2021

Report of the Fraser River Panel to the Pacific Salmon Commission on the 2021 Fraser River Sockeye and Pink Salmon Fishing Season

Prepared by the

Pacific Salmon Commission

May 2023

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Contact Information

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IN MEMORIUM

July 25, 1940 – August 10, 2021

Lorraine Loomis was an amazing leader. She was one of the first women to play an active role in fisheries policy and management and she became one of the most prominent figures at the highest level of fisheries negotiations. Her leadership abilities combined with her work ethic, allowed her to achieve consensus and co-operation on fisheries management issues at all levels of government, including among the Washington treaty Tribes, between the Tribes and Washington State, and between the United States and Canada.

Lorraine was surrounded by fisheries and the fishing industry her entire life. She was born on the Swinomish reservation July 25, 1940, to a family of fishermen and her career in fisheries started at the Swinomish Tribe's fish processing plant in 1970's.

Shortly after the Boldt decision in 1974, which reaffirmed the Tribes' treaty reserved fishing rights, Lorraine became the Fisheries Manager for the Swinomish Tribe, a position that she would hold for the rest of her life. She was a member of the Northwest Indian Fisheries Commission for over 40 years and succeeded long-time Chairman and tribal treaty rights activist Billy Frank Jr. as Chair of the Commission after his passing in 2014.

Lorraine was named to the Fraser River Panel in 1986, shortly after the Pacific Salmon Treaty was signed and throughout the years, she served as Panel Chair and Vice Chair. She was very proud of the tribal involvement in developing and implementing the Treaty and maintained that cooperation was the key to salmon recovery and upholding tribal treaty rights.

Lorraine was a highly respected and much-loved member of the Pacific Salmon Commission family. In 2016 she was awarded the inaugural Larry Rutter Memorial Award for Pacific Salmon Conservation.

Lorraine's leadership and advocacy for tribal treaty rights will go down in history. Her contributions to advances in salmon co-management, both regionally and internationally, were unprecedented. She will be greatly missed by everyone involved in fisheries management on the Pacific coast and by her friends and colleagues on the Fraser River Panel and the Pacific Salmon Commission.

REPORT OF THE
FRASER RIVER PANEL
TO THE PACIFIC SALMON COMMISSION
ON THE 2021 FRASER RIVER SOCKEYE AND PINK SALMON FISHING SEASON

2021 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

M. Frost
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

G. Witzky (Alternate)
First Nations

D. McEachern (Alternate)
Gillnet fisher

M. Shepert (Alternate)
First Nations

UNITED STATES

L. Loomis, Vice-Chair
Treaty Tribes

K. Hughes
Washington Department of Fish and Wildlife

B. Kehoe
Commercial salmon fishing industry

J. Dixon
National Marine Fisheries Service

M. Baltzell (Alternate)
Washington Department of Fish and Wildlife

R. Charles (Alternate)
Treaty Tribes

J. Giard (Alternate)
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P. Mundy (Alternate)
National Marine Fisheries Service

Prepared by

FISHERIES MANAGEMENT DIVISION

of the

PACIFIC SALMON COMMISSION

May 2023

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I. EXECUTIVE SUMMARY

The data presented in this report are accurate as of the time of publication. For updates and access to the data please see our FRP Annual Report App found at: psc1.shinyapps.io/PSC_Annual_Fraser. The following paragraphs describe the planning of the 2021 season and the Panel management actions:

Pre-season Planning

1. During the 2020/21 winter/spring season, substantial mitigation work continued to alleviate the impact of the Big Bar landslide (Figures 6 and 7). The remediation work included the completion of a nature-like fishway, configuration of the concrete fish ladder for use with trap and transport operations, underwater mapping, rock fall mitigation and access road improvements.
2. Pre-season, the median run size forecast (p50 level, Appendix B) was 1,330,000 Fraser River sockeye salmon and according to the quantitative forecast there was a one in two chance that the run size would be between 624,000 and 2,775,000. The median Fraser River pink run size forecast was 3,009,000 (p50 level, Appendix B) with a one in two chance that the run size would be between 2,229,000 and 4,051,000.
3. Pre-season expectations of migration parameters included a 35% diversion rate for Fraser River sockeye and a 53% 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 24 for Early Summer, August 5 for Summer, August 13 for Late-run sockeye, and August 25 for pink salmon.
4. At median (p50) forecast abundance levels, pre-season spawning escapement goals were 18,000 Early Stuart, 108,000 Early Summer, 1,046,000 Summer, and 159,000 Late-run sockeye for a total of 1,330,000 sockeye salmon and 2,816,600 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 12,400 Early Stuart, 42,100 Early Summer, 94,100 Summer-run, and 152,600 Late-run sockeye were added to the spawning escapement targets to increase the likelihood of achieving the targets (Appendix F, Table F 3).
6. There was no projected Total Allowable Catch (TAC) of Fraser River sockeye salmon based on the median forecasted abundances and agreed deductions. However, the projected TAC of Fraser River pink salmon was 188,900 fish, of which 25.7% (48,500 pink salmon) were allocated to the U.S.
7. Pre-season model runs at the p90 indicated it was unlikely that 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 indicated that the pink salmon TAC could be fully harvested.
8. The Panel adopted the 2021 Management Plan Principles and Constraints and Regulations, and 2021 regulations (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 Stuart run: 11 days later for the Early Summer run, 9 days later for the Summer run and 7 days later for the Late run. Pink salmon timing which was 5 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 27% compared to the pre-season forecast of 35%. The Fraser River pink salmon diversion rate was 23%, instead of 53% which was used in pre-season modelling.

11. Returns for Fraser sockeye and pink salmon were above the median pre-season forecasts: Early Stuart run: 74% above median forecast, Early Summer run: 16% above median forecast, Summer run: 45% above median forecast, Late run: 74% above median forecast and pink salmon run: 63% above median forecast. The number of returning Early Stuart and Late run sockeye was above the p90 run size forecast, and for the Early Summer and Summer run, the number of returning sockeye was between their respective p50 and p75 run size forecasts. The pink salmon return exceeded the p90 run size forecast.
12. Despite the greater than expected number of sockeye returning to the Fraser River, the spawning escapement target for the Early Stuart and Early Summer run was equal to the run size. Although the run sizes for the Summer run and Late run exceeded their spawning escapement targets, the run size increases did not occur until late in the year and Fraser River discharge was below the historical average for most of the season while river temperatures were above the historical average in July, through mid-August and near average in early September (Figure 8). Therefore, the adoption of management adjustments (MAs) for these two run timing groups was necessary, as it was expected that en route loss would have impacted the achievement of these spawning escapement targets.

Implications of the Big Bar landslide

13. A Unified Command Incident Management Team, a collaboration between First Nations, Federal and Provincial governments, continued to lead the remediation response for the 2021 season which included: the completion of a nature-like fishway, radio tagging, sonar monitoring, fish transport by truck and the collection of Early Stuart and Bowron broodstock for emergency enhancement (Figures 6 & 7).
14. Between the mitigation work and low discharge in 2021, there were no apparent migration challenges at Big Bar for sockeye and pink salmon, even for early timed stocks such as Early Stuart, Nadina and Bowron.
15. Of the stocks that migrate past Big Bar, the following proportions are estimated to have made it to the spawning grounds: 79% of the Early Stuart run, 100% of the Early Summer-run stocks and 95% of the Summer-run stocks.
16. Further construction on a permanent concrete fishway was suspended due to multiple rock fall incidents and extreme weather impacting crew safety. Fisheries and Oceans Canada (DFO) and partners are pursuing a structured analysis to review options and long-term solutions to safely restore fish passage at Big Bar.

Run Size, Catch, Escapement and Migration patterns

17. In-season estimated returns of adult Fraser sockeye totalled 2,818,100 fish (Tables 8 and 9) which was 48% greater than the escapement of 1,471,200 fish in the primary brood year (2017). Divided into management groups, adult returns totalled 69,800 Early Stuart, 134,700 Early Summer-run, 1,983,400 Summer-run and 630,200 Late-run sockeye.
18. Despite better than expected returns for both the Early Stuart and Early Summer run, they were still managed using a low abundance exploitation rate (LAER) of 10%. Summer and Late run returns were better than forecast and the Panel adopted Management Adjustments to ensure spawning escapement targets were met.
19. Catches of Fraser River sockeye salmon in all fisheries totalled 192,000 fish, including 87,200 fish caught by Canada, 86,820 fish caught by the U.S. (Washington & Alaska District 104) and 18,000 fish caught by test fisheries (Table 8). The Canadian catch was a mix of First Nations Catch; 45,400, non-commercial catch; 41,700, which included ‘other’ catch (31,900; unauthorized directed retention or unauthorized bycatch retention in fisheries direct at other species). In Washington, there was a very small unauthorized catch of 20 sockeye in the U.S. Treaty Tribe pink directed fishery. The remainder of the U.S. catch, 86,800 sockeye, occurred in Alaska District 104 fisheries. The overall harvest rate was 7% of the run (Figure 10).
20. DFO’s near-final estimates of spawning escapements to streams in the Fraser River watershed totalled 1,844,500 adult sockeye and were similar to cycle line averages for all run timing groups except Early Stuart (Tables 8 and 9, Figure 12). This was double the Fraser sockeye

brood year escapement of 940,100 adults. There were 1,046,500 effective female spawners in the Fraser watershed and an estimate of overall spawning success of 99%.

21. The total run-size estimate of Fraser River pink salmon was 8,108,200 (Figure 13). Catches totalled 280,100 fish, with 79,800 caught by Canada, of which 17,300 was caught in commercial fisheries (Table 10). For the U.S., there was a total catch of 196,000 of which 192,000 was caught in commercial fisheries (Table 11). The remaining 4,300 were caught in test fisheries (Table 8). This catch represents an exploitation rate of 3% (Table 8 and 9), which is the lowest exploitation rate since records began in 1959 (Figure 13).
22. Since 2009, estimates of pink salmon passage have been obtained through the hydroacoustics program at Mission. In 2021, the run size of Fraser River pink salmon was calculated by adding the total catch of pink salmon below Mission (246,500 fish) to the Mission passage estimate (7,862,000 fish, Table 7), while the spawner abundance (7,828,100 fish) was calculated by subtracting the total catch from the run size.

Achievement of Objectives

23. 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.
24. 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 low return, the spawning escapement targets for Early Stuart and Early Summer run equalled their run sizes, and there was no need for the Panel to adopt MA estimates. However, returns for Summer and Late run were better than expected so the Panel adopted MAs to ensure the spawning escapement targets were met. Also, with the very low catches, the potential escapements (i.e., Mission escapement minus all catch above Mission) for Early Stuart and Early Summer-run management group were very similar to the spawning escapement targets, 1% and 3% under, respectively. For the Summer and Late run the potential escapements were greater than the escapement target, 20% and 57% over, respectively (Table 12).
25. For Early Stuart and Early Summer-run 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 2021, spawning escapement targets could not be met for these two groups. The Summer run management group exceeded its spawning escapement target but the increased run size was not adopted until the last in-season meeting (September 28) so harvest opportunities were not realized until fish had already migrated from the marine areas.
26. Spawning ground estimates of Fraser sockeye abundance totalled 1,884,500 adults, which is 14% greater than the post-season target. Spawner abundance was below target for Early Stuart sockeye (23% under), below target for Early Summer-run (22% under), above target for Summer-run (41% over) and below target for Late-run sockeye (51% under) (Table 13). The exploitation rates for all management groups were less than their respective LAERs.
27. There was available international TAC of Fraser sockeye (Table 14) based on the calculation method set out in Annex IV, Chapter 4 of the Pacific Salmon Treaty. This international TAC was not available until the last meeting, September 28, at which point the large abundances of Fraser sockeye had already migrated through the marine areas. The unauthorized Washington catch of 20 Fraser sockeye occurred during the period when no International TAC was available. The total Canadian catch of 77,900 Fraser sockeye (excluding ESSR catch) consisted mostly of catch from First Nations and ‘other’ catch (which may include unauthorized directed retention or unauthorized bycatch retention in fisheries directed at other species) as well as 500 fish in the Charter test fisheries (Albion). This Canadian catch was within the Canadian share of TAC + Aboriginal Fisheries Exemption (AFE). In these calculations, the TAC is based on the TAC on the date of the last in-season Panel meeting (September 28, 2021), while catches are post-season estimates.
28. In terms of domestic U.S. allocation objectives for Fraser sockeye, U.S. Treaty Tribe fishers were 20 fish above their share of the U.S. TAC (Table 15).

29. For Fraser River pink salmon, there was a TAC of 1,995,700 salmon (Table 14) based on the calculation method set out in Annex IV, Chapter 4 of the Pacific Salmon Treaty.
30. Access to pink salmon TAC was limited by management uncertainty and challenges assessing run size at the time of U.S. and Canadian pink salmon directed fisheries. In Canada, pink salmon directed fisheries were also impacted by the comigrating sockeye stocks that were in a LAER and as a result the spawning escapement for Fraser River pink salmon was greater than the post-season target (30% over; Table 13) and the exploitation rate was very low at 3% (Table 8).
31. The Washington catch of 196,000 Fraser pink salmon was less than their 25.7% share of the international TAC and the Canadian catch of 78,200 was 1,409,200 less than their allowable catch.
32. Regarding domestic U.S. allocation objectives for Fraser pink salmon, both U.S. Treaty Tribe and All Citizen fishers were below their shares of the U.S. TAC (Table 16), 162,600 fish and 154,500 fish, respectively.
33. There was no bycatch of non-Fraser sockeye salmon, but there was a bycatch of 52,240 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 2,590 Chinook, 5,080 coho, and 140 chum.

Allocation Status

34. By Panel agreement there is a U.S. payback of 470 Fraser River sockeye to be carried forward from the 2019 season to 2021 (Table 18). The catch of 20 Fraser sockeye caught in U.S. pink directed fisheries was by Panel decision not allocated to payback. There was no payback owed for Fraser River pink salmon (Table 18).

II. FRASER RIVER PANEL

In 2021, 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 commercial 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 south of Cape Caution 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 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 bycatch in fisheries directed at Fraser River 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

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

at Fraser River sockeye and pink salmon is based on the same in-season information and hierarchy of objectives.

The Panel's regulatory authority is implemented based on the principle that all Panel-regulated fisheries are to remain closed (Appendix D) unless opened by specific order (Appendix E). The pre-season plan identifies the approximate pattern of fishery openings required to achieve the Panel objectives given pre-season expectations. However, the Panel typically determines the actual pattern of fishery openings based on in-season assessments by PSC Staff (hereinafter "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 Panel 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.

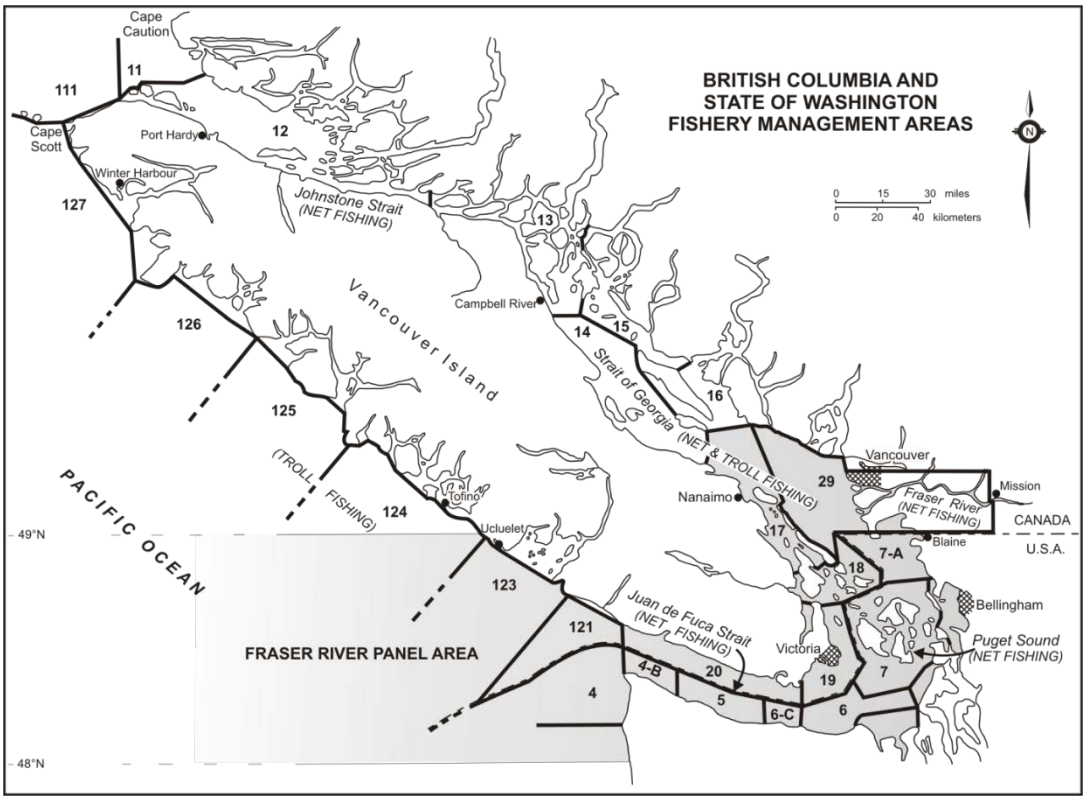

Figure 1. Fishery management areas in the Fraser River Panel Area and south coast waters.

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 objectives (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 Fraser sockeye and pink salmon directed 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. Assuming median run size estimates (p50 or 50th percentile) for both species, there was no available harvest or directed fisheries planned for sockeye salmon. Pink fishery impacts by Canada and the U.S. were constrained by both 10% low abundance exploitation rates (LAERs) assigned to all Fraser sockeye management groups, and by the limited pink salmon total allowable catch (TAC). The LAER is applied to accommodate "small but acceptable" amounts of bycatch for management groups, or species, with little or no TAC[3]. In the model, Canada was able to achieve their full pink salmon TAC, but this was largely a function of a fixed catch assigned to Food, Social, Ceremonial (FSC) catches in-river, a fishery not dynamically modelled within the simulation framework. During pre-season modelling, fishing induced mortalities (FIMs) for sockeye salmon captured and released during pink-directed U.S. All Citizen and Canadian marine FSC fisheries were included in estimates of exploitation rate, but excluded from total catch estimates (i.e., not counted against the TAC but used to assess performance relative to the LAERs).

The preliminary run-size forecast for Fraser River sockeye salmon was produced by Canada using a variety of stock-recruit models with spawner data up to and including the 2017 brood year (2018 brood year for Harrison)[4]. Several approaches were taken to select median forecast abundances that constrained the implied sockeye productivity to near recent historical levels. Typically, a smolt-based stock recruitment relationship is used to forecast pink salmon run size. However, due to COVID-19 restrictions, DFO's downstream smolt estimation program was not operational during the spring of 2020. An alternative stock-recruit model was therefore developed for pink salmon using a number of biological and environmental covariates.

Canada presented the Panel with run-size forecasts for each species 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. For planning purposes, the Panel used the median (i.e., p50) run size forecast of 1.3 million Fraser River sockeye salmon and 3.0 million pink salmon as the "base case" scenario.

Canada used the "Fraser River Sockeye Spawning Initiative" (FRSSI) model in combination with pre-season stakeholder consultations to establish escapement goals for 2021. These are

[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] Treaty Between the Government of Canada and the Government of the United States of America Concerning Pacific Salmon, as amended through January 2020. (https://www.psc.org/publications/pacific-salmon-treaty/
[4] DFO. 2021. Pre-season run size forecasts for Fraser River Sockeye (*Oncorhynchus nerka*) and Pink (*Oncorhynchus gorbuscha*) Salmon in 2021. Can. Sci. Advis. Sec. Sci. Resp. 2021/038.

documented in the Pacific Region Integrated Fisheries Management Plan[5] (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 equivalent to the run size forecast: Early Stuart – 18,000; Early Summer run – 108,000; Summer run– 1,046,000; and Late run – 159,000. Because the escapement targets were equivalent to the forecasted run size, all management groups were planned to be managed using a 10% LAER to allow for harvest of co-migrating species. There was no directed sockeye harvest planned under this scenario. The pre-season escapement target for pink salmon at the p50 run size abundance was 2,817,000.

Pre-season fisheries management planning was based on assumptions about the proportions of Fraser River sockeye and pink salmon expected to migrate through Johnstone Strait and Juan de Fuca Strait (i.e. Johnstone Strait diversion rate, Figure 2) as well as marine timing (i.e. Area 20 50% migration dates, Figure 4). The pre-season Fraser River sockeye diversion rate of 35% was derived by DFO using a combination of ocean current velocities and sea surface temperatures[6]. As the diversion rate of the Harrison component through the south is historically higher than for other co-migrating sockeye salmon, a diversion rate of 24% was assigned separately to the Harrison component. The Panel adopted a Fraser River pink salmon diversion rate of 53% for pre-season planning based on historical data, as the DFO forecast based on environmental data (later estimated to be 50%) 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 Pacific Fisheries Management Area 20) if the entire run had migrated via that route. DFOs oceanographic models[6] generated timing forecasts of July 5 for the Early Stuart run and August 3 for the Chilko run. Given the extremely early timing prediction for Chilko relative to other years on this cycle line, PSC Staff recommended a timing of August 6 based on the 10th percentile of the historical median timing for all years excluding the 2020 cycle line. The Fraser River Panel adopted the DFO forecast for Early Stuart and the revised timing estimate for Chilko. The difference between the Chilko historical median of August 10 (for all years excluding the 2020 cycle line years) compared to the adopted Chilko timing of August 6 (-4 days) was used to offset the assumed timing for all other component stock groups within the Planning Model, except Early Stuart. Historical medians were based on: all years for the all Early Summer-run stocks except Early South Thompson and Stellako, all years excluding the 2020 cycle line for Early South Thompson, Chilko, Horsefly, Raft-North Thompson, and Weaver-Cultus, and only on cycle-line years for Harrison-Widgeon, Late Stuart, Mitchell, Late Shuswap-Portage, and Birkenhead-Big Silver. The overall timing of the Early Summer, Summer and Late-run management groups were derived based on the aggregated daily abundances of component stocks assuming normal run timing distributions. The Panel adopted the resulting marine timing of July 24 for the Early Summer run, August 5 for the Summer run, and August 13 for the Late run. Given evidence of recent trends towards earlier arrival, the timing of Fraser River pink salmon (August 25) was based on a recent subset of years from 1999-2019. 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.

Pre-season, the Panel assumed a component of the Late-run and Summer-run management groups would delay their migration into the Fraser River. There has been some evidence of increasing delay in recent years but given the short and variable timeseries on this cycle line, 2021 delay was assumed to be the same as observed in 2017. For planning purposes, the model assumed 83% of the non-Birkenhead Late-run group would delay in the Strait of Georgia and would migrate

[5] Fisheries and Oceans Canada. 2021. Southern Salmon Integrated Fisheries Management Plan 2021/22. 21-2051: 600p.

[6] 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.

upstream with 50% of the run migrating upstream on September 6. For the overall Late run group, this resulted in 50% of the run migrating upstream by September 4. This timing corresponded with 8 days of travel time between Area 20 and Mission and an additional 9 days of migration delay in the Straight of Georgia. The model also assumed 23% of Harrison sockeye salmon would delay in the Strait of Georgia prior to migrating upstream with a 50% Mission date of September 6, the same upstream timing as the delaying Late-run stocks. For the entire Harrison stock group, this resulted in an August 16 Mission 50% date and assumed 2-days of migration delay.

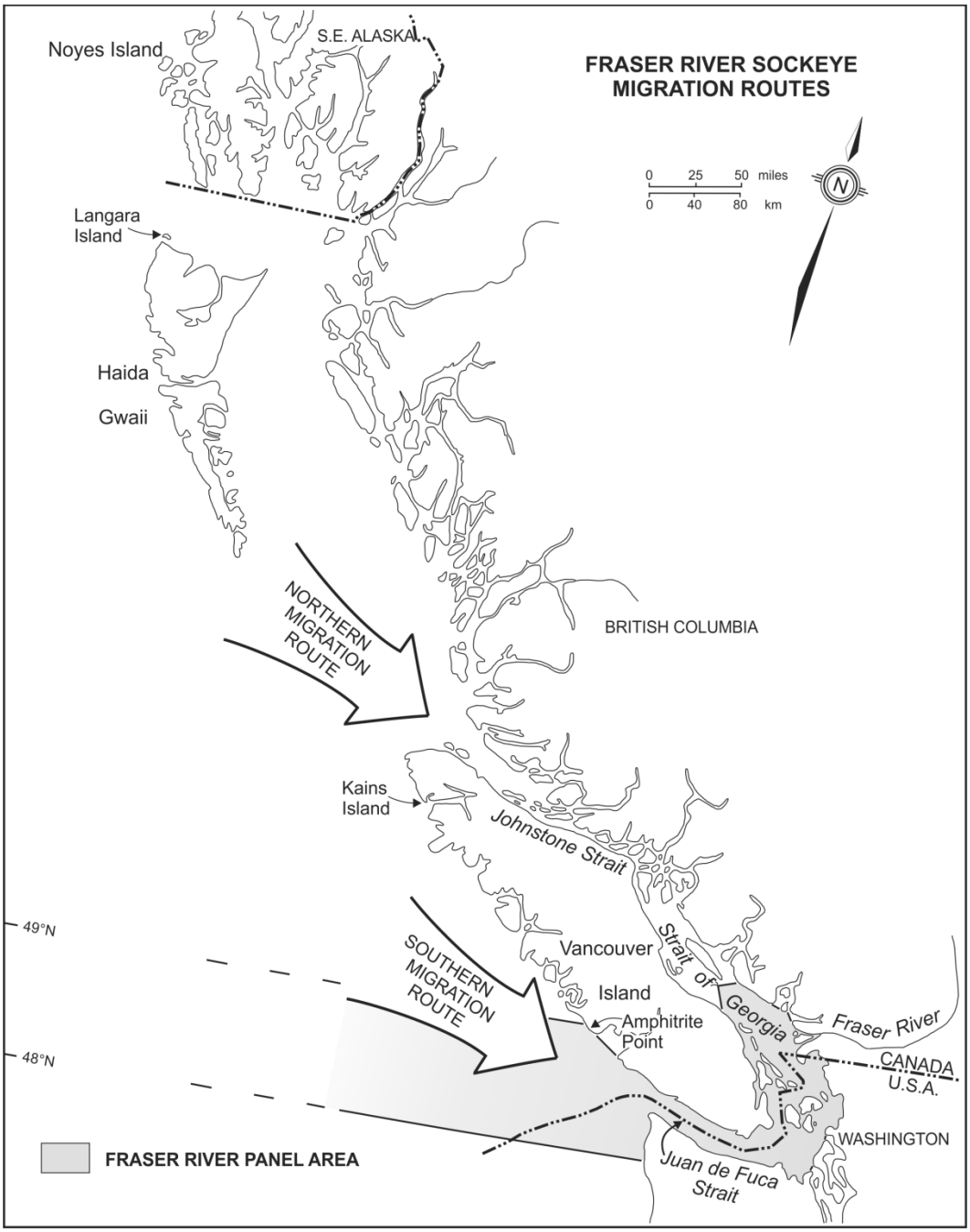

Figure 2. The northern (Johnstone Strait) and southern (Juan de Fuca Strait) routes for sockeye and pink salmon migration to the Fraser River.

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 slightly above average. Temperature and precipitation conditions through April and May were variable across the province and contributed to a near normal snow basin index by June 1[7]. The long-range forecast predicted above average to average discharge and average to above average water temperatures for the lower Fraser River over the summer months. Staff applied the environmental forecasts to 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). Additional consideration was given to the potential impact of the Big Bar slide. Over-winter remediation work was anticipated to increase the discharge threshold for natural sockeye passage through the slide area[8]. However, if impacts on Early Stuart passage remained similar to those in 2019 and 2020, then expected pDBEs could exceed 99%.

