2015

Report of the Fraser River Panel to the Pacific Salmon Commission on the 2015 Fraser River Sockeye and Pink Salmon Fishing Season

Prepared by the

Pacific Salmon Commission

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REPORT OF THE
FRASER RIVER PANEL
TO THE PACIFIC SALMON COMMISSION
ON THE 2015 FRASER RIVER SOCKEYE AND PINK SALMON FISHING SEASON

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M. Griswold
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I. EXECUTIVE SUMMARY

Pre-season Planning

1. Pre-season forecasts were for a median run size (p50 level, Appendix B) of 6,778,000 Fraser River sockeye salmon, and 14,455,000 Fraser River pink salmon.
2. Pre-season forecasts of migration parameters included a 96% diversion rate for Fraser River sockeye through Johnstone Strait (the Panel chose to adopt an 80% diversion rate for modelling) and a 56% diversion rate for Fraser River pink salmon. Pre-season planning was based on the p25-level abundance forecast for Early Stuart sockeye due to concern over the unusual age composition of the forecast (over 95% age 5 return) and median level forecasts for all other sockeye management groups. Forecast abundances and expected Area 20 50% migration dates were: Early Stuart 16,000 (July 8), Early Summer run 837,000 (August 1), Summer-run 4,675,000 (August 7), Late-run 1,236,000 (August 17), for a total of 6,764,000 Fraser Sockeye, and 14.5 million pink salmon (August 28).
3. Pre-season spawning escapement goals were 16,000 Early Stuart, 334,800 Early Summer-run, 1,636,300 Summer-run and 494,400 Late-run sockeye for a total of 2,481,500 sockeye salmon and 6,000,000 pink salmon (Table 1). The goals for each sockeye management group were established by applying Canada's Spawning Escapement Plan (Appendix B) to the forecasted run size. For pre-season planning purposes, Early Stuart was managed to a 10% low abundance exploitation rate (LAER).
4. Management Adjustments (MAs) of about 11,000 Early Stuart, 335,000 Early Summer-run, and 285,000 Summer-run sockeye were added to the spawning escapement targets to increase the likelihood of achieving the targets. The MA for Early Stuart was based on the historical median differences between lower and upriver escapement estimates. The Early Summer-run MA was adopted by the Panel as an intermediate value between the environmental forecast model estimate and the historical median differences between estimates. The MA for the total Summer-run was calculated from a weighted average of the historical median proportional Management Adjustment (pMA) for Harrison (2004-2014; 0.39) and the historical median pMA for the non-Harrison Summer-run component (0.08), using p50 forecast abundances for the weighting (Appendix F, Table F2).
5. For Late-run sockeye, the Panel assumed a continuation of the early upstream migration behaviour and associated high mortality that has occurred since 1996. The Panel adopted a pMA of 0.95 (equivalent to an MA of 471,000 sockeye) for pre-season planning, based on the weighted average of the historical median pMA of Birkenhead component (0.18) and the non-Birkenhead pMA (1.27), using p50 forecasted abundances for the weighting (Appendix F, Table F2). The pMA for the non-Birkenhead Late-run component was the odd year historical median.
6. The projected Total Allowable Catch (TAC) of Fraser River sockeye salmon for International sharing purposes based on the median forecasted abundances and agreed deductions was 2,683,000 sockeye (Table 1), of which 16.5% (443,000 sockeye) were allocated to the United States (U.S.). The projected TAC for pink salmon was 8,244,000 fish, of which 25.7% (2,119,000 pinks) were allocated to the U.S.
7. Pre-season model runs indicated it was unlikely the Summer-run TAC could be fully harvested due to fisheries constraints required to achieve spawning escapement targets for co-migrating Early Summer-run and Late-run stocks. Though less constrained than sockeye harvest, model runs also indicated that neither country was expected to harvest its full share of the pink salmon TAC due to fisheries constraints required to achieve Late-run sockeye salmon escapement targets.
8. The Panel adopted the Management Plan Principles and Constraints and the 2015 Regulations (Appendices C and D).

In-season Management Considerations

9. With the exception of Early Stuart, returns of both sockeye and pink salmon were substantially below median pre-season forecasts (Early Summer-run: 53% below median forecast, Summer-run: 65% below median forecast, Late-run: 86% below median forecast and pink salmon: 60% below median forecast).
10. Fraser River discharge remained near historical record low levels for the duration of the season while river temperatures remained high throughout the season and broke historical records in early July (Figure 6). As a result of the extreme environmental conditions, model predicted differences between potential spawning escapement and the actual number of spawners on the spawning grounds (DBE) were larger than predicted pre-season for the Early Stuart and Summer-run management groups, but slightly less than predicted for the Early Summer-run group. However, commercial fisheries directed at Fraser River sockeye were most constrained by the low returns, such that by August 11, the available TAC for all management groups except Late-run had been caught (Table 1).
11. Marine migration timing (Figure 3) was 4 days later for Summer-run and Late-run sockeye and 5 days earlier than expected for Fraser River pink salmon (Figure 4), causing the pink and sockeye migrations to overlap more than expected pre-season. The pink salmon migration also declined precipitously after August 28 (Area 20 timing) which decreased the run size and further constrained pink directed fisheries.

Run Size, Catch, Escapement and Migration patterns

12. Returns of adult Fraser sockeye totalled 2,006,000 fish (Tables 7 and 8), less than half the return of adult fish in 2011 (5,124,000), the primary brood year. With exception of 2007, 2008 and 2009, this return was the smallest over the last 50 years. Divided into management groups, adult returns totalled 29,000 Early Stuart, 285,000 Early Summer-run, 1,574,000 Summer-run and 118,000 Late-run sockeye.
13. Catches of Fraser River sockeye salmon in all fisheries totalled 377,000 fish, including 187,000 fish caught by Canada, 151,000 fish caught by the U.S. and 38,000 fish caught by test fisheries (Table 7). With the exception of 600 sockeye caught in a domestic Chinook test fishery, all of the Canadian catch occurred in First Nations FSC fisheries (Food, Social and Ceremonial). In Washington, commercial catches totalled 44,000 Fraser sockeye, mostly caught in Treaty Indian fisheries (33,000 fish). Fisheries in Alaska harvested approximately 104,400 Fraser sockeye. The overall harvest rate was 19% of the run, which is among the smallest in recent years, along with 2009 and 2013 (Figure 8).
14. DFO's near-final estimates of spawning escapements to streams in the Fraser River watershed totalled 1,189,000 adult sockeye (Tables 7 and 8). This was less than half the brood year escapement of 2,580,000 adults, but similar to the average escapement on this cycle. By management group and for this cycle line, spawning escapements in 2015 were one fourth of the average escapement to the Early Stuart system since 1939 but was the first increase on this cycle line since 1987, similar to the average Early Summer escapement, more than 50% above the average Summer-run escapement and the lowest Late-run escapement on record since 1939 (Figure 10). There were 687,000 effective female spawners in the Fraser watershed, representing an overall spawning success of 97% with below average spawning success in the Early Stuart, but near or above average in the other management groups.
15. The total run-size estimate of 5,779,000 Fraser River pink salmon was the smallest since 1999. Catches totalled 463,000 fish, with 83,000 caught by Canada, 331,000 by the U.S.

and 49,000 in test fisheries (Table 7). This catch represents an exploitation rate of 8% (Table 8), which is one sixth of the exploitation rate in 2013 and the lowest since 2001.

16. Between 2003 and 2007, the run size of Fraser River pink salmon was the adopted in-season estimate while spawner abundance was calculated by subtracting total catch from this run size. Since 2009, estimates of pink salmon passage have been obtained through the hydroacoustics system at Mission. In 2015, the run size of Fraser River pink salmon was calculated by adding the total catch of pink salmon below Mission (384,000 fish) to the Mission passage estimate (5,395,000 fish, Table 6), while the spawner abundance (5,316,000 fish) was calculated by subtracting total catch from the run size.
17. Marine migration timing (Figure 3) was 2 days earlier than pre-season expectations for Early Stuart and Early Summer-run and 4 days later for Summer-run and Late-run sockeye. No delay in the migration behaviour for Late-run sockeye was detected prior to their upstream migration. The marine migration timing of Fraser pink salmon was 5 days earlier than expected (Figure 4), causing the pink and sockeye migrations to overlap more than expected pre-season. The pink salmon migration also declined precipitously after August 28 (Area 20 timing) which decreased the run size and constrained pink directed fisheries planning.
18. The overall Johnstone Strait diversion rate was 69% for sockeye and 38% for pink salmon, compared to pre-season forecasts of 96% and 55%, respectively (Figure 5).

Achievement of Objectives

19. 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.
20. In-season management decisions are based on targets for spawning escapement, which are represented in-season by potential spawning escapement targets (i.e., spawning escapement targets plus MAs). In-season estimates of potential escapement (i.e., Mission escapement minus all catch above Mission) were similar to the targets for all management groups: Early Stuart sockeye (10% under), Early Summer-run (11% over), Summer-run (14% under) and Late-run sockeye (6% under) (Table 11).
21. Spawning ground estimates of Fraser sockeye abundance totalled 1,189,000 adults, which is 31% below the post-season target. Spawner abundance was severely below the target for Early Stuart sockeye (65% under), similar to the target for Early Summer-run (1% over), below the target for Summer-run (33% under) and severely below the target for Late-run sockeye (42% under) (Table 12). The Early Stuart exploitation rate (3%) was below the low abundance exploitation rate (LAER) of 10%. For Late-run, the exploitation rate (17%) was below the 20% LAER. For Early Stuart and Late-run sockeye, the spawning escapement target equalled the run size, so the escapement target could only be obtained in the absence of catches *and* any difference between estimates. The Summer-run exploitation rate (19%) was higher than the 10% LAER for this management group. Even in the absence of catches, due to the observed difference between estimates, the Summer-run run size was insufficient to attain the escapement target, but reduced catches could have increased the spawning escapement to be closer to the target.
22. There was an International TAC (Total Allowable Catch) of 36,000 Fraser sockeye (Table 13), based on the calculation method set out in Annex IV, Chapter 4 of the Pacific Salmon Treaty. The Washington catch of 46,000 Fraser sockeye was 40,000 fish more than their 16.5% share. The total Canadian catch of 187,000 Fraser sockeye, which excludes the ESSR catch of Weaver sockeye, was 29,000 fish less than their in-season catch goal (83.5% of 36,000 TAC fish + 187,000 AFE fish). In these calculations, the TAC is fixed on the date that Panel control of the last U.S. Panel Area was relinquished (October 3 in 2015), while catches are post-season estimates.
23. In terms of domestic U.S. allocation objectives for Fraser sockeye, Treaty Indian fishers were 31,000 fish above and All Citizen fishers were 9,000 fish above their shares of the U.S. TAC (Table 14).
24. The spawning escapement for Fraser pink salmon was 247,000 fish over the 5,069,000 target (Table 12), and the exploitation rate was 8%.

25. There was a TAC of 661,000 Fraser pink salmon (Table 13), based on the calculation method set out in Annex IV, Chapter 4 of the Pacific Salmon Treaty. The Washington catch of 331,000 Fraser pink salmon was 161,000 fish more than their 25.7% share of the international TAC and the Canadian catch of 83,000 was 408,000 fish less than their catch goal.
26. Regarding domestic U.S. allocation objectives for Fraser pink salmon, Treaty Indian and All Citizen fishers were respectively 102,000 and 59,000 fish over their shares of the U.S. TAC (Table 15).
27. By-catches of non-Fraser sockeye and pink salmon in commercial net fisheries regulated by the Fraser River Panel totalled 1,170 sockeye and 322,000 pink salmon (Table 16). Catches of other Fraser and non-Fraser salmon species included 5,500 chinook, 1,100 coho, 130 chum and 20 steelhead.

Allocation Status

28. By Panel agreement there is a U.S. payback of 900 Fraser River sockeye to carry forward to 2016 (Table 17) but no payback owed for pink salmon.

II. FRASER RIVER PANEL

In 2015, the Panel operated under the terms of Annex IV, Chapter 4 of the Pacific Salmon Treaty between Canada and the United States (U.S.)[1]. The Fraser River Panel was responsible for in-season management of fisheries that target Fraser River sockeye and pink salmon within the Panel Area (Figure 1), including net fisheries in both countries and the Canadian troll fishery in the Strait of Georgia. 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 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.

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 (Staff, Appendix I) 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 Panel Technical

[1] Pacific Salmon Treaty as modified through May 2014.

Committee (Appendix H) works in conjunction with Staff to facilitate Panel activities by providing their respective National sections with technical advice and ensuring timely exchange of data between Staff and the Parties.

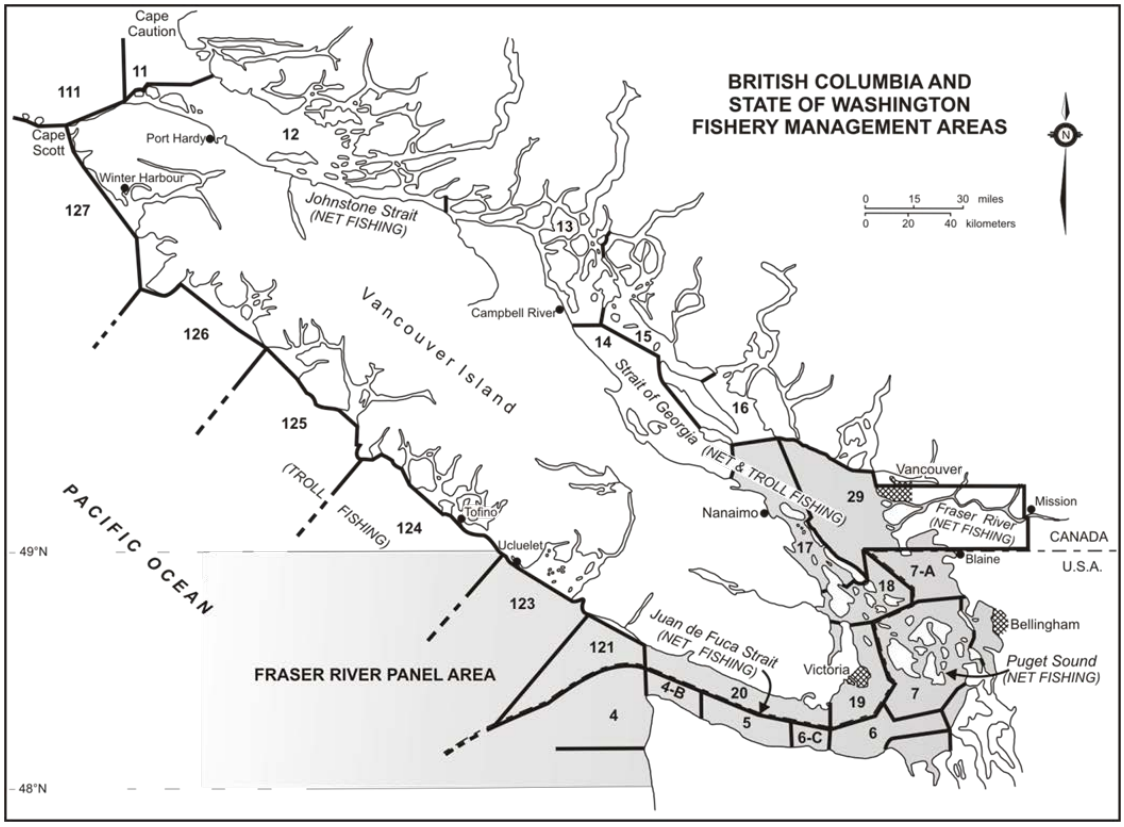

Figure 1. Fishery management areas in the Fraser River Panel Area and south coast waters.

III. PANEL MANAGEMENT ACTIVITIES

Information used for Panel management can be divided into three general categories: (1) pre-season forecasts and expectations, on which pre-season planning activities and the 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. Key information in these categories is discussed in the following sections.

A. Pre-season Planning

Pre-season fisheries management plans for Panel Area fisheries were developed by the Panel using the Fishery Planning Model[2], which helps to evaluate the impacts of alternative fishery options on the achievement of management objectives. Model inputs include forecasts of run size,

[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.

migration timing, diversion rate, Gulf delay, and deductions which include spawning escapement requirements, Management Adjustments (MAs), expected catches in Panel approved test fisheries and the agreed Fraser River Aboriginal Fishery Exemption (AFE). These deductions from the total run sizes for each management group are used to determine the international total allowable catch (TAC) shares and domestic catch allocations. Inputs to the "base case" planning model are summarized under the "Pre-season" rows in Table 1.

Both countries evaluated fishing plans that included directed sockeye and pink fisheries. Fisheries in both countries were directed primarily on Summer-run sockeye. The ability of either country to achieve their sockeye TAC was constrained by a low available TAC of Early Summer and Late-run fish that were substantially overlapped in their migrations with Summer-run fish. A 10% low abundance exploitation rate (LAER) was applied to Early Stuart sockeye that migrate very early in the season. Under Canada's escapement plan, a LAER is specified for stocks with no available harvest (defined as run size minus escapement target minus MA) and it is intended to limit the incidental harvest of these stocks in fisheries directed at other stocks or species which have harvestable surpluses available. Catches in sockeye and pink fisheries in U.S. waters were also expected to be limited by high rates of northern diversion. Neither country was expected to achieve their full TAC shares for Fraser pink salmon due to constraints related to Late-run sockeye abundance. During pre-season modelling, fishing induced mortalities (FIMs) for sockeye captured and released during pink-directed fisheries were included in estimates of exploitation rate but excluded from total catch estimates (i.e. not counted against the TAC). Alternative model runs explored the sensitivity of fishing plans to a few varying assumptions about sockeye salmon run size, sockeye northern diversion rate, the Early Summer-run MA and test fishing retention schedules and deductions.

Pre-season run-size forecasts for Fraser River sockeye salmon were produced by Canada using a variety of stock-recruit models similar to those analysed in previous years and with data up until the 2007 brood year[3]. Canada presented the Panel with sockeye and pink run-size forecasts corresponding to five probability levels (10%, 25%, 50%, 75% and 90%) that the return will be below, or at, the specified abundance (Appendix B, Table B1). In 2015, the Panel used the median (i.e., 50% probability level) forecast for most Fraser River sockeye stock-groups and 14.5 million Fraser River pink salmon as the "base case" scenario for planning purposes. However, the 25% probability level was assumed for Early Stuart sockeye given uncertainty in the forecast and conservation concerns regarding this component of the return. The Panel also explored several alternative model scenarios with varying abundances of sockeye and pink salmon ranging from the 25% to 75% probability levels with the Early Stuart-run component always modelled one "level" lower (e.g. Early Stuart at 10% with remaining stocks at 25%, Early Stuart at 50% with remaining stocks at 75%).

Canada used the "Fraser River Sockeye Spawning Initiative" (FRSSI) model to establish escapement goals for the 2015 management season. The spawning escapement plan released by Canada to the Panel (Appendix B, Table B2) was based on FRSSI guidelines with input from a domestic consultation process. Pre-season escapement targets for sockeye at the 50% probability level (median) run size by management group were: Early Stuart-run – 16,000 (at the 25% run size level); Early Summer-run – 334,800; Summer-run – 1,636,300; and Late-run – 494,400[4]. At this abundance level, the Early Stuart run was managed to a 10% LAER instead of the associated escapement target. The pre-season escapement target for pink salmon at the 50% probability level run size was 6,000,000.

Pre-season fisheries management planning was based on assumptions about the proportions of Fraser sockeye and pink salmon that would migrate through Johnstone versus Juan de Fuca Strait

[3] DFO. 2015. Pre-season run size forecasts for Fraser River Sockeye (*Oncorhynchus nerka*) and Pink (*O. Gorbuscha*) salmon in 2015. DFO Can. Sci. Advis. Sec. Sci. Resp. 2015/014.
[4] 2015/2016 Salmon Integrated Fisheries Management Plan Southern BC. Fisheries and Oceans Canada.

(i.e. Johnstone Strait diversion rate, Figure 2) as well as marine timing (i.e. Juan de Fuca or Area 20 50% migration dates). Area 20 dates are indices of marine migration timing and represent the date when 50% of the total run would have entered Juan de Fuca Strait (Canadian Area 20) if the entire run had migrated via that route. For planning purposes, the Panel adopted the median Area 20 run timing forecast of July 8 for Early Stuart-run fish generated by DFOs oceanographic models, which is four days later than the historical median of July 4. The historical median timing of August 9 was assumed for Chilko because the timing of August 4 forecast by the DFO model seemed inconsistent with the later than average timing forecast for Early Stuart-run and the observed patterns of warm ocean conditions. Area 20 timings for the Early Miscellaneous, Scotch/Seymour, Late Stuart/Stellako, Chilko/Quesnel, Raft/North Thompson, Harrison, Late Shuswap/Weaver and Birkenhead groups were calculated as a function of Early Stuart and Chilko timing using historical regression models to forecast timing of component stocks. The timing of individual stocks was then weighted by the 50% pre-season forecast run sizes (or the 2011 brood year abundance in the case of Horsefly and Mitchell) to calculate a pre-season timing forecast for each component in the Planning Model. For planning purposes, the Panel used weighted average Area 20 dates of August 1 for the Early Summer-run, August 7 for Summer-run and August 17 for Late-run aggregates based on the timing and abundance of component groups. The Panel chose to adopt an 80% diversion rate of Fraser sockeye through Johnstone Strait instead of the 96% diversion rate forecasted from Kains Island May sea surface temperatures and January northward currents by DFO's oceanographic models[5]. The diversion rate for the Harrison component was set to 64% (80% of the diversion forecast for the total sockeye run) based on historical correlations showing a traditionally lower rate of northern diversion. A median historical Area 20 timing of August 28 and median Johnstone Strait diversion of 56% over the previous nine return years was adopted for Fraser River pink salmon. Figures 3 and 4 illustrate the distribution of daily abundances for each sockeye management group and for Fraser pink salmon given these pre-season assumptions of Area 20 timing and total run size.

The Panel adopted a 16-day upstream "delay" for modelling non-Birkenhead Late-run migratory behaviour, corresponding to the median observed delay for the 2014/15 cycle line, which resulted in a September 10 Mission 50% date (i.e. the date 50% of the run has passed Mission) for this group. This scenario assumed a September 12 Mission 50% date (2014/15 cycle average) for the subset (55%) of non-Birkenhead Late-run fish assumed to delay in the Gulf. The model also assumed a 6-day delay for Harrison sockeye (median of 2014/15 cycle line), resulting in an August 20 Mission 50% date. The model assumed 37% of Harrison fish exhibited delay behaviour and that the Harrison delay component migrated upstream at the same time as the Late-run delay component (September 12 Mission timing).

DFO's Environmental Watch Program provided the Panel with long-range (3-month) projections of Fraser River temperature and discharge conditions. Forecasts projected below-average discharge and above-average water temperatures for all sockeye management groups. Staff used the environmental forecasts in Management Adjustment (MA) models developed jointly by DFO and the PSC to predict how many additional Early Stuart-run, Early Summer-run and Summer-run sockeye should be allowed to escape to increase the probability of achieving spawning escapement objectives (see references in the MA section of the Management Information chapter). The Panel chose not to adopt any of the proportional Management Adjustments (pMAs) forecast from the environmental MA models (Table F2) due to the high degree of uncertainty in the model predictions combined with better observed survival in recent years than what the models had predicted. Instead, the Panel adopted all-years historical median pMAs for the Early Stuart and Summer-run groups: Early Stuart pMA = 0.68 (10,900 fish), Summer-run pMA = 0.17 (284,900 fish) and the 2013/15 cycle line median for the Late-run group (pMA = 0.95; 471,400 fish). An Early Summer-run pMA = 1.0 (334,800) was identified, and

[5] Folkes, Michael J P and Thomson, Richard E and Hourston, Roy A S. 2016 (in press). Evaluating Models To Forecast Fraser Sockeye Return Timing And Diversion Rate. DFO Can. Sci. Advis. Sec. Res. Doc. 2016.

adopted by the Panel to reflect concerns about the impact of forecast Fraser River conditions on the Early Summer-run river migration.

