	63%	20	5%
Misc(Non-Shuswap)	27,000	39,000	70%	3	100%
Total	**3,627,300**	**4,798,780**	**64%**	**2,762**	**49%**

Sockeye catches in District 104 totaled 271,000. Analyses conducted for the PSC's Northern Panel by the US National Oceanic and Atmospheric Administration laboratory in Auke Bay, Alaska, indicated that 77,600 (28.6%) of these were of Fraser origin, with most of the Fraser catch (48,900) occurring in the week of August 11-17. Although not a record in absolute terms, this was a record high in proportional terms – approximately 14% of the accounted Fraser sockeye run was caught in District 104 in 2019. A subset of extracted DNA, targeting individual sockeye putatively originating from the Fraser River and other southern stocks, was obtained by the PSC. The samples were then analyzed using the same methods as for other sockeye DNA work done for the Fraser Panel. These analyses allowed evaluation of the Northern Panel estimates and also facilitated comparisons of stock compositions of Fraser sockeye between catches in Alaska and catches in the Fraser Panel Area. Results were congruent with the Northern Panel estimates, so the total Fraser catch estimate of 77,600 was adopted. This large proportional catch, late in the season (nearly concurrent with peak Fraser sockeye abundances near Vancouver Island), is suggestive of an anomalous marine rearing distribution or migration route for the caught fish.

Studying which stocks and ages are more frequently caught in northern fisheries may lead to improved understanding of the variable prevalence of Fraser sockeye in those areas. Fraser sockeye management groups were represented in Alaskan catch in the following frequencies: 0% Early Stuart, 9% Early Summer, 86% Summer, and 5% Late run. Proportions estimated to return to the Fraser Panel Area were, respectively, 5%, 19%, 71%, and 5%, indicating that Fraser sockeye management groups differed in their availability to the District 104 purse seine fishery. Work is ongoing regarding differences in availability of Fraser sockeye to Alaska fishing gear. One explanation of the surprising timings and compositions of Fraser sockeye catches in District 104 is that they are largely immature fish, not destined to return to the Fraser River until the year after their catch. Investigations have found no support for this notion. Chilko sockeye, for

example, were 50% age 4 and 50% age 5 in 2019 District 104 samples (n=73 age 4 scales, n=74 age 5 scales); sockeye from the same population caught in the Fraser Panel Area were over 60% age 4 and less than 40% age 5 (Figure F2).

B. Pink Salmon

Three main stock groups are identified in catches of pink salmon – Fraser River, Canada South Coast (excluding Fraser) and Washington. Estimation is made possible through the analysis of baseline genetic information that has been collected from numerous stocks from these three regions[31]. The composition of the pink baseline was similar to other recent years.

During the 2019 in-season management period, tissue samples from up to 100 pink salmon were collected at approximately weekly intervals from test fisheries. DNA analyses similar to recent years were conducted with genotype data from 16 microsatellite loci being compared to allelic frequencies in 46 baseline stocks[31] using the program ONCOR[32]. Stock composition estimates derived from these analyses were used primarily for assessing catch, migration route (diversion rate), and abundance of Fraser River pink salmon. DNA results were obtained for Canadian statistical Areas 12, 13 and 20 from test fishing catches (late July to early September), and for U.S. Areas 7 and 7A from commercial fishery samples (late August). Because pink salmon DNA samples are collected typically once per week in any given marine test fishery, a Bayesian model using historical stock proportions as a prior and in-season sample stock proportions as the data was used to update the posterior distribution for the proportion of Fraser River pink salmon. Figure F3 illustrates how the relationship between catch date and estimated Fraser River pink salmon proportions changed over weeks as more in-season samples were incorporated into the model for Area 12 (figure F3a) and Area 20 (F3b). “Week 0” represents the preseason expectation based on historical data. These figures indicate that, in 2019, Fraser River pink salmon stocks predominated in marine areas earlier in the year compared to the past. In Area 12, the relationship changed relatively little over time after in-season data were first incorporated. In contrast, estimates changed more over time in Area 20 as in-season data were added. For both areas, the most substantial change occurred when in-season sample information was first incorporated into the model, and smaller refinements occurred afterwards. For 2019, the highest in-season sample estimates of Fraser pink salmon proportions were 70% (August 23) and 68% (August 13) in Area 12 and Area 20, respectively.

[31] Beacham, T.D., McIntosh, B., MacConnachie, C., Spilsted, B., and B. White. 2012. Population structure of pink salmon (*Oncorhynchus gorbuscha*) in British Columbia and Washington, determined with microsatellites. Fish. Bull. 110:242–256

[32] Kalinowski, S.T., K.R. Manlove, and M.L. Taper. 2008. ONCOR: a computer program for genetic stock identification, v2.0. Montana State University, Bozeman. Available: http://www.montana.edu/kalinowski/Software/ONCOR.htm.