The Panel chose to adopt the proportional management adjustments (pMAs) based on historical medians for all four management groups (see Table F4). For the Summer run, the stock component weighted pDBE approach had almost no impact on the aggregate Summer run pDBE given the low forecasted relative abundances for Harrison fish. However, the relative abundances of Chilliwack and Pitt in the Early Summer-run group, and of Birkenhead in the Late-run group, did impact the aggregate pDBEs for those management groups. As a result, the Panel agreed to forego the weighted pDBE approach for the Summer-run aggregate but used the weighted pDBE approach for the Early Summer and Late-run aggregates in 2021 (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=12,400 fish), Early Summer-run aggregate (pMA=0.39; MA=42,100 fish), and Summer run aggregate (pMA=0.09; MA=94,100 fish). As long as the upstream timing remained earlier than September 8, the Panel also adopted a fixed pMA for the Late-run aggregate (pMA=0.96; MA=152,600 fish) (Table 6). If in-season upstream timing was later than September 8, the Panel would consider a timing-based MA model approach. 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, Cultus Lake sockeye, Sakinaw and other sockeye stocks that migrate through Johnstone Strait, interior Fraser River coho, interior Fraser steelhead, all Fraser River Chinook except the Summer 4-1's, west coast Vancouver Island and Strait of Georgia wild Chinook, and the Southern Resident Killer Whale population. The U.S. highlighted concerns for Puget Sound Chinook, Puget Sound coho, Puget Sound steelhead, Hood Canal summer chum, Lake Washington sockeye, Baker Lake sockeye, and the Southern Resident Killer Whale population.

Pre-season test fishing plans did not include the Naka Creek gill net, Area 13 purse seine, Area 4B, 5 gill net, or Gulf troll test fisheries. An experimental gill net test fishery in the lower Fraser River was being developed at Brownsville Bar and ran from mid-July to mid-August with costs covered by the Southern Endowment Fund (SEF)[9]. An ongoing SEF project[10] evaluating the use of an Alaska twist gill net was also scheduled to take place in Area 12 at the Round Island location.

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[7] Snow Survey and Water Supply Bulletin. River Forecast Centre. Ministry of Forests, Lands, Natural Resource Operations and Urban Development. June 1, 2022.

[8] Big Bar landslide response information bulletins. Fisheries and Oceans Canada. https://www.pac.dfo-mpo.gc.ca/pacific-smon-pacifique/big-bar-landslide-eboulement/bulletins/index-eng.html

[9] Nowak, B., Baltzell, M., Jantz, L, and A. Fisher. 2022. Lower Fraser River gillnet test fishery site evaluation: a final project report to the Southern Boundary Restoration and Enhancement Fund. Pacific Salmon Commission. March 2022.

[10] Labelle, M. and P. Van Will. 2022. Comparison of the sockeye catch composition and catch rates of two test-fishing gill nets used at Round Island in 2021: a final project report to the Southern Boundary Restoration and Enhancement Fund. Pacific Salmon Commission. March 2022.

Prior to the 2021 season, the PSC finalized a Test Fishing Policy and associated Financial Regulation to provide guidelines around retention policies and the accounting of deficits and surpluses incurred by the test fishing program[11,12]. Given the low forecasted abundances, there were no plans to retain discretionary catch of either sockeye or pink salmon. Approximately one-quarter of the cost of the proposed test fisheries ($1,046,100), was anticipated to be covered by non-discretionary catches (i.e. those unavoidably killed in gill net test fisheries or those retained for sampling purposes). The remaining test fishing expenses, with the exception of the SEF projects, would be paid through the use of the Test Fishing Revolving Fund.

The total non-discretionary catch (12,700) of Fraser sockeye 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 run-size abundances in the previous three cycle years. The distribution of this catch across management groups was based on the average proportions of the non-discretionary catch observed over the last 3 years on the cycle line. For Fraser River pink salmon, the total non-discretionary catch (3,500) was based on the average non-discretionary catch over the previous three return years and was also scaled based on the pre-season run-size forecast abundance.

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). There was no pre-season sockeye salmon TAC for international sharing (Table 1) at the p50 run size. Because all Fraser sockeye management groups were to be managed with a LAER, there was no Aboriginal Fisheries Exemption (AFE) for any groups. Under this scenario, any fishing induced mortalities (FIMs) taking place were subject to Panel approval under the “small but acceptable” clause (Paragraph 3e, Annex IV, Chapter 4) of the Pacific Salmon Treaty. Canada also scheduled fisheries assuming a 3-week moving window closure in order to protect Early Stuart sockeye, with an additional 1-week extension to protect early-timed Early Summer run stocks (e.g. Bowron, Taseko)[13]. For pink salmon, the pre-season TAC for international sharing was 188,500 (Table 1). The U.S. share was 25.7% of the TAC or 48,400, divided equally between Treaty Tribe and All Citizen fisheries. The balance to Canada was 74.3% or 140,100 pink salmon, which included 126,800 for in-river First Nations and 39,000 fish for marine First Nations. There was insufficient pink TAC for any Canadian commercial or recreational fisheries at the p50 run size.

Alternative model runs explored the sensitivity of fishing plans to Fraser sockeye and pink salmon run sizes: (1) assuming a sockeye salmon run size corresponding to the 90th percentile of the distribution of the forecasted run size (p90: 5.5 million) but holding pink salmon run size at the median forecast, and (2) assuming a pink salmon run size corresponding to the 90th percentile (p90: 5.4 million) but reducing the sockeye abundance to the 25th percentile (624,000). At the 90th percentile of the sockeye run size forecast, there was available TAC for the Early Summer and Summer-run management groups and the U.S. was able to catch close to its full sockeye and pink TAC, while Canadian catches for both species were still constrained by the LAER applied to the Late-run component.

The Panel 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 “2021 Management Plan Principles and Constraints” and “2021 Regulations” (Appendices C & D). In the pre-season plan, marine FSC fisheries were the first potential fisheries directed at Fraser River pink salmon commencing on August 24 and operating until August 31. Canadian in-river catches directed at pink salmon were entered as fixed inputs. All pink-directed fisheries were assumed to be sockeye non-retention, but

[11] Pacific Salmon Commission Test Fishing Policy. Feb. 10, 2021. Pacific Salmon Commission
[12] Rule 25: Test Fishing Revolving Fund. Pacific Salmon Commission. PSC Bylaws: Chapter IX
[13] Fisheries and Oceans Canada. 2021. Southern Salmon Integrated Fisheries Management Plan 2021/22. 21-2051: 600p.

FIMs were only modelled for marine fisheries in the pre-season plan. An estimated 200 sockeye FIMs were assigned to the marine FSC fisheries with an assumed FIM rate of 25%.

In total, the U.S. planned four days of directed pink salmon fisheries in Panel area waters. These fisheries consisted of two days of Treaty Tribes openings in Areas 6,7,7A commencing on August 27, and alternating with two days of All Citizen fisheries in the Areas 7 and 7A, concluding on August 30. All Citizen fisheries were modelled as sockeye non-retention, with an assumed FIM rate of 25% and an estimated 300 sockeye FIMs. 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. Treaty Tribes' pink-directed fisheries were modelled as sockeye retention, with a total of 1,700 landed sockeye distributed between the Summer and Late-run management groups.

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. For the U.S., this assumed that the 2,000 sockeye salmon mortalities in landed catch and FIMs were considered a "small but acceptable" impact which Canada did not agree with.

B. In-season Management

In 2021, all sockeye salmon management groups returned at abundances greater than the median pre-season forecasts. With the exception of Early Stuart, all management groups returned with a later marine timing than forecast pre-season (Figure 3). Pink salmon return abundance was also well above forecast, and the marine timing was earlier than forecast (Figure 4).

The Fraser River Panel convened 23 times between July 9, 2021 and September 28, 2021 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 sizes and the various deductions that result in the calculated TAC (i.e., spawning escapement target, MA, projected test fishing catch and AFE). Also shown are estimates of available harvest (run size minus spawning escapement target and MA), catch to date, and Mission escapement to date. The main events that transpired each week of the season are summarized below with a focus on Staff assessments and Panel decisions.

July 4 - 10, 2021:

The first in-season Panel meeting took place on Friday, July 9. A record-breaking heatwave in BC at the end of June and beginning of July caused rapid melting of the snowpack resulting in greater than average discharge for the time of year. However, this did not appear to impede sockeye migration into the Fraser River. Hydroacoustic estimates commenced July 4 at Mission and in-season abundance estimates for Early Stuart sockeye indicated returns would be at or above the pre-season median run size forecast of 18,000 sockeye given pre-season expectations of timing. The Fraser River water discharge at Hope was about 7,256 $m^3 \cdot s^{-1}$, which was approximately 24% greater than average for this date and the temperature was 1.8° C greater than average at 17.3°C. Once in the river, the high discharge levels seemed to slow upstream migration from Mission to Qualark, but starting on July 7, sockeye had been spotted migrating past Hells Gate. Sockeye stocks with spawning grounds above the Big Bar landslide needed about 10 days to migrate from the Lower Fraser River to the landslide location. To date, one sockeye had been caught in the fish wheel at Lillooet and tagged. As of July 9, no sockeye had yet been observed past the Big Bar landslide area, but Chinook salmon had been able to naturally migrate past.

July 11 – 17, 2021:

Approximately 42,100 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 much higher than the median forecast of 18,000 sockeye and it was expected that the run size would be higher than the p90 forecast of 47,000, but still well short of the spawning escapement target for Early Stuart of 108,000. Salmon were migrating naturally through the Big Bar landslide area. Two radio tagged sockeye migrated past the slide on July 14. Also, sonar images upstream of the slide indicated shorter length sonar targets than in previous weeks, another indication that sockeye were passing through the slide area. On July 15, the Fraser River water discharge at Hope was about 4,796 $m^3 \cdot s^{-1}$, which is approximately 11% less than average for this date. The temperature of the Fraser River at Hope on July 15 was 19.0° C, which was 2.2° C greater than average for this date. For Early Stuart, the 19-day model predicted an expected difference between estimates (DBE) of -89% assuming a timing of July 5 compared to pre-season expectations of -41%; however, this estimate did not account for the potential impacts on migration success of the Big Bar landslide. This high DBE indicated that the majority of Early Stuart sockeye would not reach the spawning grounds due to the high water temperatures and discharge throughout the watershed. The upstream migration of Early Stuart sockeye was expected to be negatively impacted by these migration conditions.

July 18 – 24, 2021:

Approximately 62,300 Early Stuart sockeye had been accounted for in catch plus escapement which was well above the median abundance forecast of 18,000 and also exceeded the p90 forecast level of 47,000. At the meeting on Friday, the Panel adopted an Early Stuart in-season run size of 65,000, which was still below the Spawning Escapement Target of 108,000. The associated 50% marine timing in Area 20 was July 4, which was one day earlier than expected pre-season. The estimated escapement of Early Summer-run sockeye past Mission through July 22 was 9,100 fish and the daily abundances were near the p25 forecast level of 59,000. Current data suggested the run was likely to be later and/or smaller than expected pre-season. The purse seine test fisheries were delayed by two days and would not start until July 26 and July 27 for Area 12 and Area 20, respectively. Total catch plus escapement to date equalled 77,100 sockeye which was below expectations for this date.

Discharge remained very low throughout the watershed. On July 22, the Fraser River water discharge at Hope was about 3,796 $m^3 \cdot s^{-1}$, which was approximately 23% lower than average for this date. The temperature of the Fraser River at Hope on July 22 was 18.7°C, which is 1.2°C greater than average for this date.

At Big Bar, the discharge was below average. All salmon arriving at Big Bar were able to pass the slide using the nature-like fishway and there was no delay in the upstream salmon migration. As of July 17, a total of 22,821 salmon had been detected at the Churn Creek telemetry site 40 km upstream of Big Bar. Sockeye stocks with spawning grounds in the watershed upstream of the landslide needed about 10 days to migrate from the Lower Fraser River to the landslide location. Based on pre-season timing forecasts for Early Stuart, the expected peak migration passing the landslide was around July 21. Fifty-two sockeye had been radio tagged. Thirty-six of these tagged sockeye made it to the slide area while 30 were detected past the slide area. Also, sonar images downstream and upstream of the slide indicated equal length sonar targets, suggesting no delay in passage due to size. Wildfires in the Big Bar slide area resulted in an evacuation order of the entire area on July 21 but fish monitoring at Big Bar was not interrupted.

July 25 – July 31, 2021:

Approximately 67,400 Early Stuart sockeye had been accounted for in catch plus escapement which was greater than the adopted run size of 65,000. The estimated escapement of Early Summer-run sockeye past Mission through July 29 was 17,400 fish and the daily abundances were tracking near the p25 forecast level of 59,000. With the strong test fishery catches in the marine environment there were indications that the Early Summer run was later than forecast and that the run size might

be higher than the p25 forecast. It was therefore considered still too early to recommend an Early Summer-run run size. The escapement of Summer run accounted for past Mission was 14,500. Total catch plus escapement to date equalled 77,100 sockeye which was below expectations for this date. Purse seine test fisheries started July 26 and July 27 for Area 12 and Area 20, respectively. In Area 20, the daily catch-per-unit-effort (CPUE) was tracking the cycle line average which was well above the 2017 and 2019 cycle line CPUE. In Area 12, the daily CPUE was tracking near the 2017 CPUE.

Catches of Fraser River pinks were higher than in the previous 3 pink salmon years, but there was still a lot of uncertainty associated with the pink salmon proportions which ranged from 0 to 15% in the Area 12 test fisheries. No pink salmon had yet been observed migrating in the Fraser River or caught in river test fisheries.

Temperature remained high throughout the watershed. On July 29, the Fraser River temperature at Hope was 18.7°C, which is approximately 0.4°C greater than average for this date. The discharge of the Fraser River at Hope on July 29 was about 3,039 $m^3 \cdot s^{-1}$, which was approximately 32% lower than average for this date.

At Big Bar, the discharge was below average. All salmon arriving at Big Bar were able to pass the slide using the nature-like fishway and there was no delay in the upstream salmon migration. As of July 26, a total of 81,597 salmon had been detected at the Churn Creek telemetry site 40 km upstream of Big Bar. A total of 159 sockeye had been radio tagged to date.

August 1 – August 7, 2021:

The Early Stuart run was complete with an estimated catch plus escapement of 69,000, just above the adopted in-season run size of 65,000. The estimated escapement of Early Summer-run sockeye past Mission through August 5 was 35,100 fish and the run continued to track near the p50 forecast level (108,000).

The Summer run was tracking below the p50 forecast of 1,046,000 sockeye. There was a high proportion of stocks from the Late Stuart/Stellako group, which is one of the earlier timed components of the Summer run. It appeared that the Summer run was later timed than the pre-season forecast timing of August 5 and the timing appeared more in line with the median historical timing of August 9. It was still too early to make any assessments of run size. The estimated escapement past Mission was 76,200.

Only a very limited number of Late run had been observed in the marine and in-river test fisheries. The estimated escapement past Mission was 800.

Marine pink salmon catches in the purse seine test fisheries exceeded the previous 3 pink salmon years, especially in Area 20, but Fraser River pinks still made up a low proportion. Only one pink salmon had been caught in the in-river test fisheries. No pinks had been observed migrating past Mission, Qualark or Hells Gate.

The five-day average sockeye diversion rate through Johnstone Strait had decreased to 12% by the end of the week and the pink salmon diversion rate was 28%.

Discharge remained low throughout the watershed for the time of year. On August 5, the Fraser River water discharge at Hope was about 2,950 $m^3 \cdot s^{-1}$, which is approximately 24% less than average for this date. The temperature of the Fraser River at Hope on August 5 was 20.7°C, which is 2.2°C greater than average for this date. For Early Stuart, the 31-day model predicted an expected difference between estimates (DBE) of -81% assuming a timing of July 4 compared to pre-season expectations of -41%; however, this estimate did not account for the environmental conditions at the Big Bar landslide. For Early Summer run, the 19-day model predicted an expected DBE of -44% assuming a timing of July 25 compared to pre-season expectations of -36%. However, the timing for Early Summer run was likely later than expected pre-season. Similar to Early Stuart, the DBE predictions did not account for migration conditions at Big Bar.

At Big Bar, the discharge was below average. All salmon arriving at Big Bar were able to pass the slide using the nature-like fishway and there was no delay in the upstream salmon migration. As of August 2, a total of 95,955 salmon had been detected at the Churn Creek telemetry site 40 km upstream of Big Bar. A total of 481 sockeye had been radio tagged to date. For testing purposes, 36 sockeye were transported by truck past the slide site and released upstream.

August 08-14, 2021:

The marine gillnet test fisheries were terminated as scheduled on August 9 and 11, for Area 12 and 20, respectively. In the purse seine test fisheries, sockeye CPUE remained above the cycle line average in Area 20 while CPUE in Area 12 was tracking similar to 2019. The diversion rate of 5% was well below the pre-season forecast of 35%.

The total accounted run to date was 444,400 Fraser sockeye, consisting of 69,200 Early Stuart, 84,200 Early Summer, 285,800 Summer and 5,200 Late-run sockeye. At the Panel meeting on Friday, the Panel adopted an Early Stuart run size of 69,000 with an associated 50% marine timing in Area 20 of July 5. They also adopted an Early Summer-run run size of 170,000 with an associated 50% marine timing in Area 20 of August 6. No changes were made to the Management Adjustment (MA) for Early Stuart or Early Summer run as there were no management implications. It was still too early to make any assessments for Summer-run run size, but it appeared to be tracking near the p50 forecast level of 1,046,000. Despite the upward change in run size all management groups were in a low abundance exploitation rate (LAER) scenario.

Catches of pink salmon continued to increase in the marine area with catches in Area 12 being higher than in Area 20. Stock identification indicated that in Area 12 only 23% of pinks caught were Fraser River pink salmon. Pink salmon were also caught in several of the in-river test fisheries: Cottonwood, Brownsville Bar (SEF project) and Whonnock. A pink salmon was also observed in the fish wheel near Crescent Island. No pink salmon were observed at Qualark or Hells Gate. In-river estimates of pink salmon were generated by the Mission hydroacoustics program, and as of August 12, 14,600 pink salmon were estimated to have passed the Mission site. The pink salmon diversion rate was 69% which was greater than the pre-season forecast of 50%.

Throughout the Fraser River watershed, discharge levels continued to decrease. On August 12, the Fraser River water discharge at Hope was about 2,709 cms, which is approximately 21% less than average for this date. The temperature of the Fraser River at Hope on August 12 was 19.7°C, which is 1.1°C greater than average for this date. For Early Summer run, the 19-day model predicted a weighted difference between estimates (DBE) of -38% assuming an Area 20 timing of August 4. The model predicted DBE was very similar to the supplemental management adjustment approach of -36%. For Summer run, the 19-day model predicted a DBE of -36% assuming an Area 20 timing of August 5 which was more negative than the pre-season value of -8%.

The number of sockeye passing the Big Bar slide area had decreased in the last few days, despite discharge levels well below the historical average and no additional migration concerns being noted at Big Bar. As of August 9, a total of 109,772 salmon had been detected at the Churn Creek telemetry site 40 km upstream of Big Bar.

August 15 – 21, 2021:

The total accounted run to date was 974,900 sockeye salmon, consisting of 69,700 Early Stuart, 97,700 Early Summer-, 756,500 Summer-, and 51,000 Late-run sockeye. At the Panel meeting on Friday, the Panel reduced the Early Summer-run run size from 170,000 to 115,000 with an associated Area 20 timing of August 4. Both Summer- and Late-run were tracking near the p50 forecast levels of 1,046,000 and 159,000 sockeye, respectively. There did appear to be any evidence of delay in upstream migration for the Late Shuswap and Weaver/Cultus component of the Late run.

Several pink salmon forecasts for median timing and median diversion rate were provided by DFO. The three timing forecasts provided were August 26, August 31 and September 1; all of which were later timed than the pre-season adopted timing of August 25. Three diversion rate forecasts were also provided: 50%, 55% and 75%. The first one was the same as the pre-season adopted timing of 50%.

As of August 19, 73,200 pink salmon had been estimated by the Mission hydroacoustics program. The Fraser River pink salmon daily abundances appeared to be tracking above the median forecast of 3,009,000. Assuming a timing of around August 26-September 1, it was still too early for pink salmon run size assessments using the regular assessment tools. However, a minimum run size could be estimated assuming the earliest timing on record, August 17, and an expansion line

associated with some of the smallest run sizes on record, 152. With this criteria, a minimum run size of 4,000,000 was estimated which was very close to the p75 forecast level of 4,051,000. At the meeting on Friday, the Panel adopted the minimum pink salmon run size of 4,000,000. The implied productivity at a run size of 4,000,000 was very similar to the productivity at the forecast level (~3.0 million) and would still be considered one of the lowest on record since records began in 1959.

At Friday's meeting, the Panel approved a U.S. pink directed fishery based on the adopted run size but efforts were to be made to release sockeye alive. This applied to both the Treaty Tribes fishery in Areas 4B, 5, and 6C as well as the All Citizen reef net fishery in Area 7.

The Fraser River water temperature at Hope of 18.6°C was 0.1°C higher than average for this date but was expected to decrease to 17.5°C and the discharge was below average at 2,772$m^3 \cdot s^1$ and was expected to decrease slightly to 2,739$m^3 \cdot s^1$. For Summer run, the 19-day model predicted an expected difference between estimates (DBE) of -30% assuming a timing of August 5 compared to pre-season expectations of -8%.

The number of sockeye reaching the Big Bar slide continued to increase. On August 16, it was estimated that about 176,108 total salmon had been observed at Churn Creek, 40 km upstream of the slide. No pink salmon had been observed at Churn Creek; however, one pink salmon had been caught at the fish wheel near Lytton.

August 22 – 28, 2021:

The total accounted run to date was 1,428,500 sockeye salmon, consisting of 69,700 Early Stuart, 108,500 Early Summer-, 1,170,000 Summer- and 80,300 Late-run sockeye. At the Panel meeting on Friday, the Panel adopted a Summer-run run size of 1,350,000 with an associated 50% marine timing in Area 20 of August 12. The increase in run size exceeded the spawning escapement target for Summer run; however, the pre-season adopted Management Adjustment (MA) eliminated any available harvest. The Late run was tracking above the p50 forecast level (159,000) and there was some evidence of Late-run delay; however, no recommendation was made for Late-run run size as there were no management implications.

As of August 26, 566,900 pink salmon had been estimated by the Mission hydroacoustics program. The Fraser River pink salmon daily abundances indicated two sharp increases in abundance around August 13-14 and August 23-24 and overall levels of abundance were dependent on assumed purse seine expansion lines. Assuming historical average expansion lines, the total accounted pink salmon run to date in marine areas was similar to the run size in the brood year (~8.9 million). Years with lower run sizes however are more likely to have lower expansion lines. The in-season run size model for pink salmon indicated a total run size of 5.5 million pink salmon corresponding to an expansion line of 210. At Friday's meeting the Panel adopted an in-season run size of 4,800,000 with an associated 50% marine timing in Area 20 of August 17. This was lower than the proposed recommendation of 5,500,000 but still large enough to generate sufficient international TAC to allow for the prosecution of the pink salmon fisheries proposed by the U.S.

With the increased run size there was more available pink salmon TAC for both countries. The U.S. All Citizen reefnet fishery opening from earlier in the week reported relatively low catches of Fraser River pink salmon, approximately 5,500, and the catch remaining for the U.S. was 119,430 Fraser River pink salmon. At Friday's meeting, the Panel approved a U.S. pink directed fishery but with non-retention of sockeye and all efforts were to be made to release sockeye alive. This applied to both the Treaty Tribes fishery in Areas 4B,5, 6C and in Areas 6, 7 and 7A and in All Citizen purse seine and gillnet fisheries in Areas 7 and 7A as well as the All Citizen reefnet fishery in Area 7.

Throughout the Fraser River watershed, discharge levels continued to decrease. On August 26, the Fraser River water discharge at Hope was about 2,178 cms, which was approximately 19% less than average for this date. The temperature of the Fraser River at Hope on August 26 was 17.3°C, which was slightly below average for this date. The 19-day model predictions of expected difference between estimates (DBE) for the Summer run indicated a median pDBE of -17% based on an August 12 Area 20 date and 19 days of observations. This was more negative than the adopted pre-season pDBE value of -8.

The number of sockeye reaching the Big Bar slide continued to increase. On August 24, it was estimated that about 462,449 total salmon had been observed at Churn Creek, 40 km upstream of the

slide. These estimates were in line with the abundances predicted based on the Mission hydroacoustic site estimates. Five pink salmon were radio tagged to monitor whether they could pass the slide successfully. Given that current discharge levels were lower than the pink salmon passage threshold level observed in 2019, it would not be possible to evaluate if there had been any improvement made to this threshold.

August 29 – September 4, 2020:

The total accounted run to date was 1,711,700 sockeye salmon, consisting of 69,700 Early Stuart, 111,400 Early Summer-, 1,379,500 Summer- and 151,100 Late-run sockeye. At the meeting on Monday, the Panel adopted a Late-run run size of 234,000 with an associated Area 20 timing of August 16 and at the meeting on Friday they further increased the run size to 300,000 with an associated Area 20 timing of August 18. They also increased the Summer-run run size to 1,475,000 with an associated Area 20 timing of August 13. For Summer run, the Panel adopted a proportional Management Adjustment (pMA) of 0.19 based on the 19-day model predictions of expected difference between estimates (DBE). With this increased run size there was still no available harvest for the Summer run with the adopted pMA.

As of September 3, 1,671,900 pink salmon had been estimated in catch plus escapement. This included 172,200 pink salmon caught downstream of Mission. At the Monday meeting the Panel further increased the pink salmon run size to 5,700,000 with an associated Area 20 timing of August 18, in line with increasing escapements that had been observed the previous week and over the weekend. Later that week, pink salmon abundances and catches however had not increased as expected based on marine predictions, implying either a longer travel time from Area 20 than the assumed travel time of 18 days or a smaller than average expansion line associated with the large marine test fishing catches. Despite catching most of it's pink salmon TAC, the U.S. pink directed fisheries could also not confirm the large abundances associated with the high marine test fishing catches on August 23 and 24. At the Friday meeting, both the delay in seeing larger abundances at Mission and the lack of confirmation by the U.S pink directed fisheries resulted in a more cautious approach for pink salmon management and no further changes in run size. Still, based on a run size of 5,700,000, there was a remaining U.S. available catch of 6,400 and the scheduled fisheries needed to be monitored closely to ensure the TAC was not exceeded.

On September 2, the Fraser River water discharge at Hope was about 1,847 cms, which was approximately 25% less than average for this date. The temperature of the Fraser River at Hope was 16.6°C, which was 0.3°C below average for this date.

The number of sockeye reaching the Big Bar slide continued to increase. As of September 1, a total of 1,087,066 salmon had been observed at Churn Creek, 40 km upstream of the slide. In general, abundances at Big Bar were tracking predicted abundances based on Mission and Qualark hydroacoustic data except for 7 days during the mid-August period where sockeye passage at Big Bar was higher than the Mission predictions and more closely aligned with the Qualark predictions.

September 5 –11, 2021:

The total accounted run to date was 1,921,900 sockeye salmon, consisting of 69,700 Early Stuart, 114,300 Early Summer-, 1,508,000 Summer- and 229,900 Late-run sockeye. At the meeting on Tuesday, the Panel adopted an increased Summer-run run size of 1,550,000 with an associated Area 20 timing of August 14 as well as a proportional Management Adjustment (pMA) of 0.18 which is associated with the 19-day model predictions of expected difference between estimates (DBE). The Late-run run size was also increased at the Tuesday meeting to 320,000 with an associated Area 20 timing of August 18. The upstream timing (Mission 50% date) using all years data for Late run was September 5 and the Panel adopted the weighted pMA of 1.04 associated with this date. At the meeting on Friday, they adopted an updated Summer run pMA of 0.11 which was based on the 31-day model predictions of percent DBE. With this increased Summer-run run size there was no international total allowable catch (TAC); however, it did generate TAC which allowed for some Food, Social and Ceremonial fishing opportunities in Canada within the Aboriginal Fisheries Exclusion (AFE) amount of 400,000.

