

2
0
1
2

**Report of the
Fraser River Panel
to the
Pacific Salmon Commission
on the
2012 Fraser River Sockeye
Salmon Fishing Season**



Prepared by the

**Pacific Salmon Commission
March 2017**

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

**REPORT OF THE
FRASER RIVER PANEL
TO THE PACIFIC SALMON COMMISSION
ON THE 2012 FRASER RIVER SOCKEYE
SALMON FISHING SEASON**

2012 PANEL MEMBERS AND ALTERNATES

CANADA

B. Rosenberger, Vice-Chair
Fisheries and Oceans Canada

C. Ashton
Purse seine fisher

M. Griswold
Troll fisher

K. Malloway
First Nations

R. Morley
Salmon processing industry

J. Murray
Gillnet fisher

B. Assu (Alternate)
Purse seine fisher

B. Payne (Alternate)
Fisheries and Oceans Canada

B. McCallum (Alternate)
Sport fisher

L. Rombough (Alternate)
Gillnet fisher

P. Sakich (Alternate)
Troll fisher

M. Shepert (Alternate)
First Nations

UNITED STATES

K. Adicks, Chair
Washington Department of Fish and Wildlife

L. Loomis
Treaty Indian tribes

B. Kehoe
Commercial salmon fishing industry

T. Tynan
National Marine Fisheries Service

R. Charles (Alternate)
Treaty Indian tribes

J. Giard (Alternate)
Reefnet fisher

P. Mundy (Alternate)
National Marine Fisheries Service

S. Thiesfeld (Alternate)
Washington Department of Fish and Wildlife

Prepared by

FISHERIES MANAGEMENT DIVISION

of the

PACIFIC SALMON COMMISSION

March 2017

Data Disclaimer

The Pacific Salmon Commission (PSC) obtains data from a number of agencies. Values posted in this report are the most up to date at the time of publication. The user of this data assumes all responsibilities on its usage and for verifying the completeness and accuracy of this data for both critical and non-critical uses and applications. In no event will PSC be in any way held liable to the user or any third parties who use this data or any derivatives.

Terms of Use

Use of any data, graphs, tables, maps or other products obtained through Pacific Salmon Commission (PSC), whether direct or indirect, must be fully acknowledged and/or cited. This includes, but is not limited to, all published, electronic or printed documents such as articles, publications, internal reports, external reports, research papers, memorandums, news reports, radio or print. Proper citation (subject to the documents' citing style) includes: "Pacific Salmon Commission (PSC) <http://www.psc.org/> (month and year when data was retrieved)". If the document contains an acknowledgment section, then it must be noted that data was provided by the Pacific Salmon Commission, found at <http://www.psc.org/>.

Contact Information

Please email any inquiries to info@psc.org.

TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES	2
LIST OF FIGURES	3
I. EXECUTIVE SUMMARY	4
II. FRASER RIVER PANEL	7
III. PANEL MANAGEMENT ACTIVITIES	8
A. Pre-season Planning	8
B. In-season Management.....	12
IV. MANAGEMENT INFORMATION	16
A. Abundance	17
B. Migration Timing and Diversion Rate	17
C. Management Adjustments and DBEs.....	20
D. Mission Escapement.....	22
V. RUN SIZE, CATCH AND ESCAPEMENT	22
A. Sockeye Salmon	23
VI. ACHIEVEMENT OF OBJECTIVES	28
A. Escapement	29
B. International Allocation.....	30
C. Domestic Allocation.....	31
D. Conservation of Other Stocks and Species.....	32
VII. ALLOCATION STATUS	32
VIII. APPENDICES	34
Appendix A: Glossary of Terms and Abbreviations.....	34
Appendix B: 2012 Pre-season Forecasts and Spawning Escapement Targets for Fraser River Sockeye Salmon.....	37
Appendix C: 2012 Fraser River Panel Management Plan Principles and Constraints	40
Appendix D: 2012 Regulations.....	41
Appendix E: 2012 Fraser River Panel In-Season Orders	43
Appendix F: PSC Staff Activities: Stock Monitoring, Identification and Assessment, and Management Adjustments	45
Appendix G: Historical Catch, Escapement and Production Data, and detailed TAC calculation	56
Appendix H: Members of the Fraser River Technical Committee in 2012	59
Appendix I: Staff of the Pacific Salmon Commission in 2012	60

LIST OF TABLES

	<u>Page</u>
Table 1. Pre-season and in-season updates of run size, spawning escapement targets and other TAC-related values for Fraser River sockeye salmon in 2012. The available harvest, catch to date, Mission escapement to date and migration timing are also shown	12
Table 2. Number of days when major U.S. net fisheries in the Fraser River Panel Area were open for directed harvest of Fraser sockeye salmon.....	15
Table 3. Panel-approved stock monitoring operations (test fishery, hydroacoustic and observer) conducted in 2012	16
Table 4. Individual stocks included in the Fraser River sockeye stock groups used in 2012.....	17
Table 5. Pre-season, in-season and post-season estimates of DBEs (differences between estimates) and pMAs (proportional management adjustments) related to Fraser sockeye management.....	21
Table 6. Fraser River sockeye salmon passage at Mission in 2012.....	22
Table 7. Catch, escapement, DBE and run size of Fraser sockeye salmon by management group in 2012	23
Table 8. Catch, escapement, DBE, run size and exploitation rate for Fraser sockeye salmon by stock group in 2012	24
Table 9. U.S. commercial catches of Fraser River sockeye salmon by user group, gear type and statistical area in 2012	26
Table 10. Adult female spawning success by management group	26
Table 11. Comparison of in-season spawning escapement targets and in-season estimates of potential spawning escapement for adult Fraser River sockeye salmon in 2012.....	29
Table 12. Comparison of post-season spawning escapement targets and escapement estimates for adult Fraser River sockeye salmon in 2012	30
Table 13. Total allowable catch (TAC) and achievement of international catch shares for Fraser River sockeye salmon in 2012.....	31
Table 14. Achievement of domestic catch goals in Washington for Fraser sockeye salmon	32
Table 15. Catches of non-Fraser sockeye and pink salmon and catches of other salmon species in commercial fisheries regulated by the Fraser River Panel in 2012	32
Table 16. Allocation status for Fraser River sockeye salmon in 2008-2012	33
 Appendix B – Pre-season Forecasts and Spawning Escapement Targets	
Table B1. Pre-season forecasts for Fraser River sockeye salmon in 2012	37
Table B2. Spawning escapement plan for Fraser River sockeye salmon in 2012	38
 Appendix F – PSC Staff Activities	
Table F1. Sampling details for Panel-approved test fisheries conducted in 2012	45
Table F2. Summary of DBEs and pMAs adopted pre-season and in-season to generate weighted pMA values for Early Summer, Summer and Late-run groups	54
Table F3. Summary of the pre-season and in-season MA models and assumptions used for each Fraser sockeye management group in 2012	55
 Appendix G – Historical Data and Detailed TAC Calculation	
Table G1. Catch by user group, spawning escapement, run-size adjustment and run size of Fraser River sockeye salmon for cycle years 2000-2012	56
Table G2. Escapements of sockeye salmon to Fraser River spawning areas for cycle years 2000-2012	57
Table G3. Detailed calculation of total allowable catch (TAC) and achievement of international catch shares for Fraser sockeye salmon by management group in 2012	58

LIST OF FIGURES

	<u>Page</u>
Figure 1. Fishery management areas in the Fraser River Panel Area and south coast waters.....	8
Figure 2. The northern (Johnstone Strait) and southern (Juan de Fuca Strait) routes for sockeye and pink salmon migration to the Fraser River.....	10
Figure 3. Pre-season projections and post-season reconstructions of daily Fraser River sockeye salmon abundance by management group in 2012	18
Figure 4. Pre-season projections and post-season reconstructions of daily Fraser River sockeye salmon abundance in 2012.....	19
Figure 5. Pre-season forecasts of annual Johnstone Strait diversion rate for Fraser sockeye salmon, compared to observed short-term and annual rates	19
Figure 6. Fraser River temperature and discharge measured near Hope in 2012. Also shown are the mean temperature and discharge during the central 90% of the migration of each Fraser sockeye management group (including Pitt)	21
Figure 7. Total run size of Fraser River sockeye salmon in 1893-2012. Returns on the 2012 cycle are emphasized.....	25
Figure 8. Total catch, escapement, difference between estimate, run size and exploitation rate for Fraser River sockeye salmon in 1985-2012, with returns on the 2012 cycle emphasized.....	25
Figure 9. Sockeye salmon spawning areas in the Fraser River watershed.....	27
Figure 10. Annual adult spawning escapement of Fraser River sockeye salmon for each management group and for total sockeye in 1938-2012, with returns on the 2012 cycle emphasized.....	28
Figure 11. Available harvest of Fraser sockeye compared to catch to date in all fisheries in 2012.....	30
Appendix F – PSC Staff Activities	
Figure F1. Prevalence of Summer-run stocks among Fraser River sockeye near Qualark and Bridge River rapids.	50
Figure F2. Daily reconstructed abundance estimates and corresponding run-size estimates at different times during the season, for Fraser sockeye by management group.....	52

I. EXECUTIVE SUMMARY

Pre-season Planning

1. Pre-season expectations were for a median run size (p50-level, Appendix B) of 2,119,000 Fraser River sockeye salmon and a one in two chance that the run size would be between 1,203,000 and 3,763,000.
2. Based primarily on the timing of their marine migrations, Raft/North Thompson (previously part of Early Summer-run group) and Harrison (previously part of Late-run group) stocks were re-assigned to the Summer-run group in 2012. Table 4 shows the sockeye stock resolution that was reported in 2012. Accounting for these transfers, the forecasted abundances by management group were 99,000 Early Stuart, 277,000 Early Summer, 1,585,000 Summer and 158,000 Late-run sockeye (Table 1).
3. A median of 43% diversion rate was expected for Fraser River sockeye salmon through Johnstone Strait, except for Harrison sockeye for which a 21% diversion rate was used. The following Area 20 50% migration dates were used: June 29 for Early Stuart, July 16 for Early Summer, August 1 for Summer and August 11 for Late-run sockeye.
4. Pre-season spawning escapement goals were 52,000 Early Stuart, 166,000 Early Summer, 651,000 Summer and 158,000 Late-run sockeye for a total of 1,027,000 adult spawners (Table 1). The goals for each sockeye management group were established by applying Canada's Spawning Escapement Plan (Appendix B) to the forecasted run sizes.
5. For Early Stuart, Early Summer-run (excluding Chilliwack and Pitt) and the Summer-run (excluding Harrison) groups pre-season management adjustments (MAs) were based on relationships between long range forecasts of river conditions (discharge and temperature) and historical differences between lower and upriver escapement estimates. MAs of 101,000 Early Stuart, 53,000 Early Summer and 39,000 Summer-run sockeye were added to the spawning escapement goals to increase the likelihood of achieving the targets. Pre-season, the MA for the Early Summer-run group was calculated based on the weighted average of a fixed Chilliwack pMA (0.26), and the forecast pMA (0.49) for the remaining run. A similar approach was used for the Summer-run group (including Harrison) with a fixed Harrison pMA (0.35) and the forecasted pMA (0.04) for the remaining run. The MA for Late-run sockeye (0.97) was derived primarily from an upstream timing model, but was not used for in-season management because exploitation rate limits were applied (see below).
6. For Late-run sockeye, the Panel assumed a continuation of early upstream migration behavior and associated high mortality that has occurred since 1996. Given pre-season assumptions about marine timing and recent delay behavior, the median upstream migration date for Late-run sockeye in 2012 was expected to occur during the third week of August. Given this timing and the expected difference between estimates, no directed harvest of Late-run sockeye was planned. However, some limited bycatch of Late-run sockeye was anticipated in fisheries directed at other Fraser sockeye management groups with harvestable surpluses. If the return of Late-run sockeye was less than the 75% probability level forecast (304,000 fish), the by-catch of Late-run sockeye was to be limited to a maximum exploitation rate of 20%, and if the Late-run return was equal to or greater than the 75% probability level forecast, the maximum exploitation rate was to be 30%.
7. The projected Total Allowable Catch (TAC) of Fraser River sockeye salmon (Table 1) based on the median forecasted abundances and agreed deductions was 558,000 sockeye, of which 16.5% (92,000 sockeye) were allocated to the United States (U.S.).
8. Pre-season model runs indicated it was unlikely the Summer-run TAC could be fully harvested due to fisheries constraints required to achieve spawning escapement targets for co-migrating Early Summer and Late-run stocks.
9. The Panel adopted the Principles and Constraints and the 2012 Regulations (Appendices C and D).

In-season Management Considerations

10. The end-of-season estimates of marine migration timing in 2012 were later than expected pre-season for Early Stuart (5 days later), almost as expected for Early Summer (1 day earlier), the same for Summer and earlier than expected for Late-run sockeye (6 days earlier) (Figure 3).
11. The overall Johnstone Strait diversion rate (Figure 5) for Fraser sockeye was 23%, compared to the pre-season forecast diversion rate which was between 35% and 50% with a mean of 43%.
12. The total return of 2,215,000 adult Fraser sockeye was slightly above the median pre-season forecast (2,119,000 fish). Returns of Early Stuart, Early Summer, and Late sockeye exceeded their forecasts by 87%, 91% and 65%, respectively, but Summer-run returns were 22% less than their median pre-season forecasts. In context to the pre-season forecast range, the Early Stuart and Early Summer return was between the p75 and p90 forecast, Summers below the p50 forecast, and Lates above the p50 forecast.
13. Fraser River discharge was much higher than average through July and August and river temperatures were higher than average through August and September (Figure 6). In-season management adjustments (Table 5) consequently exceeded pre-season expectations for Early Stuart and Early Summer-run groups, but were similar to pre-season values for Summer-run sockeye. The in-season Late-run MA was also larger because they migrated into the river 10 days earlier than expected, however, there was no consequence for in-season actions because management was based on a 20% maximum exploitation rate limit.

Run Size, Catch and Escapement

14. The preliminary estimate, using difference between estimates (DBE's), of the total return of adult Fraser sockeye was 2,215,000 fish (Tables 7 and 8), 27% higher than the brood year abundance of 1,739,000 adults in 2008 (Figure 7). Divided into management groups, adult returns totalled 185,000 Early Stuart, 530,000 Early Summer, 1,239,000 Summer and 261,000 Late-run sockeye. This return of Early Stuart sockeye was the largest on the 2012 cycle since 2000. Returns of the remaining management groups were within the ranges observed in recent cycle years.
15. Catches of Fraser River sockeye salmon in all fisheries totalled 666,000 fish, including 510,000 fish caught by Canada, 111,000 fish caught in Washington state and 34,000 fish caught by test fisheries (Table 7). Most of the Canadian catch occurred in First Nations fisheries (508,000 fish) with the remainder (2,200) occurring in the Albion and Qualark test fisheries. In Washington, commercial catches totalled 105,000 Fraser sockeye, mostly caught in Treaty Indian fisheries (73,000 fish). Fisheries in Alaska harvested 6,800 Fraser sockeye. The overall harvest rate was 30% of the run, which is within the range observed since the mid 1990s (Figure 8).
16. DFO's near-final estimates of spawning escapement to streams in the Fraser River watershed totalled 920,000 adult sockeye (Tables 7 and 8). This was about 13% higher than the brood year escapement of 815,000 adults. Spawning escapement for the Early Stuart and Summer-run groups were similar to their averages on the cycle. The spawning escapement for the Early Summer-run group was more than double the cycle average and the spawning escapement of the Late-run group was less than half the cycle average. There were only 365,000 effective female spawners in the Fraser watershed, representing an overall spawning success of 71%. Spawning success for Birkenhead sockeye (11%, 2,500 effective female spawners) and the entire Late-run group was the lowest in the 60-yr data set. Spawning success of the Summer-run aggregate (66%) was the third lowest on record and well below the long term average of 90%. The remaining stock groups had spawning success rates that were similar to or slightly lower than their long term averages, but there was considerable variability in the spawning success of the various components of the Early Summer-run group.

Achievement of Objectives

17. In order of descending priority, the goals of the Panel are to achieve the targets for spawning escapement, international sharing of the TAC and domestic catch allocation.

18. During the in-season management period, targets for spawning escapement are represented by potential spawning escapement targets (i.e., spawning escapement targets plus MAs). In-season estimates of potential escapement (i.e., Mission escapement minus catch above Mission, Table 11) were close to the targets for Early Stuart (5% under) and Summer-run sockeye (4% over), higher than the target for Early Summer sockeye (43% over), and less than the target for Late-run sockeye (18% under). Both the Early Stuart and Late-run groups were managed to maximum allowable exploitation rates which means the potential spawning escapement target is equal to the total return.
19. Post-season estimates of Fraser sockeye abundance on the spawning grounds totalled 920,000 adults, which is 23% below the post-season target (Table 12). Spawner abundance was severely below the target for Early Stuart (65% under) and Late-run sockeye (76% under), exceeded the target for Early Summer stocks (29% over) and was slightly lower than the target for Summer-run stocks (14% under). The shortfalls for Early Stuart and Late runs are mainly due to the large DBEs (Table 5) for these groups (-85% and -71%, respectively). With DBEs of this magnitude, run sizes of these management groups would have to be much larger than observed to achieve the escapement targets. The preliminary estimate of Late-run exploitation rate was 34%, exceeding the maximum allowable value of 20%.
20. The TAC (Total Allowable Catch) of Fraser sockeye (Table 13) was 410,000 fish, based on the calculation method set out in Annex IV, Chapter 4 of the Pacific Salmon Treaty and the February 17, 2011 Commission Guidance. The Washington catch of 111,000 Fraser sockeye was 44,000 fish more than their 16.5% share. Conversely, the total Canadian catch of 510,000 Fraser sockeye was 232,000 fish less than their in-season allowable catch (remaining 83.5% of TAC + 400,000 fish AFE). In these calculations, the TAC is fixed on the date that Panel control of the last U.S. Panel Area was relinquished (September 2 in 2012), while catches are post-season estimates.
21. In terms of domestic allocation objectives for Fraser sockeye, Treaty Indian fishers were 33,000 fish over and All Citizen fishers were 10,500 fish over their shares of the U.S. TAC (Table 14). There are no domestic allocation results to report for Canadian commercial fisheries in 2012.
22. By-catch of non-Fraser sockeye and pink salmon in commercial net fisheries regulated by the Fraser River Panel totalled 80 sockeye and zero pink salmon (Table 15). Catches of other Fraser and non-Fraser salmon species included 1,700 chinook, 2,800 coho, 120 chum and 10 steelhead.

Allocation Status

23. There are no paybacks of Fraser River sockeye or pink salmon to carry forward to 2013 (Table 16). In 2012, the U.S. exceeded its share of the international TAC as calculated on the day that Panel control of the last U.S. fishery area was relinquished (September 2), however, the TAC had decreased after the last decision about U.S. fisheries (August 10). Thus, in accordance with the Treaty and Commission Guidance, the TAC in effect on August 10 was used to determine allocation status. Using this method, the U.S. caught less than their share and so there was no payback of Fraser sockeye salmon to carry forward to the 2013 fishing season.

II. FRASER RIVER PANEL

In 2012, 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 and the February 2011 “Commission Guidance to the Fraser River Panel”². 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.

Implicit to the proposed regime is 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 Panel objectives given pre-season expectations. However, the Panel 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 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.

¹ Pacific Salmon Commission. 2009. Report of the Fraser River Panel to the Pacific Salmon Commission on the 2005 Fraser River sockeye and pink salmon fishing season. Appendix A. Vancouver, B.C.

² Pacific Salmon Commission. 2016. Report of the Fraser River Panel to the Pacific Salmon Commission on the 2011 Fraser River sockeye and pink salmon fishing season. Appendix C. Vancouver, B.C.

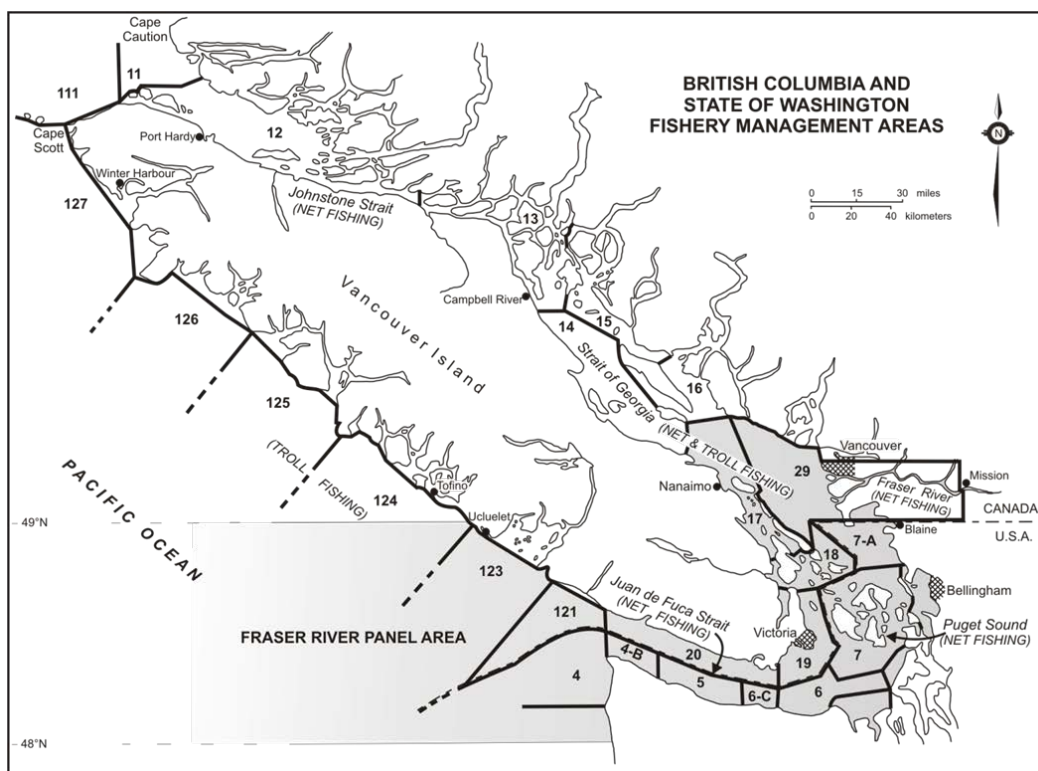


Figure 1. Fishery management areas in the Fraser River Panel Area and south coast waters.