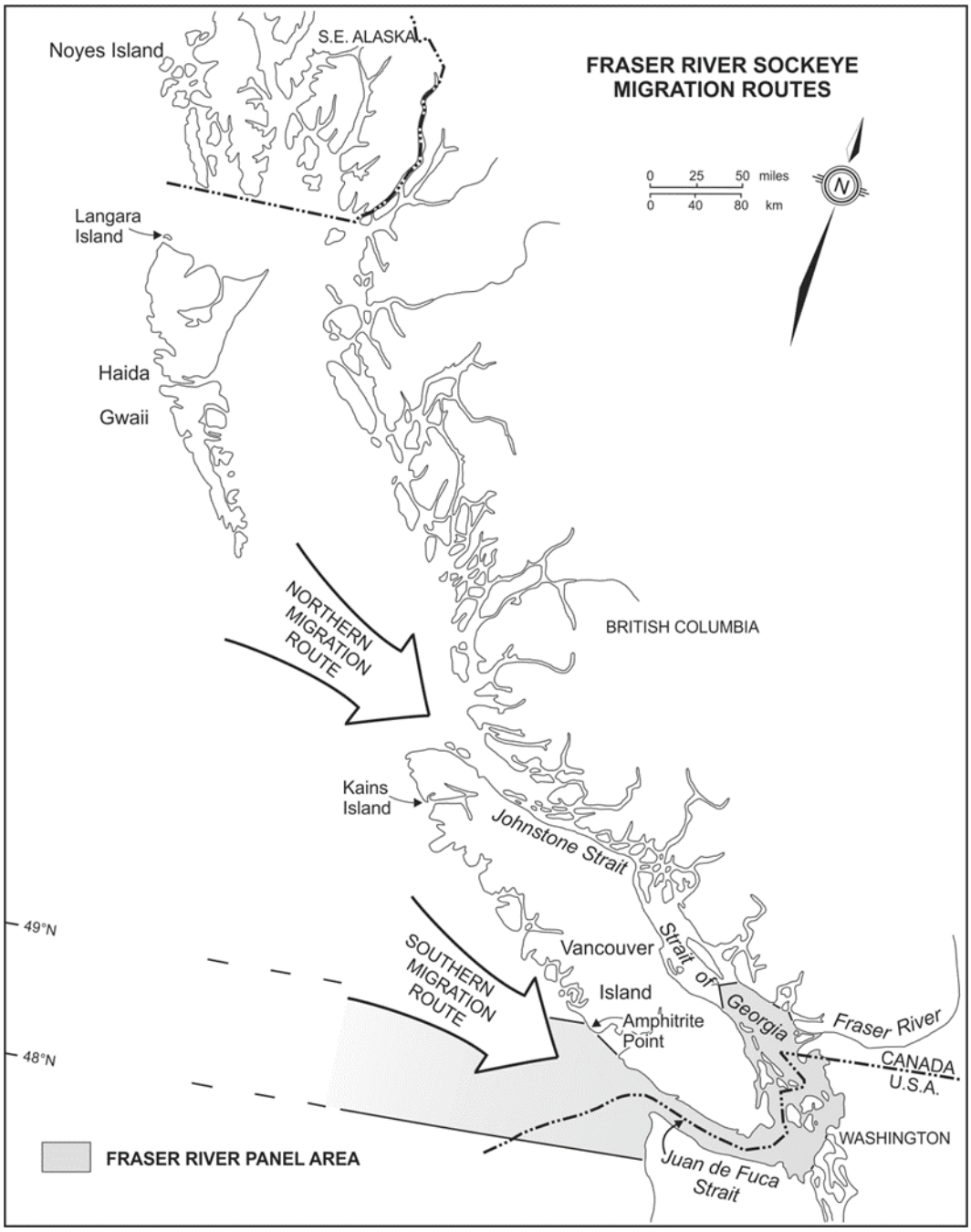

Figure 2. The northern (Johnstone Strait) and southern (Juan de Fuca Strait) routes for sockeye and pink salmon migration to the Fraser River.

For the purposes of pre-season modelling, sockeye and pink salmon retention in Fraser River Panel approved test fisheries were planned to produce a total test fishery revenue of approximately $1,400,000. Revenue calculations assumed landed catches of 110,000 sockeye and 383,000 pink salmon (210,900 Fraser pink salmon; 163,100 non-Fraser pink salmon), average weights and prices per pound for each species, and the expectations of potential harvest by the test fisheries.

Retention of sockeye salmon by purse seine test fisheries was constrained early in the season to protect Nimpkish and Sakinaw sockeye stocks. Pink salmon were assumed to be retained during the entire period of sockeye retention. A late-season period of pink-only retention followed a period of non-retention of both species and continued until the pink salmon landed target was achieved. Fishing induced mortalities (FIMs) of 25% were applied to any sockeye caught during the pink-only retention period. The pink only retention period was constrained to minimize FIM impacts on co-migrating Summer-run and Late-run sockeye stocks.

The Panel considered alternative planning scenarios that included variations in the assumed sockeye and pink salmon run sizes, Early Summer-run MA, northern diversion rate of Fraser sockeye, and various deductions. Both countries evaluated plans that included fisheries directed at Fraser sockeye and pink salmon that were constrained to achieve conservation requirements. A second June meeting of a small group of the Fraser River Panel was required to reach agreement on the approved fishing plan.

The agreed plan included the "Management Plan Principles and Constraints", and "2015 Regulations" (Appendices C, D). In the pre-season plan, the first potential salmon fisheries directed at Fraser sockeye in U.S. Panel-Area waters commenced in the week of July 31. Canada did not model any sockeye directed commercial fisheries in Panel-Area waters as part of their pre-season plan. Panel water fisheries directed at Fraser pink salmon were modelled to begin in week 4 of August for both Canada and the U.S. During proposed Individual Transferable Quota (ITQ) fisheries for pink salmon, Canada assumed sockeye non-retention and applied gear-specific FIMs to any sockeye encounters (25% mortality for seine, 10% for troll and 60% for gillnet fisheries). The U.S. assumed full sockeye retention in all fisheries. Fishing-induced mortalities for released sockeye were not included in catch totals but were incorporated into estimates of total exploitation rate. If in-season assessments indicated that return abundances, migration timing, or MAs deviated from the pre-season expectations, then the start dates and duration of fisheries as well as the assumptions about sockeye retention and fishing-induced mortalities could deviate from the proposed plan.

Calculations of TACs and international harvest shares for Fraser sockeye and pinks were based on Annex IV, Chapter 4 of the Pacific Salmon Treaty. The pre-season TAC for international sharing was 2,683,200 sockeye (Table 1), of which the 16.5% U.S. (Washington) share was 442,800 fish. Treaty Indian fishers were allocated 67.7% of the U.S. TAC and All Citizen fishers the remaining 32.3%. The remaining balance to Canada including the 400,000 Aboriginal Fishery Exemption (AFE) was 2,640,400 sockeye. Pre-season catch targets for non-commercial fisheries in Canada totalled 1,131,900 sockeye, including 783,900 fish for in-river First Nations and 280,000 fish for marine First Nations, plus projected recreational catches of 57,100 fish in the river and 10,900 fish in marine areas. In the commercial sector the overall target of 1,508,500 sockeye was allocated as follows: 48.5% for Area B purse seines, 21.6% for Area D gillnets, 25.1% for Area E gillnets and 4.8% for Area H trollers.

For pink salmon, the total TAC for international sharing was 8,244,100 (Table 1). The U.S. share was 25.7% of the TAC or 2,119,000 fish, divided equally between Tribal Indian and All Citizen fisheries. The balance to Canada was 74.3% or 6,125,100 fish. Canadian pre-season non-commercial catch targets totalled 202,000 fish, including 37,000 fish for in-river First Nations and 22,000 fish for marine First Nations, plus projected recreational catches of 80,000 fish in the river and 63,000 fish in marine areas. An additional 450,000 were allocated to in-river First Nations economic opportunity fisheries. For the commercial sector, Fraser pink catches were distributed as follows: 82.5% for Area B purse seines, 4% for Area D gillnets, 3% for Area E gillnets, 0.5% for Area G trollers and 10% for Area H trollers. The Canadian commercial allocations described above for Fraser sockeye and pink salmon are intended to guide fishing arrangements in the local area and are not fixed entitlements.

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 sockeye and pink salmon. Canada identified Fraser interior coho, west coast Vancouver Island Chinook, Georgia Strait Chinook, Fraser River Spring and Summer Chinook, summer-run interior Fraser Steelhead, Sakinaw sockeye, Nimpkish sockeye, and Rivers and Smith Inlet sockeye. The U.S. highlighted concerns for Puget Sound Chinook salmon, Hood Canal summer-run chum salmon, and Puget Sound Steelhead. Three individual populations of Puget Sound Chinook salmon are of particular concern because of listings under the Federal Endangered Species Act: Dungeness, South Fork Stillaguamish, and South Fork Nooksack.

B. In-season Management

In 2015, all sockeye, with the exception of the Early Stuart-run, and pink salmon management groups returned at run sizes that were well below the median pre-season forecasts, and with marine timing earlier than forecasted for Early Stuart-run and Early Summer-run but later for Summer-run and Late-run groups (Figure 3). Management challenges also arose due to the extreme environmental conditions resulting in difficulty in interpreting the model predicted differences between potential spawning ground escapement and the actual number of spawners on the spawning grounds. The Panel responded to these challenges in-season by modifying Management Adjustments (MAs) and fishing plans accordingly.

The Panel convened 19 times between July 10 and September 11, to discuss run status and enact in-season Orders (Appendix E) to regulate fisheries directed at Fraser River sockeye and pink salmon in Panel Areas. Table 1 summarizes pre-season and in-season data by management group and by meeting date, including estimates of run size and the various deductions that result in the calculated TAC (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 last date shown in Table 1 (October 3) is the "TAC date", which is when the Panel relinquished regulatory control of the last U.S. Panel Area and is therefore when the U.S. share of the TAC was established. The main events that transpired each week are summarized below, with a focus on Staff assessments and Panel decisions.

Table 1. Pre-season and in-season updates of run size, spawning escapement targets and other TAC-related values for Fraser River sockeye and pink salmon in 2015. The available harvest (run size minus spawning escapement target and management adjustment), catch to date, Mission escapement to date and migration timing are also shown.

				TAC*									
Date	Management Group	Total Abundance	Spawning Escapement Target	pMA	Manage-ment Adjust.	Test Fishing	Aboriginal Fishery Exemption	Total Allowable Catch	Available Harvest **	Catch to date	Mission Passage to date	50% Migration Date Area 20
June 30 Pre-season	Early Stuart	16,000	16,000	0.68	10,900	100	1,500	0	0			8-Jul
	Early Summer	837,000	334,800	1.00	334,800	16,900	35,900	114,600	167,400			1-Aug
	Summer	4,675,000	1,636,300	0.17	285,000	79,700	285,200	2,388,800	2,753,700			7-Aug
	Late	1,236,000	494,400	0.95	471,400	13,200	77,400	179,600	270,200			17-Aug
	Sockeye	**6,764,000**	**2,481,500**		**1,102,100**	**109,900**	**400,000**	**2,683,000**	**3,191,300**	**0**	**0**	
	Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**			28-Aug
July 10 In-season	Early Stuart	16,000	16,000	0.68	10,900	100	1,500	0	0	0	600	8-Jul
	Early Summer	837,000	334,800	1.00	334,800	16,900	35,900	114,600	167,400	0	600	1-Aug
	Summer	4,675,000	1,636,300	0.17	278,200	79,700	285,200	2,395,600	2,760,500	0	0	7-Aug
	Late	1,236,000	494,400	0.95	469,700	13,200	77,400	181,300	271,900	0	0	17-Aug
	Sockeye	**6,764,000**	**2,481,500**		**1,093,600**	**109,900**	**400,000**	**2,691,500**	**3,199,800**	**0**	**1,200**	
	Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**0**		28-Aug
July 17 In-season	Early Stuart	16,000	16,000	0.68	10,900	100	1,500	0	0	200	8,100	8-Jul
	Early Summer	837,000	334,800	1.00	334,800	16,900	35,900	114,600	167,400	200	4,600	1-Aug
	Summer	4,675,000	1,636,300	0.17	278,200	79,700	285,200	2,395,600	2,760,500	0	0	7-Aug
	Late	1,236,000	494,400	0.95	469,700	13,200	77,400	181,300	271,900	0	0	17-Aug
	Sockeye	**6,764,000**	**2,481,500**		**1,093,600**	**109,900**	**400,000**	**2,691,500**	**3,199,800**	**400**	**12,700**	
	Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**0**		28-Aug

Table 1, continued on next page

Date		Management Group	Total Abundance	TAC* Spawning Escapement Target	pMA	Manage-ment Adjust.	Test Fishing	Aboriginal Fishery Exemption	Total Allowable Catch	Available Harvest **	Catch to date	Mission Passage to date	50% Migration Date Area 20
July 21	In-season	Early Stuart	30,000	30,000	4.18	125,400	100	1,500	0	0	200	17,600	7-Jul
		Early Summer	837,000	334,800	1.00	334,800	16,900	35,900	114,600	167,400	400	25,700	1-Aug
		Summer	4,675,000	1,636,300	0.17	278,200	79,700	285,200	2,395,600	2,760,500	200	1,300	7-Aug
		Late	1,236,000	494,400	0.95	469,700	13,200	77,400	181,300	271,900	0	0	17-Aug
		Sockeye	**6,778,000**	**2,495,500**		**1,208,100**	**109,900**	**400,000**	**2,691,500**	**3,199,800**	**800**	**44,600**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**0**		28-Aug
July 24	In-season	Early Stuart	30,000	30,000	4.18	125,400	100	1,500	0	0	200	29,600	7-Jul
		Early Summer	837,000	334,800	1.00	334,800	16,900	35,900	114,600	167,400	1,000	53,300	1-Aug
		Summer	4,675,000	1,636,300	0.17	278,200	79,700	285,200	2,395,600	2,760,500	600	12,100	7-Aug
		Late	1,236,000	494,400	0.95	469,700	13,200	77,400	181,300	271,900	0	0	17-Aug
		Sockeye	**6,778,000**	**2,495,500**		**1,208,100**	**109,900**	**400,000**	**2,691,500**	**3,199,800**	**1,800**	**95,000**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**0**		28-Aug
July 28	In-season	Early Stuart	30,000	30,000	4.18	125,400	100	1,500	0	0	300	32,200	7-Jul
		Early Summer	837,000	334,800	1.00	334,800	16,900	35,900	114,600	167,400	1,500	94,700	1-Aug
		Summer	4,675,000	1,636,300	0.17	278,200	79,700	285,200	2,395,600	2,760,500	1,500	44,100	7-Aug
		Late	1,236,000	494,400	0.95	469,700	13,200	77,400	181,300	271,900	0	0	17-Aug
		Sockeye	**6,778,000**	**2,495,500**		**1,208,100**	**109,900**	**400,000**	**2,691,500**	**3,199,800**	**3,300**	**171,000**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**			28-Aug
July 31	In-season	Early Stuart	30,000	30,000	4.18	125,400	200	1,500	0	0	300	31,700	7-Jul
		Early Summer	837,000	334,800	1.00	334,800	16,900	35,900	114,600	167,400	2,300	118,800	1-Aug
		Summer	4,675,000	1,636,300	0.17	278,200	79,700	285,200	2,395,600	2,760,500	4,400	71,600	7-Aug
		Late	1,236,000	494,400	0.95	469,700	13,200	77,400	181,300	271,900	0	0	17-Aug
		Sockeye	**6,778,000**	**2,495,500**		**1,208,100**	**110,000**	**400,000**	**2,691,500**	**3,199,800**	**7,000**	**222,100**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**2,300**		28-Aug
August 4	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	1,500	0	0	300	31,700	6-Jul
		Early Summer	837,000	334,800	1.00	334,800	16,900	35,900	114,600	167,400	6,700	156,200	1-Aug
		Summer	4,675,000	1,636,300	0.17	278,200	79,700	285,200	2,395,600	2,760,500	23,100	142,600	7-Aug
		Late	1,236,000	494,400	0.95	469,700	13,200	77,400	181,300	271,900	200	1,400	17-Aug
		Sockeye	**6,780,000**	**2,497,500**		**1,216,500**	**110,000**	**400,000**	**2,691,500**	**3,199,800**	**30,300**	**331,900**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**18,900**		28-Aug
August 7	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	1,500	0	0	400	32,200	6-Jul
		Early Summer	424,000	169,600	1.00	169,600	16,900	35,900	32,000	84,800	13,200	202,000	1-Aug
		Summer	4,675,000	1,636,300	0.17	278,200	79,700	285,200	2,395,600	2,760,500	41,000	267,700	7-Aug
		Late	1,236,000	494,400	0.95	469,700	13,200	77,400	181,300	271,900	1,100	1,500	17-Aug
		Sockeye	**6,367,000**	**2,332,300**		**1,051,300**	**110,000**	**400,000**	**2,608,900**	**3,117,200**	**55,700**	**503,400**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**31,700**		28-Aug
August 11	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	800	0	0	400	32,200	6-Jul
		Early Summer	350,000	140,000	1.00	140,000	16,900	36,000	17,100	70,000	21,400	254,000	29-Jul
		Summer	1,701,000	1,448,000	0.17	246,200	79,700	285,600	0	6,800	79,300	418,400	7-Aug
		Late	1,236,000	494,400	0.95	469,700	13,200	77,600	181,100	271,900	1,900	3,100	17-Aug
		Sockeye	**3,319,000**	**2,114,400**		**989,700**	**110,000**	**400,000**	**198,200**	**348,700**	**103,000**	**707,700**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**101,900**		28-Aug
August 14	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	800	0	0	700	32,600	6-Jul
		Early Summer	350,000	140,000	1.00	140,000	16,900	36,000	17,100	70,000	34,900	261,800	29-Jul
		Summer	1,150,000	1,150,000	0.17	195,500	79,700	285,600	0	0	144,300	491,800	7-Aug
		Late	419,000	315,000	0.95	299,300	13,200	77,600	0	0	4,900	5,900	17-Aug
		Sockeye	**1,951,000**	**1,637,000**		**768,600**	**110,000**	**400,000**	**17,100**	**70,000**	**184,800**	**792,100**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**132,900**		28-Aug
August 18	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	800	0	0	600	32,000	6-Jul
		Early Summer	350,000	140,000	1.00	140,000	16,900	36,000	17,100	70,000	35,100	296,800	29-Jul
		Summer	1,500,000	1,448,000	0.17	246,200	79,700	285,600	0	0	146,800	674,600	11-Aug
		Late	419,000	315,000	0.95	299,300	13,200	77,600	0	0	4,900	11,900	17-Aug
		Sockeye	**2,301,000**	**1,935,000**		**819,300**	**110,000**	**400,000**	**17,100**	**70,000**	**187,400**	**1,015,300**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**135,500**		28-Aug
August 21	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	800	0	0	800	31,900	6-Jul
		Early Summer	350,000	140,000	1.00	140,000	6,300	63,700	0	70,000	39,900	304,100	29-Jul
		Summer	1,600,000	1,448,000	0.17	246,200	28,800	106,400	0	0	167,400	828,600	11-Aug
		Late	419,000	315,000	0.95	299,300	4,600	77,300	0	0	5,700	20,700	17-Aug
		Sockeye	**2,401,000**	**1,935,000**		**819,300**	**39,900**	**248,200**	**0**	**70,000**	**213,800**	**1,185,300**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**143,800**		28-Aug

Table 1, continued on next page

Table 1, continued.

Date		Management Group	Total Abundance	TAC* Spawning Escapement Target	pMA	Manage-ment Adjust.	Test Fishing	Aboriginal Fishery Exemption	Total Allowable Catch	Available Harvest **	Catch to date	Mission Passage to date	50% Migration Date Area 20
August 25	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	800	0	0	800	31,900	6-Jul
		Early Summer	350,000	140,000	1.00	140,000	6,300	63,700	0	70,000	40,100	327,300	29-Jul
		Summer	1,600,000	1,448,000	0.17	246,200	28,800	106,400	0	0	169,000	1,071,200	11-Aug
		Late	419,000	315,000	0.95	299,300	4,600	77,300	0	0	5,900	52,600	17-Aug
		Sockeye	**2,401,000**	**1,935,000**		**819,300**	**39,900**	**248,200**	**0**	**70,000**	**215,800**	**1,483,000**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**166,400**		28-Aug
August 28	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	800	0	0	800	31,900	6-Jul
		Early Summer	400,000	160,000	1.00	160,000	6,300	63,700	10,000	80,000	43,800	348,600	31-Jul
		Summer	1,700,000	1,448,000	0.17	246,200	28,800	106,400	0	5,800	179,900	1,236,100	12-Aug
		Late	419,000	315,000	0.95	299,300	4,600	77,300	0	0	6,300	83,500	17-Aug
		Sockeye	**2,551,000**	**1,955,000**		**839,300**	**39,900**	**248,200**	**10,000**	**85,800**	**230,800**	**1,700,100**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**261,100**		28-Aug
August 31	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	800	0	0	na	na	6-Jul
		Early Summer	400,000	160,000	1.00	160,000	6,300	63,700	10,000	80,000	na	na	31-Jul
		Summer	1,700,000	1,448,000	0.17	246,200	28,800	106,400	0	5,800	na	na	12-Aug
		Late	419,000	315,000	0.95	299,300	4,600	77,300	0	0	na	na	17-Aug
		Sockeye	**2,551,000**	**1,955,000**		**839,300**	**39,900**	**248,200**	**10,000**	**85,800**	**0**	**0**	
		Pink	**14,455,000**	**6,000,000**			**210,900**		**8,244,100**	**8,455,000**	**na**		28-Aug
September 1	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	800	0	0	800	31,900	6-Jul
		Early Summer	400,000	160,000	1.00	160,000	6,300	63,700	10,000	80,000	43,800	356,300	31-Jul
		Summer	1,700,000	1,448,000	0.17	246,200	28,800	106,400	0	5,800	180,900	1,449,400	12-Aug
		Late	300,000	300,000	0.95	285,000	4,600	77,300	0	0	6,900	130,100	23-Aug
		Sockeye	**2,432,000**	**1,940,000**		**825,000**	**39,900**	**248,200**	**10,000**	**85,800**	**232,400**	**1,967,700**	
		Pink	**6,000,000**	**5,235,000**			**210,900**		**554,100**	**765,000**	**331,100**		21-Aug
September 4	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	800	0	0	800	31,900	6-Jul
		Early Summer	400,000	160,000	1.00	160,000	6,600	63,700	9,700	80,000	44,100	346,600	31-Jul
		Summer	1,700,000	1,448,000	0.17	246,200	28,800	106,400	0	5,800	183,200	1,332,800	12-Aug
		Late	300,000	300,000	0.95	285,000	3,600	77,300	0	0	7,400	109,000	23-Aug
		Sockeye	**2,432,000**	**1,940,000**		**825,000**	**39,200**	**248,200**	**9,700**	**85,800**	**235,500**	**1,820,300**	
		Pink	**6,000,000**	**5,235,000**			**75,000**		**690,000**	**765,000**	**388,300**		21-Aug
September 8	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	800	0	0	800	31,900	6-Jul
		Early Summer	400,000	160,000	1.00	160,000	6,600	63,700	9,700	80,000	44,100	347,100	31-Jul
		Summer	1,500,000	1,448,000	0.17	246,200	28,800	106,400	0	0	183,600	1,360,000	10-Aug
		Late	200,000	200,000	0.95	190,000	3,600	77,300	0	0	7,500	130,600	21-Aug
		Sockeye	**2,132,000**	**1,840,000**		**730,000**	**39,200**	**248,200**	**9,700**	**80,000**	**236,000**	**1,869,600**	
		Pink	**6,200,000**	**5,383,200**			**75,000**		**741,800**	**816,800**	**370,100**		22-Aug
September 11	In-season	Early Stuart	32,000	32,000	4.18	133,800	200	800	0	0	800	31,900	6-Jul
		Early Summer	400,000	160,000	1.00	160,000	6,600	63,700	9,700	80,000	44,300	348,100	31-Jul
		Summer	1,500,000	1,448,000	0.17	246,200	28,800	106,400	0	0	195,500	1,398,700	10-Aug
		Late	200,000	200,000	0.95	190,000	3,600	77,300	0	0	7,800	140,700	21-Aug
		Sockeye	**2,132,000**	**1,840,000**		**730,000**	**39,200**	**248,200**	**9,700**	**80,000**	**248,400**	**1,919,400**	
		Pink	**6,200,000**	**5,383,200**			**50,000**		**766,800**	**816,800**	**373,500**		22-Aug
October 3	TAC Date	Early Stuart	32,100	32,100	4.18	134,200	200	800	0	0	800	31,900	6-Jul
		Early Summer	373,000	149,200	1.00	149,200	6,500	73,500	0	74,600	44,900	348,500	30-Jul
		Summer	1,549,200	1,448,000	0.17	246,200	29,000	128,400	0	0	212,200	1,424,300	11-Aug
		Late	165,800	165,800	0.95	157,500	2,300	35,200	0	0	9,400	158,600	21-Aug
		Sockeye	**2,120,100**	**1,795,100**		**687,100**	**38,000**	**237,900**	**0**	**74,600**	**267,300**	**1,963,300**	
		Pink	**5,781,300**	**5,071,100**			**48,000**		**662,200**	**710,200**	**413,700**		22-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 control of the last U.S. fishery area was relinquished.

** Available Harvest = Total abundance minus spawning escapement target and Management Adjustment.

July 4 – 10: The first in-season Panel meeting took place on Friday, July 10. Only a small number of sockeye had been caught in the in-river test fisheries at the time of the meeting, and the marine test fisheries had been planned to begin later than in other years, therefore there was not enough data to produce an estimate of the Early Stuart-run size and timing (p25 forecast of 16,000 was used for pre-season planning, July 8 Area 20 timing). The Fraser River temperature at Qualark was unseasonably warm at 19.3°C on July 9, which was 3.6°C warmer than average. The discharge at Hope was 30% lower than average for the time of year at 4,057 $m^3 \cdot s^{-1}$. All Panel Area waters remained closed to commercial salmon fishing.

July 11 – 17: As of July 16, the estimated catch plus escapement of Early Stuart sockeye was 8,300, and 4,800 for Early Summer-run sockeye. Assessment capabilities were limited as marine test fisheries and in-river hydro-acoustics operations had only begun earlier in the week, but the Early Stuart sockeye run appeared to be tracking within the p25 to p75 pre-season forecast range of 16,000 to 58,000 sockeye. On July 16 the Fraser River discharge at Hope was 3,532 $m^3 \cdot s^{-1}$ (34% lower than average) and the river temperature at Qualark was 20.0°C (3.5°C higher than average). Due to the river conditions, the Fraser River Panel anticipated an increase in the Early Stuart management adjustment. All Panel Area waters remained closed to commercial salmon fishing.

July 18 – 24: As of July 23, the estimated catch plus escapement of Early Stuart sockeye was 29,800. This estimate included daily abundance estimates derived from the hydro-acoustic program at Qualark for the period prior to July 11 when the hydro-acoustic program at Mission had not yet been operational. The resulting Early Stuart sockeye run size was estimated to be close to the p50 forecast (30,000), and on Tuesday, July 21 the Panel increased the Early Stuart run size from 16,000 to 30,000 with an estimated Area 20 50% timing of July 7. The accounted run to date of Early Summer-run and Summer-run was 54,200 and 12,700, respectively. On July 23, the Fraser River discharge at Hope was 3,008 $m^3 \cdot s^{-1}$ (38% lower than average) and the river temperature at Qualark was 19.4°C (2.1°C higher than average). Due to continued high temperatures in the Fraser River, the Panel also adopted an increased proportional Management Adjustment (pMA) for Early Stuart of 4.18 (up from 0.68). The 5-day average diversion rate for sockeye through Johnstone Strait was 34%. All Panel Area waters remained closed to commercial salmon fishing.