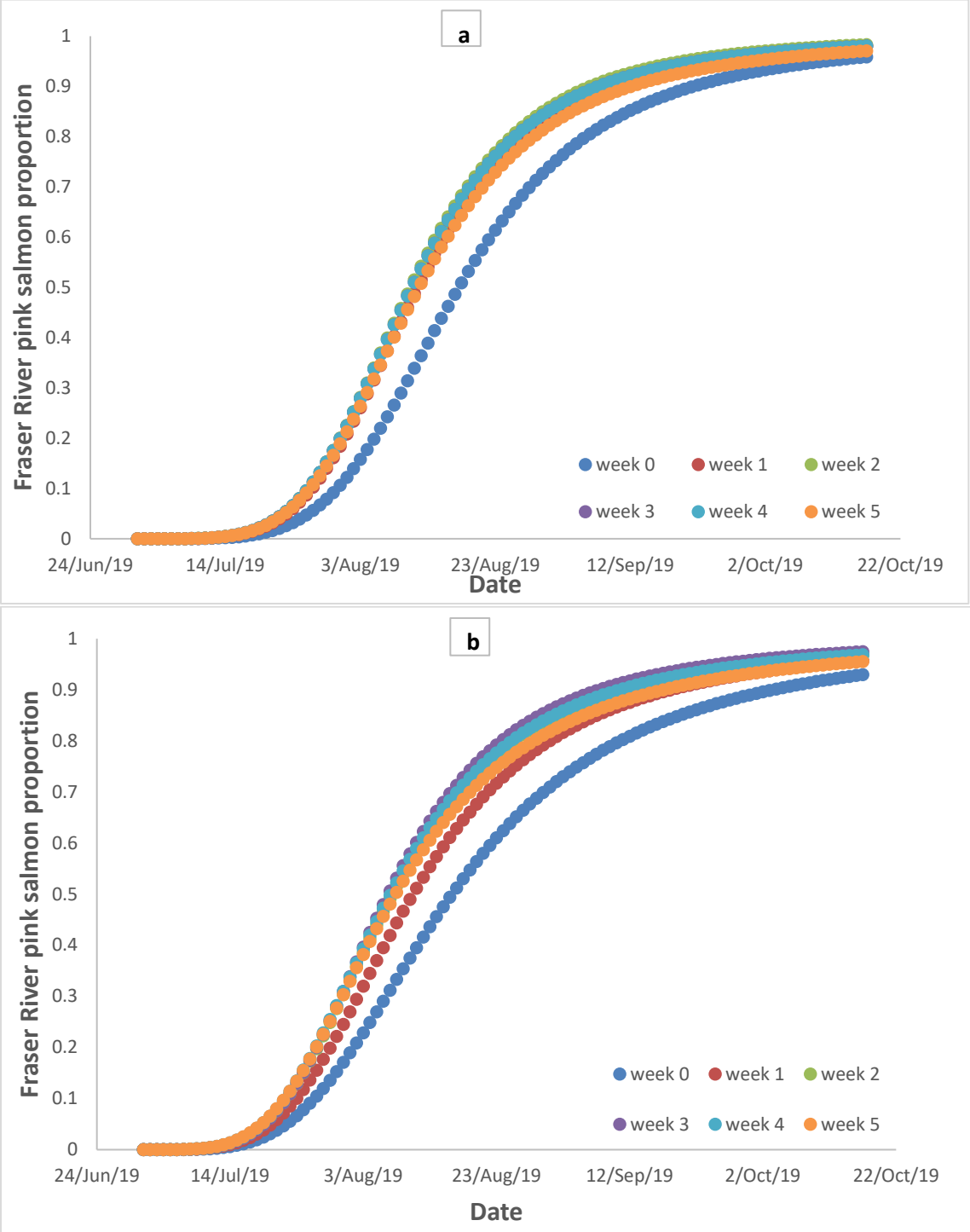

Figure F 3: Effect of incorporating weekly in-season Fraser River Pink salmon proportion estimates (i.e., in-season stock ID results) to the Bayesian model estimating Fraser River pink salmon proportions. Pre-season expectations (based on historical data) of how Fraser River pink salmon proportions change over time is shown in the series "week 0". The series shown for weeks 1-5 are based on Bayesian updates to expectations as stock composition data from each subsequent week are added to the model; a) relationship for Area 12, b) relationship for Area 20.

Stock Assessment

Assessment of Fraser River sockeye salmon abundance by stock group is primarily based on catch, effort, escapement and stock composition data. Test fishery catch per unit effort (CPUE) data was converted into daily abundance estimates using catchability estimates 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}). As the season progressed, the catchability coefficients were updated based on observed values for non-delaying stock groups by comparing Mission hydro-acoustic passage estimates to CPUE based abundances. The marine abundance estimates derived from in-river hydro-acoustic data and marine test fishery data were analysed using Bayesian stock assessment models[33, 34,35]. 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[3]. 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. This prior information is incorporated within the Bayesian model using 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.

Test fishery catch per unit effort (CPUE) data for pink salmon was converted into daily abundance estimates using catchability estimates derived using an analysis of historical data (Area 12 purse seine catchability: 2.9×10^{-3}, Area 20 purse seine catchability: 9.5×10^{-4}). Due to the long delay and inconsistent offset between marine and Mission daily abundances, the daily pink salmon catchability coefficients cannot be updated using in-season Mission information. Because the normal timing density models do not provide consistently reliable estimates of pink salmon timing or run size, a variety of alternative approaches were also used in 2019 to inform in-season pink salmon stock assessments. These methods included an evaluation of cumulative CPUE to date versus total return, a regression between CPUE from August 23-26 and total return, estimates of seaward abundance, and the use of Area 7 commercial CPUE data to provide an in-season update to the annual Area 20 test fishery catchability estimate.

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[33] Pacific Salmon Commission. 1995. Pacific Salmon Commission run-size estimation procedures: An analysis of the 1994 shortfall in escapement of Late-run Fraser River sockeye salmon. Pacific Salmon Comm. Tech. Rep. No. 6: 179 p.

[34] Pacific Salmon Commission. 1998. Report of the Fraser River Panel to the Pacific Salmon Commission on the 1995 Fraser River sockeye and pink salmon fishing season. Vancouver, B.C., 64 p.

[35] Michielsens, C.G.J. and J.D. Cave. 2018. In-season assessment and management of salmon stocks using a Bayesian time-density model. CJFAS. https://doi.org/10.1139/cjfas-2018-0213.

Figures F4 a, b, c, d and e provide an overview of the run size estimates from the different stock assessment models and the accounted run size at various dates during the season (median estimate and 80% probability intervals, if calculated). 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 2019, pre-season forecasts overestimated the run size for all sockeye salmon management groups but underestimated the run size for pink salmon. Marine timing of Early Summer and Late-run groups were within 1-day of the pre-season forecast, but marine timing of Early Stuart and Summer-run groups were 3-days and 9-days later than forecasted pre-season, respectively. In contrast, the marine timing of Fraser River pink salmon was 10-days earlier than expected pre-season.

