
**Report of the
Fraser River Panel
to the
Pacific Salmon Commission
on the
2018 Fraser River Sockeye
Salmon Fishing Season**



Prepared by the

**Pacific Salmon Commission
June 2020**

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**REPORT OF THE
FRASER RIVER PANEL
TO THE PACIFIC SALMON COMMISSION
ON THE 2018 FRASER RIVER SOCKEYE
SALMON FISHING SEASON**

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I. EXECUTIVE SUMMARY

Pre-season Planning

1. Pre-season expectations were for a median run size (p50 level, Appendix B) of 13,981,000 Fraser River sockeye salmon and a one in two chance that the run size would be between 8,423,000 and 22,937,000.
2. Pre-season expectations of migration parameters included a 63% diversion rate for Fraser River sockeye through Johnstone Strait. The Area 20 50% migration dates adopted by the Fraser River Panel were July 2 for Early Stuart, August 8 for Early Summer, August 11 for Summer, and August 17 for Late-run sockeye salmon.
3. At median (p50) forecast abundance levels, pre-season spawning escapement targets were 84,000 Early Stuart, 862,000 Early Summer, 1,737,600 Summer and 2,959,200 Late-run sockeye for a total of 5,642,800 sockeye salmon (Table 1). These management group specific targets were derived by applying Canada's Spawning Escapement Plan (Appendix B) to the median forecasted run sizes.
4. Management Adjustments (MAs) of 58,000 Early Stuart, 198,300 Early Summer, 173,800 Summer-run and 1,272,500 Late-run sockeye were added to the spawning escapement targets to account for differences between estimates (Mission, catch and escapement) and en-route losses, to increase the likelihood of achieving the escapement targets.
5. The projected Total Allowable Catch (TAC) of Fraser River sockeye salmon based on the median forecasted abundances and agreed deductions was 6,197,900 sockeye salmon (Table 1), of which 16.5% (1,022,654 sockeye minus a small payback of 2,400 fish) were allocated to the United States (U.S.).
6. For Early Stuart, an MA was adopted despite the spawning escapement target (SET) exceeding the median run size forecast. This SET, coupled with the pre-season adopted proportional management adjustment (pMA) of 0.69, meant that pre-season expectations of reaching the spawning escapement targets for Early Stuart were very low, and that Early Stuart would likely be managed under a Low Abundance Exploitation Rate (LAER). In Canada, a moving window closure was implemented to ensure the protection of the Early Stuart Run.
7. Canada implemented a 20% exploitation rate constraint to Late-run catches seaward of the Chilliwack/Vedder confluence, due to Cultus Lake sockeye harvest constraints. This was consistent with the LAER applied to the Late-run aggregate at the forecasted p50 return abundance. As a result of these harvest constraints it was unlikely that Canada would be able to harvest its full TAC.
8. The Panel adopted the 2018 Management Plan Principles and Constraints, and Regulations, (Appendices C, D).

In-season Management Considerations

9. The in-season marine migration timing (Figure 3) was near expected pre-season values for all sockeye management groups: 2 days later for Early Stuart run, 2 days earlier for Early Summer run, 1 day earlier for Summer run and as expected for Late run.
10. The overall Johnstone Strait diversion rate (Figure 4) for Fraser River sockeye at the end of the season was 33% compared to the pre-season forecast of 63%. A post-season analysis adjusted the annual diversion rate to 39% based on the assumption that catches in Johnstone Strait did not exceed 80% of the available abundance.
11. Returns for Fraser River sockeye salmon were below median pre-season forecasts except for Early Stuart run (Early Stuart run: 49% above median forecast, Early Summer run: 16%

- below median forecast, Summer run: 6% below median forecast and Late run: 36% below median forecast). In context to the pre-season forecast range, the Early Stuart return was between the p50 and p75 forecast, the Early Summer and Summer run returns were slightly below the median forecast and the Late-run return was slightly below the p25 forecast level.
12. Fraser River discharge was below average for the season while river temperatures were above average from mid-July to mid-August but decreased to near average for the remainder of the season (Figure 5). Due to the high temperatures, the in-season MA model predicted larger differences between estimates (DBEs, Table F3) than adopted pre-season for Early Stuart and Early Summer run.
 13. The in-season run size for Early Stuart was slightly larger than its spawning escapement target (SET) but this group was still managed under a LAER due to the pre-season adopted pMA. For Early Summer and Summer run, the Fraser River Panel did not make any in-season updates to DBEs given the favorable observations of fish condition. The estimated delay in the upstream migration of Late-run sockeye was substantially longer than expected, resulting in a smaller DBE than predicted pre-season which led the Panel to reduce the Late-run MA to 75,200 sockeye (Table 6; pMA=0.04).

Run Size, Catch, Escapement and Migration patterns

14. Returns of adult Fraser River sockeye totalled 10,864,000 fish (Tables 8 and 9) which was 9.3 million fish less than the total return of 20,148,100 adult sockeye in the brood year (2014). This return was one of the smallest on this cycle line in the last 40 years. Divided by management group, adult returns totalled 123,300 Early Stuart, 1,789,300 Early Summer-, 4,295,600 Summer- and 4,655,700 Late-run sockeye.
15. Catches of Fraser River sockeye salmon in all fisheries totalled 5,891,700 fish, including 4,731,500 fish caught by Canada, 1,047,300 fish caught by the U.S. and 113,000 fish caught by test fisheries (Table 8). Most of the Canadian catch occurred in commercial fisheries (3,699,400 including First Nations Economic Opportunity catch), followed by First Nations FSC fisheries (Food, Social and Ceremonial, 887,700 fish) and recreational fisheries (141,700). In Washington, commercial catches totalled 982,800 Fraser sockeye, mostly caught in Treaty Indian fisheries (589,600 fish). Fisheries in Alaska harvested 53,700 Fraser sockeye. Excluding Alaska catches, the overall exploitation rate was 54% of the run, which is the largest since the 2014 return of this cycle line (Figure 7).
16. DFO's near-final estimates of spawning escapements to streams in the Fraser River watershed totalled 4,100,200 adult sockeye (Tables 8 and 9). This was 30% below the brood year escapement of 5,877,300 adults and the lowest escapement on this cycle since 1994. By management group and on this cycle line, spawning escapements in 2018 were above average for Early Stuart, Early Summer-, and Summer-run but below average for Late-run (Figure 9). There were 2,037,080 estimated effective female spawners in the Fraser watershed, that achieved an overall spawning success of 93%.

Achievement of Objectives

17. 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.
18. Management decisions are based on spawning escapement targets, which are represented in-season by potential spawning escapement targets (i.e., spawning escapement targets plus MAs). In-season estimates of potential escapement (i.e., Mission escapement minus all catch above Mission) were respectively 8 and 4% below target for Early Stuart and Summer run, 11% above target for Early Summer run, and on target for Late run (Table 12).
19. Within the Fraser River, spawner abundance estimates totalled 4,100,200 adults, which is 2% below the post-season target. Spawner abundances were severely below target for Early Stuart sockeye (55% under), on target for Early Summer-run (1% over), above target for Summer-run (16% over) and below target for Late-run sockeye (15% under) (Table 13). For Early Stuart, the spawning escapement target was slightly below the run size, making the escapement target impossible to be met given the anticipated large pMA, even with the

- rigorous management approach that was applied in 2018. The in-season management measures however ensured that the exploitation rate for Early Stuart (7%) did not exceed the 10% LAER (Table 9).
20. The process of calculating the TAC (Total Allowable Catch) was revised post-season based on Panel agreement February 14, 2019. The updated 2020 Chapter 4, Annex IV of the Pacific Salmon Treaty also speaks to the change in calculating the TAC at the end of the season.
 21. The International TAC of Fraser sockeye (Table 14) was 5,450,200 fish based on the revised calculation method. The Washington catch of 993,500 Fraser sockeye (excluding the Alaska catch of 53,700 Fraser sockeye) exceeded their 16.5% share by 96,600 sockeye. The total Canadian catch of 4,731,500 Fraser sockeye, was 221,800 fish less than the sum of the Canadian share of the TAC and the Aboriginal Fishery Exemption (AFE).
 22. In terms of domestic U.S. allocation objectives for Fraser River sockeye, Treaty Indian fisheries were below their share, 6,900, but All Citizen fisheries exceeded their share of the U.S. TAC by 103,500 fish, respectively (Table 15).
 23. By-catches of non-Fraser sockeye and pink salmon in commercial net fisheries regulated by the Fraser River Panel totalled 3,630 sockeye and 200 pink salmon (Table 16). Catches of other Fraser and non-Fraser salmon species included 5,490 Chinook, 3,250 coho, and 270 chum.

Allocation Status

24. By Panel agreement there is no payback of Fraser River sockeye or pink salmon to be carried forward to 2019 (Table 17).

II. FRASER RIVER PANEL

In 2018, 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 salmon within the Panel Area (Figure 1), including net fisheries in both countries and the Canadian troll fishery in the Strait of Georgia. Fisheries directed at Fraser River sockeye and pink salmon that occur outside of the Panel area are coordinated with those in the Panel area but are the responsibility of the appropriate agencies (largely Canada's Department of Fisheries and Oceans (DFO)). Coordination of directed harvest of other salmon species and stocks intercepted in south coast areas is the responsibility of the Southern Panel and the Pacific Salmon Commission (PSC). Regulation of Southern Panel related fisheries is the responsibility of the appropriate agencies in each country.

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

¹ Pacific Salmon Treaty as modified through May 2014.

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

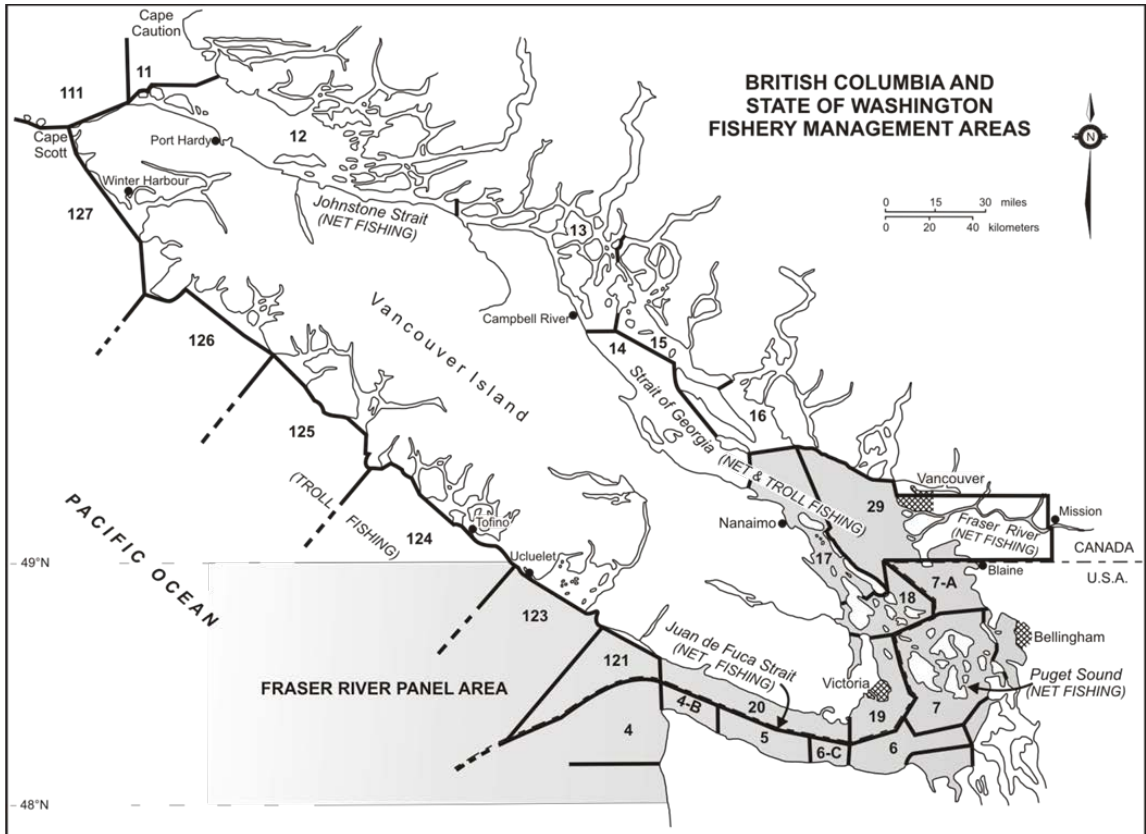


Figure 1. Fishery management areas in the Fraser River Panel Area and south coast waters.

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, diversion rate and management adjustments) and (b) some elements (e.g. spawning escapements, catches) impact post-season evaluation of the achievement of management objective (see Section VI below for more details). Key information in the first two categories is discussed in the following sections.

A. Pre-season Planning

Pre-season fisheries management plans for Panel Area fisheries were developed by the Panel using the Fishery Planning Model², which allows the Panel to evaluate the impacts of alternative fishery options on the achievement of management objectives. Model inputs include forecasts of run size, migration timing, diversion rate, migration delays in the Strait of Georgia, and management adjustments (MAs), as well as test fishery deductions and objectives for spawning escapement and catch allocation.

Both countries evaluated fishing plans directed at catching sockeye salmon. The fisheries targeted Early Summer, Summer and Late-run fish. Alternative model runs explored the sensitivity of fishing plans to sockeye salmon run size, as well as changes to Panel adopted MAs and diversion rates. The US was within a few thousand fish of their allocated TAC at both median (p50 or 50th percentile) and p25 run size forecast scenarios. Canada's ability to achieve their sockeye TAC was constrained by a 10% low abundance exploitation rate (LAER) assigned to Early Stuart sockeye. The LAER is applied to accommodate "small but acceptable" amounts of by-catch for management groups with little or no TAC, as detailed in paragraph 3 (e), Annex IV, Chapter 4 of the 2014 revised Pacific Salmon Treaty³. In addition, Canada domestically applied a 20% exploitation rate limit on Cultus Lake sockeye, effectively constraining fishing on other co-migrating Summer and Late run fish later in the season. Even at the median run size forecast, Canada could not achieve their allocated TAC, largely due to the domestic exploitation rate constraint in effect for Cultus Lake sockeye.

The preliminary run-size forecast for Fraser River sockeye salmon was produced by Canada using a variety of stock-recruit models similar to those used in previous years and with data up until the 2011 brood year (2012 brood year for Harrison)⁴. Canada presented the Panel with a sockeye salmon run-size forecast corresponding to five probability levels (10%, 25%, 50%, 75% and 90%) that the return would be below, or at, the specified abundance (Appendix B, Table B1). In 2018, the Panel used the median (i.e., p50) run size forecast of 14.0 million Fraser River sockeye as the "base case" scenario for planning purposes. The Panel also explored an alternative model, assuming a run size corresponding to the 25th percentile of the distribution of the forecasted run size (p25: 8.4 million).

Canada used the "Fraser River Sockeye Spawning Initiative" (FRSSI) model and pre-season consultations on the Canadian South Coast Integrated Fisheries Management Plan (IFMP) to establish escapement goals for the 2018 management season. The spawning escapement plan released by Canada to the Panel (Appendix B, Table B2) was based on FRSSI guidelines with stakeholder input through a domestic consultation process. Pre-season escapement targets for sockeye at the p50 run size levels by management group were: Early Stuart – 84,000; Early Summer run– 862,000; Summer run– 1,737,600; and Late run – 2,959,200⁵.

² Cave, J.D. and W.J. Gazey. 1994. A pre-season simulation model for fisheries on Fraser River sockeye salmon (*Oncorhynchus nerka*). Can. J. Fish. Aquat. Sci. 51(7): 1535-1549.

³ Pacific Salmon Commission. May 2014. Pacific Salmon Treaty.

⁴ DFO. 2018. Pre-season run size forecasts for Fraser River Sockeye (*Oncorhynchus nerka*) salmon in 2018. DFO Can. Sci. Advis. Sec. Sci. Resp. 2018/034.

⁵ 2018/2019 Salmon Integrated Fisheries Management Plan Southern BC. Fisheries and Oceans Canada.

Pre-season fisheries management planning was based on assumptions about the proportions of Fraser River sockeye salmon migrating through Johnstone Strait instead of Juan de Fuca Strait (i.e. Johnstone Strait diversion rate, Figure 2) as well as marine timing (i.e. 50% migration dates). DFO's oceanographic models⁶ generated timing forecasts of July 2 for the Early Stuart run and August 11 for the Chilko run, which were adopted by the Panel. Timing estimates for other stock components in the planning model were generated by adjusting historical medians by one day, equivalent to the difference between the historical median Chilko timing (August 10th for all years excluding the 2016 cycle line) and the 2018 Chilko timing forecast. Historical medians were based on all years excluding those in the 2016 cycle, except for Early South Thompson which used a 2018 cycle median. Unlike previous years, the timing of each management group was derived based on the aggregated daily abundances of component stocks assuming normal run timing distributions. The Panel adopted the resulting timing forecasts of July 2 for the Early Stuart run, August 8 for the Early Summer run, August 11 for the Summer run and August 17 for the Late run.

Using the same suite of eight models as applied in recent years, DFO forecasted a 56% diversion rate for Fraser sockeye through Johnstone Strait. The Panel adopted a diversion rate of 63%, equivalent to the median diversion from 1990 – 2017. The northern diversion rate for Harrison sockeye was estimated to be 34%, based on the diversion of Harrison fish through the north historically being lower than for other co-migrating Fraser River sockeye. 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.

DFO's Environmental Watch (E-Watch) Program provided the Panel with long-range (3-month) projections of Fraser River temperature and discharge conditions. Despite average spring snowpack values, the snowpack was depleted early due to an early freshet with record high discharge values in May. Forecasts suggested lower than average flow conditions which would make the river susceptible to the effects of the above average summer air temperatures predicted by the long-range forecast. Fraser River temperatures at Qualark were forecasted to be above normal. Staff used the environmental forecasts in Management Adjustment (MA) models developed jointly by DFO and the PSC to forecast the proportional Management Adjustments (pMAs) (see Table F3). These estimates predicted the additional sockeye needed to increase the probability of achieving spawning escapement objectives (see references in the MA section, Section IV, C). The Panel chose to adopt the proportional differences between estimates (pDBEs) based on the historical median (see Table F4) for all four management groups. Due to the low relative abundance of Pitt, Chilliwack, Harrison and Birkenhead, the weighted pDBE approach for the aggregate run timing groups had little impact on the aggregate pDBE or aggregate SET (spawning escapement target). As a result, the Panel agreed to forego the weighted pDBE approach for 2018 (with possible review in-season if component proportions were different than the pre-season forecast). The Panel adopted a pDBE for the Early Stuart run (pDBE=-0.41; pMA=0.69; MA=58,000 fish), Early Summer-run aggregate (pDBE=-0.19; pMA=0.23; MA=198,300 fish), Summer-run aggregate (pDBE=-0.09; pMA=0.10; MA=173,800 fish) and Late-run aggregate (pDBE=-0.30; pMA=0.43; MA=1,272,500 fish) (Table 6). For more details about how the MAs were estimated, see the "Management Adjustment and DBE" section in Appendix F.

The Panel adopted a management approach for Late-run sockeye that assumed part of the Late run will not delay their migration into the Fraser River, and a proportion of those fish will not survive migration to the spawning grounds. The proportion of the run that delays and the number of days delayed are higher on the dominant cycle line compared to other years. For planning purposes, the model assumed 16-days delay in the Strait of Georgia and a corresponding upstream timing of September 14 for the delaying component of the non-Birkenhead Late-run group based

⁶ Folkes, Michael J P and Thomson, Richard E and Hourston, Roy A S. 2017. Evaluating Models to Forecast Fraser Sockeye Return Timing and Diversion Rate. DFO Can. Sci. Advis. Sec. Res. Doc.

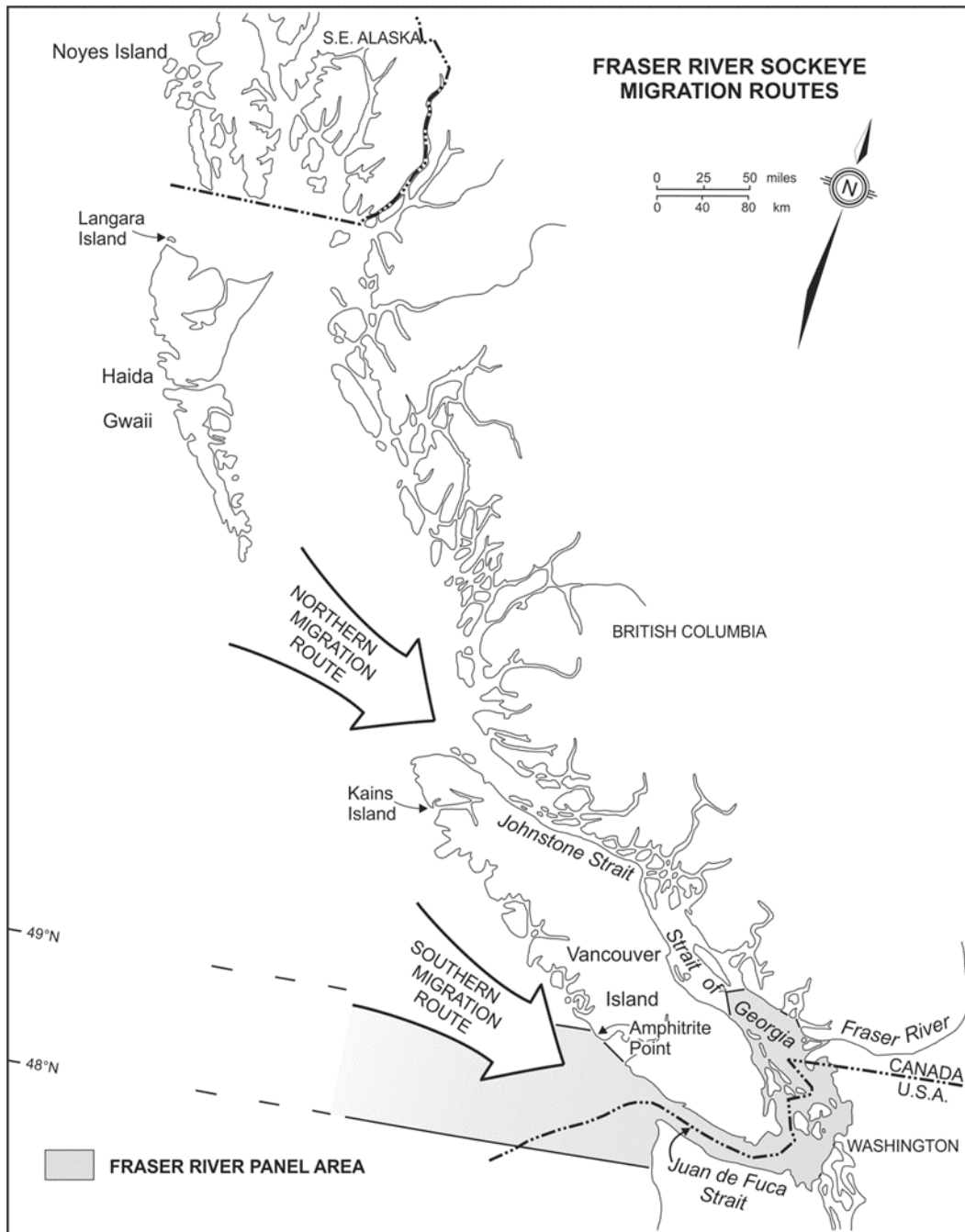


Figure 2. The northern (Johnstone Strait) and southern (Juan de Fuca Strait) routes for sockeye and pink salmon migration to the Fraser River.

on the median estimates on the cycle-line since 1996. This resulted in a September 10 Mission 50% date (i.e. the date 50% of the run has passed Mission) for the overall Late run. The model also assumed 3 days of upstream migration delay for the delaying component of the Harrison sockeye and a resulting upstream migration timing of September 2 (median of all years), resulting in an August 20 upstream timing for the overall Harrison group.

During the pre-season planning process, both countries identified salmon stocks for which they had conservation concerns and that would influence management decisions for fisheries

directed at Fraser River sockeye salmon. Canada identified Early Stuart sockeye, Cultus Lake sockeye, Nimpkish sockeye, Sakinaw sockeye, interior Fraser River coho, Strait of Georgia coho, interior Fraser Steelhead, all Fraser River Chinook except the Summer 41's, various rockfish species, and the Southern Resident Killer whale population. The U.S. highlighted concerns for Lake Washington sockeye, Baker Lake sockeye, Upper Columbia River sockeye, Puget Sound and coastal Washington coho salmon, Puget Sound chinook salmon, and the Southern Resident Killer whale population.

In-season assessment of the run size for Fraser sockeye salmon relies predominantly on test fishing data. Pre-season test fishing plans did not include the Naka Creek test fishery, but did include the Area 4B5 gillnet test fishery, a reduced Area 7 reefnet test fishery as well as the gulf troll test fishery for estimating Late-run delay. To cover the cost of the proposed test fisheries (\$1,350,000), it was anticipated a total of 104,000 sockeye would need to be caught by the test fishing program. Based on the average percent non-discretionary test fishing catch over the last three years on this cycle line (30%), the anticipated non-discretionary catch was 31,000. Pre-season plans assumed that the remainder of the test fishing costs would be paid through the discretionary catch of pay fish (73,000). The distribution of pay fish across management groups was calculated using the percent harvestable surplus assigned to each group in 2018. In the pre-season planning model, retention of fish in the purse seine test fisheries was scheduled to begin on the same date as the test fishery opening in each area. Because there was no harvestable surplus for Early Stuart, the test fishing deduction was equivalent to the non-discretionary catch.

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. The pre-season sockeye TAC for international sharing was 6,197,900 (Table 1), of which the 16.5% U.S. (Washington) share was 1,020,200 fish after the removal of a U.S. payback of 2,400 carried over from the previous year. Treaty Indian fisheries were allocated 67.7% of the U.S. TAC and All Citizen fisheries the remaining 32.3%. Adding the remaining TAC balance to the 400,000 Aboriginal Fishery Exemption (AFE) resulted in 5,577,800 sockeye available for harvest by Canada. Commercial pre-season catch targets in Canada totalled 4,305,600 sockeye; Canadian non-commercial catch targets totalled 1,272,200, including 799,500 fish for in-river First Nations and 300,500 fish for marine First Nations, plus projected recreational catches of 135,100 fish in the Fraser River and 37,100 fish in marine areas. In Canadian commercial fisheries, Area B purse seine was allocated 48.02%, Area D gill net was allocated 21.38%, Area E gill net was allocated 24.85%, Area G troll was allocated 1%, and Area H troll was allocated 4.75%.