July 25 – July 31: As of July 30, the estimated catch plus escapement of Early Stuart sockeye was 31, 900. A small increase in the adopted Early Stuart run size (30,000) was anticipated once the migration was complete. The accounted run to date of Early Summer-run was 121,000, with the Early Thompson portion of the run appearing to be lower and/or later than forecast (tracking below p25 forecast at the time of the meeting). The accounted run to date of Summer-run sockeye was 75, 900. On July 30, the Fraser River discharge at Hope was 2,922 $m^3 \cdot s^{-1}$ (34% lower than average) and the river temperature at Qualark was 19.0°C (1.0°C higher than average). The 5-day average diversion rate for sockeye through Johnstone Strait was 35%. A Treaty Indian net fishery in Areas 4B, 5, and 6C was opened at noon on July 25.

August 1 – 7: As of August 6, the estimated catch plus escapement of Early Stuart sockeye was 32,400. At the meeting on Tuesday, August 4, the Panel adopted an Early Stuart run size of 32,000 with July 6 marine timing. The accounted run to date of Early Summer-run was 212,700, with the Early Thompson portion of the run (22,000 sockeye accounted to date) being substantially lower than forecast. The Panel adopted the p25 forecast of 424,000 with August 1 timing for the Early Summer-run aggregate. The accounted run to date of Summer-run sockeye was 304,800. On August 6 the Fraser River discharge at Hope was 2,530 $m^3 \cdot s^{-1}$ (36% lower than average) and the river temperature at Qualark was 18.7°C (0.7°C higher than average), resulting in a model-projected pMA for Early Summer-run of 1.06, similar to the pre-season adopted value of 1.00. The 5-day average diversion rate for sockeye through Johnstone Strait was 54%. Several low impact Treaty Indian and All Citizen fisheries were approved in U.S. waters, resulting in a total U.S. catch of Fraser sockeye of 21,400 through August 6. On August 7, Canada provided pre-season forecasts for the timing (August 28) and Johnstone Strait diversion rate (55%) of Fraser River Pink salmon, which confirmed the values used in pre-season planning.

August 8 – 14: At the meeting on Tuesday, August 11, the Panel adopted an Early Summer-run aggregate run size of 350,000 with July 29 marine timing. The Early Thompson component of the run was particularly low in abundance, tracking at less than the 10th percentile of the pre-season forecast (122,000 Sockeye). Based on the low return of Early Summer-run sockeye and the low numbers of Summer-run sockeye observed to date, the Panel adopted a Summer-run sockeye

run size of 1,701,000 (the 10% probability level forecast) during the August 11 meeting but was not yet able to provide an associated timing estimate given the limited catch plus escapement thus far. During the Friday, August 14 meeting the Panel further reduced the Summer-run size to 1,150,000 with August 7 marine timing. The spawning escapement target was equal to this low run-size resulting in the application of a 10% LAER for this group that was in effect for the remainder of the season. Catch plus escapement of Late run sockeye through August 13 was 10,700, and too little of the run had migrated through marine assessment areas to generate credible in-season run size estimates. Considering the low returns of the Early Summer and Summer-runs, the historic correlation between Early Thompson and Late Shuswap run size estimates, and the low abundance of Late-run sockeye to date given the forecast marine timing of August 17, the Panel adopted a run size of 419,000 (Late-run sockeye (the 10% probability level) at the August 14 meeting. The combination of the Late-run adopted run size and MA resulted in the application of a 20% LAER for this group that was in effect for the remainder of the season. On August 13, Fraser River discharge at Hope was 2,440 $m^3 \cdot s^{-1}$ (30% lower than average for the date), and the river temperature at Qualark Creek was 19.8°C (1.8°C higher than average for the date). For Early Summer-run sockeye, the in-season MA remained consistent with the pre-season adopted value, so no further changes were made. For the Summer-run sockeye, early predictions indicated the proportional Management Adjustment (pMA) would likely be higher than the 0.17 value adopted pre-season. Because there were no management implications of the pMA at the adopted run size (a 10% LAER was in effect), it was decided to wait for more observed days of environmental conditions before adopting an in-season pMA estimate for Summer-run sockeye. The 5-day average diversion rate through Johnstone Strait was 78% for sockeye and 10% for pink salmon. Given the low in-season run-size estimates, the Panel acted to limit sockeye mortalities: no commercial or recreational fisheries were opened, First Nations Food, Social and Ceremonial fisheries were only permitted far upstream in the Fraser River, and test fishery catches were curtailed by terminating marine gill net test fisheries ahead of schedule and limiting the landing of purse seine catches only to fish required for biological sampling.

August 15 – 21: On Tuesday, August 18, the accounted run-to-date of Summer-run sockeye was 949,200, and the Panel adopted a Summer-run sockeye run size of 1,500,000 with August 11 timing. The Panel then updated the Summer-run run size again on Friday, August 21 to 1,600,000 (with no further change to timing). Despite increases to run-size, the combined spawning escapement targets and management adjustments continued to result in the application of the LAER. The accounted run-to-date of Late-run sockeye was 26,200. It was not possible to determine if the total Late-run sockeye run size would be smaller or larger than the currently adopted estimate of 419,000 and no changes were made to the run size or timing of the Late Run. On August 20, the Fraser River discharge at Hope was 2,203 $m^3 \cdot s^{-1}$ (28% lower than average) and the river temperature at Qualark was 19.7°C (1.7°C higher than average). Because of the lack of evidence of en-route losses and the experience in recent years, the Panel decided not to adopt the in-season Summer-run pMA estimate of 0.53 but retained the pre-season forecast of 0.17. The higher in-season pMA for Summer-run sockeye had no management implications because the low run size had resulted in a LAER for this group. The Johnstone Strait 5-day average diversion rate was 90% for sockeye and 53% for pink salmon. Due to lower than expected sockeye run-sizes, no fisheries were recommended or opened in either Canadian or U.S. waters. The impact of incidental mortality of sockeye would be a major consideration in the decision-making process concerning pink salmon fishing in the coming weeks.

August 22 – August 28: As of August 27, the estimated catch plus escapement of Early Summer-run sockeye was 373,300; the Panel adopted an Early Summer-run sockeye run-size of 400,000 with July 31 timing on Friday, August 28. The accounted run-to-date of Summer-run sockeye was 1,360,300; the Panel adopted a Summer-run sockeye run size of 1,700,000 with August 12 timing on Friday, August 28. Again the increase to run size was insufficient to negate the LAER. The accounted run-to-date of Late-run sockeye was 89,600 with another 123,000 sockeye estimated to have passed the marine test fishing sites. The catch plus escapement of pink salmon was 761,000 as of August 27, with approximately 5 million estimated to have passed the marine test fisheries. The marine migration of pink salmon dropped precipitously on August 28

(Figure 4) without any substantial subsequent increase. This decrease without recovery constrained both the run size and planning of pink directed fisheries. On August 27, the Fraser River discharge at Hope was 1,828 $m^3 \cdot s^{-1}$ (30% lower than average) and the river temperature at Qualark was 18.1°C (0.9°C higher than average). The Johnstone Strait 5-day average diversion rate was 95% for sockeye and 23% for pink salmon. No commercial fisheries were planned for sockeye, but because of the low sockeye encounter rate along the Juan de Fuca migration route, fisheries directed at pink salmon began in U.S. waters earlier in the week.

August 29 – September 4: On August 31, the total catch plus escapement of Fraser sockeye was 2,124,400, and 5 days later, on September 3, this estimate decreased to 1,975,000 due to revisions of the escapement estimates. Initially, sockeye escapement at Mission had been estimated by multiplying the total salmon passage by the sockeye proportion of that passage (determined using a length based mixture model). There were several indications that as the number of Fraser River pink salmon increased in the river, this method was overestimating the abundance of sockeye, and on September 3 a change in the method was proposed applying back to August 27. Sockeye abundance was determined instead by dividing the Whonnock CPUE by an in-season catchability estimate, which was based on the period from August 1 to 15. This resulted in a decrease of the total catch plus escapement of sockeye, as was presented during the meeting on September 4. As of September 3, the estimated catch plus escapement of Early Summer-run, Summer-run and Late-run sockeye was 370,900, 1,456,100, and 115,900 respectively. On September 1, the Panel had adopted a Late-run sockeye run size of 300,000 with August 23 timing, and there were no changes to the adopted run sizes at the meeting on September 4. On September 3rd, the Fraser River discharge at Hope was 1,982 $m^3 \cdot s^{-1}$ (19% lower than average) and the river temperature at Qualark was 16.1°C (0.4°C lower than average); the decrease in river temperature was likely due to the substantial amount of rain in the days prior. Because the estimated upstream migration date for Late-run excluding Birkenhead (August 31) was not later than September 9, the pre-season pMA estimate of 0.95 was retained consistent with the agreed management approach.

On August 31, the total catch plus escapement of Fraser pink salmon was 1,143,000. Using historic catchability estimates, the total reconstructed abundance of pink salmon to date was 6,291,000 and the Panel adopted a run size of 6,000,000 with August 21 timing. Despite a steep decline in abundance, test fisheries in marine areas were proposed to continue because of the possibility of an increase in marine abundance that had been observed in previous years (e.g. 2001, 1993 and 1991). The Johnstone Strait 5-day average diversion rate was 99% for sockeye and 77% for pink salmon by September 3. The diversion rate for Fraser pink salmon had been 11% on August 30.

September 5 – 11: As of Sept. 10, the estimated catch plus escapement of Summer-run sockeye was 1,522,300 (catch: 123,600; escapement: 1,398,700). The Panel adopted a Summer-run sockeye run size of 1.5 million on Tuesday, September 8 with an associated 50% date of August 10. The catch plus escapement of Late-run sockeye as of September 10 was 147,800 (catch: 7,100; escapement: 140,700). The Panel adopted a Late-run sockeye run size of 200,000 on September 8, and an associated timing of August 21. The catch plus escapement of pink salmon as of September 10 was 4,627,400 (catch: 371,800; escapement: 4,255,600). The Panel adopted a pink run size of 6,200,000 on September 8, and an associated timing of August 22. Both the sockeye and pink salmon migrations appeared to be nearing completion. On September 7, the discharge at Hope was 1,990 $m^3 \cdot s^{-1}$, which was approximately 17% lower than average for this date. The temperature of the Fraser River was 15.3°C on September 7, approximately 0.7°C lower than average for this date. As of September 10, the 5-day average diversion rate was 99%, for sockeye and 91% for pink salmon. A small pink fishery was opened in Area 29 on September 8, and subsequently closed on September 10. September 11 was the final in-season meeting for 2015.

Table 2. Number of days when major U.S. net fisheries in the Fraser River Panel Area were open for directed harvest of Fraser River sockeye and pink salmon in 2015. Regulatory control of U.S. Panel Areas was relinquished by the Panel on September 19 for Areas 4b, 5 and 6c, October 3 for Areas 6, 7 and portions of 7a, and October 10 for the remaining portions of Area 7a, in accordance with pre-season regulations (Appendix D).

	Treaty Indian		All Citizen		
	Areas	Areas	Areas 7 and 7A		
Date	4B, 5, 6C	6, 7, 7A	Purse Seine	Gillnet	Reefnet
May.31-Jul.18					
Jul.19-Jul.25	1				
Jul.26-Aug.1	7	1			1
Aug.2-Aug.8	7	3	4	4	3
Aug.9-Aug.15	4	3			
Aug.16-Aug.22					
Aug.23-Aug.29	5	3	2	2	2
Aug.30-Sep.5	4	2	2	2	3
Sep.6-Sep.12					
Sep.13-Sep.19					
Total	28	12	8	8	9

On October 3, Panel control of the last U.S. Panel Area was relinquished, in accordance with the pre-season regulations. The inputs used to calculate the TAC and international shares were frozen on this date (except for post-season updates to the test fishery catch deduction), according to the revised Annex IV, Chapter 4 of the Pacific Salmon Treaty. The achievement of these in-season catch objectives will be assessed by comparison with post-season catch estimates in the Achievement of Objectives section of this report.

Overviews of commercial fisheries openings in U.S. Panel Areas are contained in Table 2. There were no commercial fisheries in Canadian Panel Areas.

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, a hydroacoustic facility (Mission) and observers (Hells Gate). The locations and schedule for these Staff and DFO programs are listed in Table 3. 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 and the total abundance of pink salmon into Fraser and non-Fraser components. Table 4 shows the sockeye stock resolution that was reported in 2015. These data are augmented with catch information from commercial, First Nations, recreational and other fisheries that are provided by the two counties.

Table 3. Panel-approved stock monitoring operations (test fishery, hydroacoustic and observer) conducted during the 2015 fishing season.

Area	Location	Gear	Dates	Operated by
Canadian Panel Areas				
20	Juan de Fuca Str.	Gillnet	July 13 - August 13	PSC
20	Juan de Fuca Str.	Purse Seine	July 21 - September 8	PSC
29-14	Fraser R. (Cottonwood)	Gillnet	July 13 - September 15	PSC
29-16	Fraser R. (Whonnock)	Gillnet	June 22 - September 27	PSC
29-16	Fraser R. (Mission)	Hydroacoustic	July 11 - September 20	PSC
	Fraser R. (Qualark)	Gillnet	June 29 - September 22	PSC
	Fraser R. (Qualark)	Hydroacoustic	June 28 - September 23	DFO
	Fraser R. (Hells Gate)	Observer	July 2 - September 22	PSC
Canadian non-Panel Areas				
12	Queen Charlotte Str. (Round Is.)	Gillnet	July 13 - August 13	DFO
12	Johnstone Str. (Naka Cr.)	Gillnet	July 19 - July 31	DFO
12	Johnstone Str. (Blinkhorn)	Purse Seine	July 21 - September 8	DFO
13	Lower Johnstone Str.	Purse Seine	July 23 - August 31	DFO
United States Panel Areas				
5	Juan de Fuca Str.	Gillnet	July 17 - July 24	PSC
7	San Juan Islands	Reefnet	July 20 - August 24	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 abundances, escapement targets and catch allocations for the different sockeye management groups and Fraser River pink salmon. 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 and 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 following sections provide a summary of these results.

Table 4. Individual component stocks included in the Fraser River sockeye stock groups used in 2015.

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

A. Abundance

Final in-season estimates of run-size adopted by the Panel totalled 2,120,000 Fraser sockeye (Table 1): this much lower -than-forecasted abundance constrained fishing opportunities in both countries. The post-season abundance estimate (2,010,200 fish, Tables 7 and 8) based on accounted catches, spawning ground enumerations and run-size adjustments is slightly lower than the end-of-season estimate (2,120,000 fish), and 70% lower than the pre-season median forecast (6,778,000 fish).

The final in-season estimate of Fraser River pink salmon abundance was 6,200,000 fish. Since 2003 when DFO discontinued spawning enumeration programs for Fraser pinks, final in-season run-size estimates based on test fishery data have been used as the post-season estimates. Ongoing research at Mission [6], however, has produced hydroacoustic methods that provide reliable estimates of pink salmon passage during periods in September when high numbers of pink salmon migrate. Estimates of pink salmon passage were consequently obtained from 2009 to 2015. The post-season run-size estimate of 5,779,000 fish (Table 7) was calculated by adding the estimated catch below Mission (384,000 fish) to the Mission passage estimate (5,395,000 fish, Table 6). This estimate is 60% lower than the median pre-season forecast (14,455,000 fish, Table 1).

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 total Fraser sockeye and pink salmon. The end-of-season estimates of marine migration timing in 2015 were earlier than expected pre-

[6] Xie, Y., F. J. Martens, and J. L. Nelitz. 2012. Implementation of stationary sub-sampling systems to estimate salmon passage in the Lower Fraser River: Year 1 of 2011 and 2012 project report to Southern boundary restoration and enhancement fund. Pacific Salmon Commission, Vancouver, British Columbia. May, 2012.

season for Early Stuart and Early Summer-run sockeye (each 2 days earlier) and for pink salmon (5 days earlier) and later than expected for Summer-run and Late-run sockeye (each 4 days later). The timing of the sockeye stocks was later than the historical average while the timing for pink salmon was the earliest on record since 1961. The marine migration of pink salmon was skewed, with a sharp decrease in marine abundance in the last week of August (Figure 4).

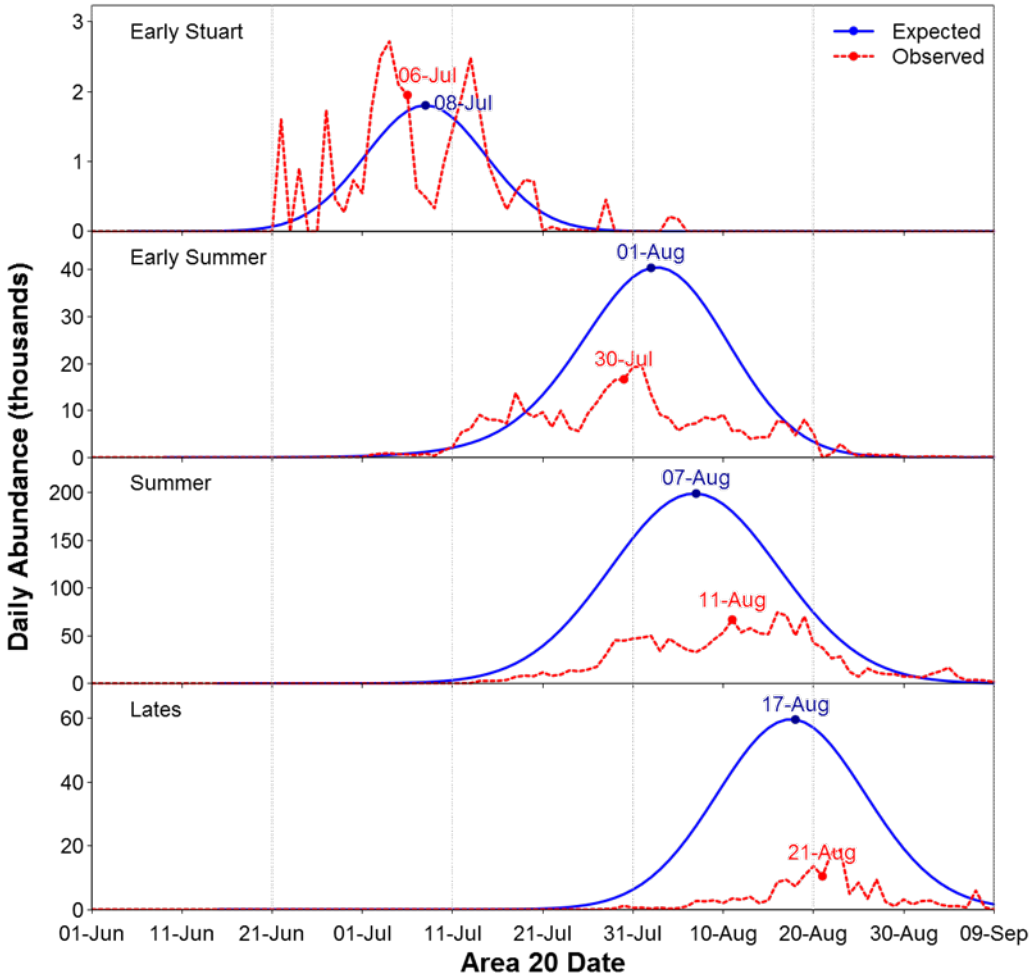

Figure 3. Pre-season projections and post-season reconstructions of daily Fraser River sockeye salmon abundance by management group in 2015 (Area 20 date), including the observed 50% dates and number of days difference with pre-season expectations.

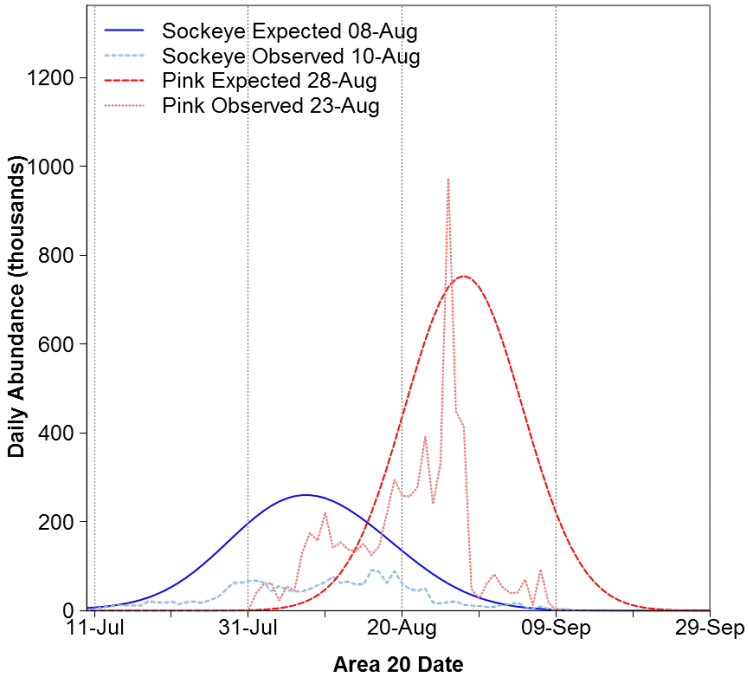

Figure 4. Pre-season projections and post-season reconstructions of daily Fraser River sockeye and pink salmon abundance in 2015 (Area 20 date), including the observed 50% dates and number of days difference with pre-season expectations.

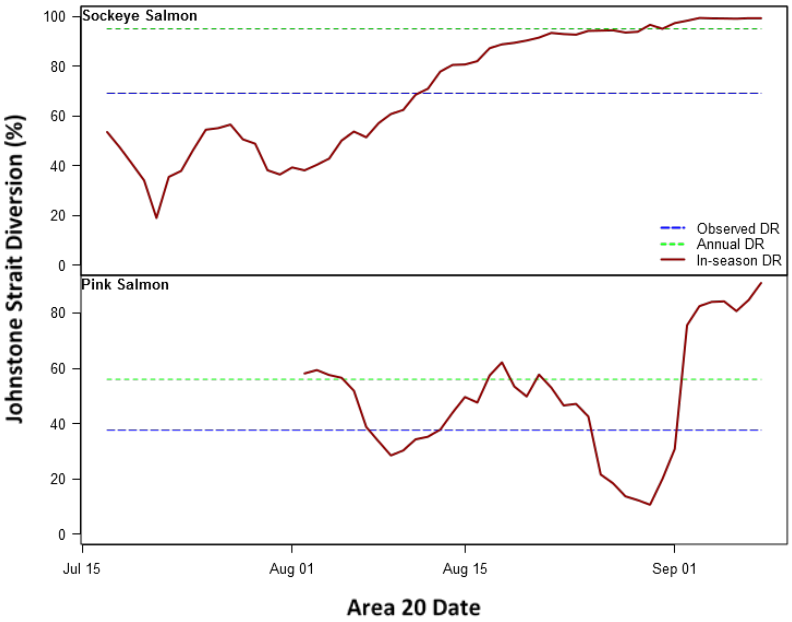

Figure 5. Pre-season forecasts (green dashed line) of annual Johnstone Strait diversion rate (DR) for Fraser sockeye and pink salmon, compared to observed short-term (solid red line) and annual rates (blue dashed line).

Northern diversion rates in 2015 were lower than forecast for both Fraser sockeye and pink salmon. The observed annual diversion through Johnstone Strait was 69% of the Fraser sockeye return, compared to the pre-season forecast of 96% provided by DFO (Figure 5), and the 80% used in the pre-season model. For Fraser River pink salmon, the Johnstone Strait diversion rate was 38% instead of the forecasted 55%.

C. Management Adjustments and DBEs

Management Adjustments (MAs) are based on statistical models [7,8,9,10] 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 sockeye stocks, the models relate historical escapement differences (difference between estimates, or DBEs) to river conditions measured near Hope, BC in the Fraser River. When discharge levels or temperatures are above average, DBEs also tend to be high. In addition, for Early Stuart and Early Summer-runs, in-season estimates are consistently higher than spawning ground estimates even when migration conditions are within normal ranges, and this tendency is also captured by the MA models. For Late-run sockeye, historical DBEs are related to the date when half the run has migrated past Mission (i.e., Mission 50% date), which captures the impact of the early migration behaviour observed since the mid-1990s on the migration success of these stocks.

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

No management adjustments are applied to Fraser River pink salmon.

[7] 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 : 55p.

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

[9] 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.

[10] 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.