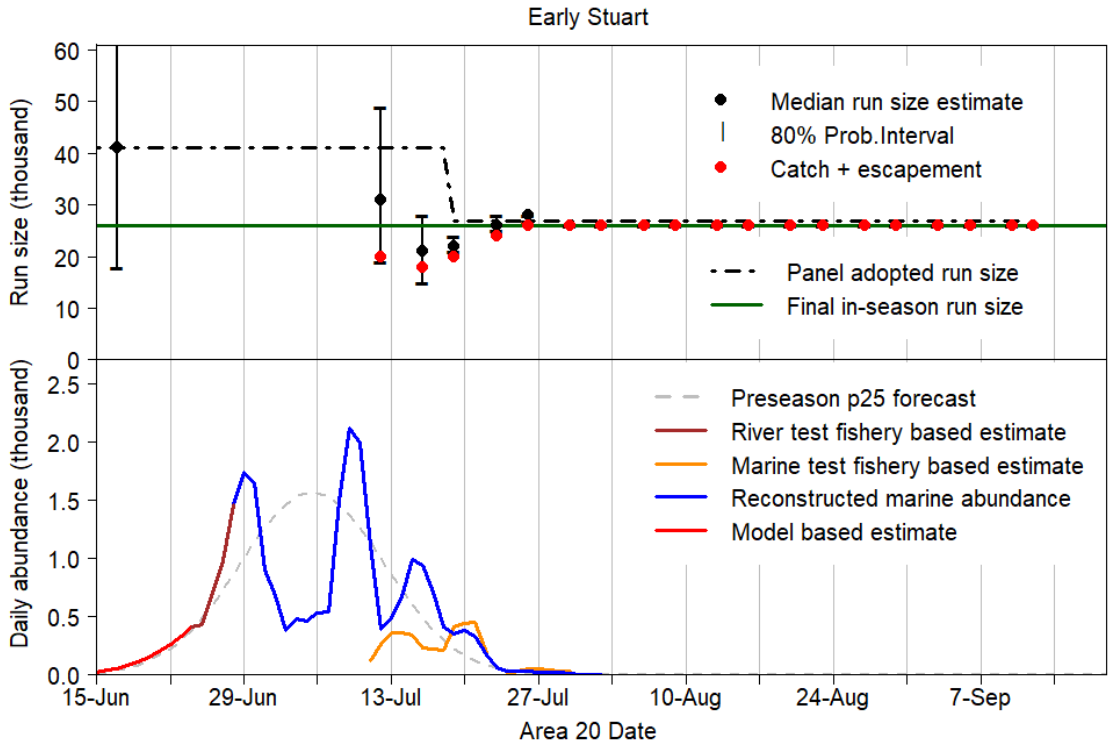

Figure F 4a: Daily reconstructed abundance estimates for Early Stuart and corresponding run size estimates at different times during the season.

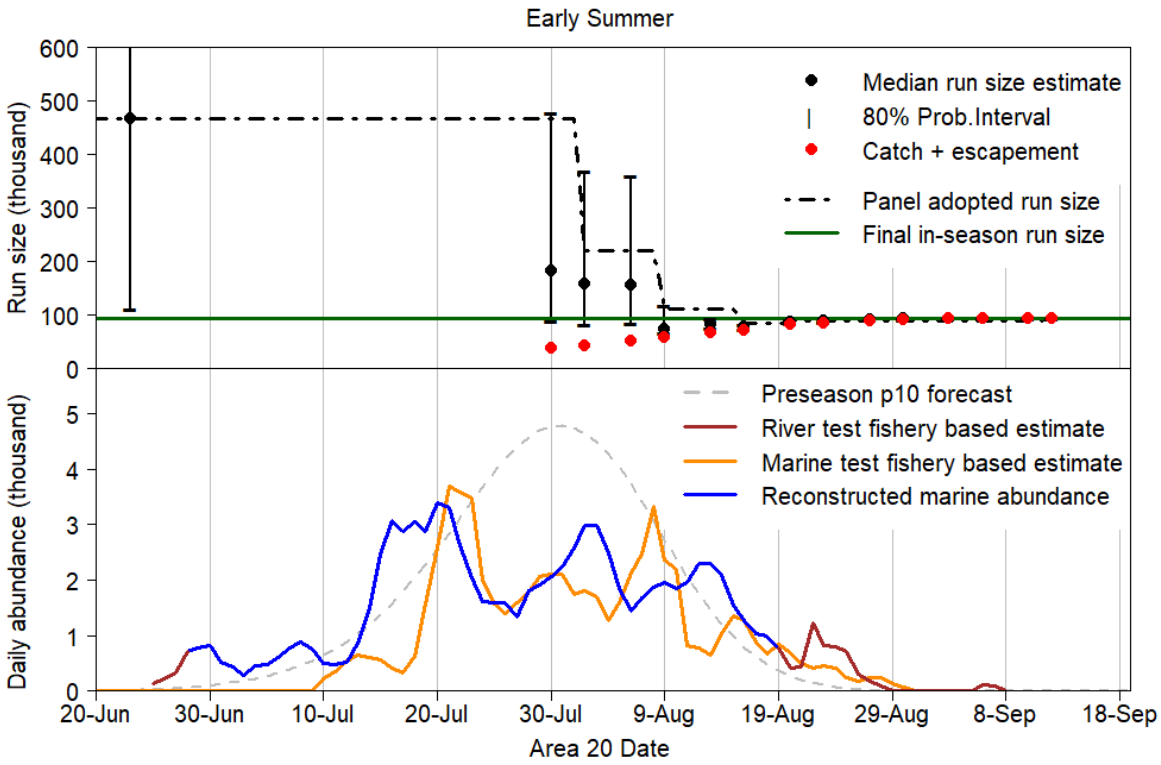

Figure F4b: Daily reconstructed abundance estimates for Early Summer-run salmon and corresponding run size estimates at different times during the season.