The Fraser River Panel considered two alternative planning scenarios at the June meeting that examined two sockeye salmon run size scenarios (p50 and p25). Final revisions to the model were completed in early July, at which time the Base Case Planning Model assuming a median (p50) run size forecast was adopted. Canada and the U.S. developed a pre-season management plan under the "base case" conditions which included the "2018 Management Plan Principles and Constraints" and "2018 Regulations" (Appendices C and D). In the pre-season plan, the first potential fisheries directed at Fraser sockeye commenced on July 27th in U.S. Panel-Area waters. The first scheduled Canadian fishery in marine waters was planned for August 3rd in Johnstone Strait. The first scheduled Canadian fishery in the river was planned for July 28th. For pre-season planning, a 10% LAER for Early Stuart, a moving window closure for fisheries directed at Early Stuart sockeye, as well as area closures to protect Nimpkish sockeye and gear and timing restrictions to protect Sakinaw sockeye, constrained fishery openings during earlier dates in the pre-season plan. In addition, a 20% exploitation rate constraint was applied domestically by Canada to Late-run catches occurring seaward of the Chilliwack/Vedder confluence, consistent with the LAER applied to the Late-run aggregate at the forecasted p50 return abundance⁴.

The planning model indicated that the U.S. was likely able to harvest most of their TAC, assuming a small, but acceptable, overage of Early Summer-run fish. Due to the moving window closures to protect the Early Stuart run, as well harvest constraints applied to Cultus Lake sockeye,

it was unlikely that Canada would be able to harvest their full TAC for any of the management groups.

B. In-season Management

In 2018, all sockeye salmon management groups returned at run sizes that were below the median pre-season forecasts, and with marine timing slightly earlier than forecast, with the exception of Early Stuart which returned above pre-season forecast and two days later than forecast (Figure 3).

The Fraser River Panel convened 29 times between July 06, 2018 and October 12, 2018 to discuss run status and enact in-season orders (Appendix E) to regulate fisheries directed at Fraser River sockeye salmon in Panel Areas. Table 1 summarizes pre-season and in-season estimates by management group and by meeting date, including estimates of run size and the various deductions that result in the calculated TAC (i.e., spawning escapement target, MA, projected test fishery catch and Aboriginal Fishery Exemption). Also shown are estimates of available harvest (run size minus spawning escapement target and MA), catch to date, Mission escapement to date and 50% migration dates. The main events that transpired each week of the season are summarized below with a focus on Staff assessments and Panel decisions.

July 01 - 07, 2018:

The first in-season Panel meeting took place on Friday, July 06. Due to favourable conditions the Mission hydroacoustics program was operational on July 5, three days earlier than expected. Only a small number of sockeye had been caught by the in-river test fishery at Whonnock. Catches consisted predominantly of Early Stuart. The Fraser River water temperature at Qualark was 15.5°C which was very close to average and the discharge was 5,208 m³·s⁻¹ which was 13% below average.

July 08 – 14, 2018:

Approximately 75,300 Early Stuart sockeye had passed by Mission to date based on initial in-river test fishing catches prior to the start of the hydroacoustic program and hydroacoustic estimates. When assessed using the reconstructed daily abundances to date in combination with 3 days of marine test fishing observations, the Early Stuart run appeared to be exceeding the p50 forecast of 84,000. Given the limited data and the lack of management implications, no changes were made to the Early Stuart run size. On July 12, the Fraser River water temperature at Qualark was 17.3°C which was 1.3°C above average and the discharge was 5,021 m³·s⁻¹ which was 9% below average.

July 15 – 21, 2018:

Approximately 107,000 Early Stuart sockeye had passed by Mission to date, exceeding the p50 forecast of 84,000 fish. On July 17, the Panel agreed to adopt an Early Stuart run size of 106,000 with a 50% marine timing of July 3, and on July 20 the Panel increased the run size to 120,000. Most of the Early Summer-run fish detected in test fisheries and migrating past Mission were Early Thompson and Nadina sockeye. The diversion rate of 50% was typical for this time of year.

Flow levels continued to decrease while water temperatures continued to increase. The Fraser River water temperature at Qualark was 19.0°C and the discharge was low at 3,902 m³·s⁻¹. As a result, the median predicted DBE for Early Stuart was -34%. Since Early Stuart was managed under a LAER (low abundance exploitation rate) and the DBE did not have any management implications, the Panel did not adjust the pre-season DBE forecast of -41%.

July 22 – 28, 2018:

As of July 26, the Early Stuart run had almost completed its migration past Mission with an estimated catch plus escapement of 122,500. At the Panel meeting on July 27, the Panel agreed to adopt an Early Stuart run size of 135,000 with a 50% marine timing of July 5. Thus far, daily abundance estimates for Early Summer run exceeded median pre-season expectations. The Early Summer-run sockeye detected in the marine test fisheries were predominantly Nadina and Early Thompson sockeye, while Summer-run sockeye consisted mainly of Quesnel and, to a lesser extent, Chilko and Late Stuart sockeye. Purse seine test fisheries in Areas 12, 20 and 13 began on July 24, 25, and 26, respectively. The five-day average diversion rate decreased to 17% which was lower than expected for this time of year.

The Fraser River water temperature at Qualark was average at 18.0°C and the discharge was low at 3,998m³·s⁻¹. The discharge was predicted to decrease further, while the temperatures were predicted to come near historic maximum temperatures. The Panel opened a Treaty Indian fishery in Areas 4B, 5, and 6C in the U.S.

July 29 – August 04, 2018:

The Early Stuart run was nearly complete with an estimated catch plus escapement of 122,300. Daily estimates of Early Summer-run abundances, consisting mainly of Nadina and Early Thompson stocks, continued to increase, and appeared to be tracking predicted abundances corresponding with the pre-season p50 forecast (2,155,000). The catch plus escapement estimate for Early Summer-run stocks reached 470,600 sockeye on August 3. Summer-run stocks, and especially Quesnel and Chilko, dominated abundances in both marine areas and the river. The five-day average diversion rate increased to 37% by the end of the week.

The Fraser River water temperature at Qualark was very high at 20.7°C and the discharge was low at 3,252m³·s⁻¹. Temperatures were predicted to decrease but still remained well above average for the time of year. The 31-day model predicted an expected Difference Between Estimates of -41% for Early Stuart run with a timing of July 4.

In the U.S., the Panel opened a Treaty Indian fishery and an All Citizen fishery in Areas 6, 7 and 7A and extended the Treaty Indian fishery in Areas 4B, 5, 6C. In Canada, the Panel agreed to open the Area E gillnet fishery in Area 29 on August 8 and 9 and the Area H Individual Transferrable Quota (ITQ) troll fishery in Areas 18 and 29 on August 6, which was opened until further notice (UFN). In non-Panel waters Area D began gillnet fishing in Areas 11, 12 and 13 on August 1 for 38 hours, Area H ITQ fishery opened in Areas 12 and 13 on August 6 UFN and the Area B purse seine fishery opened in Areas 12 and 13 on August 8 UFN.

August 5 – 11, 2018:

Mission cumulative passage estimates on August 10 for Early Stuart, Early Summer-, Summer- and Late-run groups were 121,400, 553,500, 566,000 and 94,400 fish, respectively. On August 7, the Panel adopted an Early Stuart run size of 125,000 with a 50% marine timing of July 4 in Area 20. Daily estimates of Early Summer-run abundances, consisting mostly of Nadina and Early Thompson stocks, were lower than modelled pre-season and suggested the group may be smaller and earlier timed than forecasted, with a run size closer to the p25 forecast of 1,102,000, and a timing of July 31. Daily abundance estimates for the Summer-run corresponded with the forecast of 4,344,000, assuming the pre-season timing forecast of August 11 was correct. Preliminary assessments for Late-run sockeye based on pre-season smolt ratios and in-season run size estimates for Early Thompson indicated an in-season run size estimate for Late Shuswap/Portage of 3,600,000 sockeye (between the p10 and p25 forecast). By the end of the week, the five-day average diversion rate had increased to 30%.

The Fraser River water temperature at Qualark was very high at 20.4°C and the discharge was very low at 2,881m³·s⁻¹. Temperatures were predicted to decrease but still remain well above average for the time of year. Past cycle-line years with similar discharge and temperature (1998 and 2014) indicated an average DBE of about -50%, which was in line with preliminary estimates of the 19-day model for Early Summer-run stocks.

In the U.S, the Panel approved the extension of a Treaty Indian fishery in Areas 4B, 5, 6C and opened an All Citizen fishery in Areas 6,7 and 7A. In Canada, the Area H Individual Transferrable Quota (ITQ) troll fishery in Areas 18 and 29 remained open until further notice while in non-Panel waters another Area D opening was scheduled to begin on August 5. On August 10, catches totalled 1,131,000 Fraser sockeye, with 543,000 caught by Canada, 521,000 caught by the U.S and 67,000 caught in the various test fisheries. These catches represented about 48% of the 2.4 million accounted run-to-date and were in line with pre-season fishing plans.

In Canada a modified approach regarding the management of Cultus Lake and Late Run sockeye was developed based on recent information regarding Cultus sockeye freshwater survival and increased brood stock collection. The allowable exploitation rate of Late-run sockeye would be 20% at low abundances which would be increased as run size increased and the Cultus Lake broodstock requirements were being met. Brood stock requirements for Cultus Lake sockeye was increased to 200 fish, which permitted the allowable Late-run exploitation rate to increase to 43%, even if Late-run run size matched the p25 pre-season forecast of 4.8 million.

August 12 – 18, 2018:

Mission cumulative passage estimates on August 16 for Early Stuart, Early Summer-, Summer- and Late-run groups were 121,400, 852,500, 1,1156,200 and 171,700 fish, respectively. On August 14 and 17, in-season run size models for the Early Summer run indicated a total run size of 1.8 and 2.1 million respectively with associated timing estimates of August 4 and August 7. The estimate on August 17 confirmed the median pre-season run size forecast for Early Summer run. For Summer run, the in-season run-size estimate (4.8 million) slightly exceeded the median forecast, of 4.3 million. Preliminary assessments for Late-run sockeye based on pre-season smolt ratios and in-season run size estimates for Early Thompson indicated an in-season run size estimate for Late Shuswap/Portage of 7.3 million sockeye (slightly higher than the median pre-season forecast). An alternative run size estimate using the predicted timing for Late Shuswap/Portage based on the in-season timing estimate for Early Thompson and the historic relationship between timing estimates for both groups confirmed this run size estimate which was similar to the median pre-season run size estimate. While the Panel did not adopt the recommended run size changes for Early Summer run, the recommendations were taken into account when planning fisheries. By the end of the week, the five-day average diversion rate had decreased to 28%.

As of August 16, the Fraser River water discharge at Hope was $2,731 \text{ m}^3 \cdot \text{s}^{-1}$ with water temperature at Qualark reading 19.2°C . The 19-day model predicted an expected Difference Between Estimates (DBE) of -41% for Early Summer-run assuming a timing of August 7 compared to pre-season expectations of -19%. The Summer-run 19-day model predicted an expected DBE of -30% assuming a timing of August 11. Despite high water temperatures and low discharge, there were no increased reports of holding fish, stressing or carcasses within the river and fish caught by the various fisheries seemed in good condition. The Panel therefore did not adopt the recommended DBE of -37% for Early Summer run but took this into consideration when planning fisheries.

In the U.S, the Panel approved the extension of a Treaty Indian fishery in Areas 4B, 5, 6C and opened a Treaty Indian fishery and All Citizen fishery in Areas 6,7 and 7A. In Canada, the Panel approved an Area E gillnet opening in Area 29 on August 15 and 16 and the Area H Individual Transferrable Quota (ITQ) troll fishery in Areas 18 and 29 remained open until further notice. Additional Area D openings were scheduled and the Area B and H ITQ fisheries in Johnstone Straits remained opening until further notice (UFN). On August 16, catches totalled 2,639,790 Fraser River sockeye, with 1,821,090 caught by Canada, 724,900 caught by the U.S and 93,700 caught in the various test fisheries. These catches represented about 55% of the 4.8 million accounted run-to-date and were in line with pre-season fishing plans. Assuming the Late-run run size matches the median pre-season forecast, the Late-run exploitation rate was 8.6% as of August 17.

August 19 – 25, 2018:

Mission cumulative passage estimates on August 24 for Early Stuart, Early Summer-, Summer- and Late-run groups were 121,400, 1,002,000, 1,646,800 and 301,900 fish, respectively. Test fishing catches had declined substantially by that date. The decline occurred in both approaches and the five-day average diversion rate remained low at 29%. Reconstructed abundance estimates indicated that the peak migration date had been observed at Mission for both Early Summer- and Summer-run stocks. In-season run size models for Early Summer run indicated median run size estimates of 1.7-1.8 million with a run timing of August 6. For the Summer run, the in-season run size model indicated a run size slightly higher than the median pre-season forecast of 4.3 million and a run timing of August 11. For Late-run sockeye, the total reconstructed abundance-to-date equalled 3.8 million including 800,000 Late-run sockeye that were delaying their upstream migration into the Fraser River. Run-size assessments based on pre-season smolt ratios and in-season run size estimates for Early Thompson indicated an in-season run size estimate for Late Shuswap/Portage of 5.6 million sockeye. An alternative run size estimate using the predicted timing for Late Shuswap/Portage based on the in-season timing estimate for Early Thompson and the historic relationship between timing estimates for both groups confirmed that the in-season run size estimate would likely be lower than the median pre-season run size estimate of 7.4 million. While the Panel did not adopt the recommended run size changes for Early Summer-run, the recommendations were taken into account when planning fisheries.

As of August 23, the Fraser River water discharge at Hope was $2,187 \text{ m}^3 \cdot \text{s}^{-1}$ with water temperature at Qualark reading 18.0°C . The 19-day model predicted a Difference Between Estimates (DBE) of -42% for Early Summer-run and of -23% for Summer-run stocks. Water temperatures approached normal values for the time of year, but water discharge levels remained low; there were no increased reports of holding fish or carcasses within the river and fish caught by the various fisheries seemed in good condition. The Panel did not adopt the recommended DBE of -37% for Early Summer run given the lack of negative signals regarding holding fish but took this into consideration when planning fisheries.

In the U.S, the Panel approved the extension of a Treaty Indian fishery in Areas 4B, 5, 6C and opened a Treaty Indian fishery in Areas 6,7 and 7A. As of the announcement of this fishery, the remaining total allowable catch (TAC) in the U.S. was 129,600 sockeye. In Canada, the Area H Individual Transferrable Quota (ITQ) troll fishery in Areas 18 and 29 remained open until further notice as did the ITQ fisheries for Areas B and H in Johnstone Straits and Area D had additional openings as well. On August 23, catches totalled 3,987,940 Fraser River sockeye, with 2,980,240 caught by Canada, 908,500 caught by the U.S and 99,020 caught in the various test fisheries. These catches represented about 58% of the 6.8 million accounted run-to-date. The Late-run exploitation rate on August 23 was 18.2%.

August 26 – September 1, 2018:

Cumulative Mission passage estimates on August 31 for Early Stuart, Early Summer-, Summer- and Late-run groups were 121,400, 1,079,900, 1,924,500 and 434,100 fish, respectively. Test fishing catches had declined substantially in both approaches and resulting abundances did not exceed 50,000 sockeye a day. The Early Summer run continued to track below the median forecast. On August 28, the Panel adopted a reduced run size of 1.8 million with a run timing of August 6 and later in the week the Panel further reduced the run size to 1.7 million with no change to timing. On August 28, the Panel also confirmed the median run size forecast for Summer-run sockeye, 4.344 million, with an August 11 50% marine timing estimate.

Preliminary assessments for Late-run sockeye based on pre-season smolt ratios and in-season run size estimates for Early Thompson indicated an in-season run size estimate for Late Shuswap/Portage of 5.7 million sockeye (between the p25 and median pre-season forecast). An alternative run size estimate using the predicted timing for Late Shuswap/Portage based on the in-season timing estimate for Early Thompson and the historic relationship between timing estimates for both groups confirmed this run size estimate. On August 31, the total Late-run catch plus escapement equalled 1,928,000 sockeye while the total reconstructed abundance, including the

1,870,000 Late-run sockeye assumed to delay in the Gulf before entering the Fraser River, equalled 3,852,000 sockeye. Using CPUE data collected by the Gulf Troll test fishery to estimate Late-run delay resulted in alternative Late-run run-size estimates of 3,614,000 (2,812,000-5,194,000) and 4,236,000 (3,193,000-6,165,000) sockeye depending on the historical data used. Given the uncertainty around the Late-run delay and the subsequent run size and the indication that, based on commercial catches in Area D, abundances in Johnstone Strait were likely larger than predicted by the test fishery, the Panel did not adopt the recommended run size of 4.2 million for Late-run on August 28 but used a provisional run-size estimate of 6.0 million for planning purposes and at the meeting on Friday they further reduced the provisional estimate to 5.8 million.

On August 31, catches totalled 4,449,630 Fraser River sockeye, with 3,364,080 caught by Canada, 981,300 caught by the U.S and 104,240 caught in the various test fisheries. On August 31, the Late-run exploitation rate was 25.6% given the provisional Late-run run size of 6,000,000. Due to the low test fishing catches in the Area 13 purse seine test fishery, the Panel agreed to terminate this fishery on August 31 but extended the Area 20 purse seine test fishery to September 4 as the diversion rate indicated that a decent fraction of sockeye were still migrating through Juan de Fuca Strait. By the end of the week, the five-day average diversion rate was 58%.

As of August 30, the Fraser River water discharge at Hope was $1,879 \text{ m}^3 \cdot \text{s}^{-1}$ with water temperature at Qualark reading 17.3°C . Water temperatures approached normal values for the time of year, but water discharge levels remained low. Assuming a timing of August 6, the 19-day model for Early Summer-run predicted a Difference Between Estimates (DBE) of -42%, which was more than double the pre-season DBEs of -19%. The Summer-run 19-day model predicted a DBE of -24% assuming a timing of August 11. The Panel did not adopt the model predicted DBEs because there were no increased reports of holding fish or carcasses within the river and because fish caught by the various fisheries seemed in good condition. These recommended DBEs were however taken into account when planning fisheries. With the adoption of a smaller than forecast Early Summer-run run size there was little remaining TAC available in the U.S., 800 fish, but Canada had a remaining TAC of 2,202,400. No new Panel fisheries were announced this week; however, the Area H troll fishery in Canada remained open until further notice.

September 2 - 8, 2018:

Cumulative Mission passage estimates on September 7 for Early Stuart, Early Summer-, Summer- and Late-run groups were 121,400, 1,099,500, 2,006,600 and 551,200 fish, respectively. Test fishing catches continued to decline in both approaches and resulting abundance estimates did not exceed 70,000 sockeye a day. The majority of the run now migrated through Johnstone Strait instead of Juan de Fuca Strait and the Area 20 test fishery was terminated on September 4. No changes to run size estimates were made during this reporting period.

Late-run run-size estimates ranged from 4,131,000 sockeye based on the total reconstructed abundances-to-date to 6,212,000 sockeye based on an assumed Late-run migration timing of August 19. Using CPUE data collected by the Gulf Troll test fishery to estimate Late-run delay resulted in alternative Late-run run-size estimates of 5,810,000 (4,162,000-8,911,000) sockeye based on the data for the dominant subdominant Late-run cycle lines. This median estimate was similar to the Late-run run-size based on pre-season smolt ratios. Given the uncertainty around the Late-run delay and the subsequent run size, the Panel did not adopt the recommended run size of 6.0 million for Late-run but continued to use a provisional run-size estimate of 5.8 million for planning purposes.

On September 7, catches totalled 4,671,320 Fraser River sockeye, with 3,583,450 caught by Canada, 981,300 caught by the U.S and 106,580 caught in the various test fisheries. Given the provisional Late-run run size of 5,800,000, the Late-run exploitation rate was 28.7%. The average annual diversion rate was 33%.

As of September 6, the Fraser River water discharge at Hope remained low at $1,695 \text{ m}^3 \cdot \text{s}^{-1}$ with water temperature at Qualark reading 15.7°C , which was slightly below average for the time of year. The 31-day models for Early Summer run and Summer run predicted a Difference Between Estimates (DBE) of -33% and -15%, respectively. For Late-run sockeye, the predicted upstream migration date ranged from September 14 to 18. The associated DBEs ranged from -30% to -14%. The Panel did not adopt the model predicted DBEs for Early Summer and Summer-run

because there were no increased reports of holding fish or carcasses within the river and fish caught by the various fisheries seemed in good condition. These recommended DBEs were however taken into account when considering fisheries opening. Given the uncertainty in the Late-run upstream migration timing, no recommendation was made for the Late-run DBE. Despite a remaining TAC of 1,801,070 at adopted run sizes, no new Panel fisheries were announced this week and the Area H troll fishery in Canada closed 11:59 p.m., September 4.

September 9 - 15, 2018:

Cumulative Mission passage estimates on September 14 for Early Stuart, Early Summer-, Summer- and Late-run groups were 121,400, 1,119,100, 2,059,000 and 801,500 fish, respectively. Test fishing catches had declined substantially in Johnstone Strait and the Area 12 test fishery was terminated on September 11, as scheduled.

At the meeting on September 11, the Panel increased the Early Summer-run run size to 1,800,000, but the corresponding 50% marine timing estimate remained unchanged. The Late run appeared to be tracking below the pre-season forecast. Late-run run-size estimates ranged from 4,204,000 sockeye based on the total reconstructed abundances-to-date to 6,021,000 sockeye based on pre-season smolt ratios and the in-season run size estimates of 1,336,000 for Early Thompson. The recommended Late-run run size of 5,000,000 was based on average run size estimates from the four Gulf Troll surveys conducted thus far. Given the uncertainty around the Late-run delay and the subsequent run size, the Panel adopted a Late-run run size of 6,000,000 with a 50% marine timing of August 19 based on the smolt ratios and in-season Early Thompson run size estimate.

As of September 13, the Fraser River water discharge at Hope was $1,579 \text{ m}^3\cdot\text{s}^{-1}$ with water temperature at Qualark reading 15.5°C . Water temperatures were slightly below average for the time of year, and water discharge levels remained low. The Panel adopted a Late-run upstream migration timing of September 17 which corresponded to a predicted DBE of -20%.

On September 13, catches totalled 5,186,540 Fraser River sockeye, with 4,088,620 caught by Canada, 989,400 caught by the U.S and 108,450 caught in the various test fisheries. These catches represented about 59% of the 8.7 million accounted run-to-date. The Late-run exploitation rate on September 13 was 34.8%. Given Canada had a remaining Late-run TAC of 1,171,250, the Panel announced an opening for purse seine (portions of Area 29) and troll fisheries (portions of Area 18 and 29) in Canada beginning September 12.

September 16 - 22, 2018:

Cumulative Mission passage estimates on September 21 for Early Stuart, Early Summer-, Summer- and Late-run groups were 121,400, 1,131,300, 2,060,700 and 1,504,500 fish, respectively. Due to the uncertainty regarding the number of delaying Late-run sockeye, the Panel agreed to an addition Gulf Troll survey during this week.

At the meeting on September 19, the Panel decreased the Summer-run run size to 4,100,000 with a 50% marine timing estimate of August 10. Late-run run-size estimates ranged from 4,813,000 sockeye based on the total reconstructed abundances-to-date to 6,009,000 sockeye based on pre-season smolt ratios and the in-season run size estimates of 1,343,000 for Early Thompson. Given the continued uncertainty around the total Late-run run size and associated delay, the Panel did not adopt the recommended Late-run run size of 5,000,000 sockeye but used this number as a provisional run-size estimate for planning purposes. The associated Late-run marine timing estimate was August 18, while September 19 was the estimated timing of the Late-run stocks past Mission, which corresponded with a DBE of -8%. At the meeting on Friday, the Panel did not make any changes to official run size and timing estimates, but they refined the provisional estimate for the Late-run upstream timing to September 19-20 and a DBE of -4%.

As of September 20, the Fraser River water discharge at Hope remained low at $1,509 \text{ m}^3\cdot\text{s}^{-1}$ with water temperature at Qualark reading 13.6°C , which was slightly below average for the time of year.

In Canada, Panel area waters remained open and additional quota was released for purse seine (portions of Area 29) and troll fisheries (portions of Area 18 and 29) as Canada still had a remaining TAC of 957,580 based on currently adopted run sizes.

September 23 - 29, 2018:

Cumulative Mission passage estimates on September 27 for Early Stuart, Early Summer-, Summer- and Late-run groups were 121,400, 1,131,700, 2,104,800 and 1,944,600 fish, respectively.

At the meeting on September 25, the Panel did not make any changes to run size estimates. At the in-person meeting in Kamloops, it was requested that the Gulf Troll test fishery complete an additional survey. Assuming the trend towards longer Late-run delays continues in the future, this additional survey would provide an additional data point late in September. The Panel had another in-season meeting on Friday September 28 to receive further updates on Mission passage and Gulf Troll estimates. The unforeseen extension of the Gulf troll meant that only one vessel instead of two participated in this test fishery. At the time of the meeting, not all quadrants had been sampled, but the test fishery data confirmed that a substantial amount of sockeye still delayed in the Gulf. At the meeting, no run size changes were made, and no further meetings were scheduled; however, the Panel did request that a distribution be provided with updates on Mission passage, test fishing catch, and Gulf Troll estimates the following week.

In Canada, all remaining fisheries in Panel area waters closed on September 27.

September 30- October 13, 2018:

The Gulf Troll survey conducted from September 26 to October 1 resulted in Late-run run-size estimates ranging from 5.5 million to 6 million sockeye. The associated estimates of delay ranged from 1.1 to 1.6 million. Meanwhile, from October 1 to 5 the average Mission passage estimates increased to more than 50,000 per day from less than 25,000 sockeye per day in the previous 4 days. Both the Mission hydro-acoustic program and the Gulf troll survey were extended to ensure accurate estimation of the number of Late-run sockeye. The final Gulf troll survey conducted from October 3 to 6 indicated run-size estimates of 4.6 million and estimates of delay as low as 38,000 to 67,000 sockeye. It appeared that most of the sockeye had moved out of the Gulf and had migrated upstream. After October 5, daily sockeye passage at Mission dropped to below 6,000 per day. At this point, most of the salmon within the river consisted of chum salmon. The final day of estimates from the Mission Hydroacoustics program was October 9 and the final day of test-fishing catch at Whonnock was October 12.

On October 12, the Panel met to discuss the Fraser River Late-run run-size. At the meeting, the Panel reduced the Late-run run size from the adopted 6.0 million and the provisional management estimate of 5.0 million to 4.7 million with a 50% marine timing of August 17. The Panel also adopted the provisional DBE of -4%. This corresponded to a Late-run upstream timing between September 19-20.

Unlike previous years where the inputs used to calculate the TAC and international shares were frozen on the date the last U.S. Panel Area was relinquished (October 6), the Panel revised the Treaty language for Chapter 4, Annex IV in February 2019, and made this language retroactive to the 2018 fishing season. As a result, the TAC calculation is based on the last in-season run size estimate adopted by the Panel (October 12). The achievement of in-season catch objectives will be assessed through a comparison with post-season catch estimates in the Achievement of Objectives section of this report.

Table 1. Pre-season and in-season updates of run size, spawning escapement targets and other TAC-related values for Fraser River sockeye in 2018. 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.