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 Simulation Model³, which helps to evaluate the impacts of alternative fishery options on the achievement of management objectives. Model inputs include forecasts of run size, migration timing, diversion rate and management adjustments (MAs), plus objectives for spawning escapement and catch allocation. Inputs to the “base case” planning model are summarized under the “Pre-season” rows in Table 1.

Preliminary run-size forecasts for Fraser River sockeye salmon were produced by Canada using a variety of stock-recruit models assuming a long-term productivity trend⁴. Canada presented the Panel with preliminary sockeye run-size forecasts corresponding to five probability levels (10%, 25%, 50%, 75% and 90%) that the return will be below, or at, the specified

³ 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.

⁴ MacDonald, B.L. and Grant, S.C.H. 2012. Pre-season run size forecasts for Fraser River Sockeye (*Oncorhynchus nerka*) in 2012. DFO. Can. Sci. Advis. Sec. Res. Doc. 2012/011. v + 64 pp.

abundance (Appendix B, Table B1). In 2012, the Panel used the median (i.e., 50% probability level) forecast of 2,119,000 Fraser River sockeye as the “base case” scenario for planning purposes. Harrison and Raft/North Thompson stocks were included in the Summer-run management group for 2012 fisheries planning. Both countries evaluated fishing plans that included directed Summer-run sockeye fisheries. Fishing opportunities on more abundant Summer-run stocks were constrained by the low available exploitation rates and near zero international TACs for Early Stuart and Early Summer runs, rolling-window closures early in the season to protect Early Stuart sockeye, and an exploitation rate floor on Late-runs. In the base-case modelling scenario, a 10% exploitation rate (ER) floor (Appendix B, Table B2) was applied to Early Stuart sockeye, and a 20% ER floor was applied to Late-runs to permit by-catch on these management groups in fisheries directed at management groups with available TACs.

At low abundances, fixed exploitation rate floors are implemented to protect 90% of the run timing aggregate (10% floor) while allowing for fisheries on more abundant co-migrating run timing groups and/or species. The exception is the Late-run aggregate where a 20% exploitation rate floor has been implemented consistent with recent years’ practice. New for 2012 was that if the return of Late-run sockeye was at or above the p75 forecast, consideration would be given to increasing the Late-run exploitation rate floor up to 30%.

Canada used the “Fraser River Sockeye Spawning Initiative” (FRSSI) process to establish escapement goals for the 2012 management season. The spawning escapement plan was released by Canada to the Panel (Appendix B, Table B2). Pre-season escapement targets for sockeye at the 50% run size levels by management group were: Early Stuart – 52,000; Early Summer – 166,000; Summer – 651,000; and Lates – 158,000⁵.

Pre-season fisheries management planning was based on assumptions about the proportions of Fraser sockeye salmon that would migrate through Juan de Fuca Strait versus Johnstone Strait (i.e. Johnstone Strait diversion rate, Figure 2) as well as marine timing (i.e., Juan de Fuca or Area 20 50% migration dates). Area 20 dates are indices of marine migration timing and represent the date when 50% of the total run would have entered Juan de Fuca Strait (Canadian Area 20) if the entire run had migrated via that route. In 2012, DFO introduced a revised methodology⁶ for forecasting Early Stuart and Chilko run timing. Timing forecasts were defined as the median from an ensemble of predictions generated from linear regressions fit to historic timing and a suite of oceanographic variables. For planning purposes, the Panel adopted the run timing forecast for Early Stuart generated by DFOs oceanographic models but then chose to adopt a Chilko timing forecasted from a regression between historical Early Stuart and Chilko timing estimates. Using these two approaches, a median forecasted Below Bridge (New Westminster) timing of July 4 (June 29 for Area 20) for Early Stuart and a forecasted Area 20 timing of August 3 for Chilko were used in the “base-case” model. These marine dates represent earlier than normal timing for both Early Stuart (historical median is July 4) and Chilko (historical median is August 8) stocks. Area 20 timing estimates for the remaining sockeye stocks were calculated either as a function of Early Stuart timing using regression models (Early Miscellaneous, Late Stuart/Stellako, Weaver, Birkenhead), as the historical cycle-line average (Scotch/Seymour), or as a historical offset from Chilko timing (Harrison = Chilko – 3 days; Raft/North Thompson = Chilko + 3 days). For planning purposes, the Panel used weighted average Area 20 dates of July 16 for Early Summers, August 1 for Summers and August 11 for Lates based on the timing and abundance of component stocks. Figure 3 illustrates the distribution of daily abundances for each sockeye management group given these pre-season assumptions of timing and total run size. The Panel assumed a 16-day “delay” prior to upstream migration for modelling non-Birkenhead Late-run migratory behaviour, corresponding to the mean observed delay since 2009. This delay scenario produced an expectation for September 4 median upstream timing for non-Birkenhead Late-runs and an August 20 median upstream timing for the Late-runs including Birkenhead. To achieve these expected timings, the planning model assumed 47% of non-Birkenhead Late-run fish migrated directly

⁵ 2012/2013 Southern B.C. Salmon Integrated Fishery Management Plan. Fisheries and Oceans Canada.

⁶ 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.

upstream and a September 8 upstream timing for the Late-run “delay” component. DFO also used oceanographic models to produce a pre-season forecast of 43% of Fraser sockeye diverting through Johnstone Strait.

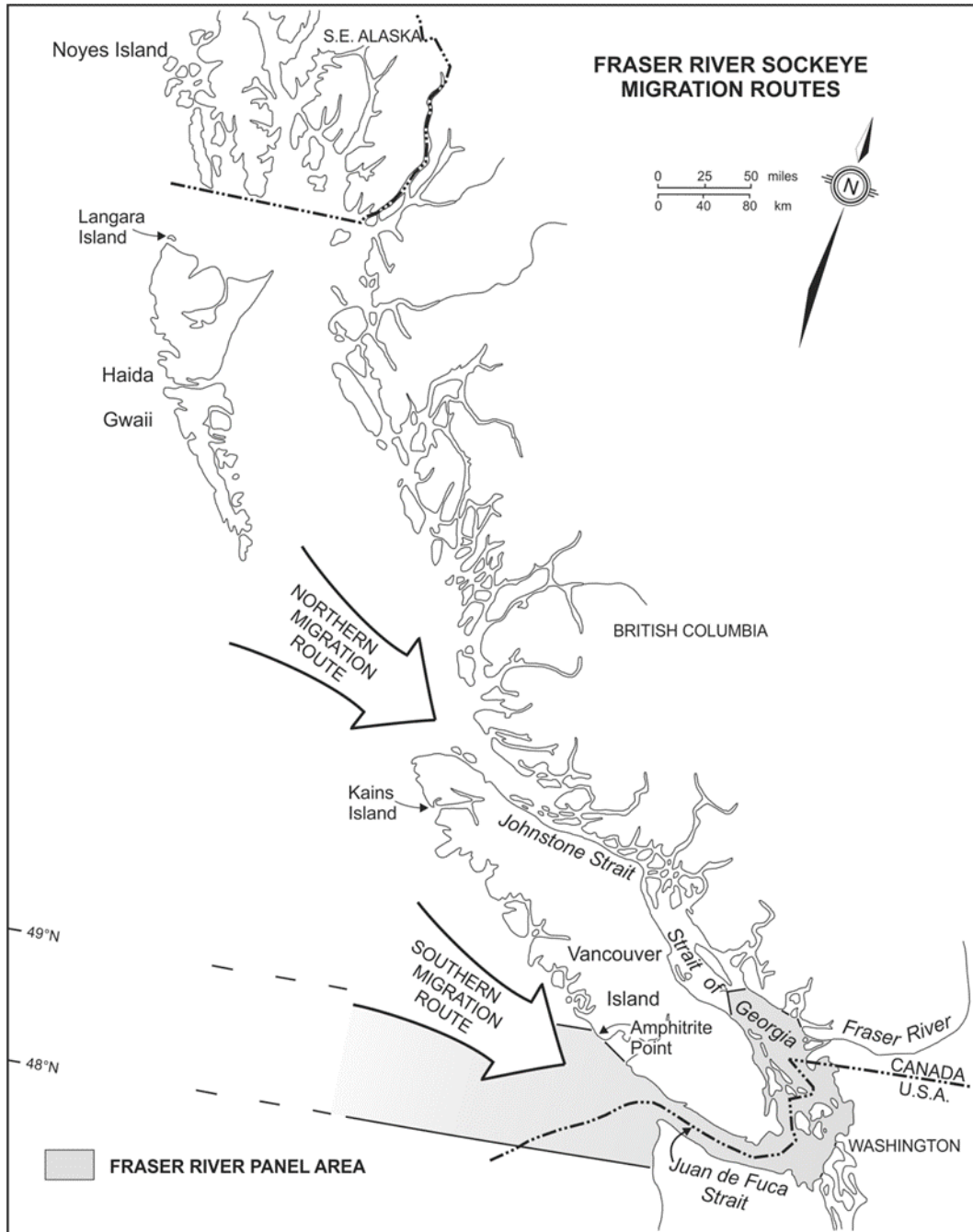


Figure 2. The northern (Johnstone Strait) and southern (Juan de Fuca Strait) routes for sockeye and pink salmon migration to the Fraser River.

In 2012, the planning model was modified to include a stock-specific diversion rate for the Harrison component based on analyses of recent years suggesting that Harrison sockeye migrate predominantly through the southern approach (M. Hague, PSC, unpublished data). A Harrison Johnstone Strait diversion of 21% was used in the model based on a historical regression between total Fraser sockeye and Harrison sockeye diversion (2005-2011). In addition, Harrison was modelled with a 33% “delay” component, corresponding to the historical average from 2009-2011,

and assuming a September 8 upstream timing for delaying fish – equivalent to the timing for delaying non-Birkenhead Late-run stocks.

DFO's Environmental Watch Program provided the Panel with long-range (3-month) projections of Fraser River temperature and discharge conditions. Forecasts projected above-average discharge and near-normal water temperatures for all sockeye management groups. Staff used the environmental forecasts in Management Adjustment (MA) models developed jointly between DFO and the PSC to predict how many additional fish from the Early Stuart, Early Summer and Summer management groups should be allowed to escape to increase the probability of achieving spawning escapement objectives (see references in the "Management Adjustments and DBEs" section of the report). Expectations for median upstream timing were used to forecast MAs for the Late-run. The median MA forecasts from the Early Stuart and Early Summer and Summer-run models were adopted by the Panel for the "base-case" scenario. The resulting Early Stuart pMA was 1.95 (101,400 fish). For the Early Summer-run, the long range forecasted MA was used for the Early Summer group excluding Chilliwack and Pitt and a fixed value of 0.26 was used for Chilliwack (Table F3). The resulting weighted average pMA for the total Early Summer-run group was 0.32 (53,100 fish at the p50 run size forecast). The forecasted pMA of 0.04 for the Summer run (including Raft/North Thompson; excluding Harrison) was combined with the fixed Harrison pMA (0.35; median of 2004-2011, excluding 2006) to calculate a weighted average pMA of 0.06 (39,100) Summer-run group. A Late-run (excluding Birkenhead) pMA of 2.14 was forecast from the assumed upstream timing of September 4 for this component and combined with the Birkenhead pMA (0.26; median of all years; Table F3) to calculate a weighted average of 0.97 (153,300) for the Late-run group. Note that the allowable impacts on Early Stuart and Late-run sockeye were based on the application of ER floors as described above.

Given the "base-case" conditions using the biological parameters described above, Canada and the U.S. developed plans with fishing beginning the weeks of July 15 (Canada; First Nations in-river only) and July 22 (U.S.). Canada had no commercial fishing plans under the "base-case" scenario. This plan included the "Management Plan Principles and Constraints", and "2012 Regulations" (Appendices C and D). Due to conservation concerns, a 3-week moving closure window for Early Stuart sockeye restricted fishery openings for earlier dates in Canada. If in-season assessments indicated that the return abundances of sockeye salmon were lower or higher than forecast, or that the return timing of sockeye stocks was significantly different than forecast, or that the in-season forecasts of MAs deviated from the pre-season forecasts, then the commencement and duration of fisheries and/or assumed exploitation rate floors could deviate from the proposed plan.

TACs and international harvest shares for Fraser sockeye were calculated according to the February 17, 2011 Commission Guidance to the Fraser River Panel² and the 2005 revised Annex IV, Chapter 4 of the Pacific Salmon Treaty¹. The U.S. (Washington) share was 16.5% of the sockeye salmon TAC. With a pre-season TAC projection of 558,400 sockeye for international sharing, the corresponding U.S. share was 92,100 fish. In terms of domestic goals, Treaty Indian fishers were allocated 67.7% and All-Citizen fishers the remaining 32.3% of the U.S. TAC. The Canadian share including the 400,000 Aboriginal Fishery Exemption (AFE) was 866,200 sockeye. The combined allocations to the non-commercial sector left no share for the Canadian commercial sector given median pre-season assumptions.

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. Canada identified lower Strait of Georgia Chinook salmon, Sakinaw sockeye salmon, summer-run and interior steelhead, interior Fraser River coho salmon, and southern resident killer whales. The U.S. highlighted concerns for Puget Sound Chinook and steelhead, Hood Canal summer-run chum, Puget Sound rockfish, eulachon, green sturgeon and southern resident killer whales.

B. In-season Management

The Panel convened 16 times in-season between July 6 and August 21 to discuss run status and enact in-season orders (Appendix E) to regulate fisheries directed at Fraser River sockeye salmon in Panel Areas. Table 1 summarizes pre-season and in-season data by meeting date, including estimates of run size and the various components that result in the calculated TAC by management group (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 median or 50% migration dates. The main events transpiring during 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 salmon in 2012. The available harvest (run size minus spawning escapement target and management adjustment), catch to date, Mission escapement to date and migration timing are also shown.

Date	Management Group	Total Abundance	TAC					Total Allowable Catch	Available Harvest *	Catch to date	Mission Passage to date	50% Migration Date	
			Spawning Escapement Target	Management pMA	Management Adjust.	Aboriginal Test Fishing	Aboriginal Fishery Exemption					Area 20	Mission
Pre-season	Early Stuart	99,000	52,000	1.95	101,400	2,500	7,400	0	0	na	na	29-Jun	5-Jul
	Early Summer	277,000	166,000	0.32	53,100	5,300	52,500	100	57,900	na	na	16-Jul	22-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,900	558,300	894,900	na	na	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	na	na	11-Aug	
	Sockeye	2,119,000	1,027,000	346,900	34,100	400,000	558,400	952,800	0	0	0		
July 6 In-season	Early Stuart	99,000	52,000	1.95	101,400	2,500	7,400	0	0	800	28,500	29-Jun	5-Jul
	Early Summer	277,000	166,000	0.32	53,100	5,300	52,500	100	57,900	300	7,700	16-Jul	22-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,900	558,300	894,900	0	0	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	0	0	11-Aug	
	Sockeye	2,119,000	1,027,000	346,900	34,100	400,000	558,400	952,800	1,100	36,200			
July 10 In-season	Early Stuart	99,000	52,000	1.95	101,400	2,500	7,400	0	0	1,400	94,900	29-Jun	5-Jul
	Early Summer	277,000	166,000	0.32	53,100	5,300	52,500	100	57,900	900	20,100	16-Jul	22-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,900	558,300	894,900	0	0	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	0	0	11-Aug	
	Sockeye	2,119,000	1,027,000	346,900	34,100	400,000	558,400	952,800	2,300	115,000			
July 13 In-season	Early Stuart	120,000	52,000	3.38	175,800	2,500	7,400	0	0	1,500	107,200	3-Jul	9-Jul
	Early Summer	277,000	166,000	0.32	53,100	5,300	52,500	100	57,900	1,500	80,900	16-Jul	22-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,900	558,300	894,900	200	600	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	0	0	11-Aug	
	Sockeye	2,140,000	1,027,000	421,300	34,100	400,000	558,400	952,800	3,200	188,700			
July 17 In-season	Early Stuart	140,000	56,000	4.55	254,800	2,500	7,400	0	0	1,900	124,500	2-Jul	8-Jul
	Early Summer	277,000	166,000	0.32	53,100	5,300	52,500	100	57,900	2,500	126,500	16-Jul	22-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,900	558,300	894,900	700	4,100	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	0	0	11-Aug	
	Sockeye	2,160,000	1,031,000	500,300	34,100	400,000	558,400	952,800	5,100	255,100			
July 20 In-season	Early Stuart	180,000	72,000	3.79	272,900	2,500	7,400	0	0	3,200	172,400	3-Jul	9-Jul
	Early Summer	277,000	166,000	0.32	53,100	5,300	52,600	0	57,900	4,800	226,500	16-Jul	22-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,800	558,400	894,900	1,000	13,700	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	0	0	11-Aug	
	Sockeye	2,200,000	1,047,000	518,400	34,100	400,000	558,400	952,800	9,000	412,600			
July 24 In-season	Early Stuart	180,000	72,000	3.19	229,700	2,500	7,400	0	0	3,500	179,100	4-Jul	10-Jul
	Early Summer	410,000	164,700	1.12	184,500	5,300	52,600	2,900	60,800	10,300	324,300	12-Jul	18-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,800	558,400	894,900	4,200	48,800	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	200	3,100	11-Aug	
	Sockeye	2,333,000	1,045,700	606,600	34,100	400,000	561,300	955,700	18,200	555,300			
July 27 In-season	Early Stuart	180,000	72,000	3.19	229,700	2,500	7,400	0	0	5,800	181,700	4-Jul	10-Jul
	Early Summer	420,000	168,000	1.12	188,200	5,300	52,600	5,900	63,800	17,500	348,700	12-Jul	18-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,800	558,400	894,900	12,300	71,400	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	800	3,400	11-Aug	
	Sockeye	2,343,000	1,049,000	610,300	34,100	400,000	564,300	958,700	36,400	605,200			
July 30 In-season	Early Stuart	180,000	72,000	3.19	229,700	2,500	7,400	0	0	5,800	181,700	4-Jul	10-Jul
	Early Summer	450,000	180,000	1.27	228,600	7,500	52,600	0	41,400	17,700	364,900	13-Jul	19-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,800	558,400	894,900	12,300	97,900	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	900	6,800	11-Aug	
	Sockeye	2,373,000	1,061,000	650,700	36,300	400,000	558,400	936,300	36,700	651,300			
July 31 In-season	Early Stuart	180,000	72,000	3.19	229,700	2,500	7,400	0	0	5,900	181,700	4-Jul	10-Jul
	Early Summer	460,000	184,000	1.05	193,200	7,500	52,600	22,700	82,800	20,600	376,500	13-Jul	19-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,800	558,400	894,900	18,400	119,300	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	1,500	9,200	11-Aug	
	Sockeye	2,383,000	1,065,000	615,300	36,300	400,000	581,100	977,700	46,400	686,700			

Table 1, continued on next page

Table 1, continued.