As of September 6, the Mission hydroacoustic program estimated a total of 4,800,200 pink salmon had entered the river and an additional 187,700 pink salmon had been caught downstream of Mission. The confirmation of large pink salmon abundances (>500,000) entering the river starting on Saturday September 4, resulted in more optimism regarding the pink salmon run size. At the Tuesday meeting the Panel further increased the pink salmon run size to 6,000,000 with an associated Area 20 timing of August 19 and this was further increased at the Friday meeting to 6,500,000 with no change to timing.

U.S. pink directed fisheries continued but reports indicated CPUE estimates that implied lower abundance than indicated by the marine test fisheries. Like the previous week, the scheduled U.S. fisheries were closely monitored to ensure they did not exceed their TAC and continued to be prosecuted with non-retention of sockeye. Canada also put forth an assessment fishery proposal for Area B in portions of Area 29 which was limited to two vessels and non-retention of sockeye.

On September 9, the Fraser River water discharge at Hope was about 1,580 cms, which was approximately 30% less than average for this date. The temperature of the Fraser River at Hope was 17.3°C, which was 1.1°C below average for this date.

The number of sockeye reaching the Big Bar slide continued to increase. As of September 8, a total of 1,595,284 salmon had been observed at Churn Creek, 40 km upstream of the slide. Recent daily abundances at Big Bar had decreased substantially, but were tracking predicted abundances based on Mission hydroacoustic data and had deviated from the predictions based on the Qualark program which assumed an increase in daily abundance before predicting a delayed decrease.

September 12- 18, 2021

The total accounted run to date was 2,047,600 sockeye salmon, consisting of 69,700 Early Stuart, 115,100 Early Summer-, 1,541,700 Summer- and 321,100 Late-run sockeye which included 15,900 in catch downstream of Mission.

As of September 16, a total of 6,824,000 pink salmon had entered the river according to the Mission hydroacoustic program estimate and an additional 211,500 pink salmon had been caught downstream of Mission. U.S. pink directed fisheries continued but reports indicated low catches and there were no concerns with the U.S. exceeding their TAC. Given continued conservation concerns, there was no retention of sockeye in this fishery opening. Canada also put forth an ITQ fishery for Areas B and H in Area 29 for pink salmon with non-retention of sockeye. The Area B ITQ fishery was terminated on September 18 due to very poor catches of pink salmon.

On September 16, the Fraser River water discharge at Hope was about 1,699 cms, which was approximately 18% less than average for this date. The temperature of the Fraser River at Hope was 15.5°C, which was 0.3°C above average for this date.

The number of sockeye reaching the Big Bar slide continued to be strong. As of September 15, a total of 1,766,200 salmon had been observed at Churn Creek, 40 km upstream of the slide. Recent daily abundances at Big Bar had decreased substantially but were tracking slightly higher than the predicted sockeye abundances based on Mission hydroacoustic data. It was noted that about 35% of the total salmon passage at Big Bar was pink salmon. A total of 1,002 salmon had been radio tagged to date.

September 19- 25, 2021

The total accounted run to date was 2,188,700 sockeye salmon, consisting of 69,700 Early Stuart, 115,100 Early Summer-, 1,579,000 Summer- and 424,900 Late-run sockeye which included 16,000 in catch downstream of Mission.

As of September 21, a total of 7,526,200 pink salmon had entered the river according to the Mission hydroacoustic program and an additional 213,800 pink salmon had been caught downstream of Mission. There were no further U.S. pink directed fisheries, and the Canadian directed Area H troll ITQ fishery closed as scheduled on September 22.

On September 20, the Fraser River water discharge at Hope was 1,865 cms, which was 4% below the average for this date. The temperature of the Fraser River at Hope was 13.8°C, which was 0.7°C below average for this date.

The number of sockeye reaching the Big Bar slide continued to be strong. As of September 20, a total of 1,841,474 salmon had been observed at Churn Creek, 40 km upstream of the slide. Recent daily abundances at Big Bar had decreased but were tracking slightly higher than the predicted abundances based on Mission hydroacoustic data.

Table 1. Pre-season and in-season updates of run size, spawning escapement targets and other TAC-related values for Fraser River sockeye and pink salmon in 2021. 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 **	Downstream Catch to date	Mission Escape. to date
June Pre-season***	Early Stuart	18,000	18,000	0.69	12,400	300	0	18,000	0	0	0	0
	Early Summer	108,000	108,000	0.39	42,100	1,800	0	108,000	0	0	0	0
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	0	0
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	0	0
	Sockeye	**1,330,000**	**1,330,000**		**301,200**	**12,700**	**0**	**1,331,000**	**0**	**0**	**0**	**0**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**0**	**0**
July 9 In-season	Early Stuart	18,000	18,000	0.69	12,400	300	0	18,000	0	0	0	11,900
	Early Summer	108,000	108,000	0.39	42,100	1,800	0	108,000	0	0	0	600
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	0	0
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	0	0
	Sockeye	**1,330,000**	**1,330,000**		**301,200**	**12,700**	**0**	**1,331,000**	**0**	**0**	**0**	**12,500**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**0**	**0**
July 13 In-season	Early Stuart	18,000	18,000	0.69	12,400	300	0	18,000	0	0	100	26,900
	Early Summer	108,000	108,000	0.39	42,100	1,800	0	108,000	0	0	100	1,700
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	100	1,600
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	0	0
	Sockeye	**1,330,000**	**1,330,000**		**301,200**	**12,700**	**0**	**1,331,000**	**0**	**0**	**300**	**30,200**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**0**	**0**
July 16 In-season	Early Stuart	18,000	18,000	0.69	12,400	750	0	18,000	0	0	300	42,100
	Early Summer	108,000	108,000	0.39	42,100	1,800	0	108,000	0	0	100	2,700
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	0	0
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	0	0
	Sockeye	**1,330,000**	**1,330,000**		**301,200**	**13,150**	**0**	**1,331,000**	**0**	**0**	**400**	**44,800**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**0**	**0**
July 20 In-season	Early Stuart	18,000	18,000	0.69	12,400	750	0	18,000	0	0	400	53,500
	Early Summer	108,000	108,000	0.39	42,100	1,800	0	108,000	0	0	200	7,300
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	100	2,700
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	0	0
	Sockeye	**1,330,000**	**1,330,000**		**301,200**	**13,150**	**0**	**1,331,000**	**0**	**0**	**700**	**63,500**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**0**	**0**
July 23 In-season	Early Stuart	65,000	65,000	0.69	44,900	750	0	65,000	0	0	400	61,900
	Early Summer	108,000	108,000	0.39	42,100	1,800	0	108,000	0	0	200	9,100
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	200	5,300
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	0	0
	Sockeye	**1,378,000**	**1,378,000**		**333,700**	**13,150**	**0**	**1,378,000**	**0**	**0**	**800**	**76,300**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**0**	**0**
July 27 In-season	Early Stuart	65,000	65,000	0.69	44,900	750	0	65,000	0	0	500	66,100
	Early Summer	108,000	108,000	0.39	42,100	1,800	0	108,000	0	0	300	13,600
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	300	9,000
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	0	0
	Sockeye	**1,378,000**	**1,378,000**		**333,700**	**13,150**	**0**	**1,378,000**	**0**	**0**	**1,100**	**88,700**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**0**	**0**
July 30 In-season	Early Stuart	65,000	65,000	0.69	44,900	750	0	65,000	0	0	500	66,900
	Early Summer	108,000	108,000	0.39	42,100	1,800	0	108,000	0	0	600	17,400
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	1,000	13,500
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	0	0
	Sockeye	**1,378,000**	**1,378,000**		**333,700**	**13,150**	**0**	**1,378,000**	**0**	**0**	**2,100**	**97,800**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**0**	**0**
August 3 In-season	Early Stuart	65,000	65,000	0.69	44,900	750	0	65,000	0	0	500	69,100
	Early Summer	108,000	108,000	0.39	42,100	1,800	0	108,000	0	0	700	26,600
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	2,200	39,800
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	100	400
	Sockeye	**1,378,000**	**1,378,000**		**333,700**	**13,150**	**0**	**1,378,000**	**0**	**0**	**3,500**	**135,900**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**300**	**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 **	Downstream Catch to date	Mission Passage to date
August 6 In-season	Early Stuart	65,000	65,000	0.69	44,900	750	0	65,000	0	0	500	68,500
	Early Summer	108,000	108,000	0.39	42,100	1,800	0	108,000	0	0	800	35,100
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	3,100	76,200
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	200	800
	Sockeye	**1,378,000**	**1,378,000**		**333,700**	**13,150**	**0**	**1,378,000**	**0**	**0**	**4,600**	**180,600**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**400**	**0**
August 10 In-season	Early Stuart	65,000	65,000	0.69	44,900	750	0	65,000	0	0	500	68,900
	Early Summer	108,000	108,000	0.39	42,100	1,800	0	108,000	0	0	1,000	50,200
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	4,500	151,000
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	300	3,600
	Sockeye	**1,378,000**	**1,378,000**		**333,700**	**13,150**	**0**	**1,378,000**	**0**	**0**	**6,300**	**273,700**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**500**	**0**
August 13 In-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	68,700
	Early Summer	170,000	170,000	0.39	66,300	1,800	0	170,000	0	0	1,200	83,000
	Summer	1,046,000	1,046,000	0.09	94,100	8,900	0	1,046,000	0	0	6,200	279,600
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	300	4,900
	Sockeye	**1,444,000**	**1,444,000**		**360,600**	**13,150**	**0**	**1,444,000**	**0**	**0**	**8,200**	**436,200**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**800**	**14,600**
August 17 In-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	68,700
	Early Summer	170,000	170,000	0.39	66,300	1,800	0	170,000	0	0	1,300	92,700
	Summer	1,046,000	1,046,000	0.09	94,100	12,000	0	1,046,000	0	0	8,300	598,800
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	700	28,600
	Sockeye	**1,444,000**	**1,444,000**		**360,600**	**16,250**	**0**	**1,444,000**	**0**	**0**	**10,800**	**788,800**
	Pink	**3,009,000**	**2,816,600**			**3,500**		**2,820,100**	**188,900**	**192,400**	**900**	**28,400**
August 20 In-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	69,200
	Early Summer	115,000	115,000	0.39	44,900	1,800	0	115,000	0	0	1,300	96,400
	Summer	1,046,000	1,046,000	0.09	94,100	12,000	0	1,046,000	0	0	9,200	747,300
	Late	159,000	159,000	0.96	152,600	1,700	0	159,000	0	0	1,100	49,000
	Sockeye	**1,389,000**	**1,389,000**		**339,200**	**16,250**	**0**	**1,389,000**	**0**	**0**	**12,100**	**961,900**
	Pink	**4,000,000**	**3,660,000**			**3,500**		**3,663,500**	**336,500**	**340,000**	**1,100**	**73,200**
August 24 In-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	69,200
	Early Summer	115,000	115,000	0.54	62,100	1,500	0	115,000	0	0	1,300	107,600
	Summer	1,046,000	1,046,000	0.09	94,100	12,500	0	1,046,000	0	0	10,400	992,500
	Late	159,000	159,000	0.96	152,600	2,000	0	159,000	0	0	1,400	81,500
	Sockeye	**1,389,000**	**1,389,000**		**356,400**	**16,750**	**0**	**1,389,000**	**0**	**0**	**13,600**	**1,250,800**
	Pink	**4,000,000**	**3,660,000**			**3,500**		**3,663,500**	**336,500**	**340,000**	**9,500**	**193,000**
August 27 In-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	69,200
	Early Summer	115,000	115,000	0.39	44,900	1,500	0	115,000	0	0	1,300	107,200
	Summer	1,350,000	1,250,000	0.09	112,500	12,500	0	1,350,000	0	0	11,000	1,159,000
	Late	159,000	159,000	0.96	152,600	2,000	0	159,000	0	0	1,500	78,800
	Sockeye	**1,693,000**	**1,593,000**		**357,600**	**16,750**	**0**	**1,693,000**	**0**	**0**	**14,300**	**1,414,200**
	Pink	**4,800,000**	**4,310,400**			**3,500**		**4,313,900**	**486,100**	**489,600**	**7,300**	**566,900**
August 30 In-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	69,200
	Early Summer	115,000	115,000	0.54	62,100	1,500	0	115,000	0	0	1,300	107,600
	Summer	1,350,000	1,250,000	0.09	112,500	12,500	0	1,350,000	0	0	11,300	1,204,900
	Late	234,000	234,000	0.96	224,600	2,000	0	234,000	0	0	1,700	106,400
	Sockeye	**1,768,000**	**1,668,000**		**446,800**	**16,750**	**0**	**1,768,000**	**0**	**0**	**14,800**	**1,488,100**
	Pink	**5,700,000**	**5,009,600**			**3,500**		**5,013,100**	**686,900**	**690,400**	**68,300**	**1,006,800**
September 3 In-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	69,200
	Early Summer	115,000	115,000	0.39	44,900	1,500	0	115,000	0	0	1,300	110,100
	Summer	1,475,000	1,250,000	0.19	237,500	13,500	0	1,475,000	0	0	11,800	1,367,700
	Late	300,000	300,000	0.96	288,000	2,200	0	300,000	0	0	1,800	149,300
	Sockeye	**1,959,000**	**1,734,000**		**618,000**	**17,950**	**0**	**1,959,000**	**0**	**0**	**15,400**	**1,696,300**
	Pink	**5,700,000**	**5,009,600**			**5,000**		**5,014,600**	**685,400**	**690,400**	**172,200**	**1,499,700**

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 **	Downstream Catch to date	Mission Passage to date
September 7 In-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	69,200
	Early Summer	115,000	115,000	0.39	44,900	1,500	0	115,000	0	0	1,400	111,900
	Summer	1,550,000	1,250,000	0.18	225,000	13,700	61,300	1,550,000	0	75,000	12,000	1,470,100
	Late	320,000	300,000	1.04	312,000	2,200	0	320,000	0	0	1,800	208,800
	Sockeye	**2,054,000**	**1,734,000**		**629,500**	**18,150**	**61,300**	**2,054,000**	**0**	**75,000**	**15,700**	**1,860,000**
	Pink	**6,000,000**	**5,235,000**			**5,000**		**5,240,000**	**760,000**	**765,000**	**179,700**	**3,036,500**
September 10 In-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	69,200
	Early Summer	115,000	115,000	0.39	44,900	1,500	0	115,000	0	0	1,400	112,900
	Summer	1,550,000	1,250,000	0.11	137,500	13,700	148,800	1,550,000	0	162,500	12,000	1,496,000
	Late	320,000	300,000	1.04	312,000	2,200	0	320,000	0	0	1,900	228,000
	Sockeye	**2,054,000**	**1,734,000**		**542,000**	**18,150**	**148,800**	**2,054,000**	**0**	**162,500**	**15,800**	**1,906,100**
	Pink	**6,500,000**	**5,602,200**			**5,000**		**5,607,200**	**892,800**	**897,800**	**187,700**	**4,612,600**
September 13 In-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	69,200
	Early Summer	115,000	115,000	0.39	44,900	1,500	0	115,000	0	0	1,400	113,700
	Summer	1,550,000	1,250,000	0.11	137,500	13,700	148,800	1,550,000	0	162,500	12,100	1,515,800
	Late	320,000	300,000	1.04	312,000	2,200	0	320,000	0	0	1,900	259,900
	Sockeye	**2,054,000**	**1,734,000**		**542,000**	**18,150**	**148,800**	**2,054,000**	**0**	**162,500**	**15,900**	**1,958,600**
	Pink	**6,500,000**	**5,602,200**			**5,000**		**5,607,200**	**892,800**	**897,800**	**199,800**	**5,938,400**
September 17 In-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	69,200
	Early Summer	115,000	115,000	0.39	44,900	1,500	0	115,000	0	0	1,400	113,700
	Summer	1,550,000	1,250,000	0.11	137,500	13,700	148,800	1,550,000	0	162,500	12,100	1,529,600
	Late	320,000	300,000	1.04	312,000	2,200	0	320,000	0	0	1,900	319,200
	Sockeye	**2,054,000**	**1,734,000**		**542,000**	**18,150**	**148,800**	**2,054,000**	**0**	**162,500**	**15,900**	**2,031,700**
	Pink	**6,500,000**	**5,602,200**			**5,000**		**5,607,200**	**892,800**	**897,800**	**211,500**	**6,824,000**
September 21 End-of-season	Early Stuart	69,000	69,000	0.69	47,600	750	0	69,000	0	0	500	69,200
	Early Summer	115,000	115,000	0.39	44,900	1,500	0	115,000	0	0	1,400	113,700
	Summer	1,550,000	1,250,000	0.11	137,500	13,700	148,800	1,550,000	0	162,500	12,100	1,566,900
	Late	320,000	300,000	1.04	312,000	2,200	0	320,000	0	0	2,000	422,900
	Sockeye	**2,054,000**	**1,734,000**		**542,000**	**18,150**	**148,800**	**2,054,000**	**0**	**162,500**	**16,000**	**2,172,700**
	Pink	**8,000,000**	**6,000,000**			**5,000**		**6,005,000**	**1,995,000**	**2,000,000**	**213,800**	**7,526,200**
September 28 Post-season	Early Stuart	70,000	70,000	0.69	48,300	750	0	70,000	0	0	500	69,200
	Early Summer	120,000	120,000	0.39	46,800	1,500	0	120,000	0	0	1,400	118,300
	Summer	1,763,000	1,250,000	0.11	137,500	13,700	361,800	1,763,000	0	375,500	12,100	1,751,100
	Late	600,000	300,000	0.28	84,000	2,200	38,200	424,400	175,600	216,000	2,100	594,200
	Sockeye	**2,553,000**	**1,740,000**		**316,600**	**18,150**	**400,000**	**2,377,400**	**175,600**	**591,500**	**16,100**	**2,532,800**
	Pink	**8,000,000**	**6,000,000**			**5,000**		**6,005,000**	**1,995,000**	**2,000,000**	**220,000**	**7,766,300**

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

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

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

On October 9, 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 28) 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 2021. Regulatory control of Canadian Panel Areas was relinquished by the Panel on September 18 for Area 20, October 2 for Areas 17 and 18, and October 9 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.14-Aug.1									
Aug.2-Aug.8									
Aug.9-Aug.15									
Aug.16-Aug.22									
Aug.23-Aug.29									
Aug.30-Sep.5									
Sep.6-Sep.12			1						
Sep.13-Sep.19			6		5				
Sep.20-Sep.26					3				
Sep.27-Oct.3									
Oct.4-Oct.10									
Total	0	0	7	0	8	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 2021. Regulatory control of U.S. Panel Areas was relinquished by the Panel as follows; Areas 4B, 5, 6, 6C on September 18 as per pre-season regulations, Areas 6, 6A and 7 on September 18 by in-season order (Appendix E), Area 7A (excluding Apex) as per pre-season regulations on October 2 and 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 October 9, 2021, as per 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.14-Aug.1					
Aug.2-Aug.8					
Aug.9-Aug.15					
Aug.16-Aug.22	2				
Aug.23-Aug.29	7	1	1	1	1
Aug.30-Sep.5	7	5	2	2	
Sep.6-Sep.12	7	7			
Sep.13-Sep.19	1	1			
Sep.20-Sep.26					
Sep.27-Oct.3					
Total	24	14	3	3	1

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 and hydroacoustics. The locations and schedule for these PSC 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 2021.

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 2021 fishing season.

Area	Location	Gear	Dates	Operated by
Canadian Panel Areas				
20	Juan de Fuca Str.	Gillnet	July 11 - August 11	PSC
20	Juan de Fuca Str.	Purse Seine	July 27 - September 4	PSC
29-14	Fraser R. (Cottonwood)	Gillnet	July 12 - September 14	PSC
29-16	Fraser R. (Whonnock)	Gillnet	June 28 - October 3	PSC
29-16	Fraser R. (Mission)	Hydroacoustic	July 1 - October 3	PSC
Canadian non-Panel Areas				
12	Queen Charlotte Str. (Round Is.)	Gillnet	July 9 - August 9	DFO
12	Johnstone Str. (Blinkhorn)	Purse Seine	July 26 - September 3	DFO
	Fraser R. (Hells Gate)	Observer	July 5 - September 29	PSC
	Fraser R. (Qualark)	Gillnet	July 2 - October 5	DFO
	Fraser R. (Qualark)	Hydroacoustic	June 30 - October 6	DFO

Table 5. Individual stocks included in the Fraser River sockeye stock groups used in 2021.

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 2,553,000 Fraser River sockeye and 8,000,000 pink salmon (Table 1). Despite this higher than forecast abundance of sockeye salmon there were no sockeye directed fishing opportunities in the US and only very limited terminal FSC fisheries in Canada. The post-season abundance estimate for sockeye salmon (2,818,100 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, 9%, and more than double the pre-season median forecast (1,330,000).

Research at Mission[14,15] has produced hydroacoustic methods that provide reliable daily estimates of pink salmon passage. The post season run-size estimate of 8,108,200 fish (Table 8) was calculated by adding the estimated catch below Mission (246,500 fish) to the Mission passage estimate (7,862,000 fish, Table 7). This estimate is 63% greater than the median pre-season forecast (3,009,000).

B. Migration Timing and Diversion Rate

Figures 3 and 4 show the forecast 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 estimate of marine migration timing in 2021 was the same as the pre-season

[14] 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.
[15] 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.

expectation for Early Stuart (0-days difference) but end-of-season estimates were later than pre-season expectations for Early Summer-run (11-days later), Summer-run (9-days later) and Late-run (7-days later) groups, and earlier than expected for pink salmon (5-days earlier). These timings were slightly later than the cycle line median timing for each of the sockeye management groups. The timing for pink salmon was three days earlier than the recent-years historical median (1999-2019), and 6-days earlier than the long term historical median (1987-2019).

The diversion rate in 2021 was lower than forecast for both Fraser sockeye and pink salmon. For Fraser sockeye, the observed annual diversion through Johnstone Strait was 27%, compared to the forecast of 35% used for pre-season planning (Figure 5). For Fraser River pink salmon, the Johnstone Strait diversion rate was 23%, compared to the value of 50% used in pre-season planning.

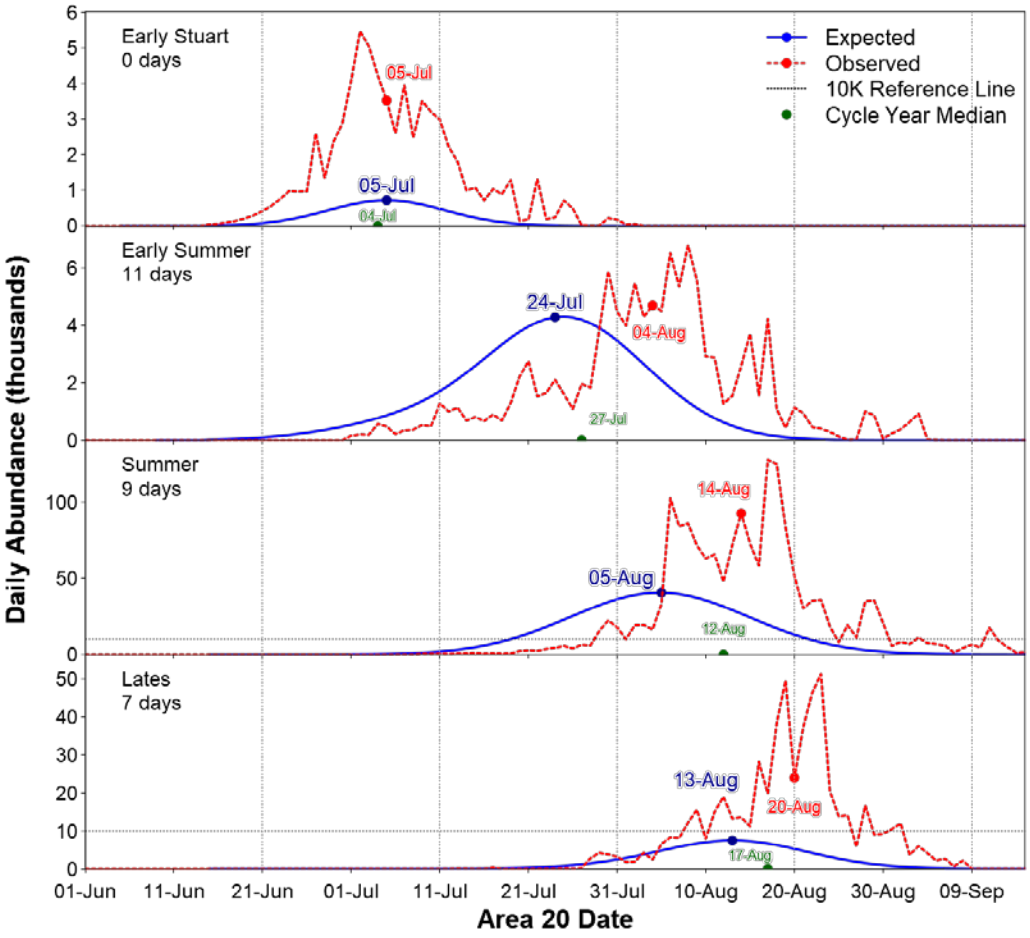

Figure 3. Pre-season expectations and post-season reconstructions of daily Fraser River sockeye salmon abundance by management group in 2021 (Area 20 date), including the observed 50% dates and number of days difference with pre-season expectations.

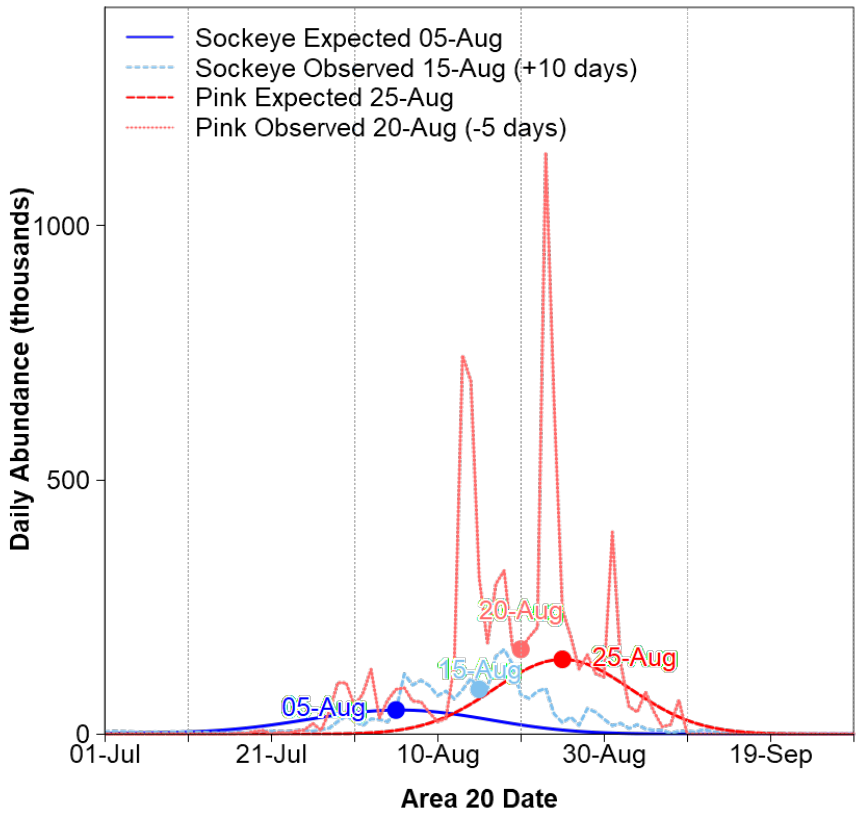

Figure 4. Pre-season projections and post-season reconstructions of daily Fraser River sockeye and pink salmon abundance in 2021 (Area 20 date), including the observed 50% dates and number of days difference with pre-season expectations.