Date	Management Group	Total Abundance	TAC*					Total Allowable Catch	Available Harvest **	Catch to date	Mission Escape. to date	50% Migration Date
			Spawning Escapement Target	pMA	Management Adjust.	Test Fishing	Aboriginal Fishery Exemption					
June	Pre-season***	Early Stuart	84,000	84,000	0.69	58,000	800	7,500	84,000	0	0	2-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,700	74,900	1,154,900	1,000,100	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,800	153,200	2,102,400	2,241,600	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,700	164,400	4,441,800	2,956,200	3,166,300	17-Aug
		Sockeye	13,981,000	5,642,800	1,702,600	104,000	400,000	7,783,100	6,197,900	6,693,600		
July 6	In-season	Early Stuart	84,000	84,000	0.69	58,000	800	7,500	84,000	0	0	2-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,700	74,900	1,154,900	1,000,100	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,800	153,200	2,102,400	2,241,600	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,700	164,400	4,441,800	2,956,200	3,166,300	17-Aug
		Sockeye	13,981,000	5,642,800	1,702,600	104,000	400,000	7,783,100	6,197,900	6,693,600	71	21,600
July 10	In-season	Early Stuart	84,000	84,000	0.69	58,000	800	7,500	84,000	0	0	2-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,700	74,900	1,154,900	1,000,100	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,800	153,200	2,102,400	2,241,600	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,700	164,400	4,441,800	2,956,200	3,166,300	17-Aug
		Sockeye	13,981,000	5,642,800	1,702,600	104,000	400,000	7,783,100	6,197,900	6,693,600	220	63,500
July 13	In-season	Early Stuart	84,000	84,000	0.69	58,000	800	7,500	84,000	0	0	2-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,700	74,900	1,154,900	1,000,100	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,800	153,200	2,102,400	2,241,600	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,700	164,400	4,441,800	2,956,200	3,166,300	17-Aug
		Sockeye	13,981,000	5,642,800	1,702,600	104,000	400,000	7,783,100	6,197,900	6,693,600	790	92,500
July 17	In-season	Early Stuart	106,000	106,000	0.69	73,100	800	7,500	106,000	0	0	3-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,700	74,900	1,154,900	1,000,100	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,800	153,200	2,102,400	2,241,600	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,700	164,400	4,441,800	2,956,200	3,166,300	17-Aug
		Sockeye	14,003,000	5,664,800	1,717,700	104,000	400,000	7,805,100	6,197,900	6,693,600	1,410	135,600
July 20	In-season	Early Stuart	120,000	108,000	0.69	74,500	800	7,500	120,000	0	0	3-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,700	74,900	1,154,900	1,000,100	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,800	153,200	2,102,400	2,241,600	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,700	164,400	4,441,800	2,956,200	3,166,300	17-Aug
		Sockeye	14,017,000	5,666,800	1,719,100	104,000	400,000	7,819,100	6,197,900	6,693,600	2,270	175,700
July 24	In-season	Early Stuart	120,000	108,000	0.69	74,500	1,000	10,700	120,000	0	0	3-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,662	74,342	1,154,304	1,000,696	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,727	151,940	2,101,067	2,242,933	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,611	163,018	4,440,329	2,957,671	3,166,300	17-Aug
		Sockeye	14,017,000	5,666,800	1,719,100	104,000	400,000	7,815,700	6,201,300	6,693,600	3,640	268,600
July 27	In-season	Early Stuart	135,000	108,000	0.69	74,500	1,000	10,700	135,000	0	0	5-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,662	74,342	1,154,304	1,000,696	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,727	151,940	2,101,067	2,242,933	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,611	163,018	4,440,329	2,957,671	3,166,300	17-Aug
		Sockeye	14,032,000	5,666,800	1,719,100	104,000	400,000	7,830,700	6,201,300	6,693,600	14,340	396,900
July 31	In-season	Early Stuart	135,000	108,000	0.69	74,500	1,000	10,700	135,000	0	0	5-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,662	74,342	1,154,304	1,000,696	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,727	151,940	2,101,067	2,242,933	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,611	163,018	4,440,329	2,957,671	3,166,300	17-Aug
		Sockeye	14,032,000	5,666,800	1,719,100	104,000	400,000	7,830,700	6,201,300	6,693,600	43,500	587,000
August 3	In-season	Early Stuart	135,000	108,000	0.69	74,500	1,000	10,700	135,000	0	0	5-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,662	74,342	1,154,304	1,000,696	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,727	151,940	2,101,067	2,242,933	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,611	163,018	4,440,329	2,957,671	3,166,300	17-Aug
		Sockeye	14,032,000	1,860,100	1,719,100	104,000	400,000	7,830,700	6,201,300	6,693,600	134,370	901,600
August 7	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,000	10,700	125,000	0	0	4-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,662	74,342	1,154,304	1,000,696	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,727	151,940	2,101,067	2,242,933	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,611	163,018	4,440,329	2,957,671	3,166,300	17-Aug
		Sockeye	14,022,000	1,735,000	1,719,100	104,000	400,000	7,820,700	6,201,300	6,693,600	257,990	198,100
August 10	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,000	10,700	125,000	0	0	4-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	19,662	74,342	1,154,304	1,000,696	1,094,700	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	37,727	151,940	2,101,067	2,242,933	2,432,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	45,611	163,018	4,440,329	2,957,671	3,166,300	17-Aug
		Sockeye	14,022,000	1,735,000	1,719,100	104,000	400,000	7,820,700	6,201,300	6,693,600	1,131,170	1,335,300

Table 1, continued on next page

Table 1, continued.

Date	Management Group	Total Abundance	TAC*							Available Harvest **	Catch to date	Mission Passage to date	50% Migration Date Area 20	
			Spawning Escapement		Management	Test Fishing	Aboriginal Fishery Exemption***	Total Deductions	Total Allowable Catch					
			Target	pMA	Adjust.									
August 14	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	10,700	125,000	0	0	8,100	121,400	4-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	23,000	74,342	1,157,642	997,358	1,094,700	344,070	729,100	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	50,000	151,940	2,113,340	2,230,660	2,432,600	750,800	910,800	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	30,000	163,018	4,424,718	2,973,282	3,166,300	318,920	127,500	17-Aug
		Sockeye	14,022,000	5,666,800	1,719,100	104,070	400,000	7,820,700	6,201,300	6,693,600	1,421,890	1,888,800		
August 17	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	10,700	125,000	0	0	8,530	121,400	4-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	23,000	74,342	1,157,642	997,358	1,094,700	594,990	959,200	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	50,000	151,940	2,113,340	2,230,660	2,432,600	1,627,120	1,448,200	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	30,000	163,018	4,424,718	2,973,282	3,166,300	1,131,330	254,900	17-Aug
		Sockeye	14,022,000	5,666,800	1,719,100	104,070	400,000	7,820,700	6,201,300	6,693,600	3,361,970	2,783,700		
August 21	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	10,700	125,000	0	0	8,530	121,400	4-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	24,000	74,342	1,158,642	996,358	1,094,700	594,990	959,200	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	50,000	151,940	2,113,340	2,230,660	2,432,600	1,627,120	1,448,200	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	29,000	163,018	4,423,718	2,974,282	3,166,300	1,131,330	254,900	17-Aug
		Sockeye	14,022,000	5,666,800	1,719,100	104,070	400,000	7,820,700	6,201,300	6,693,600	3,361,970	2,783,700		
August 23	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	9,000	125,000	0	0	8,430	121,400	4-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	24,000	74,667	1,158,967	996,033	1,094,700	714,430	991,300	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	50,000	152,603	2,114,003	2,229,997	2,432,600	1,918,470	1,562,800	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	29,000	163,730	4,424,430	2,973,570	3,166,300	1,337,610	271,100	17-Aug
		Sockeye	14,022,000	5,666,800	1,719,100	104,070	400,000	7,822,400	6,199,600	6,693,600	3,978,940	2,946,600		
August 24	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	9,000	125,000	0	0	8,430	121,400	4-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	24,000	74,667	1,158,967	996,033	1,094,700	694,090	1,002,000	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	50,000	152,603	2,114,003	2,229,997	2,432,600	1,937,340	1,646,800	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	29,000	163,730	4,424,430	2,973,570	3,166,300	1,347,890	301,900	17-Aug
		Sockeye	14,022,000	5,666,800	1,719,100	104,070	400,000	7,822,400	6,199,600	6,693,600	3,987,750	3,072,100		
August 27	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	9,000	125,000	0	0	8,430	121,400	4-Jul
		Early Summer	2,155,000	862,000	0.23	198,300	24,000	74,667	1,158,967	996,033	1,094,700	717,390	1,047,000	8-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	50,000	152,603	2,114,003	2,229,997	2,432,600	2,029,890	1,821,000	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	29,000	163,730	4,424,430	2,973,570	3,166,300	1,467,160	408,900	17-Aug
		Sockeye	14,022,000	5,666,800	1,719,100	104,070	400,000	7,822,400	6,199,600	6,693,600	4,222,780	3,398,300		
August 28	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	9,000	125,000	0	0	8,430	121,400	4-Jul
		Early Summer	1,800,000	720,000	0.23	165,600	24,000	74,667	984,267	815,733	914,400	720,180	1,066,100	6-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	50,000	152,603	2,114,003	2,229,997	2,432,600	2,049,620	1,848,200	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	29,000	163,730	4,424,430	2,973,570	3,166,300	1,460,800	414,500	17-Aug
		Sockeye	13,667,000	5,524,800	1,686,400	104,070	400,000	7,647,700	6,019,300	6,513,300	4,239,030	3,450,200		
August 31	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	9,000	125,000	0	0	8,480	121,400	4-Jul
		Early Summer	1,700,000	680,000	0.23	156,400	24,000	74,667	935,067	764,933	863,600	751,490	1,079,900	6-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	51,600	152,603	2,115,603	2,228,397	2,432,600	2,154,570	1,924,500	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	29,330	163,730	4,424,760	2,973,240	3,166,300	1,535,120	434,100	17-Aug
		Sockeye	13,567,000	5,484,800	1,677,200	106,000	400,000	7,600,430	5,966,570	6,462,500	4,449,660	3,559,900		
September 4	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	9,000	125,000	0	0	8,480	121,400	4-Jul
		Early Summer	1,700,000	680,000	0.23	156,400	24,000	74,667	935,067	764,933	863,600	753,250	1,094,000	6-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	51,600	152,603	2,115,603	2,228,397	2,432,600	2,177,470	1,992,800	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	29,330	163,730	4,424,760	2,973,240	3,166,300	1,581,680	490,600	17-Aug
		Sockeye	13,567,000	5,484,800	1,677,200	106,000	400,000	7,600,430	5,966,570	6,462,500	4,520,880	3,698,800		
September 7	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	9,000	125,000	0	0	8,480	121,400	4-Jul
		Early Summer	1,700,000	680,000	0.23	156,400	24,000	74,667	935,067	764,933	863,600	761,880	1,099,500	6-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	51,600	152,603	2,115,603	2,228,397	2,432,600	2,238,820	2,006,600	11-Aug
		Late	7,398,000	2,959,200	0.43	1,272,500	29,330	163,730	4,424,760	2,973,240	3,166,300	1,662,140	551,200	17-Aug
		Sockeye	13,567,000	5,484,800	1,677,200	106,000	400,000	7,600,430	5,966,570	6,462,500	4,671,320	3,778,700		
September 11	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	6,850	125,000	0	0	8,480	121,400	4-Jul
		Early Summer	1,800,000	720,000	0.23	165,600	24,000	75,077	984,677	815,323	914,400	763,090	1,114,600	6-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	51,600	153,442	2,116,442	2,227,558	2,432,600	2,243,380	2,032,900	11-Aug
		Late	6,000,000	2,400,000	0.25	600,000	32,330	164,631	3,196,961	2,803,039	3,000,000	1,669,950	736,900	19-Aug
		Sockeye	12,269,000	4,965,600	1,013,900	109,000	400,000	6,423,080	5,845,920	6,347,000	4,684,900	4,005,800		
September 14	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	6,850	125,000	0	0	8,480	121,400	4-Jul
		Early Summer	1,800,000	720,000	0.23	165,600	24,000	75,077	984,677	815,323	914,400	782,860	1,119,100	6-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	51,600	153,442	2,116,442	2,227,558	2,432,600	2,305,540	2,059,000	11-Aug
		Late	6,000,000	2,400,000	0.25	600,000	32,330	164,631	3,196,961	2,803,039	3,000,000	2,089,660	801,500	19-Aug
		Sockeye	12,269,000	4,965,600	1,013,900	109,000	400,000	6,423,080	5,845,920	6,347,000	5,186,540	4,101,000		

Table 1, continued on next page

Table 1, continued.

Date	Management Group	Total Abundance	TAC*						Total Allowable Catch	Available Harvest**	Catch to date	Mission Passage to date	50% Migration Date Area 20	
			Spawning Escapement Target	pMA	Management Adjust.	Test Fishing	Aboriginal Fishery Exemption	Total Deductions						
September 17	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	6,850	125,000	0	0	8,480	121,400	4-Jul
		Early Summer	1,800,000	720,000	0.23	165,600	24,000	75,077	984,677	815,323	914,400	783,020	1,120,400	6-Aug
		Summer	4,344,000	1,737,600	0.10	173,800	51,600	153,442	2,116,442	2,227,558	2,432,600	2,303,040	2,063,300	11-Aug
		Late	6,000,000	2,400,000	0.25	600,000	32,380	164,631	3,196,961	2,803,039	3,000,000	2,195,550	1,147,700	19-Aug
		Sockeye	12,269,000	4,965,600	1,013,900	109,000	400,000	6,423,080	5,845,920	6,347,000	5,290,090	4,452,800		
September 19	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	6,850	125,000	0	0	8,480	121,400	4-Jul
		Early Summer	1,800,000	720,000	0.23	165,600	24,000	75,077	984,677	815,323	914,400	789,340	1,126,400	6-Aug
		Summer	4,100,000	1,640,000	0.10	164,000	51,600	153,442	2,009,042	2,090,958	2,296,000	2,296,270	2,079,200	10-Aug
		Late	6,000,000	2,400,000	0.25	600,000	34,380	164,631	3,198,961	2,801,039	3,000,000	2,200,400	1,354,100	19-Aug
		Sockeye	12,025,000	4,868,000	1,004,100	111,000	400,000	6,317,680	5,707,320	6,210,400	5,294,490	4,681,100		
September 21	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	6,850	125,000	0	0	8,470	121,400	4-Jul
		Early Summer	1,800,000	720,000	0.23	165,600	24,000	75,077	984,677	815,323	914,400	790,030	1,131,300	6-Aug
		Summer	4,100,000	1,640,000	0.10	164,000	51,600	153,442	2,009,042	2,090,958	2,296,000	2,298,570	2,060,700	10-Aug
		Late	6,000,000	2,400,000	0.25	600,000	34,380	164,631	3,198,961	2,801,039	3,000,000	2,213,380	1,504,500	19-Aug
		Sockeye	12,025,000	4,868,000	1,004,100	111,000	400,000	6,317,680	5,707,320	6,210,400	5,310,450	4,817,900		
September 25	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	6,850	125,000	0	0	8,510	121,400	4-Jul
		Early Summer	1,800,000	720,000	0.23	165,600	24,000	75,077	984,677	815,323	914,400	796,450	1,130,100	6-Aug
		Summer	4,100,000	1,640,000	0.10	164,000	51,600	153,442	2,009,042	2,090,958	2,296,000	2,314,760	2,079,900	10-Aug
		Late	6,000,000	2,400,000	0.25	600,000	34,380	164,631	3,198,961	2,801,039	3,000,000	2,396,610	1,723,800	19-Aug
		Sockeye	12,025,000	4,868,000	1,004,100	111,000	400,000	6,317,680	5,707,320	6,210,400	5,516,330	5,055,200		
September 28	In-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	6,850	125,000	0	0	8,510	121,400	4-Jul
		Early Summer	1,800,000	720,000	0.23	165,600	24,000	75,077	984,677	815,323	914,400	798,070	1,131,700	6-Aug
		Summer	4,100,000	1,640,000	0.10	164,000	51,600	153,442	2,009,042	2,090,958	2,296,000	2,316,180	2,104,800	10-Aug
		Late	6,000,000	2,400,000	0.25	600,000	34,380	164,631	3,198,961	2,801,039	3,000,000	2,454,880	1,944,600	19-Aug
		Sockeye	12,025,000	4,868,000	1,004,100	111,000	400,000	6,317,680	5,707,320	6,210,400	5,577,640	5,302,500		
October 12	End-of-season	Early Stuart	125,000	108,000	0.69	74,500	1,070	6,850	125,000	0	0	8,510	121,400	4-Jul
		Early Summer	1,800,000	720,000	0.23	165,600	24,000	75,077	984,677	815,323	914,400	798,930	1,128,300	6-Aug
		Summer	4,100,000	1,640,000	0.10	164,000	51,600	153,442	2,009,042	2,090,958	2,296,000	2,322,550	2,066,500	10-Aug
		Late	4,700,000	1,880,000	0.04	75,200	34,380	164,631	2,154,161	2,545,839	2,744,800	2,656,910	2,318,300	17-Aug
		Sockeye	10,725,000	4,348,000	479,300	111,000	400,000	5,272,880	5,452,120	5,955,200	5,786,900	5,634,500		14-Aug

* The TAC is determined by the run sizes and TAC deductions (spawning escapement targets, management adjustments, projected test fishing catches and AF Exemptions) that were in effect when Panel had the last in-season meeting (Oct 12).

** Available Harvest = Total abundance minus spawning escapement target and Management Adjustment. Management groups that meet the criteria of Low

*** 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

Overviews of commercial fisheries openings in Canadian and U.S. Panel Areas are contained in Table 2 and 3.

Table 2. Number of days when major Canadian commercial fisheries in the Fraser River Panel Area were open for directed harvest of Fraser River sockeye salmon in 2018. Regulatory control of Canadian Panel Areas was relinquished by the Panel on September 15 For Area 20, September 29 for Areas 17 and 18, and October 13 for Area 29, in accordance with pre-season regulations (Appendix D).

Date	Panel Areas					Non-Panel Areas			
	20		29		18, 29	11-16			
	Purse Seine	Gillnet	Purse Seine	Gillnet	Troll	Purse Seine	Gillnet	Troll H	Troll G
Jun.3-Jul.21									
Jul.22-Jul.28									
Jul.29-Aug.4							3		
Aug.5-Aug.11			2		6	4	6	6	
Aug.12-Aug.18			2		7	7	7	7	3
Aug.19-Aug.25			1		7	7	6	7	1
Aug.26-Sep.1					7	7	5	7	
Sep.2-Sep.8					3	4		3	
Sep.9-Sep.15			4		4		3		
Sep.16-Sep.22			7		7				
Sep.23-Sep.29			5		5				
Total	0	0	16	5	46	29	30	30	4

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 sockeye salmon in 2018. Regulatory control of U.S. Panel Areas was relinquished by the Panel on September 16 for Areas 4b, 5 and 6c, Areas 6, 7 and portions of 7a (according to in-season orders), and October 6 for the remaining portions of Area 7a, in accordance with pre-season regulations (Appendix D).

Date	Treaty Indian		All Citizen		
	Areas 4B, 5, 6C	Areas 6, 7, 7A	Areas 7 and 7A		
			Purse Seine	Gillnet	Reefnet
Jun.3-Jul.21					
Jul.22-Jul.28	2				
Jul.29-Aug.4	7	3	1	1	
Aug.5-Aug.11	7	4	2	2	3
Aug.12-Aug.18	7	3	1	1	1
Aug.19-Aug.25	6	1			
Aug.26-Sep.1					
Sep.2-Sep.8					
Sep.9-Sep.15					
Sep.16-Sep.22					
Total	29	11	4	4	4

IV. MANAGEMENT INFORMATION

To facilitate decision making, the Panel requires information about the abundance, timing, migration route and catch levels of Fraser River sockeye (by management group) and pink salmon. Pre-season, these quantities are provided by DFO in the form of forecasts that are augmented by PSC Staff through analysis of historical data. Staff update these estimates in-season through various assessment programs (Appendix F). Stock monitoring programs collect information about

abundance at various points along the migration route using test fisheries, hydroacoustics and observers. The locations and schedule for these Staff and DFO programs are listed in Table 4. These data are augmented with catch information from commercial, First Nations, recreational and other fisheries that are provided by the two countries. Stock identification programs collect and analyze biological samples (e.g., DNA, scales) from various fisheries, which are used to apportion the total abundance of sockeye into component stock groups. Table 5 shows the sockeye stock resolution that was reported in 2018.

Table 4. Panel-approved stock monitoring operations (test fishery, hydroacoustic and observer) conducted during the 2018 fishing season.

Area	Location	Gear	Dates	Operated by
Canadian Panel Areas				
20	Juan de Fuca Str.	Gillnet	July 10 - August 16	PSC
20	Juan de Fuca Str.	Purse Seine	July 25 - September 4	PSC
29-1 to 6	Str. of Georgia	Troll	August 21 - October 6	PSC
29-14	Fraser R. (Cottonwood)	Gillnet	July 12 - September 26	PSC
29-16	Fraser R. (Whonnock)	Gillnet	June 22 - October 12	PSC
29-16	Fraser R. (Mission)	Hydroacoustic	July 5 - October 9	PSC
	Fraser R. (Qualark)	Gillnet	July 2 - October 10	DFO
	Fraser R. (Qualark)	Hydroacoustic	July 1 - October 14	DFO
	Fraser R. (Hells Gate)	Observer	July 4 - October 12	PSC
Canadian non-Panel Areas				
12	Queen Charlotte Str. (Round Is.)	Gillnet	July 12 - August 14	DFO
12	Johnstone Str. (Blinkhorn)	Purse Seine	July 24 - September 11	DFO
13	Lower Johnstone Str.	Purse Seine	July 26 - August 31	DFO
United States Panel Areas				
5	Juan de Fuca Str.	Gillnet	July 17 - July 23	PSC
7	San Juan Islands	Reefnet	August 30 - August 30	PSC

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 abundances⁷, 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 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.

⁷ 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>.

Table 5. Individual stocks included in the Fraser River sockeye stock groups used in 2018.

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

Final in-season estimates of run-size adopted by the Panel totalled 10,725,000 Fraser River sockeye salmon (Table 1). This large abundance resulted in substantial fishing opportunities in both countries. The post-season abundance estimate (10,850,900 fish, Tables 8 and 9) based on accounted catches, spawning ground enumerations and difference between estimates (DBEs) is 22% lower than the median pre-season forecast (13,981,000) but similar to the final in-season estimate (10,725,000).

B. Migration Timing and Diversion Rate

Figures 3 and 4 show the forecasted and observed daily migrations, and Area 20 50% migration dates for each sockeye management group and for the total Fraser sockeye run. The end-of-season estimates of marine migration timing in 2018 were near expected pre-season values for all groups: Early Stuart (2 days later), Early Summer-run (2 days earlier), Summer-run (1 day earlier) and Late-run sockeye (as forecasted). The overall run was 1-day earlier than expected pre-season.

The in-season estimate of diversion rate through Johnstone Strait in 2018 was 33% compared to the pre-season prediction of 63% adopted for planning purposes. However, there were indications in-season that the northern diversion had been underestimated, as indicated by periods with catches near, or exceeding, the reconstructed daily abundance through Johnstone Strait. A post-season analysis adjusted the annual diversion rate to 39% based on the assumption that catches in Johnstone Strait did not exceed 80% of the available abundance (Figure 4).

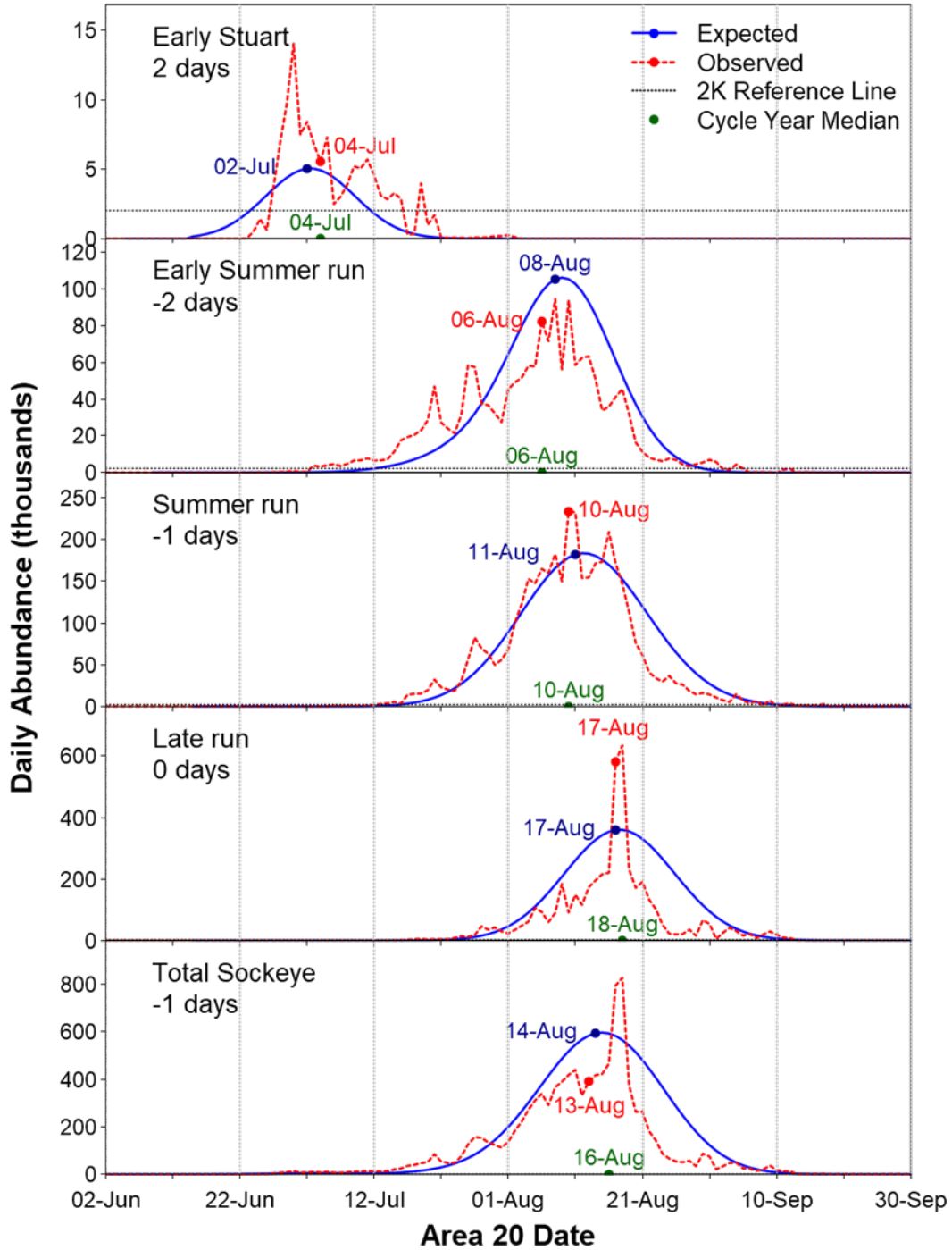


Figure 3. Pre-season expectations and post-season reconstructions of daily Fraser River sockeye salmon abundance by management group in 2018 (Area 20 date), including the observed 50% dates and number of days difference with pre-season expectations.