Date	Management Group	Total Abundance	TAC					Total Allowable Catch	Available Harvest *	Catch to date	Mission Passage to date	50% Migration Date	
			Spawning Escapement Target	Management pMA	Management Adjust.	Aboriginal Test Fishing	Fishery Exemption					Area 20	Mission
August 3	Early Stuart	180,000	72,000	3.19	229,700	2,500	7,400	0	0	6,500	181,700	4-Jul	10-Jul
	Early Summer	510,000	204,000	0.58	118,300	9,000	52,600	126,100	187,700	37,600	417,700	15-Jul	21-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,800	558,400	894,900	73,400	240,700	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	7,600	25,000	11-Aug	
	Sockeye	2,433,000	1,085,000	540,400	37,800	400,000	684,500	1,082,600	125,100	865,100			
August 6	Early Stuart	180,000	72,000	3.19	229,700	2,500	7,400	0	0	6,600	182,500	4-Jul	10-Jul
	Early Summer	530,000	212,000	0.54	114,500	9,000	52,600	141,900	203,500	34,600	459,800	15-Jul	21-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,800	558,400	894,900	97,800	374,300	1-Aug	7-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	10,800	38,900	11-Aug	
	Sockeye	2,453,000	1,093,000	536,600	37,800	400,000	700,300	1,098,400	149,800	1,055,500			
August 7	Early Stuart	180,000	72,000	3.19	229,700	2,500	7,400	0	0	6,600	182,500	4-Jul	10-Jul
	Early Summer	550,000	220,000	0.49	107,800	9,000	52,600	160,600	222,200	39,300	478,000	16-Jul	22-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,800	558,400	894,900	108,400	461,500	5-Aug	11-Aug
	Late	158,000	158,000	0.97	153,300	2,600	27,200	0	0	13,300	47,600	11-Aug	
	Sockeye	2,473,000	1,101,000	529,900	37,800	400,000	719,000	1,117,100	167,600	1,169,600			
August 10	Early Stuart	180,000	72,000	3.19	229,700	2,500	7,400	0	0	9,200	182,500	4-Jul	10-Jul
	Early Summer	550,000	220,000	0.49	107,800	9,000	52,600	160,600	222,200	57,800	476,500	16-Jul	22-Jul
	Summer	1,585,000	651,000	0.06	39,100	23,700	312,800	558,400	894,900	202,600	613,100	5-Aug	11-Aug
	Late	200,000	200,000	0.97	194,000	2,600	27,200	0	0	21,000	101,400	11-Aug	
	Sockeye	2,515,000	1,143,000	570,600	37,800	400,000	719,000	1,117,100	290,600	1,373,500			
August 14	Early Stuart	180,000	72,000	3.19	229,700	1,800	10,000	0	0	9,200	182,500	4-Jul	10-Jul
	Early Summer	550,000	220,000	0.49	107,800	9,000	94,700	118,500	222,200	57,700	487,700	16-Jul	22-Jul
	Summer	1,300,000	651,000	0.09	58,600	20,000	271,700	298,700	590,400	231,000	764,600	2-Aug	8-Aug
	Late	200,000	200,000	0.97	194,000	3,000	23,600	0	0	25,200	139,200	3-Aug	
	Sockeye	2,230,000	1,143,000	590,100	33,800	400,000	417,200	812,600	323,100	1,574,000			
August 17	Early Stuart	185,000	74,000	3.19	236,100	1,800	10,000	0	0	10,100	182,500	4-Jul	10-Jul
	Early Summer	550,000	220,000	0.49	107,800	8,500	94,700	119,000	222,200	71,800	496,000	16-Jul	22-Jul
	Summer	1,300,000	651,000	0.09	58,600	20,000	271,700	298,700	590,400	351,900	877,800	2-Aug	8-Aug
	Late	250,000	250,000	0.97	242,500	3,200	23,600	0	0	36,300	167,100	5-Aug	
	Sockeye	2,285,000	1,195,000	645,000	33,500	400,000	417,700	812,600	470,100	1,723,400			
August 21	Early Stuart	185,000	74,000	3.19	236,100	1,800	10,000	0	0	10,100	182,500	4-Jul	10-Jul
	Early Summer	550,000	220,000	0.49	107,800	8,500	94,700	119,000	222,200	72,600	496,700	16-Jul	22-Jul
	Summer	1,300,000	651,000	0.09	58,600	21,000	271,700	297,700	590,400	384,700	963,400	2-Aug	8-Aug
	Late	260,000	260,000	0.97	252,200	4,000	23,600	0	0	42,800	189,500	5-Aug	
	Sockeye	2,295,000	1,205,000	654,700	35,300	400,000	416,700	812,600	510,200	1,832,100			
August 24	Early Stuart	185,000	74,000	3.19	236,100	1,800	10,000	0	0	9,200	182,500	4-Jul	10-Jul
	Early Summer	530,000	212,000	0.49	103,900	8,300	94,700	111,100	214,100	75,000	497,000	15-Jul	21-Jul
	Summer	1,300,000	651,000	0.09	58,600	20,200	271,700	298,500	590,400	421,100	979,800	2-Aug	8-Aug
	Late	260,000	260,000	0.97	252,200	3,900	23,600	0	0	44,300	199,400	5-Aug	
	Sockeye	2,275,000	1,197,000	650,800	34,200	400,000	409,600	804,500	549,600	1,858,700			
September 2	Early Stuart	185,000	74,000	3.19	236,100	1,800	10,000	0	0	9,100	182,500	4-Jul	10-Jul
	Early Summer	530,000	212,000	0.49	103,900	8,300	94,700	111,100	214,100	77,000	497,300	16-Jul	22-Jul
	Summer	1,300,000	651,000	0.09	58,600	20,200	271,700	298,500	590,400	464,000	1,000,400	2-Aug	8-Aug
	Late	260,000	260,000	0.97	252,200	3,900	23,600	0	0	46,800	207,400	5-Aug	
	Sockeye	2,275,000	1,197,000	650,800	34,200	400,000	409,600	804,500	596,900	1,887,600			
September 26	Early Stuart	185,000	74,000	3.19	236,100	1,800	10,000	0	0	9,100	182,500	4-Jul	10-Jul
	Early Summer	530,000	212,000	0.49	103,900	8,300	94,700	111,100	214,100	78,100	497,400	16-Jul	22-Jul
	Summer	1,300,000	651,000	0.09	58,600	20,200	271,700	298,500	590,400	490,500	1,000,900	2-Aug	8-Aug
	Late	260,000	260,000	0.97	252,200	3,900	23,600	0	0	48,100	221,200	5-Aug	
	Sockeye	2,275,000	1,197,000	650,800	34,200	400,000	409,600	804,500	625,800	1,902,000			

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

** 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.

July 1-7: High river flows delayed the start of the Mission hydroacoustic monitoring program and likely reduced catches in the gillnet test fishery at Whonnock. The Panel was concerned that continued high flows would negatively impact the upstream migration success of Early Stuart sockeye, resulting in elevated levels of en route mortality. Run-size assessments for Early Stuart sockeye were highly uncertain (80% prediction interval of 32,000 to 135,000 fish).

July 8-14: High water flows continued to delay the start of shore-based components of the Mission hydroacoustic program, so test fishing catches were used to estimate sockeye passage in the lower Fraser River until July 11th after which hydroacoustics estimates were used. Although flow levels were decreasing, they were approximately 50% higher than average for the date and at levels that can negatively affect the upstream migration success of sockeye. The Panel approved an Early Stuart run-size estimate of 120,000 fish with an Area 20 50% date of July 3, and increased the Early Stuart pMA from the pre-season forecast of 1.95 to 3.38. Preliminary assessments of the Chilliwack component of the Early Summer-run group indicated that their run size was close to or above the p50 forecast of 127,000 fish.

July 15-21: Marine test fisheries indicated a moderate migration of Fraser sockeye through marine assessment areas. The Panel approved increased Early Stuart run sizes of 140,000 fish and then 180,000 fish, with an Area 20 timing of July 3, and a Chilliwack run size of 170,000 fish with an Area 20 timing of July 6. Stock identification analyses indicated that Late Stuart and Stellako sockeye were the strongest components so far of the Summer-run group. The Panel approved an increased Early Stuart pMA of 4.55, which was reduced to 3.79 later in the week. The Hells Gate observer reported that a strong sockeye migration had occurred over the past several days.

July 22-28: Flow levels in the Fraser River near Hope were nearly 40% higher than average for this period, while water temperatures in the Fraser River at Qualark Creek were close to average. The Early Stuart marine timing estimate was updated to July 4, which was five days later than the pre-season forecast, while the Chilliwack run size estimate increased to 200,000 fish. The Early Summer run was returning in a bi-modal migration pattern, which increased the uncertainty in run size assessments for these sockeye. The Panel adopted increased Early Summer-run abundances of 410,000 fish and then 420,000 fish with an Area 20 50% date of July 12, which was four days earlier than the pre-season expectation. Preliminary assessments for Summer-run stocks indicated that they would likely return at smaller than median forecasted abundances and/or later than expected timing. The diversion rate of Fraser sockeye through Johnstone Strait was estimated to be 28%. The Panel approved a reduced Early Stuart pMA of 3.19 and increased the Early Summer-run pMA from the pre-season forecast of 0.32 to 1.12. U.S. Treaty Indian drift gillnet fisheries in Areas 4B, 5 and 6C were approved since conditions were consistent with the pre-season criteria established for initiating these fisheries.

July 29-August 4: Marine test fisheries indicated a stronger than expected migration of Fraser sockeye through marine assessment areas, with a diversion rate through Johnstone Strait that was less than 20%. Stock proportions in Area 20 test fishing samples were approximately 10% Early Summer-run, 80% Summer-run and 10% Late-run sockeye. The migration of Early Summer-run sockeye appeared to be protracted with several pulses in their migration through marine approach routes to the Fraser River. Early Summer-run assessments were therefore more uncertain than usual. The Panel adopted increased Early Summer-run abundance estimates of 450,000 fish, then 460,000 fish and finally 510,000 fish, with marine timing through Area 20 of July 15. Assessments of Summer-run sockeye through marine areas indicated either later than expected timing or smaller than median forecast abundance. Birkenhead proportions in fishery samples were higher than expected, with strength in the five-year-old age component. Harrison sockeye appeared to be returning at higher than forecast abundance and they were migrating directly into the river without delay. There were also indications that Adams/Weaver sockeye may be early or larger than forecast. The Panel initially approved an increased Early Summer-run pMA of 1.27 but then reduced it to 1.05 due to changes in Early Summer-run stock composition, and then reduced it again to 0.58 due to changes in timing and environmental forecasts. The Panel approved U.S. Treaty Indian and All Citizen fisheries directed at Summer-run sockeye. Staff noted that there was no available TAC for Early Summer-run sockeye, however, the Commission Guidance to the Fraser River Panel² allows for a small, but acceptable by-catch.

August 5-August 11: Fraser River flows declined steadily but remained above seasonal averages, while water temperatures increased rapidly to 19.4°C. Marine test fisheries indicated declining abundances of Fraser sockeye, with a 30% diversion rate through Johnstone Strait, while strong migrations were observed past Mission and Hells Gate. Early Summer-run sockeye continued to display a broad, multi-peak marine migration profile, which resulted in the Panel adopting run size increases of 530,000 and then 550,000 fish. The associated marine timing adopted by the Panel was July 16, which was the expected timing used for pre-season planning. The abundance of Summer-run sockeye appeared to be consistent with the pre-season forecast of 1,585,000 fish, although their estimated marine timing was August 5, four days later than expected. Chilko sockeye were the largest component of Summer-run sockeye migrating through marine areas. Assessments indicated that Birkenhead sockeye were returning earlier and stronger than forecast. The Panel adopted an increased run-size estimate of 200,000 Late-run sockeye, but it was too early to update their marine timing or estimate the abundances of component stocks. The Panel adopted a decreased Early Summer pMA of 0.54 and then 0.49. The Panel initially approved U.S. Treaty Indian and All Citizen fishery openings, but due to a lack of available Late-

run TAC they later terminated the Treaty Indian drift gillnet fishery in Areas 4B, 5 and 6C, 18 hours earlier than originally scheduled.

August 12-August 18: Fraser River flow and water temperatures were similar to historic average conditions this week. Marine purse seine test fisheries indicated a continuing decline in the migration of Fraser sockeye. The stock composition of Fraser sockeye migrating through Juan de Fuca Strait was approximately 2% Early Summer, 70% Summer and 28% Late-run sockeye. Estimates of Mission passage were lower than expected, which affected run-size assessments. Late Stuart/Stellako sockeye were tracking the p25 forecast level, while Chilko/Quesnel sockeye were tracking close to the p50 forecast. The Panel approved a decreased Summer-run abundance of 1,300,000 fish with marine timing of August 2. They also adopted an increased Late-run abundance of 250,000 fish (Area 20 timing of August 5), with almost 150,000 fish of the total assigned to the Birkenhead stock. An accounted (i.e., based on catch + Mission passage in a run reconstruction rather than on a run-size model) Early Stuart run size of 185,000 fish (marine timing of July 4) was adopted. The Panel adopted an increased Summer-run pMA from the pre-season forecast of 0.06 to 0.09. There were no further Panel Area fisheries scheduled this week or for the balance of the season.

August 21 (Final in-season Panel meeting): The marine migration of Fraser sockeye continued to decline with most of the migration returning through Johnstone Strait. The Panel adopted an increased Late-run abundance of 260,000 fish with marine timing unchanged at August 5. The Panel agreed to relinquish regulatory control of Panel Areas as follows: Canadian Area 20 on August 26, Canadian Areas 11, 17 and 18 on September 16, Canadian Area 29 on September 30, and U.S. Areas 4B, 5, 6, 6A, 6C, 7 and 7A on September 2.

August 24 (Chair to Chair meeting): The Panel Co-Chairs met by teleconference on August 24 and adopted a decreased Early Summer abundance of 530,000 fish with 50% marine timing of July 15. The final in-season run size and marine timing estimates were: 185,000 Early Stuart sockeye with marine timing of July 4; 530,000 Early Summer-run sockeye with marine timing of July 15; 1,300,000 Summer-run sockeye, with marine timing of August 2; and 260,000 Late-run sockeye with marine timing of August 5, for a total of 2,275,000 Fraser sockeye. Approximately 78% of returning adult Fraser sockeye in 2012 were four-year-old fish, with most of the remainder being 5-year-old fish.

Panel control of the last U.S. Panel Area was relinquished on September 2 by in-season order. The inputs used to calculate the TAC and international shares were frozen on this date (except for post-season updates to any catches including the test fishery catch deduction), according to the revised Annex IV, Chapter 4 of the Pacific Salmon Treaty¹ and the Commission Guidance to the Panel². The achievement of the in-season catch objectives will be assessed by comparison with post-season catch estimates in the Achievement of Objectives section of this report.

A summary of commercial fisheries openings in U.S. Panel Areas is contained in Table 2. There were no commercial openings in Canada.

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 salmon in 2012. Regulatory control of all U.S. Panel Areas was relinquished by the Panel on September 2, by in-season order (Appendix E).

Date	Treaty Indian		All Citizen		
	Areas	Areas	Areas 7 and 7A		
	4B, 5, 6C	6, 7, 7A	Purse Seine	Gillnet	Reefnet
Jul.15-Jul.21					
Jul.22-Jul.28	3				
Jul.29-Aug.4	5	2	1	1	1
Aug.5-Aug.11	6	2	1	1	1
Aug.12-Aug.18					
Total	14	3	2	2	2

IV. MANAGEMENT INFORMATION

To facilitate decision making, the Panel requires information about the abundance, timing, migration route and catch levels of Fraser sockeye salmon by management group. Pre-season, these quantities are provided by DFO in the form of forecasts and 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, hydroacoustic facilities (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. The resulting information is used to apportion the total abundance of sockeye into component stock groups. 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 2012 fishing season.

Area	Location	Gear	Dates	Operated by
Canadian Panel Areas				
20	Juan de Fuca Str.	Gillnet	June 22 - August 14	PSC
20	Juan de Fuca Str.	Purse Seine	July 20 - August 21	PSC
29-14	Fraser R. (Cottonwood)	Gillnet	July 16 - September 14	PSC
29-16	Fraser R. (Whonnock)	Gillnet	June 20 - September 27	PSC
29-16	Fraser R. (Mission)	Hydroacoustic	July 11 - August 26	PSC
	Fraser R. (Hells Gate)	Observer	July 3 - August 31	PSC
Canadian non-Panel Areas				
12	Queen Charlotte Str. (Round Is.)	Gillnet	July 9 - August 15	DFO
12	Johnstone Str. (Naka Cr.)	Gillnet	July 18 - July 31	DFO
12	Johnstone Str. (Blinkhorn)	Purse Seine	July 20 - August 24	DFO
13	Lower Johnstone Str.	Purse Seine	July 20 - August 17	DFO
United States Panel Areas				
5	Juan de Fuca Str.	Gillnet	July 17 - July 23	PSC
7	San Juan Islands	Reefnet	July 16 - August 14	PSC

There were two notable changes in how stocks were grouped, beginning in 2012. The main purpose of the change was to group together stocks that have similar migration times as this has changed since the original stock assignments were made. Raft/North Thompson stocks, with the exception of Upper Barriere (i.e., Fennell), were reassigned from the Early Summer management group into the Summer-run group. Similarly, the Harrison stock was re-assigned from the Late-run group into the Summer-run group. Table 4 shows the sockeye stock resolution that was reported in 2012.

Table 4. Individual stocks included in the Fraser River sockeye stock groups used in 2012. The Raft/North Thompson (formerly in the Early Summer group) and Harrison stocks (formerly in the Late-run group) were re-assigned to the Summer-run group beginning in 2012.

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
Upper Barriere/Taseko	Upper Barriere, 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*
Late	
Birkenhead	Birkenhead, Big Silver, Widgeon*
Late Shuswap/Portage	{ Lower Adams, Portage, Lower Shuswap, Middle Shuswap, Shuswap Lake, late Eagle
Weaver/Cultus	Weaver, Cultus

* Widgeon was included in the Summer-run Harrison group in-season, but with the Late-run Birkenhead group post-season.

Stock assessment activities described above are used 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. Based on the combination of real time observations and forecasts of Fraser River temperature and flow obtained from DFO's Environmental Watch Program, 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 river conditions. These data are compiled and analysed by Staff and the results provided to the Panel. The following sections provide a summary of these results.

A. Abundance

Final in-season estimates of run size adopted by the Panel totalled 2,275,000 Fraser sockeye (Table 1). This small run size constrained fishing opportunities in both countries. The post-season abundance estimate (2,219,000 fish, Tables 7 and 8) based on accounted catches, spawning ground enumerations and preliminary difference between estimates (DBE's) is close to both the median pre-season forecast (2,119,000 fish) and final in-season estimate.

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. The end-of-season estimates of marine migration timing in 2012 were later than expected pre-season for Early Stuart (5 days later), almost as expected for Early Summer (1 day earlier), the same for Summer and earlier than expected for Late-run sockeye (6 days earlier). The migration dates for these groups were earlier than the historical average, except for the Early Stuart group. With the Early

Stuart group being later than expected and Late-run sockeye being earlier than expected, the total Fraser sockeye migration was more compressed than expected pre-season.

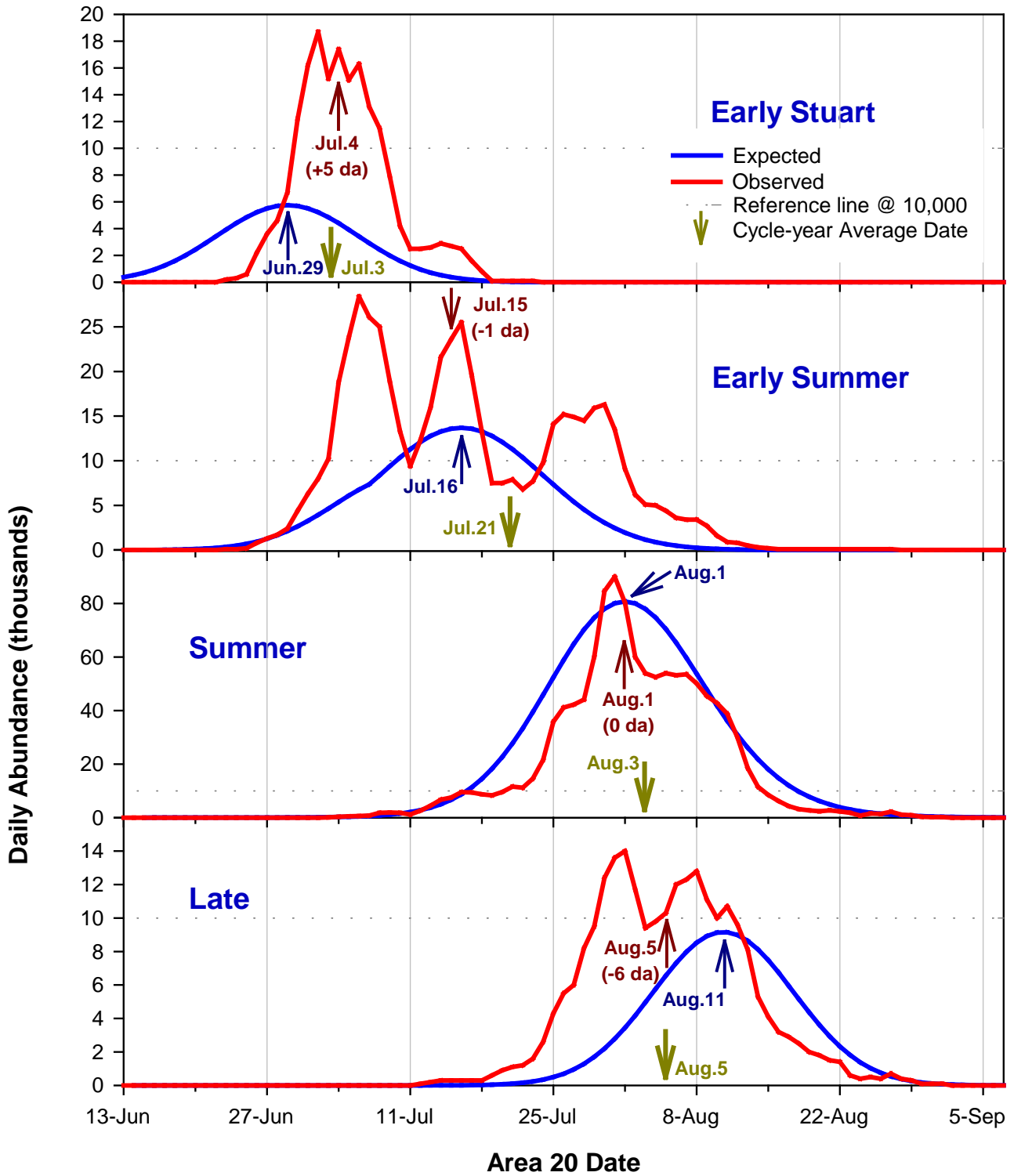


Figure 3. Pre-season projections and post-season reconstructions of daily Fraser River sockeye salmon abundance by management group in 2012 (Area 20 date), including the 50% dates and number of days' difference with pre-season expectations. The cycle-year average dates are also shown.