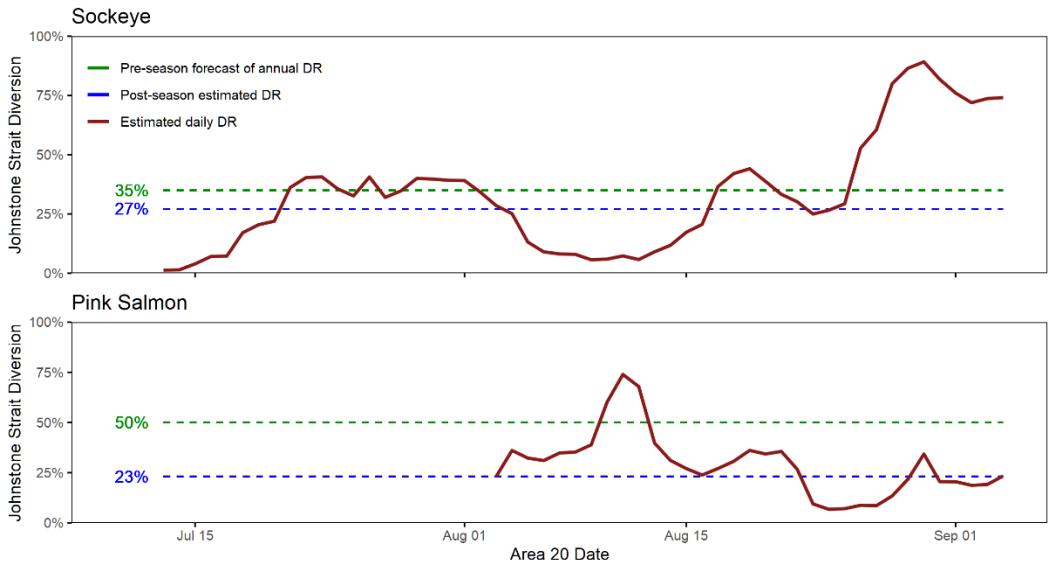

Figure 5. Pre-season forecast of annual Johnstone Strait diversion rate (DR) for Fraser sockeye salmon, compared to post-season estimates of daily and annual rates for 2021.

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 populations with spawning grounds above Big Bar. A Unified Command Incident Management Team was set up in response to the slide which involved collaboration between First Nations, Federal and Provincial governments. The response both immediate and on-going was to improve site safety, improve natural and assisted passage through or over the slide and monitor successful passage and fish condition of salmon populations spawning above Big Bar.

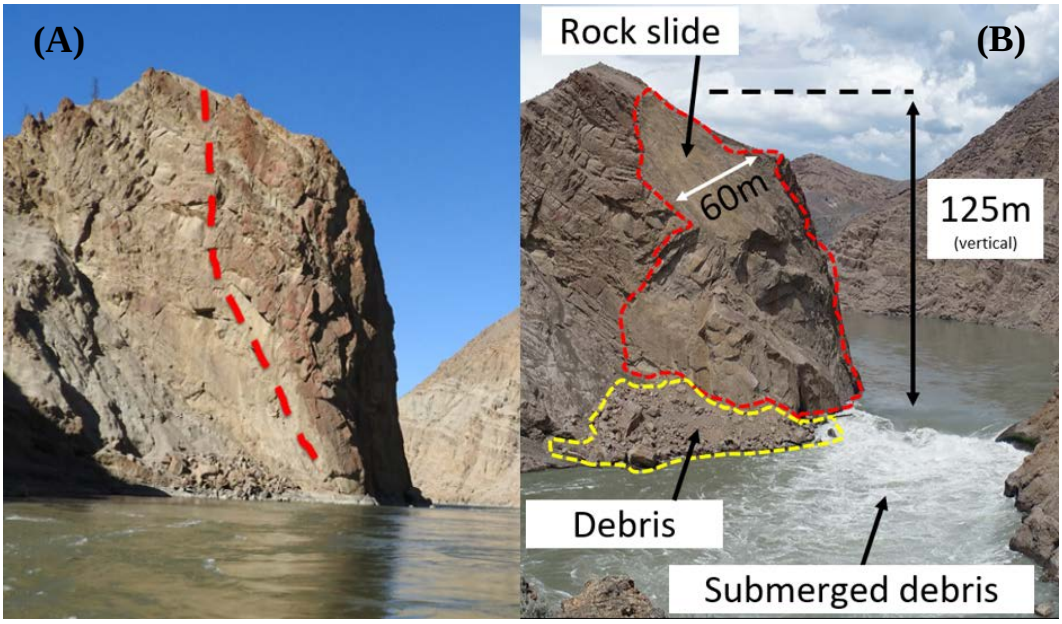

Figure 6. Big Bar Site before (A) and after (B) the slide. (A) The red line depicts what part of the cliff fell into the Fraser River. (B) Rock and debris 125 m in height and 60 m in width fell onto the banks and into the Fraser River.

In the winter of 2021 remediation work on the slide site continued. This work included the completion of a nature-like fishway, configuration of the concrete fish ladder for use with "trap and transport" operations, underwater mapping, rock fall mitigation and access road improvements.

Pre-season, an array of cameras and radio tag sensors were installed along the path of the nature-like fishway to provide more detailed information about the response of salmon populations to in-river passage conditions and passage improvement efforts to date (Figure 7). In 2021, it was expected the slide could impact 68% of the total Fraser River sockeye run (100% of the Early Stuart, 10% of the Early Summers run, and 94% of the Summer run) as well as an uncertain proportion of the pink salmon run. To provide in-season feedback to managers to inform them about natural passage success of all salmon, hydroacoustic fish monitoring stations were set up downstream and upstream of the slide and fish were radio tagged to track fish traveling through the slide site. Radio tag receivers were set up along the Fraser River and in tributaries which also informed the Stock Monitoring group on fish behavior associated with barriers and salmon condition.

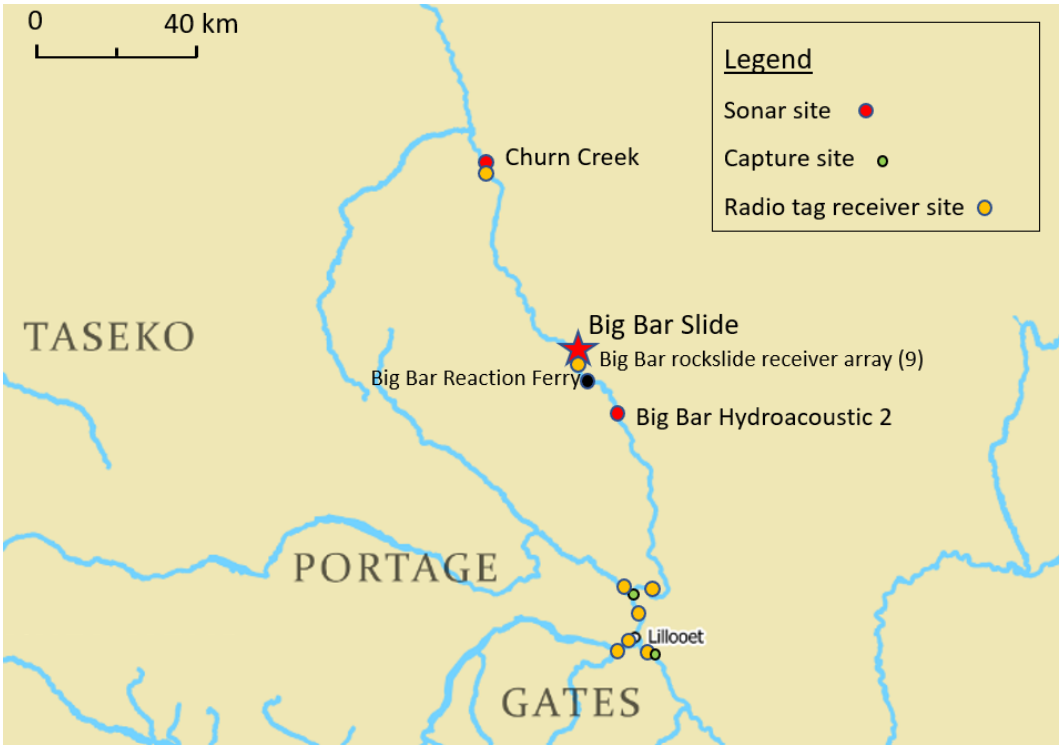

Figure 7. Map of sonar, salmon capture and radio tag receiver locations on the Fraser River near the Big Bar landslide in 2021.

In-season, after a peak freshet in early July that impacted salmon passage at Big Bar, discharge levels dropped to below average levels for the duration of the season. Due to low discharge levels and continued mitigation efforts over the winter and spring period, salmon were able to pass the Big Bar slide successfully.

Of the sockeye stocks that spawn above Big Bar, the following proportions, by management group, made it to the spawning grounds: 79% Early Stuart run, 100% Early Summer run stocks and 95% of the Summer run stocks. The Big Bar landslide did not have a major impact on the sockeye migration in 2021.

Due to multiple rock fall incidents and extreme weather impacting crew safety, the safe and timely implementation of the planned permanent concrete fishway at Big Bar was impacted. As a result, further construction on the fishway was suspended and the contract with Kiewit was terminated following the completion of the Summer site operations. Fisheries and Oceans Canada (DFO) and partners decided to pursue a structured analysis to review options and long-term solutions to safely restore natural fish passage through the area.

D. Management Adjustments and DBEs

Management Adjustments (MAs) are based on statistical models [16,17,18,19] 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 entry migration behaviour observed since the mid-1990s on the migration success of these stocks.

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

In 2021, the Fraser River watershed snow basin index was 116% of normal in early spring (April 1, BC Fraser Basin Snow Water Index). Due to slightly delayed snowmelt compared to average, the overall snow basin index was 111% for June 1. In early June, the E-Watch program generated a long-range forecast of Lower Fraser River summer temperature and flow conditions using relationships between winter snowpack accumulation, summer air temperatures and river environmental conditions. The long-range forecast was for average discharge and average to above average water temperature in the Fraser River. In-season, Fraser River peak freshet was in early June and discharge levels peaked again in early July (July 3, 8,447 m3/s), then discharge levels began to drop and continued to drop to below average levels for the duration of the season. River temperature was above average until it peaked at 20.7°C on August 5 and 6. Temperature then began to drop with some small fluctuations from average for the time of year (Figure 8).

A summary of the pre-season and in-season MA models used during 2021 are provided in the "Management Adjustment and DBE" section in Appendix F. Due to the low total pre-season forecast of abundances for each management group, the MAs would have no management implications and the Panel chose to adopt pMAs for pre-season planning purposes that were based on median values from historical datasets for each management group. In-season, predictions of proportional difference between estimates (pDBEs; Table F3) derived from in-season environmental MA models for the Early Stuart, Early Summer and Summer run and from the run-timing MA model for the Late run were presented to the Panel. Given that Management Adjustments had no management implications for Early Stuart and Early Summer run, the Panel did not adopt an in-season

[16] 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.
[17] Macdonald, J.S., Patterson, D.A., Guthrie, I., Lapointe, M. 2008. Improvements to environmental Management Adjustment models: SEF final report.
[18] 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.
[19] 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.

management adjustment for these management groups. For the Summer run, the Panel adopted a final pMA of 0.11 that was based on the 31-day Temperature and Discharge MA Model estimate. For the Late run aggregate, the Panel adopted a pMA of 0.28 that was based on the weighted pDBE of the run timing model estimate for the Late run excluding Birkenhead/Big Silver group and the median estimate for the Birkenhead/Big Silver group. The adopted pMAs and the final observed DBEs derived from near final spawning ground escapement estimates are shown in Table 6 for comparison purposes.

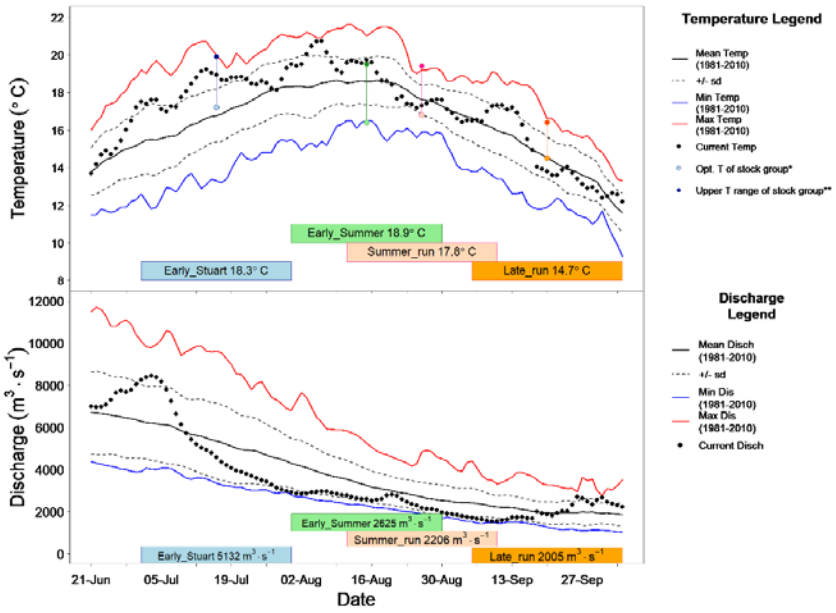

Figure 8. Fraser River temperature and discharge measured near Hope in 2021. Also shown are run timing bars that represent a 31 day spread of the run centred around the Hells Gate date and the mean temperature and discharge for the 31 day spread.

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[2]		Early Summer run Aggregate[2]		Summer run Aggregate		Late run Aggregate	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Pre-season adopted[1]	-41%	0.69	-28%	0.39	-8%	0.09	-49%	0.96
In-season adopted	NA	NA	NA	NA	-10%	0.11	-22%	0.28
Observed[3]	-21%	0.27	-10%	0.12	-6%	0.07	-73%	2.69

1 Pre-season adopted pMAs for planning purposes.

2 In-season, given that Management Adjustments had no management implications for Early Stuart, Early Summer run and Late run the Panel did not adopt an in-season management adjustment for these management groups.

3 Derived from Near Final escapement estimates.

The observed %DBE for Early Stuart, -21%, and Early Summer run, -10%, was lower (less negative) than that predicted pre-season, -41% and -28%, respectively. For Summer run, the in-season adopted %DBE of -10% was slightly higher (more negative) than the observed %DBE of -6%. Although the Late run did exhibit considerable delay, 21 days, the observed %DBE, -73% was much higher (more negative) than predicted by the run timing DBE model, -22%.

D. Mission Passage

The upstream passage of Fraser River sockeye at Mission was estimated to be 2,458,100; consisting of 68,500 Early Stuart, 116,700 Early Summer-run (including Pitt), 1,669,400 Summer-run, and 603,400 Late-run sockeye (Table 7). The total upstream passage of Fraser River pink salmon at Mission was estimated to be 7,862,000.

Table 7. Fraser River sockeye and pink salmon passage at Mission in 2021.

Management Group	Mission Escapement	
Stock Group	fish	%
Early Stuart	**68,500**	**3%**
Early Summer	**116,700**	**5%**
Chilliwack	4,100	0%
Early Miscellaneous	67,000	3%
Early South Thompson	25,700	1%
North Barriere/Taseko	2,100	0%
Pitt[1]	17,800	1%
Summer	**1,669,400**	**68%**
Raft/N.Thompson	58,400	2%
Chilko	1,026,000	42%
Quesnel	110,100	4%
Late Stuart/Stellako	433,300	18%
Harrison	41,700	2%
Late	**603,400**	**25%**
Birkenhead	124,800	5%
Late Shuswap/Portage	101,800	4%
Weaver/Cultus	376,800	15%
Total Sockeye	**2,458,100**	**100%**
Pink Salmon	**7,862,000**	**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

The Mission hydroacoustics program implemented a sampling method similar to previous years from 2011 to present 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 bank. As part of a Southern Endowment Fund (SEF) project[20], in 2021 an ARIS was also installed on the transecting vessel. Detailed description of the hydroacoustic methods used to estimate salmon passage in 2021 are provided in Appendix F.

[20] Bartel-Sawatzky, M. and R. Hornsby. 2022. Improved estimation of offshore fish passage at Mission by replacing split-beam system with imaging sonar: a final project report to the Southern Boundary Restoration and Enhancement Fund. Pacific Salmon Commission. March 2022.

V. RUN SIZE, CATCH AND ESCAPEMENT

A. Sockeye Salmon

The total abundance of sockeye salmon in 2021 was 2,818,100 fish (Tables 8 and 9), which is more than double the median forecast of 1,330,000 fish and 48% above the total adult return in 2017 (1,471,200). However, the 2021 return was 74% below the historical cycle line average (10,788,700; Figure 9).

The causes for the better than forecast return are unknown. Downstream migration of out-migrating smolts in 2019 experienced low discharge which is generally associated with higher productivity and may have been a contributing factor to the greater than expected return of Fraser sockeye in 2021. However, these same sockeye experienced extremely warm sea surface temperatures which are less than ideal conditions for marine rearing. Marine food availability was more abundant than in 2020 when there was a record low sockeye return to the Fraser River. Due to these confounding factors and the overly optimistic forecasts in recent years, the forecast for 2021 was very conservative.

Freshwater smolt information from Chilko indicated high freshwater survival given that an estimated 58 million fry left Chilko Lake in 2019, which was almost double the cycle average. Four-year-old Chilko sockeye were expected to contribute 30% of the median pre-season forecast for the Summer-run group. In-season, the return of age four Chilko fish was much greater than its median forecast. This better than expected survival of Chilko four-year-olds, coupled with the better returns relative to forecast of several other Fraser sockeye stock groups (see below), suggests that the forecast for 2021 may have been too conservative. Based on recent poor returns, a marine mechanism may have caused the better than expected productivity observed in 2021. Returns of all other Fraser River sockeye stocks were also better than forecast with the exception of Chilliwack, Pitt and Quesnel stocks.

Returns of Fraser River pink salmon which shared at least part of their ocean residence with Fraser River sockeye exceeded the forecast by 63%. Ocean distribution is likely different between Fraser sockeye and pink salmon however it is probable that there is some overlap in distribution. It seems that the higher than forecast pink salmon returns also benefitted from the same conditions experienced by sockeye salmon.

All management groups returned at abundances greater than their median (p50 level) pre-season forecast. The total return of Early Stuart sockeye was 69,700 adults (Table 9), 74% greater than the median forecast. Early Summer-run sockeye returns were dominated by Nadina/Bowron sockeye and totalled 133,700 fish, 19% greater than the median forecast level. The abundance of Summer-run sockeye was 1,964,900 adults, 47% greater than the median forecast level. Most Summer-run sockeye belonged to the Chilko stock group, which comprised 41% of the total return to the Fraser River. Returns to all Late-run components were also greater than their median forecasts resulting in an aggregate Late-run return of 628,400 adults, which was 75% greater than the group's median pre-season forecast.

Table 8. Catch, escapement, difference between estimates and run size for Fraser River sockeye (by management group) and pink salmon in 2021.

	Fraser Sockeye						Fraser Pinks	
	Early Stuart	Early Summer	Summer	Late	Total	% of Run	Total	% of Run
CANADIAN CATCH	**500**	**900**	**76,200**	**9,600**	**87,200**	**3%**	**79,800**	**1%**
Commercial Catch	**0**	**0**	**0**	**0**	**0**	0%	**17,400**	**0%**
Panel Area	0	0	0	0	0	0%	17,300	0%
Non-Panel Areas	0	0	0	0	0	0%	90	0%
First Nations Catch	**70**	**70**	**45,100**	**200**	**45,400**	2%	**26,600**	**0%**
Marine FSC	0	0	0	0	0	0%	2,900	0%
Fraser River FSC	70	70	45,100	200	0	0%	7,700	0%
Economic Opportunity	0	0	0	0	0	0%	16,100	0%
Non-commercial Catch	**400**	**800**	**31,100**	**9,400**	**41,700**	1%	**35,700**	**0%**
Marine Recreational	0	10	70	10	90	0%	21,700	0%
Fraser Recreational	0	0	0	0	0	0%	13,700	0%
Charter (Albion & Area 12 Chum)	10	40	400	80	500	0%	300	0%
ESSR	0	0	0	9,300	9,300	0%	0	0%
Other Catch***	400	700	30,700	60	31,900	1%		
UNITED STATES CATCH	**0**	**5,900**	**67,700**	**13,300**	**86,820**	**3%**	**196,000**	**2%**
Washington Total	**0**	**0**	**20**	**0**	**20**	**0%**	**196,000**	**2%**
Commercial catch	**0**	**0**	**0**	**0**	**0**	0%	**192,000**	**2%**
Treaty Tribal	0	0	0	0	0	0%	90,000	1%
All Citizen	0	0	0	0	0	0%	102,000	1%
Non-commercial Catch	**0**	**0**	**20**	**0**	**20**	0%	**3,900**	**0%**
Ceremonial	0	0	20	0	20	0%	3,900	0%
Recreational	0	0	0	0	0	0%	0	0%
Alaska	0	5,900	67,700	13,300	86,800	3%	0	0%
TEST FISHING CATCH	**800**	**1,500**	**13,600**	**2,100**	**18,000**	**1%**	**4,300**	**0%**
PSC (Panel Areas)	**400**	**1,100**	**8,800**	**1,500**	**11,800**	**0%**	**3,000**	**0%**
Canada	400	1,100	8,800	1,500	11,800	0%	3,000	0%
United States	0	0	0	0	0	0%	0	0%
Canada (non-Panel Areas)	**300**	**400**	**4,800**	**700**	**6,200**	**0%**	**1,300**	**0%**
TOTAL RUN	**69,800**	**134,700**	**1,983,400**	**630,200**	**2,818,100**	**100%**	**8,108,200**	**100%**
Total Catch in All Fisheries	1,200	8,200	157,500	25,100	192,000	7%	280,100	3%
Adult Spawning Escapement *	53,900	104,600	1,562,500	163,500	1,884,500	67%	7,828,100	97%
Jack Spawning Escapement	80	1,000	18,500	1,800	21,400	1%	0	0%
Difference Between Estimates**	14,600	20,900	245,000	439,900	720,400	26%	0	0%
Percentage of Total Run	**100%**	**100%**	**100%**	**100%**	**100%**		**100%**	
Total Catch in All Fisheries	2%	6%	8%	4%	7%		3%	
Spawning Escapement	77%	78%	80%	26%	68%		97%	
Difference Between Estimates	21%	16%	12%	70%	26%		0%	

* Spawning escapement estimate for Cultus sockeye include 132 individuals captured as brood stock.

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

*** May include unauthorized directed retention or unauthorized bycatch retention in fisheries directed at other species

The total sockeye catch of 192,000 represented about 7% of the total return (Tables 8 and 9). This exploitation rate of 7% includes Alaskan catch (3% of the total run, Figure 10). Of the total sockeye catch, 87,200 fish were caught in Canada, 86,820 fish in the U.S. (Alaska) and 18,000 fish in test fisheries (Table 8). Canadian catches included First Nations catch; 45,700, and non-commercial catch; 41,700, which included an ESSR (Excess Salmon to Spawning Requirements) catch of 9,300, Charter and recreational catch of 500 and 'other' catch 31,900. In Washington State

there was no commercial catch taken but 20 sockeye were caught in Treaty Tribes Ceremonial and Subsistence fisheries directed at Fraser River pink salmon. The Alaska catch of Fraser sockeye from District 104 was 86,800 fish.

Table 9. Catch, escapement, difference between estimates, run size and exploitation rate for Fraser River sockeye (by stock group) and pink salmon in 2021.

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	**1,200**	**53,900**	**14,600**	**69,700**	**80**	**69,800**	**2%**	**2%**
Early Summer-run	**8,200**	**104,600**	**20,900**	**133,700**	**1,000**	**134,700**	**5%**	**6%**
Chilliwack	30	2,000	2,100	4,200	0	4,200	0%	1%
Early Miscellaneous	2,500	53,800	18,300	74,500	500	75,000	3%	3%
Early South Thompson	4,700	27,200	0	31,900	500	32,400	1%	15%
North Barriere/Taseko	100	2,200	500	2,900	0	2,900	0%	3%
Pitt	800	19,400	0	20,200	0	20,200	1%	4%
Summer-run	**157,500**	**1,562,500**	**245,000**	**1,964,900**	**18,500**	**1,983,400**	**70%**	**8%**
Raft/N.Thompson	4,700	5,300	53,100	63,100	0	63,100	2%	7%
Chilko	118,700	900,300	125,700	1,144,700	17,800	1,162,600	41%	10%
Quesnel	5,500	102,500	49,000	156,900	400	157,400	6%	4%
Late Stuart/Stellako	28,000	498,100	17,100	543,200	200	543,400	19%	5%
Harrison/Widgeon	600	56,300	0	56,900	30	57,000	2%	1%
Late-run	**25,100**	**163,500**	**439,900**	**628,400**	**1,800**	**630,200**	**22%**	**4%**
Birkenhead/BigSilver	5,400	49,900	74,900	130,200	40	130,200	5%	4%
Late Shuswap/Portage	3,700	32,800	69,000	105,500	1,700	107,200	4%	4%
Weaver/Cultus	15,900	80,800 *2*	296,000	392,700	70	392,800	14%	4%
Total	**192,000**	**1,884,500**	**720,400**	**2,796,800**	**21,400**	**2,818,100**	**100%**	**7%**
Portion of Total Run	7%	67%	26%	99%	1%	100%		
Fraser Pink Salmon								
Total	**280,100**	**7,828,100**	**0**	**8,108,200**	**0**	**8,108,200**	**100%**	**3%**
Portion of Total Run	3%	97%	-	100%		100%		

1 ESSR catches are included in the total Weaver and pink salmon total.

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 132 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.

DFO annually assesses the spawning ground abundance of sockeye populations in the Fraser watershed (Figure 11). In 2021, the near-final estimate of adult spawners (primarily age-4 and age-5 fish) totalled 1,884,500 fish, or 67% of the total run. This escapement was just over double the brood year (2017) escapement of 940,100 adults.

Spawner abundances for all management groups were greater than those observed in the brood year (2017, Figure 12). By management group, spawning escapements in 2021 were 3.5 times higher than the brood year but only 28% of the cycle average escapement. For Early Summer run, the spawning escapement was 31% greater than the brood year escapement and slightly greater than the cycle average escapement. For Summer run and Late run, the spawning escapement was double the brood year escapement and very similar to the cycle average escapement.

The overall spawning success of adult female sockeye in the Fraser watershed was 99%. The effective female spawning population in 2021 totalled 1,046,494 fish, which was double the number of effective females in 2017. The DBE[21] was 720,400 fish, or 26% of the total return. As a percentage of run size for each management group, Late run had the largest DBE at 70%, while the DBEs for Early Stuart, Early Summer and Summer run ranged from 12 to 21% (Tables 8 and 9).

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).

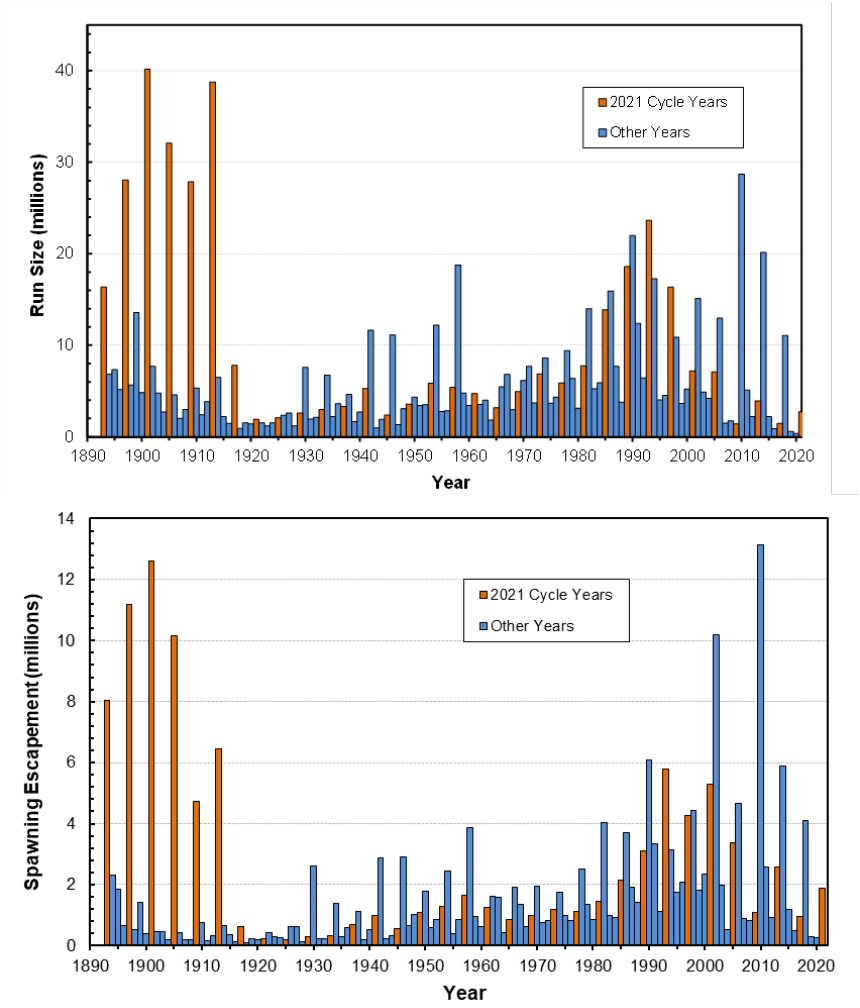

Figure 9. Total run size and spawning escapement of Fraser River sockeye salmon from 1893-2021. Returns on the 2021 cycle are emphasized.