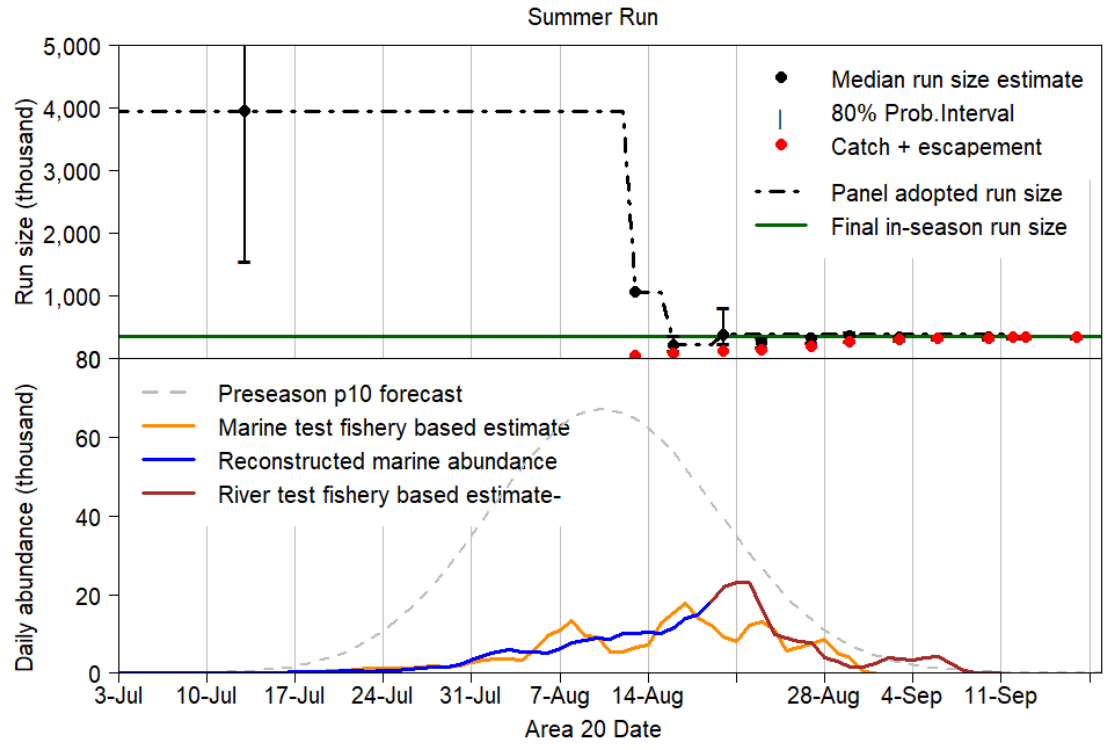

Figure F4c: Daily reconstructed abundance estimates for Summer-run salmon and corresponding run size estimates at different times during the season.

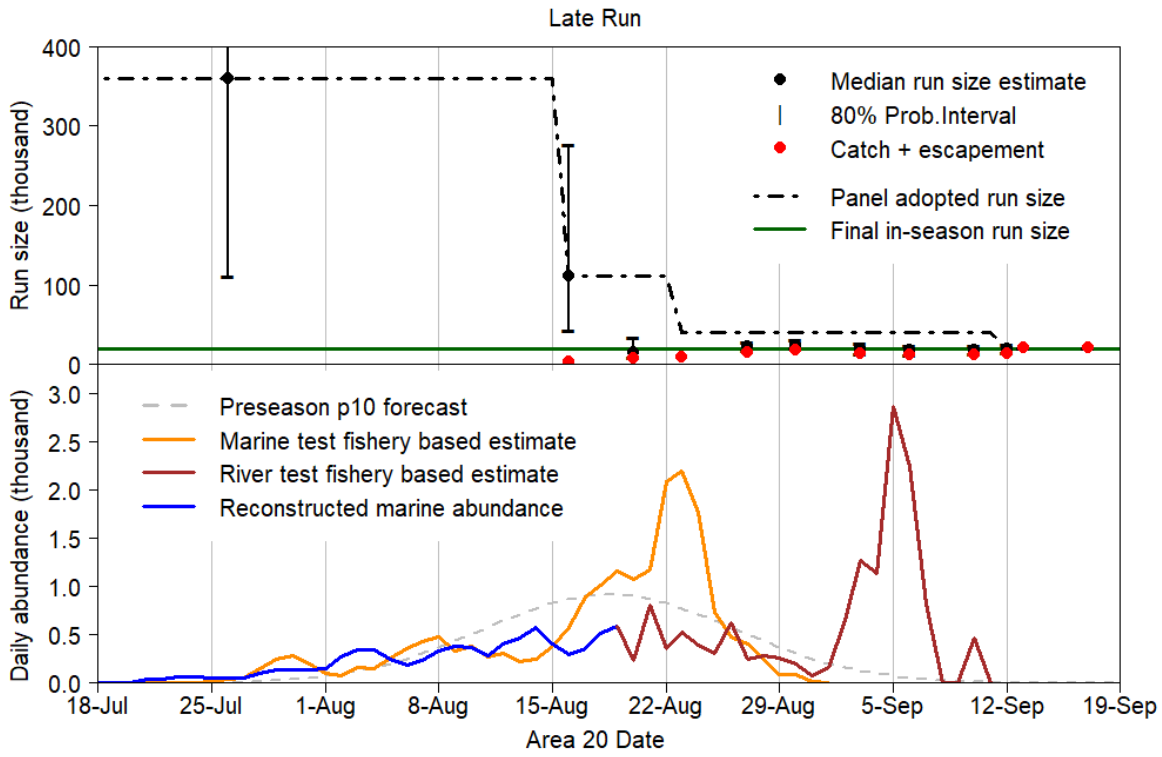

Figure F4d: Daily reconstructed abundance estimates for Late-run salmon and corresponding run size estimates at different times during the season.