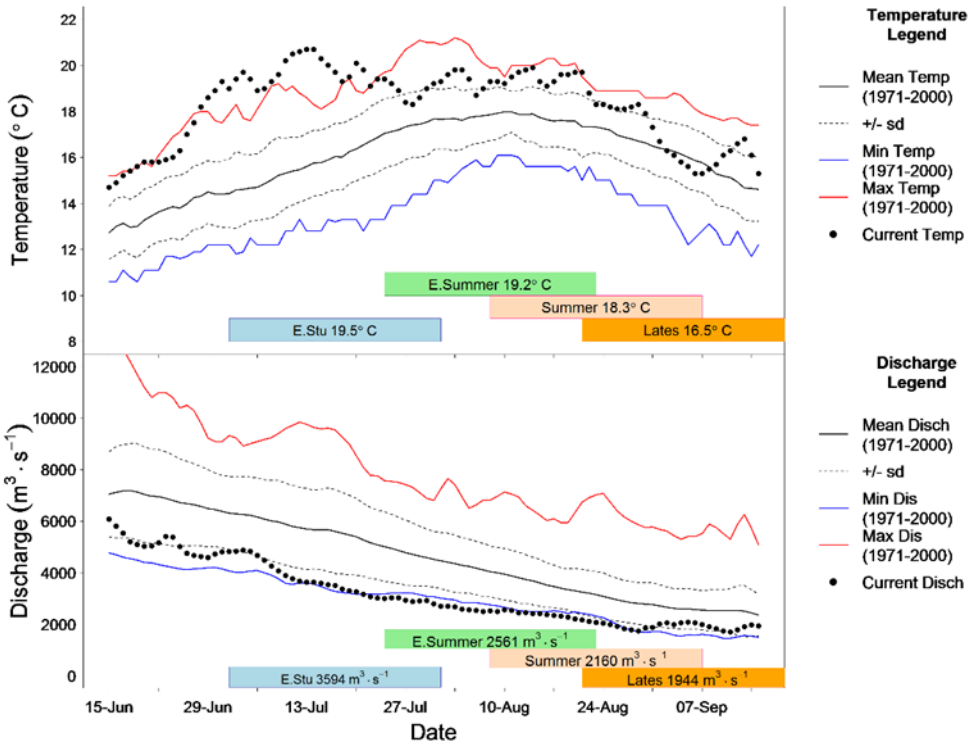

Figure 6. Fraser River temperature and discharge measured near Hope in 2015. Also shown are run timing bars that represent a 31 day spread of the run centred around the Hells Gate date and the mean temperature and discharge for the 31 day spread.

In the spring, snowpack values were near average in the upper Fraser, but the early freshet and above normal air temperatures conditions in May and June decreased the snowpack resulting in below average discharge and above average water temperatures from late July through the end of August. Observed temperatures rose beyond the upper range of the optimum temperature for aerobic swimming for Early Stuart and Early Summer-run sockeye during most of their 31-day migration period centered on the 50% Hells Gate date[11] (Figure 6). Cooler air temperatures and rain events at the end of August allowed for cooling in the Fraser (Figure 6); however, due to the effects of the lake sources, the Thompson River did not cool as quickly.

A summary of the pre-season and in-season MA models adopted during 2015 are provided in the "Management Adjustment and DBE" section in Appendix F. Comparisons of % DBE (pMA) estimates for the pre-season, in-season and post-season periods are shown in Table 5. The in-season % DBE forecasted for the Early Stuart-run was more negative than the pre-season adopted value due to very low discharge and above-average temperatures. In-season, the Panel adopted the % DBE of the highest temperature year on record (1998) for Early Stuart. The observed post-season DBE value for the Early Stuart-run was less negative than the in-season adopted value. In-season model predictions for the Early Summer-run were very similar to the pre-season adopted % DBE values, consequently the Panel did not update the pre-season adopted value. The Panel considered reports of moderate mid and upper Fraser River main-stem temperatures, the temperatures of major tributaries, fish carcass and limited fish condition observations and they decided not to adopt the in-season MA model predictions for Summers, and remained with the pre-season adopted %DBE value. However, a decision not to adopt the in-season pMA for

[11] 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.

Summer-run sockeye had no management implications because the low run size had resulted in a LAER for this group. The %DBE values observed post-season for both Early Summers and Summers were more negative than those adopted in-season. The Late-run did not delay and the observed Mission upstream timing was August 31. As per pre-season agreement, the Panel used the pre-season adopted %DBE in-season because the Late-run upstream timing was earlier than September 9. The %DBE value observed post-season was more negative than the value adopted in-season for Late-run.

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 MAs (see Table 5). In such cases, changes in relative abundances of component stocks may impact the MAs for the aggregate even when river conditions are relatively unchanged. This fact was not a significant source of differences in the MA estimates compared in Table 5.

Table 5. Pre-season, in-season and post-season estimates of DBEs (differences between estimates) and implied pMAs (proportional management adjustments). Pre-season predictions are based on the historical median for Early Stuart, an intermediate estimate between the historical median estimate and forecast for the Early Summer-run, a weighted average of the historical median for Harrison and non-Harrison for the Summer-run and a weighted average of the historic median for Birkenhead and non-Birkenhead for the Late-run. In-season estimates reflect the final values adopted by the Panel for in-season management. The 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.

Description	Early Stuart		Early Summer [1] Aggregate		Summer [2] Aggregate		Late [3] Aggregate	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Pre-season adopted	-40%	0.68	-50%	1.00	-15%	0.17	-49%	0.95
In-season adopted	-81%	4.18	-50%	1.00	-15%	0.17	-49%	0.95
Observed [4]	-65%	1.83	-59%	1.43	-27%	0.37	-56%	1.29

1 The Early Summer aggregate pMA was estimated from the weighted average of the pMA for the non-Pitt Early Summer component (that is updated in-season based on river conditions) and the pMA for Pitt of 0.18 (that remains fixed in-season) based on the p50 level of abundances.

2 The Summer aggregate pMA was estimated from the weighted average of the pMA for the non-Harrison Summer component (that is updated in-season based on river conditions) and the pMA for Harrison of 0.39 (that remains fixed in-season) based on the p50 level of abundances.

3 The Late aggregate pMA was estimated from the weighted average of the pMA for the non-Birkenhead Late component (that remained fixed in-season at 1.27 and would be updated if Mission timing was September 9th or later) and the pMA for Birkenhead of 0.18 (that remains fixed in-season), based on the p50 level of abundances.

4 Derived from Near Final escapement estimates.

D. Mission Passage

Estimates of Mission passage totalled 1,964,000 sockeye, consisting of 29,000 Early Stuart, 352,000 Early Summer-run, 1,425,000 Summer-run, and 157,000 Late-run sockeye (Table 6). The in-season estimate of pink salmon passage of 5,395,000 was generated using a combination of split-beam and imaging sonar with most of the pink passage being obtained from the near-shore

DIDSON (Dual-frequency IDentification SONar) imaging sonars operated on both banks of the river (Appendix F).

Table 6. Fraser River sockeye and pink salmon passage at Mission in 2015.

Management Group	Mission Passage	
Stock Group	fish	%
Early Stuart	**29,200**	**1%**
Early Summer	**351,800**	**18%**
Chilliwack	21,700	1%
Early Miscellaneous	153,900	8%
Seymour/Scotch	60,300	3%
Barriere River/Taseko	24,600	1%
Pitt[1]	91,300	5%
Summer	**1,425,400**	**73%**
Raft/N.Thompson	114,200	6%
Chilko	912,600	46%
Quesnel	58,500	3%
Late Stuart/Stellako	172,900	9%
Harrison	167,200	9%
Late	**157,400**	**8%**
Birkenhead	76,900	4%
Late Shuswap/Portage	70,400	4%
Weaver/Cultus	10,100	1%
Total Sockeye	**1,963,800**	**100%**
Pink Salmon	**5,395,000**	**100%**

1 Pitt does not escape past Mission

V. RUN SIZE, CATCH AND ESCAPEMENT

A. Sockeye Salmon

The total abundance of sockeye salmon in 2015 was 2,010,200 fish (Tables 7 and 8), which is 70% smaller than the median forecast of 6,778,000 fish and half the total adult return in 2011 (5,130,000). The 2015 return was the fourth smallest in the last 50 years (Figure 7; returns in 2007-2009 were smaller). The causes of the small 2015 Fraser River sockeye return are unknown. The recruitment of age 4 fish, which entered the ocean in 2013, was poor relative to the median forecast for most, but not all, Fraser sockeye stocks. Smolt to age 4 survival for Chilko sockeye was less than 2% and slightly more than one third of that implied by the median forecast. This poor survival coupled with the poor returns relative to forecast of several Fraser sockeye stock groups (see below), suggests that a marine mechanism may have caused the poor productivity observed in 2015. However, returns of other sockeye stocks and other salmon species which shared at least part of their ocean residence with Fraser River sockeye were also not uniformly poor. Thus, while is it tempting to blame the low return on the anomalously warm ocean temperatures in the Gulf of Alaska where age 4 Fraser River sockeye that returned in 2015 reared

from late fall of 2013 through the spring of 2015, the lack of consistent response among populations and species, suggests a more complicated causal mechanism.

All management groups returned at lower abundances than their median (50p level) pre-season forecast abundances except Early Stuart sockeye. The total return of Early Stuart sockeye was 29,000 adults (Tables 7 and 8) close to its median forecast level of 30,000 fish. Early Summer-run sockeye returns totalled 285,000 fish, less than 35% of the median forecast level. The largest Early Summer stock components were Early Miscellaneous (140,000 fish) and Seymour/Scotch (72,000 fish). The abundance of Summer-run sockeye was 1,574,000 adults, only 34% of the median forecast level. Most Summer-run fish were from the Chilko group which had poorer than expected marine survival. The total abundance of the Harrison group (187,000 adults) was also only a fraction (less than 15%) of its median pre-season forecast of 1,414,000 fish. Returns to all Late-run components were very poor relative to their median forecasts resulting in an aggregate Late-run return (118,000) that was less than 10% of the group's median pre-season forecast.

Table 7. Catch, escapement, run-size adjustment and run size for Fraser River sockeye (by management group) and pink salmon in 2015.

	Fraser Sockeye						Fraser Pinks	
	Early Stuart	Early Summer	Summer	Late	Total	% of Run	Total	% of Run
CANADIAN CATCH	600	33,000	150,100	4,200	187,900	9%	83,300	1%
Commercial Catch	0	0	0	0	0	0%	0	0%
Panel Area	0	0	0	0	0	0%	0	0%
Non-Panel Areas	0	0	0	0	0	0%	0	0%
First Nations Catch	600	32,900	149,600	4,100	187,200	9%	68,000	1%
Marine FSC	0	5,400	33,500	1,500	40,400	2%	3,400	0%
Fraser River FSC	600	27,500	116,200	2,600	146,800	7%	25,200	0%
Economic Opportunity	0	0	0	0	10	0%	39,400	1%
Non-commercial Catch	10	100	500	50	600	0%	15,300	0%
Marine Recreational	0	0	30	10	40	0%	0	0%
Fraser Recreational	0	0	30	10	40	0%	15,300	0%
Charter (Albion)	10	100	400	30	500	0%	30	0%
ESSR	0	0	0	0	0	0%	0	0%
UNITED STATES CATCH	0	15,600	121,700	13,300	150,600	7%	330,900	6%
Washington Total	0	5,800	37,800	2,600	46,200	2%	330,900	6%
Commercial catch	0	5,500	36,600	2,100	44,200	2%	328,000	6%
Treaty Indian	0	4,100	27,400	1,600	33,100	2%	183,700	3%
All Citizen	0	1,400	9,100	500	11,100	1%	144,300	2%
Non-commercial Catch	0	300	1,300	500	2,000	0%	2,800	0%
Ceremonial	0	300	1,300	500	2,000	0%	2,800	0%
Recreational	0	0	0	0	0	0%	0	0%
Alaska	0	9,800	83,900	10,700	104,400	5%	0	0%
TEST FISHING CATCH	200	6,500	29,100	2,200	38,000	2%	48,900	1%
PSC (Panel Areas)	200	3,400	12,600	700	17,000	1%	38,100	1%
Canada	200	2,500	9,100	600	12,400	1%	25,400	0%
United States	0	900	3,500	100	4,500	0%	12,700	0%
Canada (non-Panel Areas)	60	3,100	16,500	1,400	21,100	1%	10,800	0%
TOTAL RUN	28,700	287,300	1,576,100	118,100	2,010,200	100%	5,778,900	100%
Total Catch in All Fisheries	800	55,200	300,900	19,600	376,500	19%	463,100	8%
Adult Spawning Escapement *	10,100	135,600	974,800	68,000	1,188,600	59%	5,315,800	92%
Jack Spawning Escapement	10	2,200	2,200	200	4,600	0%	0	0%
Run-Size Adjustment	17,800	94,300	298,200	30,300	440,600	22%	0	0%
Percentage of Total Run	100%	100%	100%	100%	100%		100%	
Total Catch in All Fisheries	3%	19%	19%	17%	19%		8%	
Spawning Escapement	35%	48%	62%	58%	59%		92%	
Run-Size Adjustment	62%	33%	19%	26%	22%		0%	

* Spawning escapement estimate for Cultus sockeye includes 196 individuals captured as brood stock.

The total sockeye catch of 377,000 fish was about 19% of the run (Tables 7 and 8). This exploitation rate is one of the lowest in recent years (Figure 8). Of the total sockeye catch, 188,000 fish were caught in Canada, and 151,000 fish in the U.S. and 38,000 fish in test fisheries. All of the Canadian catch was taken in First Nations Food, Social and Ceremonial (FSC) fisheries and recreational fisheries, with the exception of the 10 fish caught in an Economic Opportunity fishery. There was no commercial catch in Canada. In Washington State most of the commercial catch of 44,000 sockeye (Table 9) was taken in Treaty Indian fisheries and the remaining in All Citizen fisheries. The Alaska catch of Fraser sockeye was 104,000.

Table 8. Catch, escapement, run-size adjustment, run size and exploitation rate for Fraser River sockeye (by stock group) and pink salmon in 2015.

Management Group / Stock Group	Catch	Adult Spawning Escapement	Run-size Adjustment	Abundance Adult	Abundance Jack [1]	Abundance Total	Portion of Run	Adult Exploitation Rate
Fraser Sockeye Salmon								
Early Stuart	**800**	**10,100**	**17,800**	**28,700**	**10**	**28,700**	**1%**	**3%**
Early Summer-run	**55,200**	**135,600**	**94,300**	**285,100**	**2,200**	**287,300**	**14%**	**19%**
Chilliwack	600	6,600	2,600	9,700	100	9,900	0%	6%
Early Miscellaneous	28,300	61,000	51,100	140,300	2,100	142,400	7%	20%
Seymour/Scotch	16,200	27,200	28,300	71,700	0	71,700	4%	23%
Barriere River/Taseko	3,900	2,400	2,000	8,400	0	8,400	0%	46%
Pitt	6,200	38,500	10,200	54,900	0	54,900	3%	11%
Summer-run	**300,900**	**974,800**	**298,200**	**1,573,900**	**2,200**	**1,576,100**	**78%**	**19%**
Raft/N.Thompson	17,500	40,100	54,800	112,300	0	112,300	6%	16%
Chilko	207,100	660,600	129,000	996,700	2,100	998,800	50%	21%
Quesnel	11,600	45,800	9,700	67,100	0	67,100	3%	17%
Late Stuart/Stellako	43,100	112,500	55,200	210,800	50	210,900	10%	20%
Harrison/Widgeon	21,700	115,800	49,600	187,100	30	187,100	9%	12%
Late-run	**19,600**	**68,000**	**30,300**	**117,900**	**200**	**118,100**	**6%**	**17%**
Birkenhead/BigSilver	9,600	54,000	9,800	73,400	80	73,500	4%	13%
Late Shuswap/Portage	8,300	9,700	13,200	31,300	0	31,300	2%	27%
Weaver/Cultus	1,600	4,300 [2]	7,300	13,200	100	13,300	1%	12%
Total	**376,500**	**1,188,600**	**440,600**	**2,005,600**	**4,600**	**2,010,200**	**100%**	**19%**
Portion of Total Run	19%	59%	22%	100%	0%	100%		
Fraser Pink Salmon								
Total	**463,100**	**5,315,800**	**0**	**5,778,900**	**0**	**5,778,900**	**100%**	**8%**
Portion of Total Run	8%	92%	-	100%		100%		

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

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

2 Spawning escapement estimate of Cultus sockeye includes 196 individuals captured as brood stock.

DFO annually assesses the spawning ground abundance of sockeye populations in the Fraser watershed (Figure 9). In 2015, the near-final estimate of adult spawners (primarily age 4 and age 5 fish) totalled 1,189,000 fish, or 59% of the total run. This escapement was less than half of the brood year (2011) escapement of 2,580,000 adults.

Spawner abundances for most management groups were much less than those observed in the brood year (2011, Figure 10). By management group and for this cycle line, spawning escapements in 2015 were one fourth of the average escapement to the Early Stuart system since 1939, close to the average for the Early Summer run, and more than 50% above the average for the

Summer run and the lowest on record for the Late run. Early Stuart sockeye were the only management group where 2015 escapements exceeded the 2011 brood year levels. The very low escapements relative to those in the brood year are attributed primarily to the combination of low overall returns and the very warm Fraser River temperatures that Fraser sockeye experienced during their upstream migrations in 2015.

The overall spawning success of adult female sockeye in the Fraser watershed was 97%. The effective female spawning population in 2015 totalled 687,000 fish, which was lower than the number of effective females in 2011.

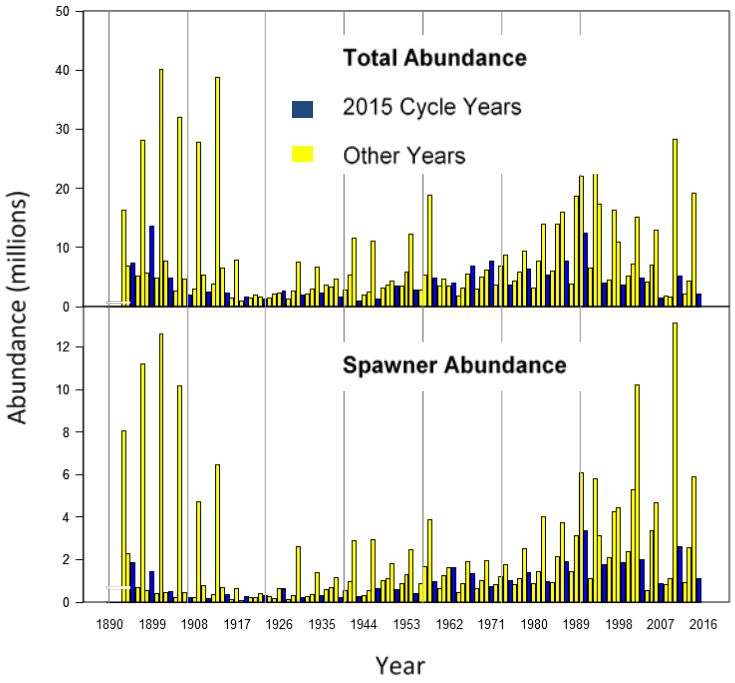

Figure 7. Total run size and spawning escapement of Fraser River sockeye salmon in 1893-2015. Returns on the 2015 cycle are emphasized.

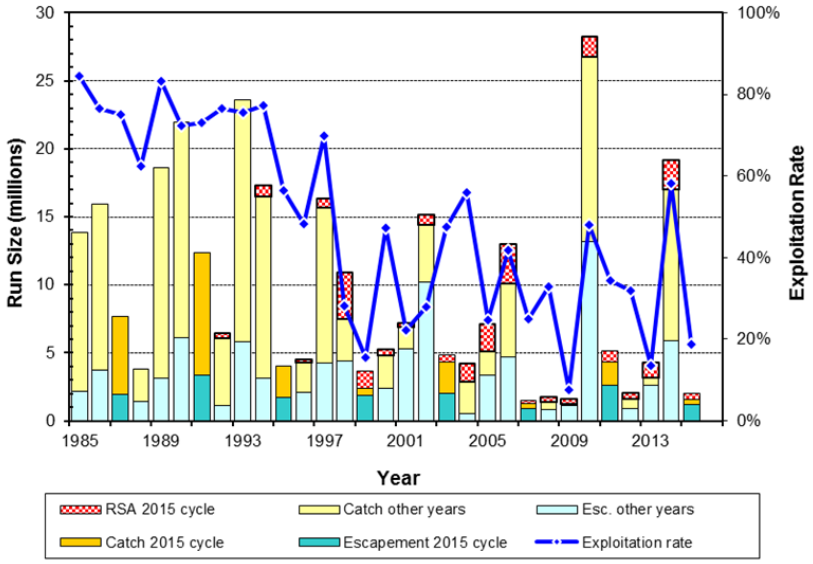

Figure 8. Total catch, escapement, run-size adjustment, run size and exploitation rate for Fraser River sockeye salmon in 1985-2015, with returns on the 2015 cycle emphasized.

The RSA[12] estimate was 440,600 fish, or 26% of the total return. As a percentage of run size for each management group, Early Stuart had the largest RSA (62%) and the remaining management groups ranged from 19% to 33% (Tables 7 and 8). These estimates and the methods for determining them are currently under review by PSC and DFO staff, and the Fraser River Technical Committee.

Table 9. U.S. commercial catches of Fraser River sockeye salmon by user group, gear type and statistical area in 2015.

Areas	Troll	Purse Seine	Gillnet	Reefnet	Total
Panel Area (Washington)	**0**	**32,600**	**8,710**	**2,830**	**44,200**
Treaty Indian *	**0**	**26,200**	**6,890**	**0**	**33,100**
4B, 5 and 6C	0	0	790	0	790
6 and 7	0	23,600	1,220	0	24,800
7A	0	2,620	4,880	0	7,510
All Citizen **	**0**	**6,400**	**1,820**	**2,830**	**11,100**
7	0	5,970	780	2,830	9,590
7A	0	430	1,030	0	1,460
Alaska (District 104) Catch					**104,400**
United States Total					**148,600**

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

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

[12] Run-size Adjustments (RSAs) 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.

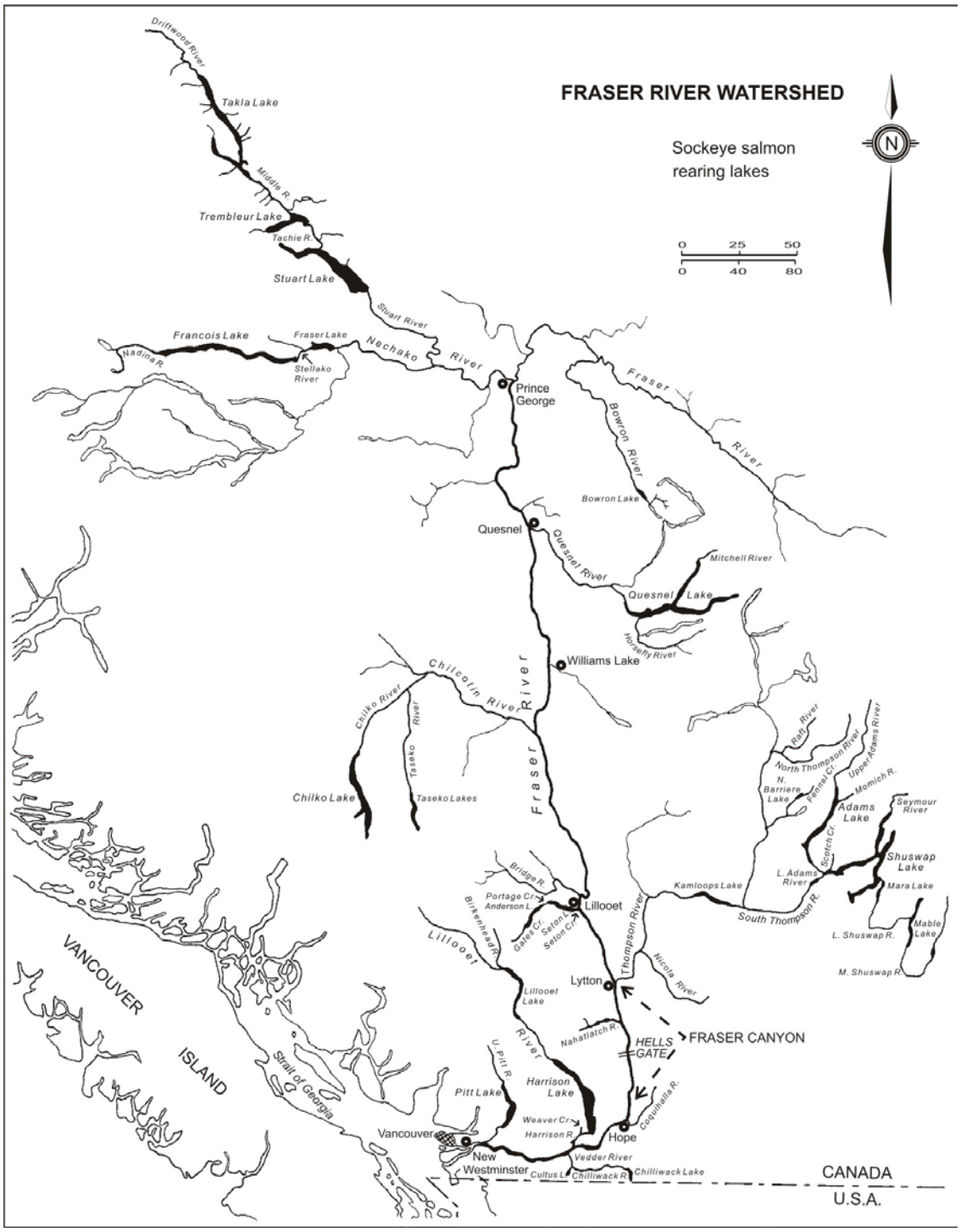

Figure 9. Sockeye salmon spawning areas in the Fraser River watershed.