[21] 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.

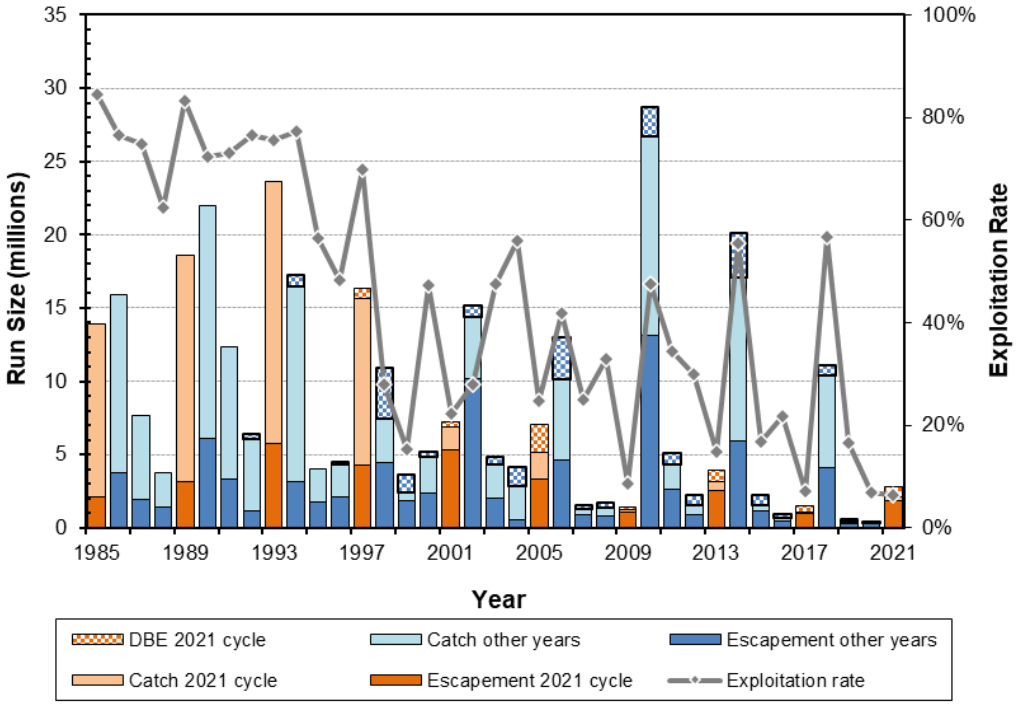

Figure 10. Total catch, escapement, difference between estimates, run size and exploitation rate for Fraser River sockeye salmon in 1985-2021, with returns on the 2021 cycle emphasized.

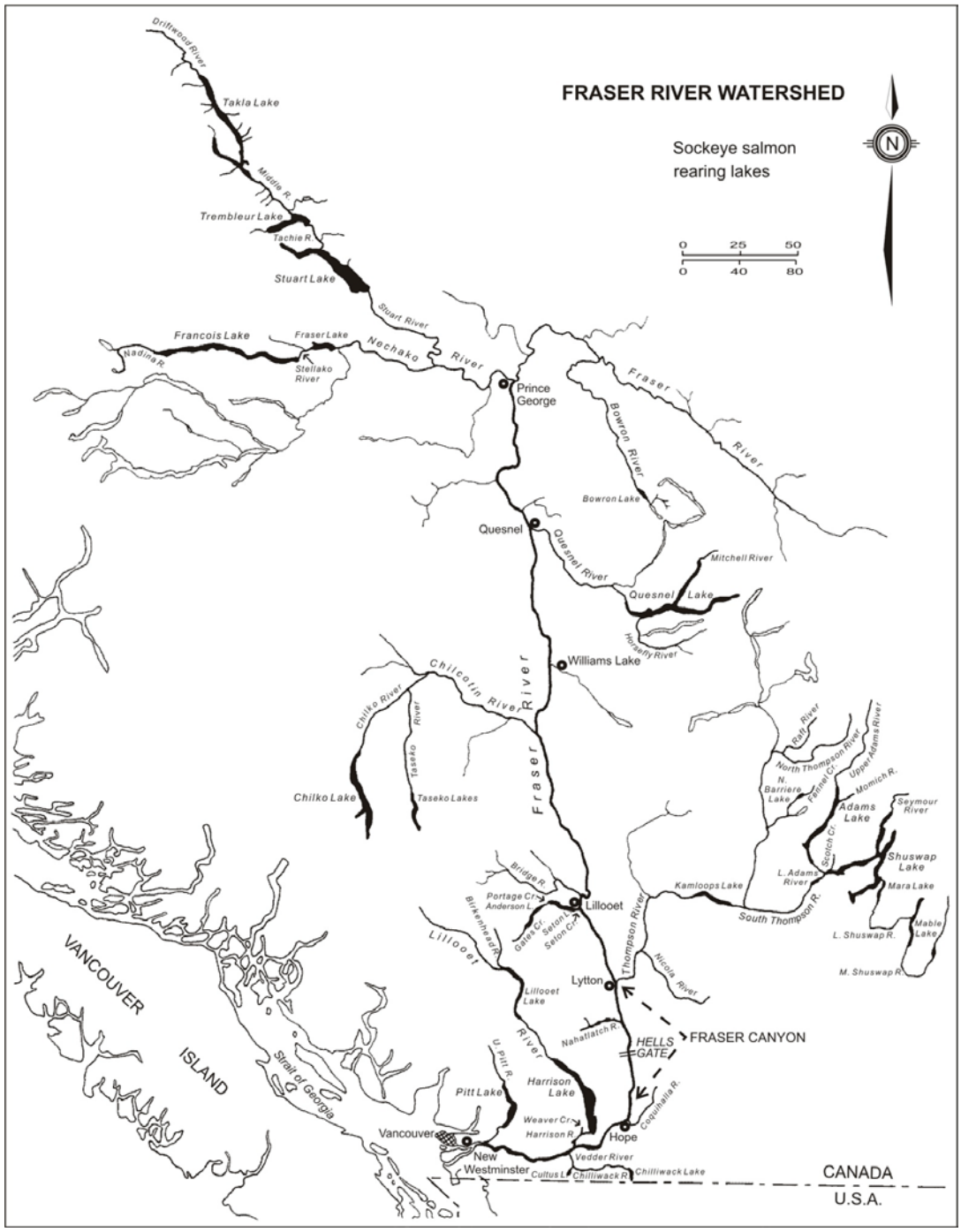

Figure 11. Sockeye salmon spawning areas in the Fraser River watershed.

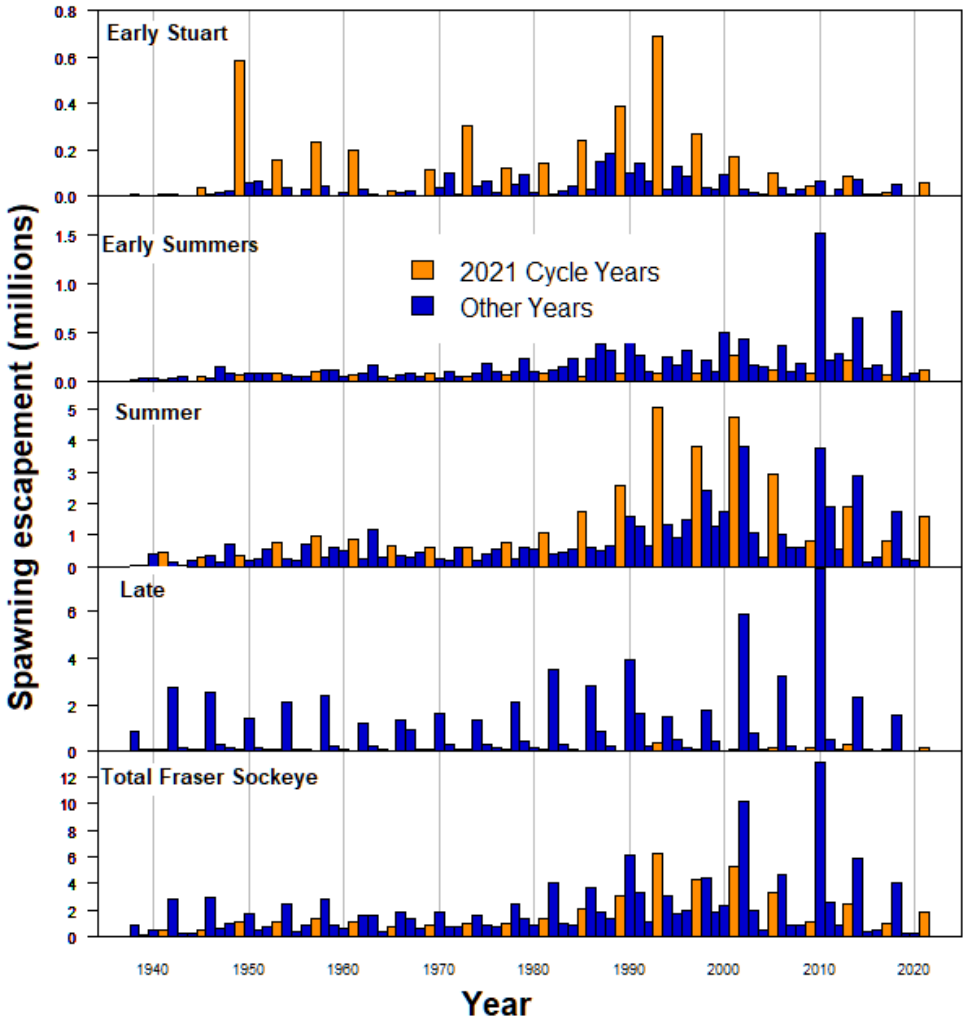

Figure 12. Annual adult spawning escapement of Fraser River sockeye salmon for each management group and for total sockeye in 1938-2021, with escapements on the 2021 cycle emphasized.

B. Pink Salmon

The in-season run-size estimate of 8,108,200 fish was greater than the median pre-season forecast of 3,009,000 fish (Table 1). The in-season estimate was made up of a Mission hydroacoustic passage estimate of 7,861,700 and a catch below Mission estimate of 246,500.

The 2021 return was similar to the return in the brood year (Figure 13), but less than the historical average return. Returns of Fraser pink salmon (Figure 13) have been highly variable over the years, as 2017 was the lowest return since 1965 (3,549,000), while 2003 was one of the highest returns (26,000,000) since records began in 1959.

The exploitation rate of Fraser River pink salmon in 2021 was 3%, similar to the low exploitation rates (5-10%) observed in 1999-2007, 2015, 2017 and 2019, 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 Fraser pink salmon. These low harvest levels have resulted in substantial spawning escapements of Fraser pinks in recent years. In 2021, although the sockeye run size was better than forecast it was still low enough that in combination with the uncertainty regarding the pink salmon run size it resulted in constraints on pink-directed fisheries in both countries. Overall, the pink salmon return in 2021 was the fourth smallest since 1999.

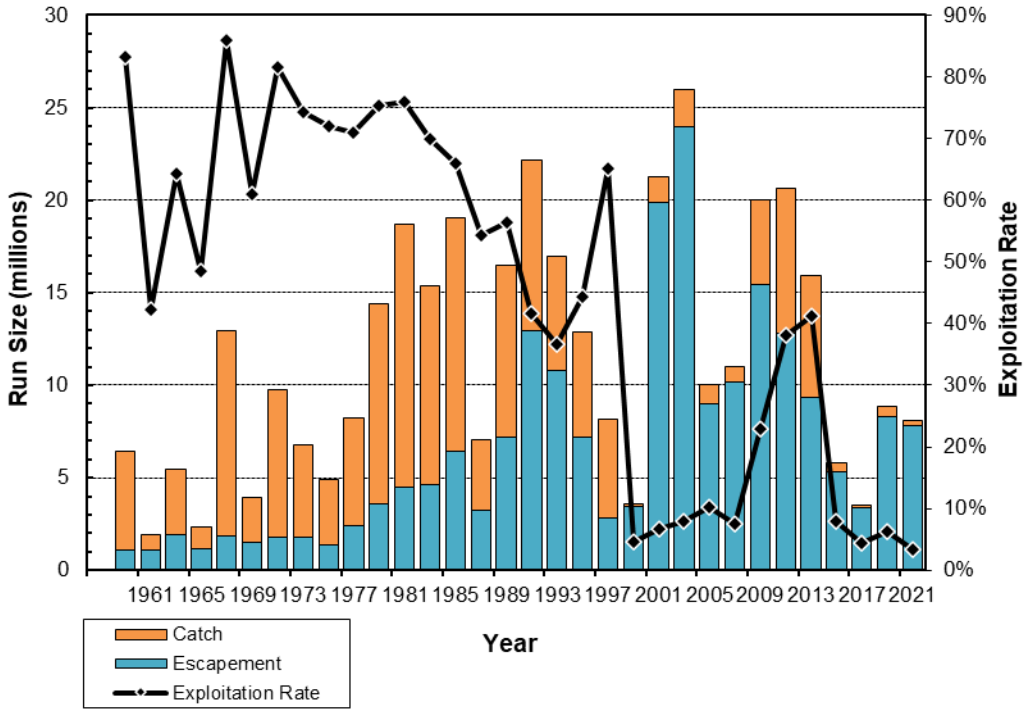

Figure 13. Annual spawning escapement, catch, and exploitation rate for Fraser River pink salmon, 1959-2021.

Table 10. Canadian commercial catches of Fraser River pink salmon by gear type, license designation and statistical area in 2021. 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**	**17,300**	**0**	**0**	**0**	**0**	**100**	**0**	**17,400**
Panel Areas	**0**	**17,300**	**0**	**0**	**0**	**0**	**0**	**0**	**17,300**
20		0			0		0		0
17, 18, 29		17,300			0			0	17,300
121-124 *		0		0			0		0
Non-Panel Areas	**0**	**0**	**0**	**0**	**0**	**0**	**100**	**0**	**100**
1-10	0		0			0			0
11-16		0		0	0		0	0	0
124-127 *		0		0			100		100
First Nations Economic Opportunity and Demo Fisheries									**16,100**
Total Catch									**33,500**

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

Of the total Fraser River pink salmon catch, 79,800 were caught in Canada, 196,000 in the U.S. and 4,300 in test fisheries (Table 8). The Canadian commercial catch was 17,400 (Table 10), the First Nations catch was 26,600, the non-commercial catch was 35,700 and the Charter catch was 300. The U.S. catch included a commercial catch of 192,000, of which 90,000 were caught in Treaty Tribes fisheries and 102,000 were caught in All Citizen fisheries (Table 11). There was a small catch of 3,900 pink salmon in a U.S. Treaty Tribes Ceremonial and Subsistence fishery.

Table 11. U.S. commercial catches of Fraser River pink salmon by user group, gear type and statistical area in 2021.

Areas	Purse Seine	Gillnet	Reefnet	Total
Panel Area (Washington)	**162,000**	**1,000**	**29,000**	**192,000**
Treaty Tribal *	**90,000**	**0**	**0**	**90,000**
4B, 5 and 6C	0	0	0	0
6 and 7	50,000	0	0	50,000
7A	40,000	0	0	40,000
All Citizen **	**72,000**	**0**	**29,000**	**102,000**
7	51,000	0	29,000	80,000
7A	22,000	0	0	22,000
Non-Panel Area				**0**
United States Total				**192,000**

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

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

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).

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 2021, the run size estimates for all sockeye management groups were smaller than

the Lower Fishery Reference Points, so all management groups were to be managed using the low abundance exploitation rate (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 abundances 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 minus catch above Mission). Final in-season PSE estimates indicate the in-season PSE targets were almost reached for Early Stuart (1% under) and Early Summer (3% under). Potential spawning escapement targets were exceeded for Summer run (21% over) and Late run (57% over) (Table 12). Pre-season, all management groups were constrained by a LAER of 10%. In-season, run size abundances were greater than the pre-season forecast however all management groups were still constrained by a LAER for the majority of the season.

Table 12. Comparison of in-season targets and in-season estimates of potential spawning escapement (PSE) for adult Fraser River sockeye salmon in 2021.

	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	**2,553,000**	**1,740,000**	**316,600**	**1,961,500**	**2,458,000**	**496,500**	**25%**
Early Stuart	70,000	70,000	48,300	70,000	69,000	-1,000	-1%
Early Summer	120,000	120,000	46,800	120,000	117,000	-3,000	-3%
Summer	1,763,000	1,250,000	137,500	1,387,500	1,669,000	281,500	20%
Late	600,000	300,000	84,000	384,000	603,000	219,000	57%

* 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 14% above the target, while the estimated escapement of Fraser River pink salmon was 30% larger than its target (Table 13). The spawning escapement targets for Early Stuart and Early Summer run equalled their in-season run sizes and escapement targets were unattainable given the predicted en route losses. Terminal spawning ground escapement estimates were below target by 23%, 22% and 51% for Early Stuart, Early Summer, and Late run, respectively, but exceeded the target for Summer run by 41% (Table 13). The harvest of Fraser sockeye only contributed to a limited extent to this failure to meet spawning escapement targets for Early Stuart, Early Summer and Late run as the exploitation rate (which includes Alaska D104 catch) for these three management groups was less than the 10% LAER: Early Stuart (2%), Early Summer run (6%) and Late run (4%).

Although the low sockeye returns in 2021 were better than expected they were still well below the cycle line averages and reflect a continuing trend of declining productivity that is a growing concern[22]. 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

[22] 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.

Stuart, Quesnel, Portage, Weaver, Cultus) and two as threatened (Upper Barriere, Widgeon)[23]. Of these stocks, Early Stuart, Bowron, Taseko, Quesnel and Late Stuart all have spawning grounds above Big Bar.

Table 13. Comparison of post-season spawning escapement targets and escapement estimates for adult Fraser River sockeye salmon in 2021. 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	%
Sockeye salmon	**2,818,100**	**1,650,600**	**1,884,500**	**233,900**	**14%**
Early Stuart	69,800	69,800	53,900	-15,900	-23%
Early Summer	134,700	134,700	104,600	-30,100	-22%
Summer	1,983,400	1,109,500	1,562,500	453,000	41%
Late	630,200	336,600	163,500 *	-173,100	-51%
Pink salmon	**8,108,200**	**6,000,000**	**7,828,100**	**1,828,100**	**30%**

* Late-run escapement estimate includes 132 Cultus fish kept for broodstock.

For Fraser River pink salmon, the spawning escapement estimate was 30% above the target (Table 13) and the exploitation rate was 3% (Table 8). This was due to in-season challenges related to determining the run size for Fraser pink salmon and to the fact that access to pink salmon TAC had been restricted as all sockeye management groups were being managed with a LAER at the time of U.S. pink directed fishery openings.

B. International Allocation

The Panel's second priority is to achieve the international allocation goals 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 28). This agreement is reflected in the revised 2020 Chapter 4, Annex IV of the Pacific Salmon Treaty. The test fishing catch and Aboriginal Fisheries Exemption deductions used in this calculation are the post-season estimates, however.

Given the low run sizes in 2021, there was no international TAC for Fraser River sockeye in-season; however, the final adopted in-season run sizes on September 28 did realize a small TAC for Late run (Table 1 & 14). Due to the catch of 20 sockeye in Washington in pink salmon directed fisheries, the United States exceeded its sockeye share by 20 fish (Table 15), but by Panel agreement the payback of 20 fish was forgiven for the 2021 season. However, there was still carryover payback of 470 sockeye from the 2019 season that was still considered payback. Canada's catch of 77,900, which excludes ESSR catch, Fraser sockeye was largely from First Nations catch as well as 'other' catch, 31,900, which was associated with unauthorized directed retention or unauthorized bycatch retention in fisheries directed at other species. A detailed version of the TAC calculations by management group is presented in Appendix G, Table G5.

The TAC for Fraser pink salmon was 1,995,700 fish, with a U.S. share of 512,900 fish (25.7%) and Canadian allowable harvest of 1,482,800 fish (Table 14). Both the U.S. and Canada caught less than their allocation. Access to pink salmon TAC had been restricted due to all sockeye management

[23] 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.

groups being managed with a LAER at the time of U.S. and Canadian pink salmon directed fisheries and the fact that pink salmon run size was increased 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 2021. 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 28), 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		**2,553,000**		**8,000,000**	
Deductions		**2,474,600**		**6,004,300**	
In-season Spawning Escapement Target		1,740,000		6,000,000	
In-season Management Adjustment		316,600		n/a	
Aboriginal Fishery Exemption (AFE)		400,000		n/a	
Post-season Test Fishing Catch		18,000		4,300	
Total Allowable Catch	*1, 2*	**175,700**		**1,995,700**	
UNITED STATES					
Washington Total Share	*3*	**28,500**		**512,900**	
Washington Share of TAC	*1*	29,000	16.5%	512,900	25.7%
Payback		-470		0	
Washington Catch		**20**		**196,000**	
Deviation		**28,500**		**316,900**	
In-season Alaska Catch Estimate		0		0	
CANADA					
Canadian Share of TAC + U.S. Payback + AFE		**547,200**		**1,482,800**	
Canadian Catch (excluding ESSR & Other Catch)		**46,000**		**79,800**	
Other Catch	*4*	**31,900**			
Deviation (excluding ESSR)		**469,300**		**1,403,000**	

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 May include unauthorized directed retention or unauthorized bycatch retention in fisheries directed at other species

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 U.S., Treaty Tribes fishers caught more than their domestic share of the U.S. sockeye salmon TAC, 20 fish (Table 15). For Fraser River pink salmon, Treaty Tribes and All Citizen fishers caught less than their domestic share of the U.S. pink salmon TAC, 162,600 and 154,500 under, respectively (Table 16).

Table 15. Achievement of domestic catch goals in Washington for Fraser River sockeye salmon in 2021.

	Actual Catch		Share of TAC		
User Category	Fish	%	Fish	%	**Deviation**
Washington Total	**20**	**100.0%**	**28,495**	**100.0%**	**-28,500**
Treaty Tribal *	20	100.0%	19,295	67.7%	-19,300
All Citizen **	0	0.0%	9,200	32.3%	-9,200

* Treaty Tribal 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 2021.

	Actual Catch		Share of TAC		
User Category	Fish	%	Fish	%	**Deviation**
Washington Total	**195,900**	**100.0%**	**512,900**	**100.0%**	**-317,000**
Treaty Tribal *	93,900	47.9%	256,500	50.0%	-162,600
All Citizen **	102,000	52.1%	256,500	50.0%	-154,500

* Treaty Tribal catch includes commercial and ceremonial catches.

** All Citizen catch includes commercial and recreational catches.

In Canada, First Nations catch and 'other' sockeye catch (unauthorized directed retention or unauthorized bycatch retention in fisheries directed at other species) accounted for 45,400 and 31,900 fish, respectively. Commercial, First Nations FSC fisheries and recreational fisheries were directed towards Fraser pink salmon and together harvested 79,800 fish which was less than Canada's balance of the international TAC (Tables 8, 14). Marine and in-river recreational fisheries accounted for 21,700 and 13,700 in pink salmon catch, respectively. An additional 500 Fraser River sockeye and 300 Fraser River pink salmon were caught in domestic, Chinook and chum test fisheries.

D. Conservation of Other Stocks and Species

Non-target stocks and species are caught in Panel Area fisheries directed at Fraser River sockeye and pink salmon. The conservation needs and management requirements for these stocks and species caught incidentally in fisheries regulated by the Fraser Panel are taken into account through a variety of bilateral and domestic processes associated with the implementation of Chapter 4 (Fraser River sockeye and pink salmon) and other Chapters of Annex IV. A comprehensive summary of all the methods in which bycatch 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 bycatch 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 bycatch of non-Fraser sockeye salmon, but there was a bycatch of 50,180 non-Fraser pink salmon in commercial net fisheries regulated by the Fraser River Panel. Catches of other Fraser and non-Fraser salmon species included 2,590 Chinook, 5,080 coho, and 140 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 2021.

Area and Gear	Non-Fraser		Fraser and Non-Fraser			
	Sockeye	Pink	Chinook	Coho	Chum	Steelhead
United States *	**0**	**50,180**	**2,550**	**5,050**	**100**	**0**
Areas 4B, 5 and 6C Net	0	0	0	10	0	0
Areas 6, 7 and 7A Net	0	50,180	2,550	5,040	100	0
Canada **	**0**	**2,070**	**40**	**30**	**40**	**0**
Area 20 Net	0	0	0	0	0	0
Area 29 Net	0	2,070	40	30	40	0
Total	**0**	**52,240**	**2,590**	**5,080**	**140**	**0**

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

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

VII. ALLOCATION STATUS

Annex IV, Chapter 4, (paragraph 8 (c)(iv)) specifies that *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.* The resulting calculations indicate there was an overage for Fraser River sockeye in 2021 (Table 18). The Panel agreed post-season that the 20 sockeye landed in Panel regulated fisheries directed at Fraser River pink salmon in 2021 would not be carried over as payback to 2022. However, the payback associated with pink directed fisheries in 2019 which caught 470 sockeye was still considered payback and would be carried over to the 2022 season. The 20 sockeye caught in the Treaty Tribes fishery were not sold but retained by U.S. Tribes for ceremonial and subsistence purposes. The resulting calculations also indicate there was no payback due for Fraser River pink salmon in 2021 (Table 18).

Table 18. Allocation status for Fraser River sockeye and pink salmon in 2017-2021.

	2017 (Oct 7)	2018 (Aug 23)	2019 (Sep 13)	2020 (Sep 1)	2021 (Sep 28)
TOTAL ALLOWABLE CATCH					
Total Run Size	1,487,000	14,022,000	500,000	293,000	2,553,000
Escapement and other deductions	1,487,000	7,822,400	500,000	293,000	2,377,260
Total Allowable Catch:	0	6,199,600	0	0	175,740
UNITED STATES					
Washington Catch	1,500	993,500	470	0	20
Washington Share (excld s payback)	0	1,020,300	0	0	29,000
Deviation:	1,500	-26,800	470	0	-28,980
Cumulative Allocation Status:	**2400****	**0****	**470****	**470****	**470****
CANADA					
Catch	71,900	4,731,500	9,860	11,360	77,920
Share + Aboriginal Exemption	71,700	5,251,000	9,710	11,290	546,740
Deviation:	200	-519,500	150	70	-468,820

	2,017 (Aug 31)	2,019 (Sep 13)	2,021 (Sep 28)
TOTAL ALLOWABLE CATCH			
Total Run Size	4,800,000	8,900,000	8,000,000
Escapement and other deductions	4,388,100	6,017,240	6,004,320
Total Allowable Catch:	411,900	2,882,760	1,995,680
UNITED STATES			
Washington Catch	102,200	233,290	195,970
Washington Share	105,900	740,870	512,890
Deviation:	-3,700	-507,580	-316,920
Cumulative Allocation Status:	0	0	0
CANADA			
Catch	37,200	300,260	79,780
Share	306,000	2,141,890	1,482,790
Deviation:	-268,800	-1,841,630	-1,403,010

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

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: Shall not exceed 16.5% for Fraser sockeye and 25.7% for Fraser pinks. As there was no TAC for sockeye salmon, any sockeye caught in pink-directed fisheries generated an overage

2020: No payback was generated in 2020, but by Panel agreement 470 sockeye were carried forward from the 2019 season

2021: No payback was generated in 2021, but by Panel agreement 470 sockeye were carried forward from the 2019 season

VIII. APPENDICES

APPENDIX A: GLOSSARY OF TERMS AND ABBREVIATIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

Low Abundance Exploitation Rate (LAER): The purpose of managing a sockeye management group in a LAER situation is to permit bycatch 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 bycatch 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: 2021 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 2021. (Provided to the Panel by Fisheries and Oceans Canada).