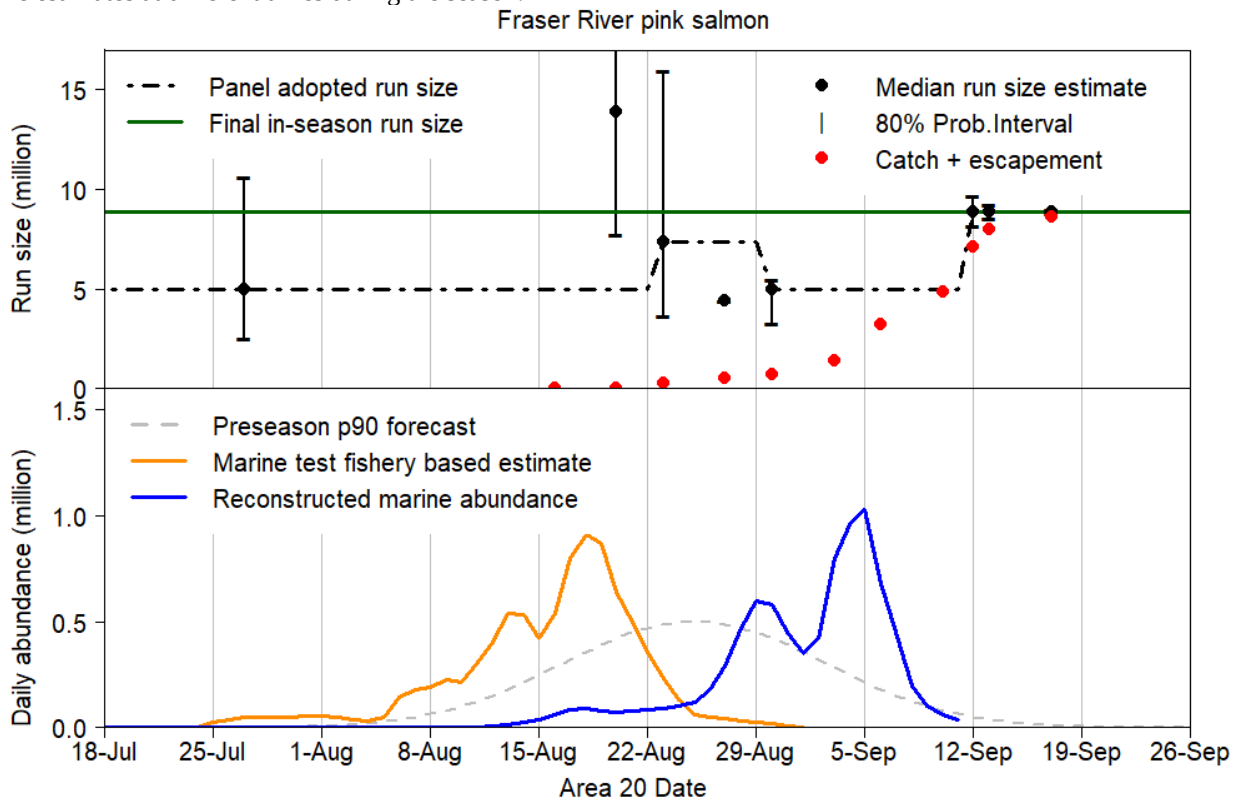

Figure F4e: Daily reconstructed abundance estimates for pink salmon and corresponding run size estimates at different times during the season.

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. Fraser River watershed snowpack was 80% of normal in early spring (April 1, BC Fraser Basin Snow Water Index). Due to warm temperatures and rapid snow melt in May, snow basin indices dropped significantly by June 1. The low June 1 snowpack was attributed to snow melt that was 1-3 weeks ahead of normal for most areas. The diminished snowpack increased the likelihood of low flow conditions in the summer. The long-range forecast was for below average discharge and above average water temperature in the Fraser River. Low flows would reduce the water temperature buffering capacity of the watershed to hot and cool weather. 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, the Panel adopted the proportional Management Adjustments (pMAs) based on historical medians (see Table G4) for all four management groups (Table 6). Management Adjustments (MAs) of 28,300 Early Stuart, 83,700 Early Summer-, 141,500 Summer- and 188,500 Late-run sockeye were added to the spawning escapement targets to increase the likelihood of achieving the targets. The spawning escapement target for Early Stuart was its entire run size at median forecast abundance levels, therefore, fisheries decisions that could impact Early Stuart sockeye would be based on Low Abundance Exploitation Rate (LAER) limits of 10%.

In recent years, pre-season MA estimates for some management groups have been estimated based on the weighted average of component abundances and their respective %DBEs. Due to the low forecasted relative abundances of Pitt and Chilliwack fish in the Early Summer-run aggregate and Harrison fish in the Summer-run aggregate, the weighted pDBE approach had almost no impact on the aggregate pDBE for these two run timing groups. The relative abundances of Birkenhead in the Late-run aggregate would still have an impact on the weighted pDBE approach. As a result, the Panel agreed to forego the weighted pDBE approach for the Early Summer and Summer-run aggregate but use the weighted pDBE approach for the Late-run aggregate for 2019. In-season, the relative abundances of all the component stocks had no impact on the aggregate pDBE for all three run-timing groups.

In-season predictions from environmental MA model estimates (Table G3) were presented to the Panel for Early Stuart, Early Summer and Summer run. Environmental conditions in-season were similar to those predicted pre-season and the in-season Temperature and Discharge MA models predicted similar, but slightly lower (more positive) pDBEs for these run timing groups. For Late-run sockeye the final in-season Mission 50% Date based on Mission passage, was September 8, which meant a delay of 12 days. Based on this timing, the run-timing MA model predicted a pDBE for the Late-run excluding Birkenhead (BiBS) that was virtually the same as that adopted pre-season (Table F3). In-season the Panel did not adopt a pMA for Early Stuart, Early Summer, Summer or Late-run sockeye. Given the in-season adopted run-size for the Early Stuart, Early Summer, Summer and Late-run sockeye, all four management groups were managed based on a Low Abundance Exploitation Rate (LAER) and Management Adjustments had no management implications. Additionally, in-season fish passage past Big Bar was affected by a rock slide that occurred in a narrow portion of the Fraser River near Big Bar. The slide created a complete blockage to sockeye salmon passage when river flows were high, especially early in the season. As a result, fish were physically transported across the slide via helicopter and truck. As flow decreased, restricted natural fish passage through the slide started to increase. The repercussions on sockeye passage from the Big Bar landslide had an impact on the observed DBE that was not within the purview of any of the MA models.

Table F 3: Summary of the pre-season and in-season MA model predictions of %DBE for Early Stuart, Early Summer-, Summer- and Late-run management groups.

Description	Early Stuart[1]		Early Summer Aggregate[1]		Summer-run Aggregate[1]		Late-run (excl. BiBS)[2]	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Pre-season 31-day MA Model Predictions[3]	-55%	1.22	-40%	0.67	-14%	0.16	NA	NA
In-season 19-day MA Model Predictions	-53%	1.13	-26%	0.35	-3%	0.03	NA	NA
In-season 31-day MA Model Predictions	-48%	0.92	-35%	0.54	-3%	0.03	NA	NA
In-season run-timing Model Predictions[4]	NA	NA	NA	NA	NA	NA	-57%	1.33

1 MAs are estimated by 19-day and 31-day temperature and discharge models.

2 MAs are estimated by the run timing model using their Mission 50% date.

3 Pre-season MA Model Predictions use the Pre-season Forecast of Fraser River Temperature and Discharge from DFO's E-watch Program.