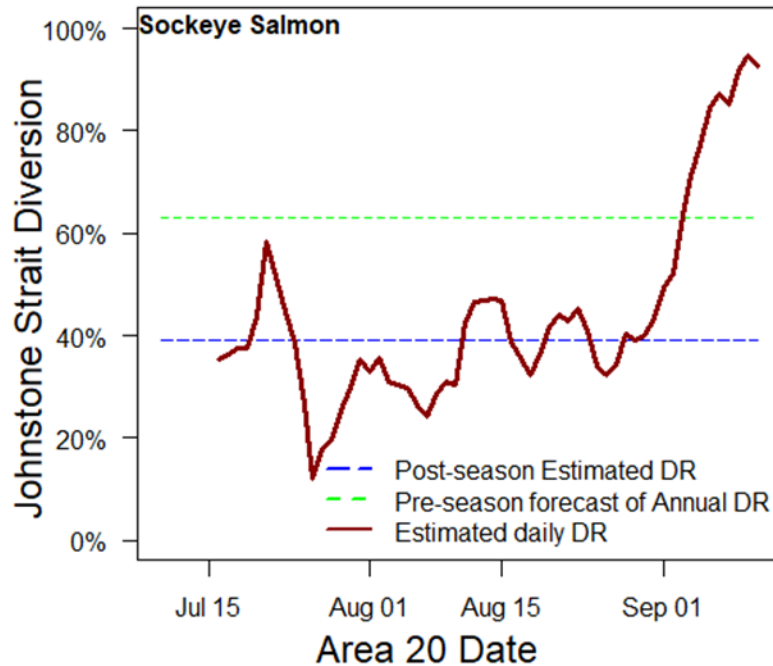


Figure 4. Pre-season forecast of annual Johnstone Strait diversion rate (DR) for Fraser sockeye salmon, compared to post-season estimates of daily and annual rates.

C. Management Adjustments and DBEs

Management Adjustments (MAs) are based on statistical models^{8,9,10,11} 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, B.C. in the Fraser River. When discharge levels or temperatures are above average, DBEs also tend to be high. In addition, for Early Stuart and Early Summer runs, in-season estimates are consistently higher than spawning ground estimates even when migration conditions are within normal ranges, and this tendency is also captured by the MA models. For Late-run sockeye, historical DBEs are related to the date when half the run has migrated past Mission (i.e., Mission 50% date), which captures the impact of the early migration behaviour observed since the mid-1990s on the migration success of these stocks.

Pre-season MA predictions and DBEs are based on median values from historical datasets for each management group or are based on models using long-range forecasts of river conditions and

⁸ 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.

⁹ Macdonald, J.S., Patterson, D.A., Guthrie, I., Lapointe, M. 2008. Improvements to environmental Management Adjustment models: SEF final report.

¹⁰ 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.

¹¹ 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.

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.

Spring snowpack values were average in the Fraser watershed; however, an early freshet with record high discharge in May depleted the snowpack early. Forecasts suggested lower than average flow conditions, which would make the Fraser River susceptible to the effects of the above average summer air temperatures predicted by the long-range forecast. Fraser River temperatures at Qualark were forecasted to be above normal. With minimal precipitation during the season, Fraser River discharge at Hope was one standard deviation below the historical average through August and into October. Water temperature remained high into August; however, towards the middle of August, with some possible buffering from the smoke of BC wildfires and some cooler weather, temperatures dropped close to average for the time of year. Observed temperatures exceeded the upper range of the optimum temperature for aerobic swimming for Early Summer-run and Summer-run sockeye during most of their 31-day migration period centered on the 50% Hells Gate date¹² (Figure 5).

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							
	Early Stuart ^{1,2}		Summer Aggregate		Summer Aggregate		Late Aggregate	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Pre-season adopted	-41%	0.69	-19%	0.23	-9%	0.10	-30%	0.43
In-season adopted	NA	NA	NA	NA	NA	NA	-4%	0.04
Observed ³	-58%	1.36	-27%	0.37	1%	-0.01	-19%	0.23

1 Pre-season, given the pre-season forecast of abundances, fisheries decisions that could impact the Early Stuart sockeye management group were based on a Low Abundance Exploitation Rate (LAER) limit.

2 In-season, given the 2018 in-season adopted run size and the pre-season adopted MA, fisheries decisions that could impact the Early Stuart sockeye management groups were based on a Low Abundance Exploitation Rate (LAER) limit.

3 Derived from Near Final escapement estimates

¹² Elliason, E.J., Clark, T.D., Hague, M.J., Hanson, L.M., Gallagher, Z.S., Jeffries, K.M., Gale, M.K., Patterson, D.A., Hinch, S.G., and Farrell, A.P. 2011. Differences in Thermal Tolerance Among Sockeye Salmon Populations. *Science* 332:109-112.

A summary of the pre-season MA models adopted and in-season MA models used during 2018 are provided in the “Management Adjustment and DBE” section in Appendix F. Comparisons of proportional management adjustment (pMA) estimates adopted for the pre-season, in-season and post-season periods are shown in Table 6. In-season, predictions from in-season environmental MA models of estimates of proportional difference between estimates (pDBEs) (Table F3) were presented to the Panel for the Early Stuart, Early Summer and Summer run. Environmental conditions in-season were more severe than predicted pre-season and the in-season models predicted larger (more negative) pDBEs for these run timing groups. The Panel did not adopt a change in-season to the pMA estimates for Early Stuart, Early Summer- or Summer-run sockeye as fish condition observations indicated fish were not being noticeably impacted by the higher than predicted temperatures. Instead these groups were managed based on the pre-season adopted pMA values (Table 6). In-season, Late-run sockeye seemed to delay their upstream migration longer than predicted pre-season. The longer delay (22 days) led to a later upstream 50% migration date for the Late-run and resulted in a lower pDBE (-4%) estimate from the upstream timing MA model than predicted pre-season (-30%, Table 6). The Panel adopted the corresponding pMA of 0.04. The end-of-season upstream timing date for Late-run sockeye based on Mission hydroacoustic estimates was September 17th, which resulted in a predicted pDBE of -0.20 (Table F3) based on the upstream timing MA model.

The post-season estimates of the %DBEs for Early Stuart and Early Summer-run sockeye were higher than those predicted pre-season, while the observed %DBEs for Summer- and Late-run sockeye were lower than predicted (see Table 6 for final observed %DBEs). For Early Stuart, the 19-day and 31-day MA models underestimated the observed %DBE. Despite the underestimated MA and the fact that the in-season run size was slightly larger than its spawning escapement target, this stock was managed in-season under a LAER of 10%. The sizeable DBE resulted in a much lower spawning escapement (48,500 sockeye, Table 9) than the in-season spawning escapement target of 125,000 sockeye (Table 12). For Early Summer-run sockeye, the 19-day and 31-day MA models overestimated the observed %DBE, although the 31-day model prediction of -33% was only 6% higher than the actual observed %DBE of -27%. The Early Summer run spawning escapement of 717,700 sockeye was similar to the in-season spawning escapement target of 720,000 sockeye. For Summer-run sockeye the observed DBE was positive (1%) suggesting slightly more fish on the spawning grounds than expected. The 19-day and 31-day MA models overestimated the observed %DBE. The Summer run sockeye escapement (1,749,000 sockeye, Table 9) exceeded the in-season spawning escapement target of 1,640,000 sockeye (Table 12). For Late run, the upstream timing MA model predicted a %DBE of -20% (using the final Mission 50% date of September 17th) which was similar to the observed %DBE of -19%. The spawning escapement for Late run of 1,585,000 sockeye (Table 9) was lower than the in-season spawning escapement target of 1,880,000 sockeye (Table 12).

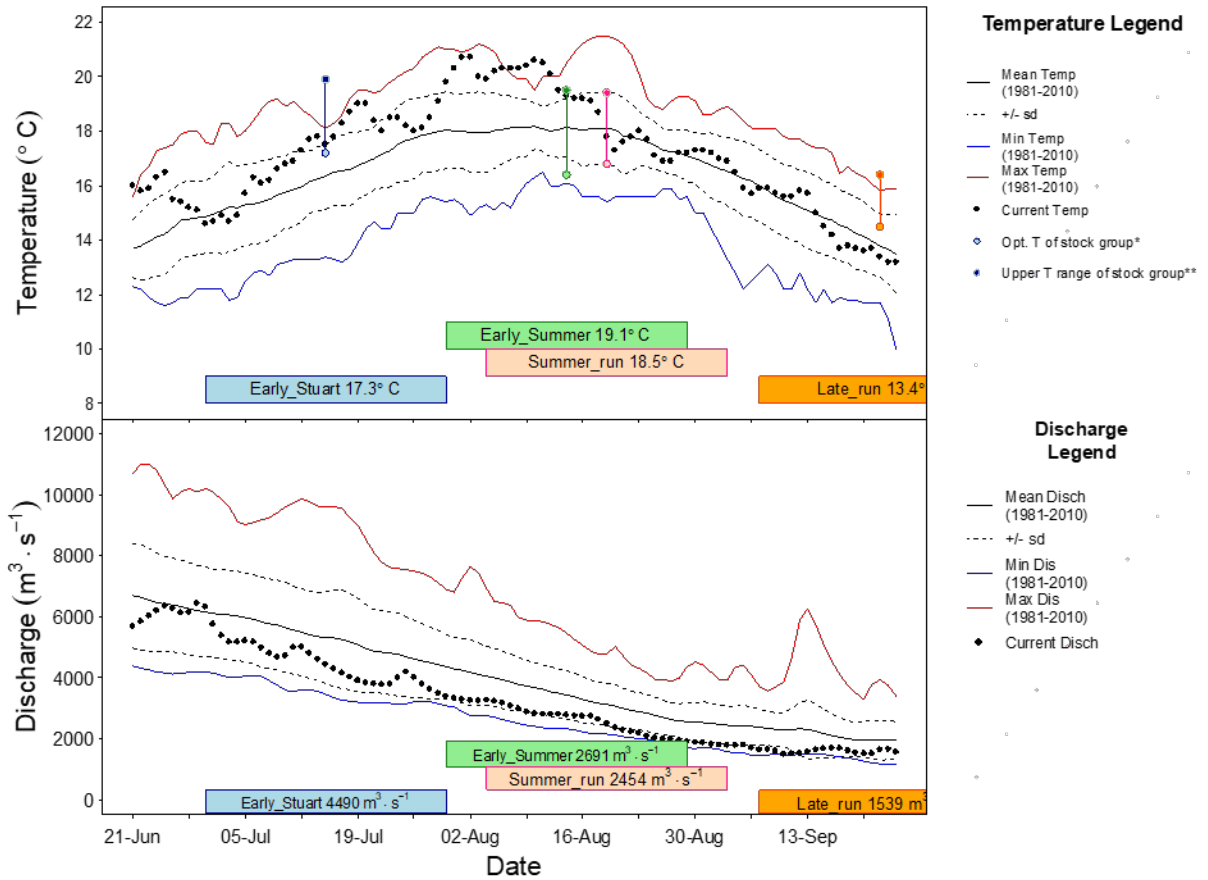


Figure 5. Fraser River temperature and discharge measured near Hope in 2018. Also shown are run timing bars that represent a 31-day spread of the run centred around the Hell’s Gate date and the mean temperature and discharge for the 31-day spread.

D. Mission Escapement

The upstream passage estimate of Fraser sockeye at Mission was 5,636,600, consisting of 121,400 Early Stuart, 1,127,800 Early Summer-run (including Pitt), 2,071,700 Summer-run, and 2,315,600 Late-run sockeye (Table 7). Sockeye passage estimates were derived using the hydroacoustics monitoring facility at Mission from July 5 to October 9. Mission passage from June 29 to July 1 was estimated using the passage estimates generated by the Qualark hydro-acoustic program. The Qualark hydroacoustics site is located 95km upstream from Mission and operated by DFO to provide estimates of sockeye passage further upstream. Qualark passage estimates are converted into Mission abundance estimates through a backwards reconstruction, taking into account catches taken between Mission and Qualark as well as stocks that migrate past Mission but not past Qualark due to the location of their spawning grounds. Before the commencement, and after the termination of hydroacoustics monitoring programs, daily sockeye passages were estimated by expansion of CPUE (catch per unit effort) data from the Whonnock gillnet test fishery.

Salmon passage was estimated by the Mission hydroacoustics program using a sampling method similar to that implemented in recent years by combining observations from a vessel-based mobile split-beam, a shore-based split-beam on the left bank, and a shore-based Adaptive

Resolution Imaging Sonar (ARIS) on both the left and right banks. Detailed descriptions of the hydroacoustics estimation methodology for 2018 are provided in Appendix F.

Table 7. Fraser River sockeye and pink salmon passage at Mission in 2018.

Management Group Stock Group	Mission Escapement	
	fish	%
Early Stuart	121,400	2%
Early Summer	1,127,800	20%
Chilliwack	4,900	0%
Early Miscellaneous	293,300	5%
Early South Thompson	797,100	14%
North Barriere/Taseko	7,200	0%
Pitt ¹	25,200	0%
Summer	2,071,700	37%
Raft/N.Thompson	18,000	0%
Chilko	662,200	12%
Quesnel	1,111,700	20%
Late Stuart/Stellako	260,500	5%
Harrison	19,400	0%
Late	2,315,600	41%
Birkenhead	30,800	1%
Late Shuswap/Portage	2,246,000	40%
Weaver/Cultus	38,800	1%
Total Sockeye	5,636,600	100%

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

V. RUN SIZE, CATCH AND ESCAPEMENT

A. Sockeye Salmon

The total abundance of sockeye salmon in 2018 was 10,864,000 fish (Tables 8 and 9), which is 22% smaller than the median forecast of 13,981,000 fish and about half the total return in 2014 (20,215,000). The 2018 return was the smallest run size on this cycle since 1978 (Figure 6). The causes of the small 2018 Fraser River sockeye return are unknown.

Table 8. Catch, escapement, difference between estimates and run size for Fraser River sockeye salmon (by management group) in 2018.

	Fraser Sockeye				Total	% of Run
	Early Stuart	Early Summer	Summer	Late		
CANADIAN CATCH	6,900	578,300	1,807,800	2,338,400	4,731,500	44%
Commercial Catch	0	301,200	1,141,600	1,745,500	3,188,300	29%
Panel Area	0	127,600	476,100	766,000	1,369,700	13%
Non-Panel Areas	0	173,600	665,500	979,500	1,818,600	17%
First Nations Catch	6,900	252,700	601,000	538,300	1,398,900	13%
Marine FSC	100	47,400	121,900	111,200	280,600	3%
Fraser River FSC	6,700	150,400	319,800	130,200	607,100	6%
Economic Opportunity	0	54,900	159,300	296,900	511,100	5%
Non-commercial Catch	50	24,500	65,300	54,500	144,300	1%
Marine Recreational	40	5,600	15,900	40,300	61,900	1%
Fraser Recreational	0	18,400	48,300	13,100	79,800	1%
Charter (Albion & Area 12 Chum)	10	500	1,000	1,100	2,600	0%
ESSR	0	0	0	0	0	0%
UNITED STATES CATCH	800	202,600	511,900	332,100	1,047,300	10%
Washington Total	600	191,500	490,600	310,800	993,500	9%
Commercial catch	600	189,300	486,300	306,600	982,800	9%
Treaty Indian	300	111,600	285,200	192,500	589,600	5%
All Citizen	300	77,700	201,100	114,200	393,200	4%
Non-commercial Catch	0	2,200	4,300	4,200	10,700	0%
Ceremonial	0	2,200	4,300	4,200	10,700	0%
Recreational	0	0	0	0	0	0%
Alaska	200	11,000	21,300	21,200	53,700	0%
TEST FISHING CATCH	1,100	24,200	51,600	36,200	113,000	1%
PSC (Panel Areas)	1,000	16,500	32,000	22,300	71,800	1%
Canada	1,000	15,500	30,200	21,700	68,400	1%
United States	10	1,000	1,800	600	3,400	0%
Canada (non-Panel Areas)	40	7,700	19,600	13,800	41,200	0%
TOTAL RUN	123,300	1,789,300	4,295,600	4,655,700	10,864,000	100%
Total Catch in All Fisheries	8,700	805,100	2,371,300	2,706,600	5,891,700	54%
Adult Spawning Escapement *	48,500	717,700	1,749,000	1,585,000	4,100,200	38%
Jack Spawning Escapement	0	900	1,300	10	2,200	0%
Difference Between Estimates**	66,100	265,700	174,000	364,100	869,900	8%
Percentage of Total Run	100%	100%	100%	100%	100%	
Total Catch in All Fisheries	7%	45%	55%	58%	54%	
Spawning Escapement	39%	40%	41%	34%	38%	
Difference Between Estimates	54%	15%	4%	8%	8%	

* Spawning escapement estimate for Cultus sockeye include 168 individuals captured as brood stock.

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

The returning abundances for all management groups were lower than pre-season expectations except for Early Stuart sockeye. A total of 123,300 Early Stuart sockeye adults (Table 9) returned, which exceeded the median forecast of 84,000 fish by about 50%. Early Summer-run sockeye returns totalled 1,788,400 adults, 17% less than the median forecast level. The dominant Early Summer-run component was Early South Thompson sockeye (1,340,900). The abundance of Summer-run sockeye was 4,294,400 adults, which was very similar to the median forecast of 4,344,000 sockeye. Most Summer-run fish were from the Quesnel group which had better than expected survival. The total abundance of Chilko fish (1,497,100 adults) was 34% less than the median pre-season forecast of 2,259,000 fish. Returning abundances to all Late-run stock components were very low relative to their median forecasts, especially for Late Shuswap/Portage, resulting in an aggregate Late-run return of 4,655,700 adults that was only 63% of the group's median pre-season forecast.

The total sockeye catch of 5,891,700 fish was about 54% of the run (Tables 8 and 9). This exploitation rate is the second highest since 2004 (Figure 7). Of the total sockeye catch, 4,731,500 fish were caught in Canada, and 1,047,300 fish in the U.S. and 113,000 fish in test fisheries (Table 8).

Table 9. Catch, escapement, difference between estimates, run size and exploitation rate for Fraser River sockeye (by stock group) salmon in 2018.

Management Group Stock Group	Catch	Adult Spawning	Difference	Abundance			Portion of Run	Adult Exploitation Rate
		Escapement	Between Estimates ³	Adult	Jack ¹	Total		
Fraser Sockeye Salmon								
Early Stuart	8,700	48,500	66,100	123,300	0	123,300	1%	7%
Early Summer-run	805,100	717,700	265,700	1,788,400	900	1,789,300	16%	45%
Chilliwack	300	2,300	2,500	5,100	0	5,100	0%	6%
Early Miscellaneous	157,100	191,700	50,700	399,500	900	400,400	4%	39%
Early South Thompson	636,300	507,100	197,500	1,340,900	0	1,340,900	12%	47%
North Barriere/Taseko	3,800	2,500	3,700	9,900	0	9,900	0%	38%
Pitt	7,700	13,900	11,300	32,900	0	32,900	0%	23%
Summer-run	2,371,300	1,749,000	174,000	4,294,400	1,300	4,295,600	40%	55%
Raft/N.Thompson	18,400	7,000	8,500	33,900	0	33,900	0%	54%
Chilko	878,700	618,500	0	1,497,100	1,300	1,498,400	14%	59%
Quesnel	1,130,100	818,900	136,300	2,085,300	0	2,085,300	19%	54%
Late Stuart/Stellako	323,900	289,400	25,400	638,800	0	638,800	6%	51%
Harrison/Widgeon	20,100	15,300	3,800	39,200	30	39,300	0%	51%
Late-run	2,706,600	1,585,000	364,100	4,655,700	10	4,655,700	43%	58%
Birkenhead/BigSilver	19,900	16,600	12,500	49,000	10	49,000	0%	41%
Late Shuswap/Portage	2,655,000	1,552,900	329,300	4,537,100	0	4,537,100	42%	59%
Weaver/Cultus	31,700	15,600 ²	22,300	69,600	0	69,600	1%	46%
Total	5,891,700	4,100,200	869,900	10,861,800	2,200	10,864,000	100%	54%
Portion of Total Run	54%	38%	8%	100%	0%	100%		

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

² Spawning escapement estimates of Cultus sockeye include 168 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 components of management groups.

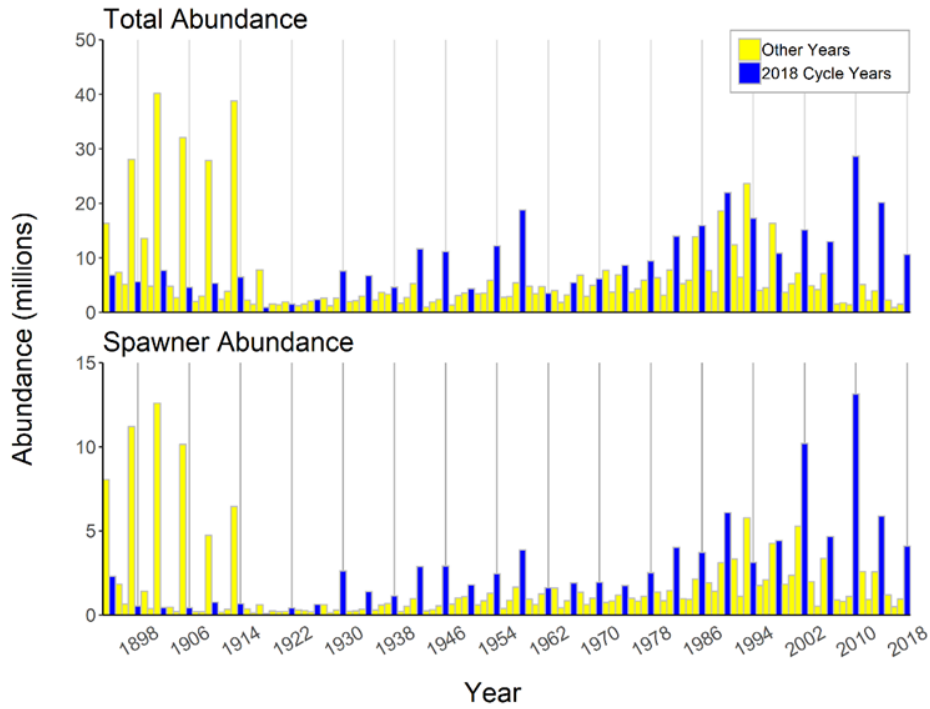


Figure 6. Total run size and spawning escapement of Fraser River sockeye salmon from 1893-2018. Returns on the 2018 cycle are emphasized.

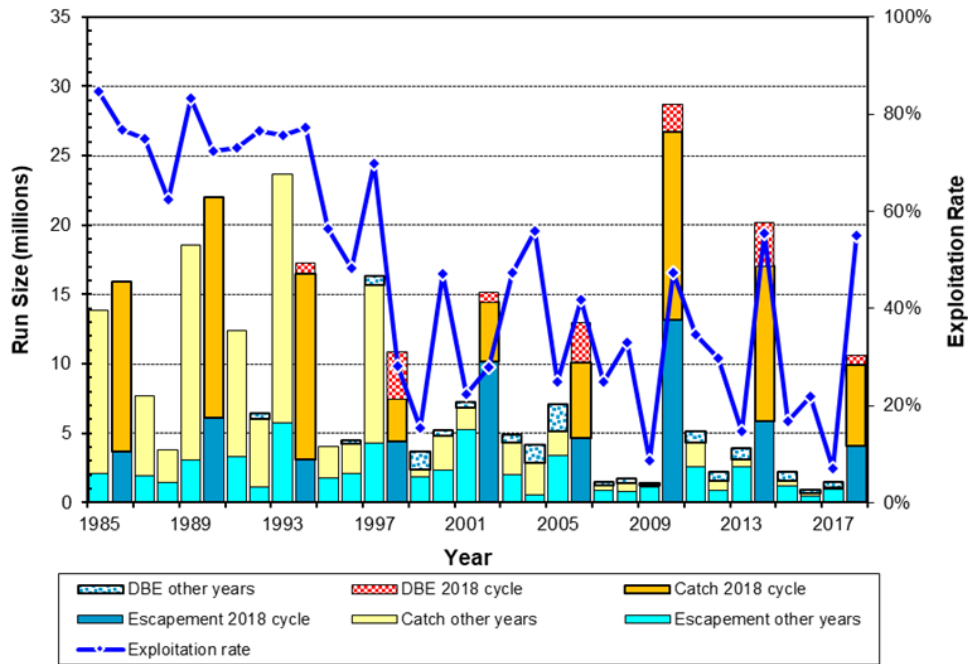


Figure 7. Total catch, escapement, difference between estimates, run size and exploitation rate for Fraser River sockeye salmon in 1985-2018, with returns on the 2018 cycle emphasized.

Most of the Canadian catch was taken in commercial fisheries (including First Nations Economic Opportunity fisheries), followed by First Nations FSC fisheries (Table 8). Within the commercial sector, most of the catch was taken in purse seines, followed by gillnet and then troll fisheries (Table 10).

Table 10. Canadian commercial catches of Fraser River sockeye salmon by gear type, license designation and statistical area in 2018. Grey areas indicate fishery areas are not part of the license-area designation.

Fishery Areas	Purse Seine		Gillnet			Troll			Total
	Area A	Area B	Area C	Area D	Area E	Area F	Area G	Area H	
Commercial	0	1,899,300	0	475,300	601,800	0	29,896	181,900	3,188,300
Panel Areas	0	627,500	0	0	601,800	0	10,100	120,100	1,359,600
20		0			0		0		0
17, 18, 29		627,500			601,800			120,100	1,349,500
121-124 *		0		0			10,100		10,100
Non-Panel Area	0	1,271,800	0	475,300	0	0	19,796	61,800	1,828,700
1-10	0		0			0			0
11-16		1,271,800		475,300	0		9,540	61,800	1,818,500
124-127 *		0		0			10,256		10,256
First Nations Economic Opportunity and Demo Fisheries									511,100
Total Catch									3,699,400

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

In Washington State 60% of the commercial catch (Table 8) was taken in Treaty Indian fisheries and the remainder in All Citizen fisheries. Most fish were caught by purse seines, followed by gillnets and reefnets (Table 11). The Alaska catch of Fraser sockeye was estimated to be 53,700.

Table 11. U.S. commercial catches of Fraser River sockeye salmon by user group, gear type and statistical area in 2018.