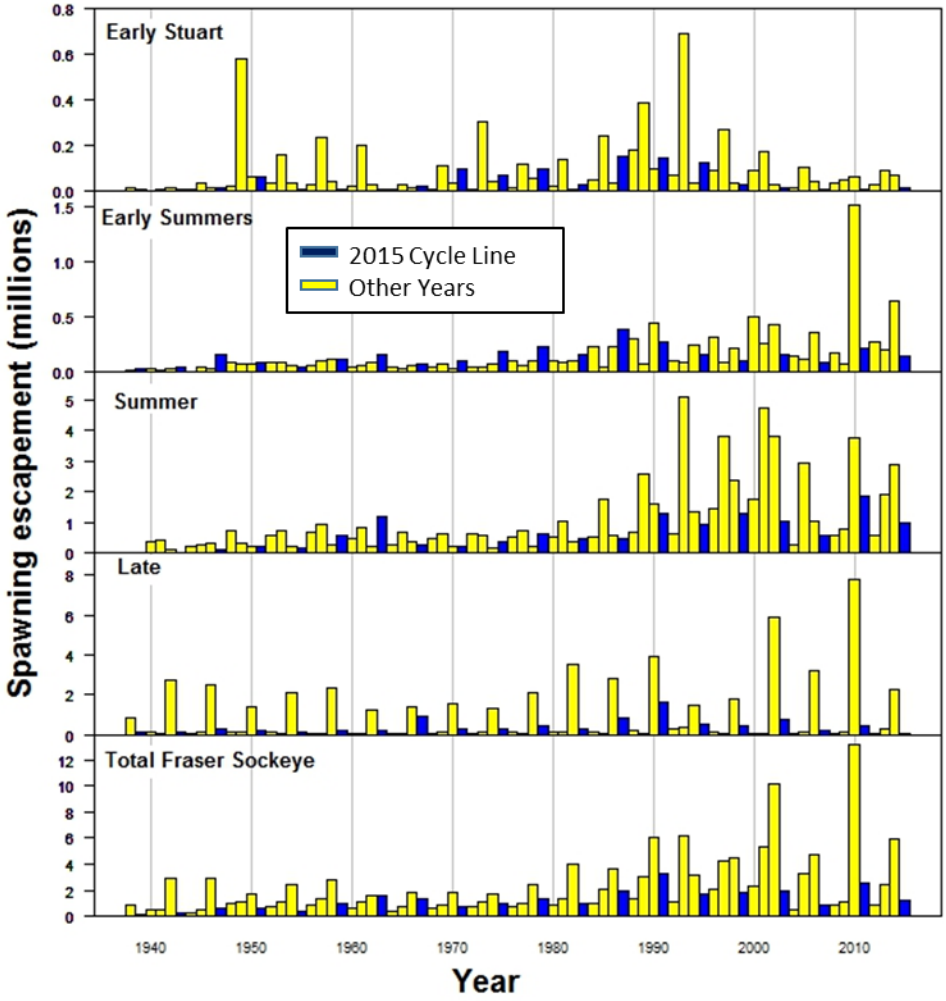

Figure 10. Annual adult spawning escapement of Fraser River sockeye salmon for each management group and for total sockeye in 1938-2015, with escapements on the 2015 cycle emphasized.

Further details regarding sockeye salmon abundances, catches and spawning escapements including comparisons with the last four cycle years can be found in Appendix G (Tables G1 and G3).

B. Pink Salmon

The in-season run-size estimate of 6,200,000 fish is less than half of the median pre-season forecast of 14,455,000 fish (Table1). The post-season estimate of 5,779,000 fish was 60% lower than the median forecast level (Tables 7 and 8). Hydroacoustic research has provided Staff with the ability to reliably estimate pink salmon passage at Mission. Summing this passage estimate (5,395,000) with the catch below Mission (384,000) provided the post-season estimate of total abundance noted above.

Returns of Fraser pink salmon (Figure 11) have shown large variation in recent years, with the lowest return since 1965 occurring in 1999 (3,586,000 fish), followed four years later by the highest return (26,000,000 fish) since records began in 1959. The 2015 return was substantially lower than average and the smallest return since 1999.

The exploitation rate of Fraser River pink salmon in 2015 was 8%, similar to the low exploitation rates (5-10%) observed in 1999-2007, and much smaller than the 1959-1989 average exploitation rate of 68% (Figure 11). The low exploitation rates observed in the 1999-2007 period were a result of poor markets for the sale of pink salmon and conservation concerns for Late-run sockeye that co-migrate with pink salmon. These low harvest levels have resulted in substantial spawning escapements of Fraser pinks in recent years. In 2015, Late-run sockeye conservation concerns were the primary factor constraining pink directed fisheries in both countries. Limited pink directed fisheries were possible in US waters due to the low sockeye encounter rates along the Juan de Fuca migration route. Despite limited harvests, the low overall Fraser pink salmon return also resulted in a small pink salmon escapement. Overall, the pink salmon return in 2015 had one of the smallest catches since 1999 and one of the smallest spawning escapements since 1997.

Of the total Fraser River pink salmon catch, 83,000 fish were caught in Canada, 331,000 in the U.S. and 49,000 in test fisheries (Table 7). There was no Canadian commercial catch but there was a First Nations catch of 68,000 (which included a catch of 39,400 in Economic Opportunity fisheries in the Fraser River) and a recreational catch of 15,300. The U.S. catch included a commercial catch of 328,000 fish that was split nearly evenly between Treaty Indian and All Citizen fishers (Table 10), a ceremonial catch of 3,000 fish and no recreational catch.

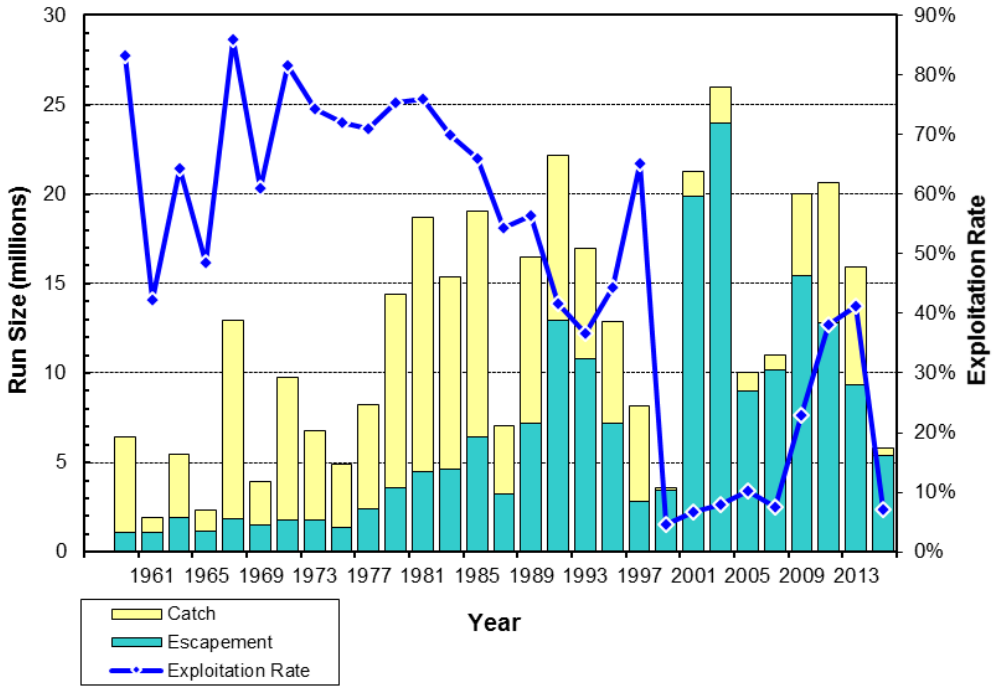

Figure 11. Total catch, escapement, run size and exploitation rate for Fraser River pink salmon in 1959-2015.

Table 10. U.S. commercial catches of Fraser River pink salmon by user group, gear type and statistical area in 2015.

Areas	Purse Seine	Gillnet	Reefnet	Total
Panel Area (Washington)	**306,000**	**2,000**	**20,000**	**328,000**
Treaty Indian *	**182,000**	**1,000**	**0**	**184,000**
4B, 5 and 6C	0	1,000	0	1,000
6 and 7	167,000	0	0	167,000
7A	16,000	1,000	0	16,000
Non-Indian **	**124,000**	**0**	**20,000**	**144,000**
7	91,000	0	20,000	112,000
7A	32,000	0	0	32,000
Non-Panel Area				**0**
United States Total				**328,000**

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

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

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

VI. ACHIEVEMENT OF OBJECTIVES

The mandate of the Fraser River Panel is to manage commercial fisheries in Panel Area waters to achieve a hierarchy of objectives. In order of importance, the objectives are to: (1) achieve spawning escapement targets for Fraser River sockeye and pink salmon that are set 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 as specified by Canada. Spawning escapement targets were determined by applying Canada's spawning escapement plan to abundance estimates for each management group.

In-season monitoring of the progress toward spawning escapement targets is not directly measureable because in most cases spawner abundance cannot be assessed on the spawning grounds until well after the fishing season has ended. In-season management is therefore based on targets for potential spawning escapement (i.e., PSE target = in-season spawning escapement

target + MA). Progress towards these targets is monitored by comparison with in-season PSE estimates (i.e., Mission escapement to-date - catch above Mission).

Final in-season PSE estimates indicate variable achievement of in-season PSE targets among management groups: Early Stuart (10% under), Early Summer (11% over), Summer (14% under) and Late (6% under) (Table 11). One contributing cause limiting deviations to within 15% of the targets for each management group was the Panel's response to the low in-season run size estimates that triggered the implementation of low abundance exploitation rates (LAERs) for the Early Stuart, Summer and Late-run groups. Thus, as the season progressed the sockeye TAC and available harvest decreased dramatically (Figure 12), resulting in the Panel constraining sockeye-directed fisheries.

Table 11. Comparison of in-season targets and in-season estimates of potential spawning escapement (PSE) for adult Fraser River sockeye salmon in 2015.

	Final	Potential Spawning Escapement (PSE)					
Management Group	In-season Abundance Estimate	Spawning Escapement Target	Management Adjustment *	In-season PSE ** Target	PSE *** Estimate	Difference Fish	Difference %
Adult sockeye	**2,120,100**	**1,795,100**	**687,100**	**2,045,500**	**1,849,000**	**-196,500**	**-10%**
Early Stuart	32,100	32,100	134,200	32,100	29,000	-3,100	-10%
Early Summer	373,000	149,200	149,200	298,400	331,000	32,600	11%
Summer	1,549,200	1,448,000	246,200	1,549,200	1,333,000	-216,200	-14%
Late	165,800	165,800	157,500	165,800	156,000	-9,800	-6%

* 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.

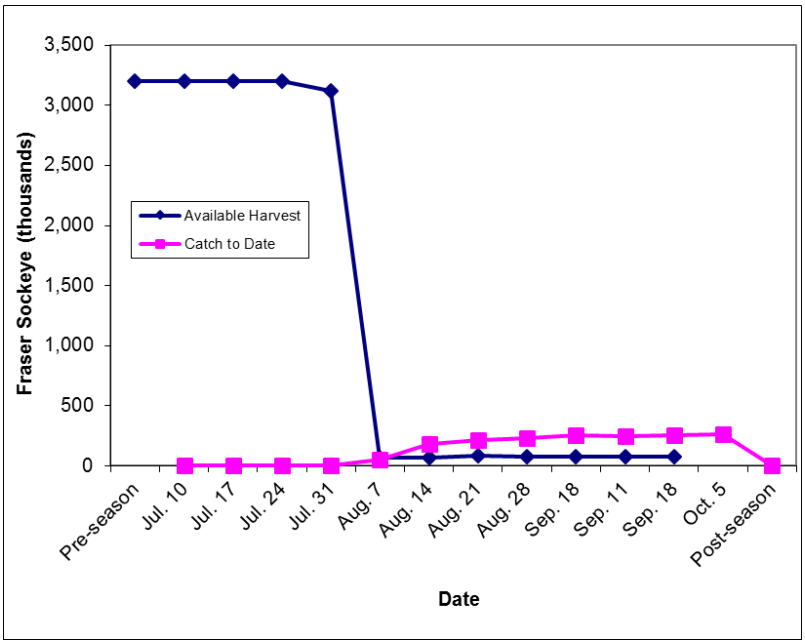

Figure 12. Available harvest of Fraser sockeye compared to catch to date in all fisheries in 2015. The available harvest is calculated as run size minus spawning escapement target and management adjustment, and represents fish that are available for catch in all commercial, recreational, First Nations and test fisheries.

In terms of the achievement of post-season objectives, the spawning ground escapement estimates were 31% below the Fraser sockeye aggregate target and each sockeye management group was 33-65% below their target with the exception of the Early Summer-run which was 1% over the target (Table 12). The spawning escapement targets for Early Stuart and Late-run sockeye equalled their run sizes, so the escapement targets were unattainable unless there was no harvest and no difference between estimates. The exploitation rates of Early Stuart (3%) and Late-run sockeye (17%) were low and less than their respective LAERs (10% and 20%). Thus, the negative deviations observed between spawning escapements and targets largely reflect the impact of the negative %DBEs observed for these groups (Table 5). The spawning escapement target for Summer-run sockeye was 92% of its run-size (Table 12). While the exploitation rate of Summer-run sockeye (19%) exceeded its LAER of 10%, the %DBE was also larger (more negative) than the Panel adopted value (Table 5). Thus, both factors contributed to the spawning escapement being less than the target for this group. The Early Summer-run return was sufficient to generate a TAC, but harvest restrictions on co-migrating Early Stuart and Summer-run groups limited directed fisheries. Thus, a portion of the available surplus of Early Summer-run sockeye went un-caught and its in-season PSE target was exceeded (Table 11). However, the observed %DBE for the Early Summer-run group was larger than anticipated by the adopted Management Adjustment (Table 6), thus resulting in the spawning escapement being less than the target. The escapement of Fraser River pink salmon was slightly above (5%) its post-season target (Table 12).

Table 12. Comparison of post-season spawning escapement targets and escapement estimates for adult Fraser River sockeye and pink salmon in 2015. Post-season estimates of sockeye escapement are from spawning ground enumeration programs (DFO), while pink salmon escapement was estimated by subtracting total catch from the run-size estimate.

Management Group	Post-season Run-size Estimate	Spawning Escapement			
		Post-season Target	Adult Estimate	Difference	
				Fish	%
Sockeye salmon	**2,010,200**	**1,728,800**	**1,188,600**	**-540,300**	**-31%**
Early Stuart	28,700	28,700	10,100	-18,600	-65%
Early Summer	287,300	134,000	135,600	1,600	1%
Summer	1,576,100	1,448,000	974,800	-473,200	-33%
Late	118,100	118,100	68,000 *	-50,100	-42%
Pink salmon	**5,778,900**	**5,069,300**	**5,315,800**	**246,500**	**5%**

* Late-run escapement estimate include 196 Cultus fish kept for broodstock.

B. International Allocation

The Panel's second priority is to achieve the goals for international allocation of the TACs for Fraser sockeye and pink salmon. In accordance with Annex IV, Chapter 4 of the Pacific Salmon Treaty, the TAC calculations are based on the run sizes, spawning escapement targets and MAs in effect when the Panel relinquished control of the last U.S. Panel Area (October 3). The test fishing catch deduction is the post-season estimate, however.

With the total in-season abundance estimate of 2,120,100 Fraser sockeye, minus deductions for spawning escapement, MA, test fishing catch and AFE, the International TAC in 2015 was 36,000 sockeye (Table 13). The Washington share of the TAC (16.5%) was 6,000 fish and their catch was 46,000 fish, leaving a negative deviation of 40,000 Fraser sockeye. For TAC comparison purposes, Canada's catch excludes ESSR catch. In 2015, the ESSR catch was 0 fish. Canada's catch of 187,000 Fraser sockeye was 29,000 fish less than the total of their allowable

harvest of the International TAC plus the AFE of 187,000 (i.e., less than the agreed 400,000 maximum AFE amount). A detailed version of the TAC calculations by management group is presented in Appendix G, Table G5.

Table 13.Total allowable catch (TAC) and achievement of international catch shares for Fraser River sockeye and pink salmon in 2015. TAC calculations use the in-season estimates of run size, spawning escapement target and management adjustment at the time the Panel relinquished control of the last U.S. Panel Area (October 3), in accordance with Annex IV, Chapter 4 of the Treaty.

		Sockeye		Pink	
TOTAL ALLOWABLE CATCH					
In-season Total Run Size		**2,120,100**		**5,781,300**	
Deductions		**2,706,800**		**5,119,900**	
In-season Spawning Escapement Target		1,795,100		5,071,100	
In-season Management Adjustment		687,000		n/a	
Aboriginal Fishery Exemption (AFE)		186,700		n/a	
Post-season Test Fishing Catch		37,900		48,900	
Total Allowable Catch	*1, 2*	**35,500**		**661,400**	
UNITED STATES					
Washington Share		**5,900**		**170,000**	
Washington Share of TAC	*1, 3*	5,900	16.5%	170,000	25.7%
Payback		0		0	
Washington Catch		**46,200**		**330,900**	
Deviation		**-40,300**		**-160,900**	
In-season Alaska Catch Estimate		0		0	
CANADA					
Canadian Share of TAC + U.S. Payback + AFE		**216,300**		**491,400**	
Canadian Catch excluding ESSR Catch		**187,200**		**83,300**	
Deviation		**29,000**		**408,100**	

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 Table 7 in Appendix I.

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).

The TAC for Fraser pink salmon was 661,000 fish, with a U.S. share of 170,000 fish (25.7%) and Canadian allowable harvest of 491,000 fish (Table 13). The U.S. caught more than their share (161,000 over) and Canada caught less than their share (408,000 under).

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 and All Citizen fishers in the U.S. caught more than their share of the TAC; 31,000 and 9,000 fish, respectively (Table 14). Similarly, regarding Fraser pink salmon, Treaty Indian and All Citizen fishers caught more than their share of the TAC; 102,000 and 59,000 fish, respectively (Table 15).

Table 14. Achievement of domestic catch goals in Washington for Fraser River sockeye salmon in 2015.

	Actual Catch		Share of TAC		
User Category	Fish	%	Fish	%	Deviation
Washington Total	**46,200**	**100.0%**	**5,900**	**100.0%**	**40,300**
Treaty Indian *	35,100	76.0%	4,000	67.7%	31,100
All Citizen **	11,100	24.0%	1,900	32.3%	9,200

* Treaty Indian catch includes commercial and ceremonial catches.

** All Citizen catch includes commercial and recreational catches.

Table 15. Achievement of domestic catch goals in Washington for Fraser River pink salmon in 2015.

	Actual Catch		Share of TAC		
User Category	Fish	%	Fish	%	Deviation
Washington Total	**330,800**	**100.0%**	**170,000**	**100.0%**	**160,800**
Treaty Indian *	186,500	56.4%	85,000	50.0%	101,500
All Citizen **	144,300	43.6%	85,000	50.0%	59,300

* Treaty Indian catch includes commercial and ceremonial catches.

** All Citizen catch includes commercial and recreational catches.

The only fisheries in Canada directed on Fraser sockeye salmon were in First Nations FSC fisheries which harvested 187,000 from their allowable harvest of 216,000. An additional 600 Fraser River sockeye were caught in a domestic, in-river Chinook test fishery. Canadian pink salmon fisheries harvested 83,000 fish from their allowable harvest of 491,000. First Nations harvested 68,000 (28,600 for FSC and 39,400 for Economic Opportunity), and recreational fishers harvested the remaining 15,300 fish. Both groups were under their allowable harvest levels. Due to conservation concerns for Fraser sockeye there were no commercial fisheries directed on Fraser pink salmon in 2015.

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 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. By-catches of non-Fraser sockeye and pink

salmon in commercial net fisheries regulated by the Fraser River Panel totalled 1,200 sockeye and 322,400 pink salmon in 2015 (Table 16). Catches of other Fraser and non-Fraser salmon species included 5,500 Chinook, 1,100 Coho, 100 chum and 20 steelhead.

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 2015.

	Non-Fraser		Fraser and Non-Fraser			
Area and Gear	Sockeye	Pink	Chinook	Coho	Chum	Steelhead
United States *	**1,170**	**322,410**	**5,450**	**1,100**	**130**	**20**
Areas 4B, 5 and 6C Net	140	1,220	710	690	100	20
Areas 6, 7 and 7A Net	1,030	321,200	4,740	410	30	0
Canada **	**0**	**0**	**0**	**0**	**0**	**0**
Area 20 Net	0	0	0	0	0	0
Area 29 Net	0	0	0	0	0	0
Total	**1,170**	**322,410**	**5,450**	**1,100**	**130**	**20**

* 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.

** There were no commercial fisheries directed at Fraser River sockeye or pink salmon in Canadian Panel waters in 2015.

VII. ALLOCATION STATUS

Annex IV, Chapter 4, (paragragh 8 (c)(iv)) specifies that *the US share will not be adjusted for an overage resulting from TAC reductions after the scheduling of the last Fraser River Panel approved U.S. fishery of the season.* The resulting calculations indicate there was no overage for either Fraser River sockeye or pink salmon in 2015 (Table 17). However, the Panel agreed in-season that any sockeye landed in Panel regulated fisheries directed at Fraser River pink salmon would generate a payback as at that time the US International share of Fraser sockeye had already been exceeded. Thus, the U.S. owes a payback of 900 Fraser sockeye to Canada in future years (Table 17). These sockeye were not sold, but retained by US tribes for ceremonial and subsistence purposes. There are no paybacks due for Fraser pink salmon.

Table 17. Allocation status for Fraser River sockeye and pink salmon in 2011-2015. After 2015, the US owed a payback of 900 sockeye salmon. There were no paybacks for Fraser pink salmon.

	Fraser Sockeye				
	2011	**2012**	**2013**	**2014**	**2015**
TOTAL ALLOWABLE CATCH					
Total Run Size	5,077,000	2,515,000	3,732,000	19,883,500	6,367,000
Escapement and other deductions	2,999,200	1,796,000	3,649,400	8,688,600	3,758,100
Total Allowable Catch:	2,077,800	719,000	82,600	11,194,900	2,608,900
UNITED STATES					
Washington Catch	278,800	111,300	20,200	1,181,700	46,200
Washington Share (excld s payback) *	342,800	118,600	13,600	1,847,100	430,500
Deviation:	-64,000	-7,300	6,600	-665,400	-384,300
Cumulative Allocation Status:	**0 ****	**0 ****	**6,600**	**0 ****	**900 ****
CANADA					
Catch	1,405,200	510,400	410,100	8,981,100	187,200
Share + Aboriginal Exemption	2,135,000	1,000,400	469,000	9,747,800	2,365,100
Deviation:	-729,800	-490,000	-58,900	-766,700	-2,177,900

	Fraser Pink		
	2011	**2013**	**2015**
TOTAL ALLOWABLE CATCH			
Total Run Size	18,300,000	26,000,000	14,455,000
Escapement and other deductions	6,013,100	7,883,400	6,210,900
Total Allowable Catch:	12,286,900	18,116,600	8,244,100
UNITED STATES			
Washington Catch	2,916,500	3,200,400	330,900
Washington Share *	3,157,700	4,656,000	2,118,700
Deviation:	-241,200	-1,455,600	-1,787,800
Cumulative Allocation Status:	**0 ****	**0 ****	**0 ****
CANADA			
Catch	4,931,000	3,309,300	83,300
Share	9,129,200	13,460,600	6,125,400
Deviation:	-4,198,200	-10,151,300	-6,042,100

* Washington share of the TAC according to Annex IV of the Pacific Salmon Treaty:
- 2011: Shall not exceed 16.5% for Fraser sockeye and 25.7% for Fraser pinks.
- 2012: 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 2012 (Aug. 10), because TAC decreased between date of last U.S. fishery decision (Aug. 10) and when Panel control of last U.S. fishery area was relinquished (Sep. 2).
- 2013: Shall not exceed 16.5% for Fraser sockeye and 25.7% for Fraser pinks. Allocation status based on TAC when Panel control of last U.S. fishery area was relinquished.
- 2014: Shall not exceed 16.5% for Fraser sockeye and 25.7% for Fraser pinks.
- 2015: Shall not exceed 16.5% for Fraser sockeye and 25.7% for Fraser pinks. By Panel agreement, any U.S. catch of Fraser sockeye catch after August 25 is considered an overage.

** By Panel agreement

VIII. APPENDICES

APPENDIX A: GLOSSARY OF TERMS AND ABBREVIATIONS

Bayesian inference: Statistical inference which allows pre-season forecasts of run size, diversion rate, and migration timing to be updated with in-season observations. Uncertainty in the estimates decreases as more in-season data become available. The name "Bayesian" comes from the frequent use of Bayes' theorem in the inference process.

CPUE: Catch per unit of effort. Typically associated with data obtained from test fisheries (e.g. catch per 100 fathom minutes).

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 starting from that year (e.g., 2003, 2007, 2015).

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 potential spawning escapement (PSE) and spawning escapement (SE) (DBE=PSE–SE. 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/SE) 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.

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 such pre-season expectations 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., 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, associated with 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 passed 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.

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): Additions to the total return 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.

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., Quesnel spawners omitted in 2002). Such escapement numbers do not include losses from pre-spawn mortality on the spawning grounds, however, pre-spawn mortality is accounted for in estimates of Effective Female spawners.

Spawning escapement target: Target for total adult spawning escapement for each spawning population as defined each year by Canada's Spawning Escapement Plan.

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

List of abbreviations

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

APPENDIX B: 2015 PRE-SEASON FORECASTS AND SPAWNING ESCAPEMENT TARGETS FOR FRASER RIVER SOCKEYE AND PINK SALMON

Table B1. Pre-season forecasts for Fraser River sockeye and pink salmon in 2015. (Provided to the Panel by Fisheries and Oceans Canada).