4 Mission 50% date is the final in-season hydroacoustic estimate of Sept. 17th.

Spawning ground estimates of total Fraser sockeye abundance were 301,955 sockeye, which means a total %DBE of (-36%) was observed in 2019. The Early Stuart, Early Summer-, Summer- and Late-run sockeye did not achieve their spawning escapement target (SET), 26,000, 94,000, 360,000 and 20,000 sockeye, respectively. Poor escapement in 2019 was due to both, low returns and the Big Bar landslide.

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

Table F 4: Summary of the pre-season and in-season MA models and assumptions used during 2019 for each management group. 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 of the report under the section Panel Management Activities.

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
Early Summer Aggregate	Historical Dominant and Subdominant Cycle (2018 & 2019)Median	19-day temp and discharge[1]	Dominant and Subdominant Cycle (2018 & 2019)	1993, 2006
Summer-run Aggregate	Historical Median	19-day temp and discharge[1]	All	2002, 2006
Late-run Aggregate	Historical Odd year (2017 & 2019) Cycle Line Median since 1996	Historical Dominant Cycle Line Median since 1996 if timing September 8 or earlier, All Years Run Timing Model[2] if timing is later than September 8.	Odd-year cycle (2017 & 2019) if timing September 8 or earlier, All if timng is later than September 8.	2006 and All years model also excludes, 1977, 1979, 1980, 1981, 1983, 1984, 1985, 1987, 1988, 1989, 1991, 1992, 1993, 1995

[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 2007-2019.

	Fraser Sockeye Salmon			
	2007	**2011**	**2015**	**2019**
CANADIAN CATCH	**199,200**	**1,439,100**	**187,900**	**9,860**
Commercial Catch	**0**	**368,000**	**0**	**0**
Panel Area	0	160,800	0	0
Non-Panel Areas	0	207,200	0	0
First Nations Catch	**196,900**	**931,300**	**187,200**	**0**
Marine FSC	42,900	265,300	40,400	0
Fraser River FSC	154,000	584,800	146,800	0
Economic Opportunity	0	81,200	10	0
Non-commercial Catch	**2,300**	**139,800**	**620**	**80**
Marine Recreational	200	17,300	40	0
Fraser Recreational	0	84,300	40	0
Charter	0	4,240	550	80
ESSR	2,100	33,900	0	0
Unsanctioned Catch*	**0**	**0**	**0**	**9,770**
UNITED STATES CATCH	**142,400**	**297,200**	**150,600**	**78,100**
Washington Total	**3,400**	**278,800**	**46,200**	**470**
Commercial catch	**0**	**265,900**	**44,200**	**0**
Treaty Indian	0	181,000	33,100	0
Non-Indian	0	84,900	11,100	0
Non-commercial Catch	**3,400**	**12,900**	**2,020**	**470**
Ceremonial	3,400	12,900	2,020	470
Recreational	0	0	0	0
Alaska	**139,000**	**18,400**	**104,400**	**77,600**
TEST FISHING CATCH	**34,800**	**40,400**	**38,000**	**6,410**
PSC (Panel Areas)	**21,800**	**26,500**	**17,000**	**1,470**
Canada	13,400	24,700	12,400	1,470
United States	8,400	1,740	4,550	0
Canada (non-Panel Areas)	**13,000**	**14,000**	**21,100**	**4,950**
TOTAL RUN	**1,510,300**	**5,130,100**	**2,010,200**	**571,000**
Total Catch in All Fisheries	376,400	1,776,800	376,500	94,400
Adult Spawning Escapement	887,100	2,580,100	1,188,600	302,000
Jack Spawning Escapement	1,910	6,460	4,610	920
Difference between estimates	244,900	766,800	440,600	173,700
Percentage of Total Run	**100%**	**100%**	**100%**	**100%**
Total Catch in All Fisheries	25%	35%	19%	17%
Adult Spawning Escapement	59%	50%	59%	53%
Jack Spawning Escapement	0%	0%	0%	0%
Difference between estimates	16%	15%	22%	30%

*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 2019

Table G 2. Catch by user group, spawning escapement and run size of Fraser River pink salmon for cycle years 2013-2019.

	Fraser Pink Salmon			
	2013	**2015**	**2017**	**2019**
CANADIAN CATCH	**3,313,700**	**83,300**	**37,200**	**300,300**
Commercial Catch	**1,994,300**	**0**	**0**	**0**
Panel Area	1,322,500	0	0	0
Non-Panel Areas	671,800	0	0	0
First Nations Catch	**1,220,700**	**68,000**	**33,600**	**263,600**
Marine FSC	2,900	3,400	14,800	5,400
Fraser River FSC	8,200	25,200	18,900	37,200
Economic Opportunity	1,209,600	39,400	0	220,900
Non-commercial Catch	**98,700**	**15,300**	**3,500**	**36,700**
Marine Recreational	30,200	0	0	30,200
Fraser Recreational	63,800	15,300	0	5,700
Charter	200	0	3,500	700
ESSR	4,500	0	0	0
UNITED STATES CATCH	**3,200,400**	**330,900**	**102,200**	**233,300**
Washington Total	**3,200,400**	**330,900**	**102,200**	**233,300**
Commercial catch	**3,186,700**	**328,000**	**102,200**	**233,200**
Treaty Indian	1,340,600	183,700	91,300	159,600
Non-Indian	1,846,100	144,300	10,900	73,500
Non-commercial Catch	**13,700**	**2,800**	**0**	**100**
Ceremonial	5,900	2,800	0	100
Recreational	7,800	0	0	0
Alaska	**0**	**0**	**0**	**0**
TEST FISHING CATCH	**39,200**	**48,900**	**17,700**	**17,200**
PSC (Panel Areas)	**22,000**	**38,100**	**13,700**	**14,600**
Canada	15,500	25,400	11,800	14,400
United States	6,600	12,700	1,800	200
Canada (non-Panel Areas)	**17,200**	**10,800**	**4,000**	**2,700**
TOTAL RUN	**15,897,800**	**5,778,900**	**3,549,200**	**8,858,600**
Total Catch in All Fisheries	6,553,300	463,100	157,100	550,800
Adult Spawning Escapement	9,344,500	5,315,800	3,392,200	8,307,800
Percentage of Total Run	**100%**	**100%**	**100%**	**100%**
Total Catch in All Fisheries	41%	8%	4%	6%
Adult Spawning Escapement	59%	92%	96%	94%