Areas	Troll	Purse			Total
		Seine	Gillnet	Reefnet	
Panel Area (Washington)	0	577,500	362,000	43,300	982,800
Treaty Indian *	0	307,400	282,200	0	589,600
4B, 5 and 6C	0	0	54,200	0	54,200
6 and 7	0	167,200	107,600	0	274,800
7A	0	140,200	120,300	0	260,500
All Citizen **	0	270,100	79,800	43,300	393,200
7	0	155,400	20,500	43,300	219,200
7A	0	114,700	59,300	0	174,000
Alaska (District 104) Catch	0	53,700	0	0	53,700
United States Total					1,036,600

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

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

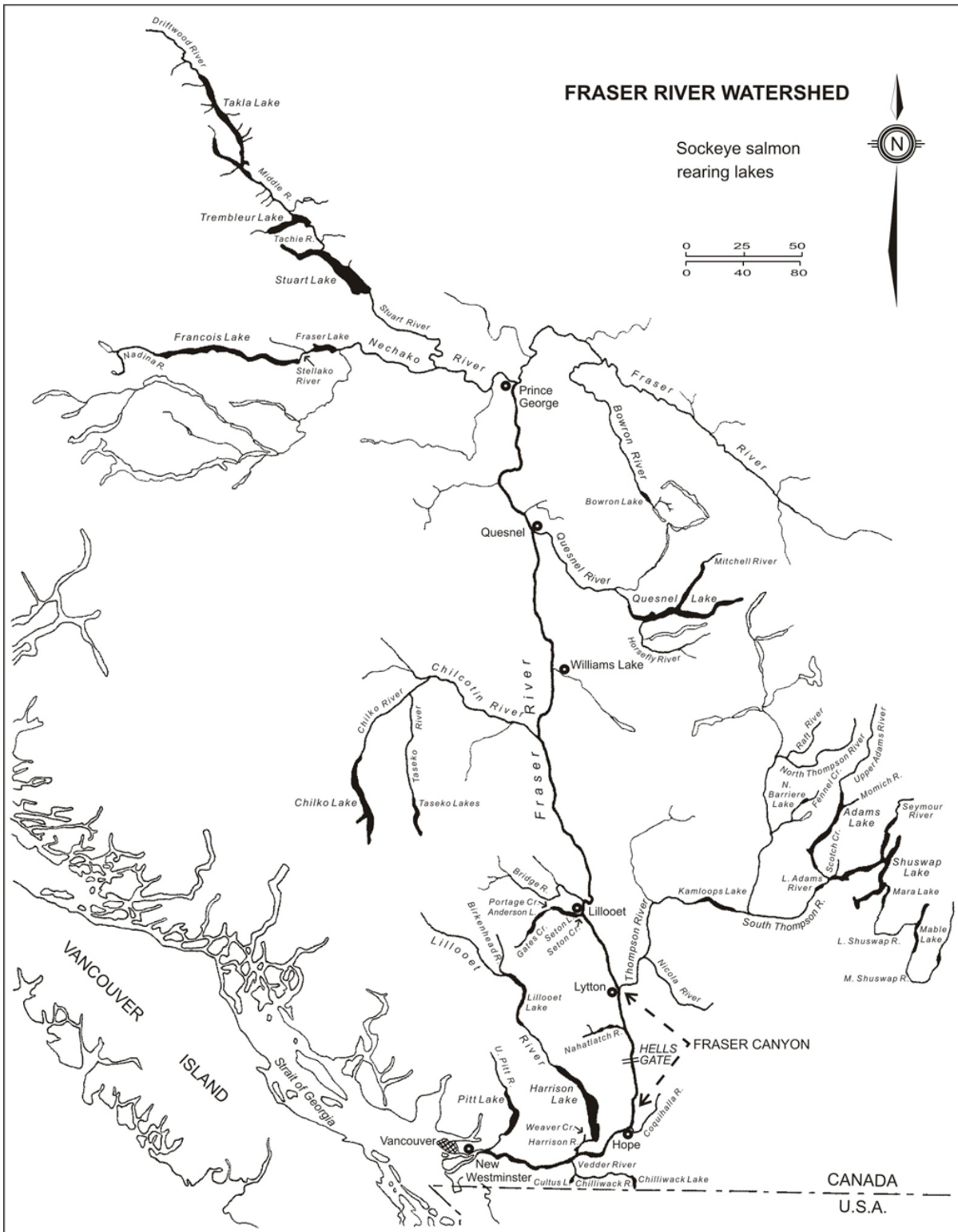


Figure 8. Sockeye salmon spawning areas in the Fraser River watershed.

DFO annually assesses the spawning ground abundance of sockeye populations in the Fraser watershed (Figure 8). In 2018, the near-final estimate of adult spawners (primarily age 4 and age 5 fish) totalled 4,100,200 fish (Table 9), or 38% of the total run. This escapement was 70% of the brood year (2014) escapement of 5,877,300 adults.

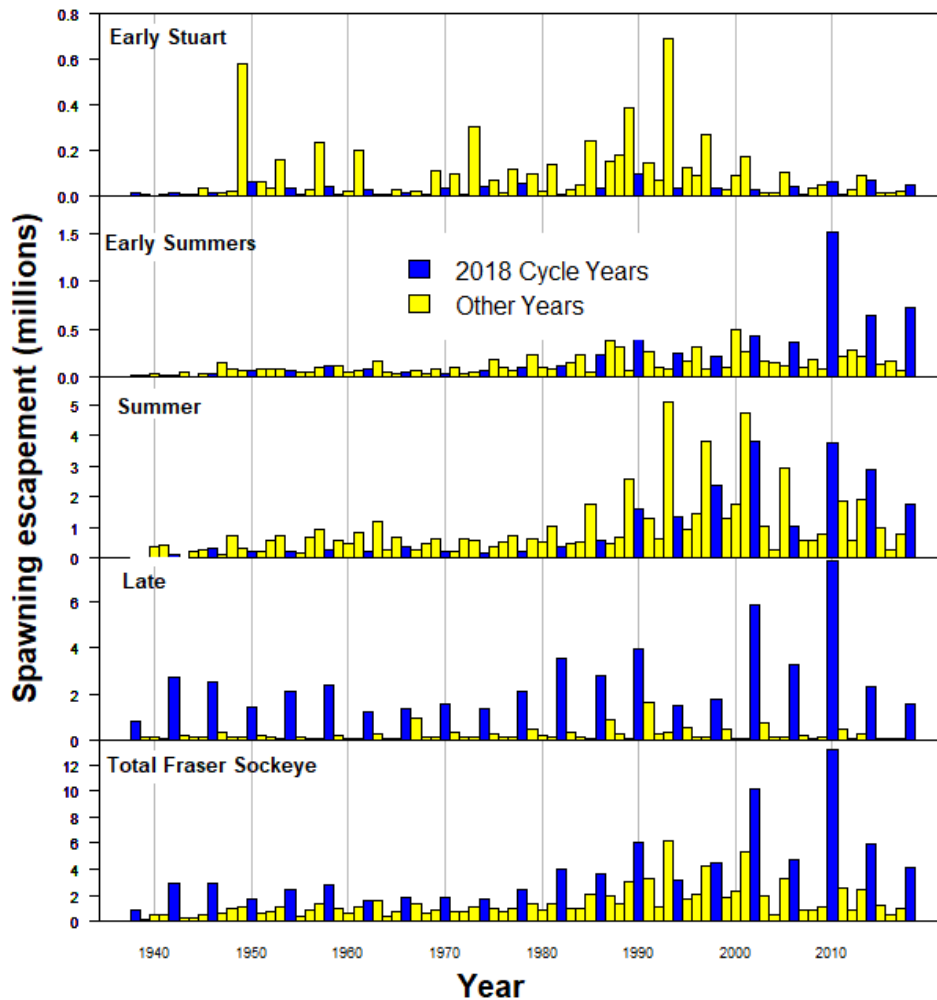


Figure 9. Annual adult spawning escapement of Fraser River sockeye salmon for each management group and for total sockeye in 1938-2018, with escapements on the 2018 cycle emphasized.

Spawner abundances for most management groups were much lower than those observed in the brood year (2014, Figure 9) except for the Early Summer run. On this cycle line, spawning escapements in 2018 were larger than cycle line medians for the Early Stuart system, Early Summer- and Summer-run, but less than cycle line median for Late run.

The overall spawning success of adult female sockeye in the Fraser watershed was estimated to be 93%. The effective female spawning population in 2018 totalled 2,037,080 fish, which was only 66% of the number of effective females in 2014.

The total DBE¹³ estimate was 869,900 fish, or 8% of the total return. As a percentage of the run size, the Early Stuart management group had the largest DBE at 54% while the DBEs for the Early Summer-, Summer- and Late run management groups ranged from 4 to 15% (Tables 8 and 9).

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

VI. ACHIEVEMENT OF OBJECTIVES

The mandate of the Fraser River Panel is to manage commercial fisheries in Panel Area waters to achieve a hierarchy of objectives. In order of importance, the objectives are to: (1) achieve spawning escapement targets for Fraser River sockeye and pink salmon as determined by the schedule provided by Canada; (2) achieve 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. Spawning escapement targets were determined by applying Canada's spawning escapement plan (Appendix B, Table B2) to abundance estimates for each management group, which resulted in the calculation of TAM rules (Total Allowable Mortality rates as a percentage of the total return) and corresponding escapement goals.

In-season, the progress toward reaching spawning escapement targets can not be directly measured because in most cases spawner abundance cannot be assessed on the spawning grounds until well after the fishing season has ended. In-season management is therefore based on potential spawning escapement targets (i.e., PSE target = in-season spawning escapement target + MA). Progress towards these targets is monitored by comparison with in-season potential spawning escapement (PSE) estimates (i.e., Mission escapement to-date - catch above Mission).

Based on final in-season estimates, in-season PSE estimates were below PSE targets for Early Stuart (8% under) and Summer-run stocks (4% under) but exceeded the target for Early Summer run (11% over) and were on target for Late run (Table 12). As discussed in the pre-season

¹³ 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.

planning section, Early Stuart sockeye were constrained by a 10% Low Abundance Exploitation Rate (LAER). In-season, as the total run size estimate decreased due to lower than expected Late-run returns, the available TAC decreased (Figure 10), resulting in the Panel constraining sockeye-directed fisheries, especially for Late run.

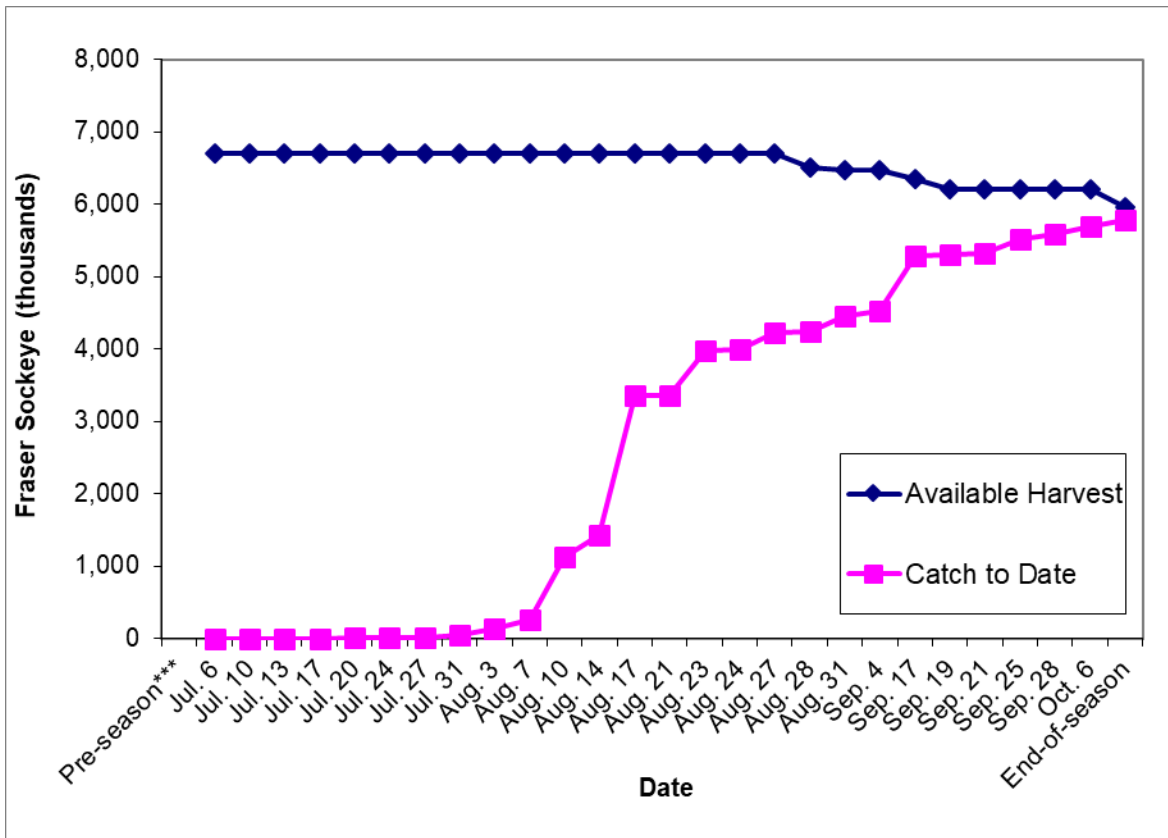


Figure 10. Available harvest of Fraser sockeye compared to catch to date in all fisheries in 2018. The available harvest is calculated as run size minus spawning escapement target and management adjustment and represents fish that are available for catch in all commercial, recreational, First Nations and test fisheries.

Table 12. Comparison of in-season targets and in-season estimates of potential spawning escapement (PSE) for adult Fraser River sockeye salmon in 2018.

Management Group	Final	Potential Spawning Escapement (PSE)						
	In-season	Spawning		In-season		PSE *** Estimate	Difference	
	Abundance Estimate	Escapement Target	Management Adjustment *	PSE ** Target	Fish		%	
Adult sockeye	10,725,000	4,348,000	479,300	4,769,800	4,783,000	13,200	0%	
Early Stuart	125,000	108,000	74,500	125,000	115,000	-10,000	-8%	
Early Summer	1,800,000	720,000	165,600	885,600	983,000	97,400	11%	
Summer	4,100,000	1,640,000	164,000	1,804,000	1,736,000	-68,000	-4%	
Late	4,700,000	1,880,000	75,200	1,955,200	1,949,000	-6,200	0%	

* 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 2% below the target (Table 13). Spawning ground escapement estimates for Early Stuart and Late run were below their targets, -55% and -15%, respectively; however targets were met for Early Summer and exceeded for Summer run (16%) (Table 13). The spawning escapement for Early Stuart sockeye fell short of the target primarily because the target was most of the run and the observed DBE (-58%, Table 6) made the target unattainable. With DBEs of this magnitude, the run size would have to be much larger than observed to achieve the escapement target, even in the absence of fishing. For the Late-run sockeye, the shortfall is mainly due to the larger than predicted DBE (-4% in-season versus -19% observed, Table 6), which means that in-season management objectives did not sufficiently account for the estimated loss of fish.

Table 13. Comparison of post-season spawning escapement targets and escapement estimates for adult Fraser River sockeye salmon in 2018. Post-season estimates of sockeye escapement are from spawning ground enumeration programs (DFO).

Management Group	Post-season Run-size Estimate	Spawning Escapement			
		Post-season Target	Adult Estimate	Difference	
				Fish	%
Sockeye salmon	10,864,000	4,189,500	4,100,200	-89,300	-2%
Early Stuart	123,300	108,000	48,500	-59,500	-55%
Early Summer	1,789,300	715,700	717,700	2,000	0%
Summer	4,295,600	1,503,500	1,749,000	245,500	16%
Late	4,655,700	1,862,300	1,585,000 *	-277,300	-15%

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

B. International Allocation

The Panel's second priority is to achieve the goals for international allocation of the TACs for Fraser sockeye and pink salmon. In accordance with Annex IV, Chapter 4 of the Pacific Salmon Treaty, the TAC calculations were based on the run sizes, spawning escapement targets and MAs in effect on the date when the Panel relinquished control of the last U.S. Panel Area, but an agreement by the Panel on February 14, 2019, established a new process for calculating the TAC (Total Allowable Catch). Instead of using the date of relinquishment of the last U.S. Panel Area, the Panel agreed to use the last in-season run size estimates adopted by the Panel (October 12). This agreement is reflected in the revised 2020 Chapter 4, Annex IV of the Pacific Salmon Treaty and retroactively modifies the TAC for 2018. The test fishing catch and Aboriginal Fisheries Exemption deductions are the post-season estimates, however.

Given the total in-season abundance estimate of 10,725,000, and deductions for spawning escapement, MA, test fishing catch and AFE, the International TAC for Fraser River sockeye salmon in 2018 was 5,450,100 (Table 14). The United States exceeded its share by 96,700 fish (Table 14). For Canada, the excess salmon to spawning requirements (ESSR) are excluded from catch totals when comparing them to the TAC. In 2018, the ESSR catch was 0 fish. Canada's catch of 4,731,500 Fraser sockeye fell 221,800 fish short of their allocated share of the International TAC plus their Aboriginal Fisheries Exemption (AFE) of 400,000 fish. A detailed version of the TAC calculations by management group is presented in Appendix G, Table G3.

Table 14. Total allowable catch (TAC) and achievement of international catch shares for Fraser River sockeye salmon in 2018. The process of calculating the TAC (Total Allowable Catch) was revised post-season based on Panel agreement February 14, 2019. TAC calculations use the in-season estimates of run size, spawning escapement target and management adjustment at the time of the last in-season Panel meeting (October 12), retroactively agreed to in accordance with the revised Annex IV, Chapter 4 of the Treaty agreed to January 2020.

	<u>Sockeye</u>	
TOTAL ALLOWABLE CATCH		
In-season Total Run Size		10,725,000
Deductions		5,340,300
In-season Spawning Escapement Target		4,348,000
In-season Management Adjustment		479,300
Aboriginal Fishery Exemption (AFE)		400,000
Post-season Test Fishing Catch		113,000
Total Allowable Catch	<i>1, 2</i>	5,450,100
UNITED STATES		
Washington Total Share	<i>3</i>	896,900
Washington Share of TAC	<i>1</i>	899,300 16.5%
Payback		-2,400
Washington Catch		993,500
Deviation		-96,700
In-season Alaska Catch Estimate		0
CANADA		
Canadian Share of TAC + U.S. Payback + AFE		4,953,300
Canadian Catch excluding ESSR Catch		4,731,500
Deviation		221,800

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).

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.

With respect to domestic allocations of Fraser sockeye salmon, Treaty Indian fishers in the U.S. caught 6,900 fish less than their share of the sockeye salmon TAC and All Citizen fishers caught 103,500 fish more (Table 15). There is no report of the domestic allocation for Canadian commercial fisheries as allocations are often moved between fishers through the ITQ system or when some groups are unable to harvest their pre-season share due to a variety of reasons.

Table 15. Achievement of domestic catch goals in Washington for Fraser River sockeye salmon in 2018.

User Category	Actual Catch		Share of TAC		Deviation
	Fish	%	Fish	%	
Washington Total	993,500	100.0%	896,901	100.0%	96,600
Treaty Indian *	600,300	60.4%	607,201	67.7%	-6,900
All Citizen **	393,200	39.6%	289,700	32.3%	103,500

* Treaty Indian catch includes commercial and ceremonial catches.

** All Citizen catch includes commercial and recreational catches.

D. Conservation of Other Stocks and Species

Non-target stocks and species are caught in Panel Area fisheries directed at Fraser River sockeye and pink salmon. The conservation needs and management requirements for these stocks and species caught incidentally in fisheries regulated by the Fraser Panel are taken into account through a variety of bilateral and domestic processes associated with the implementation of Chapter 4 (Fraser River sockeye and pink salmon) and other Chapters of Annex IV. A comprehensive summary of all the methods in which by-catch impacts are taken into account is beyond the scope of this report, but we provide a few examples below. In the United States, the Pacific Fishery Management Council takes into account modelled by-catch of Chinook and Coho salmon in Fraser Panel regulated sockeye and pink-directed fisheries to ensure consistency with Chapters 3 (Chinook) and 5 (Coho) of Annex IV. Similarly, Canada through its Integrated Fisheries Management Plan for South Coast salmon fisheries specifies closure windows for sockeye and pink-directed fisheries in the Fraser River and these closures are regularly implemented to protect Chinook and Coho. In 2018, Canada recommended a 20% exploitation rate constraint to Late-run catches seaward of the Chilliwack/Vedder confluence, due to Cultus Lake sockeye harvest constraints. This was later modified in-season to a level of exploitation that the late run aggregate could withstand once the Cultus Lake broodstock targets (about 200) were assured of being achieved. By-catches of non-Fraser sockeye and pink salmon in commercial net fisheries regulated by the Fraser River Panel totalled 3,600 sockeye and 200 pink salmon. Catches of other Fraser and non-Fraser salmon species included 5,490 Chinook, 3,250 Coho, and 270 chum (Table 16).

Table 16. Catches of non-Fraser sockeye and pink salmon and catches of other salmon species in commercial fisheries regulated by the Fraser River Panel in 2018.

Area and Gear	Non-Fraser		Fraser and Non-Fraser			
	Sockeye	Pink	Chinook	Coho	Chum	Steelhead
United States *	3,620	180	5,450	3,220	230	0
Areas 4B, 5 and 6C Net	400	10	2,150	3,070	210	0
Areas 6, 7 and 7A Net	3,220	170	3,300	150	30	0
Canada **	10	20	40	30	40	0
Area 20 Net	0	0	0	0	0	0
Area 29 Net	10	20	40	30	40	0
Total	3,630	200	5,490	3,250	270	0

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

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

VII. ALLOCATION STATUS

Annex IV, Chapter 4, (paragraph 8 (c)(iv)) specifies that *the US share will not be adjusted for an overage resulting from TAC reductions after the scheduling of the last Fraser River Panel approved U.S. fishery of the season.* The resulting calculations indicate there was no overage for Fraser River sockeye in 2018 (Table 17).

Table 17. Allocation status for Fraser River sockeye salmon in 2014-2018. No paybacks were owed by the U.S. after the 2018 fishing season.

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

*

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

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

- 2015: By Panel agreement, any U.S. catch of Fraser sockeye after August 7, when the last U.S. sockeye-directed fishery was scheduled, is considered an overage.
- 2016: No payback was generated in 2016, but by Panel agreement 900 sockeye were carried forward from the 2015 season.
- 2017: By Panel agreement 900 sockeye were carried forward from the 2015 season as well as the 1,500 sockeye overage generated from the 2017 season. U.S. pink salmon allocation status is based on TAC share in effect on Aug 31, when the last U.S. fishery was scheduled.
- 2018: Shall not exceed 16.5% for Fraser sockeye and 25.7% for Fraser pinks. Allocation status based on TAC when Panel made it's last decision about U.S. fisheries in 2018 (Aug. 23), because TAC decreased between date of last U.S. fishery decision (Aug. 23) and when Panel adopted last in-season run size (Oct 12).

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.

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 in to one of the above three categories.

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

Fishery-induced Mortality (FIM) or Release Mortality: In fisheries where some component of the catch is released (e.g., non-retention), some proportion of the released fish are expected to die due to the stress of capture and handling. These mortalities are referred to as fishery-induced mortality or release mortality.

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

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

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

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

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

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

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

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

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

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

Mission Escapement or Mission Passage: PSC estimates of the daily number of fish that migrate upstream past the hydroacoustic field station at Mission, B.C. Mission passage is primarily estimated by hydroacoustic methods, but at times (usually early and late in the season) is estimated by dividing the CPUE by catchability using data from in-river test fisheries.

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

Potential Spawning Escapement (PSE)

Potential spawning escapement target: In-season target for PSE by management group, where the PSE is the sum of the spawning escapement target plus the Management Adjustment (MA). May also be called the “Adjusted Spawning Escapement target”. The management objective is to achieve the PSE target in-season as measured by the potential spawning escapement.

Potential spawning escapement: Mission escapement estimate minus in-river catch upstream of Mission. If there were no en route mortalities or estimation errors in Mission escapement, up-river catch, spawning escapement or stock identification, the potential spawning escapement would in theory equal the number of fish estimated to have reached the spawning areas.

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

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

Spawning Escapement

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 Catch (TAC): The TAC is the remaining portion of the annual aggregate Fraser River sockeye and pink runs after the spawning escapement targets (excluding any catch of Fraser River sockeye identified in Alaskan waters), which are established by Canada’s pre-season escapement plan, the agreed Fraser River Aboriginal Exemption and the catch in Panel authorized test fisheries have been deducted.

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: <u>A</u> daptive <u>R</u> esolution <u>I</u> maging <u>S</u> onar	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: 2018 PRE-SEASON FORECASTS AND SPAWNING ESCAPEMENT TARGETS FOR FRASER RIVER SOCKEYE SALMON

Table B1. Pre-season forecasts for Fraser River sockeye salmon in 2018. (Provided to the Panel by Fisheries and Oceans Canada).

Run timing group Stocks	Forecast Model ^a	Probability that Return will be at/or Below Specified Run Size				
		10%	25%	50%	75%	90%
Early Stuart	<i>Ricker (Ei)</i>	37,000	54,000	84,000	133,000	199,000
Early Summer		584,000	1,102,000	2,155,000	3,765,000	6,587,000
(total excluding miscellaneous)		393,000	674,000	1,175,000	2,168,000	3,750,000
Bowron	<i>Ricker (Pi)</i>	7,000	12,000	20,000	35,000	59,000
Upper Barriere (Fennell)	<i>Power</i>	9,000	14,000	25,000	46,000	80,000
Gates	<i>Larkin</i>	11,000	20,000	38,000	76,000	149,000
Nadina	<i>MRJ</i>	45,000	81,000	153,000	291,000	518,000
Pitt	<i>Larkin</i>	22,000	32,000	53,000	84,000	130,000
Scotch	<i>Larkin</i>	89,000	166,000	330,000	750,000	1,513,000
Seymour	<i>RickerCyc</i>	210,000	349,000	556,000	886,000	1,301,000
Misc (EShu) ^b	<i>R/S</i>	186,000	416,000	956,000	1,546,000	2,736,000
Misc (Taseko) ^c	<i>R/S</i>	-	-	-	1,000	1,000
Misc (Chilliwack)	<i>Ricker</i>	2,000	5,000	11,000	25,000	53,000
Misc (Nahatlatch) ^d	<i>R/S</i>	3,000	7,000	13,000	25,000	47,000
Summer		1,470,000	2,473,000	4,344,000	7,669,000	13,173,000
(total excluding miscellaneous)		1,442,000	2,417,000	4,250,000	7,473,000	12,778,000
Chilko	<i>4-PowJuvPi; 5-Sib</i>	833,000	1,345,000	2,259,000	3,801,000	6,098,000
Late Stuart	<i>R1C</i>	55,000	88,000	149,000	251,000	401,000
Quesnel	<i>RickerEi</i>	292,000	573,000	1,148,000	2,223,000	4,152,000
Stellako	<i>Larkin</i>	229,000	347,000	559,000	895,000	1,454,000
Harrison ^e	<i>3-Ricker; 4-sibling</i>	13,000	33,000	87,000	225,000	548,000
Raft ^e	<i>Ricker (PDO)</i>	20,000	31,000	48,000	78,000	125,000
Misc (N. Thomp. Tribs) ^{e & f}	<i>R/S</i>	2,000	4,000	7,000	15,000	31,000
Misc (N. Thomp River) ^{e & f}	<i>R/S</i>	25,000	50,000	84,000	175,000	354,000
Misc (Widgeon) ^g	<i>R/S</i>	1,000	2,000	3,000	6,000	10,000
Late		3,174,000	4,794,000	7,398,000	11,370,000	16,934,000
(total excluding miscellaneous)		3,164,000	4,776,000	7,363,000	11,303,000	16,818,000
Cultus	<i>power (juv) (Pi)</i>	-	1,000	1,000	3,000	6,000
Late Shuswap	<i>RickerCyc</i>	3,045,000	4,548,000	6,923,000	10,415,000	15,091,000
Portage	<i>Larkin</i>	22,000	44,000	102,000	234,000	479,000
Weaver	<i>Ricker PDO</i>	38,000	78,000	150,000	318,000	655,000
Birkenhead	<i>Ricker (Ei)</i>	59,000	105,000	187,000	333,000	587,000
Misc Harrison/Lillooet ^g	<i>R/S</i>	10,000	18,000	35,000	67,000	116,000
TOTAL SOCKEYE SALMON		5,265,000	8,423,000	13,981,000	22,937,000	36,893,000
(TOTAL excluding miscellaneous)		5,036,000	7,921,000	12,872,000	21,077,000	33,545,000

a. See Table 4 for model descriptions

b. Misc. Early Shuswap uses Scotch and Seymour R/EF

c. Misc. Taseko uses Chilko R/EFS

d. Misc. Nahatlatch uses Early summer-run stocks R/EFS

e. Raft, Harrison, Misc. North Thompson stocks moved to Summer run-timing group

f. Misc. North Thompson stocks use Raft and Fennel R/EFS

g. Misc. Late Run stocks (Harrison Lake down-stream migrants including Big Silver, Cogburn, etc.), and river-type Widgeon use Birkenhead R/EFS

Table B2. Spawning escapement plan for Fraser River sockeye salmon in 2018, provided to the Panel by Fisheries and Oceans Canada and based on Fraser River Sockeye Spawning Initiative (FRSSI) guidelines with input from domestic consultations.