Run timing group / Stocks	Forecast Model	Probability that Return will be at/or Below Specified Run Size				
		10%	25%	50%	75%	90%
Early Stuart	*Ricker (Pi)*	8,000	12,000	18,000	30,000	47,000
Early Summer Total		33,000	59,000	108,000	207,000	375,000
Total excluding misc. stocks		26,000	46,000	83,000	158,000	280,000
Bowron	*Ricker (Pi)*	100	200	400	700	1,000
Upper Barriere (Fennell)	*Ricker (Pi)4/Sibling5*	300	500	1,000	3,000	5,000
Gates	*RS8yr*	2,000	4,000	9,000	19,000	39,000
Nadina	*PowerJuvFrD-peak4 /Sibling5*	6,000	10,000	19,000	37,000	68,000
Pitt	*Ricker(Ei)4 /Sibling5*	14,000	23,000	40,000	69,000	108,000
Scotch	*Ricker(Pi)4 /Sibling5*	1,000	3,000	6,000	13,000	28,000
Seymour	*Ricker(Ei)*	3,000	5,000	8,000	16,000	31,000
Misc (EShu)	*R/S*	1,000	3,000	6,000	11,000	19,000
Misc (Taseko)	*R/S*	30	60	100	200	300
Misc (Chilliwack)	*Power4/Sibling5*	4,000	6,000	10,000	21,000	44,000
Misc (Nahatlatch)	*R/S*	2,000	4,000	8,000	17,000	32,000
Summer Total		232,000	474,000	1,046,000	2,225,000	4,502,000
Total excluding misc. stocks		228,000	464,000	1,024,000	2,181,000	4,412,000
Chilko	*RS8yr*	71,000	142,000	311,000	677,000	1,366,000
Late Stuart	*Power (Pi)*	62,000	128,000	285,000	600,000	1,241,000
Quesnel	*Ricker(Ei)*	69,000	147,000	331,000	708,000	1,425,000
Stellako	*Larkin4/Sibling5*	21,000	35,000	68,000	128,000	229,000
Harrison	*Ricker(Ei)Odd3/Sibling4*	3,000	8,000	21,000	52,000	120,000
Raft	*Ricker(Pi)4/Sibling5*	2,000	4,000	8,000	16,000	31,000
Misc (N. Thomp.	*R/S*	800	2,000	4,000	9,000	18,000
Misc (N. Thomp	*R/S*	3,000	8,000	17,000	34,000	70,000
Misc (Widgeon)	*R/S*	90	300	700	1,000	2,000
Late Total		40,000	79,000	159,000	313,000	572,000
Total excluding misc. stocks		37,000	67,000	134,000	267,000	492,000
Cultus	*PowerJuv (Pi)4/Sibling5*	200	500	900	2,000	4,000
Late Shuswap	*Ricker(Ei)*	8,000	16,000	35,000	78,000	149,000
Portage	*RS8yr*	400	800	2,000	4,000	9,000
Weaver	*RS8yr*	23,000	40,000	74,000	136,000	235,000
Birkenhead	*RS8yr*	5,000	10,000	22,000	47,000	95,000
Misc Harrison/Lillooet	*R/S*	3,000	12,000	25,000	46,000	80,000
TOTAL SOCKEYE SALMON		313,000	624,000	1,330,000	2,775,000	5,496,000
Total Sockeye excluding misc. stocks		299,000	589,000	1,259,000	2,636,000	5,231,000
TOTAL PINK SALMON	*Ricker(FrD-peak _MayPi_JulSepSSS)*	1,701,000	2,229,000	3,009,000	4,051,000	5,375,000

Table B2. Spawning escapement plan for Fraser River sockeye and pink salmon in 2021. (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
	lower ref. pt. (w misc)	108,000	108,000	108,000	108,000	108,000
	upper ref. pt. (w misc)	216,000	216,000	216,000	216,000	216,000
Early Stuart	forecast	8,000	12,000	18,000	30,000	47,000
	TAM Rule (%)	0%	0%	0%	0%	0%
	Escapement Target	8,000	12,000	18,000	30,000	47,000
	MA	5,500	8,300	12,400	20,700	32,400
	Esc. Target + MA	13,500	20,300	30,400	50,700	79,400
	LAER	10%	10%	10%	10%	10%
	Available ER at Return	0%	0%	0%	0%	0%
	Allowable ER	10%	10%	10%	10%	10%
	Allowable Harvest	800	1,200	1,800	3,000	4,700
	2021 Performance					
	Projected S (after MA)	4,200	6,400	9,600	15,900	25,000
	BY Spawners	15,433	15,433	15,433	15,433	15,433
	Proj. S as % BY S	27%	41%	62%	103%	162%
	cycle avg S	204,064	204,064	204,064	204,064	204,064
	Proj. S as % cycle S	2%	3%	5%	8%	12%

Management Unit		Pre-season Forecast Return				
		p10	p25	p50	p75	p90
Early Summer (w/o RNT)	*lower ref. pt. (w misc)*	126,600	128,600	128,900	131,200	134,000
	upper ref. pt. (w misc)	253,300	257,200	257,800	262,400	268,100
	forecast (incl. misc)	33,430	58,760	107,500	206,900	375,300
	TAM Rule (%)	0%	0%	0%	37%	50%
	Escapement Target	33,430	58,760	107,500	131,200	187,650
	MA	12,400	21,700	41,900	53,800	80,700
	Esc. Target + MA	45,830	80,460	149,400	185,000	268,350
	LAER	10%	10%	10%	10%	10%
	Available ER at Return	0%	0%	0%	11%	28%
	Allowable ER	10%	10%	10%	11%	28%
	Allowable Harvest	3,300	5,900	10,800	21,900	107,000
	2021 Performance					
	Projected S (after MA)	22,000	38,300	69,700	131,900	188,900
	BY Spawners	68,477	68,477	68,477	68,477	68,477
	Proj. S as % BY S	32%	56%	102%	193%	276%
	cycle avg S	94,107	94,107	94,107	94,107	94,107
	Proj. S as % cycle S	23%	41%	74%	140%	201%

Table B2, continued on next page

Table B2, continued.

Management Unit		Pre-season Forecast Return				
		p10	p25	p50	p75	p90
Summer	*lower ref. pt. (w misc)*	1,250,000	1,250,000	**1,250,000**	1,250,000	1,250,000
(w. RNT & Har)	*upper ref. pt. (w misc)*	2,500,000	2,500,000	**2,500,000**	2,500,000	2,500,000
	forecast	231,890	474,300	**1,045,700**	2,225,000	4,502,000
	TAM Rule (%)	0%	0%	0%	44%	50%
	Escapement Target	231,890	474,300	**1,045,700**	1,250,000	2,251,000
	MA	20,900	42,700	**94,100**	112,500	225,100
	Esc. Target + MA	252,790	517,000	**1,139,800**	1,362,500	2,476,100
	LAER	10%	10%	**10%**	10%	10%
	Available ER at Return	0%	0%	0%	39%	45%
	Allowable ER	10%	10%	**10%**	39%	45%
	Allowable Harvest	23,189	47,430	**104,570**	862,500	2,025,900
	2021 Performance					
	Projected S (after MA)	191,400	391,200	**861,900**	1,247,000	2,264,600
	BY Spawners	788,761	788,761	**788,761**	788,761	788,761
	Proj. S as % BY S	24%	50%	**109%**	158%	287%
	cycle avg S	1,611,409	1,611,409	**1,611,409**	1,611,409	1,611,409
	Proj. S as % cycle S	12%	24%	**53%**	77%	141%

Management Unit		Pre-season Forecast Return				
		p10	p25	p50	p75	p90
Late	*lower ref. pt. (w misc)*	300,000	300,000	**300,000**	300,000	300,000
(w/o Har)	*upper ref. pt. (w misc)*	600,000	600,000	**600,000**	600,000	600,000
	forecast	39,600	79,300	**158,900**	313,000	572,000
	TAM Rule (%)	0%	0%	0%	4%	48%
	Escapement Target	39,600	79,300	**158,900**	300,000	300,000
	MA	42,800	79,300	**152,500**	288,000	288,000
	Esc. Target + MA	82,400	158,600	**311,400**	588,000	588,000
	LAER	10%	10%	**10%**	10%	10%
	Available ER at Return	0%	0%	0%	0%	0%
	Allowable ER	10%	10%	**10%**	10%	10%
	Allowable Harvest	3,960	7,930	**15,890**	31,300	57,200
	2021 Performance					
	Projected S (after MA)	17,100	35,900	**72,800**	143,400	263,500
	BY Spawners	83,120	83,120	**83,120**	83,120	83,120
	Proj. S as % BY S	21%	43%	**88%**	173%	317%
	cycle avg S	184,910	184,910	**184,910**	184,910	184,910
	Proj. S as % cycle S	9%	19%	**39%**	78%	143%
Allowable Harvest (TF, US, CDN)		31,249	62,460	**133,060**	918,700	2,194,800
Total projected spawners		234,700	471,800	**1,014,000**	1,538,200	2,742,000

2021 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%

	Pre-season Forecast Return				
	p10	p25	**p50**	p75	p90
forecast	1,701,000	2,229,000	**3,009,000**	4,051,000	5,375,000
escapement target	1,640,000	2,123,000	**2,817,000**	3,702,000	4,761,000
allowable ER	4%	5%	**6%**	9%	11%
Available Harvest (TF, US, CDN)	61,000	106,000	**192,000**	349,000	614,000

APPENDIX C: 2021 FRASER RIVER PANEL MANAGEMENT PLAN PRINCIPLES AND CONSTRAINTS (agreed July 9, 2021)

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 very 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 1,330,000 fish, and there is a one in four chance that the actual number of returning sockeye will be at or below 624,000 fish and there is a one in four chance that the actual number of returning sockeye will be at or larger than 2,775,000 fish. The median forecasts for the four different management groups are 18,000 Early Stuart, 108,000 Early Summer-run, 1,046,000 Summer-run, and 159,000 Late-run sockeye. Of note, Chilko, Late Stuart and Quesnel sockeye represent 70% of the total Fraser sockeye return and 88% of the Summer-run return at the median forecast. The median forecast for Fraser River pink salmon is 3,009,000 fish, and there is a one in four chance that the actual number of returning pink salmon will be below 2,229,000, and a one in four chance that the return will be larger than 4,051,000. 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 adopt updated run size estimates of Fraser River sockeye and pink salmon, as appropriate.

2. The Panel's first priority is to attain sockeye spawning escapement goals by management group and the pink escapement objective. A coordinated approach to management has been developed that reflects both Parties sharing the burden of conservation. At the median forecast, no directed harvest of sockeye is planned. 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 2021 correspond to the range of forecasts provided (p10 to p90).

3. TAC and international shares are calculated according to the 2020 revised Annex IV, Chapter 4, of the Pacific Salmon Treaty, which limits the United States harvest (in Washington State) to 16.5% of the international TAC of Fraser River sockeye salmon and 25.7% of the international TAC of Fraser River pink salmon. For 2021, 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 each management group. 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 a large 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 0.96. If in-season information suggests the upstream timing of Late-run, excluding Birkenhead-Big Silver, is later than September 8 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 harvestable surpluses of other co-migrating Fraser River sockeye management groups and Fraser River pink salmon.

Regulations

i) If in-season conditions are consistent with pre-season expectations, low impact fisheries directed at pink salmon would be expected to commence in late-August 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 2021 management season.

APPENDIX D: 2021 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 18, 2021.

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 27th day of June 2021, to the 18th day of September 2021, 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 27th day of June 2021, to the 18th day of September 2021, 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 27th day of June 2021 to the 2nd day of October 2021, 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 27th day of June 2021, to the 2nd day of October 2021, 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 27th day of June 2021, to the 9th day of October 2021, both dates inclusive.

   b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 29 from the 27th day of June 2021, to the 9th day of October 2021, both dates inclusive.

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

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

   b) Pacific Fishery Management Area 19, Area 20-2 and 5 to 7 and Area 29-8.

   c) Commercial troll fishing in Pacific Fishery Management Area 17, Area 18-2, 3 and 5 to 10.

   d) The Fraser River and the tributary streams and lakes above the train bridge at Mission.

During the 2021 season, the Fraser River Panel will adopt orders establishing open fishing periods based on a 2021 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 27th day of June 2021 to the 18th day of September 2021, 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 27th day of June 2021, to the 2nd day of October 2021, 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 3rd day of October 2021, to the 9th day of October 2021, 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 27th day of June 2021, to the 18th day of September 2021, 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 27th day of June 2021, to the 2nd day of October 2021, 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 3rd day of October 2021, to the 9th day of October 2021, 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 2021 season, the Fraser River Panel will adopt orders establishing open fishing periods based on a 2021 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: 2021 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, 2021

United States

Tribal Indian

Areas 4B, 5 and 6C

Open to drift gillnets from 12:00 p.m. (noon), Saturday, August 21, 2021 through 12:00 p.m. (noon) Wednesday, August 25, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

All Citizen

Areas 7 and 7A

Open to reef net fishing, with non-retention of sockeye, 5:00 a.m. to 9:00 p.m., Monday, August 23, 2021.

August 24, 2021

United States

Tribal Indian

Areas 4B, 5 and 6C

Extend for drift gillnets from 12:00 p.m. (noon), Wednesday, August 25, 2021 through 12:00 p.m. (noon) Saturday, August 28, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

All Citizen

Areas 7 and 7A, excluding the Apex

Open to purse seine fishing, with non-retention of sockeye, from 5 a.m. to 9 p.m., Friday, August 27, 2021.

Areas 7 and 7A, excluding the Apex

Open to drift gillnet fishing, with non-retention of sockeye, from 8 a.m. to 11:59 p.m., Friday, August 27, 2021.

August 27, 2021

United States

Tribal Indian Fishery

Areas 4B, 5 and 6C

Extend for drift gillnets from 12:00 p.m. (noon), Saturday, August 28, 2021 to 12:00 p.m. (noon) Wednesday, September 1, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

Areas 6, 7 and 7A, excluding the Apex

Open for net fishing, from 5:00 a.m., Sunday, August 29, 2021 to 9:00 a.m., Monday, August 30, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

All Citizen

Areas 7 and 7A, excluding the Apex

Open to purse seine fishing, with non-retention of sockeye, from 5:00 a.m. to 9:00 p.m., Tuesday, August 31, 2021.

Areas 7 and 7A, excluding the Apex

Open to drift gillnet fishing, with non-retention of sockeye, from 8:00 a.m. to 11:59 p.m., Tuesday, August 31, 2021.

Area 7

Open to reef net fishing, with non-retention of sockeye, from 5 a.m. to 9 p.m. Tuesday, August 31, 2021.

August 30, 2021

United States

Tribal Indian Fishery

Areas 4B, 5, 6C

Extend for drift gillnets from 12:00 p.m. (noon), Wednesday, September 1, 2021 to 12:00 p.m. (noon) Saturday, September 4, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

Areas 6, 7 and 7A, excluding the Apex

Open for net fishing from 5:00 a.m., Tuesday, August 31, 2021 through 9:00 a.m. Thursday, September 2, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

All Citizen

Areas 7 and 7A, excluding the Apex

Open to purse seine fishing, with non-retention of sockeye, from 5:00 a.m. to 9:00 p.m., Tuesday, August 31, 2021 and from 5:00 a.m., to 9:00 p.m., Wednesday, September 1, 2021.

Areas 7 and 7A, excluding the Apex

Open to drift gillnet fishing, with non-retention of sockeye, from 8:00 a.m. to 11:59 p.m., Tuesday, August 31, 2021, and from 8:00 a.m. to 11:59 p.m., Wednesday, September 1, 2021.

Area 7

Open to reef net fishing, with non-retention of sockeye, from 5 a.m. to 9 p.m. Tuesday, August 31, 2021, and from 5 a.m. to 9 p.m., Wednesday, September 1, 2021.

September 3, 2021

United States

Tribal Indian Fishery

Areas 4B, 5, and 6C

Extend for drift gillnet fishing from 12:00 p.m. Saturday, September 4, 2021, through 12:00 p.m. Tuesday, September 7, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

Areas 6, 7 and 7A, excluding the Apex

Open for net fishing from 5:00 a.m. Saturday, September 4, 2021, through 9:00 a.m. Tuesday, September 7, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

September 7, 2021

United States

Tribal Indian Fishery

Areas 4B, 5, and 6C

Open for drift gillnet fishing from 12:00 p.m. Wednesday, September 8, 2021, through 12:00 p.m. Friday, September 10, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

Areas 6, 7 and 7A, excluding the Apex

Open for net fishing from 5:00 a.m. Wednesday, September 8, 2021, through 9:00 a.m. Friday, September 10, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

September 10, 2021

Canada

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

Open for Area B purse seine Assessment fishery from 7:00 a.m. to 8:00 p.m. daily from Sunday, September 12, 2021 until Tuesday, September 14, 2021. Limited to 2 vessels operating at any given time, mandatory observers, non-retention of Sockeye. (Please refer to DFO Fishery Notice for further details).

Areas 29-3, 29-4 and 29-10

Open for Area B purse seine Assessment fishery from 7:00 a.m. to 8:00 p.m., Tuesday, September 14, 2021. Limited to 2 vessels operating at any given time, mandatory observers, non-retention of Sockeye. (Please refer to DFO Fishery Notice for further details).

United States

Tribal Indian

Areas 4B, 5, and 6C

Open for drift gillnet fishing from 12 p.m. (noon), Saturday, September 11, 2021, through 12 p.m. (noon), Monday September 13, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

Areas 6, 7 and 7A, excluding the Apex

Open for net fishing from 5 a.m., Saturday, September 11, 2021, through 9 a.m., Monday, September 13, 2021. Sockeye non-retention, all efforts must be made to release sockeye alive.

All Citizen

Area 7

Open to reef net fishing, with non-retention of sockeye, from 5 a.m. to 9 p.m. Saturday, September 11, 2021 and 5 a.m. to 9 p.m., Sunday, September 12, 2021.

September 13, 2021

Canada

Areas 29-3 and 29-4

Open to Area B purse seine ITQ from 7:00 a.m. to 8:00 p.m Wednesday, September 15, 2021. Mandatory observers, non-retention of sockeye. (Please refer to DFO Fishery Notice for further details)

Areas 29-6, 29-7, 29- 9 and 29-10

Open to Area B purse seine ITQ from 7:00 a.m. to 8:00 p.m. daily from Wednesday, September 15, 2021, to Saturday, September 18, 2021. Mandatory observers, non-retention of sockeye. (Please refer to DFO Fishery Notice for further details)

Areas 29-3, 29-4 and 29-6

Open to Area H troll ITQ from 7:00 a.m. Wednesday, September 15, 2021 to 11:59 p.m. Saturday, September 18, 2021. Non-retention of sockeye. (Please refer to DFO Fishery Notice for further details)

United States

All Citizen

Area 7

Open to reef net fishing, with non-retention of sockeye, from 5 a.m. to 9 p.m. Tuesday, September 14, 2021, 5 a.m. to 9 p.m. Wednesday, September 15, 2021, 5 a.m. to 9 p.m. Thursday, September 16, 2021 and 5 a.m. to 9 p.m., Friday, September 17, 2021.

September 17, 2021

Canada

Areas 29-6, 29-7, 29- 9 and 29-10

Area B purse seine ITQ fishery closing as scheduled at 8:00 p.m. Saturday, September 18, 2021.

Areas 29-3, 29-4 and 29-6

Extend for Area H troll ITQ from 11:59 p.m. Saturday, September 18, 2021 to 11:59 p.m. Wednesday, September 22, 2021. Non-retention of sockeye. (Please refer to DFO Fishery Notice for further details)

United States

Areas 4B, 5, and 6C

Relinquish regulatory control effective 23:59 p.m., Saturday, September 18, 2021, as previously scheduled.

Areas 6, 6A, and 7

Relinquish regulatory control effective 11:59 p.m., Saturday, September 18, 2021.

September 21, 2021

Canada

Areas 29-3, 29-4 and 29-6

Area H troll ITQ fishery closing as scheduled at 11:59 p.m., Wednesday, September 22, 2021.

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 18; Areas 17 and 18 on October 2; and Area 29 on October 9. Panel control of United States Panel Areas were relinquished as follows; Areas 4B, 5, 6, 6C on September 18 as per pre-season regulations, Areas 6, 6A and 7 on September 18 by in-season order, Area 7A (excluding Apex) as per pre-season regulations on October 2 and 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 October 9, 2021, as per 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 River sockeye and pink salmon, including catch-per-unit-effort (CPUE) to estimate abundance and biological samples used to estimate stock and species composition. Table 4 in the main body of the report summarizes the locations and operational timing of Panel-approved test fisheries. Table F1 provides more detailed information about the gear used and sampling methods employed.

Table F 1. Sampling details for Panel-approved test fisheries conducted in 2021.

			2021						
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		6	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 primarily obtained from the test fisheries in Area 20 (Juan de Fuca Strait) and Area 12 (upper Johnstone Strait), but may be augmented by test fisheries in Area 13 (lower Johnstone Strait), U.S. Area 5 (Juan de Fuca Strait), and U.S. Area 7 (San Juan Islands). Test fisheries in Area 29 (Lower Fraser River) are used to assess in-river species and stock composition for application to Mission passage estimates. When the Mission hydroacoustics program is not in operation, test fisheries in Area 29 provide passage estimates for sockeye salmon using CPUE models. The Qualark (Fraser River canyon) gillnet test fishery provides information on salmon species and stock composition for the Qualark hydroacoustics program.

In 2021, the Fraser River Panel aimed to minimize the financial costs of Panel-approved test fisheries as well as the impacts on successful escapement of sockeye salmon to spawning grounds within the Fraser River watershed. The Area 4B, 5 gillnet, Area 29 gulf troll, Area 12 (Naka Creek) gillnet, and Area 13 purse seine test fisheries were not scheduled for this year. The Area 7 reefnet observation test fishery operated for only three days prior to U.S. pink salmon commercial fisheries. The Area 12 and Area 20 gillnet test fisheries did not begin until July 9 and July 11, respectively. These dates were after most of the Early Stuart sockeye were expected to have migrated through the test fishing area. The number of Area 20 gillnet test fishing vessels remained at two per night, with both vessels fishing contemporaneously for safety purposes. Due to the low expected return for Fraser River sockeye, a reduced number of fishing days were scheduled for the Area 12 and Area 20 purse seines compared to the previous cycle line. Both purse seine test fisheries were delayed by two days and then extended an additional four days in-season. The Cottonwood gillnet test fishery in Area 29 began as scheduled on August 12 and was extended by four days in-season. The Whonnock gillnet test fishery in Area 29 ended three days later than scheduled on October 3, while delaying sockeye continued to enter the river. The entire cost of the Qualark gillnet test fishery was paid for through the use of the bilateral Test Fishing Revolving Fund. To improve worker safety at Hells Gate, counters were scheduled to work together at all times resulting in counts being performed five days per week, Sunday through to Thursday. Due to reduced transmission of Covid-19 and increased rates of vaccination in British Columbia, observers were permitted to board vessels in Area 20.

Early in the season, daily catches of sockeye in Area 12 and Area 20 gillnets were consistent with brood year catches but lower than the cycle-year average. As the season progressed, catches in the marine gillnets remained low and did not increase to the extent that they had in the brood year. Daily catches of sockeye in the Area 20 purse seine were high compared to the brood year and comparable to the cycle-year average due to strong southern diversion through Juan de Fuca Strait. Catches in the Area 12 purse seine were relatively similar to the brood year and low compared to the cycle-year average. Catches at Cottonwood, Whonnock and Qualark were all higher than the brood year but low compared to the cycle-year average throughout the entire season.

Due to higher than expected run sizes of both Fraser River sockeye and pink salmon, the number of salmon retained in all Panel-approved test fisheries was greater than expected pre-season. Only sockeye that could not be released alive or those required for scientific samples were retained in the test fisheries and fish sales were unable to offset program costs. The 2021 program deficit of $591,100 was paid for by the Test Fishing Revolving Fund. The 2021 season was the third 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[24]. The experimental program ran for 20 days and was fully-funded by the SEF. The experimental program will continue in 2022. This was also the first year of a four-year SEF project to evaluate a transition from the Cottonwood test fishing location to a new location at Brownsville Bar[25]. The project aims to increase stock identification sample sizes while continuing to provide representative estimates of the true stock composition migrating into the lower Fraser River.

B. Mission Hydroacoustics

Every summer, Pacific Salmon Commission staff operate a hydroacoustics monitoring facility upstream of the Mission Railway Bridge, approximately 80 km 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.

[24] Labelle, M. and P. Van Will. 2022. Comparison of the sockeye catch composition and catch rates of two test-fishing gill nets used at Round Island in 2021: a final project report to the Southern Boundary Restoration and Enhancement Fund. Pacific Salmon Commission. March 2022..

[25] Nowak, B., M. Baltzell, L. Jantz, and A. Fisher. 2022. Lower Fraser River gillnet test fishery site evaluation: a final project report to the Southern Boundary Restoration and Enhancement Fund. Pacific Salmon Commission. March 2022.

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[26,27]. For 2021, the 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). As part of a Southern Endowment and Enhancement Fund (SEF) project, an ARIS was operated as a secondary sonar on the vessel. The sonar systems operate 24 hours a day to collect information on the density, direction of travel, speed, and size distributions of fish targets.

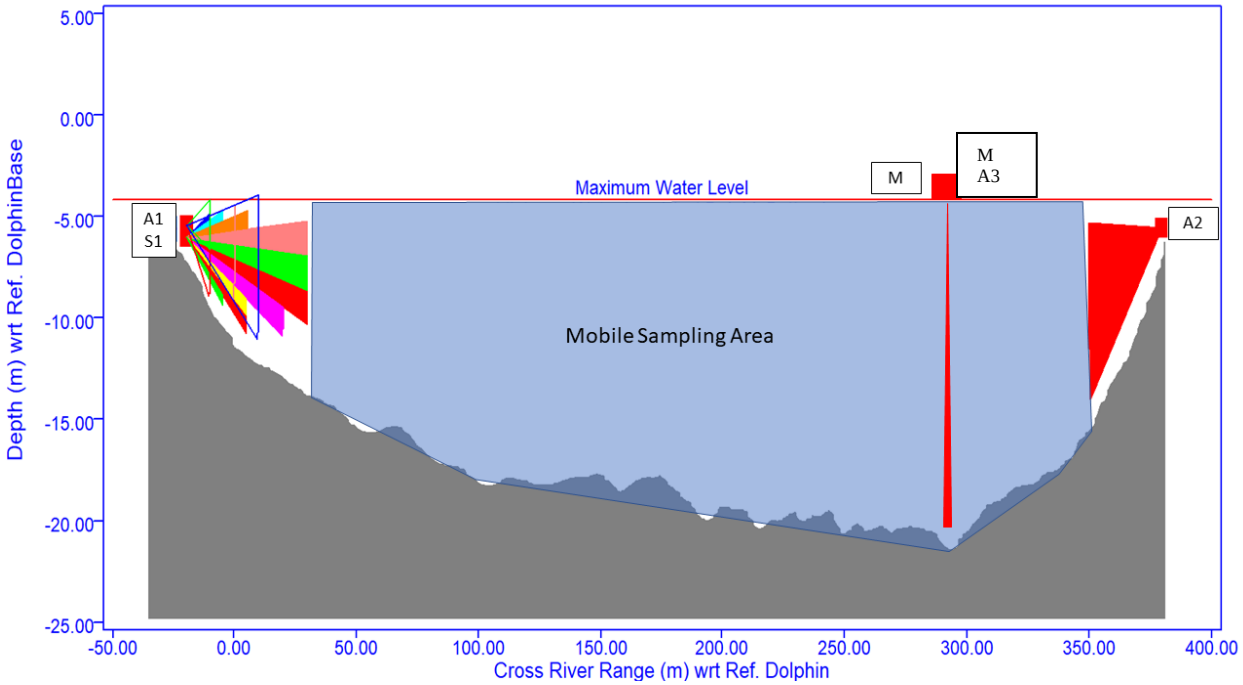

Figure F 1. Cross-river view of the sampling geometry of the sonar systems operated at the Mission hydroacoustics site. The four systems shown are the left bank split-beam (S1), the left bank ARIS (A1), the mobile split-beam (M), the mobile ARIS (A3), and the right bank ARIS (A2). The beam geometries of A1 are represented by hollow triangles and overlap with the S1 beam geometries, which are represented by filled coloured triangles. The blue-filled offshore area represents the cross-river region sampled by the mobile split-beam and A3. The beam coverage of A2 is represented by the red-filled triangle and the gray-filled area represents the river bottom. Note that the cross-river range scale on the x-axis is compressed relative to the vertical depth scale on the y-axis.