Table G 3. Escapements of sockeye salmon to Fraser River spawning areas for cycle years 2007-2019*

DISTRICT / Stock Group / Stream/Lake	Year 2007	2011	2015	2019
NORTHEAST				
Upper Bowron R.	1,554	8,983	12,147	20
STUART				
Early Stuart				
Driftwood R.	7,230	25,783	21,774	0
Takla L. Streams	10,261	11,061	14,193	28
Middle R. Streams	11,576	16,971	24,351	53
Trembleur L. Streams	6,671	6,447	8,234	8
Miscellaneous	78	0	58	0
Late Stuart				
Kazchek Cr.	104	32	9	11
Kuzkwa Cr.	3,139	3,610	4,325	358
Middle R.	7,513	13,340	9,086	877
Tachie R.	14,178	57,887	36,036	4,441
Miscellaneous	2,570	372	1,235	114
NECHAKO				
Nadina R. (Late)	4,144	4,783	30,235	16,575
Nadina Channel	4,511	21,359	31,154	6,621
Stellako R.	147,189	202,783	506,157	45,940
QUESNEL				
Horsefly R.	110,388	128,121	463,621	14,413
Horsefly Channel	19,599	22,493	18,078	28
McKinley Cr.	3,007	1,534	10,266	659
Mitchell R.	22,446	75,029	277,953	4,466
Miscellaneous	14,328	21,854	64,458	2,034
CHILCOTIN				
Chilko R. & L.	468,947	2,459,946	1,025,587	168,121
Chilko Channel	0	0	0	0
Taseko L.	2,140	1,117	107	0
SETON-ANDERSON				
Gates Cr.	0	6,280	9,679	7,287
Gates Channel	2,858	9,486	6,071	2,274
Portage Cr.	18,882	57,870	24,275	520
NORTH THOMPSON				
North Thompson R.	25,488	8,044	22,741	353
Raft R.	6,111	5,119	17,078	619
Fennell Cr.	11,482	10,808	11,451	524
SOUTH THOMPSON				
Early Summer-run				
Scotch Cr.	144,199	522,367	135,100	1,719
Seymour R.	107,941	552,149	114,002	1,180
Upper Adams / Momich / Cayenne	370	3,101	5,810	18
Miscellaneous	39,717	351,176	246,918	2,246
Late-run				
Adams R.	1,461,673	3,867,225	707,883	1,960
Little R.	416,790	422,358	213,304	335
Lower Shuswap R.	901,059	2,897,006	1,027,591	2,217
Miscellaneous	118,187	332,429	259,290	751
HARRISON-LILLOOET				
Birkenhead R.	266,459	128,285	35,548	2,998
Big Silver Cr. & misc. Birk. types	23,076	12,578	6,011	67
Harrison R.	168,259	761,668	399,531	3,813
Weaver Cr.	6,967	23,833	2,207	92
Weaver Channel	32,814	36,064	22,439	1,714 1
LOWER FRASER				
Nahatlatch R. & L.	1,678	5,413	3,873	1,288
Cultus L.	3,660 1	9,922 1	4,574 1	68 1
Upper Pitt R.	38,816	16,818	36,496	3,507
Chilliwack L./Chilliwack R., upper	1,097	2,775	3,470	1,347
MISCELLANEOUS 2	2,178	4,482	2,909	301
ADULTS	4,661,334	13,130,761	5,877,315	301,965
JACKS	1,674	12,056	5,588	919
TOTAL NET ESCAPEMENT	4,663,008	13,142,817	5,882,903	302,884

* Estimates are from DFO.

1 Cultus estimates include 151 adults in 2007, 253 adults in 2011, 196 adults in 2015, 45 in 2019.

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

Table G 4. Fraser River pink salmon production for odd brood years in 1961-2017 (return years 1963-2019).

Brood Year	Spawners		Potential Egg Deposition		Fry Production		Adult Returns (Catch + Escapement)		% Survival		Average To Date
	Total (millions)	Female (millions)	(millions)		(millions)		(millions)		Fresh Water	Marine	
(by)	*(by)*	*(by)*	*(by)*		*(by+1)*		*(by+2)*				
1961	1.092	0.654	1,569		143.6		5.482		9.2%	3.8%	3.8%
1963	1.954	1.216	2,435		284.2		2.320		11.7%	0.8%	2.3%
1965	1.194	0.692	1,488		274.0		12.963		18.4%	4.7%	3.1%
1967	1.831	0.973	2,132		308.0		3.931		14.4%	1.3%	2.7%
1969	1.531	0.957	2,018		287.7		9.763		14.3%	3.4%	2.8%
1971	1.805	1.096	1,923		273.6		6.801		14.2%	2.5%	2.8%
1973	1.754	1.009	1,865		212.3		4.894		11.4%	2.3%	2.7%
1975	1.367	0.781	1,493		319.7		8.209		21.4%	2.6%	2.7%
1977	2.388	1.362	2,960		483.7		14.404		16.3%	3.0%	2.7%
1979	3.561	2.076	3,787		341.3		18.685		9.0%	5.5%	3.0%
1981	4.488	2.560	4,814		607.0		15.346		12.6%	2.5%	2.9%
1983	4.632	2.931	4,702		557.4		19.038		11.9%	3.4%	3.0%
1985	6.461	3.561	5,900		264.5		7.172		4.5%	2.7%	3.0%
1987	3.224	1.856	3,471		436.0		16.484		12.6%	3.8%	3.0%
1989	7.189	4.383	7,198		400.4		22.174		5.6%	5.5%	3.2%
1991	12.943	8.002	12,330		685.5		16.983		5.6%	2.5%	3.1%
1993	10.768	6.454	9,192		437.7		12.904		4.8%	2.9%	3.1%
1995	7.175	4.248	10,233		279.1		8.176		2.7%	2.9%	3.1%
1997	2.842	1.740	2,863		257.5		3.608		9.0%	1.4%	3.0%
1999	3.445	1.885	2,702		219.0		21.262		8.1%	9.7%	3.4%
2001	19.814	9.543	16,274		714.4		24.250		4.4%	3.4%	3.4%
2003	n/a	n/a	n/a	*1*	419.0		9.870	*3*	n/a	2.4%	3.3%
2005	n/a	n/a	n/a	*1*	614.5		8.490	*3*	n/a	1.4%	3.2%
2007	n/a	n/a	n/a	*1*	497.0		19.936	*3*	n/a	4.0%	3.3%
2009	15.429	n/a	n/a	*1*	1062.4		20.649	*4*	n/a	1.9%	3.2%
2011	12.788	n/a	n/a	*1*	519.3		15.898	*4*	n/a	3.1%	3.2%
2013	9.344	n/a	n/a	*1*	609.4		5.779	*4*	n/a	0.9%	3.1%
2015	5.369	n/a	n/a	*1*	230.0		3.550	*4*	n/a	1.5%	3.1%
2017	3.392	n/a	n/a	*1*	192.0		8.858	*4*	n/a	4.6%	3.1%
2019	8.307	n/a	n/a	*1*	n/a	*2*					
Average	5.781	2.761	4,826		411.4		11.996		10.6%	3.1%	