Run timing group	Mean Run Size		Probability that Return will be at/or Below Specified Run Size [a]				
Stocks	all cycles[c]	2015 cycle[c]	10%	25%	50%	75%	90%
Early Stuart	**303,000**	**162,000**	**8,000**	**16,000**	**30,000**	**58,000**	**108,000**
Early Summer	--	--	**236,000**	**424,000**	**837,000**	**1,603,000**	**2,963,000**
(total excluding miscellaneous	**507,000**	**462,000**	**192,000**	**325,000**	**624,000**	**1,256,000**	**2,342,000**
Bowron	38,000	75,000	6,000	11,000	21,000	40,000	72,000
Fennell	24,000	30,000	10,000	16,000	27,000	47,000	78,000
*Gates	54,000	31,000	46,000	79,000	141,000	280,000	502,000
Nadina	75,000	81,000	8,000	15,000	31,000	65,000	126,000
Pitt	71,000	70,000	33,000	51,000	79,000	120,000	190,000
*Scotch	100,000	20,000	48,000	85,000	185,000	430,000	845,000
*Seymour	145,000	155,000	41,000	68,000	140,000	274,000	529,000
Misc (Early Shuswap) [d]	--	--	33,000	74,000	164,000	258,000	459,000
****Misc (Taseko) [e]			1,000	2,000	4,000	7,000	9,000
Misc (Chilliwack) [f]	--	--	4,000	9,000	18,000	33,000	61,000
Misc (Nahatlatch) [f]	--	--	6,000	14,000	27,000	49,000	92,000
Summer	--	--	**1,701,000**	**2,681,000**	**4,675,000**	**8,764,000**	**16,511,000**
(total excluding miscellaneous	**3,866,000**	**2,524,000**	**1,693,000**	**2,666,000**	**4,648,000**	**8,710,000**	**16,406,000**
Chilko [g]	1,405,000	1,545,000	1,117,000	1,587,000	2,387,000	3,813,000	5,972,000
Late Stuart	544,000	81,000	12,000	25,000	54,000	118,000	245,000
Quesnel	1,324,000	151,000	108,000	197,000	367,000	684,000	1,421,000
Stellako	457,000	568,000	186,000	261,000	390,000	552,000	823,000
Raft [h]	31,000	20,000	15,000	23,000	36,000	56,000	87,000
***Harrison [h & j]	105,000	159,000	255,000	573,000	1,414,000	3,487,000	7,858,000
Misc (N. Thomp. Tribs) [h & k]	--	--	1,000	2,000	3,000	7,000	14,000
Misc (N. Thomp River) [h & k]	--	--	5,000	10,000	18,000	37,000	74,000
Misc (Widgeon) h & l	--	--	2,000	3,000	6,000	10,000	17,000
Late	--	--	**419,000**	**703,000**	**1,236,000**	**2,210,000**	**3,998,000**
(total exlcuding miscellaneous	**3,169,000**	**2,061,000**	**400,000**	**671,000**	**1,176,000**	**2,103,000**	**3,809,000**
Cultus [g]	38,000	81,000	1,000	3,000	6,000	12,000	22,000
*Late Shuswap	2,379,000	1,357,000	168,000	293,000	517,000	924,000	1,758,000
*Portage	41,000	25,000	1,000	3,000	8,000	19,000	55,000
Weaver	346,000	222,000	110,000	189,000	346,000	635,000	1,095,000
*Birkenhead	365,000	376,000	120,000	183,000	299,000	513,000	879,000
Misc non-Shuswap [m]	--	--	19,000	32,000	60,000	107,000	189,000
TOTAL SOCKEYE SALMON	--	--	**2,364,000**	**3,824,000**	**6,778,000**	**12,635,000**	**23,580,000**
(TOTAL excluding miscellaneo	**7,845,000**	**5,209,000**	**2,293,000**	**3,678,000**	**6,478,000**	**12,127,000**	**22,665,000**
TOTAL PINK SALMON	--	**13,400,000**	**7,661,000**	**10,385,000**	**14,455,000**	**20,450,000**	**27,776,000**

a. Probability that return will be at, or below, specified projection
c. Sockeye average run size from 1953-2010 (depending on the start of the time series)
d. Misellaneous Early Shuswap uses Scotch and Seymour R/EFS in forecast
e. Miscellaneous Taseko uses Chilko R/EFS in forecast
f. Miscellaneous Chilliwack and Nahatlach use Early Summer Run stocks R/EFS in forecast
g. Chilko and Cultus smolt data are presented in column C & D (rather than EFS data that is presented for all other stocks)
h. Raft, Harrison, North Thompson Tributaries and River, and Widgeon were moved into the Summer Run Timing group
j. Harrison are age-4 and age-3
k. Miscellaneous North Thompson Tributaries and River (used Raft/Fennell R/EFS)
l. Miscellaneous Widgeon (used Birkenhead R/EFS)
m. Miscellaneouse non-Shuswap stocks includes Big Silver, Cogburn, etc., (used Birkenhead R/EFS)

* Stocks with uncertain five year old forecasts due to exceptional EFS in 2010; note: Gates had exceptional escapement in 2011
***Harrison forecasts are extremely uncertain due to exceptionall large 2011 brood year EFS

Table B2. Spawning escapement plan for Fraser River sockeye and pink salmon in 2015. (Provided to the Panel by Fisheries and Oceans Canada).

Raft North Thompson & Harrison in Summer Run. Variable Late Run LAER.

		Harvest Rule Parameters				
Management Unit		**Low Abundance ER (LAER)**	**TAM Cap**	**Lower Fishery Reference Point**	**Upper Fishery Reference Point**	**Pre-season pMA**
Early Stuart		10%	60%	108,000	270,000	0.68
Early Summer (w/o misc)		10%	60%	100,000	250,000	0.64
Summer (w/o misc)		10%	65%	1,000,000	2,857,000	0.17
Late (w/o misc)		20-30%	60%	300,000	750,000	0.95

Management Unit		**Pre-season Forecast Return**				
		p10	p25	**p50**	p75	p90
Early Stuart	forecast	8,000	16,000	**30,000**	58,000	108,000
	TAM Rule (%)	0%	0%	**0%**	0%	0%
	Escapement Target	8,000	16,000	**30,000**	58,000	108,000
	MA	5,400	10,900	**20,400**	39,400	73,400
	Esc. Target + MA	13,400	26,900	**50,400**	97,400	181,400
	LAER	10%	10%	**10%**	10%	10%
	ER at Return	0%	0%	**0%**	0%	0%
	Allowable ER	10%	10%	**10%**	10%	10%
	available harvest	800	1,600	**3,000**	5,800	10,800
	2015 Performance					
	Projected S (after MA)	4,000	9,000	**16,000**	31,000	58,000
	BY Spawners	1,000	1,000	**1,000**	1,000	1,000
	Proj. S as % BY S	400%	900%	**1600%**	3100%	5800%
	cycle avg S	51,000	51,000	**51,000**	51,000	51,000
	Proj. S as % cycle S	8%	18%	**31%**	61%	114%

Management Unit		**Pre-season Forecast Return**				
		p10	p25	**p50**	p75	p90
Early Summer (w/o RNT)	*lower ref. pt. (w misc)*	134,000	134,000	134,000	134,000	134,000
	upper ref. pt. (w misc)	335,000	335,000	335,000	335,000	335,000
	forecast (incl. misc)	236,000	424,000	837,000	1,603,000	2,963,000
	TAM Rule (%)	43%	60%	**60%**	60%	60%
	Escapement Target	134,000	169,600	**334,800**	641,200	1,185,200
	MA	85,800	108,500	**214,300**	410,400	758,500
	Esc. Target + MA	219,800	278,100	**549,100**	1,051,600	1,943,700
	LAER	10%	10%	**10%**	10%	10%
	ER at Return	7%	34%	**34%**	34%	34%
	Allowable ER	10%	34%	**34%**	34%	34%
	available harvest	23,600	145,900	**287,900**	551,400	1,019,300
	2015 Performance					
	Projected S (after MA)	130,000	170,000	**335,000**	641,000	1,185,000
	BY Spawners	219,000	219,000	**219,000**	219,000	219,000
	Proj. S as % BY S	59%	78%	**153%**	293%	541%
	cycle avg S	150,000	150,000	**150,000**	150,000	150,000
	Proj. S as % cycle S	87%	113%	**223%**	427%	790%

Table B2, continued on next page

Table B2, continued.

Management Unit		Pre-season Forecast Return p10	p25	**p50**	p75	p90
Summer	*lower ref. pt. (w misc)*	1,448,000	1,448,000	**1,448,000**	1,448,000	1,448,000
(w. RNT & Har)	*upper ref. pt. (w misc)*	4,138,000	4,138,000	**4,138,000**	4,138,000	4,138,000
	forecast	1,701,000	2,681,000	**4,675,000**	8,764,000	16,511,000
	TAM Rule (%)	15%	46%	**65%**	65%	65%
	Escapement Target	1,448,000	1,448,000	**1,636,250**	3,067,400	5,778,850
	MA	246,200	246,200	**278,200**	521,500	982,400
	Esc. Target + MA	1,694,200	1,694,200	**1,914,450**	3,588,900	6,761,250
	LAER	10%	10%	**10%**	10%	10%
	ER at Return	0%	37%	**59%**	59%	59%
	Allowable ER	10%	37%	**59%**	59%	59%
	available harvest	170,100	986,800	**2,760,550**	5,175,100	9,749,750
	2015 Performance					
	Projected S (after MA)	1,308,000	1,448,000	**1,636,000**	3,067,000	5,779,000
	BY Spawners	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000
	Proj. S as % BY S	70%	78%	**88%**	164%	310%
	cycle avg S	778,000	778,000	**778,000**	778,000	778,000
	Proj. S as % cycle S	168%	186%	**210%**	394%	743%

Management Unit		Pre-season Forecast Return p10	p25	**p50**	p75	p90
Late	*lower ref. pt. (w misc)*	315,000	315,000	**315,000**	315,000	315,000
(w/o Har)	*upper ref. pt. (w misc)*	788,000	788,000	**788,000**	788,000	788,000
	forecast	419,000	703,000	**1,236,000**	2,210,000	3,998,000
	TAM Rule (%)	25%	55%	**60%**	60%	60%
	Escapement Target	315,000	315,000	**494,400**	884,000	1,599,200
	MA	299,300	299,300	**469,700**	839,800	1,519,200
	Esc. Target + MA	614,300	614,300	**964,100**	1,723,800	3,118,400
	LAER	20%	20%	**20%**	30%	30%
	ER at Return	0%	13%	**22%**	22%	22%
	Allowable ER	20%	20%	**22%**	30%	30%
	available harvest	83,800	140,600	**271,900**	663,000	1,199,400
	2015 Performance					
	Projected S (after MA)	172,000	288,000	**494,000**	793,000	1,435,000
	BY Spawners	494,000	494,000	494,000	494,000	494,000
	Proj. S as % BY S	35%	58%	**100%**	161%	290%
	cycle avg S	519,000	519,000	**519,000**	519,000	519,000
	Proj. S as % cycle S	33%	55%	**95%**	153%	276%
Available Harvest (TF, US, CDN)		278,300	1,274,900	**3,323,350**	6,395,300	11,979,250
Total projected spawners		1,614,000	1,915,000	**2,481,000**	4,532,000	8,457,000

Fraser River pink salmon spawning escapement target plan

7,059,000	Lower Fishery Reference Point
20,000,000	Upper Fishery Reference Point
70%	Maximum Exploitation Rate

	Pre-season Forecast Return p10	p25	**p50**	p75	p90
forecast	7,661,000	10,385,000	**14,455,000**	20,450,000	27,776,000
escapement target	6,000,000	6,000,000	**6,000,000**	6,135,000	8,333,000
allowable ER	22%	42%	**58%**	70%	70%

APPENDIX C: 2015 FRASER RIVER PANEL MANAGEMENT PLAN PRINCIPLES AND CONSTRAINTS (agreed July 15, 2015)

1. Fisheries and Oceans Canada (DFO) has provided the Panel with run-size forecasts for Fraser River sockeye and pink salmon. It is broadly understood that the sockeye and pink run-size forecasts are 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 6,778,000 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 3,824,000 fish and there is a one in four chance that the actual number of returning sockeye will be at or larger than 12,635,000 fish. By stock grouping, the 50% probability forecasts are 30,000 Early Stuart, 837,000 Early Summer-run, 4,675,000 Summer-run, and 1,236,000 Late-run sockeye[1]. Due to the expectations for overall low abundance and the very high proportions of age 5 fish in the forecast the Panel used the 25% probability level abundance for Early Stuart sockeye (16,000 fish) for pre-season planning purposes. The 50% probability level abundance was used for the remaining sockeye stocks. For pre-season planning of Fraser River pink salmon, the Panel used the 50% probability level forecast of 14,455,000 fish. To put the uncertainty around the pink salmon forecast into context, there is a one in four chance that the actual return of pink salmon will be below 10,385,000, and a one in four chance that the return will be larger than 20,450,000. When sufficient information is available in-season, the Panel will update run size estimates of Fraser River sockeye and pink salmon, as appropriate.

2. The Panel's first priority in 2015 is to achieve 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. As a result of the pre-season planning and with consideration of the current and expected adverse environmental conditions for fish survival and productivity, as well as the projected high diversion rate through Johnstone Strait, neither Canada nor the US anticipates harvesting their full sockeye TAC. Initiation of both US and Canadian commercial fisheries openings were modeled in response to conservation needs for the Early Summer sockeye stock group, resulting in modeled catches for each country being at or below 50% of their available TACs.

3. TAC and international shares will be 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% and 25.7% of the total allowable catches (TACs) of Fraser River sockeye and pink salmon, respectively. Based upon the 50% probability levels of abundance, for the purposes of computing TAC by stock management grouping in 2015, the Panel agreed to pre-season Fraser River Aboriginal Exemptions as follows: Early Stuart sockeye, 1,500 fish; Early Summer-run sockeye, 35,900 fish; Summer-run sockeye, 285,200 fish; and Late-run sockeye, 77,400 fish. In situations where the allowable harvest of a 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 sockeye management groups and/or Fraser pink salmon. At the 50% probability forecasts, the LAERs set at 10% for Early Stuart, Early Summer and Summer-run sockeye, and at 20% 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 years, Late-run sockeye will enter the Fraser River earlier than the long-term average, and some proportion will not survive to spawn.

5. Given pre-season assumptions about Late-run sockeye marine timing and recent delay behavior, the Fraser Panel has agreed to use a Management Adjustment for the aggregate (pMA) of 0.95. If in-season information suggest that the upstream timing of the Late-run

excluding Birkenhead is later than September 9th, the Panel will consider adjusting the management adjustment 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 during 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 2015 management season.

APPENDIX D: 2015 REGULATIONS

The Fraser River Panel approved regulations for the management of the Fraser River sockeye and pink salmon fishery in Panel Area waters and submitted these to the Pacific Salmon Commission. The Commission approved the Fishery Regime and Regulations and submitted these to the respective national governments for approval on June 18, 2015.

Canadian Fraser River Panel Area

In accordance with Article VI, Paragraph 5 of the Pacific Salmon Treaty, the Commission recommends to the Canadian Government the adoption of the following Fishing Regime developed by the Fraser River Panel, namely:

1 a) No person shall commercially fish for sockeye or pink salmon in Pacific Fishery Management Area 20-1, 3 and 4 with nets from the 28th day of June, 2015, to the 19th day of September, 2015, both dates inclusive.

b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 20-1, 3 and 4 from the 28th day of June, 2015, to the 19th day of September, 2015, both dates inclusive.

2 a) No person shall commercially fish for sockeye or pink salmon in Pacific Fishery Management Areas 17 and 18 with nets from the 28th day of June, 2015 to the 3rd day of October, 2015, both dates inclusive.

b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 18-1, 4 and 11 from the 28th day of June, 2015, to the 3rd day of October, 2015, both dates inclusive.

3. a) No person shall commercially fish for sockeye or pink salmon with nets in Pacific Fishery Management Area 29 from the 28th day of June, 2015, to the 10th day of October, 2015, both dates inclusive.

b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishe1y Management Area 29 from the 28th day of June, 2015, to the 10th day of October, 2015, 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 2015 season, the Fraser River Panel will adopt Orders establishing open fishing periods based on a 2015 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 to the United States Government the adoption of the following Fishing Regime developed by the Fraser River Panel, namely:

Treaty Indian Fisheries:

1. No Treaty Indian shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 4B, 5 and 6C with drift gillnets or purse seines from the 28th day of June, 2015 to the 19th day of September, 2015, both dates inclusive.
2. No Treaty Indian shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 6A, 7 and 7A with nets from the 28th day of June, 2015, to the 26th day of September, 2015, 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 27th day of September, 2015, to the 3rd day of October, 2015, both dates inclusive.

All-Citizen Fisheries:

4. No person shall fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 4B, 5, and 6C with nets from the 28th day of June, 2015, to the 19th day of September, 2015, both dates inclusive.
5. No person shall fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 6A, 7 and 7A with nets from the 28th day of June, 2015, to the 26th day of September, 2015, both dates inclusive.
6. 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 27th day of September, 2015, to the 3rd day of October, 2015, both dates inclusive.

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

Treaty Indian and All-Citizen Fisheries:

7. High Seas westerly of the Bonilla Point-Tatoosh Island Lighthouse Line.
8. Puget Sound Salmon Management and Catch Reporting Areas 6B, 6D, 7B, 7C, 7D and 7E.

During the 2015 season, the Fraser River Panel will adopt Orders establishing open fishing periods based on a 2015 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: 2015 FRASER RIVER PANEL IN-SEASON ORDERS

To provide for adequate escapement of the various stocks of Fraser River sockeye and pink 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, 2015

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Open to drift gillnets from 12:00 p.m. (noon), Saturday, July 25, 2015 to 12:00 p.m. (noon) Wednesday, July 29, 2015.

July 28, 2015

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon) Wednesday, July 29, 2015 to 12:00 p.m. (noon), Saturday, August 1, 2015.

July 31, 2015

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon) Saturday, August 1, 2015 to 12:00 p.m. (noon), Wednesday, August 5, 2015.

Areas 6, 7, and 7A

Open to net fishing from 5:00 a.m. to 11:59 p.m. (midnight) Saturday, August 1, 2015.

Areas 6, 7, and 7A

Open to net fishing from 5:00 a.m. to 11:59 p.m. (midnight) Monday, August 3, 2015.

All Citizen Fishery

Areas 7 and 7A

Open to reefnets from 9:00 a.m. to 9:00 p.m. Saturday, August 1, 2015.

Areas 7 and 7A

Open to purse seines from 9:00 a.m. to 9:00 p.m. Sunday, August 2, 2015.

Areas 7 and 7A

Open to drift gillnets from 11:00 a.m. to 11:00 p.m. Sunday, August 2, 2015.

August 4, 2015

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon) Wednesday, August 5, 2015 to 12:00 p.m. (noon), Saturday, August 8, 2015.

Areas 6, 7, 7A

Open to net fishing from 5:00 a.m. Thursday, August 6, 2015 to 9:00 a.m. Friday, August 7, 2015.

All Citizen Fishery

Areas 7 and 7A

Open to reefnets from 5:00 a.m. to 9:00 p.m. Thursday, August 6, 2015, and from 5:00 a.m to 9:00 p.m Friday, August 7, 2015.

Areas 7 and 7A

Open to purse seines from 5:00 a.m. to 9:00 p.m. Wednesday, August 5, 2015 and from 5:00 a.m to 9:00 p.m. Friday, August 7, 2015.

Areas 7 and 7A

Open to drift gillnets from 8:00 a.m. to 11:59 p.m. (midnight) Wednesday, August 5, 2015 and from 8:00 a.m to 11:59 p.m (midnight) Friday, August 7, 2015.

August 7, 2015

United States

Treaty Indian Fishery

Areas 4B, 5, and 6C

Extended for drift gillnets from 12:00 p.m. (noon) Saturday, August 8, 2015 to 12:00 p.m. (noon), Wednesday, August 12, 2015.

Areas 6, 7, 7A

Open to net fishing from 5:00 a.m. Sunday, August 9, 2015 to 9:00 a.m. Tuesday, August 11, 2015.

All Citizen Fishery

Areas 7 and 7A

Open to reefnets from 5:00 a.m. to 9:00 p.m. Saturday, August 8, 2015.

Areas 7 and 7A

Open to purse seines from 5:00 a.m. to 9:00 p.m. Saturday, August 8, 2015.

Areas 7 and 7A

Open to drift gillnets from 8:00 a.m. to 11:59 p.m. (midnight) Saturday, August 8, 2015.

August 24, 2015

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon) Tuesday, August 25, 2015 to 12:00 p.m. (noon), Saturday, August 29, 2015. Sockeye may be retained for ceremonial and subsistence purposes only.

Areas 6, 7, and 7A

Open to net fishing from 5:00 a.m. Thursday, August 27, 2015 to 9:00 a.m. Saturday, August 29, 2015. Sockeye may be retained for ceremonial and subsistence purposes only.

All Citizen Fishery

Areas 7, and 7A

Open to reefnets with non-retention of sockeye from 5:00 a.m. to 9:00 p.m. Wednesday, August 26, 2015 and from 5:00 a.m. to 9:00 p.m. Thursday, August 27, 2015.

Areas 7, and 7A

Open to purse seines with non-retention of sockeye from 5:00 a.m. to 9:00 p.m. Tuesday, August 25, 2015 and from 5:00 a.m. to 9:00 p.m. Wednesday, August 26, 2015.

Areas 7, and 7A

Open to drift gillnets with non-retention of sockeye from 8:00 a.m. to 11:59 p.m. (midnight) Tuesday, August 25, 2015 and from 8:00 a.m. to 11:59 p.m. (midnight) Wednesday, August 26, 2015.

August 28, 2015

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon) Saturday, August 29, 2015 to 12:00 p.m. (noon), Wednesday, September 2, 2015. Sockeye may be retained for ceremonial and subsistence purposes only.

Areas 6, 7, and 7A

Open to net fishing from 5:00 a.m. Monday, August 31, 2015 to 9:00 a.m. Tuesday, September 1, 2015. Sockeye may be retained for ceremonial and subsistence purposes only.

All Citizen Fishery

Areas 7, and 7A

Open to reefnets with non-retention of sockeye from 5:00 a.m. to 9:00 p.m. Sunday, August 30, 2015 and from 5:00 a.m. to 9:00 p.m. Monday, August 31, 2015.

Areas 7, and 7A

Open to purse seines with non-retention of sockeye from 5:00 a.m. to 9:00 p.m. Sunday, August 30, 2015.

Areas 7, and 7A

Open to drift gillnets with non-retention of sockeye from 8:00 a.m. to 11:59 p.m. (midnight) Sunday, August 30, 2015.

August 31, 2015

United States

All Citizen Fishery

Areas 7, and 7A

Open to reefnets with non-retention of sockeye from 5:00 a.m. to 9:00 p.m. Tuesday, September 1, 2015.

Areas 7, and 7A

Open to purse seines with non-retention of sockeye from 5:00 a.m. to 9:00 p.m. Tuesday, September 1, 2015.

Areas 7, and 7A

Open to drift gillnets with non-retention of sockeye from 8:00 a.m. to 11:59 p.m. (midnight) Tuesday, September 1, 2015.

September 8, 2015

Canada

Area 29-6, 29-7, 29-9

Open to Area B seine assessment ITQ (two vessels) seine fishery for pink salmon with non-retention of sockeye salmon daily from 6:00 a.m. to 9:00 p.m. on Wednesday, September 9, 2015 until further notice.

September 11, 2015

Canada

Area 29-6, 29-7, 29-9

Open to Area B seine assessment ITQ (two vessels) seine fishery for pink salmon with non-retention of sockeye salmon closed effective 4:20 p.m., Thursday, September 10, 2015.

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 19; Areas 17 and 18 on October 3; and Area 29 on October 10. Panel control of United States Panel Areas were relinquished as follows; Areas 4B, 5 and 6C on September 8 by in-season order; Areas 6,7 and portions of 7A on September 8 by in-season order; and the remaining portions of Area 7A on October 3 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 route. 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 migrations 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 3 in the main body of the report summarizes the locations and temporal patterns of Panel-approved test fisheries, Table F1 summarizes more detailed information about the nets and sampling strategies employed.

Table F1. Sampling details for Panel-approved test fisheries conducted in 2015.

Area	Name	Gear	Number of Vessels	Net Length (m)	Net Depth (meshes)	Mesh Size (mm)	Mesh Size (in)	Number of Sets	Set Duration (minutes)
Canadian Panel Areas									
20	Juan de Fuca Str.	Gillnet	2	547	90	130	5 1/8	2	300
20	Juan de Fuca Str.	Purse Seine	1	n/a	875	95	3 3/4	6	20
29-14	Fraser R. (Cottonwood)	Gillnet	1	292	Variable	Variable		1	30
29-16	Fraser R. (Whonnock)	Gillnet	1	319	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
Canadian Non-Panel Areas									
12	Queen Charlotte Str. (Round Is.)	Gillnet [2]	1	365	60-90	130	5 1/8	4	100
12	Johnstone Str. (Naka Cr.)	Gillnet [2]	1	365	90	130	5 1/8	4	100
12	Johnstone Str. (Blinkhorn)	Purse Seine	1-2	401	575	95	3 3/4	6	20
13	Lower Johnstone Str.	Purse Seine	1	401	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 vessels used a 60 mesh nylon net and Naka Creek vessels a 90 Mesh Alaska twist 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). For Fraser River pink salmon, CPUE and stock composition data from the seine test fisheries in Areas 20 and 12 are particularly important for estimating total abundance. 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 or when high abundances of pink salmon confounds estimates of sockeye proportions migrating upstream, lower river (Area 29) test fisheries provide passage estimates through the use of CPUE models.

As a result of the low forecasted return for Early Stuart in 2015 (p50% 30,000 sockeye), the marine gillnet test fisheries were delayed until July 13, when most Early Stuart sockeye were thought to have migrated past these test fishery sites.

The low overall sockeye and pink salmon return led to reduced catches in test fisheries relative to the brood year and cycle averages. In the Area 12 (Round Island) gillnet test fishery, daily catches were equally low compared to the brood year and the cycle year average with the exception of a short period between July 28 and August 5 when catches were similar to catches in both the brood year as well as the cycle year average. Purse seine test fishing catches started off similar to both the brood year as well as the cycle year average in July but were much lower in August and similar to catches in 2007. Later in the season, high Johnstone Strait diversion rates resulted in further reductions in the daily catches in the Area 20 gillnet and purse seine test fisheries.

In the Fraser River, sockeye test fishery catches at both Cottonwood and Whonnock were low across the season with Cottonwood catches only exceeding 100 sockeye/set on one single day (August 4) while at Whonnock, the total catch of both test fishing sets only exceeded 100 sockeye on August 16. Catches in both river test fisheries were smaller compared to the brood year as well as the cycle year average.