The left bank split-beam (S1) consists of a side-looking transducer with an elliptical beamwidth of 2°x10° manufactured by Hydroacoustic 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 50m. On August 10th, 2021, the ten-aim sampling design was adjusted higher in the water column to accommodate the transition to surface-oriented pink salmon passage. The aim and orientation of the

[26] 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.
[27] Xie, Y., F.J. Martens, C.G. Michielsens, J.D. Cave. 2013. Implementation of Stationary Hydroacoustic Sampling Systems to Estimate Salmon Passage in the Lower Fraser River: A final project report to the southern boundary restoration and enhancement fund. Pacific Salmon Commission, Vancouver, British Columbia. May, 2013.

transducer 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. Due to high water, the S1 system was not deployed until July 13 and operated until October 3, 2021.

A 14° ARIS system (A1), manufactured by Soundmetrics Corporation, 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 up to a range of 30 metres. The ARIS was deployed and collected data from July 3 to October 3 and was used for official estimates of salmon passage within the nearshore area (up to 30m range) between July 3 and July 14, and from August 2 to October 3. For the first period, the ARIS was used, as high water prevented the deployment of the S1 system, and for the second period the ARIS was used due to the high density of pink salmon that could not be accurately tracked by the split-beam system.

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 165 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[28]. The mobile split-beam was included in official estimates from July 3 to October 2. Beginning on August 5, an ARIS system (A3) was operated on the vessel to assess the use of imaging sonar in identifying fish targets and swimming direction and to quantify fish lengths and swim speed on a mobile platform[29]. This information was experimental and not included in the official estimation of salmon escapement at Mission.

The right bank area was also sampled by a 14° ARIS system (A2). During the early part of the season, A2 could not be permanently deployed due to high water; therefore, between July 6 and July 17, A2 was deployed in 3-hour intervals at mid-day on alternating days from an anchored vessel. The A2 daily passage was extrapolated using the daily A1 passage as a benchmark. This was implemented by calculating the ratio of A2/A1 during the 3-hour A2 monitoring period. The ratio was then applied to the concurrent A1 daily passage to estimate the A2 passage over the entire 24-hour period. On days where no sampling occurred on the right bank, the A2 passage was calculated by applying the most recent A2/A1 ratio to A1 passage from the current day. On July 18, A2 was deployed permanently at the end of a telescopic fish weir and commenced full-time data collection. A2 was used for official estimates from July 6 to October 3.

The data collected by the shore-based ARIS systems (A1 and A2) was visually 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 sampled up to a range of 30 meters. 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 estimate of upstream salmon passage, fork length measurements were taken on a subset of fish from the ARIS imagery. A normally distributed length-based model was then applied to determine the proportion of adult

[28] 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.

[29] Bartel-Sawatzky, M. and R. Hornsby. 2022. Improved estimation of offshore fish passage at Mission by replacing split-beam system with imaging sonar: a final project report to the Southern Boundary Restoration and Enhancement Fund. Pacific Salmon Commission. March 2022.

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[30] and then classified as either fish or noise (e.g., debris, air bubbles) by a discriminate function analysis[31]. 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[32]. The left-bank 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 up to 30 meters range. Over the entire monitoring period from July 4 to October 3, the ARIS and split beam left bank systems saw a combined 85% of total salmon passage, the right bank ARIS observed 11% of passage, and the offshore system observed 3% of passage.

In 2021 there were four Food, Social, Ceremonial (FSC) fisheries openings at the Mission Hydroacoustic site, occurring on August 8,14, 21 and 28. The mobile vessel was docked during fisheries openings, as outlined in the Memorandum of Understanding (MOU) between the PSC, DFO, and Sumas First Nation. Fisheries openings are known to affect salmon passage behaviour and work funded by the SEF is ongoing to investigate methods for calculating alternative estimates during fisheries openings[33]. No changes to methods for calculating the official estimate were implemented for the 2021 season.

Species Composition

Lower river escapement estimates are apportioned among Pacific salmon species using information from multiple sources, including: species proportions or catch-per-unit effort (CPUE) from the Whonnock and Albion gillnet test fisheries, modelled forecasts of daily Chinook salmon abundance, length-based model estimates using ARIS fork length frequency distributions[34], or species proportions from fish wheel data. For species such as pink salmon, which concentrate in near shore areas, a stratified approach is applied using a combination of methods. When available, comparisons are also made to other upriver assessment programs. The primary goal is to produce in-

[30] Blackman, S.S. and R. Popoli. Design and Analysis of Modern Tracking Systems. Artech House, Boston, 1999.
[31] 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.
[32] 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.
[33] Bzonek, P. and R. Hornsby. 2022. SEF Report – Mission Data Imputation During Fishery Openings. Pacific Salmon Commission. March 2022.
[34] 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.

season estimates of sockeye and pink salmon daily abundances that best reflect their true daily abundances.

When sockeye salmon are the dominant species and the Mission hydroacoustic program is operational, sockeye abundance is primarily estimated by subtracting estimates of Chinook and pink salmon from the total hydroacoustic estimate. In 2021, this was the case from July 3 till August 23. During this period, Chinook salmon abundance was estimated using either Albion gillnet CPUE data or a stratified method combining Whonnock species composition for offshore estimates and the length-based model for nearshore estimates. Pink salmon abundance during this period was estimated using either Whonnock CPUE data (August 13 to 16) or a stratified method combining Whonnock pink salmon proportions for offshore estimates and Matsqui fish wheel data for near shore estimates (August 17 to 23).

During periods when the Mission hydroacoustic site is not operational and/or pink salmon are the dominant species, sockeye abundance is primarily estimated using Whonnock test fishery CPUE data, and pink salmon are estimated by subtracting sockeye and other salmon species (Chinook, chum, coho) from the total hydroacoustic estimate. This method relies on an historical time-varying expansion line for sockeye salmon. In 2021, sockeye abundance was estimated using Whonnock CPUE data from August 24 – September 21. After September 21 the historical expansion line overestimated abundance (sockeye estimates exceeded total Mission hydroacoustic estimates), and Whonnock species composition estimates were used to estimate sockeye abundance for the remainder of the season.

Stock Identification

PSC staff conduct sampling programs designed to identify stock proportions of Fraser River sockeye and pink salmon in commercial, test fishery, 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 2021 used DNA and scale pattern analyses from fish caught in marine and in-river fisheries. Pink salmon stock identification for 2021 relied on DNA analyses of marine test fisheries and commercial catches. During the in-season period, a method is required to estimate stock compositions for catches that have not been analyzed and prior to planned fisheries. For sockeye salmon, stock proportions were based on extrapolations of multinomial trends in DNA estimates available from 2021 samples. For pink salmon, projections were made using a Bayesian approach that relied on data from previous years and 2021 DNA data.

A. Sockeye Salmon

Stock identification methods for sockeye salmon relied on DNA[35] (using the program CBAYES[36]) and scale pattern analyses[37]. Both techniques involve comparing the attributes of

[35] 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.

[36] 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).

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

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. In addition to these standard collections, a sample from near Haida Gwaii was collected by the Haida Fisheries Program from a Food, Social, and Ceremonial purse seine catch, and several samples were collected in the Fraser River near Lillooet and Big Bar as part of the Big Bar landslide response program. Some samples from "other" fisheries were also provided by DFO.

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. Age compositions in test fishing catches were dominated by age-4 sockeye, as expected following the poor recruitment of age-4 sockeye observed in 2020 (that is, there were few recruits from the 2016 brood year available to return at age-5). Detections of age-3 Fraser River sockeye in test fisheries were infrequent in 2021. On this cycle, CPUE of "jacks" in marine purse seines was higher in every year for which comparable data were available (see Figure F 2). The few jack samples that were collected in marine areas were rarely from Shuswap stocks (contrary to expectations, only six out of 26 Fraser sockeye jack samples with both age and DNA indicated source populations that rear in Shuswap Lake). Unless some as-yet unknown factor reduced the "jacking rate" from the 2018 brood year, this would be a negative signal regarding the return strength of Early Summer and Late-run stocks in 2022.

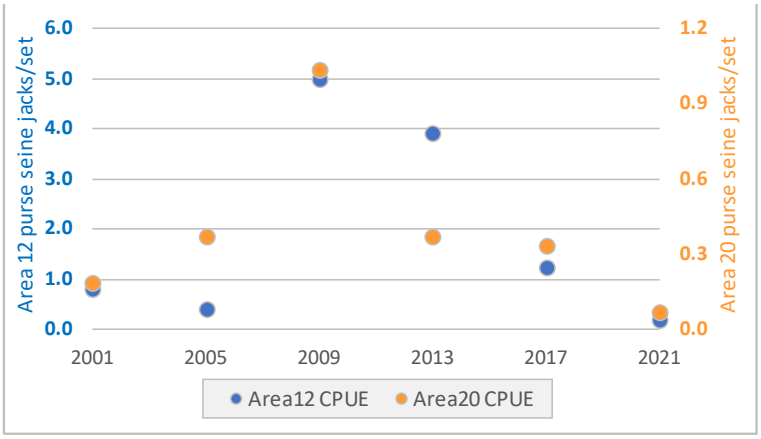

Figure F 2. Frequency of age 3_2 sockeye caught in Area 12 and Area 20 purse seine test fisheries on the 2021 cycle from 2001-2021. Results are averages for statistical weeks 31-36, for which samples were available in each year including 2021.

Table F1 summarizes age compositions of caught sockeye (excluding District 104) compared to the pre-season forecast. In 2021, the forecast for Early Stuart, Summer-run and Late-run sockeye predicted predominantly age-4 sockeye close to 90%. A much lower age-4 proportion of 58% was predicted for the Early Summer run. In-season age-4 proportions were somewhat higher than forecast for Early Stuart, Summer-run and Late-run groups. In-season age-4 proportions were observed to be considerably higher than forecast for most stocks within the Early Summer-run group, with the exception of Chilliwack. Of note, the in-season age-4 proportion for Birkenhead (91%) was substantially higher than was forecast (59%).

Sockeye stock/timing group	2021 Fraser Sockeye Forecasts			2021 In-season	
	Median Age-4 Forecast	Total Median Forecast	% Age-4	Sample size	% Age -4
Early Stuart	**16,000**	**18,000**	**89%**	**174**	**99%**
Chilliwack	5,000	10,000	50%	12	25%
Pitt	11,000	40,000	28%	80	33%
Nadina	13,000	19,000	68%	38	82%
Bowron	300	400	75%	11	82%
Nahatlatch	7,000	8,000	88%	12	92%
Gates	6,000	9,000	67%	187	98%
Taseko	40	100	40%	9	100%
North Barriere	600	1,000	60%	5	80%
Early S. Thompson	19,640	20,000	99%	74	99%
Early Summer	**62,580**	**107,500**	**58%**	**428**	**82%**
Harrison	20,000	21,000	95%	63	94%
Widgeon	400	700	57%	0	NA
Late Stuart/Stellako	327,000	353,000	93%	1,403	98%
Chilko	285,000	311,000	92%	2,595	99%
Quesnel	330,800	331,000	100%	165	99%
Raft/North Thompson	21,500	29,000	74%	69	86%
Summer	**984,700**	**1,045,700**	**94%**	**4,295**	**98%**
Birkenhead	13,000	22,000	59%	217	91%
Misc. Lillooet-Harrison	19,000	25,000	76%	4	100%
Late Shuswap/Portage	37,000	37,000	100%	93	98%
Weaver	73900	74,000	100%	484	100%
Cultus	890	900	99%	1	100%
Late	**143,790**	**158,900**	**90%**	**799**	**97%**
Total	**1,207,000**	**1,330,000**	**91%**	**5,696**	**96%**

Table F 2: Summary of the 2021 forecast and in-season age composition estimates of sockeye sampled from fisheries. Scale-based ages of individuals with probabilities of origin greater than 50% (as determined by genetic stock identification) to a stock aggregate are included here.

Samples were obtained from three test fishing operations in the Fraser River downstream of Mission (Whonnock, Cottonwood, and Brownsville Bar), a test fishing operation at Qualark Creek, and a research and tagging operation near Lillooet and at Big Bar. The migration from Mission to Big Bar was modeled to evaluate the transition from earlier-timed to later-timed stocks at these locations. Figure F 2 compares the decline of Early Stuart and the rise of Summer-run proportions in 2021 to expectations based on travel times of three[38] days from Mission to Qualark and seven days from Qualark to Big Bar (one day was assumed for Lillooet to Big Bar). Migration speeds, as judged by this comparison, were similar to expectations in 2021. This contrasts with 2020, when an assumed travel time of eight days between Mission and Qualark had a much better correspondence in the shape of the stock composition curves than the normal assumption of three days, suggesting that the upstream migration of stocks was delayed. As in other years, these comparisons were complicated by stock proportion estimates tending to include higher proportions of smaller-bodied sockeye in samples from the Qualark test fishery than in samples from the other sources (not shown). Body size may be biased low in the Qualark test fishery owing to the practice of fishing gillnet meshes in order of increasing size but not allowing the area swept by the drift net to fully re-populate between each drift.

Sockeye catches in Alaska's District 104 fishery totaled 496,404. Analyses conducted for the PSC's Northern Panel by the US National Oceanic and Atmospheric Administration laboratory in Auke Bay, Alaska, indicated that 86,797 (17%) of these were of Fraser origin. This would comprise approximately 3% of the total Fraser sockeye run size. The highest proportions of Fraser sockeye were estimated during the weeks of August 15-21 (48%) and August 22-28 (41%) and August 29-September 4 (56%). These were also the weeks with the highest catches of Fraser sockeye there (27,000 and 27,000, and 15,000, respectively). Sockeye were also caught in Canadian waters near Haida Gwaii. A sample of a purse seine catch in Area 1 on August 9-11 comprised 93% Fraser sockeye, which was significantly higher than the estimate during the same week in District 104 (7%). In 2021, a higher proportion of the Fraser sockeye catch in District 104 occurred in statistical

[38] Travel time assumptions between Mission and Qualark may vary between 2 -3 days.

weeks 35 and 36 (the latter two weeks) compared to all other years with a substantial Fraser catch (>10,000) since 2005.

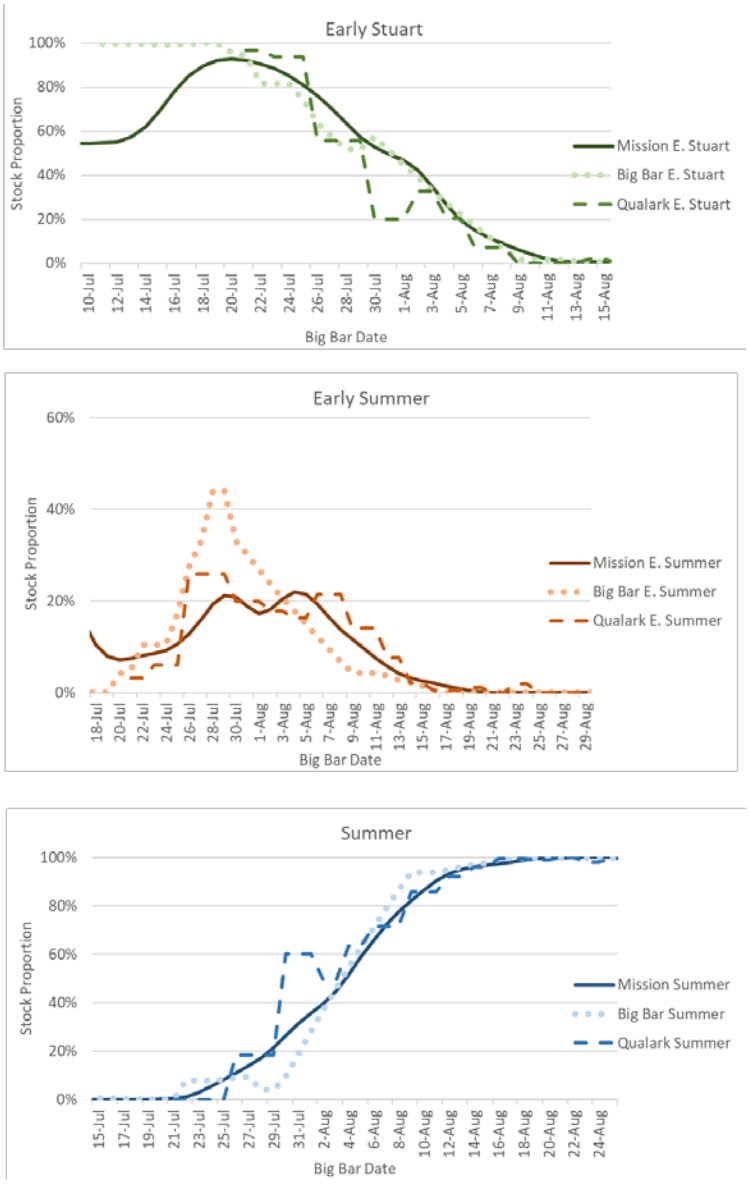

Figure F 3. Estimated stock proportions at Mission, Qualark, and Big Bar, aligned to "Big Bar date" by historical sockeye travel times among the locations (i.e., 3 days for Mission to Qualark, and 7 days for Qualark to Big Bar). The estimates for Early Stuart, Early Summer, and Summer-run management groups represent expectations only for those stocks that migrate upstream of each site (proportions for stocks that spawn in downstream locations were subtracted to allow the locations to be compared). Results suggest that travel times were shorter in 2021 than usually assumed. In particular, the increase and decrease of Early Summer-run stock proportions at Big Bar appear to occur earlier than expected, but otherwise stock compositions estimated at Big Bar were similar to projections based on modelled projections from Mission and Qualark.

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[39]. The composition of the pink salmon baseline was similar to other recent years. During the 2021 in-season management period, DNA samples from approximately 400 pink salmon were collected per week from marine test fisheries. The DNA analyses were conducted similarly to those in recent years, with genotype data from 16 microsatellite loci being compared to allelic frequencies in 46 baseline stocks[5] using the program ONCOR[40]. 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 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 to early September). 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 in each statistical area, and these estimates were applied to catches. This approach has served to provide estimates for catches on dates without samples and to ameliorate the high variability inherent in the ONCOR estimates of pink salmon stock composition for specific dates, improving stock composition predictions for fishery planning. In 2021, however, the late dates and limited number of samples available for especially Area 7A fisheries led to difficulties in applying this method.

Although catches of pink salmon had occurred in Area 7A in August, samples were only available for this area from catches that occurred in September. Therefore, for catch accounting purposes, no update of the pre-season expected stock composition was possible until well after most of the catch in Area 7A had occurred. The two samples from Area 7A yielded Fraser proportion estimates of 96% (September 1, 95% confidence interval: 66-95%) and 71% (Sep 8, 95% confidence interval: 49-84%). The model result for the September 1 estimate was deemed unreliable because the point estimate was outside of the confidence interval, so the pre-season expectation for Area 7A Fraser proportions was used instead, until a second sample from September 8 was available for calculating a weighted average. The pre-season expectation for Area 7A was deemed acceptable, in the interim, after examining likely proportions based on historical relationships with Area 7. Further exploration of the ability to inform stock proportions in one area based on samples from another will be conducted before 2023, improving stock proportion estimation for statistical areas that are poorly sampled due to late or low fishing effort.

For 2021, the highest in-season sample estimates of Fraser pink salmon proportions were 63% (August 27) and 76% (September 2) in Area 12 and Area 20, respectively. Fraser pink salmon proportions in Area 12 and Area 20 samples were low in 2021 compared to most years since 1989 (see Figure F 3). This could be due to relatively strong returns of non-Fraser stocks or relatively greater overlap in migration timing of Fraser and non-Fraser stocks in 2021.

[39] 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

[40] 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.

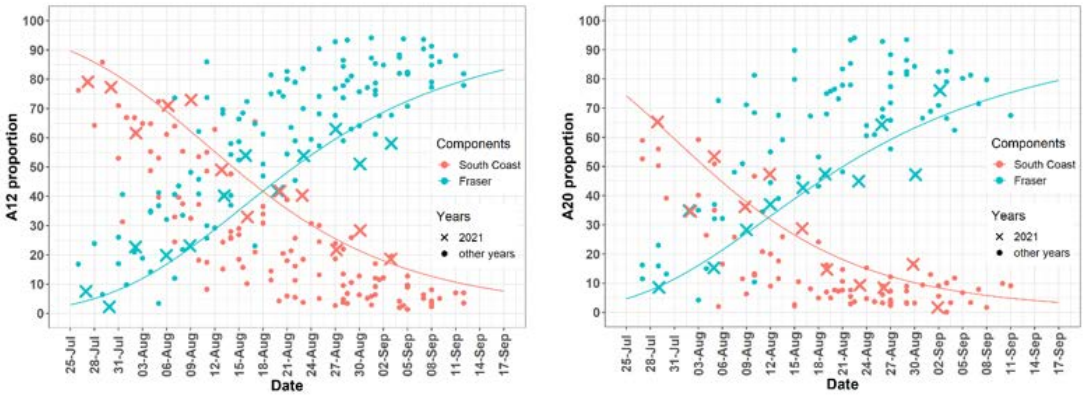

Figure F 4. Observed proportions of Canada South Coast and Fraser River pink salmon for Area 12 (left) and Area 20 (right). Data from 1989-2019 are shown for context, but the curves representing 2021 Bayesian model fits are informed by data from 2009-2021, which were generated by equivalent DNA methods.

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 is converted into daily abundances using catchability estimates derived from 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 progresses, the catchability coefficients are updated based on observed values for non-delaying stock groups by comparing Mission hydroacoustic passage estimates to CPUE-based abundances. The reconstructed marine abundances derived from in-river hydroacoustic, and marine test fishery data are analysed using Bayesian stock assessment models[41, 42,43]. 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 by doubling the abundance up to the observed 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). Prior to the peak of the run, run size and timing estimates are confounded and there is considerable uncertainty as to whether the run is earlier and smaller than forecast, or later and larger than forecast.

Bayesian methodology is used to quantify the uncertainty in run size and timing estimates[3]. A Bayesian cumulative normal model is informed by additional forecasted and historical information, including (1) pre-season forecasts of run size based on historic stock-recruit data, (2) pre-season forecasts of timing, (3) expected duration of the run, (4) average historical expansion line (inverse catchability) estimates, and (5) pre-season forecasts of diversion rate, 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 likely than others.

[41] 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.

[42] 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.

[43] 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.

Theoretically, the Bayesian version of the cumulative normal model should provide more stable estimates since it relies on both in-season observations as well as historical data. Retrospective analyses have confirmed that incorporating prior knowledge is especially informative prior to, and immediately after, the 50% migration date. Once more than 50% of the run has been observed at the Mission hydroacoustics site, 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 CPUE data for pink salmon is converted into daily abundance estimates using catchability coefficients 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 cannot be updated using in-season Mission information. As a result, pink run size and timing estimates from the Bayesian cumulative normal model are often highly uncertain. Therefore, a variety of alternative approaches were also used in 2021 to inform in-season pink salmon stock assessments. These methods included regressions of run size against (1) cumulative CPUE-to-date, (2) average short-range (3-7 days) CPUE prior to the peak of the run, and (3) cumulative Mission passage-to-date. In addition, estimates of seaward abundance based on historical observations were used to expand current observations into total run size estimates. Finally, daily abundances estimated from U.S. commercial CPUE in Areas 7 and 7a were also monitored and compared to estimates from test fishery data.

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 2021, pre-season forecasts underestimated the run size for all sockeye salmon management groups and underestimated the run size for pink salmon. Marine timing of the Early Stuart management group was identical to the pre-season forecast, but marine timing of Early Summer, Summer, and Late-run groups were 11-days, 9-days, and 7-days later than forecasted pre-season, respectively. In contrast, the marine timing of Fraser River pink salmon was 3-days earlier than expected pre-season.

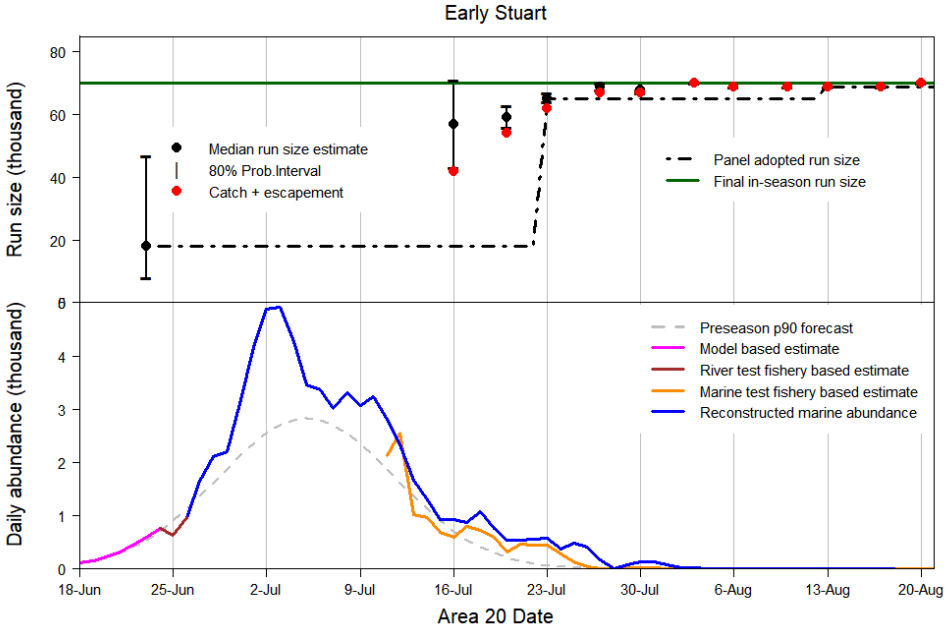

Figure F 4a: Daily reconstructed abundance estimates for Early Stuart and corresponding run size estimates at different times during the season.

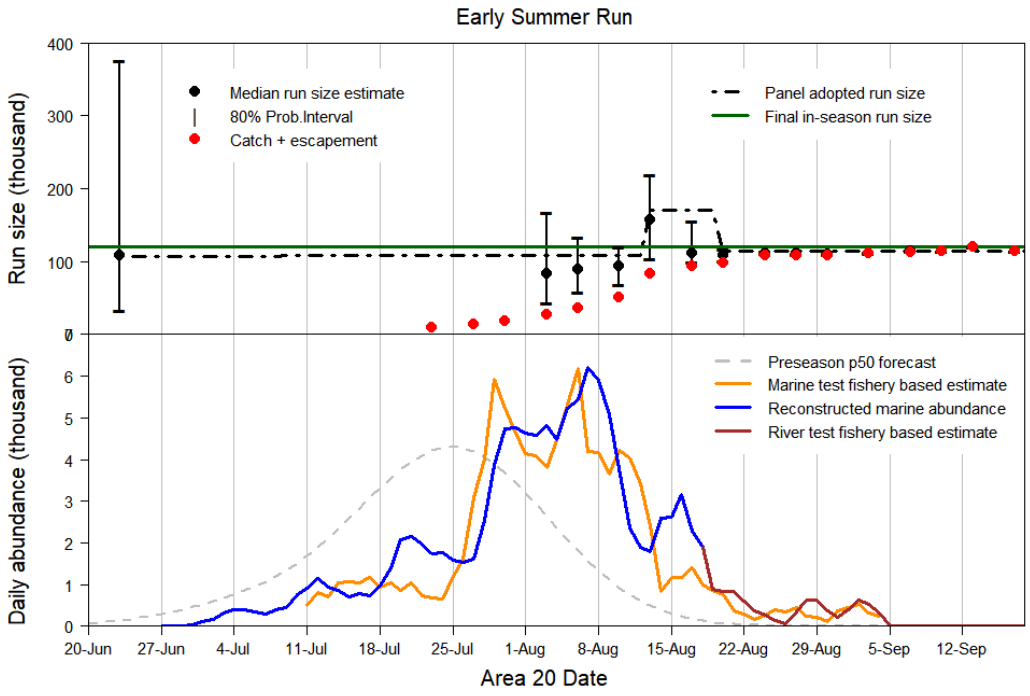

Figure F 4b: Daily reconstructed abundance estimates for Early Summer-run salmon and corresponding run size estimates at different times during the season.