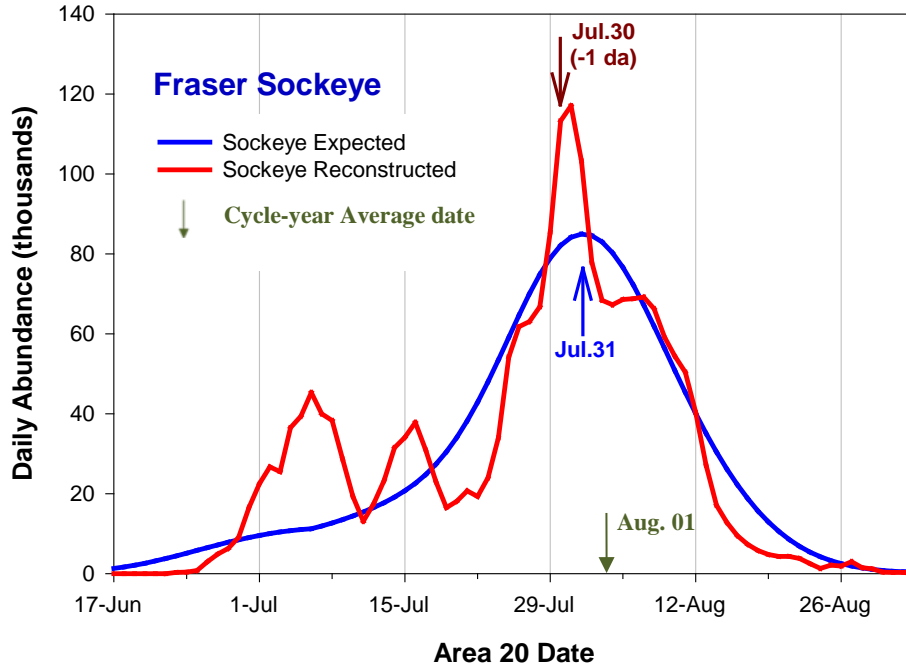


Figure 4. Pre-season projections and post-season reconstructions of daily Fraser River sockeye salmon abundance in 2012 (Area 20 date), including the 50% dates.

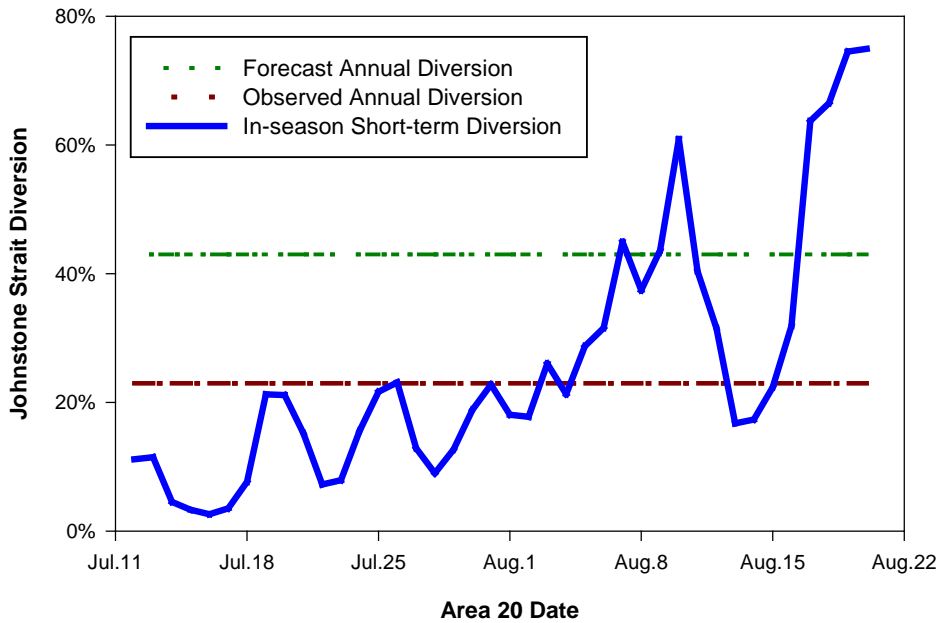


Figure 5. Pre-season forecast of annual Johnstone Strait diversion rate for Fraser sockeye salmon, compared to observed short-term and annual rates.

Diversion rates in 2012 were lower than forecast for Fraser sockeye. The observed annual diversion through Johnstone Strait was 23% of the Fraser sockeye return, compared to the initial forecast of 43% used for pre-season planning (Figure 5). During the in-season period, the relative magnitude of sockeye CPUEs in Juan de Fuca Strait versus Johnstone Strait test fisheries provided an index of short-term diversion rate. The diversion rate was low during most of the migration and increased in the second half of August (Figure 5), when the majority of the Summer-run and Late-run sockeye had already migrated through marine areas.

C. Management Adjustments and DBEs

Management adjustments or MAs are based on statistical models^{7,8,9,10} that consider the historical differences between projections of spawning escapement (i.e., Mission escapement minus catch upstream of Mission) and spawning ground estimates of abundance. For Early Stuart, Early Summer and Summer-run stocks, the models relate historical escapement differences (difference between estimates, or DBEs) to river conditions measured near Hells Gate in the Fraser River. When discharge levels or temperatures are above average, DBEs 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 relate to the date when half the run has migrated past Mission (i.e., 50% date), which captures the negative impact of the early migration behaviour on the migration success of these stocks that has been observed since the mid 1990s.

Pre-season MAs and DBEs are either based on median values from historical datasets for each management group, or are projected from long-range forecasts of river conditions and in-river migration timing. Occasionally, values intermediate to these alternatives may be chosen prior to the season. In-season values are generated using updated migration timing estimates and observed and/or short-range forecasts of river discharge and temperature. In contrast, post-season values are calculated independently of any environmental data as the difference between potential and spawning ground estimates of escapement. Potential spawning escapement (PSE) is defined as Mission passage minus in-river catch that occurs upstream of Mission between the hydroacoustic site and the spawning areas.

Comparisons of %DBE and pMA estimates for the pre-season, in-season and post-season (observed) periods are shown in Table 5. MA values adopted in-season were of a larger magnitude (more negative %DBEs, larger pMAs) than those forecasted pre-season for Early Stuart and Early Summer runs. Post-season observed values were greater than pre-season and in-season predictions for all management groups. A summary of the pre-season and in-season MA models adopted in 2012 are provided in the “Management Adjustment and DBE” section in Appendix F.

Due to cool, rainy spring conditions and above-average winter snowpack, discharge levels in the lower Fraser River remained elevated above the historic average until the end of August when flows dropped to near the historic average (Figure 6). The high discharges lead to failure of temperature monitoring devices at Hope, Stuart, Qualark, Thompson and Shelley on June 21. The spot checks began at Qualark on July 11. Temperatures for June 21 to June 27 were extrapolated using the upward temperature trend observed prior to June 21. Temperatures for June 28 to July 10 were obtained from 10-day forecast data provided by DFO’s Environmental Watch Program. High discharge levels and cooler than normal air temperatures resulted in below average water

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 : vii + 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.

temperatures through mid-July followed by near average temperatures until early August. Water temperatures subsequently increased to reach one standard deviation above average (Figure 6). Discharge levels at Hope that exceeded $8,000 \text{ m}^3\text{s}^{-1}$ have been associated with migration delays and elevated levels of en route mortality for Early Stuart sockeye. In 2012, discharge levels exceeded this threshold for more than half of a 31-day period centered on the 50% Hells Gate date for Early Stuart.

Table 5. Pre-season, in-season and post-season estimates of DBEs (differences between estimates) and pMAs (proportional management adjustments) related to Fraser sockeye management. Pre-season predictions are based on long-range forecasts of migration timing and of 31-day mean Fraser River temperature and discharge. In-season estimates reflect the final values adopted by the Panel for in-season management. The models that generate DBE and pMA values for the Panel in-season use in-season forecasts of migration timing and 19-day mean river conditions as predictor variables. 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		Summer		Late	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Pre-season prediction	-66%	1.95	-24%	0.32	-6%	0.06	-49%	0.97
In-season prediction	-76%	3.19	-33%	0.49	-8%	0.09	-49%	0.97
Observed	-85%	5.71	-39%	0.64	-22%	0.28	-71%	2.42

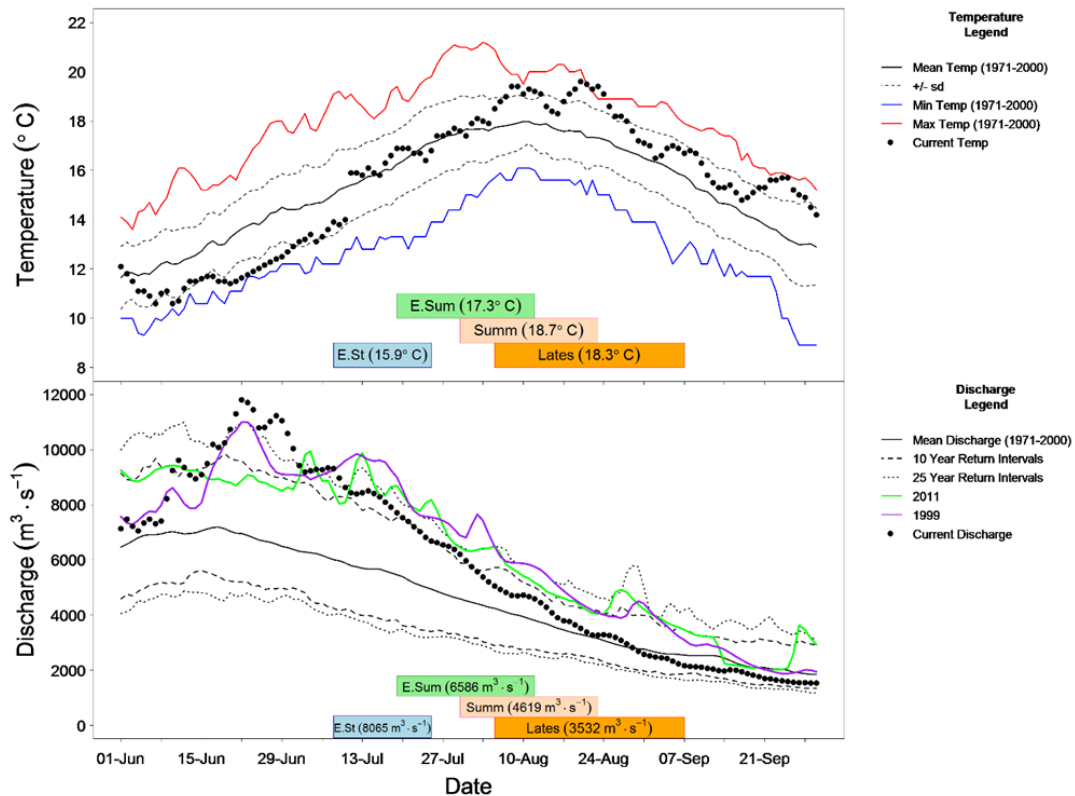


Figure 6. Fraser River temperature and discharge measured near Hope in 2012 (Current Temperature and Discharge). Also shown are the mean temperature and discharge during the central 90% of the migration of each Fraser sockeye management group (including Pitt).

D. Mission Escapement

Estimates of Mission passage totalled 1,902,000 sockeye, including 183,000 Early Stuart, 497,000 Early Summer, 1,101,000 Summer and 221,000 Late-run sockeye (Table 6). Details of the Mission hydroacoustic program in 2012 are contained in Appendix F.

Table 6. Fraser River sockeye salmon passage at Mission in 2012.

Management Group Stock Group	Mission Passage	
	fish	%
Early Stuart	182,500	10%
Early Summer	497,400	26%
Chilliwack	207,100	11%
Early Miscellaneous	148,600	8%
Seymour/Scotch	17,300	1%
Upper Barriere/Taseko	15,900	1%
Pitt*	108,500	6%
Summer	1,000,900	53%
Raft/N.Thompson	68,300	4%
Chilko	397,000	21%
Quesnel	15,000	1%
Late Stuart/Stellako	375,800	20%
Harrison	144,800	8%
Late	221,200	12%
Birkenhead	134,100	7%
Late Shuswap/Portage	3,800	0%
Weaver/Cultus	83,300	4%
Total Sockeye	1,902,000	100%

* Pitt does not escape past Mission

V. RUN SIZE, CATCH AND ESCAPEMENT

Table 7 provides an overview of run size by management group for Fraser sockeye salmon. Included are estimates of catches, spawning escapements and Difference Between Estimates (DBE's)¹¹. Table 8 provides similar information, but with more detail on individual sockeye stock groups. Figure 7 shows total sockeye abundance by year, while Figure 8 shows catch, escapement and exploitation rate by year for a historical perspective. Details of commercial catch distributions by area and gear in the U.S. are provided in Table 9. Table G1 in Appendix G shows catch by user group, spawning escapement, DBE and total abundance over the last four cycle years. Sockeye salmon escapements since 1938 are summarized for total Fraser sockeye and by management group in Figure 10, and by stock for the last four cycle years in Table G2.

¹¹ Difference Between Estimates (DBE's) will eventually be replaced by Run-size Adjustments (RSAs) which are revisions to the total run size in cases when there is evidence that more fish returned than were accounted for in catch and escapement, e.g., evidence of en route mortality, evidence of biased or incomplete estimates of catch, Mission escapement or spawning escapement. The focus of RSAs is on providing the best assessments of total returns, i.e., recruitment. Models that relate recruitment and spawning stock are used to develop both pre-season abundance forecasts and escapement policy. Staff work with the Fraser Technical Committee to provide recommendations to the Fraser Panel about how RSAs are assigned and corresponding best estimates of total return. PSC staff, Technical Committee members and DFO staff collaborate in a formal process for determining RSAs.

A. Sockeye Salmon

The total abundance of sockeye salmon in 2012 was 2,219,000 fish (Tables 7 and 8), which is only slightly (5%) higher than the median forecast of 2,119,000 fish and about 22% larger than the brood year abundance of 1,741,000 fish in 2008. With the exception of the poor 2008 returns, the return in 2012 was the smallest on the 2012 cycle since 1964 (Figure 7).

Table 7. Catch, escapement, difference between estimates and run size for Fraser River sockeye salmon by management group in 2012.

	Fraser Sockeye				Total	% of Run
	Early Stuart	Early Summer	Summer	Late		
CANADIAN CATCH	7,300	64,700	405,900	32,400	510,300	23%
Commercial Catch	0	0	0	0	0	0%
Panel Area	0	0	0	0	0	0%
Non-Panel Areas	0	0	0	0	0	0%
First Nations Catch	7,200	64,400	404,200	32,300	508,100	23%
Marine FSC	0	3,000	41,900	8,200	53,200	2%
Fraser River FSC	7,200	61,400	362,300	24,000	454,900	20%
Economic Opportunity	0	0	0	0	0	0%
Non-commercial Catch	60	300	1,700	200	2,200	0%
Marine Recreational	0	0	0	0	0	0%
Fraser Recreational	0	0	0	0	0	0%
Charter (Albion + Qualark)	60	300	1,700	200	2,200	0%
ESSR	0	0	0	0	0	0%
UNITED STATES CATCH	0	8,500	96,300	13,400	118,100	5%
Washington Total	0	8,300	90,500	12,500	111,300	5%
Commercial catch	0	7,800	85,600	11,800	105,200	5%
Treaty Indian	0	5,300	60,100	7,400	72,800	3%
All Citizen	0	2,500	25,500	4,300	32,300	1%
Non-commercial Catch	0	500	4,900	700	6,100	0%
Ceremonial	0	500	4,900	700	6,100	0%
Recreational	0	0	0	0	0	0%
Alaska	0	200	5,700	900	6,800	0%
TEST FISHING CATCH	1,800	8,300	20,000	3,700	33,900	2%
PSC (Panel Areas)	1,800	7,100	14,600	2,700	26,200	1%
Canada	1,700	4,700	9,000	1,600	17,000	1%
United States	100	2,400	5,600	1,000	9,200	0%
Canada (non-Panel Areas)	0	1,200	5,400	1,100	7,700	0%
TOTAL RUN	184,900	532,900	1,239,800	261,500	2,219,200	100%
Total Catch in All Fisheries	9,100	81,500	522,200	49,500	662,300	30%
Adult Spawning Escapement *	26,200	273,300	559,300	61,500	920,400	41%
Jack Spawning Escapement *	0	2,700	1,200	400	4,300	0%
Difference Between Estimates **	149,600	175,400	157,000	150,100	632,100	28%
Percentage of Total Run	100%	100%	100%	100%	100%	
Total Catch in All Fisheries	5%	15%	42%	19%	30%	
Spawning Escapement	14%	52%	45%	24%	42%	
Difference Between Estimates	81%	33%	13%	57%	28%	

* Spawning escapement estimate for Cultus sockeye includes 247 adults and 16 jacks captured as brood stock.

** Difference Between Estimates as at the time of the final spawning ground estimates.

The return of Summer-run sockeye was less than the median forecast, however, all other management groups returned at higher abundances than their median pre-season forecasts. The total return of Early Stuart sockeye was 185,000 adults (Tables 7 and 8), which was 87% larger than the median forecast, and the largest on the 2012 cycle since 2000. Early Summer returns totalled 533,000 adult sockeye, 91% larger than the median forecast. The largest Early Summer stock components were the Chilliwack (214,000 adults), Early Miscellaneous (165,000 adults) and Pitt stock groups (113,000 adults). The abundance of Summer-run sockeye was 1,239,000 adults, 22% smaller than the median forecast. Most Summer-run fish were from the Chilko and Late Stuart/Stellako groups. As noted earlier, the Summer-run management group in 2012 included two new stock groups - Raft/North Thompson which was reassigned from the Early Summer group, and Harrison which was reassigned from the Late-run group. The abundance of Late-run sockeye was 261,000 adults, 65% more than its median forecast. Birkenhead and Weaver/Cultus were the main components in the Late-run management group.

Table 8. Catch, escapement, difference between estimates, run size and exploitation rate for Fraser River sockeye salmon by stock group in 2012.

Management Group Stock Group	Catch	Adult Spawning	Difference	Abundance			Portion of Run	Adult Exploitation Rate
		Escapement	Between Estimates	Adult	Jack ¹	Total		
Early Stuart	9,100	26,200	149,600	184,900	0	184,900	8%	5%
Early Summer-run	81,500	273,300	175,400	530,200	2,700	532,900	24%	15%
Chilliwack	8,500	126,200	78,900	213,600	0	213,600	10%	4%
Early Miscellaneous	54,900	63,600	47,000	165,400	2,700	168,100	8%	33%
Seymour/Scotch	6,000	3,500	10,100	19,600	0	19,600	1%	31%
Upper Barriere/Taseko	5,900	2,100	10,500	18,400	0	18,400	1%	32%
Pitt	6,200	78,000	29,000	113,200	0	113,200	5%	5%
Summer-run	522,200	559,300	157,000	1,238,500	1,200	1,239,800	56%	42%
Raft/N.Thompson	30,700	11,100	41,400	83,200	10	83,200	4%	37%
Chilko	253,900	245,500	13,900	513,400	1,100	514,400	23%	49%
Quesnel	6,700	700	10,400	17,800	20	17,800	1%	38%
Late Stuart/Stellako	204,800	231,100	23,200	459,100	40	459,200	21%	45%
Harrison	26,100	70,900	68,000	165,000	100	165,100	7%	16%
Late-run	49,500	61,500	150,100	261,100	400	261,500	12%	19%
Birkenhead/Widgeon	31,200	59,500	68,500	159,300	300	159,600	7%	20%
Late Shuswap/Portage	2,200	40	3,000	5,200	0	5,200	0%	42%
Weaver/Cultus ²	16,100	2,000	78,600	96,700	60	96,800	4%	17%
Total	662,300	920,400	632,100	2,214,800	4,300	2,219,200	100%	30%
Portion of Total Run	30%	41%	28%	100%	0%	100%		

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

² Spawning escapement estimate for Cultus sockeye includes 247 adults and 16 jacks captured as brood stock.