Purse seine test fishery catches of pink salmon in Juan de Fuca and Johnstone Strait were lower than in the brood year. In Juan de Fuca Strait catches increased to historic averages around the end of August but declined rapidly after August 27 as the majority of the run had migrated through the marine areas.

The low returns of sockeye and pink salmon resulted in retention restrictions and/or termination of some test fisheries earlier than scheduled. Consequently the sale of fish from test fishery landings was inadequate to fully fund program activities in 2015. The resulting deficit was in excess of $700,000. Both Parties sought funds from their governments to cover this shortfall which has occurred allowing for the replenishment of the Test Fishery revolving fund.

B. Mission Hydroacoustics

PSC Staff operate a hydroacoustic facility on the Fraser River above the Mission Railway Bridge from June to September to provide timely in-season estimates of sockeye and pink salmon escapement through the lower river. Improved technologies and research effort by PSC staff in recent years[13,14] have resulted in standardized acoustic sampling methods for sockeye and pink salmon at the site. In the 2015 season, daily salmon passage at Mission was estimated using a standardized sampling method with four sonar systems consisting of a DIDSON imaging sonar and a split-beam sonar system on the left bank of the river, a split-beam system on a vessel that transected

[13] 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.

[14] Xie, Y., C. G. J. Michielsens, A. P. Gray, F. J. Martens, and J. L. Boffey. 2009. Observations of avoidance reactions of migrating salmon to a mobile survey vessel in a riverine environment. Can. J. Fish. Aquat. Sci. 65: 2178-2190.

the river, and a DIDSON system on the right bank (see Figure F1 for schematic of the sampling geometry from these systems). The four sonar systems operated 24 hours a day throughout the

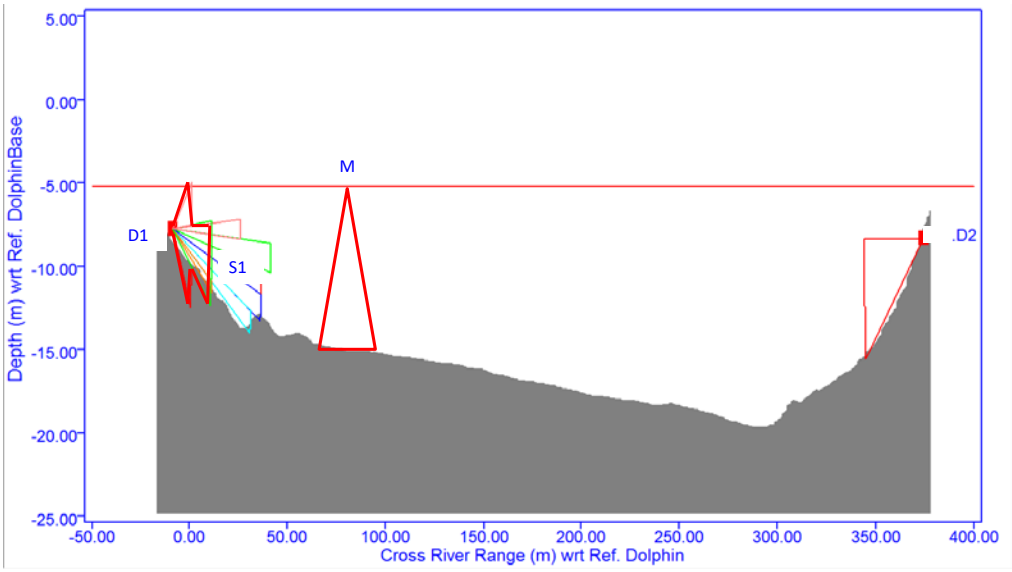

Figure F1. Cross river view of the sampling geometry of the four sonar systems operated 24hrs per day at the Mission hydraocoustics site. The four systems include the left-bank DIDSON near shore (D1), left-bank split-beam (S1), mobile split-beam (M), and the right-bank inshore DIDSON (D2).

period of salmon migration and provided key information on density, behaviour, speed and direction of travel as well as size distributions of detected fish targets. Estimates of daily salmon passage were produced by combining fish counts from the four systems. Information on the behaviour of fish migrating in offshore waters was also gathered using a vessel-based DIDSON during stationary soundings to verify assumptions used in the estimation of offshore fish migration. The vessel-based DIDSON data was also used periodically to assess and validate fish densities estimated from the mobile split-beam system in areas where data were available from both systems.

The left-bank split-beam system (S1) started operating July 9 using a side-looking transducer with an elliptically shaped beam pattern of 2°×10°. This unit which has a 2° vertical beam aperture, is more suitable for counting high density fish passage than a 4°×10° unit[15]. The transducer was attached to a rotator to control its pan and tilt, thereby allowing a stratified sampling of the water column by the narrow beam aperture at multiple aiming angles. The aim and orientation of the transducer were monitored and verified with an attitude sensor. The transducer was deployed near the far end of an extendable fish-deflection weir which prevented fish from swimming behind or too close to the transducer. This ensured that the split beam system acquired adequate numbers of echoes from individual fish targets in the insonified zone for target tracking. The transducer aim was optimized to reduce un-sampled areas where migratory abundance must be estimated by extrapolation.

The vessel-based split-beam system (M) started operating July 9. This system consisted of a downward-looking 6° circular beam transducer. The vessel transected the river every five minutes to obtain cross-river target density data. A DIDSON, which was aimed offshore, was also deployed

[15] F. J. Martens and Y. Xie. 2014. Implementation of stationary estimation of near-shore salmon passage using stratified vertical sampling by DIDSON sonar**:** *A final project report to the southern boundary restoration and enhancement fund*. Pacific Salmon Commission. June, 2014.

from the vessel approximately 6 times per day when the vessel was anchored near the left or right bank for stationary samplings. The imaging data collected was used to assess and validate fish densities estimated from the mobile split-beam system especially at the beginning of the season when there was a large amount of debris in the river due to high discharge.

The right-bank inshore DIDSON (D2) commenced operations on July 14 and the data from this unit was included in the subsequent daily estimates. A fish deflection weir was also deployed on the right bank to prevent fish from swimming behind or too close to D2. The near-shore bottom on the right bank follows a slightly concave profile with an average slope of approximately 15°. This bottom slope fits almost perfectly to the vertical beam shape of the DIDSON allowing the sonar to sample the entire near-shore water column up to 30m from the shoreline with a fixed aim. The 2015 season was the second season using the counting software IntelliHAT (Intelligent Hydro-Acoustics Tracker) to produce fish counts from the D2 data files. The software counts were verified daily by a small set of manual counts that were randomly selected to ensure that the software achieved statistically similar performance to the manual counting method.

The left-bank inshore DIDSON (D1) began operating on July 14. This system played a vital role in the 2015 season for the enumeration of pink salmon passage migrating in the near-shore area of the left bank. Fish counts and lengths from D1 were used for estimating daily pink salmon passage. The D1 estimates were incorporated into the daily estimate starting August 27, 2015. 2015 was the first season the hydroacoustics group was able to produce daily pink salmon estimates in-season.

Acoustic targets detected by the split-beam systems were tracked using an alpha-beta tracker[16,17]. The resulting tracks were classified as fish or noise (e.g., debris, air bubbles) using discriminate function analysis[18]. The integrity of statistically identified fish tracks was further verified by trained staff. The unusual or atypical targets were removed using graphical user interface (GUI) utilities under the editing software. This data processing procedure was performed each day for all the data collected from both the left-bank and vessel-based split-beam systems. The key information (position, velocity, target strength, etc.) of finalized individual fish tracks was imported to a fish-flux estimation software program. Daily fish passages in the areas sampled by the left-bank and mobile split-beam systems were then estimated from the software which also projected fish flux through the un-sampled areas by a nearest-neighbour extrapolation algorithm. Daily DIDSON files collected by D1 for net upstream fish were counted using a hand tally counter while files collected by D2 were counted using fish tracking software with manual counting as a supplemental approach for files showing abnormal fish behaviour. These counts were expanded in time to estimate daily fish passage near the left-bank and right-bank areas. Fish counts from the DIDSON systems were apportioned through a mixture model into salmon sized targets using a subset of length data estimated from the same imaging data that produced the fish counts.

Because some areas were sampled by more than one sonar system, the combination of GPS data (from the vessel) and sampling range information from the shore based systems was used to ensure that only the data from one system per area was used in the estimation. This generally meant that data from the vessel was only used for portions of the river that could not be accurately insonified by the shore based systems. The daily total salmon passage was estimated by merging daily flux estimates produced by the four sonar systems. This estimate was further apportioned by

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

[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.

[18] 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.

species and stocks based on species composition and stock identification information obtained from the daily test-fishing programs.

When pink salmon started co-migrating in the river at a comparable abundance level to sockeye, species estimates derived from the PSC Whonnock test fishing program failed to represent the true proportions of salmon species due to the extremely shore oriented behaviour of pink salmon. A methodology developed in 2013 by PSC[19] was implemented in 2015 to apportion sockeye and pink salmon during a transitional migration period prior to the arrival of the bulk abundance of pink salmon. This methodology stratifies species composition by utilizing the shore based DIDSON length data to estimate pink and sockeye proportions for the inshore areas while adopting species estimates for the offshore area based on Whonnock test fishing data. The length data was imported to a mixture model with fixed means and coefficients of variation of salmon sized targets to apportion salmon species on a daily basis[20]. The biological length information of salmon species was obtained from the PSC test fishing and the LGL fish wheel programs[21]. This cross-river stratified method was applied to the total salmon estimate to derive the pink and sockeye salmon escapements at Mission for the transitional period from August 1-26. Starting on August 27 and for the remainder of the season, daily sockeye abundance was estimated using the Whonnock CPUE data. The stratified apportionment method was no longer in use after August 26.

An ARIS (Adaptive Resolution Imaging Sonar) system was also deployed in the near-shore left-bank area as part of a research projected funded by the PSC's Southern Boundary Restoration and Enhancement Fund[22]. The 2015 program also included data exchanges with DFO to permit comparisons of estimates obtained from the hydroacoustics sites at Qualark Creek (DFO) and Mission.

Stock Identification

PSC staff conduct programs designed to estimate the 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 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 migration past Mission into discrete stock groups. Stock identification methods for sockeye salmon in 2015 used DNA and scale pattern analyses from fish caught in marine and in-river fisheries. 2015 was the fifth year that stock identification for pink salmon relied on DNA analyses rather than the protein electrophoretic techniques used previously; these analyses were applied to mixtures sampled in marine fisheries. For both sockeye and pink salmon, continuing a practice developed in recent years, a multinomial extrapolation procedure was used for predicting stock composition estimates in catches that had not yet occurred or had not yet been analyzed. For pink salmon, these

[19] Grant, S., M. Townsend, B. White, and M. Lapointe. 2014. Fraser River Pink Salmon (Oncorhynchus gorbuscha) Data Review: Inputs for Biological Status and Escapement Goals. Report prepared for Pacific Salmon Commission. May, 2014.

[20] Xie, Y., F. J. Martens, Catherine G. J. Michielsens and James 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. May, 2013.

[21] Robichaud, D, J.J. Smith, K.K. English, and S.C. Tyerman. 2011. Survival and Timing of Sockeye Returns to the Fraser River Assessed using Fishwheels, Radio-telemetry and Additional Monitoring of In-river Fisheries, 2010. Report prepared for Pacific Salmon Commission. April, 2011.

[22] C.R. Lagasse, F.J. Martens, J.L. Nelitz, M. Bartel-Sawatzky, and Y. Xie. Assessment of Adaptive Resolution Imaging Sonar (ARIS) for fish counting and measurements of fish length and swim speed in the Lower Fraser River: *A final project report to the southern boundary endowment restoration and enhancement fund.* Pacific Salmon Commission, June 2016.

extrapolations used prior information from stock composition estimates in previous years whereas, for sockeye, only information from 2015 samples was used.

A. Sockeye Salmon

Stock identification methods for sockeye salmon relied on DNA[23] (using the program CBAYES[24]) and scale pattern analyses[25]. Both 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 mostly in early- to mid-July and continuing as late as mid-September. PSC staff sampled sockeye from most test fishery catches and commercial fishery landings. Sampling locations included Port Renfrew and the lower Fraser River in British Columbia, and Bellingham and Sekiu in Washington. DFO provided samples from landings in Prince Rupert and from test fisheries in Johnstone Strait and in the Fraser River at Albion and Qualark. Alaska's Department of Fish and Game (ADF&G) collected samples for the PSC from District 104 purse seine landings in Ketchikan 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.

Sockeye catches in District 104 totaled 494,000 of which 104,400 were of Fraser origin.

B. Pink Salmon

Pink salmon mixtures are apportioned into three components - Fraser, Canada South Coast (excluding Fraser) and Washington. Estimation is made possible through the analysis of baseline genetic information that has been collected from numerous stocks from each region. In 2015, the baseline was composed similarly to other recent years with pink salmon stocks from the three regions as follows: (1)Fraser River – lower Fraser mainstem, Vedder, Harrison, Weaver, Chehalis, Coquihalla, Nahatlatch, Churn, Thompson, North Thompson, Gates, Cayoosh, Portage, Seton and Bridge River stocks; (2) Canada South Coast (Non-Fraser) – Quatse, Cluxewe, Wakeman, Adam, Kakweiken, Glendale, Klinaklini, Lull, Heydon, Big Qualicum, Keogh, Nanaimo, Quinsam, Puntledge, Ahta, Salmon, Oyster, Squamish and Indian river stocks; and (3) Washington – Nooksack, Skagit, Stillaguamish, Snohomish, Green, Puyallup, Hamma Hamma, Duckabush, Dosewallips, Dungeness, Hood Canal, and Nisqually river stocks. The stocks in this baseline represent most of the pink salmon production that could contribute to marine fishery catches where Fraser pinks are typically harvested.

During the 2015 in-season management period, tissue samples from up to 100 pink salmon were collected at approximately weekly intervals from particular fisheries. DNA analysis was similar to recent years with genotypic data from 16 microsatellite loci being compared to 46 baseline stocks using the program ONCOR[26]. Stock composition estimates derived from these

[23] 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.

[24] 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).

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

[26] Kalinowski, S.T., K.R. Manlove, and M.L. Taper. 2008. ONCOR: a computer program for genetic stock identification, v2.0. Montana State University, Bozeman. Available: http://www.montana.edu/kalinowski/Software/ONCOR.htm (January 2012).

analyses were used primarily for assessing catch, migration route (diversion rate) and abundance of Fraser River pinks.

DNA results were obtained for Canadian statistical Areas 12, 13 and 20, and U.S. Areas 7 and 7A from early August to early September. Estimated proportions of Fraser River pink salmon in these various samples are presented in Figure F2. Fraser pink salmon in both Johnstone Strait and the Strait of Juan de Fuca increased from about 15-30% in early August to approximately 60-75% by mid- to late-August. These results reflect the relatively early and weak return of Fraser River pink salmon in 2015.

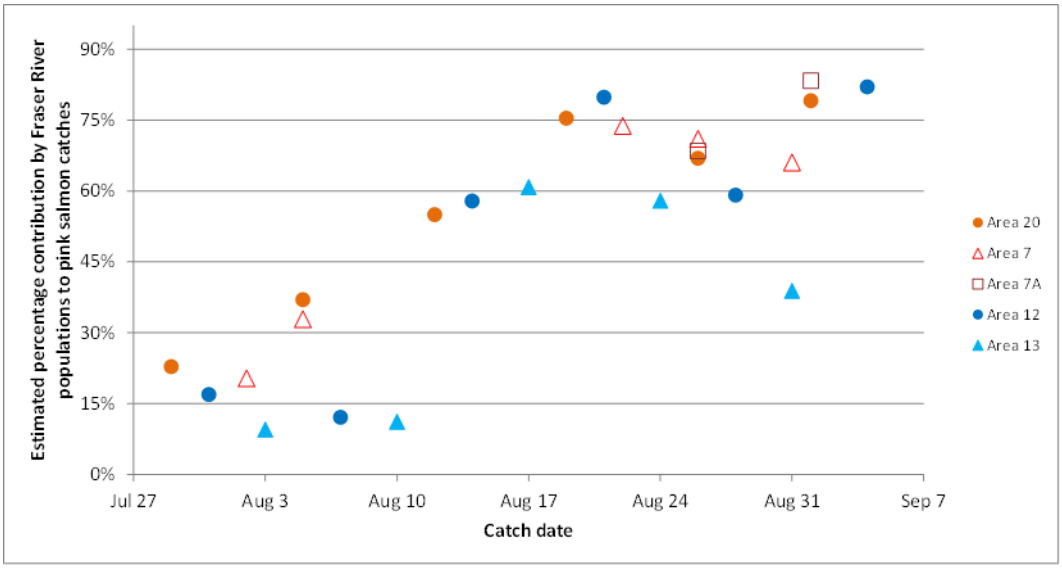

Figure F2. Percentages of Fraser River pink salmon in commercial and test fishery samples from Areas 12, 13, 20, 7 and 7A. Dates are approximate catch dates unadjusted for migration.

Stock Assessment

Assessment of Fraser River sockeye abundance by stock group is primarily based on catch, effort, escapement and stock composition data. Stock assessment methods mainly rely on catch and CPUE data from test fishing vessels to assess abundances by stock group. These data are analysed using Bayesian stock assessment models[27, 28]. These models compare the reconstructed daily migration pattern to ideal run-timing curves, assuming the run is normally distributed. By assuming the run follows this idealized pattern, the run size can be estimated once the 50% migration date (i.e., the date 50% of the run has migrated past the reference location, which corresponds to the peak of the normal distribution) has been identified, by doubling the abundance up to that date. Prior to observing the peak of the run, there is considerable uncertainty about the run size. Also because the idealized migration curves are generated based on potential estimates of timing (e.g. 50% migration dates), the estimates based on initial observations prior the peak of the run can indicate that the run is either earlier and smaller than forecast, or later and larger than forecast.

[27] 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.
[28] 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.

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

Figures F3a, b, c, d and e provide an overview of the run size estimates from the stock assessment model and the accounted run size at various dates during the season (median and 80% probability interval). These estimates can be compared against the Panel adopted in-season run size estimates used for management purposes and against the final in-season estimates of the accounted run-to-date. In 2015, pre-season forecasts overestimated the run size for Early Summer-run, Summer-run, Late-run sockeye as well as pink salmon, while for Early Stuart sockeye the final run size was close to the median pre-season forecast. The timing of the run was earlier than expected pre-season for Early Stuart and Early Summer-run, later than expected for Summer-run and Late-run sockeye and earlier than expected for pink salmon.

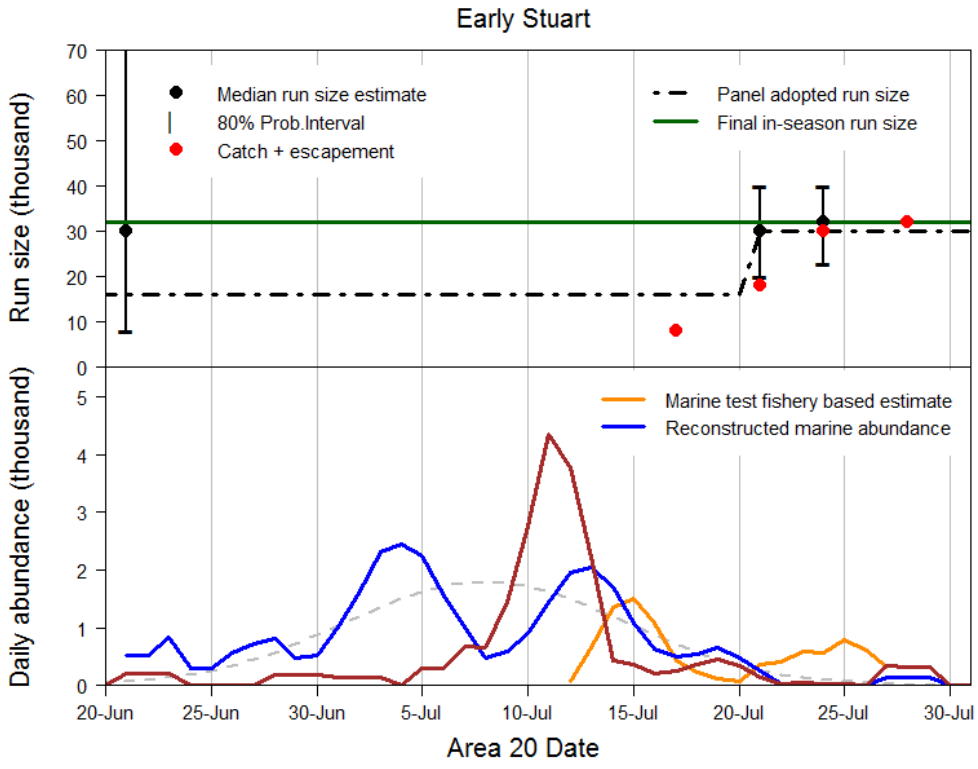

Figure F3 a: Daily reconstructed abundance estimates for Early Stuart and corresponding run-size estimates at different times during the season.

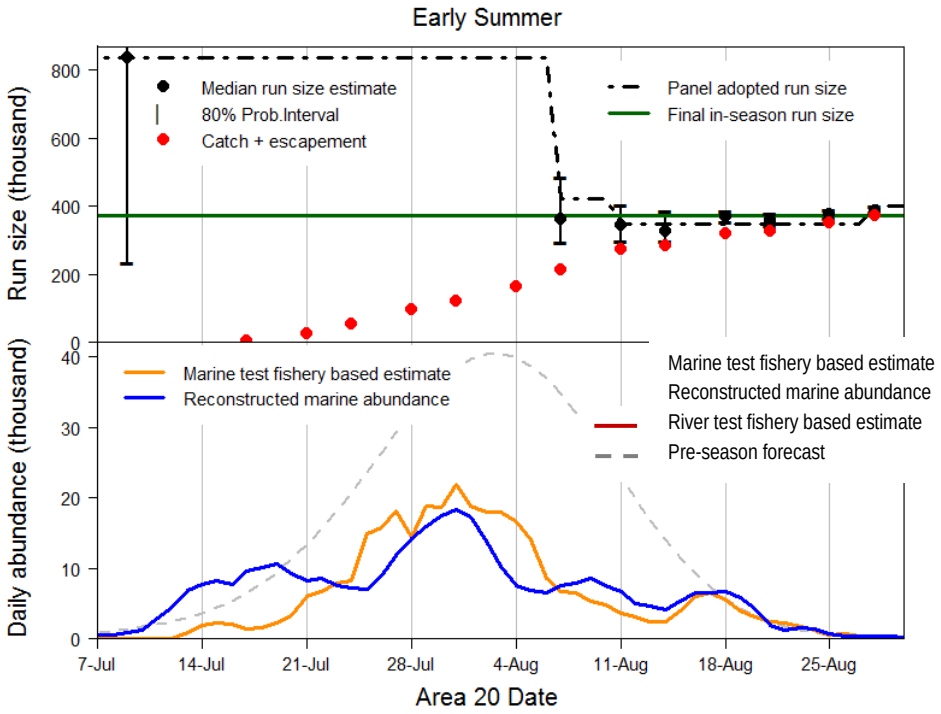

Figure F3 b: Daily reconstructed abundance estimates for Early Summer-run salmon and corresponding run-size estimates at different times during the season.

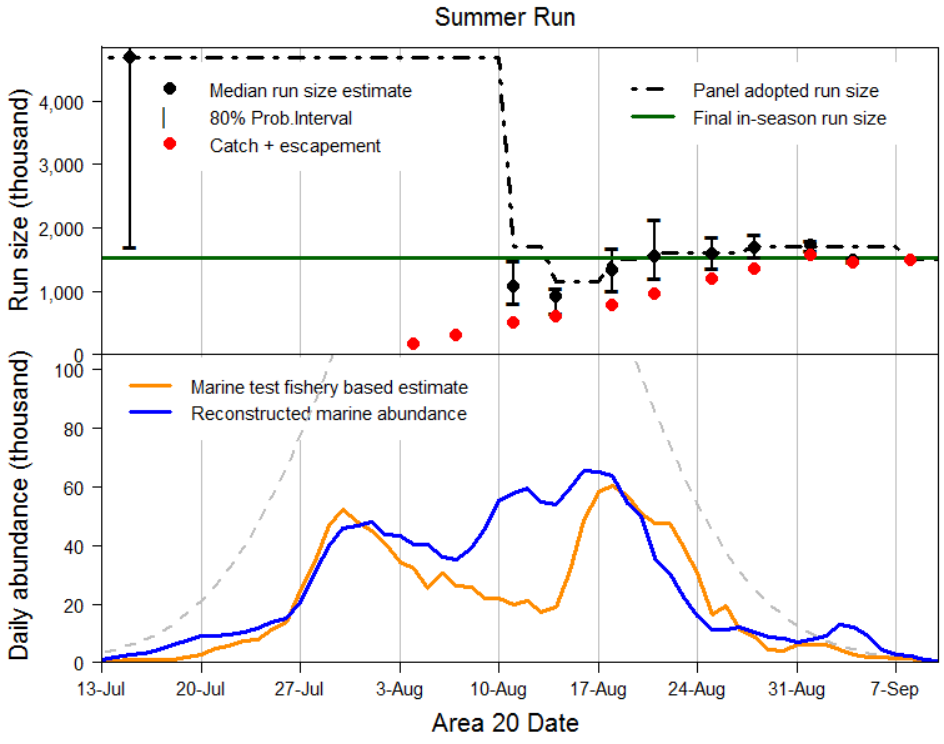

Figure F3 c: Daily reconstructed abundance estimates for Summer-run salmon and corresponding run-size estimates at different times during the season.