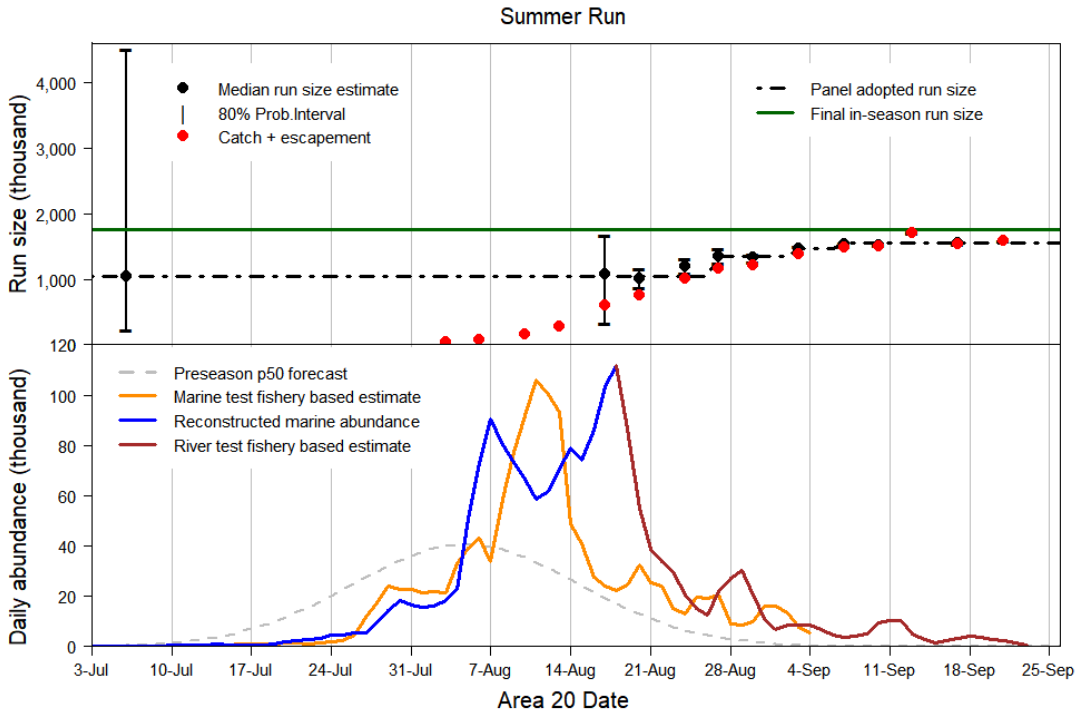

Figure F 4c: Daily reconstructed abundance estimates for Summer-run salmon and corresponding run size estimates at different times during the season.

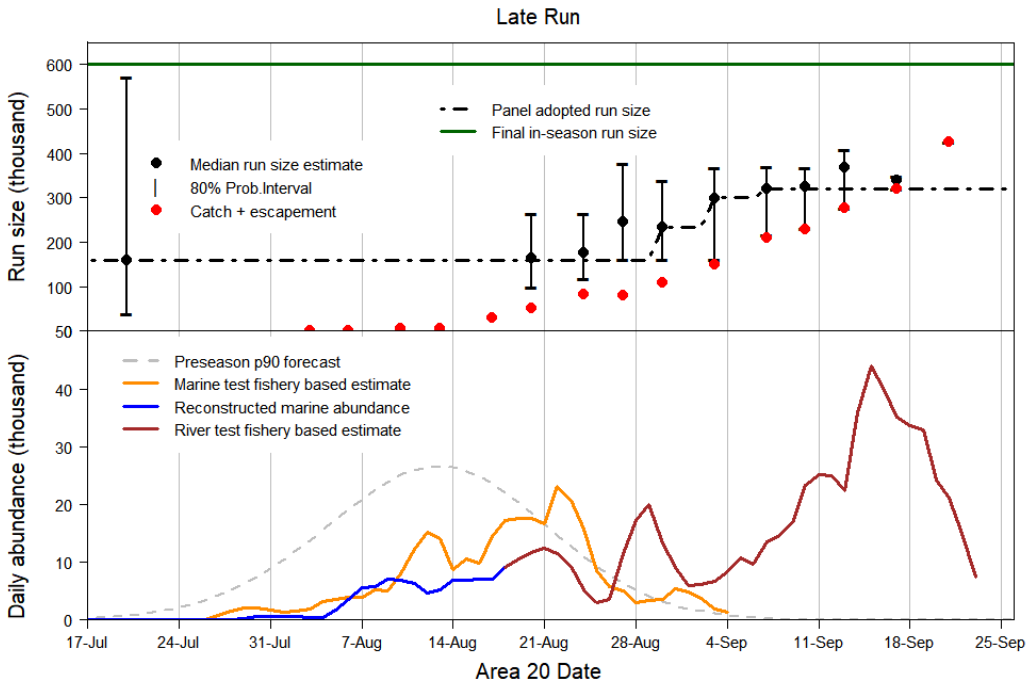

Figure F 4d: Daily reconstructed abundance estimates for Late-run salmon and corresponding run size estimates at different times during the season.

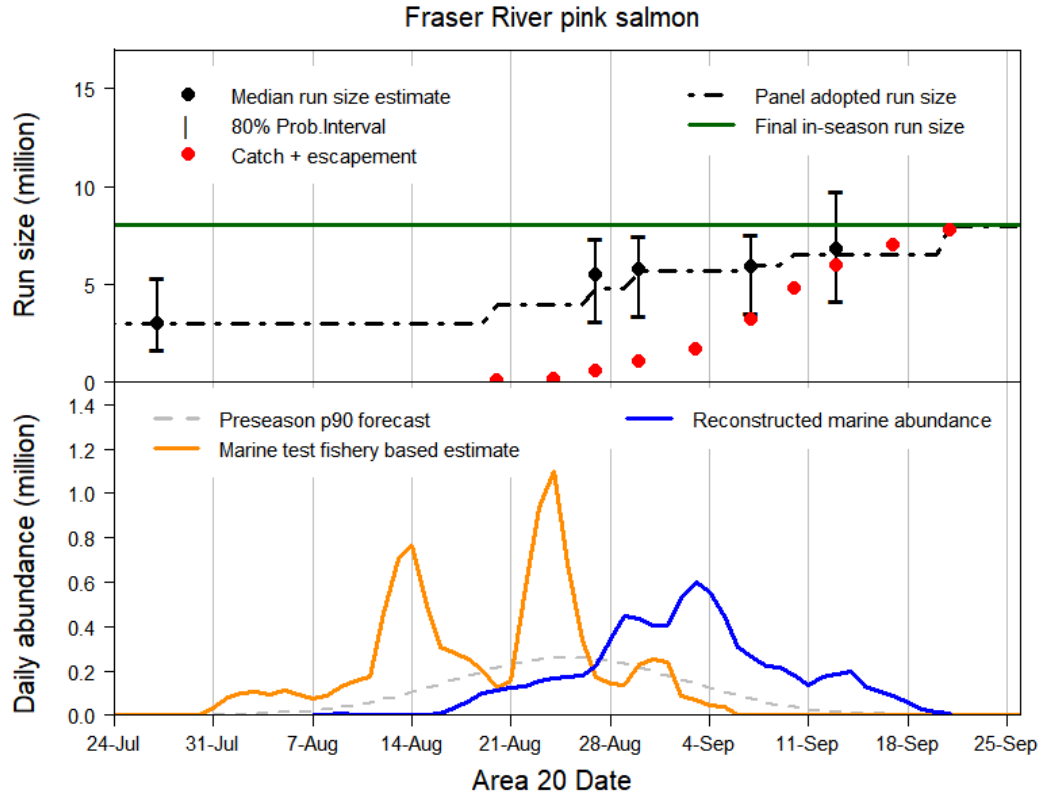

Figure F 4e: Daily reconstructed abundance estimates for pink salmon and corresponding run size estimates at different times during the season.

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. In early June, the EWatch program generated a long-range forecast of lower Fraser River summer temperature and flow conditions using relationships between winter snowpack accumulation, summer air temperatures and river environmental conditions. The long-range forecast was for average discharge and average to above average water temperature in the Fraser River. Staff used the environmental forecasts in Management Adjustment (MA) models developed jointly by DFO and the PSC to forecast the proportional difference between estimates (pDBEs) (see Table F3) to predict how many additional sockeye should be allowed to escape to increase the probability of achieving spawning escapement objectives (see references in the MA section of the Management Information chapter).

For pre-season planning purposes Management Adjustments (MAs) of 12,400 Early Stuart, 58,300 Early Summer, 167,400 Summer and 119,300 Late-run sockeye were added to the spawning escapement targets (SET). However, the SET was already the entire run size for all four management groups. At pre-season forecast of abundances all four management groups would be in a Low Abundance Exploitation Rate (LAER) situation. Since MAs would not impact fishery management decisions, MAs were adopted for pre-season planning purposes only.

In-season, predictions of proportional difference between estimates (pDBEs) derived from in-season environmental MA models for the Early Stuart, Early Summer and Summer run sockeye (Table F3) and from the run-timing MA model for the Late run (Table F3) were presented to the Panel. Early in the season, Fraser River discharge levels were high due to a second peak in freshet observed in early July (July 3, 8447 m^3/s); however, discharge levels then dropped and continued to drop to below average levels for the duration of the season. River temperature was above average until it peaked at 20.7°C on August 5 and 6. River temperature then began to drop with some small fluctuations from average for the time of year (Figure 8). The in-season Temperature and Discharge MA models for Early Stuart predicted higher (more negative) pDBEs (Table F3) than the pre-season MA models. This was mainly due to the higher than forecast temperature levels observed in-season. For Early Summer and Summer run the Temperature and Discharge MA models predicted lower %DBEs due to a combination of later timing, higher discharge levels and lower temperature than forecast pre-season (Table F3). For Late-run sockeye the final in-season Mission 50% Date based on Mission passage, was September 17 (Table F3). The later than predicted Mission timing for the Late run would greatly improve their likelihood of survival to the spawning ground. Given that Management Adjustments had no management implications for Early Stuart and Early Summer run, the Panel did not adopt an in-season management adjustment for these management groups. For the Summer run, the Panel adopted a final pMA of 0.11 that was based on the 31-day Temperature and Discharge MA Model estimate. For the Late run Aggregate, the Panel adopted a pMA of 0.27 that was based on the weighted pDBE of the run timing model estimate for the Late run excluding Birkenhead/Big Silver group and the median estimate for the Birkenhead/Big Silver group.

At Big Bar, high freshet in early July would have had an impact on successful migration of the early migrating sockeye past the slide; however, discharge levels dropped and continued to decrease below the 2020 sockeye 25% and 75% passage threshold. In 2021, successful migration past the slide was observed for all sockeye stocks that migrate past the slide.

Spawning ground estimates of Fraser sockeye abundance totalled 1,884,472 sockeye, which means a total %DBE of (-24%) was observed in 2021. Both the Summer-run and the Late-run sockeye (SET) of 1,250,000 and 300,000 sockeye respectively, was exceeded. However, the Early Stuart and Early Summer-run (SET), 70,000 and 120,000 sockeye respectively, was not quite achieved. The favorable escapement in 2021 was due to higher than forecasted returns and limited harvest opportunities.

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

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 (excld. Pitt and Chw.)[1]		Summer (excld. Harrison)[1]		Lates (excld. Birk.)[2]	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Pre-season 31-day MA Model Predictions[3]	-55%	1.22	-67%	2.03	-14%	0.16	NA	NA
In-season 19-day MA Model Predictions	-88%	7.33	-50%	1.00	-15%	0.18	NA	NA
In-season 31-day MA Model Predictions	-82%	4.56	-44%	0.79	-10%	0.11	NA	NA
In-season run-timing Model Predictions[4]	NA	NA	NA	NA	NA	NA	-21%	0.27

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.

Table F 4: Summary of the pre-season and in-season MA models and assumptions used during 2021 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, 2018,2019
Early Summer run w/o Chilliwack and Pitt	Historical Median	19-day temp and discharge[1]	All	1993, 2006,2019
Chilliwack	Historical Dom/Subdom Cycle Median	Historical Dom/Subdom Cycle Median	2020 & 2021	years with DNA n<30 fish identified as Chilliwack
Pitt	Historical Median, using inseason data for 1998, 2000-2004	Historical Median, using inseason data for 1998, 2000-2004	All	1982, 1983, 1999, 2005, 2006
Summer run	Historical Median	19-day temp and discharge[1]	All	2002, 2006,2019
Late run w/o Birkenhead	Historical Odd-year Cycle Line Median since 1996	Historical Odd-year Cycle Line Median since 1996 if timing Sept 8th or earlier, All Years Run Timing Model[2] if timing is later than Sept 8th	If timing Sept 8th or earlier - (All) If timng is Sept 16th or later than Sept 8th - (2017 & 2019)	2006 and All years model also excludes, 1977, 1979, 1980, 1981, 1983, 1984, 1985, 1987, 1988, 1989, 1991, 1992, 1993, 1995
Birkenhead	Median of all years	Median of all years	All	1979, 2002, 2006

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

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

APPENDIX G: HISTORICAL CATCH, ESCAPEMENT AND PRODUCTION DATA

Table G 1. Catch by user group, spawning escapement, difference between estimates and run size of Fraser River sockeye salmon for cycle years 2009-2021.

	Fraser Sockeye Salmon			
	2009	2013	2017	2021
CANADIAN CATCH	**73,800**	**411,300**	**71,900**	**87,200**
Commercial Catch	**0**	**2,100**	**0**	**0**
Panel Area	0	1,230	0	0
Non-Panel Areas	0	870	0	0
First Nations Catch	**71,800**	**407,400**	**71,700**	**45,400**
Marine FSC	9,920	122,900	9,440	0
Fraser River FSC	61,900	284,400	62,300	45,400
Economic Opportunity	0	140	0	0
Non-commercial Catch	**1,990**	**1,830**	**140**	**9,820**
Marine Recreational	0	0	0	90
Fraser Recreational	30	0	0	0
Charter	1,960	670	140	480
ESSR	0	1,160	0	9,250
Other Catch*	0	0	0	31,900
UNITED STATES CATCH	**17,200**	**66,600**	**1,480**	**86,800**
Washington Total	**4,300**	**20,200**	**1,480**	**20**
Commercial catch	**0**	**4,300**	**0**	**0**
Treaty Tribal	0	4,120	0	0
All Citizens	0	180	0	0
Non-commercial Catch	**4,300**	**15,900**	**1,480**	**20**
Ceremonial	4,300	15,900	1,480	20
Recreational	0	0	0	0
Alaska	**12,900**	**46,400**	**18,700**	**86,800**
TEST FISHING CATCH	**32,100**	**99,700**	**13,800**	**18,000**
PSC (Panel Areas)	**20,400**	**36,600**	**7,370**	**11,800**
Canada	16,900	29,600	7,370	11,800
United States	3,540	6,970	0	0
Canada (non-Panel Areas)	**11,700**	**63,100**	**6,450**	**6,190**
TOTAL RUN	**1,637,400**	**4,279,000**	**1,471,200**	**2,818,100**
Total Catch in All Fisheries	123,200	577,600	87,200	192,000
Adult Spawning Escapement	1,055,700	2,479,500	940,100	1,884,500
Jack Spawning Escapement	47,900	92,800	15,800	21,400
Difference between estimates	410,600	1,129,100	428,100	720,400
Percentage of Total Run	**100%**	**100%**	**100%**	**100%**
Total Catch in All Fisheries	8%	13%	6%	7%
Adult Spawning Escapement	64%	58%	64%	67%
Jack Spawning Escapement	3%	2%	1%	1%
Difference between estimates	25%	26%	29%	26%

* May include unauthorized directed retention or unauthorized bycatch retention in fisheries directed at other species

Table G 2. Catch by user group, spawning escapement and run size of Fraser River pink salmon for cycle years 2015-2021.

	Fraser Pink Salmon			
	2015	2017	2019	2021
CANADIAN CATCH	**83,300**	**37,200**	**300,300**	**79,800**
Commercial Catch	**0**	**0**	**0**	**17,400**
Panel Area	0	0	0	17,300
Non-Panel Areas	0	0	0	100
First Nations Catch	**68,000**	**33,600**	**263,600**	**26,600**
Marine FSC	3,400	14,800	5,400	2,900
Fraser River FSC	25,200	18,900	37,200	7,700
Economic Opportunity	39,400	0	220,900	16,100
Non-commercial Catch	**15,300**	**3,500**	**36,700**	**35,700**
Marine Recreational	0	0	30,200	21,700
Fraser Recreational	15,300	0	5,700	13,700
Charter	0	3,500	700	300
ESSR	0	0	0	0
UNITED STATES CATCH	**330,900**	**102,200**	**233,300**	**196,000**
Washington Total	**330,900**	**102,200**	**233,300**	**196,000**
Commercial catch	**328,000**	**102,200**	**233,200**	**192,000**
Treaty Indian	183,700	91,300	159,600	90,000
Non-Indian	144,300	10,900	73,500	102,000
Non-commercial Catch	**2,800**	**0**	**100**	**3,900**
Ceremonial	2,800	0	100	3,900
Recreational	0	0	0	0
Alaska	**0**	**0**	**0**	**0**
TEST FISHING CATCH	**48,900**	**17,700**	**17,200**	**4,300**
PSC (Panel Areas)	**38,100**	**13,700**	**14,600**	**3,000**
Canada	25,400	11,800	14,400	3,000
United States	12,700	1,800	200	0
Canada (non-Panel Areas)	**10,800**	**4,000**	**2,700**	**1,300**
TOTAL RUN	**5,778,900**	**3,549,200**	**8,858,600**	**8,108,200**
Total Catch in All Fisheries	463,100	157,100	550,800	280,100
Adult Spawning Escapement	5,315,800	3,392,200	8,307,800	7,828,100
Percentage of Total Run	**100%**	**100%**	**100%**	**100%**
Total Catch in All Fisheries	8%	4%	6%	3%
Adult Spawning Escapement	92%	96%	94%	97%

Table G 3. Escapements of sockeye salmon to Fraser River spawning areas for cycle years 2007-2021*

DISTRICT / Stock Group / Stream/Lake	Year 2009	2013	2017	2021
NORTHEAST				
Upper Bowron R.	2,170	3,268	244	3,158
STUART				
Early Stuart				
Driftwood R.	8,292	23,875	1,342	2,808
Takla L. Streams	16,513	27,011	3,819	14,390
Middle R. Streams	9,877	18,441	7,213	23,630
Trembleur L. Streams	10,580	16,258	3,044	13,104
Miscellaneous	35	677	5	0
Late Stuart				
Kazchek Cr.	1,271	1,800	332	558
Kuzkwa Cr.	4,109	5,282	6,639	13,664
Middle R.	28,831	24,293	22,538	37,930
Tachie R.	47,415	96,385	114,226	322,835
Miscellaneous	5,338	4,004	3,240	4,991
NECHAKO				
Nadina R. (Late)	7,008	4,973	2,053	5,471
Nadina Channel	4,392	8,247	2,938	7,048
Stellako R.	27,541	97,757	90,998	117,701
QUESNEL				
Horsefly R.	62,627	70,659	71,598	48,395
Horsefly Channel	8,162	8,670	0	0
McKinley Cr.	11,527	14,510	6,831	1,808
Mitchell R.	46,065	62,127	23,605	24,253
Miscellaneous	21,019	25,740	12,130	28,022
CHILCOTIN				
Chilko R. & L.	213,379	1,197,733	369,573	900,055
Chilko Channel	0	0	0	0
Taseko L.	40	201	20	1,327
SETON-ANDERSON				
Gates Cr.	4,688	42,357	4,495	15,930
Gates Channel	5,190	12,582	2,442	0
Portage Cr.	1,773	7,327	1,198	2,888
NORTH THOMPSON				
North Thompson R.	4,957	21,498	7,155	1,939
Raft R.	11,504	16,368	4,516	3,325
Fennell Cr.	1,170	3,471	667	891
SOUTH THOMPSON				
Early Summer-run				
Scotch Cr.	4,672	23,867	4,975	14,144
Seymour R.	5,164	22,594	3,223	8,061
Upper Adams / Momich / Cayenne	268	538	47	182
Miscellaneous	2,363	10,191	1,646	4,767
Late-run				
Adams R.	16,057	114,194	14,626	27,293
Little R.	14,491	30,892	267	1,823
Lower Shuswap R.	598	2,445	117	29
Miscellaneous	1,335	5,450	59	254
HARRISON-LILLOOET				
Birkenhead R.	53,977	80,085	18,627	45,853
Big Silver Cr. & misc. Birk. types	7,620	8,742	7,013	4,039
Harrison R.	307,210	250,087	49,983	56,184
Weaver Cr.	8,442	8,099	6,956	36,979
Weaver Channel	27,114	27,438	25,822	43,416 [1]
LOWER FRASER				
Nahatlatch R. & L.	1,439	2,099	1,923	5,997
Cultus L.	856 [1]	2,359 [1]	869 [1]	322 [1]
Upper Pitt R.	31,034	59,247	34,159	19,441
Chilliwack L./Chilliwack R., upper	5,587	11,705	6,746	2,037
MISCELLANEOUS [2]	1,980	3,974	297	849
ADULTS	1,055,680	2,479,520	940,216	1,867,791
JACKS	47,792	92,840	15,768	21,305
TOTAL NET ESCAPEMENT	1,103,472	2,572,360	955,984	1,889,096

* Estimates are from DFO.

1 Cultus estimates include 184 adults in 2009, 200 adults in 2013, 111 in 2017 and 132 in 2021.

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 1961-2019 (return years 1963-2021).

Brood Year	Spawners		Potential Egg		Fry		Adult Returns (Catch +		% Survival		Average
	Total (millions)	Female (millions)	Deposition (millions)		Production (millions)		Escapement) (millions)		Freshwater	Marine	To Date
1961	1.093	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		6.804		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		20.645	[4]	n/a	1.9%	3.2%
2011	12.785	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		5.865	[4]	n/a	1.0%	3.1%
2015	5.369	n/a	n/a	[1]	230.0		3.563	[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]	8.108	[4]	n/a	n/a	3.1%
2021	7.827	n/a	n/a	[1]	n/a	[2]					
Average	5.781	2.761	4,826		411.4		11.999		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 2009-2021 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 2021. 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 28), 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	**70,000**	**120,000**	**1,763,000**	**600,000**	**2,553,000**		**8,000,000**	
Adjusted Spawning Escapement Target *	**70,000**	**120,000**	**1,387,500**	**384,000**	**1,961,500**		**6,000,000**	
Spawning Escapement Target (SET)	70,000	120,000	1,250,000	300,000	1,740,000		6,000,000	
%SET from TAM rules	*100%*	*100%*	*71%*	*50%*			1	
Management Adjustment (MA)	48,300	46,800	137,500	84,000	316,600		n/a	
Proportional MA (pMA)	*0.39*	*0.39*	*0.09*	*0.28*				
Test Fishing Catch (TF, post-seas. est.)	800	1,500	13,600	2,100	18,000		4,300	
Surplus above Adjusted SET & TF *	**0**	**0**	**361,900**	**213,900**	**575,700**		**1,995,700**	
DEDUCTIONS & TAC FOR INTERNATIONAL SHARING								
Aboriginal Fishery Exemption (AFE)	**0**	**0**	**361,800**	**38,200**	**400,000**		**n/a**	
Total Deductions (Adj.SET + TF + AFE)	70,800	121,500	1,762,900	424,300	2,379,500		6,004,300	
Available TAC (Abundance - Deductions)	**0**	**0**	**100**	**175,700**	**175,700**		**1,995,700**	
UNITED STATES (Washington) TAC								
Propor. distrib. TAC - Payback	**0**	**0**	**0**	**28,500**	**28,500**		**512,900**	
Proportionally distributed TAC **	0	0	0	29,000	29,000	16.5%	512,900	25.7%
U.S. Payback	0	0	0	-500	-500		0	
Washington Catch	0	0	20	0	20		196,000	
Deviation from TAC - Payback	**0**	**0**	**0**	**28,500**	**28,500**		**316,900**	
CANADIAN TAC								
Propor. distrib. TAC + Payback + AFE	**0**	**0**	**361,900**	**185,300**	**547,200**		**1,482,800**	
Propor. distrib. TAC + U.S. Payback	0	0	100	147,100	147,200	83.8%	1,482,800	74.3%
AFE	0	0	361,800	38,200	400,000		0	
Other Catch***	400	700	30,700	100	31,900			
Canadian Catch excluding ESSR Catch	500	900	76,200	400	77,900		79,800	
Deviation from TAC + Payback + AFE	**-500**	**-900**	**285,700**	**185,000**	**469,300**		**1,403,000**	
TOTAL								
Available TAC + U.S. Payback + AFE	**0**	**0**	**361,900**	**214,300**	**576,200**		**1,995,700**	
Total Catch excluding ESSR Catch	500	900	68,220	400	69,520		275,700	
Deviation from TAC + U.S. Payback + AFE	**-500**	**-900**	**285,700**	**214,000**	**498,300**		**1,719,900**	

* The surplus cannot exceed the estimated abundance.

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

*** May include unauthorized directed retention or unauthorized bycatch retention in fisheries directed at other species

APPENDIX H: MEMBERS OF THE FRASER RIVER PANEL TECHNICAL COMMITTEE IN 2021

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

APPENDIX I: STAFF OF THE PACIFIC SALMON COMMISSION IN 2021

EXECUTIVE OFFICE

John Field, Executive Secretary

John Son, Information Technology Manager

Julie Ehrmantraut, Administrative Assistant

Kim Bartlett, Meeting Planner

Teri Tarita, Librarian, Archivist, and Records Manager

FINANCE AND ADMINISTRATION

Ilinca Manisali, Director of Finance

Witty Lam, Senior Accountant

Koey Lu, Accountant

Tom Alpe, Manager, Restoration & Enhancement Funds

Victor Keong, Program Assistant, Restoration & Enhancement Funds

Christina Langlois, Administrative Assistant, Restoration & Enhancement Funds

FISHERIES MANAGEMENT DIVISION STAFF

Fiona Martens, Chief Biologist Programs

Catherine Michielsens, Chief Biologist Science

Stock Assessment Group

Merran Hague, Stock Assessment Biologist

Serena Wong, Stock Assessment Assistant

Mark McMillan, Database Manager

Jessica Gill, Chinook Technical Committee Coordinator

Stock Identification Group

Maxine Forrest, Environmental Salmon Biologist

Steve Latham, Manager, Stock Identification

Julie Sellars, Senior Scale Analyst

Catherine Ball, Scale Lab Technician

Angela Phung, Stock Identification Biologist

Dejan Brkic, Salmon Technician

Stock Monitoring Group

Eric Taylor, Quantitative Biologist

Benia Nowak, Manager, Test Fishing Operations

Chris Dailey, Assistant Quantitative Biologist

Rachael Hornsby, Manager, Hydroacoustic Fisheries Biologist

Jacqueline Nelitz, Senior Hydroacoustic Technician

Mike Bartel-Sawatzky, Senior Hydroacoustic Technician

Paul Bzonek, Assistant Fisheries Biologist

Jie Xu, Assistant Hydroacoustics Fisheries Biologist