1 No on the grounds surveys

2 Estimates of fry production unavailable due to COVID19.

3 Estimates of adult returns between 2005-2009 (2003-2007 brood years) are less certain because pink salmon escapement enumeration programs were not conducted. Instead, estimates of adult returns for these years are based on in-season abundance estimates by the PSC.

4 Estimates of escapements for the 2009 - 2019 return years are from the PSC's Mission hydroacoustics program.

Table G 5. Detailed calculation of total allowable catch (TAC) and achievement of international catch shares for Fraser sockeye (by management group) salmon in 2019. 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 12), in accordance with Annex IV, Chapter 4 of the Pacific Salmon Treaty.

	Fraser Sockeye							Fraser Pinks	
	Early Stuart	Early Summer	Summer	Late	Total				
RUN STATUS, ESCAPEMENT NEEDS & AVAILABLE SURPLUS									
In-season Abundance Estimate	**26,000**	**94,000**	**360,000**	**20,000**	**500,000**			**8,900,000**	
Adjusted Spawning Escapement Target *	**26,000**	**94,000**	**360,000**	**20,000**	**500,000**			**6,000,000**	
Spawning Escapement Target (SET)	26,000	94,000	360,000	20,000	500,000			6,000,000	
%SET from TAM rules	*100%*	*100%*	*100%*	*100%*				1	
Management Adjustment (MA)	17,900	42,300	32,400	11,200	103,800			n/a	
Proportional MA (pMA)	*0.45*	*0.45*	*0.09*	*0.56*					
Test Fishing Catch (TF, post-seas. est.)	80	1,080	4,990	270	6,410			17,200	
Surplus above Adjusted SET & TF *	**0**	**0**	**0**	**0**	**0**			**2,882,800**	
DEDUCTIONS & TAC FOR INTERNATIONAL SHARING									
Aboriginal Fishery Exemption (AFE)	**0**	**0**	**0**	**0**	**0**			**n/a**	
Total Deductions (Adj.SET + TF + AFE)	26,100	95,100	365,000	20,300	506,400			6,017,200	
Available TAC (Abundance - Deductions)	**0**	**0**	**0**	**0**	**0**			**2,882,800**	
UNITED STATES (Washington) TAC									
Propor. distrib. TAC - Payback	**0**	**0**	**0**	**0**	**0**			**740,900**	
Proportionally distributed TAC **	0	0	0	0	0	16.5%		740,900	25.7%
U.S. Payback	0	0	0	0	0			0	
Washington Catch	0	50	330	90	470			233,300	
Deviation from TAC - Payback	**0**	**-50**	**-330**	**-90**	**-470**			**507,600**	
CANADIAN TAC									
Propor. distrib. TAC + Payback + AFE	**120**	**1,520**	**8,110**	**30**	**0**			**2,141,900**	
Propor. distrib. TAC + U.S. Payback	0	0	0	0	0	83.5%		2,141,900	74.3%
AFE	0	0	0	0	0			0	
Unsanctioned Catch***	120	1,520	8,110	30	9,780				
Canadian Catch excluding ESSR Catch	120	1,530	8,180	30	9,860			300,300	
Deviation from TAC + Payback + AFE	**-120**	**-1,530**	**-8,180**	**-30**	**-9,860**			**1,841,600**	
TOTAL									
Available TAC + U.S. Payback + AFE	**0**	**0**	**0**	**0**	**0**			**2,882,800**	
Total Catch excluding ESSR Catch	120	1,580	8,510	120	10,300			533,500	
Deviation from TAC + U.S. Payback + AFE	**-120**	**-1,580**	**-8,510**	**-120**	**-10,330**			**2,349,200**	

* 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 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 2019

APPENDIX H: MEMBERS OF THE FRASER RIVER PANEL TECHNICAL COMMITTEE IN 2019

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

APPENDIX I: STAFF OF THE PACIFIC SALMON COMMISSION IN 2019

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, Controller

Witty Lam, Senior Accountant

Koey Lu, Accounting Assistant

Angus Mackay, 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

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

Pasan Samarasin, Stock Identification Biologist

Angela Phung, Fisheries Biologist

Dejan Brkic, Salmon Technician

Stock Monitoring Group

Erica Jenkins, Director of Stock Monitoring

Eric Taylor, Manager, Test Fishing Operations

Yunbo Xie, Hydroacoustic Scientist

Cory Lagasse, Manager, Hydroacoustic Operations

Jacqueline Nelitz, Hydroacoustic Technician

Mike Bartel Sawatzky, Hydroacoustic Technician