The total catch of 662,000 fish was about 30% of the run (Tables 7 and 8). This exploitation rate is much less than the long term average, but within the range observed since the mid 1990s (Figure 8). Of the total catch, 510,000 fish were caught in Canada, 111,000 in Washington state, 6,800 in Alaska, and 34,000 fish in test fisheries. Almost all of the Canadian catch was taken in First Nations fisheries, with a small remainder (2,200) caught in the Albion and Qualark test fisheries. In Washington State roughly two thirds of the commercial catch (Table 9) was taken in Treaty Indian fisheries and the remainder in All Citizen fisheries. The Alaska catch of Fraser sockeye accounted for less than 1% of the Fraser River return.

DFO annually assesses the spawning ground abundance of sockeye populations in the Fraser watershed (Figure 9). In 2012, the near-final estimate of adult spawners (primarily age 4 and age 5

fish) totalled 920,000 fish, or 41% of the total run. This escapement was 13% larger than the brood year (2008) escapement of 815,000 adults.

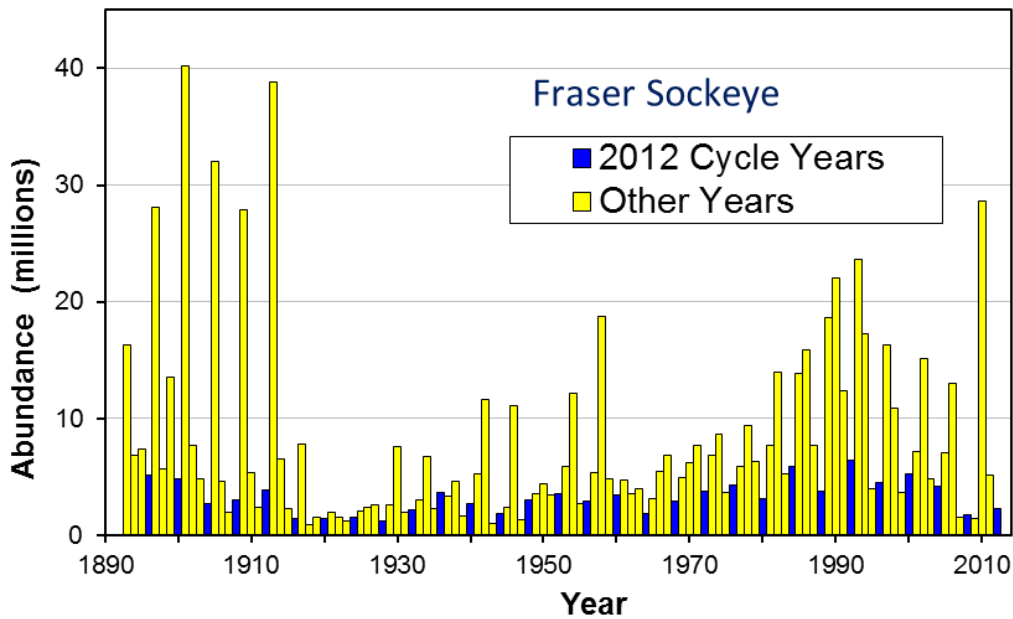


Figure 7. Total run size of Fraser River sockeye salmon in 1893-2012. Returns on the 2012 cycle are emphasized.

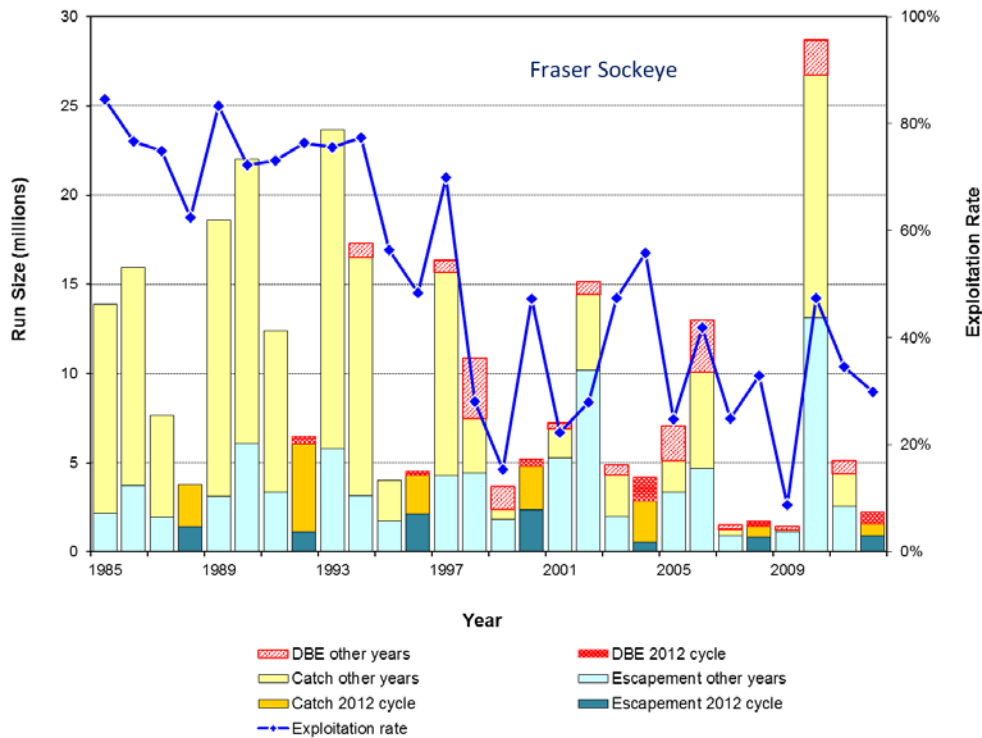


Figure 8. Total catch, escapement, difference between estimates (DBE), run size and exploitation rate for Fraser River sockeye salmon in 1985-2012, with returns on the 2012 cycle emphasized.

Spawner abundances for Early Summer (57% higher) and Late runs (139% higher) exceeded those observed in the brood year (2008, Figure 10), while the Early Stuart escapement was 12% lower and the Summer-run escapement about the same (4% lower). In a historical cycle-line context, spawning escapements in 2012 represent the: (1) continuation of low escapements to the Early Stuart system observed for the last three cycles; (2) similar Early Summer-run escapement as other recent cycle years; (3) continuation of low Summer-run escapements observed for the last three cycles; (4) continuation of low Late-run escapements observed for the last four cycles (Figure 10).

Table 9. U.S. commercial catches of Fraser River sockeye salmon by user group, gear type and statistical area in 2012.

Areas	Purse				Total
	Troll	Seine	Gillnet	Reefnet	
Panel Area (Washington)	0	48,200	55,500	1,500	105,200
Treaty Indian *	0	28,100	44,800	0	72,800
4B, 5 and 6C	0	0	13,700	0	13,700
6 and 7	0	26,700	15,000	0	41,700
7A	0	1,400	16,000	0	17,400
All Citizen **	0	20,100	10,800	1,500	32,300
7	0	14,700	6,000	1,500	22,100
7A	0	5,400	4,800	0	10,200
Alaska (District 104) Catch					6,800
United States Total					111,900

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

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

The overall spawning success of adult female sockeye in the Fraser watershed was 71%, based on assessments of 515,000 female spawners and 365,000 effective female spawners (Table 10). This effective female spawning population was 33% higher than in 2008. In a historical cycle-line context, the number of effective female spawners in 2012 was: (1) Early Stuart (6,800 fish, 76% spawning success) - 47% of the brood year abundance and lowest since 1976; (2) Early Summer (146,000 fish, 89% spawning success) – almost four times larger than the brood year and within the range of recent cycle years; (3) Summer (208,000 fish, 66% spawning success) – similar to the brood year but much less than 1996 and 2000; and (4) Late (4,500 fish, 17% spawning success) - 53% of the brood year abundance and the lowest on record on any cycle. The spawning success of Summer-run and Late-run groups was the third lowest and lowest on record respectively, in the 60 year record.

Table 10. Adult female spawning success by management group.

	Fraser Sockeye				Total
	Early Stuart	Early Summer	Summer	Late	
Run Size	26,200	273,300	559,300	61,300	920,100
Female Spawners to Grounds	9,000	164,300	315,700	26,200	515,200
Effective Females	6,800	145,900	208,100	4,500	365,300
Spawning Success	76%	89%	66%	17%	71%

The preliminary DBE was 632,000 fish, or 28% of the total return. As a percentage of run size for each management group, Early Stuart had the largest DBE (81%) and the Summer group the lowest (13%), with the remaining groups in the 33-57% range (Tables 7 and 8).

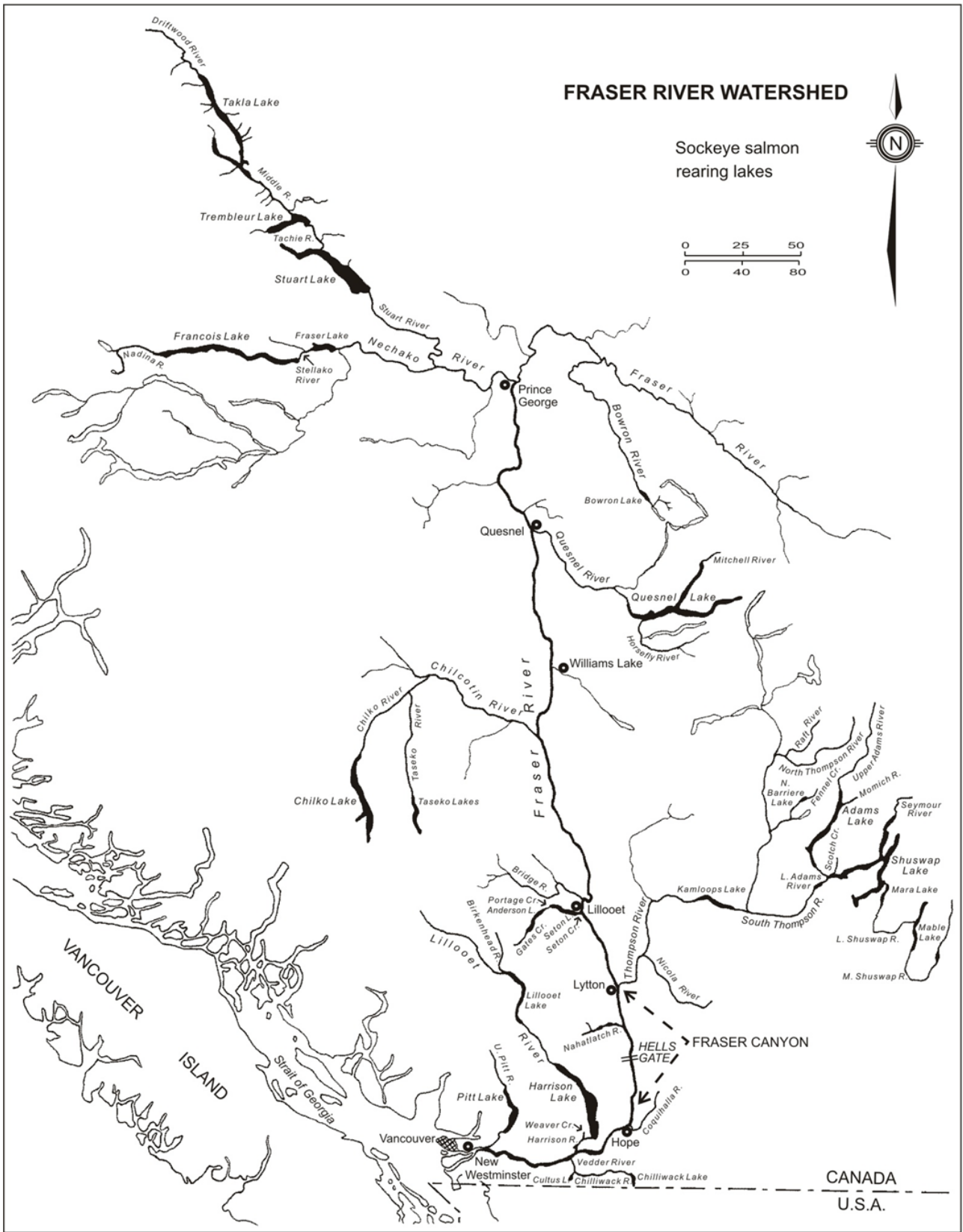


Figure 9. Sockeye salmon spawning areas in the Fraser River watershed.

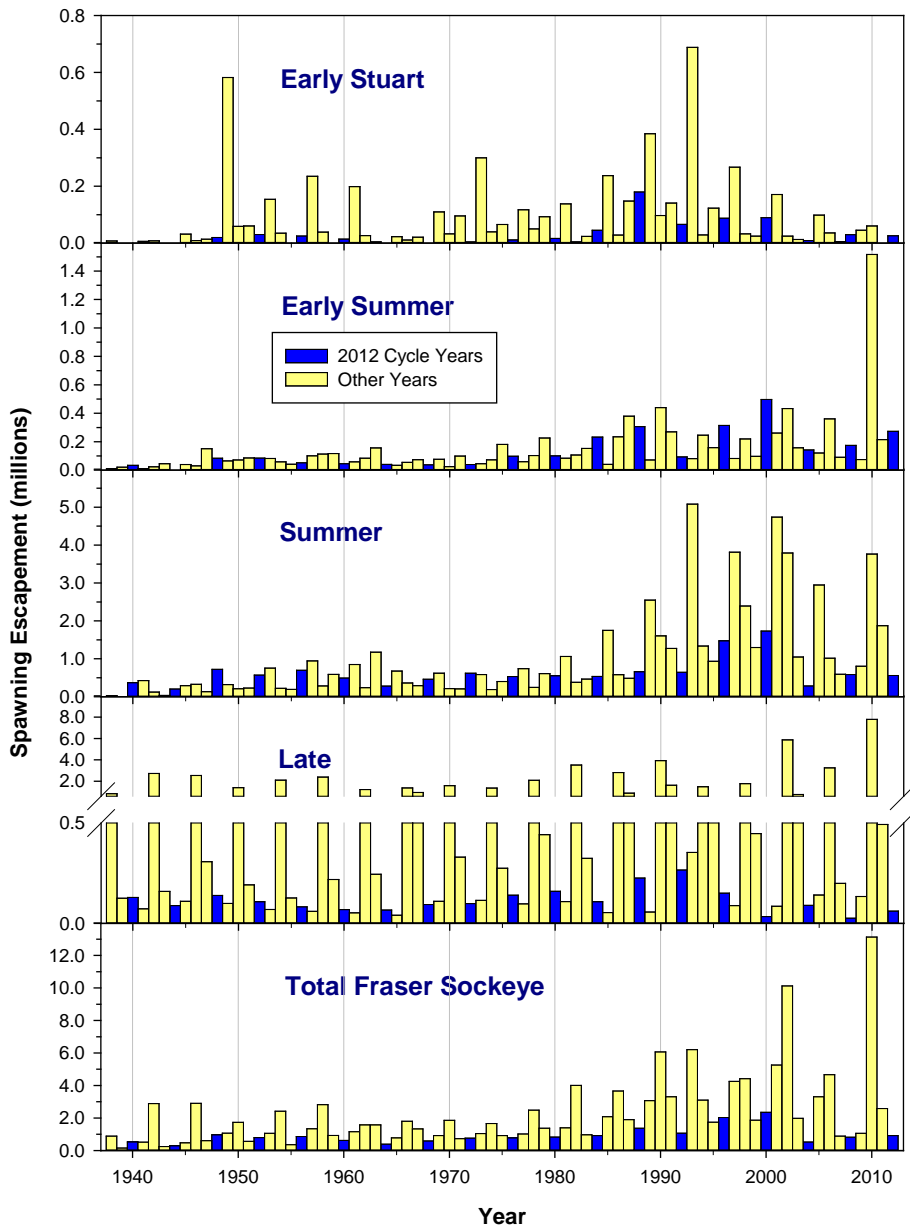


Figure 10. Annual adult spawning escapement of Fraser River sockeye salmon for each management group and for total sockeye in 1938-2012, with escapements on the 2012 cycle emphasized.

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 catch allocation goals within each country. In addition, the Panel must consider conservation concerns for other stocks and species of salmon when planning and conducting fisheries. 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 to First Nations FSC (Food, Social and Ceremonial) harvest within Canada’s allocation policy.

A. Escapement

The Panel’s first task is to achieve spawning escapement targets as specified by Canada. Spawning escapement targets were determined by applying the TAM rules (total allowable mortality) from Canada’s spawning escapement plan. TAM rules are abundance-based and specify escapement targets as a percentage of the total return for each of the four management groups.

In-season monitoring of the progress toward spawning escapement targets is not directly measurable because in most cases spawner abundance cannot be assessed on the spawning grounds until well after the fishing season has ended. In-season management is therefore based on targets for potential spawning escapement (i.e., PSE target = in-season spawning escapement target + MA). In circumstances where an Exploitation rate floor is in effect (See Appendices A, B) for any management group the potential spawning escapement target is re-defined as the total return for that group. This redefinition acknowledges that the PSE target cannot exceed the total return. Progress towards these targets is monitored by comparison with in-season PSE estimates (i.e., Mission passage to date - catch above Mission).

Based on final in-season PSE estimates, in-season PSE targets were nearly achieved for Early Stuart (5% under) and Summer-run (4% over) groups, exceeded for the Early Summer group (43% over) and less than the target (18% under) for the Late run (Table 11). The Late-run target was not achieved because the spawning escapement target and management adjustment exceeded the run size, so even in the absence of any fishing the in-season target could not be achieved. The overall in-season target for Fraser sockeye (1,471,000 fish) was exceeded by 7%, mainly due to the restrained fisheries that operated in 2012. Figure 11 shows the available harvest and catch-to-date of total Fraser sockeye through the fishing season.

Table 11. Comparison of in-season spawning escapement targets and in-season estimates of potential spawning escapement (PSE) for adult Fraser River sockeye salmon in 2012.

Management Group	Final	Potential Spawning Escapement (PSE)					
	In-season	Spawning		In-season		In-season	
	Abundance Estimate	Escapement Target	Management Adjustment *	PSE ** Target	PSE *** Estimate	Difference Fish	%
Adult sockeye	2,275,000	1,197,000	650,800	1,470,500	1,576,000	105,500	7%
Early Stuart	185,000	74,000	236,100	185,000	176,000	-9,000	-5%
Early Summer	530,000	212,000	103,900	315,900	452,000	136,100	43%
Summer	1,300,000	651,000	58,600	709,600	736,000	26,400	4%
Late	260,000	260,000	252,200	260,000	212,000	-48,000	-18%

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

** If the spawning escapement target + MA exceeds the total abundance, then the target equals the total abundance. Spawning escapement target + MA or total abundance if ER floor is in effect (see Appendix A).

*** Mission passage minus all catch above Mission.

To assess the achievement of post-season objectives, post-season spawning escapement targets were determined by applying Canada’s spawning escapement plan to post-season run-size estimates, and these were compared to observed abundances on the spawning grounds. The total spawning escapement of Fraser sockeye was 23% less than the post-season target (Table 12). Spawning escapements of Early Stuart (65% below) and Late-run (76% below) sockeye were severely below the targets, while the Early Summer-run escapement exceeded the target by 29% and the Summer-run escapement was 14% less than the target. For Early Stuart and Late runs, the shortfalls are mainly due to the large DBEs for these groups (Table 5, -85% and 71%, respectively). Thus, for both the Early Stuart and Late run groups, an exploitation rate (ER) floor was in effect. For the Early Stuart and Late-run groups, the spawning targets were equal to the

total returns, thus any negative DBEs would cause the spawning escapement estimates to be less than the targets.

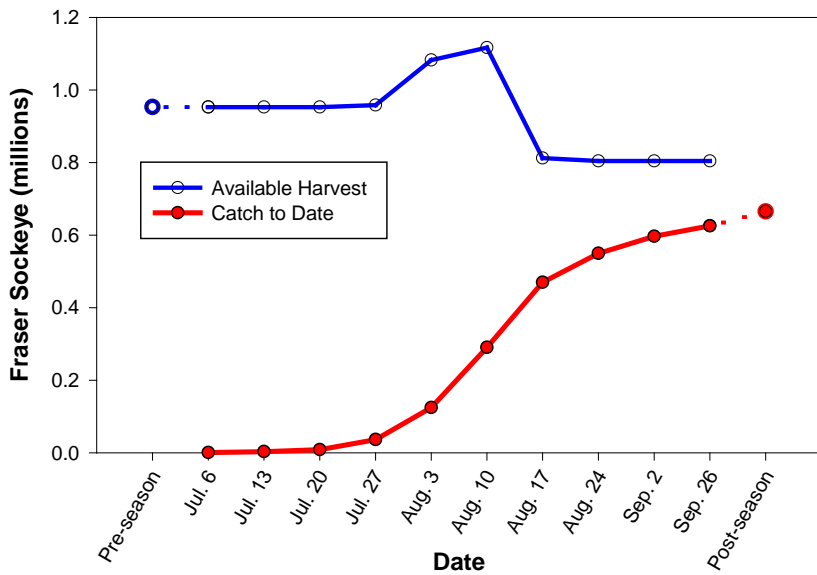


Figure 11. Available harvest of Fraser sockeye compared to catch to date in all fisheries in 2012. The available harvest is calculated as run size minus spawning escapement target and management adjustment, and represents fish that are available for catch in all commercial, recreational, First Nations and test fisheries.