Harvest Rule Parameters						
Management Unit	Low Abundance ER (LAER)	TAM Cap	Lower Fishery Reference Point	Upper Fishery Reference Point	Pre-season pMA @p50	
Early Stuart	10%	60%	108,000	270,000	0.69	
Early Summer (w/o misc)	20%	60%	180,000	450,000	0.23	
Summer (w/o misc)	20%	60%	1,020,000	2,550,000	0.10	
Late (w/o misc)	20-30%	60%	1,100,000	2,750,000	0.43	

Management Unit	Pre-season Forecast Return					
	p10	p25	p50	p75	p90	
Early Stuart forecast	37,000	54,000	84,000	133,000	199,000	
TAM Rule (%)	0%	0%	0%	19%	46%	
Escapement Target	37,000	54,000	84,000	108,000	108,000	
MA	25,500	37,300	58,000	74,500	74,500	
Esc. Target + MA	62,500	91,300	142,000	182,500	182,500	
LAER	10%	10%	10%	10%	10%	
Available ER at Return	0%	0%	0%	0%	8%	
Allowable ER	10%	10%	10%	10%	10%	
Allowable Harvest	3,700	5,400	8,400	13,300	19,900	
<u>2018 Performance</u>						
Projected S (after MA)	19,600	28,700	44,600	70,600	105,700	
BY Spawners	68,613	68,613	68,613	68,613	68,613	
Proj. S as % BY S	29%	42%	65%	103%	154%	
cycle avg S	33,275	33,275	33,275	33,275	33,275	
Proj. S as % cycle S	59%	86%	134%	212%	318%	

Management Unit	Pre-season Forecast Return					
	p10	p25	p50	p75	p90	
Early Summer (w/o RNT) lower ref. pt. (w misc)	267,500	294,300	330,100	312,600	316,200	
upper ref. pt. (w misc)	668,700	735,800	825,300	781,500	790,400	
forecast (incl. misc)	584,000	1,102,000	2,155,000	3,765,000	6,587,000	
TAM Rule (%)	54%	60%	60%	60%	60%	
Escapement Target	267,500	440,800	862,000	1,506,000	2,634,800	
MA	61,500	101,400	198,300	346,400	606,000	
Esc. Target + MA	329,000	542,200	1,060,300	1,852,400	3,240,800	
LAER	20%	20%	20%	20%	20%	
Available ER at Return	44%	51%	51%	51%	51%	
Allowable ER	44%	51%	51%	51%	51%	
Allowable Harvest	255,000	559,800	1,094,700	1,912,600	3,346,200	
<u>2018 Performance</u>						
Projected S (after MA)	266,500	439,200	858,800	1,500,400	2,625,000	
BY Spawners	647,784	647,784	647,784	647,784	647,784	
Proj. S as % BY S	41%	68%	133%	232%	405%	
cycle avg S	330,355	330,355	330,355	330,355	330,355	
Proj. S as % cycle S	81%	133%	260%	454%	795%	

Table B2, continued on next page

Table B2, continued.

Management		Pre-season Forecast Return				
Unit		p10	p25	p50	p75	p90
Summer	<i>lower ref. pt. (w misc)</i>	1,064,300	1,064,300	1,064,300	1,064,300	1,064,300
(w. RNT & Ha	<i>upper ref. pt. (w misc)</i>	2,660,900	2,660,900	2,660,900	2,660,900	2,660,900
	forecast	1,470,000	2,473,000	4,344,000	7,669,000	13,173,000
	TAM Rule (%)	28%	57%	60%	60%	60%
	Escapement Target	1,064,300	1,064,300	1,737,600	3,067,600	5,269,200
	MA	106,400	106,400	173,800	306,800	526,900
	Esc. Target + MA	1,170,700	1,170,700	1,911,400	3,374,400	5,796,100
	LAER	20%	20%	20%	20%	20%
	Available ER at Return	20%	53%	56%	56%	56%
	Allowable ER	20%	53%	56%	56%	56%
	Allowable Harvest	299,300	1,302,300	2,432,600	4,294,600	7,376,900
<u>2018 Performance</u>						
	Projected S (after MA)	1,065,300	1,065,300	1,739,400	3,070,700	5,274,500
	BY Spawners	2,837,275	2,837,275	2,837,275	2,837,275	2,837,275
	Proj. S as % BY S	38%	38%	61%	108%	186%
	cycle avg S	815,485	815,485	815,485	815,485	815,485
	Proj. S as % cycle S	131%	131%	213%	377%	647%
Management		Pre-season Forecast Return				
Unit		p10	p25	p50	p75	p90
Late	<i>lower ref. pt. (w misc)</i>	1,105,200	1,105,200	1,105,200	1,105,200	1,105,200
(w/o Har)	<i>upper ref. pt. (w misc)</i>	2,763,100	2,763,100	2,763,100	2,763,100	2,763,100
	forecast	3,174,000	4,794,000	7,398,000	11,370,000	16,934,000
	TAM Rule (%)	60%	60%	60%	60%	60%
	Escapement Target	1,269,600	1,917,600	2,959,200	4,548,000	6,773,600
	MA	545,900	824,600	1,272,500	1,955,600	2,912,600
	Esc. Target + MA	1,815,500	2,742,200	4,231,700	6,503,600	9,686,200
	LAER	20%	20%	20%	30%	30%
	Available ER at Return	43%	43%	43%	43%	43%
	Allowable ER	43%	43%	43%	43%	43%
	Allowable Harvest	1,358,500	2,051,800	3,166,300	4,866,400	7,247,800
<u>2018 Performance</u>						
	Projected S (after MA)	1,270,900	1,919,500	2,962,200	4,552,500	6,780,300
	BY Spawners	2,303,384	2,303,384	2,303,384	2,303,384	2,303,384
	Proj. S as % BY S	55%	83%	129%	198%	294%
	cycle avg S	2,652,186	2,652,186	2,652,186	2,652,186	2,652,186
	Proj. S as % cycle S	48%	72%	112%	172%	256%
	Allowable Harvest (TF, US, CDN)	1,916,500	3,919,300	6,702,000	11,086,900	17,990,800
	Total projected spawners	2,622,300	3,452,700	5,605,000	9,194,200	14,785,500

APPENDIX C: 2018 FRASER RIVER PANEL MANAGEMENT PLAN PRINCIPLES AND CONSTRAINTS (agreed July 6, 2018)

1. Fisheries and Oceans Canada (DFO) has provided the Panel with run-size forecasts for Fraser River sockeye salmon. It is broadly understood that the sockeye run-size forecasts are associated with relatively high uncertainty due to high variability in annual salmon productivity (e.g. recruits/spawner, recruits/fry) and observation error in the associated data. The 50% probability level forecast for the total Fraser sockeye return is 13,981,000 fish. To put the sockeye run size forecast uncertainty into context, there is a one in four chance that the actual number of returning sockeye will be at or below 8,423,000 fish and there is a one in four chance that the actual number of returning sockeye will be at or larger than 22,937,000 fish. By stock grouping, the median or 50% probability forecasts are 84,000 Early Stuart, 2,155,000 Early Summer-run, 4,344,000 Summer-run, and 7,398,000 Late-run sockeye. The 50% probability level abundance forecasts for Fraser River sockeye salmon were used for pre-season planning purposes. When sufficient information is available in-season, the Panel will update run size estimates of Fraser River sockeye salmon, as appropriate.
2. The Panel's first priority is to obtain spawning escapement goals by stock or stock grouping. A coordinated approach to management has been developed that reflects both Parties sharing the burden of conservation. The US anticipates harvesting their full sockeye salmon total allowable catch (TAC). Canada has an additional constraint for the Late run as its allowable exploitation rate is higher than the allowable exploitation rate for Cultus (Late run LAER 20-30%) which limits Canada's ability to harvest their full share of the sockeye salmon TAC.
3. TACs and international shares are calculated according to the 2014 revised Annex IV, Chapter 4, of the Pacific Salmon Treaty, which limits the United States harvest (in Washington State) to 16.5% of the TAC of Fraser River sockeye salmon. Based upon the 50% probability levels of abundance, for the purposes of computing Fraser River sockeye TAC by stock management grouping in 2018, the Panel agreed to pre-season Fraser River Aboriginal Exemptions as determined by the process outlined in paragraph 3d. In situations where the allowable harvest of Fraser sockeye salmon management group, according to Total Allowable Mortality rules as defined in Canada's escapement plan, is less than the harvest allowed under the low abundance exploitation rates (LAERs), the Panel will implement LAERs in order to allow access to available TAC in other Fraser River sockeye salmon management groups. At the 50% probability forecasts, the LAERs are set at 10% for Early Stuart, 20% for Early Summer and Summer-run sockeye, and 20-30% for Late-run sockeye. LAERs are not intended to create directed harvest opportunities in mixed stock areas and do not contribute to International TACs. Calculated International TACs that fall below the LAER amount will contribute to the International share.
4. The Panel has adopted a management approach for Late-run sockeye that presumes that similar to recent dominant Adams return years, where a small portion of Late-run sockeye will enter the Fraser River earlier than the long-term average, and some proportion will not survive to spawn.

5. Given pre-season assumptions about Late-run sockeye marine timing and recent delay behavior, the Panel has agreed to use a proportional Management Adjustment (MA) factor for the aggregate (pMA) of 0.43. If in-season information suggests that the upstream timing of the Late-run excluding Birkenhead is later than September 15th, the Panel will consider adjusting the MA factor based on predictions from the timing model fit to all years.

Regulations

- i) If in-season conditions are consistent with pre-season expectations, low impact fisheries would be expected to commence in late-July in Panel Waters. The actual start dates and duration of fisheries will depend on in-season estimates of timing, abundance, diversion, and agreed management adjustments.
- ii) The Parties' conservation concerns for other species and stocks will be taken into account throughout the 2018 management season.

APPENDIX D: 2018 REGULATIONS

The Fraser River Panel approved regulations for the management of the Fraser River sockeye salmon fishery in Panel Area waters and submitted these to the Pacific Salmon Commission. The Commission approved the Fishery Regime and Regulations and submitted these to the respective national governments for approval on June 13, 2018.

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 24th day of June, 2018, to the 15th day of September, 2018, 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 24th day of June, 2018, to the 15th day of September, 2018, 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 24th day of June, 2018 to the 29th day of September, 2018, 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 24th day of June, 2018, to the 29th day of September, 2018, 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 24th day of June, 2018, to the 13th day of October, 2018, both dates inclusive.
 - b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 29 from the 24th day of June, 2018, to the 13th day of October, 2018, both dates inclusive.
4. The following Fraser River Panel Area waters are excluded:
 - a) High Seas westerly of the Bonilla Point-Tatoosh Island Lighthouse Line.
 - b) Pacific Fishery Management Area 19, Area 20-2 and 5 to 7 and Area 29-8.
 - c) Commercial troll fishing in Pacific Fishery Management Area 17, Area 18-2, 3 and 5 to 10.

During the 2018 season, the Fraser River Panel will adopt orders establishing open fishing periods based on a 2018 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 24th day of June, 2018 to the 22nd day of September, 2018, 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 24th day of June, 2018, to the 22nd day of September, 2018, 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 23rd day of September, 2018, to the 6th day of October, 2018, 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 24th day of June, 2018, to the 22nd day of September, 2018, 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 24th day of June, 2018, to the 22nd day of September, 2018, 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 23rd day of September, 2018, to the 6th day of October, 2018, 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 2018 season, the Fraser River Panel will adopt orders establishing open fishing periods based on a 2018 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: 2018 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.

July 24, 2018

United States

Treaty Indian

Areas 4B, 5 and 6C

Open to drift gillnets from 12:00 p.m. (noon), Friday, July 27, 2018 through 12:00 p.m. (noon) Tuesday, July 31, 2018.

July 27, 2018

United States

Treaty Indian

Areas 4B, 5 and 6C

Extend for drift gillnets 12:00 p.m. (noon), Tuesday, July 31, 2018, to 12:00 p.m. (noon) Wednesday, August 01, 2018.

July 31, 2018

United States

Treaty Indian

Areas 4B, 5 and 6C

Extend for drift gillnets 12:00 p.m. (noon), Wednesday, August 01, 2018, to 12:00 p.m. (noon) Saturday, August 04, 2018.

Areas 6, 7 and 7A

Open for net fishing from 5:00 a.m., Thursday August 2, 2018 to 9:00 a.m., Friday, August 3, 2018 and from 5:00 a.m. Saturday August 4, 2018 through 9:00 a.m. Sunday August 5, 2018.

All Citizen

Areas 7 and 7A

Open to purse seines from 5:00 a.m. to 9:00 p.m., Friday August 3, 2018.

Areas 7 and 7A

Open to drift gillnets from 8:00 a.m. to 11:59 p.m., Friday August 3, 2018.

Areas 7 and 7A

Open to reefnets from 5:00 a.m. to 9:00 p.m., Monday August 6, 2018.

August 3, 2018

Canada

Areas 18-1, 18-11 and Area 29-1 to 6

Open to Area H troll ITQ fishery from 12:01 a.m. Monday, August 6, 2018 until further notice.

Area 29: Portions of 29-3, 4, 6, 7, 9, 10 and 11 to 17

Open to Area E gillnets from 7:00 a.m., Wednesday August 8 to 7:00 a.m., Thursday August 9, 2018.

United States

Treaty Indian

Areas 4B, 5 and 6C

Extended for drift gillnets 12:00 p.m. (noon), Saturday, August 4, 2018 to 12:00 p.m. (noon) Wednesday, August 8, 2018.

Areas 6, 7 and 7A

Open for net fishing from 5:00 a.m., Tuesday August 7, 2018 to 9:00 a.m., Thursday, August 9, 2018.

All Citizen

Areas 7 and 7A

Open to purse seines from 5:00 a.m. to 9:00 p.m., Monday August 6, 2018.

Areas 7 and 7A

Open to drift gillnets from 8:00 a.m. to 11:59 p.m.(midnight) Monday, August 6, 2018.

Areas 7 and 7A

Open to reefnets from 5:00 a.m. to 9:00 p.m., Wednesday August 8, 2018.

August 7, 2018

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets 12:00 p.m. (noon), Wednesday, August 8, 2018 to 12:00 p.m. (noon) Saturday, August 11, 2018.

August 8, 2018

United States

All Citizen

Areas 7 and 7A

Open to purse seines from 5:00 a.m. to 9:00 p.m., Thursday August 9, 2018.

Areas 7 and 7A

Open to drift gillnets from 8:00 a.m. to 11:59 p.m.(midnight) Thursday, August 9, 2018.

Areas 7 and 7A

Open to reefnets from 5:00 a.m. to 9:00 p.m., Thursday, August 9, 2018.

August 10, 2018

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon), Saturday, August 11, 2018 to 12:00 p.m. (noon) Wednesday, August 15, 2018.

August 14, 2018

Canada

Area 29: Portions of 29-3, 4, 6, 7, 9, 10, 11 and 13 to 17

Open to Area E gillnets from 6:00 a.m. to 10:00 p.m. Wednesday August 15 and 6:00 a.m. to 10:00 p.m., Thursday August 16, 2018.

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon), Wednesday, August 15, 2018 to 12:00 p.m. (noon) Saturday, August 18, 2018.

Areas 6, 7 and 7A

Open for net fishing from 5:00 a.m. Wednesday August 15, 2018 to 9:00 a.m., Friday, August 17, 2018.

All Citizen

Areas 7 and 7A

Open to purse seines from 9:00 a.m. to 5:00 p.m., Friday August 17, 2018.

Areas 7 and 7A

Open to drift gillnets from 2:30 p.m. to 10:30 p.m., Friday August 17, 2018.

Areas 7 and 7A

Open to reefnets from 6:30 a.m. to 2:30 p.m., Saturday, August 18, 2018.

August 17, 2018

Canada

Area 29: Portions of 29-3, 4, 6, 7, 9, 10, and 11 to 17

Open to Area E gillnets from 10:00 a.m. to 6:00 p.m. Tuesday August 21, 2018.

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon), Saturday, August 18, 2018 to 12:00 p.m. (noon) Wednesday, August 22, 2018.

August 21, 2018

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon), Wednesday, August 22, 2018 to 1:00 p.m. Friday, August 24, 2018.

Areas 6, 7 and 7A

Open for net fishing from 5:00 a.m. to 1:00 p.m., Friday, August 24, 2018.

August 23, 2018

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 1:00 p.m. to 11:59 p.m. Friday, August 24, 2018.

Areas 6, 7 and 7A

Extended for drift gillnet fishing from 1:00 p.m. to 11:59 p.m. Friday, August 24, 2018.

Areas 6, 7 and 7A

Extended for purse seine fishing from 1:00 p.m. to 9:00 p.m. Friday, August 24, 2018.

September 4, 2018

Canada

Areas 18-1, 18-11 and Area 29-1 to 6

Open to Area H troll ITQ fishery from 12:01 a.m. Monday, August 6, 2018 with an anticipated closure of 11:59 p.m. Tuesday, September 4, 2018.

September 11, 2018

Canada

Areas 18-1, 18-11 and Area 29-1 to 6

Open to Area H troll ITQ fishery from 12:01 a.m. Wednesday September 12, 2018 until further notice.

Area 29: Portions of 29-3, 4, 6 and 10 (seaward of the 45 meter depth contour):

Open to Area B purse seine ITQ from 6:00a.m. to 9:00 p.m. daily Wednesday, September 12, 2018 until further notice.

United States

Areas 4B, 5 and 6C

Relinquish regulatory control effective (11:59 p.m.) Saturday, September 15, 2018.

Areas 6, 6A and 7

Relinquish regulatory control effective (11:59 p.m.) Saturday, September 15, 2018.

September 28, 2018

Canada

Areas 18-1, 18-11 and Area 29-1 to 6

Open to Area H troll ITQ fishery from 12:01 a.m. Wednesday September 12, 2018 to 11:59 p.m. Thursday, September 27, 2018.

Area 29: Portions of 29-3, 4, 6 and 10 (seaward of the 45 meter depth contour):

Open to Area B purse seine ITQ from 6:00a.m. to 9:00 p.m. daily Wednesday, September 12, 2018 to 9:00 p.m. Thursday, September 27, 2018.

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 15; Areas 17 and 18 on September 29; and Area 29 on October 13. Panel control of United States Panel Areas were relinquished as follows; Areas 4B, 5 and 6C on September 15 by in-season order; Areas 6, 6A and 7 on September 15 by in-season order, and the remaining portions of Area 7A on October 6 in accordance with the pre-season Regulations.

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

Stock Monitoring

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

A. Test Fishing

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

Table F1. Sampling details for Panel-approved test fisheries conducted in 2018.

Area	Name	Gear	Number of Vessels	Net Length (m)	Net Depth (meshes)	Mesh Size (mm) (in)		Number of Sets	Set Duration (minutes)
Canadian Panel Areas									
20	Juan de Fuca Str.	Gillnet	2	547	90	130	5 1/8	2	300
20	Juan de Fuca Str.	Purse Seine	1	549	875	95	3 3/4	6	20
29-1 to 6	Str. of Georgia	Troll	2	n/a	n/a	n/a	n/a	n/a	n/a
29-14	Fraser R. (Cottonwood)	Gillnet	1	220	Variable	Variable		2	20
29-16	Fraser R. (Whonnock)	Gillnet	1	320	Variable	Variable		2	20
	Fraser R. (Qualark)	Gillnet	1	30	Variable	Variable		6	5
United States Panel Areas									
5	Juan de Fuca Str.	Gillnet	1	803	220	130	5 1/8	2	400
7	San Juan Islands	Reefnet ¹	3	n/a	n/a	n/a	n/a	n/a	n/a
Canadian Non-Panel Areas									
12	Queen Charlotte Str. (Round Is.)	Gillnet ²	1	366	60-90	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

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

² Round Island vessel used a 60 mesh nylon net.

Information pertaining to the migration of Fraser River sockeye and pink salmon through marine areas is provided primarily by test fisheries in Area 20 (Juan de Fuca Strait) and Areas 12 and 13 (upper and lower Johnstone Strait) but is augmented during the early part of the season by

test fisheries in U.S. Areas 4B and 5 (Juan de Fuca Strait) and Area 7 (San Juan Islands). The Gulf Troll test fishery provides supplemental information on the abundance of delaying fish off the mouth of the Fraser River. Test fisheries in the Fraser River (Area 29) are used to assess species and stock composition for application to Mission passage estimates. When the Mission hydroacoustic program is not active, lower river (Area 29) test fisheries provide passage estimates for sockeye salmon through the use of CPUE models.

In 2018, the Fraser River Panel tried to minimize the duration and cost of Panel-approved test fisheries. Also, as a result of the low forecast for Early Stuart sockeye (p50: 84,000 sockeye), the Area 20 gillnet test fishery start date was delayed until July 10th, and the Area 12 gillnet test fishery start date was delayed until July 12th, after which most of the Early Stuart sockeye were thought to have migrated past the test fishery sites. For safety and training purposes, the number of Area 20 gillnet test fishing vessels was again increased from one to two. To minimize costs, the Area 12 Naka Creek gillnet test fishery was cancelled, the number of reefnet observation days was reduced to operate only prior to potential U.S. commercial fishery openings, and the Area 5 U.S. gillnet test fishery was reduced to a seven-day program.

Early in the season, daily marine gillnet catches in Area 20 were high compared to brood year catches but remained below the cycle year average. Daily marine gillnet catches in Johnstone Strait were low compared to brood year catches and the cycle year average. Later in the season, purse seine test fishery catches in Area 20 were also high compared to the brood year as well as the cycle year average, but purse seine test fishery catches in Johnstone Strait were low compared to brood year and cycle line average catches. These differences with the brood year can be explained by the very high diversion rate in 2014. In the Fraser River, test fishing catches were similar to the brood year as well as the cycle year average at Cottonwood despite no longer using an electric net, but below brood year and cycle year average at Whonnock. Weekly Gulf troll surveys began late-August and were extended into early-October as Late-run sockeye delayed longer in the Strait of Georgia. Sockeye payfish were caught in the marine purse seines and reefnets with the goal of achieving a revenue-neutral program in 2018. The total number of Fraser River sockeye retained from all Panel approved test fisheries was approximately equal to what was planned pre-season. With relatively strong prices for sockeye salmon and upward price adjustments post-season, fish sales were able to pay for the 2018 program and add \$670,000 in extra revenue to the Test Fish Revolving fund.

The 2018 season was the last year of a three-year Southern Endowment Fund (SEF) project to evaluate the impact of tide and currents on test fishing catches¹⁴. The project utilizes Global Positioning Satellite tracking technology to collect tide and current data and evaluate the its effects on Area 12 catch-per-unit effort of Fraser River sockeye in test fisheries. Another SEF project conducted in 2018 was a feasibility study using hydroacoustics surveys to estimate the abundance of delaying Late-run sockeye in the Strait of Georgia. The survey was conducted from August 21 to September 12. Estimates of Late Run delay from this hydroacoustic survey will be available in the report to the Southern Endowment Fund.

B. Mission Hydroacoustics

A hydroacoustics monitoring facility is operated by PSC staff upstream of the Mission Railway Bridge throughout the summer to provide accurate and timely estimates of sockeye and

¹⁴Taylor, E., C. McConnell, L. Kearey, C. Michielsens, M. Shimomura, M. Lapointe, and K. Forrest. 2019. Deployment of ocean surface current trackers in upper Johnstone Strait for the collection of local tide and current data to explain variability in marine catch data and improve daily abundance and run size estimates of Fraser River Sockeye & Pink salmon: A project report to Southern boundary restoration and enhancement fund. Pacific Salmon Commission, Vancouver, British Columbia. April 2019.

pink salmon passage through the lower Fraser River. Since the 2011 season, staff have implemented a standardized sampling method to estimate daily salmon passage using a combination of split-beam and imaging sonars^{15,16}. The sonar systems operate 24 hours a day to collect information on the density, direction of travel, speed, and size distributions of fish targets. For 2018, daily salmon passage was estimated using a side-looking split-beam sonar and an Adaptive Resolution Imaging Sonar (ARIS) on the left bank of the river, a downward-looking split-beam sonar mounted on a vessel transecting the river, and an ARIS imaging sonar on the right bank of the river (Figure F1).