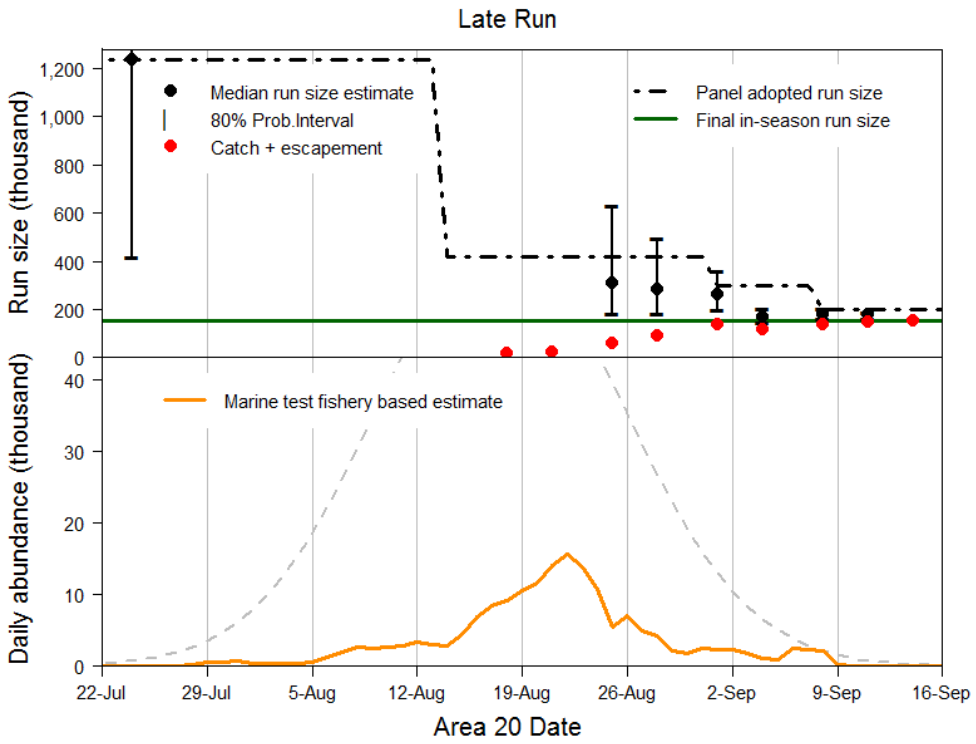

Figure F3 d: Daily reconstructed abundance estimates for Late-run salmon and corresponding run-size estimates at different times during the season.

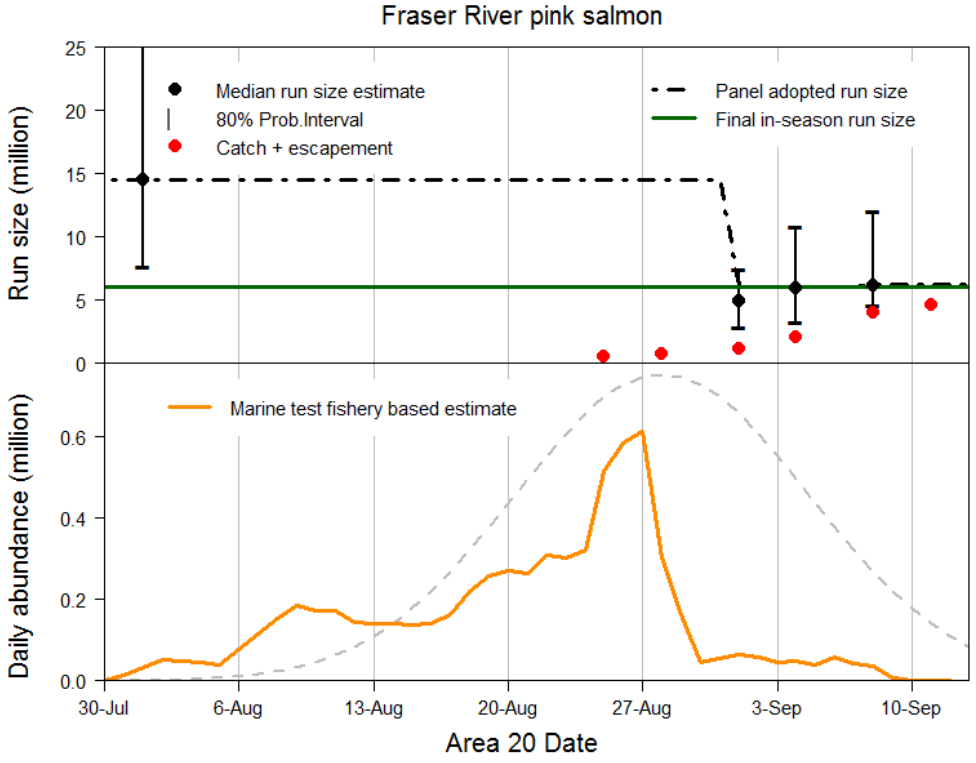

Figure F3 e: Daily reconstructed abundance estimates for Fraser River pink salmon and corresponding run-size estimates at different times during the season.

Management Adjustment and DBE

For pre-season planning, the Environmental Watch program at Fisheries and Oceans Canada presented a pre-season forecast of Fraser River environmental conditions that suggested extremely low discharge conditions (61% of normal) would make the river highly vulnerable to air temperature fluctuations. Taking the precautionary approach the Panel adopted the historic median proportional Management Adjustment (pMA) of 0.68 for Early Stuart, which was higher than the pre-season model output of 0.55 (Table F2) with July 8 Area 20 timing. For Early Summer run, the Panel decided to adopt a pMA between the historic median and the pre-season model output (a pMA of 1.00; Table F2). The Panel approved no unique treatment of Chilliwack and a pMA of 0.18 for Pitt River, but because they adopted a pMA for the aggregate that remained unchanged throughout the season, these component stock pMAs had no impact on in-season management. For the Summer-run group, the all-years temperature plus discharge MA model was presented for the non-Harrison portion of the group and Harrison was treated separately. The Panel adopted the historical median pMA of 0.08 for Summer-run without Harrison and the fixed pMA of 0.39 (the median pMA for 2004-2014) for Harrison (Table F2). The Summer-run aggregate pMA was the weighted average of the pMA for the non-Harrison Summer-run component and the pMA for Harrison, based on the forecasted p50 level of abundances.

The Panel adopted a two stage approach for the Late-run MA in 2015: (1) using historical odd-year (2013 & 2015 cycles) median if in-season timing is September 9 or earlier and (2) using a predicted MA based on the all years upstream timing model if in-season timing is later than September 9. The Panel applied this approach for the non-Birkenhead Late-run group and used a fixed pMA of 0.18 (historical median) for Birkenhead group (Table F2). The Late-run aggregate pMA was the weighted average of the pMA for the non-Birkenhead Late-run component and the pMA for Birkenhead group, based on their p50 level forecasts of abundance.

See Table F3 for a detailed summary of the Management Adjustment approaches by stock group.

Table F2. Summary of the MA model predictions and adopted values for the different components used pre-season and in-season to generate the pMA for Early Stuart, Early Summer, Summer and Late-run Management groups**.**

Description	Early Stuart		Early Summer (excld. Pitt)		Early Summer Pitt*		Summer (excld. Harrison)		Summer Harrison*		Lates* (excld. Birk.)		Lates* Birkenhead*	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Pre-season MA Model Predictions	-35%	0.55	-58%	1.39	NA	NA	-29%	0.40	NA	NA	NA	NA	NA	NA
Adopted Pre-season	-40%	0.68	-52%	1.09	-15%	0.18	-7%	0.08	-28%	0.39	-56%	1.27	-15%	0.18
In-season MA Model Predictions	-98%	41.77	-53%	1.14	NA	NA	-34%	0.51	NA	NA	NA	NA	NA	NA
Adopted In-season	-81%	4.18	-52%	1.09	-15%	0.18	-7%	0.08	-28%	0.39	-56%	1.27	-15%	0.18

*The pMAs adopted pre-season for these stocks remained fixed in-season.

Table F3. Summary of the pre-season and in-season MA models and assumptions used during 2015 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.

	Pre-season				In-season			
Management Group	Predictor variables	Upstream 50% Date[1]	Cycle lines	Excluded years	Predictor variables	Upstream 50% Date[1]	Cycle lines	Excluded years
Early Stuart	Historical Median	15/Jul	All	1977, 1980, 1982, 1984, 1986	19-day temp and discharge[2]	17/Jul	All	1977, 1980, 1982, 1984, 1986
Early Summer	Fraser River Panel	NA	NA	1993	Fraser River Panel	8/Aug	NA	1993
Summer (excluding Harrison)	Historical Median	18/Aug	All	2002	Historical Median	23/Aug	All	2002
Harrison	Historical Median 2004-2014	NA	NA	NA	Historical Median 2004-2014	NA	NA	NA
Birkenhead	Median of all years	NA	All	NA	Median of all years	NA	All	NA
Late (excluding Birkenhead)	Odd Years (2013&2015) Historical Median if timing is Sept 9th and earlier	<= 09/Sep	2013 & 2015	pre 1997	Odd Years (2013&2015) Historical Median if timing is Sept 9th and earlier	31/Aug	2013 & 2015	pre 1997
	All Years Run Timing Model[3] if timing is later than Sept. 9th	> 09/Sep	All	1977,1979-1981, 1983-1985, 1987-1989,1991-1993, 1995, 2006				

[1] Hells Gate timing for Early Stuart, Early Summer and Summer runs. Mission timing for Late runs.

[2] $\ln(DBE) = a + b_1T + b_2T^2 + b_3Q + b_4Q^2$ where T = 31-day (or 19-day; 3-days before, 15-days after) temperature centred on the Hells Gate 50% date and q = 31-day (19-day) discharge.

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

APPENDIX G: HISTORICAL CATCH, ESCAPEMENT AND PRODUCTION DATA

Table G1. Catch by user group, spawning escapement, run-size adjustment and run size of Fraser River sockeye salmon for cycle years 2003-2015.

	Fraser Sockeye Salmon			
	2003	**2007**	**2011**	**2015**
CANADIAN CATCH	**1,929,000**	**199,200**	**1,439,100**	**187,900**
Commercial Catch	**1,036,000**	**0**	**368,000**	**0**
Panel Area	266,000	0	160,800	0
Non-Panel Areas	770,000	0	207,200	0
First Nations Catch	**805,000**	**196,900**	**931,300**	**187,200**
Marine FSC	218,000	42,900	265,300	40,400
Fraser River FSC	587,000	154,000	584,800	146,800
Economic Opportunity	0	0	81,200	0
Non-commercial Catch	**88,000**	**2,300**	**139,800**	**600**
Marine Recreational	3,000	200	17,300	0
Fraser Recreational	74,000	0	84,300	0
Charter	1,000	0	4,200	500
ESSR	10,000	2,100	33,900	0
UNITED STATES CATCH	**311,000**	**142,400**	**297,200**	**150,600**
Washington Total	**243,000**	**3,400**	**278,800**	**46,200**
Commercial catch	**243,000**	**0**	**265,900**	**44,200**
Treaty Indian	159,000	0	181,000	33,100
Non-Indian	84,000	0	84,900	11,100
Non-commercial Catch	**0**	**3,400**	**12,900**	**2,000**
Ceremonial	0	3,400	12,900	2,000
Recreational	0	0	0	0
Alaska	**68,000**	**139,000**	**18,400**	**104,400**
TEST FISHING CATCH	**107,000**	**34,800**	**40,400**	**38,000**
PSC (Panel Areas)	**41,000**	**21,800**	**26,500**	**17,000**
Canada	40,000	13,400	24,700	12,400
United States	1,000	8,400	1,700	4,500
Canada (non-Panel Areas)	**66,000**	**13,000**	**14,000**	**21,100**
TOTAL RUN	**4,898,000**	**1,510,300**	**5,130,100**	**2,010,200**
Total Catch in All Fisheries	2,347,000	376,400	1,776,800	376,500
Adult Spawning Escapement	1,979,400	887,100	2,580,100	1,188,600
Jack Spawning Escapement	8,600	1,900	6,500	4,600
Run-size Adjustment	563,000	244,900	766,800	440,600
Percentage of Total Run	**100%**	**100%**	**100%**	**100%**
Total Catch in All Fisheries	48%	25%	35%	19%
Adult Spawning Escapement	40%	59%	50%	59%
Jack Spawning Escapement	0%	0%	0%	0%
Run-size Adjustment	11%	16%	15%	22%

Table G2. Catch by user group, spawning escapement and run size of Fraser River pink salmon for cycle years 2009-2015.

	Fraser Pink Salmon			
	2009	**2011**	**2013**	**2015**
CANADIAN CATCH	**1,726,800**	**4,931,000**	**3,313,700**	**83,300**
Commercial Catch	**915,600**	**3,757,200**	**1,994,300**	**0**
Panel Area	75,100	797,700	1,322,500	0
Non-Panel Areas	840,400	2,959,500	671,800	0
First Nations Catch	**520,500**	**1,050,300**	**1,220,700**	**68,000**
Marine FSC	10,500	21,600	2,900	3,400
Fraser River FSC	2,000	37,400	8,200	25,200
Economic Opportunity	508,000	991,300	1,209,600	39,400
Non-commercial Catch	**290,800**	**123,600**	**98,700**	**15,300**
Marine Recreational	38,600	63,200	30,200	0
Fraser Recreational	237,200	55,300	63,800	15,300
Charter	2,700	1,200	200	0
ESSR	12,300	3,800	4,500	0
UNITED STATES CATCH	**2,815,600**	**2,916,500**	**3,200,400**	**330,900**
Washington Total	**2,815,600**	**2,916,500**	**3,200,400**	**330,900**
Commercial catch	**2,793,600**	**2,901,500**	**3,186,700**	**328,000**
Treaty Indian	1,031,400	1,403,800	1,340,600	183,700
Non-Indian	1,762,200	1,497,700	1,846,100	144,300
Non-commercial Catch	**22,000**	**15,000**	**13,700**	**2,800**
Ceremonial	1,000	13,800	5,900	2,800
Recreational	21,000	1,200	7,800	0
Alaska	**0**	**0**	**0**	**0**
TEST FISHING CATCH	**21,800**	**13,100**	**39,200**	**48,900**
PSC (Panel Areas)	**18,300**	**11,900**	**22,000**	**38,100**
Canada	12,500	9,300	15,500	25,400
United States	5,800	2,600	6,600	12,700
Canada (non-Panel Areas)	**3,500**	**1,200**	**17,200**	**10,800**
TOTAL RUN	**19,993,000**	**20,649,000**	**15,897,800**	**5,778,900**
Total Catch in All Fisheries	4,564,200	7,860,600	6,553,300	463,100
Adult Spawning Escapement	15,428,800	12,788,400	9,344,500	5,315,800
Percentage of Total Run	**100%**	**100%**	**100%**	**100%**
Total Catch in All Fisheries	23%	38%	41%	8%
Adult Spawning Escapement	77%	62%	59%	92%

Table G3. Escapements of sockeye salmon to Fraser River spawning areas for cycle years 2003-2015.*

DISTRICT Stock Group Stream/Lake	Year 2003	2007	2011	2015
NORTHEAST				
Upper Bowron R.	6,752	2,173	4,101	3,845
STUART				
Early Stuart				
Driftwood R.	425	97	12	726
Takla L. Streams	3,070	881	229	2,641
Middle R. Streams	7,561	3,735	415	5,144
Trembleur L. Streams	2,100	634	101	1,403
Miscellaneous	10	0	0	173
Late Stuart				
Kazchek Cr.	115	22	16	0
Kuzkwa Cr.	1,578	1,318	569	533
Middle R.	3,851	835	564	3,605
Tachie R.	26,899	4,499	2,318	6,822
Miscellaneous	4,204	1,813	316	164
NECHAKO				
Nadina R. (Late)	1,557	497	3,535	10,912
Nadina Channel	1,606	1,244	6,521	23,506
Stellako R.	78,093	41,328	85,174	101,255
QUESNEL				
Horsefly R.	155,564	55,919	29,952	23,928
Horsefly Channel	22,965	3,628	2,362	4,315
McKinley Cr.	3,748	1,245	72	228
Mitchell R.	90,779	9,880	11,558	13,009
Miscellaneous	6,114	4,428	1,527	4,198
CHILCOTIN				
Chilko R. & L.	608,321	305,853	916,643	660,600
Chilko Channel	0	0	0	0
Taseko L.	380	233	964	980
SETON-ANDERSON				
Gates Cr.	880	0	38,153	11,594
Gates Channel	8,931	2,555	17,707	6,669
Portage Cr.	4,940	1,699	1,114	36
NORTH THOMPSON				
North Thompson R.	26,004	18,142	4,929	24,004
Raft R.	10,040	14,353	9,241	16,054
Fennell Cr.	9,218	11,403	9,988	1,420
SOUTH THOMPSON				
Early Summer-run				
Scotch Cr.	5,089	8,272	33,807	6,614
Seymour R.	31,345	9,979	16,456	7,897
Upper Adams / Momich / Cayenne	371	232	552	211
Miscellaneous	5,044	6,313	15,508	12,486
Late-run				
Adams R.	355,866	52,792	148,175	5,485
Little R.	15,647	1,937	3,956	229
Lower Shuswap R.	5,767	5,427	11,068	3,057
Miscellaneous	3,998	887	2,496	917
HARRISON-LILLOOET				
Birkenhead R.	309,878	93,480	227,742	44,973
Big Silver Cr. & misc. Birk. types	14,174	5,020	16,942	8,993
Harrison R.	8,259	128,295	805,596	115,684
Weaver Cr.	14,452	10,969	26,938	1,130
Weaver Channel	35,036	26,331	45,631	1,884
LOWER FRASER				
Nahatlatch R. & L.	3,070	3,853	6,955	4,414
Cultus L.	2,184 *1*	689 *1*	7,201 *1*	1,309 *1*
Upper Pitt R.	78,229	41,829	55,997	38,478
Chilliwack L./Chilliwack R., upper	4,956	1,965	4,479	6,589
MISCELLANEOUS *2*	315	455	2,551	421
ADULTS	1,979,385	887,139	2,580,131	1,188,535
JACKS	8,575	1,908	6,464	4,607
TOTAL NET ESCAPEMENT	1,987,960	889,047	2,586,595	1,193,142

* Estimates are from DFO.

1 Cultus estimates include 245 fish in 2003, 151 in 2007, 253 in 2011 and 196 in 2015 removed for broodstock

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

Table G4. Fraser River pink salmon production for odd brood years in 1961-2013 (return years 1963-2015).

Brood Year (by)	Spawners Total (millions) (by)	Spawners Female (millions) (by)	Potential Egg Deposition (millions) (by)		Fry Production (millions) (by+1)	Adult Returns (Catch + Escapement) (millions) (by+2)		% Survival Fresh Water	% Survival Marine	Average To Date
1961	1.092	0.654	1,569		143.6	5.482		9.2%	3.8%	3.8%
1963	1.954	1.216	2,435		284.2	2.320		11.7%	0.8%	2.3%
1965	1.194	0.692	1,488		274.0	12.963		18.4%	4.7%	3.1%
1967	1.831	0.973	2,132		308.0	3.931		14.4%	1.3%	2.7%
1969	1.531	0.957	2,018		287.7	9.763		14.3%	3.4%	2.8%
1971	1.805	1.096	1,923		273.6	6.801		14.2%	2.5%	2.8%
1973	1.754	1.009	1,865		212.3	4.894		11.4%	2.3%	2.7%
1975	1.367	0.781	1,493		319.7	8.209		21.4%	2.6%	2.7%
1977	2.388	1.362	2,960		483.7	14.404		16.3%	3.0%	2.7%
1979	3.561	2.076	3,787		341.3	18.685		9.0%	5.5%	3.0%
1981	4.488	2.560	4,814		607.0	15.346		12.6%	2.5%	2.9%
1983	4.632	2.931	4,702		557.4	19.038		11.9%	3.4%	3.0%
1985	6.461	3.561	5,900		264.5	7.172		4.5%	2.7%	3.0%
1987	3.224	1.856	3,471		436.0	16.484		12.6%	3.8%	3.0%
1989	7.189	4.383	7,198		400.4	22.174		5.6%	5.5%	3.2%
1991	12.943	8.002	12,330		685.5	16.983		5.6%	2.5%	3.1%
1993	10.768	6.454	9,192		437.7	12.904		4.8%	2.9%	3.1%
1995	7.175	4.248	10,233		279.1	8.176		2.7%	2.9%	3.1%
1997	2.842	1.740	2,863		257.5	3.608		9.0%	1.4%	3.0%
1999	3.445	1.885	2,702		219.0	21.262		8.1%	9.7%	3.4%
2001	19.814	9.543	16,274		714.4	24.250		4.4%	3.4%	3.4%
2003	n/a	n/a	n/a	*1*	419.0	9.870	*2*	n/a	2.4%	3.3%
2005	n/a	n/a	n/a	*1*	614.5	8.490	*2*	n/a	1.4%	3.2%
2007	n/a	n/a	n/a	*1*	497.0	19.936	*2*	n/a	4.0%	3.3%
2009	15.429	n/a	n/a	*1*	1062.4	20.649		n/a	1.9%	3.2%
2011	12.788	n/a	n/a	*1*	519.3	15.898		n/a	3.1%	3.2%
2013	9.344	n/a	n/a	*1*	609.4	5.781		n/a	0.9%	3.1%
Average	5.792	2.761	4,826		426.2	12.425		10.6%	3.1%	

1 No on the grounds surveys

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

Table G5. Detailed calculation of total allowable catch (TAC) and achievement of international catch shares for Fraser sockeye (by management group) and pink salmon in 2015. Calculations are based on the in-season estimates of abundance, spawning escapement target and Management Adjustment at the time the Panel relinquished control of the last U.S Panel Area (October 3), in accordance with Annex IV, Chapter 4 of the Pacific Salmon Treaty.

	Fraser Sockeye						Fraser Pinks	
	Early Stuart	Early Summer	Summer	Late	Total			
RUN STATUS, ESCAPEMENT NEEDS & AVAILABLE SURPLUS								
In-season Abundance Estimate	**32,100**	**373,000**	**1,549,200**	**165,800**	**2,120,100**		**5,781,300**	
Spawning Escapement Target (SET)	32,100	149,200	1,448,000	165,800	1,795,100		5,071,100	
%SET from TAM rules	*100%*	*40%*	*93%*	*100%*			1	
Management Adjustment (MA)	134,200	149,200	246,200	157,500	687,000		n/a	
Proportional MA (pMA)	*0.00*	*0.00*	*0*	*0.95*				
Test Fishing Catch (TF, post-seas. est.)	200	6,500	29,000	2,200	37,900		48,900	
Surplus above Adjusted SET & TF *	**0**	**68,100**	**0**	**0**	**68,100**		**661,400**	
DEDUCTIONS & TAC FOR INTERNATIONAL SHARING								
Aboriginal Fishery Exemption (AFE)	**600**	**32,700**	**148,900**	**217,800**	**186,700**		**n/a**	
Total Deductions (Adj.SET + TF + AFE)	32,900	337,500	1,727,100	172,500	2,270,100		5,119,900	
Available TAC (Abundance - Deductions)	**0**	**35,500**	**0**	**0**	**35,500**		**661,400**	
UNITED STATES (Washington) TAC								
Propor. distrib. TAC - Payback	**0**	**5,900**	**0**	**0**	**5,900**		**170,000**	
Proportionally distributed TAC **	0	5,900	0	0	5,900	16.5%	170,000	25.7%
U.S. Payback	0	0	0	0	0		0	
Washington Catch	0	5,800	37,900	2,600	46,200		330,900	
Deviation from TAC - Payback	**0**	**100**	**-37,900**	**-2,600**	**-40,300**		**-160,900**	
CANADIAN TAC								
Propor. distrib. TAC + Payback + AFE	**600**	**62,300**	**148,900**	**217,800**	**216,300**		**491,400**	
Propor. distrib. TAC + U.S. Payback	0	29,600	0	0	29,600	83.5%	491,400	74.3%
AFE	600	32,700	148,900	217,800	186,700		0	
Canadian Catch excluding ESSR Catch	600	32,800	149,300	4,600	187,200		83,300	
Deviation from TAC + Payback + AFE	**0**	**29,500**	**-400**	**0**	**29,000**		**408,100**	
TOTAL								
Available TAC + U.S. Payback + AFE	**600**	**68,100**	**148,900**	**4,500**	**222,100**		**661,400**	
Total Catch excluding ESSR Catch	600	38,600	187,200	7,100	233,400		414,200	
Deviation from TAC + U.S. Payback + AFE	**0**	**29,600**	**-38,300**	**-2,600**	**-11,300**		**247,200**	

* 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 2015

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

APPENDIX I: STAFF OF THE PACIFIC SALMON COMMISSION IN 2015

EXECUTIVE OFFICE

John Field, Executive Secretary

Sandie Gibson, Information Technology Manager

Clare Rochfort, Secretary/Receptionist

Kim Bartlett, Meeting Planner

Teri Tarita, Records Administrator/Librarian

FINANCE AND ADMINISTRATION

Ilinca Manisali, Controller

Bonnie Dalziel, Senior Accountant

Witty Lam, Accountant

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

Ian Guthrie, Manager, Stock Assessment

Merran Hague, Quantitative Fisheries Biologist

Keith Forrest, Manager, Test Fishing Biologist

Kent Collens, Database Manager

Stock Identification Group

Maxine Forrest, Manager, Scale Lab

Cory Lagasse, Sampling Coordinator

Steve Latham, Sockeye Stock Identification Biologist

Julie Sellars, Senior Scale Analyst

Catherine Ball, Scale Lab Assistant

Erica Jenkins, Stock Identification Biologist

Stock Monitoring Group

Yunbo Xie, Hydroacoustic Scientist

Fiona Martens, Manager, Hydroacoustic Operations

Jacqueline Nelitz, Hydroacoustic Technician

Mike Bartel Sawatzky, Hydroacoustic Technician