Table 12. Comparison of post-season spawning escapement targets and escapement estimates for adult Fraser River sockeye salmon in 2012. Post-season estimates of sockeye escapement are from spawning ground enumeration programs (DFO).

Management Group	Post-season Adult Abundance Estimate	Spawning Escapement			
		Post-season Target	Adult Estimate	Difference	
				Fish	%
Sockeye salmon	2,214,800	1,198,200	920,400	-277,900	-23%
Early Stuart	184,900	74,000	26,200	-47,800	-65%
Early Summer	530,200	212,100	273,300	61,200	29%
Summer	1,238,500	651,000	559,300	-91,700	-14%
Late	261,100	261,100	61,500 *	-199,600	-76%

* Late-run escapement estimate include 247 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 salmon. In accordance with Annex IV, Chapter 4 of the Pacific Salmon Treaty¹ and the February 17, 2011 Commission Guidance², 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 (September 2). All catches, including the test fishing catch deduction are post-season estimates, however.

With the total in-season abundance estimate of 2,275,000 Fraser sockeye, minus deductions for spawning escapement, MA, test fishing catch and AFE, the TAC in 2012 was 410,000 sockeye (Table 13). The Washington share of the TAC (16.5%) was 67,600 fish and their catch was 111,300 fish, resulting in a catch overage of 43,700 Fraser sockeye. Canada's catch of 510,000 Fraser sockeye was 232,000 fish less than the total of their share of the TAC plus the AFE. A detailed version of the TAC calculations by management group is presented in Table G3 in Appendix G.

Table 13. Total allowable catch (TAC) and achievement of international catch shares for Fraser River sockeye salmon in 2012. 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 (September 2), in accordance with Annex IV of the Treaty and the February 17, 2011 Commission Guidance.

	Sockeye	
TOTAL ALLOWABLE CATCH		
In-season Total Run Size		2,275,000
Deductions		2,281,600
In-season Spawning Escapement Target		1,197,000
In-season Management Adjustment		650,700
Aboriginal Fishery Exemption (AFE)	▼	400,000
Post-season Test Fishing Catch		33,900
Total Allowable Catch	1, 2	409,800
UNITED STATES		
Washington Share		67,600
Washington Share of TAC	1, 3	67,600 16.5%
Payback	▼	0
Washington Catch		111,300
Deviation		-43,700
 In-season Alaska Catch Estimate		 0
CANADA		
Canadian Share of TAC + U.S. Payback + AFE		742,200
Canadian Catch excluding ESSR Catch		510,300
Deviation		231,800

- 1 TAC and Washington sockeye share according to Annex IV of the Pacific Salmon Treaty and Feb. 17, 2011, Commission Guidance.
- 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 G3 in Appendix G.
- 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).

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 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. Thus, achievement of Canadian domestic allocation goals requires coordination between Panel and non-Panel regulatory actions.

With respect to domestic allocations of Fraser sockeye salmon, Treaty Indian fishers in the U.S. caught 33,100 fish more than their share of the TAC and All Citizen fishers caught 10,500 fish more than their share (Table 14). There is no domestic allocation to report for Canadian commercial fisheries since there was no commercial TAC share identified at these run sizes and as such no commercial openings in 2012.

Table 14. Achievement of domestic catch goals in Washington for Fraser River sockeye salmon in 2012.

User Category	Actual Catch		Share of TAC		Deviation
	Fish	%	Fish	%	
Washington Total	111,200	100.0%	67,600	100.0%	43,600
Treaty Indian *	78,900	71.0%	45,800	67.7%	33,100
All Citizen **	32,300	29.0%	21,800	32.3%	10,500

* Treaty Indian catch includes commercial and ceremonial catches.

** All Citizen catch includes commercial and recreational catches.

D. Conservation of Other Stocks and Species

Non-target stocks and species are caught in Panel Area fisheries directed at Fraser River sockeye salmon. By-catches of non-Fraser sockeye and pink salmon in commercial net fisheries regulated by the Fraser River Panel totalled 80 sockeye and zero pink salmon in 2012 (Table 15). Catches of other Fraser and non-Fraser salmon species included 1,660 Chinook, 2,820 coho, 120 chum and 10 steelhead.

Table 15. Catches of non-Fraser sockeye and pink salmon and catches of other salmon species in commercial fisheries regulated by the Fraser River Panel in 2012.

Area and Gear	Non-Fraser		Fraser and Non-Fraser			
	Sockeye	Pink	Chinook	Coho	Chum	Steelhead
United States *	80	0	1,660	2,820	120	10
Areas 4B, 5 and 6C Net	70	0	1,230	2,740	110	10
Areas 6, 7 and 7A Net	10	0	430	70	10	0
Canada **	0	0	0	0	0	0
Area 20 Net	0	0	0	0	0	0
Area 29 Net	0	0	0	0	0	0
Total	80	0	1,660	2,820	120	10

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

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

VII. ALLOCATION STATUS

In accordance with the Treaty and the February 17, 2011 Commission Guidance², to determine whether U.S. paybacks are owed in future years, the first step is to determine whether the U.S. catch exceeded their allocation on the day that the TAC was established (i.e., when Panel control of the last U.S. fishery was relinquished). If the U.S. exceeded its share on this "TAC day", then the Panel considers the TAC in effect on the day of the last decision about U.S.

fisheries. If the TAC decreased after the last fishery decision, then the TAC on this decision day is used. Otherwise, the TAC on the “TAC day” is used for calculations of allocation status.

In 2012, the U.S. exceeded its share according to calculations on the “TAC day” (September 2, Tables 1 and 13), but the TAC decreased after the last decision about U.S. fisheries (August 10, Appendix E). Thus, the TAC calculation in effect on August 10 was used to determine allocation status. Using this method, the U.S. caught less than their share and so there was no payback of Fraser sockeye salmon to carry forward to the 2013 fishing season (Table 16).

Table 16. Allocation status for Fraser River sockeye salmon in 2008-2012. After 2012, no paybacks were due for Fraser sockeye salmon.

	Fraser Sockeye				
	2008	2009	2010	2011	2012
TOTAL ALLOWABLE CATCH					
Total Run Size	1,715,000	1,370,000	34,546,000	5,077,000	2,515,000
Escapement and other deductions	1,369,700	1,370,000	18,769,100	2,999,200	1,796,000
Total Allowable Catch:	345,300	0	15,776,900	2,077,800	719,000
UNITED STATES					
Washington Catch	49,400	4,300	1,959,600	278,800	111,300
Washington Share (exclds payback) *	57,000	0	2,603,200	342,800	118,600
Deviation:	-7,600	4,300	-643,600	-64,000	-7,300
Cumulative Allocation Status:	0 **	4,300	0 **	0 **	0 **
CANADA					
Catch	481,100	73,800	11,558,700	1,405,200	510,400
Allowable Catch + Aboriginal Exemption	688,300	146,800	13,573,700	2,135,000	1,000,400
Deviation:	-207,200	-73,000	-2,015,000	-729,800	-490,000

* Washington share of the TAC according to Annex IV of the Pacific Salmon Treaty:
 2008: Shall not exceed 16.5% for Fraser sockeye. By Panel agreement (Sep. 25, 2008), no paybacks resulted from the 2008 season.
 2009: Shall not exceed 16.5% for Fraser sockeye and 25.7% for Fraser pinks.
 2010: Shall not exceed 16.5% for Fraser sockeye and 25.7% for Fraser pinks.
 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 was based on the TAC in effect when the Panel made it's last decision about U.S. fisheries in 2012 (Aug. 10), because the TAC decreased between the date of the last U.S. fishery decision (Aug. 10) and when Panel control of the last U.S. fishery area was relinquished (Sep. 2).

** By Panel agreement, no paybacks are to be carried forward.

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.

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.

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., 2004, 2008, 2012).

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

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.

Exploitation rate (ER) floor

The purpose of managing a sockeye management group in an exploitation rate (ER) floor 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 an ER floor for a management group has the effect of limiting the exploitation rate of that group to a small amount (e.g. 10% or 20% of a run timing group). The need to implement an ER floor 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 available ER is less than the ER floor.

ESSR: Terminal harvest of Weaver Creek sockeye that are "Excess Salmon to Spawning Requirements".

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 Simulation 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 Fraser River First Nations fishery.

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, Summer 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, it is the date when 50% of a stock or management group (for the Early Summer run this would include Pitt) is estimated to have passed the Mission hydroacoustic site.

Reconstructed Mission date: An index of in-river migration timing based on the reconstructed run to Mission (Mission escapements plus catches seaward of Mission, which include Pitt). 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 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 supplemented by expanded CPUE estimates derived 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 2011 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 passage estimate minus in-river catch upstream of Mission. If there were no en route mortalities or estimation errors in Mission passage, 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, spawning grounds that did not have enumeration programs.

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 enumeration programs conducted on the spawning grounds, or projected from other data when such programs are not conducted in all areas (e.g., Quesnel spawners 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 escapement target. The number of fish remaining after escapement has been subtracted from the total run size is the total allowable mortality from all sources, including fishery removals (catch) and en route mortality (represented by the Management Adjustment). Pre-spawn mortality is not incorporated into this concept.

List of abbreviations

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

APPENDIX B: 2012 PRE-SEASON FORECASTS AND SPAWNING ESCAPEMENT TARGETS FOR FRASER RIVER SOCKEYE SALMON

Table B1. Pre-season forecasts for Fraser River sockeye salmon in 2012, provided to the Panel by Fisheries and Oceans Canada. The Panel subsequently revised the management groups by re-assigning Raft/North Thompson stocks from the Early Summer to the Summer-run group, and the Harrison stock (excluding Widgeon) from the Late to the Summer-run group. Following the re-assignment of these stocks to different management groups, the resulting total abundance estimates for Early Summer-run excluding Raft/North Thompson, Summer-run including Raft/North Thompson and Harrison and Late-run excluding Harrison are marked in blue within the table.

Run timing group Stocks	Forecast Model ^b	BY (08) (EFS)	BY (07) (EFS)	Prod. (-8yr)	Prod. (-4yr)	Ret 2012	Mean Run Size		Probability that Return will be at/or Below Specified Run Size ^a				
							all cycles ^c	2012 cycle ^d	10%	25%	50%	75%	90%
Early Stuart	Ricker (E)	14,400	2,400	2.5	2.1		311,000	120,000	39,000	61,000	99,000	161,000	270,000
Early Summer excluding Raft/North Thompson							502,000	423,000	78,000	145,000	277,000	522,000	967,000
Early Summer (total excluding miscellaneous)							510,000	517,000	109,000	195,000	359,000	665,000	1,214,000
Bowron	KF	300	1,100	2.8	2.3		39,000	27,000	1,000	1,000	2,000	4,000	6,000
Fennell	Power	200	6,800	4.0	3.2		25,000	34,000	5,000	7,000	12,000	20,000	32,000
Gates	KF	1,800	1,100	4.5	3.1		53,000	135,000	4,000	6,000	12,000	21,000	36,000
Nadina	MRJ	10,200	1,000	3.0	3.5		80,000	137,000	17,000	33,000	70,000	147,000	289,000
Pitt	KF	5,400	19,900	0.3	0.1		72,000	81,000	11,000	18,000	35,000	65,000	110,000
Raft	Ricker (PDO)	3,600	8,100	2.7	2.0		32,000	57,000	22,000	34,000	55,000	88,000	135,000
Scotch	Larkin	100	4,800	6.7	3.5		78,000	12,000	100	200	300	700	1,400
Seymour	Ricker-cyc	300	5,900	5.4	3.6		131,000	34,000	2,000	4,000	8,000	16,000	29,000
Misc ^e	RS (Sc/Se)	500	3,800				NA	NA	1,000	3,000	6,000	10,000	17,000
Misc ^f	RS (Ra/Fe)	200	1,000				NA	NA	1,000	2,000	3,000	6,000	13,000
Misc ^g	RS (Ra/Fe)	1,000	9,900				NA	NA	8,000	14,000	24,000	49,000	99,000
Misc ^h	RS (Esum)	19,700	1,100				NA	NA	36,000	70,000	127,000	230,000	431,000
Misc ⁱ	RS (Esum)	150	2,000				NA	NA	1,000	3,000	5,000	8,000	16,000
Summer including Raft/North Thompson + Harrison							3,866,000	2,620,000	580,000	917,000	1,585,000	2,776,000	4,808,000
Summer							3,730,000	2,501,000	529,000	828,000	1,420,000	2,449,000	4,160,000
Chilko ^j	KF (juv)	11.8 M	25.2 M	0.02	0.02		1,350,000	1,790,000	229,000	342,000	562,000	868,000	1,274,000
Late Stuart	Power	57,900	4,100	2.6	2.1		560,000	187,000	92,000	166,000	338,000	730,000	1,550,000
Quesnel	R1C	2,500	33,800	1.0	1.0		1,358,000	57,000	17,000	33,000	67,000	137,000	261,000
Stellako	R2C	73,800	19,600	1.5	0.7		462,000	467,000	191,000	287,000	453,000	714,000	1,075,000
Late excluding Harrison							3,169,000	689,000	46,000	80,000	158,000	304,000	589,000
Late (total excluding miscellaneous)							3,020,000	711,000	66,000	119,000	241,000	488,000	990,000
Cultus ^k	KF (juv)	145,300	341,000	0.02	0.02		39,000	21,000	1,000	1,000	3,000	7,000	15,000
Harrison ^l	KF	4,400	100,600	6.3	3.4		60,000	19,000	20,000	39,000	83,000	184,000	401,000
Late Shuswap	Ricker-cyc	80	32,300	2.4	0.7		2,152,000	29,000	1,000	3,000	8,000	19,000	46,000
Portage	Larkin	60	800	3.5	2.2		40,000	16,000	500	1,000	2,000	4,000	9,000
Weaver	RS4yr	600	15,800	8.8	3.9		363,000	345,000	12,000	23,000	47,000	96,000	181,000
Birkenhead	KF	6,800	54,300	1.6	0.9		366,000	281,000	27,000	45,000	85,000	155,000	298,000
Misc. non-Shuswap ^l	RS (Birkenhead)	900	2,600				NA	NA	4,000	7,000	13,000	23,000	40,000
TOTAL SOCKEYE SALMON							-	-	743,000	1,203,000	2,119,000	3,763,000	6,634,000
(TOTAL excluding miscellaneous)							(7,571,000)	(3,849,000)	(692,000)	(1,104,000)	(1,941,000)	(3,437,000)	(6,018,000)

- a. Probability that return will be at, or below, specified projection.
- c. Sockeye: 1953-2009 (depending on start of time series)
- d. Sockeye: 1956-2008 (depending on start of time series)
- e. Unforecasted miscellaneous Early Summer stocks (Early Shuswap stocks: S.Thompson; used Scotch/Seymour R/EFS)
- f. Unforecasted miscellaneous Early Summer stocks (N. Thomson tributaries; used Raft/Fennell R/EFS).
- g. North Thompson River (used Raft/Fennell R/EFS)
- h. Chilliwack Lake and Dolly Varden Creek (used Early Summer R/EFS)
- i. Nahatlach River & Lake (used Early Summer R/EFS)
- j. Brood year smolts in columns C & D (not effective females)
- k. Harrison are age-4 (column C) and age-3 (column D).
- l. Unforecasted miscellaneous Late Run stocks (Harrison Lake down stream migrants including Big Silver, Cogburn, etc.; used Birkenhead R/EFS)

Definitions: BY: Brood year; BY08: brood year 2008; BY07: brood year 2007; EFS: effective female spawners; Prod. (8yr), Prod. (4yr): Productivity in age-4 recruits-per-effective female spawners in the last 8 yrs (1998-2005) or last 4 yrs (2001-2005); E

Table B2. Spawning escapement plan for Fraser River sockeye salmon in 2012, provided to the Panel by Fisheries and Oceans Canada.

Scenario 6: Raft North Thompson & Harrison in Summer Run. Adjusted Early Stuart TAM & variable Late Run ER floor.

Harvest Rule Parameters						
Management Unit	ER Floor	TAM Cap	Lower Fishery Reference Point	Upper Fishery Reference Point	Pre-season pMA	
Early Stuart	10%	60%	52,000	130,000	0.64	
Early Summer (w/o misc)	10%	60%	100,000	250,000	0.38	
Summer (w/o misc)	10%	60%	640,000	1,600,000	0.10	
Late (w/o misc)	20-30%	60%	300,000	750,000	1.27	

Management Unit	Pre-season Forecast Return				
	p10	p25	p50	p75	p90
Early Stuart forecast	39,000	61,000	99,000	161,000	270,000
TAM Rule (%)	0%	15%	47%	60%	60%
Escapement Target	39,000	52,000	52,000	64,400	108,000
MA	25,000	33,300	33,300	41,200	69,100
Esc. Target + MA	64,000	85,300	85,300	105,600	177,100
ER floor	10%	10%	10%	10%	10%
ER at Return	0%	0%	14%	34%	34%
Allowable ER	10%	10%	14%	34%	34%
TAC	3,900	6,100	13,700	55,400	92,900

2012 Performance

Projected S (after MA)	21,000	33,000	52,000	64,000	108,000
BY Spawners	30,000	30,000	30,000	30,000	30,000
Proj. S as % BY S	70%	110%	173%	213%	360%
cycle avg S	41,000	41,000	41,000	41,000	41,000
Proj. S as % cycle S	51%	80%	127%	156%	263%

Management Unit	Pre-season Forecast Return				
	p10	p25	p50	p75	p90
Early Summer (w/o RNT) lower ref. pt. (w misc)	147,000	167,000	166,000	170,000	184,000
upper ref. pt. (w misc)	368,000	417,000	415,000	425,000	460,000
forecast (incl. misc)	78,000	145,000	277,000	522,000	967,000
TAM Rule (%)	0%	0%	40%	60%	60%
Escapement Target	78,000	145,000	166,000	208,800	386,800
MA	29,600	55,100	63,100	79,300	147,000
Esc. Target + MA	107,600	200,100	229,100	288,100	533,800
ER floor	10%	10%	10%	10%	10%
ER at Return	0%	0%	17%	45%	45%
Allowable ER	10%	10%	17%	45%	45%
TAC	7,800	14,500	47,900	233,900	433,200

2012 Performance

Projected S (after MA)	51,000	95,000	166,000	209,000	387,000
BY Spawners	174,000	174,000	174,000	174,000	174,000
Proj. S as % BY S	29%	55%	95%	120%	222%
cycle avg S	132,000	132,000	132,000	132,000	132,000
Proj. S as % cycle S	39%	72%	126%	158%	293%

Table B2, continued on next page

Table B2, continued.