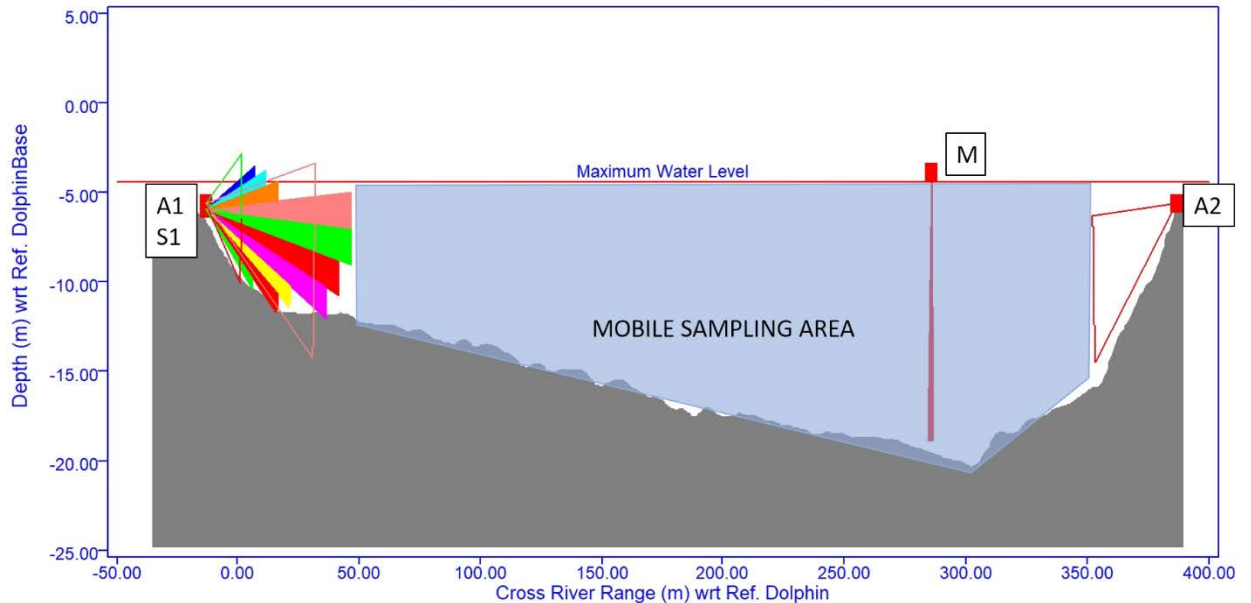


Figure F 1. Cross-river view of the sampling geometry of the sonar systems operated at the Mission hydroacoustics site. The four systems shown are the left bank split-beam (S1), the left bank ARIS (A1), the mobile split-beam (M), and the right bank ARIS (A2). The beam geometries of left bank ARIS (A1)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

The left bank split-beam (S1) consists of a side-looking transducer with an elliptical beam width of $2^{\circ} \times 10^{\circ}$ manufactured by Hydroacoustics Technology Incorporated. The transducer was attached to a SIDUS SS250 rotator to control its pan and tilt, allowing stratified sampling of the water column by the narrow vertical beam. The hourly stratified sampling design consisted of ten aims of non-overlapping, 2° vertical apertures with each aim sampling for 6 minutes each hour up to a range of 60 metres. In 2018, the number of vertical aims was increased from six to ten to maximize the portion of water column insonified by the sonar, thereby minimizing unsampled areas where migratory abundance must be estimated by extrapolation. The aim and orientation of the transducer were monitored and verified using a Thinksensor TSR-100 motion reference unit. The split-beam system was deployed towards the far end of an extendable fish-deflection weir

¹⁵ 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.

¹⁶ 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.

which prevented fish from swimming behind or close to the transducer. The left bank split beam system was operated for the full duration of the hydroacoustics program from July 5 to October 9.

An ARIS system (A1) was also operated on the left bank for the entire duration of the hydroacoustics program from a location adjacent to the split-beam at the end of the fish-deflection weir. The ARIS system was deployed on an AR2 rotator that allowed it to cycle through multiple vertical aims for full sampling coverage of the water column up to a range of 45 metres. Data collected by the ARIS was used to estimate salmon passage within the nearshore area up to 25m range from August 26 to October 9 when, periodically, small non-salmonid species (average length of approximately 20cm) were observed actively migrating upstream in the nearshore area. ARIS was used instead of the split-beam during this period for estimating the nearshore salmon passage because of its superior ability to distinguish between salmon and smaller, non-salmonid targets. Prior to August 26, data collection with the ARIS was on-going, but there were few small fish actively tracked by the split-beam system, making it unnecessary to adopt the ARIS estimate for nearshore salmon passage.

The vessel-based split-beam system (M) was operated from July 5 to October 9 using a downward-looking 6° circular beam transducer manufactured by Biosonics Incorporated. The transducer was towed by a vessel 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. 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 passage¹⁷. To validate offshore fish passage, the vessel also deployed a DIDSON imaging sonar from anchored positions near the left or right bank. The DIDSON was aimed offshore for stationary sampling of fish passage up to a range of 20 metres from the vessel. Anchored deployment of the DIDSON occurred six times per day (three times from each side of the river) for an hour each time.

The right bank inshore ARIS (A2) commenced data collection on July 13 and was included in subsequent daily estimates of salmon passage up to October 8. The ARIS was deployed near the end of a fish deflection weir to prevent fish from swimming behind or close to the sonar. The A2 system used a single vertical aim to sample the entire water column up to 40 metres range from the sonar. This was the first year that an ARIS imaging sonar was used on the right bank of the river instead of a DIDSON imaging sonar. Operating an ARIS instead of DIDSON increased the sampling range from 30 metres to 40 metres offshore and provided higher resolution imaging data for more accurate identification of salmon targets.

To determine salmon passage in areas sampled by the ARIS systems, a subset of the imaging sonar data was manually counted by trained technicians. Technicians counted the number of fish targets and their direction of travel for 5 minutes of each hour within 10 metre sampling strata. These counts were then expanded to estimate the hourly passage of fish in both the upstream and downstream directions. Since these counts included small, resident fish, a normally-distributed mixture model was applied to apportion the salmon passage from the total passage of fish for each day. The mixture model, using biological lengths from test-fishing samples as priors, estimated the proportion of each salmon species and resident fish species using hydro-acoustic-based fork length measurements from a subset of the same imaging data used for counting fish passage.

¹⁷ 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.

To determine salmon passage sampled by the split-beam systems, acoustic echoes were tracked using an alpha-beta tracker¹⁸ and then classified as fish or noise (e.g. debris, air bubbles) by a discriminate function analysis¹⁹. 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 providing information on the density and position of fish targets. Processed fish tracks from the stationary left bank system also provided information on the velocity and direction of travel of offshore fish targets.

The daily total salmon passage was estimated by adding the salmon passage estimates from the left bank split-beam, the left bank ARIS, the vessel-based split-beam and the right bank ARIS. Since there is some overlap in sampling areas between the vessel-based split-beam and the shore-based systems in nearshore areas, the overlapped sampling areas were identified using GPS and only passage estimates from the shore-based systems were included in the daily total estimate for the nearshore areas. Estimates from the shore-based systems were preferentially adopted because the vessel-based split-beam estimates are the least precise due to lower sampling intensity and prone to negative bias due to avoidance behaviour²⁰. Salmon passage estimates were apportioned among Pacific salmon species based on forecasted daily abundance estimates as well as daily catch proportions from the Whonnock gillnet test fishery, the Albion test fishery, and historic escapement estimates. The different methods to derive species proportions included a model applied to species proportion estimates of the Whonnock gillnet test fishery that takes into consideration differential catchabilities among species as suggested by Carl Walters²¹.

Stock Identification

PSC staff conduct sampling programs designed to identify stock proportions of Fraser River sockeye and pink salmon in commercial, test, First Nations and recreational catches. Coupled with abundance indices from stock monitoring programs, these data provide information on the abundance and timing of sockeye and pink salmon stocks as they migrate to their natal rivers in the Fraser watershed. Stock identification data are also used to account for Fraser sockeye and pink salmon wherever they are caught, and to apportion the daily estimates of sockeye escapement past Mission into discrete stock groups. Stock identification methods for sockeye salmon in 2018 used DNA and scale pattern analyses from fish caught in marine and in-river fisheries. No stock composition estimates were produced for pink salmon in 2018 because the Fraser River pink salmon run is virtually non-existent in even numbered years. For sockeye salmon, continuing a practice developed in recent years, a multinomial extrapolation procedure was used for predicting stock composition estimates in catches that had not yet occurred or had not yet been analyzed.

¹⁸ Blackman, S. S. and R. Popoli. Design and Analysis of Modern Tracking Systems. Artech House, Boston, 1999.

¹⁹ 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.

²⁰Xie, 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

²¹Walters, C. 2015, Comparison of Mission and Qualark hydroacoustic facilities for providing escapement information for management of Fraser River sockeye and pink fisheries. October 10, 2015 a Review Report to Fraser Strategic Review Committee.

A. Sockeye Salmon

Stock identification methods for sockeye salmon relied on DNA²² (using the program CBAYES²³) and scale pattern analyses²⁴. Both techniques involve comparing the attributes of individuals in mixture samples (e.g., from mixed-stock fisheries) to the attributes of pure samples obtained from the spawning grounds of each of the named stocks (i.e., “standards” or “baselines”). Samples from test fishery catches were analyzed daily, beginning in early July and continuing to early October. PSC staff sampled sockeye from test fishery catches (Bellingham in Washington; Port Renfrew and locations within the lower Fraser River, B.C.) and commercial fishery landings (Bellingham in Washington, Tofino and Nanaimo on Vancouver Island, and Vancouver, Richmond, and Delta, B.C.). 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, Craig and Petersburg, and Langara Fishing Adventures provided samples from recreational catches near Haida Gwaii. DFO and First Nations personnel obtained samples from Fraser River First Nations catches when available.

Catches in District 104 totaled 121,400 sockeye. Extracted DNA of fish putatively originating from southern stocks (as determined by examination of Single Nucleotide Polymorphisms²⁵ by the US National Oceanic and Atmospheric Administration laboratory in Auke Bay, Alaska) was obtained and analyzed with methods consistent with other DNA results reported here and to the Fraser Panel. The preliminary catch of Fraser River sockeye in Alaska was estimated to be 53,700. Research was initiated regarding temporal relationships between stock compositions of Fraser sockeye caught in Alaska versus stock compositions observed in the Fraser Panel Area. More than 60% of the sockeye catch in District 104, and more than 90% of the Fraser sockeye catch there in 2018, occurred after August 18, which is unusual compared to prior years.

Approximately half of sockeye returning to the Fraser Panel Area were forecast to belong to the Late-run management group. These sockeye were first detected in Area 12 and Area 20 on July 13th and July 15th, respectively. Figures F2 and F3 illustrate Late-run stock proportions estimated in Juan de Fuca Strait and Johnstone Strait, respectively, as they changed throughout the management season. There was considerable variance among samples within both approach routes, but in each case the Late-run management group appeared relatively constant from late July to early August. In Area 20, the Late-run proportion increased rapidly after about August 9, peaked on August 19, and then declined in late August to early September. The decline near the end of the time series mainly co-occurred with small catches and sample sizes. In Areas 12 and 13 a concurrent increase, peak, and decline in Late-run proportions occurred from mid to late August. This was followed by a rise to another peak in early to mid September. These trends will be compared to those detected in samples from District 104 in the aforementioned research project.

²² 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.

²³ Neaves, P.I., C.G. Wallace, J.R. Candy, and T.D. Beacham. 2005. CBAYES: Computer program for mixed stock analysis of allelic data, v5.01. Department of Fisheries and Oceans (Canada). Available: <http://www.pac.dfo-mpo.gc.ca/science/facilities-installations/pbs-sbp/mgl-lgm/apps/index-eng.htm> (January 2012).

²⁴ Gable, J. and S. Cox-Rogers. 1993. Stock identification of Fraser River sockeye salmon: methodology and management application. PSC Tech. Rep. No. 5.

²⁵ Guthrie III, C.M., Nguyen, H. and J.R. Guyon. Northern Boundary Area Sockeye Salmon Genetic Stock Identification For Year 2015 District 101 Gillnet and District 104 Purse Seine Fisheries. A project report to Northern boundary restoration and enhancement fund. Pacific Salmon Commission, Vancouver, British Columbia. April 10, 2017.

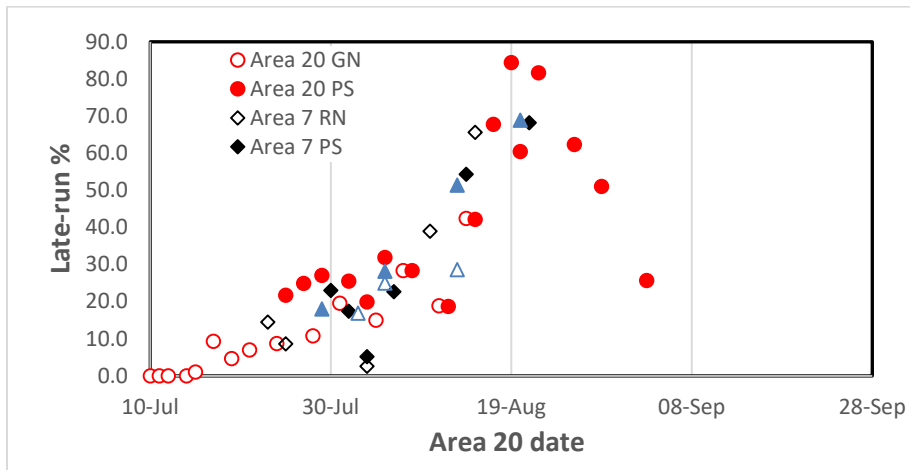


Figure F 2. Late-run stock proportions in Juan de Fuca Strait fisheries (GN: gillnet; PS: purse seine; RN: reefnet). Area 20 date is the date at which the sampled fish would have been or were estimated to be near Port Renfrew waters in the Salish Sea, which may differ from the actual sampling date because of the location of the catch. When the catch spanned multiple days, the median date was used to calculate the corresponding Area 20 date.

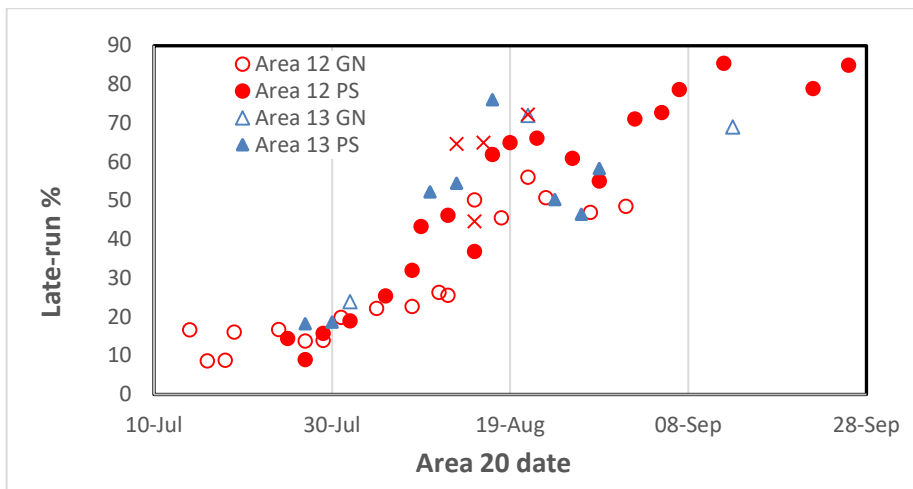


Figure F 3. Late-run stock proportions in Johnstone Strait fisheries (GN: gillnet; PS: purse seine; TR: troll). The last two Area 12 PS data points represent sockeye samples obtained from DFO's chum test fishery. Area 20 date is the date at which the sampled fish would have been near Port Renfrew waters in the Salish Sea if they migrated through Juan de Fuca Strait. The estimated common Area-Date facilitates comparisons of stock proportions across different sampling areas.

Other research, extending an approach tried during the 2014 management season, a Smolt Method for Updating Run Figures²⁶ (called SMURFing) was used to provide an independent estimate of total Late-run abundance. Ratios of Late Shuswap/Portage to Early Thompson stocks were examined among outmigrant juveniles samples collected in Shuswap Lake, the lower Fraser

²⁶ Latham, S., C. Michielsens, C. Wallace, T. Whitehouse, J. Tadey, C. Neville, M. Trudel. (2015, May 17). Stock identification of Fraser sockeye smolt samples provides marine fisheries managers with more timely and accurate estimates of adult run size. North Pacific Anadromous Fish Commission. Retrieved from <https://npafc.org/wp-content/uploads/Poster-42-Latham-et-al.pdf>.

River²⁷, and Georgia and Johnstone straits²⁸ in 2016. Juveniles of both stock groups rear predominantly in Shuswap Lake and are assumed to be similar in body size and behaviour. It was therefore hypothesized that they would be equally vulnerable to sampling gear and would share similar survival rates among their spawning cohorts. Furthermore, these stocks are similar in age at maturity which should result in similar ratios between their return abundance as adults and their ocean entry as juveniles, if survival rates are similar during the intervening period. The average ratio of Late Shuswap/ Portage to Early Thompson stocks across all the outmigrant juvenile programs was 4.4, which was applied to the in-season run size estimate of Early Thompson to generate an estimate of the Late Shuswap/Portage run. This estimate was independent of the reconstruction-based run size estimate. The first in-season SMURFing estimate of Late Shuswap/Portage on August 10 was 3.6 million (80% PI: 2.6 million – 5.0 million). Two weeks later (August 24), the SMURFing estimate was 5.6 million (80% PI: 5.2 million – 5.9 million). The final in-season Late Shuswap/Portage SMURFing estimate on September 21 was 5.9 million. The median estimates ranged from as low as 3.6 million to as high as 7.3 million. The final in-season ratio of Late Shuswap/Portage to Early Thompson stocks was 3.4:1.

In addition to the smolt ratios of stocks that rear in Shuswap Lake, the smolt ratios for Quesnel to Chilko stocks provided context for interpretations of run size. This ratio was 1.6:1 within the 2016 outmigrant juvenile samples, which was closer to the final 2018 in-season run size estimate ratio of 1.5:1 than the pre-season forecast ratio of 0.5:1. In-season, the similarity of the smolt and adult ratios for these stocks that rear in very different lakes increased the confidence that stocks that share a lake (as is the case for Early Thompson and Late Shuswap) would have similar juvenile and adult ratios. In contrast, the ratio of late populations (from Mitchell and other tributaries) to early populations (from the Horsefly drainage) within Quesnel Lake was near 1:1 among the 2016 outmigrant juvenile samples, but in-season assessments made it clear by mid September that the late component would not be as abundant as the earlier Horsefly component. The final in-season ratio of late to early Quesnel stocks was 1:1.9, perhaps hinting that the late:early ratio of returning Shuswap adults would also be lower than was observed in outmigrant juveniles.

Each year during the management season, DNA estimates, scale measurements (including age), sex, and length information are compiled at the individual level to assist interpretations and assess possible sampling issues. Table F2 summarizes the age composition (based on scale readings by PSC Staff) of sockeye catches compared to the pre-season forecast. The age-four forecast for returning Early Stuart sockeye was lower than the frequency of age-four fish in fishery samples in 2018. Fishery samples of Early Summer-run sockeye were predominantly age-four fish except for the Pitt River stock, which comprised predominantly age-five fish similar to the forecast. The Summer-run consisted predominantly of age-four sockeye as expected. A significant deviation from the forecast was observed for Harrison sockeye, however, where the estimate from fishery samples was 90% age-four fish compared to a forecast of 6% (the remainder being age-three). Fishery samples of Late-run sockeye consisted predominantly of age-four fish, except for Birkenhead sockeye which were mostly age-five fish as expected. Overall, age readings for the Late run were similar to the forecast. Preliminary evaluation of the 2018 age-four Harrison sockeye return compared to the 2017 age-three return indicates a much higher proportion of this cohort matured at age-4 than expected.

²⁷ Mahoney, J.E., Tadey, J.A., Whitehouse, T.R., Neville, C., and Kalyn, S.M. 2013. Evaluation of Timing, Size, Abundance and Stock Composition of Downstream Migrating Juvenile Sockeye Salmon in the Lower Fraser River – A Report to the Pacific Salmon Commission. Fisheries and Oceans Canada, Delta, BC. 2013.

²⁸ Neville, C., Trudel, M., Beamish, R.J., Johnson, S.C. 2013. The Early Marine Distribution of Juvenile Sockeye Salmon Produced from the Extreme Low Return in 2009 and the Extreme High Return in 2010. North Pacific Anadromous Fish Commission, Technical Report No. 9: 65-68.

Table F 2: Summary of the 2018 forecast and in-season age composition estimates of sockeye sampled from fisheries. Scale-based ages of individuals with probabilities of origin greater than 67% (determined via genetic stock identification) to a stock aggregate are included here.

Sockeye stock/timing group	2018 Fraser Sockeye Forecasts			2018 In-season	
	Median Age-4 Forecast	TOTAL Median Forecast	FOUR YEAR OLD PROPORTION	Sample size	% Age -4
Early Stuart	66,000	84,000	79%	272	90%
Early Summer	2,052,158	2,166,036	95%	2163	96%
Bowron	17,000	20,000	85%	26	92%
Upper Barriere	20,000	25,000	80%	5	80%
Gates	29,000	38,000	76%	36	64%
Nadina	142,000	153,000	93%	733	99%
Pitt	6,000	53,000	11%	48	13%
Early S. Thompson	1,816,000	1,842,000	99%	1292	99%
Taseko	400	500	80%	6	100%
Chilliwack	9,978	21,116	47%	13	92%
Nahatlatch	11,780	13,420	88%	4	25%
Summer	4,016,000	4,344,000	92%	3999	97%
Chilko	2,240,000	2,259,000	99%	1369	95%
Quesnel	1,060,000	1,148,000	92%	2030	100%
Late Stuart/Stellako	610,000	708,000	86%	541	95%
Harrison	5,000	87,000	6%	39	90%
Raft / N. Thompson	100,000	139,000	72%	20	85%
Widgeon	1,000	3,000	33%	0	NA
Late	7,176,000	7,398,000	97%	2630	98%
Cultus	1,000	1,000	100%	0	NA
Late Shuswap/Portage	6,994,000	7,025,000	100%	2548	99%
Weaver	92,000	150,000	61%	34	74%
Birkenhead	71,000	187,000	38%	47	28%
Misc Lillooet-Harrison	18,000	35,000	51%	1	0%
Total	13,310,158	13,992,036	87%	9064	97%

Stock Assessment

Assessment of Fraser River sockeye abundance by stock group is primarily based on catch, effort, escapement and stock composition data. Test fishery catch per unit effort (CPUE) data was converted into daily abundance estimates using catchability estimates derived from an hierarchical analysis of historical data (Area 12 purse seine catchability: 5.6×10^{-3} , Area 20 purse seine catchability: 2.5×10^{-3}). As the season progressed, the catchability coefficients were updated based on observed values for non-delaying stock groups by comparing Mission passage estimates to CPUE based abundances. The marine abundance estimates derived from in-river hydro-acoustic data and marine test fishery data were analysed using Bayesian stock assessment models^{29, 30, 31}. These models compare the reconstructed daily migration pattern to ideal run-timing curves,

²⁹ 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.

³⁰ 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.

³¹ 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>.

assuming the run is normally distributed. By assuming the run follows this idealized pattern, the run size can be estimated once the 50% migration date (i.e., the date 50% of the run has migrated past the reference location, which corresponds to the peak of the normal distribution) has been identified, by doubling the abundance up to that date. Prior to observing the peak of the run, there is considerable uncertainty about the run size. Based on initial observations before the peak of the run, the estimates can indicate the run to be earlier and smaller than forecast, or later and larger.

The uncertainty about the actual size of the run is estimated using Bayesian methodology³². The Bayesian time-density model relies on additional information (pre-season forecasts of run size based on historic stock-recruit data and timing based on sea-surface temperature (SST) and eastward current speed index in the Gulf of Alaska, expected duration of the run, average historical expansion line estimates and pre-season forecasts of diversion rate based on SST) to reduce the uncertainty and keep the run size estimates within realistic bounds. This prior information is incorporated within the Bayesian model using prior probability distributions (priors). These priors indicate a range of values that are assumed plausible for the various model parameters and depending on the shape of the prior probability distribution indicate which parameter values are assumed more plausible than others. Theoretically the Bayesian version of the cumulative normal model should provide more stable estimates since it relies on both in-season data as well as historical data. Retrospective analyses have confirmed that incorporating prior knowledge is especially advantageous before the 50% migration date is known. Bayesian stock assessment models are especially useful around the 50% migration date of the run as well as immediately after. After this period, when the run size will depend on the remainder of the run still to come, the run size can be estimated by adding the Bayesian estimate of the tail of the normal distribution to the accounted run-to-date.

Because the traditional models for estimating Late-run abundance did not perform well in 2018 (poor model fit to the test fishing data and reconstructed CPUE-based abundances were thought to be biased low), alternative methodologies were applied. First, marine timing estimates for Late Shuswap/Portage, Weaver/Cultus and Birkenhead components were estimated using a Bayesian regressions model and assuming an Early Thompson timing of August 8 and a Chilko timing of August 12. If the estimated 50% date had not yet been observed, the corresponding abundance was calculated from the percent of the run expected seaward using 2006, 2010 and 2014 data. A Bayesian model using the average historical ratio of Late Shuswap/Portage to Early Thompson juveniles in 2016 was also used to provide an alternative run size estimate for Late Shuswap/Portage component. For further information on the Bayesian model see the Stock ID section on SMURFing in Appendix F.

Finally, reconstructed estimates of Late-run abundance were informed by estimates of the number of fish delaying in the Strait of Georgia. Two troll vessels in the Strait of Georgia fished six quadrants over three-day assessment periods throughout August and September. The CPUE data were combined across all six quadrants but weighted by the relative size of the area. A Bayesian model was fit to historical Gulf troll CPUE data and reconstructed estimates of abundance in the Gulf corresponding to the dates of each survey. Due to uncertainty in model estimates, predictions of abundance were made using different subsets of the historical data: August-only, September-only, dominant years only. Alternative delay estimates were combined with catch, escapement, and seaward projection estimates to reconstruct estimates of the total Late-run abundance. Due to the uncertainty in estimates both within, and across, surveys, an average abundance across several survey dates was also provided.

The high degree of uncertainty in all the Late run estimation methods, combined with inconsistent estimates depending on the approach applied, contributed to challenges in producing an in-season estimate of run size and timing in 2018. The final in-season reconstruction confirmed that test fishing CPUE based abundances were biased low throughout the season.

³² Michielsens, C.G.J. and J.D. Cave. 2019. In-season assessment and management of salmon stocks using a Bayesian time-density model. CJFAS. <https://doi.org/10.1139/cjfas-2018-0213>.

Figures F4 a, b, c, and d 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 and 80% probability interval). These estimates can be compared against the Panel adopted in-season run size estimates used for management purposes and against the final in-season estimates of the accounted run-to-date. In 2018, pre-season forecasts overestimated the run size for all management groups except for Early Stuart.

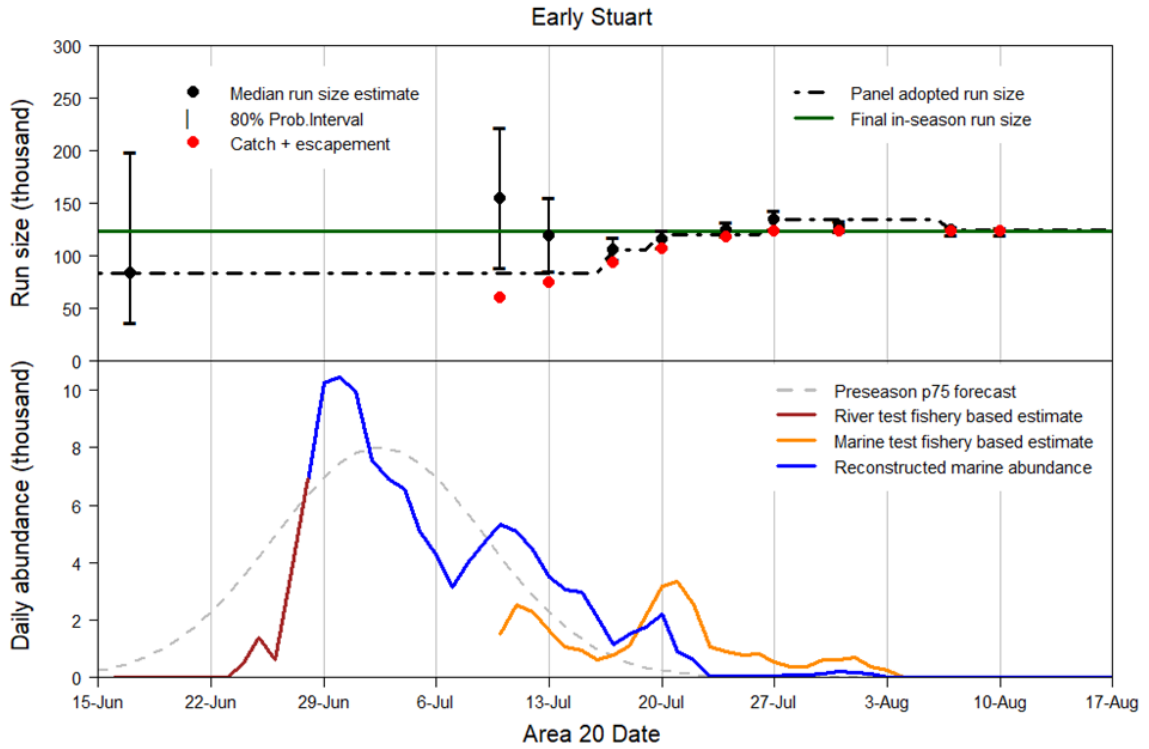


Figure F 4a: Daily reconstructed abundance estimates for Early Stuart and corresponding run size estimates at different times during the season.

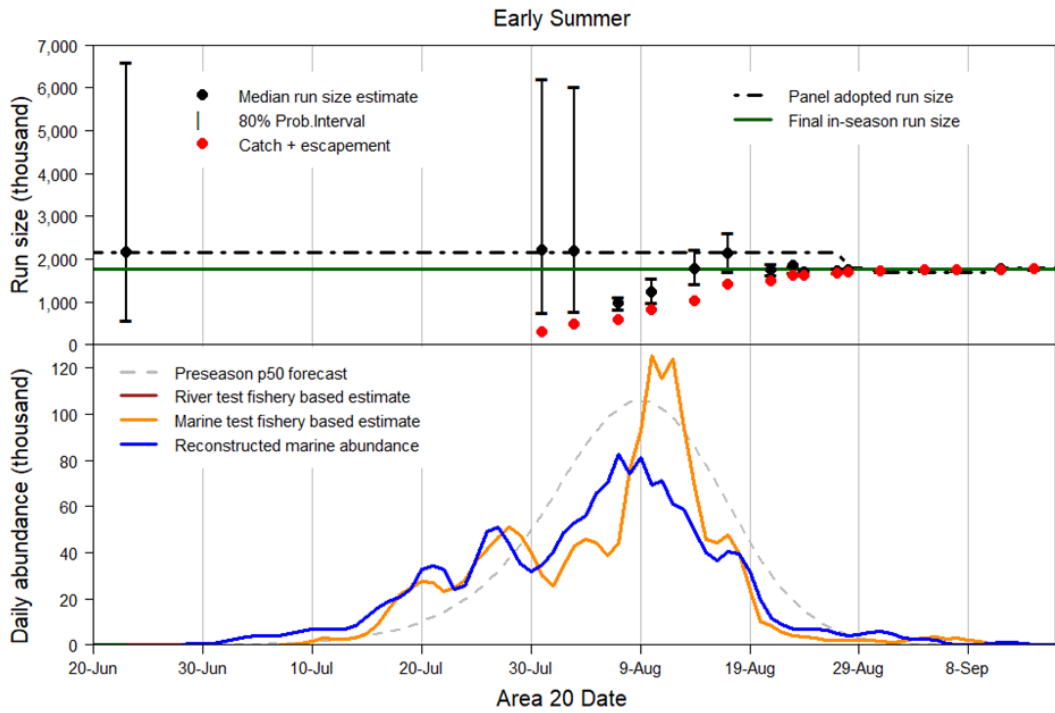


Figure F4b: Daily reconstructed abundance estimates for Early Summer-run salmon and corresponding run size estimates at different times during the season.

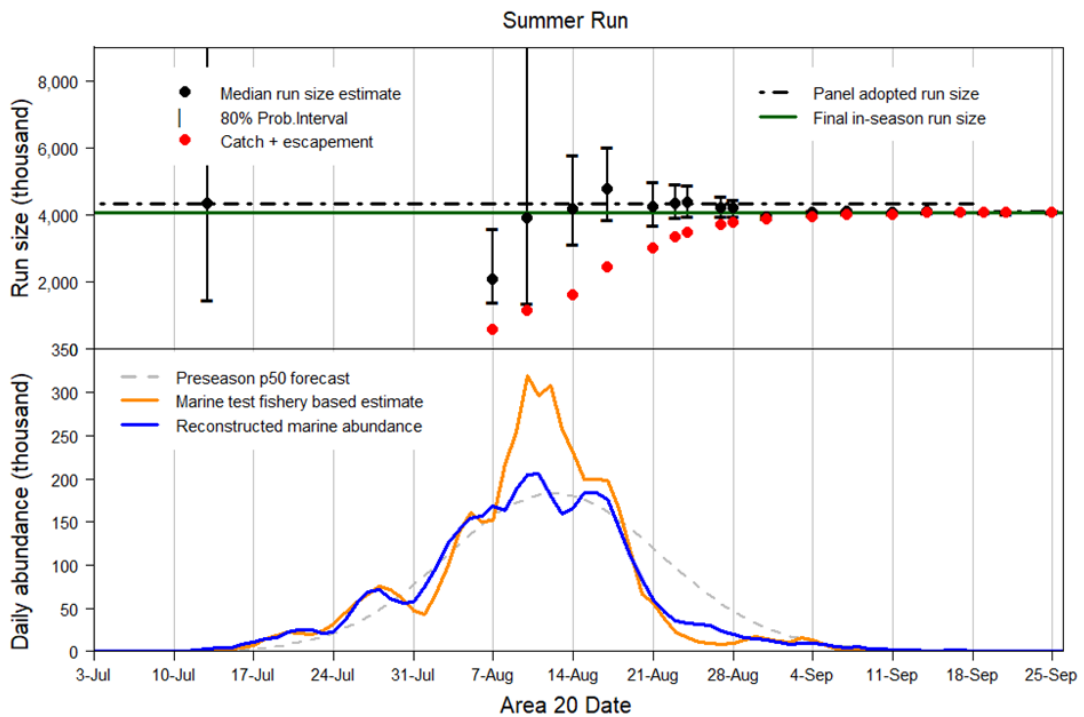


Figure F4c: Daily reconstructed abundance estimates for Summer-run salmon and corresponding run size estimates at different times during the season.

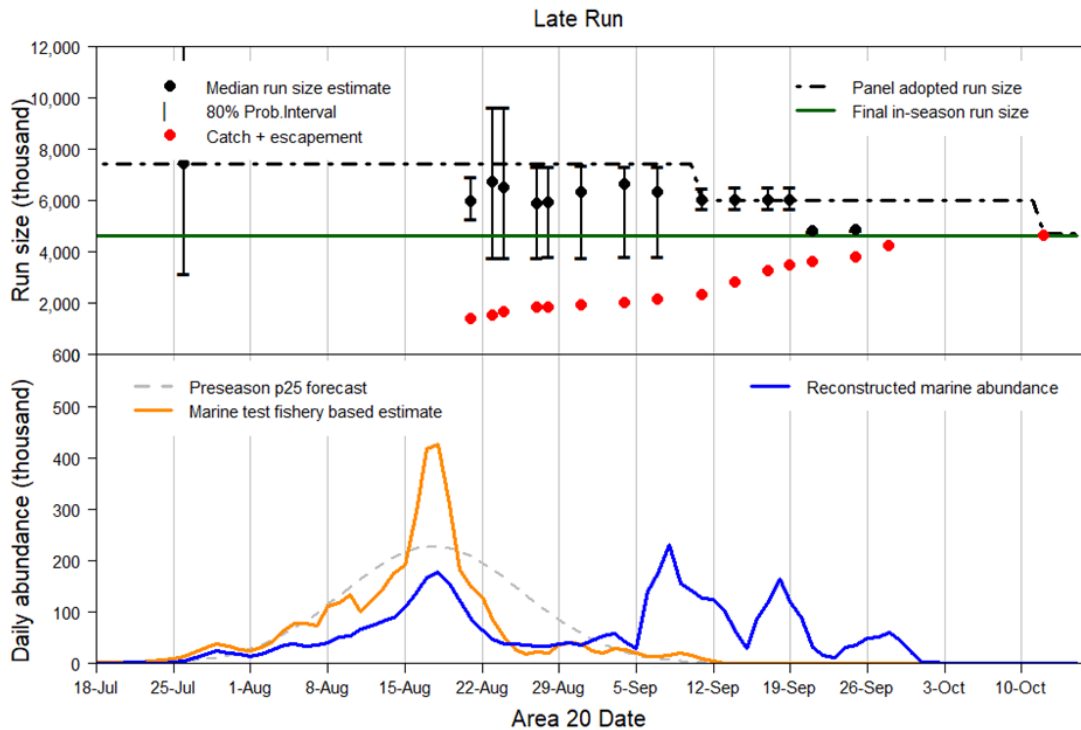


Figure F4d: Daily reconstructed abundance estimates for Late-run salmon and corresponding run size estimates at different times during the season.

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. Spring snowpack values were average in the Fraser watershed; however, an early freshet with record high discharge in May depleted the snowpack early. Forecasts suggested lower than average water flows, which would make the Fraser River susceptible to the effects of the above average summer air temperatures predicted by the long-range forecast. Fraser River temperatures at Qualark were forecasted to be above normal. Staff used the environmental forecasts in Management Adjustment (MA) models developed jointly by DFO and the PSC to predict how many additional sockeye should be allowed to escape to increase the probability of achieving spawning escapement objectives (see references in the MA section of the Management Information section).

For pre-season planning purposes, the Panel adopted the proportional Management Adjustments (pMAs) based on the historical median (see Table F4) for all four management groups (Table 6). Management Adjustments (MAs) of 58,000 Early Stuart, 198,300 Early Summer, 173,800 Summer and 1,272,500 Late-run sockeye were added to the spawning escapement targets to increase the likelihood of achieving the targets. The spawning escapement target for Early Stuart was its entire run size at median forecast abundance levels, therefore, fisheries decisions that could impact Early Stuart sockeye would be based on Low Abundance Exploitation Rate (LAER) limits of 10%.

In recent years, pre-season MA estimates for some management groups have been estimated based on the weighted average of component abundances and their respective proportional Difference Between Estimates (pDBEs). Due to the low forecasted relative abundances of Pitt and Chilliwack fish in the Early Summer-run aggregate, Harrison fish in the Summer-run aggregate and Birkenhead fish in the Late-run aggregate, the weighted pDBE approach had almost no impact

on the aggregate for these three run timing groups. As a result, the Panel agreed to forego the weighted pDBE approach for these three run timing groups for 2018. In-season, there were minimal changes in relative abundances of these component stocks and the weighted pDBE approach had no impact on the MAs for the aggregate.

In-season predictions from environmental MA model estimates (Table F3) were presented to the Panel for Early Stuart, Early Summer and Summer run. Environmental conditions were more severe than predicted pre-season and the in-season models predicted larger (more negative) pDBEs for these run timing groups. The Panel did not adopt an in-season pMA for Early Stuart, Early Summer run or Summer-run sockeye. Instead, these three timing groups were managed based on the pre-season adopted pMA values (Table 6). In-season, the run size adopted for Early Stuart was slightly larger than its spawning escapement target (SET) but due to the pre-season adopted pMA, this group continued being managed under a LAER. In-season, Late-run sockeye delayed their upstream migration longer than expected pre-season. With longer delay, the Late-run Mission 50% Date was predicted to be later than September 15th. As agreed by the Panel pre-season (Table F3), the MA run timing model using all years of data was used to estimate the Late-run pDBE under those conditions. This model estimated a smaller pDBE for the Late-run than predicted pre-season. The Panel therefore adopted a pMA of 0.04 for the Late-run aggregate (Table 6). The final upstream timing date for Late run based on Mission hydroacoustic estimates was September 17, with a predicted pDBE of -0.20 (Table F3).

Spawning ground estimates of Fraser sockeye abundance totalled 4,100,200 sockeye in 2018, which corresponded to a total %DBE of (-14%). Early Stuart, and Late-run sockeye did not achieve their spawning escapement target (SET) of 125,000, and 1,880,000 sockeye respectively, while for Early Summer run spawning escapement was very close to the target of 720,000 sockeye. The Summer run sockeye exceeded the SET (1,640,000 sockeye) with a spawning escapement of 1,749,027 adult sockeye.

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

Table F3. Summary of the pre-season and in-season MA model predictions of %DBE for Early Stuart, Early Summer, Summer and Late-run Management groups.

Description	Early Stuart ¹		Early Summer Aggregate ¹		Summer-run Aggregate ¹		Late-run Aggregate ²	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Pre-season 31-day MA Model Predictions ³	-34%	0.52	-17%	0.20	-14%	0.16	NA	NA
In-season 19-day MA Model Predictions	-37%	0.59	-42%	0.72	-24%	0.28	NA	NA
In-season 31-day MA Model Predictions	-41%	0.69	-33%	0.49	-15%	0.15	NA	NA
In-season run-timing Model Predictions ⁴	NA	NA	NA	NA	NA	NA	-20%	0.25

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 F4. Summary of the pre-season and in-season MA models and assumptions used during 2018 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	In-season	Cycle lines	
	Predictor Variables	Predictor Variables	Used	Excluded Years
Early Stuart	Historical Median	19-day temp and discharge ¹	All	1977, 1980, 1982, 1984, 1986, 2006, 2015, 2016, 2017
Early Summer Aggregate	Historical Median	19-day temp and discharge ¹	Dominant Cycle (2018)	1993, 2006
Summer-run Aggregate	Historical Median	19-day temp and discharge ¹	All	2002, 2006
Late-run Aggregate	Historical Dominant Cycle Line Median since 1996	Historical Dominant Cycle Line Median since 1996 if timing Sept 15th or earlier, All Years Run Timing Model ² if timing is Sept 16th or later	2018 if timing Sept 15th or earlier, All if timing is Sept 16th or later	2006 and All years model also excludes, 1977, 1979, 1980, 1981, 1983, 1984, 1985, 1987, 1988, 1989, 1991, 1992, 1993, 1995

¹ln(DBE) = a + b₁T + b₂T² + b₃Q + b₄Q² 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.

²ln(DBE) = a + bR where R is Mission timing

APPENDIX G: HISTORICAL CATCH, ESCAPEMENT AND PRODUCTION DATA

Table G1. Catch by user group, spawning escapement, difference between estimates and run size of Fraser River sockeye salmon for cycle years 2006-2018.

	Fraser Sockeye Salmon			
	2006	2010	2014	2018
CANADIAN CATCH	4,571,100	11,569,200	10,123,400	4,731,500
Commercial Catch	3,247,000	9,243,700	7,989,400	3,188,300
Panel Area	921,300	3,459,100	3,022,200	1,369,700
Non-Panel Areas	2,325,700	5,784,600	4,967,300	1,818,600
First Nations Catch	1,144,900	2,015,100	1,776,600	1,398,900
Marine FSC	297,700	308,500	321,100	280,600
Fraser River FSC	391,100	570,100	615,800	607,100
Economic Opportunity	456,100	1,136,500	839,600	511,100
Non-commercial Catch	179,100	310,400	357,400	144,300
Marine Recreational	37,400	80,500	110,300	61,900
Fraser Recreational	134,300	212,800	242,400	79,800
Charter (Albion)	600	6,600	4,100	2,600
ESSR	6,900	10,500	600	0
UNITED STATES CATCH	727,200	1,959,500	887,200	1,047,300
Washington Total	707,600	1,959,500	701,600	993,500
Commercial catch	703,100	1,945,100	698,200	982,800
Treaty Indian	486,800	1,202,600	470,300	589,600
Non-Indian	216,300	742,500	227,900	393,200
Non-commercial Catch	4,500	14,400	3,400	10,700
Ceremonial	4,500	14,400	3,400	10,700
Recreational	0	0	0	0
Alaska	19,600	0	185,500	53,700
TEST FISHING CATCH	140,000	71,900	148,700	113,000
PSC (Panel Areas)	72,000	27,000	41,000	71,800
Canada	62,600	17,800	35,100	68,400
United States	9,400	9,200	5,800	3,400
Canada (non-Panel Areas)	68,000	44,900	107,800	41,200
TOTAL RUN	12,980,000	28,672,800	20,215,000	10,864,000
Total Catch in All Fisheries	5,438,300	13,600,600	11,159,300	5,891,700
Adult Spawning Escapement	4,661,500	13,130,900	5,877,300	4,100,200
Jack Spawning Escapement	1,700	12,100	5,600	2,200
Difference between estimates	2,878,600	1,929,200	3,172,800	869,900
Percentage of Total Run	100%	100%	100%	100%
Total Catch in All Fisheries	42%	47%	55%	54%
Adult Spawning Escapement	36%	46%	29%	38%
Jack Spawning Escapement	0%	0%	0%	0%
Difference between estimates	22%	7%	16%	8%

Table G2. Escapements of sockeye salmon to Fraser River spawning areas for cycle years 2006-2018*

DISTRICT <u>Stock Group</u> Stream/Lake	Year			
	2006	2010	2014	2018
NORTHEAST				
Upper Bowron R.	1,554	8,983	12,176	8,406
STUART				
<u>Early Stuart</u>				
Driftwood R.	7,230	25,783	21,774	12,808
Takla L. Streams	10,261	11,061	14,193	10,413
Middle R. Streams	11,576	16,971	24,351	15,308
Trembleur L. Streams	6,671	6,447	8,234	9,960
Miscellaneous	78	0	58	0
<u>Late Stuart</u>				
Kazchek Cr.	104	32	9	31
Kuzkwa Cr.	3,139	3,610	4,325	5,395
Middle R.	7,513	13,340	9,086	17,224
Tachie R.	14,178	57,887	36,036	88,796
Miscellaneous	2,570	372	1,235	743
NECHAKO				
Nadina R. (Late)	4,144	4,783	30,235	148,128
Nadina Channel	4,511	21,359	31,154	29,066
Stellako R.	147,189	202,783	506,157	177,180
QUESNEL				
Horsefly R.	110,388	128,121	463,621	587,012
Horsefly Channel	19,599	22,493	18,078	895
McKinley Cr.	3,007	1,534	10,266	14,202
Mitchell R.	22,446	75,029	277,953	162,918
Miscellaneous	14,328	21,854	64,458	53,833
CHILCOTIN				
Chilko R. & L.	468,947	2,459,946	1,025,587	618,365
Chilko Channel	0	0	0	0
Taseko L.	2,140	1,117	114	70
SETON-ANDERSON				
Gates Cr.	0	6,280	9,679	1,872
Gates Channel	2,858	9,486	6,071	1,605
Portage Cr.	18,882	57,870	24,275	35,548
NORTH THOMPSON				
North Thompson R.	25,488	8,044	22,741	3,429
Raft R.	6,111	5,119	17,078	3,544
Fennell Cr.	11,482	10,808	11,451	2,430
SOUTH THOMPSON				
<u>Early Summer-run</u>				
Scotch Cr.	144,199	522,367	135,100	82,192
Seymour R.	107,941	552,149	114,002	141,888
Upper Adams / Momich / Cayenne	370	3,101	5,810	14,047
Miscellaneous	39,717	351,176	246,918	269,001
<u>Late-run</u>				
Adams R.	1,461,673	3,867,225	707,883	536,333
Little R.	416,790	422,358	213,304	127,386
Lower Shuswap R.	901,059	2,897,006	1,027,591	630,844
Miscellaneous	118,187	332,429	259,290	222,739
HARRISON-LILLOOET				
Birkenhead R.	266,459	128,285	35,552	15,056
Big Silver Cr. & misc. Birk. types	23,076	12,578	6,011	1,504
Harrison R.	168,259	761,668	399,531	15,148
Weaver Cr.	6,967	23,833	2,207	1,339
Weaver Channel	32,814	36,064	22,439	13,756 ¹
LOWER FRASER				
Nahatlatch R. & L.	1,678	5,413	3,873	2,534
Cultus L.	3,785 ¹	10,026 ¹	4,603 ¹	504 ¹
Upper Pitt R.	38,816	16,818	36,496	13,949
Chilliwack L./Chilliwack R., upper	1,097	2,775	3,470	2,341
MISCELLANEOUS ²	<u>2,178</u>	<u>4,482</u>	<u>2,913</u>	<u>389</u>
ADULTS	4,661,459	13,130,865	5,877,388	4,100,131
JACKS	1,674	12,056	5,588	2,211
TOTAL NET ESCAPEMENT	<u>4,663,133</u>	<u>13,142,921</u>	<u>5,882,976</u>	<u>4,102,342</u>

* Estimates are from DFO.

¹ Cultus estimates include 276 adults in 2006, 357 adults in 2010, 225 adults in 2014, 168 in 2018.

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

Table G3. Detailed calculation of total allowable catch (TAC) and achievement of international catch shares for Fraser sockeye (by management group) salmon in 2018. 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 (October 12), in accordance with Annex IV, Chapter 4 of the Pacific Salmon Treaty, January 2020.

	Fraser Sockeye				Total
	Early Stuart	Early Summer	Summer	Late	
RUN STATUS, ESCAPEMENT NEEDS & AVAILABLE SURPLUS					
In-season Abundance Estimate	125,000	1,800,000	4,100,000	4,700,000	10,725,000
Adjusted Spawning Escapement Target *	125,000	885,600	1,804,000	1,955,200	4,769,800
Spawning Escapement Target (SET)	108,000	720,000	1,640,000	1,880,000	4,348,000
<i>%SET from TAM rules</i>	86%	40%	40%	40%	
Management Adjustment (MA)	74,500	165,600	164,000	75,200	479,300
<i>Proportional MA (pMA)</i>	0.23	0.23	0.10	0.04	
Test Fishing Catch (TF, post-seas. est.)	1,100	24,200	51,600	36,200	113,000
Surplus above Adjusted SET & TF *	0	890,200	2,244,400	2,708,600	5,843,300
DEDUCTIONS & TAC FOR INTERNATIONAL SHARING					
Aboriginal Fishery Exemption (AFE)	6,900	75,100	153,400	164,600	400,000
Total Deductions (Adj.SET + TF + AFE)	132,900	984,800	2,009,000	2,156,000	5,282,800
Available TAC (Abundance - Deductions)	0	815,200	2,091,000	2,544,000	5,450,100
UNITED STATES (Washington) TAC					
Propor. distrib. TAC - Payback	0	134,100	344,100	418,600	896,900
Proportionally distributed TAC **	0	134,500	345,000	419,800	899,300 16.5%
U.S. Payback	0	-400	-900	-1,100	-2,400
Washington Catch	600	191,500	490,600	310,800	993,500
Deviation from TAC - Payback	-600	-57,400	-146,500	107,800	-96,700
CANADIAN TAC					
Propor. distrib. TAC + Payback + AFE	6,900	756,100	1,900,300	2,290,000	4,953,300
Propor. distrib. TAC + U.S. Payback	0	681,000	1,746,900	2,125,400	4,553,300 83.5%
AFE	6,900	75,100	153,400	164,600	400,000
Canadian Catch excluding ESSR Catch	6,900	578,300	1,807,800	2,338,400	4,731,500
Deviation from TAC + Payback + AFE	-100	177,700	92,500	-48,400	221,800
TOTAL					
Available TAC + U.S. Payback + AFE	6,900	890,600	2,245,400	2,709,700	5,852,500
Total Catch excluding ESSR Catch	7,500	769,900	2,298,400	2,649,200	5,725,000
Deviation from TAC + U.S. Payback + AFE	-600	120,700	-53,100	60,600	127,500

* The surplus cannot exceed the estimated abundance.

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

APPENDIX H: MEMBERS OF THE FRASER RIVER PANEL TECHNICAL COMMITTEE IN 2018

Canada	United States
J. Scroggie, Co-Chair <i>Fisheries and Oceans Canada</i>	R. Conrad, Co-Chair <i>Northwest Indian Fisheries Commission</i>
S. Grant <i>Fisheries and Oceans Canada</i>	M. Litz <i>Washington Department of Fish and Wildlife</i>
M. Mortimer <i>Fisheries and Oceans Canada</i>	P. Mundy <i>National Marine Fisheries Service</i>
M. Hawkshaw <i>Fisheries and Oceans Canada</i>	
M. Staley <i>First Nations Advisor</i>	

APPENDIX I: STAFF OF THE PACIFIC SALMON COMMISSION IN 2018

EXECUTIVE OFFICE

John Field, Executive Secretary
John Son, Information Technology Manager
Julie Ehrmantraut, Administrative Assistant
Kim Bartlett, Meeting Planner
Teri Tarita, Librarian, Archivist, and Records Manager

FINANCE AND ADMINISTRATION

Ilinca Manisali, Controller
Witty Lam, Senior Accountant
Koey Lu, Accounting Assistant
Angus Mackay, Manager, Restoration & Enhancement Funds
Victor Keong, Program Assistant, Restoration & Enhancement Funds

FISHERIES MANAGEMENT DIVISION STAFF

Mike Lapointe, Chief Biologist

Stock Assessment Group

Catherine Michielsens, Director, Modelling and Data Management
Merran Hague, Quantitative Fisheries Biologist
Mark McMillan, Database Manager

Stock Identification Group

Fiona Martens, Director, Coordination and Stock Identification
Maxine Forrest, Manager, Scale Lab
Steve Latham, Manager, Stock Identification
Julie Sellars, Senior Scale Analyst
Catherine Ball, Scale Lab Technician
Pasan Samarasin, Stock Identification Biologist
Miki Shimomura, Salmon Data Technician

Stock Monitoring Group

Eric Taylor, Test Fishing Biologist
Angela Phung, Salmon Technician (term)
Yunbo Xie, Hydroacoustic Scientist
Cory Lagasse, Manager, Hydroacoustic Operations
Jacqueline Nelitz, Hydroacoustic Technician
Mike Bartel Sawatzky, Hydroacoustic Technician