Management		Pre-season Forecast Return				
Unit		p10	p25	p50	p75	p90
Summer	<i>lower ref. pt. (w misc)</i>	651,000	651,000	651,000	651,000	651,000
(w. RNT & Har)	<i>upper ref. pt. (w misc)</i>	1,628,000	1,628,000	1,628,000	1,628,000	1,628,000
	forecast	580,000	917,000	1,585,000	2,776,000	4,808,000
	TAM Rule (%)	0%	29%	59%	60%	60%
	Escapement Target	580,000	651,000	651,000	1,110,400	1,923,200
	MA	55,200	62,000	62,000	105,700	183,100
	Esc. Target + MA	635,200	713,000	713,000	1,216,100	2,106,300
	ER floor	10%	10%	10%	10%	10%
	ER at Return	0%	22%	55%	56%	56%
	Allowable ER	10%	22%	55%	56%	56%
	TAC	58,000	204,000	872,000	1,559,900	2,701,700
<u>2012 Performance</u>						
	Projected S (after MA)	477,000	651,000	651,000	1,110,000	1,923,000
	BY Spawners	586,000	586,000	586,000	586,000	586,000
	Proj. S as % BY S	81%	111%	111%	189%	328%
	cycle avg S	694,000	694,000	694,000	694,000	694,000
	Proj. S as % cycle S	69%	94%	94%	160%	277%
Management		Pre-season Forecast Return				
Unit		p10	p25	p50	p75	p90
Late	<i>lower ref. pt. (w misc)</i>	327,000	327,000	327,000	327,000	327,000
(w/o Har)	<i>upper ref. pt. (w misc)</i>	817,000	817,000	817,000	817,000	817,000
	forecast	46,000	80,000	158,000	304,000	589,000
	TAM Rule (%)	0%	0%	0%	0%	44%
	Escapement Target	46,000	80,000	158,000	304,000	327,000
	MA	58,400	101,600	200,700	386,100	415,300
	Esc. Target + MA	104,400	181,600	358,700	690,100	742,300
	ER floor	20%	20%	20%	30%	30%
	ER at Return	0%	0%	0%	0%	0%
	Allowable ER	20%	20%	20%	30%	30%
	TAC	9,200	16,000	31,600	91,200	176,700
<u>2012 Performance</u>						
	Projected S (after MA)	16,000	28,000	56,000	94,000	182,000
	BY Spawners	26,000	26,000	26,000	26,000	26,000
	Proj. S as % BY S	62%	108%	215%	362%	700%
	cycle avg S	114,000	114,000	114,000	114,000	114,000
	Proj. S as % cycle S	14%	25%	49%	82%	160%
	Available Harvest (TF, US, CDN)	78,900	240,600	965,200	1,940,400	3,404,500
	Total projected spawners	565,000	807,000	925,000	1,477,000	2,600,000

APPENDIX C: 2012 FRASER RIVER PANEL MANAGEMENT PLAN PRINCIPLES AND CONSTRAINTS (agreed July 30, 2012)

1. Fisheries and Oceans Canada (DFO) has provided the Panel with run-size forecasts for Fraser River sockeye salmon. DFO stated that the Fraser River sockeye run-size forecasts remain highly uncertain due to variability in annual survival rates and uncertainty about changes in their productivity. For pre-season planning purposes, the Panel used the 50% probability levels of abundance for the forecasted sockeye stocks (2,119,000 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 1,203,000 fish and there is a three in four chance that the actual number of returning sockeye will be at or below 3,763,000 fish. By stock grouping, the 50% probability forecasts are 99,000 Early Stuart, 277,000 Early Summer-run, 1,585,000 Summer-run, and 158,000 Late-run sockeye¹². When sufficient information is available in-season, the Panel will update run size estimates of Fraser River sockeye salmon, as appropriate.
2. The Panel's first priority in 2012 is to achieve conservation objectives for all stocks. A coordinated approach to management has been developed that reflects both Parties sharing the burden of conservation.
3. 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. Given the low anticipated return of Late-run sockeye in 2012, it is unlikely that PSC staff will be able to provide the Panel with predictions of Late-run upstream timing and mortality during the in-season management period.
4. TAC and international shares will be calculated according to the February 17, 2011 Commission Guidance to the Fraser River Panel and the 2005 revised Annex IV, Chapter 4, of the Pacific Salmon Treaty, which limits the United States harvest (in Washington State) to 16.5% of the total allowable catch (TAC) of Fraser River sockeye salmon. Based upon the 50% probability levels of abundance, for the purposes of computing TAC by stock management grouping in 2012, the Panel agreed to pre-season Fraser River Aboriginal Exemptions as follows: Early Stuart sockeye, 7,400 fish, Early Summer-run sockeye, 50,300 fish; Summer-run sockeye, 314,900 fish; and Late-run sockeye, 27,400 fish. There is no TAC for international sharing for Early Stuart, Early Summer-run, and Late-run sockeye at the 50% probability level of abundance. In situations where the abundance of a management group is not sufficient to allow for directed harvest according to Total Allowable Mortality rules, the Panel will implement exploitation rate (ER) floors in order to allow access to available TAC in other management groups. The ER floors, set at 10% for Early Stuart, Early Summer and Summer-run sockeye, and at 20% for Late run sockeye, are not intended to create directed harvest opportunities in mixed stock areas.
5. Given pre-season assumptions about marine timing and recent delay behavior, the median upstream migration date for Late-run sockeye in 2012 is expected to occur on August 22. Given this timing and the expected difference between estimates, no directed harvest of Late-run sockeye is planned. However, some limited by-catch of Late-run sockeye may occur in fisheries directed at other Fraser sockeye management groups with harvestable surpluses. If the return of Late-run sockeye is less than the 75% probability level forecast (304,000 fish) the by-catch of Late-run sockeye will be limited to a maximum exploitation rate of 20% and if their return is equal or greater than the 75% probability level forecast, the maximum exploitation rate is 30%.

Regulations

- i) If the abundance of Early Summer-run sockeye salmon is tracking at approximately the 50% probability level (277,000 fish) and the abundance of Summer-run sockeye salmon is tracking at approximately the 50% probability level (1,585,000 fish) and the runs arrive at or near expected dates, low impact fisheries would be expected to commence during the third week of July in Panel Waters. The actual start dates and duration of fisheries will depend on in-season estimates of timing and abundance.
- ii) The Parties' conservation concerns for other species and stocks will be taken into account throughout the 2012 management season.

¹² For the 2012 management season, Raft, North Thompson, and Harrison sockeye will be managed as part of the Summer-run group.

APPENDIX D: 2012 REGULATIONS

The Fraser River Panel approved regulations for the management of the Fraser River sockeye salmon fishery in Panel Area waters and submitted these to the Pacific Salmon Commission. The Commission approved the Fishery Regime and Regulations and submitted these to the respective national governments for approval on June 21, 2012.

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 1st day of July, 2012, to the 8th day of September, 2012, 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 1st day of July, 2012, to the 8th day of September, 2012, 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 1st day of July, 2012 to the 29th day of September, 2012, 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 1st day of July, 2012, to the 29th day of September, 2012, 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 1st day of July, 2012, to the 13th day of October, 2012, both dates inclusive.
- b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 29 from the 1st day of July, 2012, to the 13th day of October, 2012, 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 2012 season, the Fraser River Panel will adopt Orders establishing open fishing periods based on a 2012 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 1st day of July, 2012 to the 8th day of September, 2012, 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 1st day of July, 2012, to the 15th day of September, 2012, 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 16th day of September, 2012, to the 6th day of October, 2012, 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 1st day of July, 2012, to the 8th day of September, 2012, 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 1st day of July, 2012, to the 15th day of September, 2012, 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 16th day of September, 2012, to the 6th day of October, 2012, 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 2012 season, the Fraser River Panel will adopt Orders establishing open fishing periods based on a 2012 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: 2012 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, 2012

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Open to drift gillnets 12:00 p.m. (noon), Wednesday, July 25, 2012, to 12:00 p.m. (noon) Saturday, July 28, 2012.

July 30, 2012

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Open to drift gillnets 3:00 p.m., Monday, July 30, 2012, to 12:00 p.m. (noon) Wednesday, August 1, 2012.

July 31, 2012

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon) Wednesday, August 1, 2012 through 12:00 p.m. (noon) Saturday, August 4, 2012.

Areas 6,7 and 7A

Open to net fishing from 5:00 a.m. Thursday, August 2, 2012 through 9:00 a.m. Friday, August 3, 2012.

All Citizen Fishery

Areas 7 and 7A

Open to purse seines from 5:00 a.m. to 9:00 p.m., Wednesday, August 1, 2012.

Areas 7 and 7A

Open to reef nets from 5:00 a.m. to 9:00 p.m., Wednesday, August 1, 2012.

Areas 7 and 7A

Open to gillnets from 8:00 a.m. to 11:59 p.m. (midnight), Wednesday, August 1, 2012.

August 3, 2012

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon) Saturday, August 4, 2012, through 12:00 p.m. (noon) Tuesday, August 7, 2012.

Areas 6,7 and 7A

Open to net fishing from 5:00 a.m. Saturday, August 4, 2012 through 9:00 a.m. Sunday, August 5, 2012.

August 6, 2012

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon) Tuesday, August 7, 2012, through 12:00 p.m. (noon) Wednesday, August 8, 2012.

August 7, 2012

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

Extended for drift gillnets from 12:00 p.m. (noon) Wednesday, August 8, 2012 through 12:00 p.m. (noon) Saturday, August 11, 2012.

Areas 6,7 and 7A

Open to net fishing from 5:00 a.m. Wednesday, August 8, 2012 through 9:00 a.m. Thursday, August 9, 2012.

All Citizen Fishery

Areas 7 and 7A

Open to gillnets from 1:00 p.m. to 11:00 p.m., Thursday, August 9, 2012.

Areas 7 and 7A

Open to purse seines from 8:00 a.m. to 2:00 p.m., Friday, August 10, 2012.

Areas 7 and 7A

Open to reef nets from 5:00 a.m. to 9:00 p.m., Saturday, August 11, 2012.

August 10, 2012

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C

The previously announced fishery to extend drift gillnets from 12:00 p.m. (noon) Wednesday, August 8, 2012 through 12:00 p.m. (noon) Saturday, August 11, 2012 has been modified. This fishery will now close at 6:00 p.m., Friday, August 10, 2012.

August 21, 2012

Canada

Area 20

Relinquish regulatory control effective 12:01 a.m., Sunday, August 26, 2012.

Areas 11, 17, 18

Relinquish regulatory control effective 12:01 a.m., Sunday, September 16, 2012.

Area 29

Relinquish regulatory control effective 12:01 a.m., Sunday, September 30, 2012.

United States

Areas 4B, 5, 6C

Relinquish regulatory control effective 12:01 a.m., Sunday, September 2, 2012.

Areas 6, 6A, 7, 7A

Relinquish regulatory control effective 12:01 a.m., Sunday, September 2, 2012.

Fraser River Panel control of Canadian Panel Areas was relinquished in accordance with the pre-season regulations (Appendix D) as follows: Area 20 on August 26 by in-season order; Areas 17 and 18 on September 16 by in-season order; and Area 29 on September 30. Panel control of United States Panel Areas were relinquished as follows: Areas 4B, 5, 6C on September 2 by in-season order; Areas 6, 7 and portions of 7A on September 2 by in-season order; and the remaining portions of Area 7A on October 6 in accordance with the pre-season Regulations.

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

Stock Monitoring

Stock monitoring programs assess the abundance and migration timing of Fraser River sockeye and pink salmon at different points along their migration route. In conjunction with stock composition information from the Stock Identification Group, 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. 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. Test fishing programs in Canada were conducted in a manner similar to 2007- 2011 (following the 2006 Larocque Court decision) in that the PSC retained only those sockeye required for management purposes. 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 2012.

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 ³	1	30
29-16	Fraser R. (Whonnock)	Gillnet	1	319	Variable		Variable ³	2	20
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	Johnstone Str. (Round I.)	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.

³ Cottonwood mesh sizes (in): 4 1/4, 4 3/4, 5 1/4, 5 3/4 ; Whonnock mesh sizes (in): 4, 4 5/8, 5 1/4, 6, 6 3/4, 7 3/4, 8 1/2

Information used to assess the migration of Fraser River sockeye and pink salmon through marine areas is provided primarily by the marine 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 marine test fisheries in U.S. Areas 4B and 5 (Juan de Fuca Strait) and Area 7 (San Juan Islands).

In 2012, to reduce test fishing catch impacts on Early Stuart sockeye, only one Area 20 gillnet test fishing vessel began operating on June 22, 2012. A second Area 20 gillnet vessel began test fishing on July 8 and both gillnet vessels operated nightly for the duration of the test fishery as scheduled. Daily sockeye catches in the Area 20 gillnet test fishery were highly variable

throughout the season with peak daily catches and CPUE occurring on June 27, July 8 and August 1. With the exception of the late June time period, Area 20 gillnet sockeye catches were less than those of the brood year and cycle year average. In contrast, sockeye catches in the Area 20 purse seine test fishery were often larger than those of the brood year and similar to the cycle year average. The different abundance estimates derived from the gillnet (night) versus the purse seine (day) test fisheries highlight the assessment impacts of both inter-annual variability in catchability and/or diurnal patterns in migration abundance. Sockeye catches in the Area 12 (Round Island) gillnet and Area 12 Blinkhorn purse seine test fisheries were similar to the brood year, but less than the cycle year average. Peak sockeye catches in the Area 12 purse seine test fishery occurred on July 26 and August 6 and 7. Corresponding peak sockeye catches were observed in the Area 20 purse seine test fishery on July 28 and 29 and between August 2 and 7.

High Fraser River discharge and water levels negatively impacted the Whonnock and Cottonwood gillnet test fisheries from late June to early July. The high water levels were a factor that contributed to the very poor daily sockeye catches observed at Whonnock (<2 sockeye per day), which therefore provided only weak signals about sockeye migration and species composition. The high water levels also caused the start date for the Cottonwood test fishery to be delayed until July 16, five days later than scheduled. As in recent years, seal predation on sockeye caught in the nets at both test fishing sites were a source of concern. The number of seals observed per day, however, was substantially less than the maximum number observed in 2007.

The timing and abundance of sockeye salmon migrations, as indicated by daily visual counts at Hells Gate, were confirmed by hydroacoustic observations at DFO's Qualark site (located below Hells Gate near Hope). Sockeye salmon observed at Hells Gate were in good condition.

B. Mission Hydroacoustics

PSC Staff have operated a hydroacoustic facility on the Fraser River near the Mission Bridge since 1977, for the purpose of providing timely in-season estimates of sockeye and pink salmon passage through the lower river. This program has benefited from improved technologies and research in recent years^{13, 14}. In 2012, daily abundance at Mission was estimated using a split-beam hydroacoustic system on the left (south) bank of the Fraser River, a split-beam system mounted on a vessel that ran back and forth across the river, and a Long Range Dual frequency IDentification SONar system (LR DIDSON) on the right (north) bank. The 3 sonar systems operated 24 hours a day and provided information about fish targets, such as their density, behaviour, speed and direction of travel as well as size distributions. Due to high water at the beginning of the season a split-beam system could not be deployed on the left-bank. Instead, a scanning DIDSON mounted on a tripod was used to collect data on fish passage in the left bank area in early July. Additional work focused on gathering independent fish behaviour information using a vessel-based standard DIDSON unit to verify assumptions used in the estimation of offshore fish flux (i.e., abundance) by the vessel. Daily estimates of fish abundance past Mission are produced by combining estimates from shore-based and vessel-based sonar systems.

The left-bank DIDSON, which was mounted on a tripod with a rotator, was operated in substitution of the left-bank split-beam system from July 11 - 25 during the period of high water. From July 11 - 15 it operated with four aims and from July 16 - 25 it operated with 8 aims, allowing sampling of the water column in both the inshore and offshore areas of the left bank. During this period the DIDSON was combined with the vessel based sonar to produce the estimate. The left-bank shore-based split-beam system, which operated from July 26 - August 26, consists of two side-looking split-beam elliptical transducers ($2^{\circ} \times 10^{\circ}$ and $4^{\circ} \times 10^{\circ}$) mounted on a

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.

rotator to control pan and tilt of the transducer units, thereby allowing sampling of the water column by the narrow vertical sonar beams at multiple aiming angles. The aim and orientation of the transducers were monitored and verified with an attitude sensor. An extendable fish-deflection weir prevented fish from swimming in acoustic blind zones (behind or too close to the transducers), and also increased the duration for which they were insonified (i.e., detectable in the sonar beam). This ensured adequate numbers of echoes for tracking individual fish. Transducer aims were optimized to reduce unsampled areas where migratory abundance must be estimated by extrapolation.

The vessel-based system consisted of a circular downward-looking split-beam transducer (6°) that transected the river every five minutes to obtain target density information. A standard DIDSON unit was also deployed 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 from these 2 stationary locations were used to estimate fish behaviour factors in the calculation of offshore fish flux. The right-bank shore-based LR DIDSON system has a 30° horizontal beam width which consists of 48 fan-shaped composite beams and a 14° vertical beam, thereby allowing sampling of nearly the entire water column. Data can be collected at different frequencies (high or low) and different ranges (0-80 m). Both high frequency and low frequency files with range windows from 1 to 11 m and 11 to 21 m were used for the in-season daily estimate, respectively. The aim and orientation of the DIDSON was monitored and verified with an orientation sensor. Similar to the left-bank, a telescopic fish deflection weir prevented fish from swimming in acoustic blind zones (behind or too close to the DIDSON), and also increased the duration for which they were insonified. The right-bank LR DIDSON system started operation on August 6, and was used in the daily estimate after this date.

Acoustic targets detected by the split-beam systems were tracked using an alpha-beta tracker^{15, 16}. The resulting tracks were classified as fish or noise (e.g., debris, air bubbles) using statistical methods¹⁷ (i.e., DFA or “discriminant function analysis”). The integrity of statistically identified fish tracks was further verified by trained staff, and unusual or atypical targets were removed using graphical user interface (GUI) software. This data processing procedure was performed each day for all the data collected from both the left-bank split-beam and vessel-based systems. The finalized fish track data were imported to a fish-flux estimation software program. Daily fish passages in the sampling areas by the left-bank and mobile split-beam systems were then estimated from the software which also projected fish flux through the unsampled areas. Daily high and low frequency DIDSON files for upstream fish were counted using a hand tally counter. These counts were expanded in time to estimate daily fish passage near the right-bank area. Daily total salmon passage was estimated by merging daily flux estimates produced by the 3 sonar systems. Total salmon estimates were further apportioned by species and sockeye stock based on species composition and stock identification information obtained from the test fisheries.

The 4 DIDSON systems (left-bank, right-bank, right-bank offshore and vessel-based units) deployed in 2012 collected fish flux and behaviour information for a 2-year project funded by the Southern Boundary Restoration and Enhancement Fund (SEF) to improve the accuracy and precision of Mission estimates^{18,19}. Also included in the 2012 program were data exchange and estimate comparisons between Mission and DFO’s Qualark hydroacoustic site.

¹⁵ Blackman, S. S. and R. Popoli. Design and Analysis of Modern Tracking Systems. Artech House, Boston, 1999.

¹⁶ 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.

¹⁷ 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.

¹⁸ 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.

¹⁹ 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.

2012 was the fifth consecutive season that DFO operated an in-season hydroacoustic monitoring site using DIDSON systems at Qualark Creek (95 km upstream of Mission). PSC and DFO staff at the Mission and Qualark sites exchanged daily salmon estimates beginning in mid July. By the end of the season, regular information exchanges occurred 2-3 times each week. Estimates of daily salmon passage at the PSC Mission site were higher than at the DFO Qualark site. For the sockeye time period (July 11-August 26), Qualark estimated a total of 1.3 million salmon while Mission estimated a total of 1.8 million.

Stock Identification

PSC staff conduct programs designed to identify 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 escapement past Mission into discrete stock groups. Stock identification methods for sockeye salmon in 2012 used DNA and scale pattern analyses from fish caught in marine and in-river fisheries. No stock composition estimates were produced for pink salmon in 2012 because the Fraser River pink salmon run is virtually non-existent in even numbered years.

A. Sockeye Salmon

Stock identification methods for sockeye salmon relied on DNA²⁰ (using the program CBAYES2²¹) and scale pattern analyses²². Both techniques involve comparing the attributes of individuals in mixture samples (e.g., from mixed-stock fisheries) to the attributes of pure samples obtained from the spawning grounds of each of the named stocks (i.e., “standards” or “baselines”). The DNA baseline in 2012 was altered compared to recent years due to the reclassification of some North Thompson basin spawners as Summer-run sockeye. Sockeye from the Upper Barriere River, an earlier-timed population within the North Thompson drainage, retained membership within the Early Summer-run management group. Similarly, Harrison River sockeye estimates were transferred from the Late-run to the Summer-run group. Widgeon Slough sockeye, which in past years was associated with Harrison sockeye, was included with Harrison in the in-season period but in the post-season period it was considered a member of the Late-run group where it was associated with the Birkenhead stock group. In addition, a new population was added to the sockeye baseline – Taseko Lake sockeye are part of the Early Summer management group. Prior to its inclusion in the baseline in 2012, fish from this population were likely misidentified by DNA as being Summer-run sockeye. Consistent with the expected performance of the baseline, DNA analyses detected nearly a dozen Taseko sockeye in 2012.

Samples from test fishery catches were analyzed daily, beginning in late June and continuing past mid September. PSC staff sampled sockeye from most test fishery catches and commercial fishery landings. Sampling locations included Port Renfrew and Greater Vancouver in British Columbia, and Bellingham and Neah Bay in Washington. DFO provided samples from test fisheries in Johnstone Strait and from in-river test fisheries at Albion and Qualark. Alaska’s Department of Fish and Game collected samples for the PSC from District 104 purse seine landings in Ketchikan and Petersburg, and Langara Fishing Adventures provided samples from recreational catches near Haida Gwaii. DFO coordinated delivery of samples collected by FSC

²⁰ 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.

²¹ 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).

²² Gable, J. and S. Cox-Rogers. Stock identification of Fraser River sockeye salmon: methodology and management application. PSC Tech. Rep. No. 5, October, 1993.

purse seine skippers operating in Areas 18 and 29. DFO and First Nations personnel obtained samples from Fraser River First Nations catches.

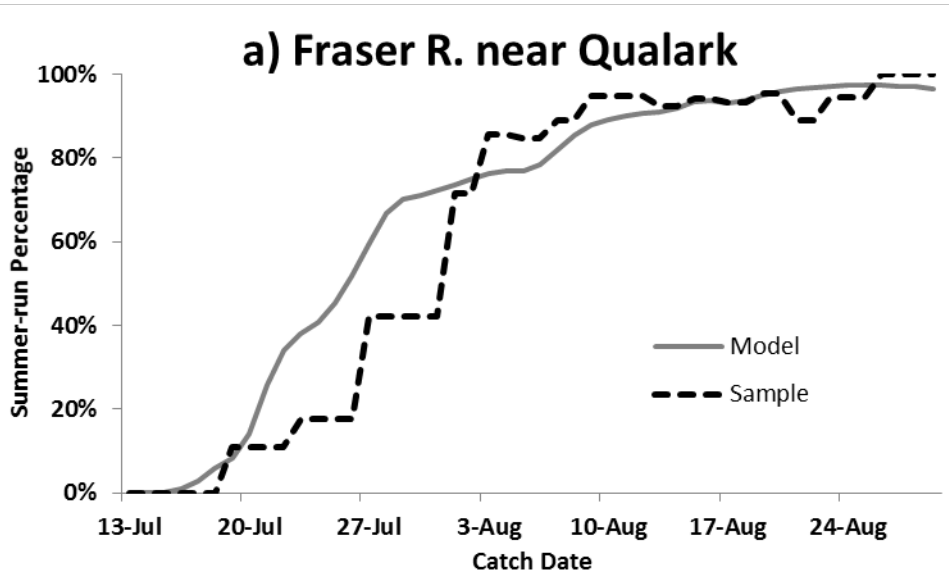
Of particular interest in 2012 due to the change in management groups for Raft/North Thompson and Harrison stock groups, these samples, combined with reconstructed abundances, were used to estimate median run timings in marine areas. The Early Summer, Summer, and Late run management groups had post-season estimates of Area 20 timings of July 15, August 1, and August 5, respectively. The Raft/North Thompson and Harrison stock groups had Area 20 timings of August 3 and July 31, respectively, which supports their membership within the Summer-run management group. Median dates at Mission for Early Summer, Summer, and Late run sockeye were estimated to be July 21, August 7, and August 10, respectively. The median date estimate at Mission for Raft/North Thompson was August 9, indicating again that these stocks are better matched to the Summer-run rather than the Early Summer-run management group. The median Mission date for Harrison sockeye was August 6 in 2012, which is more similar to Summer-run timing than to the timing of Late-run sockeye.

In years with limited commercial fishing in marine areas, timings of management groups at up-river locations become relatively more important for catch accounting by stock. Increased efforts were made to assess stock compositions at upstream locations in 2012. Samples from the Qualark test fishery (95 km upstream of Mission) and from Xwisten and Xaxli'p FSC fisheries (near the Bridge River rapids, approximately 250 km upstream of Mission) comprised considerable proportions of Early Stuart and Early Summer-run populations later in the season than predicted using a migration model based upon estimated Mission escapement-by-stock profiles. Reciprocally, increases in Summer-run proportions at these locations was delayed relative to predictions (Figure F1). There are several possible explanations, but this difference is consistent with the possibility that the high river flows observed in 2012 slowed the sockeye migration relative to model expectations (which are based on historically average conditions). Over time the collection of such data is expected to yield important insights into migration behaviour, in addition to the obvious benefits to improved accuracy in catch accounting.

Proportions of Fraser River sockeye in District 104 seine catches were estimated by DNA analyses in 2012. Estimates provided by the National Oceanic and Atmospheric Administration and the Alaska Department of Fish and Game, examining Single Nucleotide Polymorphisms²³, were verified with the same suite of genetic loci and style of analysis that generated the DNA results reported here and to the Fraser Panel. Results from the two approaches were similar. Sockeye catches in District 104 totaled 72,000, with Fraser sockeye detected in highest frequency in mid to late August. Post-season estimates of Fraser sockeye caught in District 104 totaled 10,000 in 2012, 14 % of the purse seine sockeye catch there.

²³ Habicht, C., Seeb, L.W., Myers, K.W., Farley, E.V., Seeb, J.E. 2010. Summer-Fall Distribution of Stocks of Immature Sockeye Salmon in the Bering Sea as Revealed by Single-Nucleotide Polymorphisms. *Trans. Am. Fish. Soc.* 139: 1171-1191.

(Fig. F1a)



(Fig. F1b)

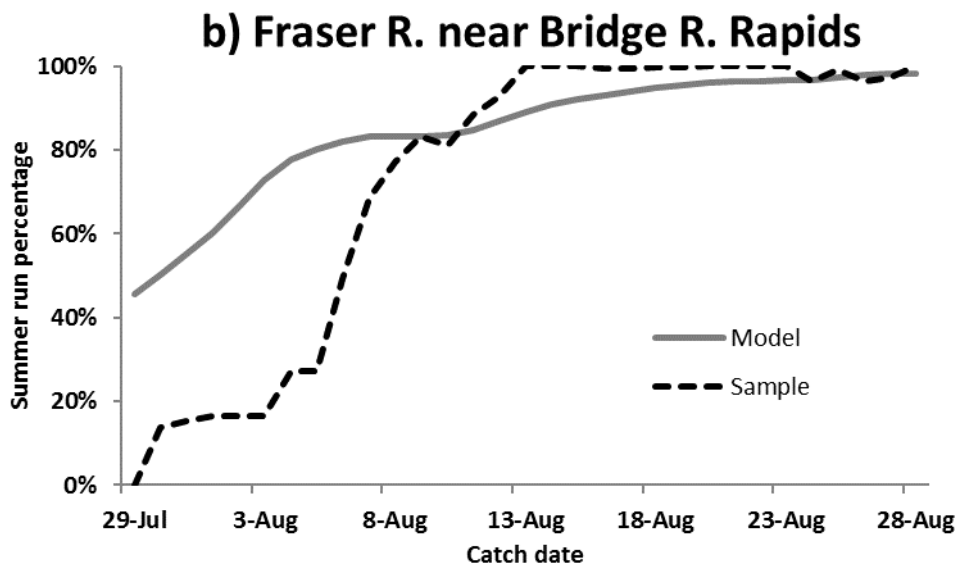


Figure F1. Prevalence of Summer-run stocks among Fraser River sockeye near (a) Qualark and (b) Bridge River rapids. In both cases, “Model” results (solid grey line) are generated from estimates of stock proportions at Mission which are then moved upstream. “Sample” results (dashed black line) come from direct samples taken in (a) the Qualark test fishery and (b) Fraser River FSC fisheries in the vicinity of Lillooet. Direct samples were pooled across days and were not smoothed.

Stock Assessment

Assessment of Fraser River sockeye abundance by stock group is primarily based on catch, effort, escapement and stock composition data. Since commercial catches were limited in 2012, stock assessment methods to estimate run size relied mainly on catch and catch per unit effort (CPUE) data from test fishing vessels in addition to reconstructed marine daily abundance estimates derived from in-river hydro-acoustic data. The CPUE data was converted into daily abundance estimates using a catchability estimate derived using a hierarchical analysis of historical data (Area 12 purse seine catchability: 5.6×10^{-3} , Area 20 purse seine catchability: 2.5×10^{-3}). The marine abundance estimates derived from in-river hydro-acoustic data and marine test

fishery data were analysed using Bayesian stock assessment models^{24, 25}. These models compare the reconstructed daily migration pattern to ideal run-timing curves, assuming the run is normally distributed. By assuming the run follows this idealized pattern, the run size can be estimated once the 50% migration date (i.e., the date 50% of the run has migrated past the reference location, which corresponds to the peak of the normal distribution) has been identified, by doubling the abundance up to that date. Prior to observing the peak of the run, there is considerable uncertainty about the run size. Based on initial observations before the peak of the run, the estimates can indicate whether the run is either earlier, and smaller than forecast, or later, and larger than forecast.

The uncertainty about the actual size of the run is estimated using Bayesian methodology. The Bayesian version of the cumulative normal model relies on additional information (pre-season forecasts of run size based on historic stock-recruit data and timing based on sea-surface temperature (SST) and eastward current speed index in the Gulf of Alaska, expected duration of the run, average historical expansion line estimates and pre-season forecasts of diversion rate based on SST) to reduce the uncertainty and keep the run-size estimates within realistic bounds. 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 depends 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 F2a, b, c and d provide an overview of the run-size estimates from the stock assessment model and the accounted run size at various dates during the season (median and 80% probability interval). The left most estimates (black circles) in each Figure represent the pre-season forecasts for each group. These estimates can be compared against the adopted run-size estimates used for management purposes and against the final in-season estimates of the accounted run-to-date. In 2012, the median pre-season forecasts underestimated the run size for Early Stuart, Early Summer and Late-run sockeye while for Summer-run sockeye the final run size was smaller than the median forecast. The historic catchability assumed for the gillnet test fishery proved to be too large in 2012, thereby underestimating daily abundance based on gillnet CPUE data. This was not the case for the purse seine test fishery - the purse seine CPUE data in combination with the historic catchability resulted in reliable daily abundance estimates, except during the early part of the Late-run sockeye migration. The timing of the run was later than forecast for Early Stuart sockeye, as forecasted for Early Summer and Summer-run sockeye, and earlier than forecast for Late-run sockeye.

²⁴ 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.

²⁵ 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.

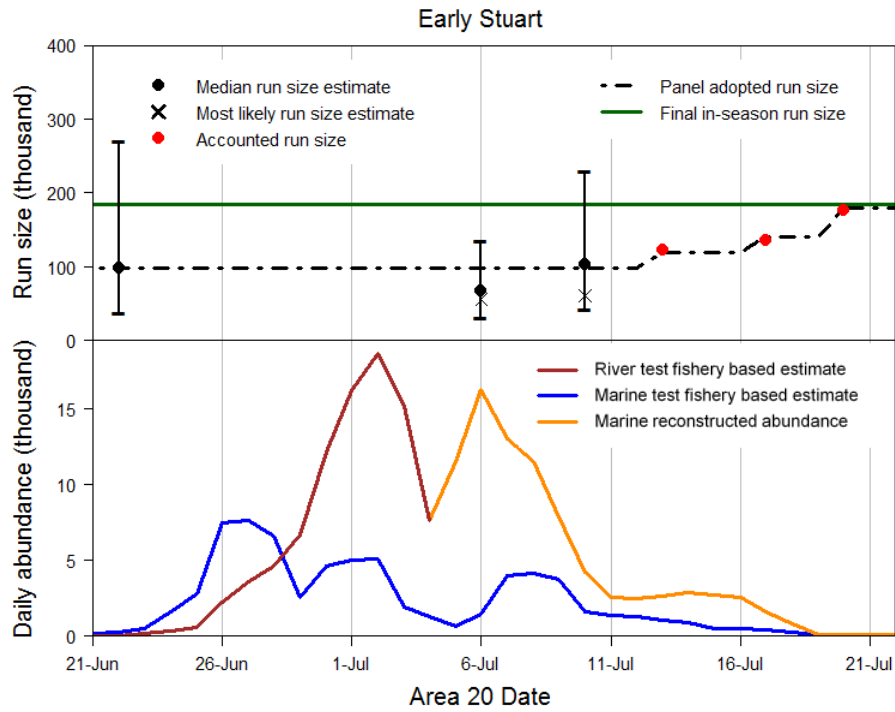


Figure F2a. Daily reconstructed abundance estimates for Early Stuart sockeye and corresponding run-size estimates at different times during the season.

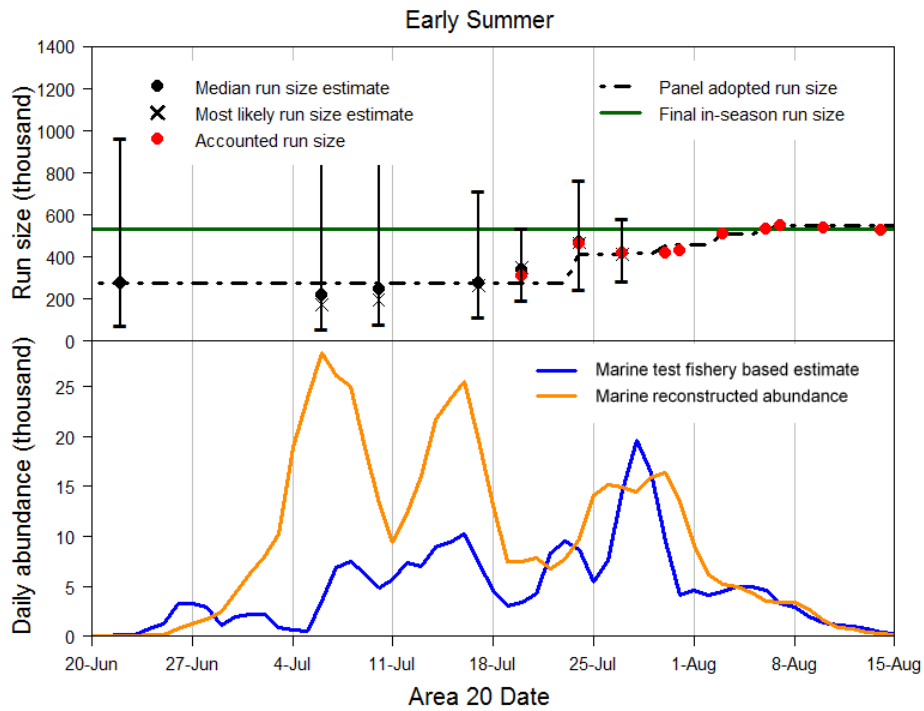


Figure F2b. Daily reconstructed abundance estimates for Early Summer-run sockeye and corresponding run-size estimates at different times during the season.

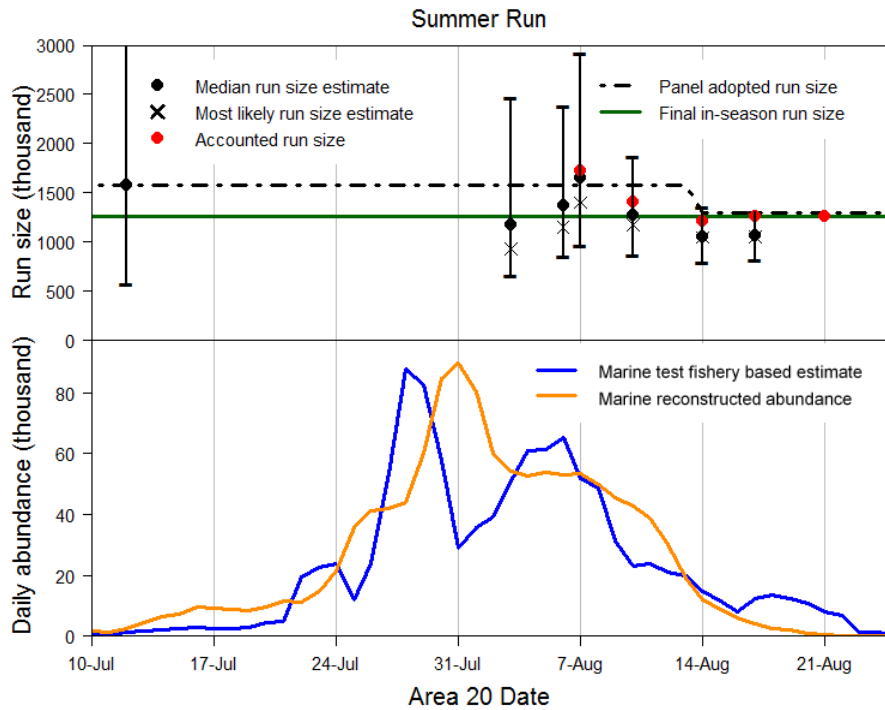


Figure F2c. Daily reconstructed abundance estimates for Summer-run sockeye and corresponding run-size estimates at different times during the season.

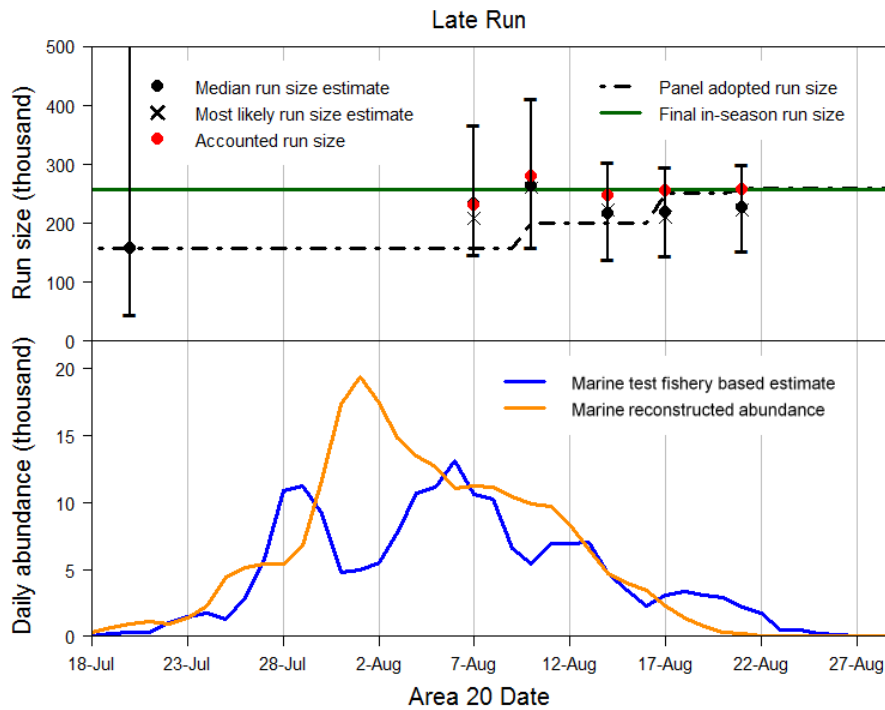


Figure F2d. Daily reconstructed abundance estimates for Late-run sockeye and corresponding run-size estimates at different times during the season.

Management Adjustment and DBE

Table F2 shows the component pMAs for the MA calculation methodologies agreed to by the Panel for the Early Stuart, Early Summer, Summer and Late-run groups, while Table F3 summarizes the calculation methodologies in more detail.

The implications of management group membership changes (i.e., moving Raft/North Thompson and Harrison to the Summer-run group) on the MA models were evaluated during the 2012 pre-season period as requested by the Panel. Removing Harrison from the Late-run group shifted Late-run timing to a later date and resulted in a larger Late-run DBE for all years since 1995, but had virtually no impact on values for the 2012 cycle. Moving Raft/North Thompson and Harrison stocks into the Summer-run did not affect Summer-run timing and had minimal impact on the median DBE. However, the river temperature and flow-based MA relationship for Harrison is poor ($r^2=0.0$ all years) and although variable, Harrison has historically shown a significant DBE (median since 1995: -51%). Summer-run stocks have a much smaller DBE (median all years: -6%).

For pre-season planning, Staff presented the Panel with the all-years temperature and flow-based MA models for the Early Stuart and Early Summer groups. The Panel adopted the all-years Early Stuart model (Table F3), but were concerned that the large contribution of Chilliwack sockeye in 2012 was influencing the timing of the entire Early Summer group. Staff provided the Panel with historical information on Chilliwack DBEs and pMAs for years where Chilliwack sockeye were uniquely identified in the data, as well as an assessment of the quality of these data. The Panel chose to treat Chilliwack separately from the Early Summers and to use a weighted Chilliwack pMA of 0.26 based on data from 2008, 2010 and 2011. The Early Summer aggregate pMA was the weighted average of the pMAs for Chilliwack and the non-Pitt non-Chilliwack components, based on the forecasted p50 abundances.

For the revised Summer-run group that included Raft/North Thompson and Harrison, the Panel chose to treat Harrison separately and they adopted a fixed pMA of 0.35 (historical median for 2004-2011, excluding 2006 and 2010). For the remainder of the Summer-run group, the temperature and discharge-based MA models were applied (pMA of 0.04). The Summer-run aggregate pMA was the weighted average of the pMAs for the Harrison and the non-Harrison components, based on the forecasted p50 abundances.

Staff presented the Panel with two approaches for Late-run MAs in 2012: 1) using median MAs from past years' data, or 2) using a predicted MA based on upstream timing estimates derived from timing and delay assumptions. Staff also provided Late-run pMA estimates under different Mission timing assumptions and with various options for grouping Late-run and Birkenhead stocks. The Panel adopted a separate MA for both groups. For Late-run sockeye excluding Birkenhead, the Mission timing model would be applied with a date of September 4 with 16 days' delay, while the Birkenhead pMA would remain fixed at 0.26 (median of all years). The Late-run aggregate pMA was the weighted average of the pMAs for Birkenhead and the non-Birkenhead components, based on the forecasted p50 abundances. The Panel recognized that due to the low relative abundance of Late-run sockeye, estimates of stock composition and upstream time would be uncertain and so the Late-run pMA would not be updated in-season.

Table F2. Summary of DBEs and pMAs adopted pre-season and in-season to generate weighted pMA values for Early Summer, Summer and Late-run groups.

Description	Early Stuart		Early Summer				Summer				Lates			
			(excl. Pitt and Chwk)		Chilliwack*		(excl. Harrison)		Harrison*		(excl. Birk.)		Birkenhead*	
	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA	%DBE	pMA
Adopted Pre-season	-66%	1.95	-33%	0.49	-21%	0.26	-4%	0.04	-26%	0.35	-68%	2.14	-21%	0.26
Adopted In-season	-76%	3.19	-51%	1.03	-21%	0.26	-5%	0.05	-26%	0.35	-94%	15.79	-21%	0.26

*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 for each Fraser sockeye management group in 2012.

Management Group	Pre-season Predictor Variables	In-season Predictor Variables	Cycle lines Used	Excluded Years
Early Stuart	31-day temp and discharge ²	19-day temp and discharge ²	All	1977, 1980, 1982, 1984, 1986
Early Summer (excl. Chwk & Pitt)	31-day temp and discharge	19-day temp and discharge	All	1993
Pitt	DBE assumed to be 0	DBE assumed to be 0	NA	NA
Chilliwack	Weighted based on 2008-2011, excl. 2009	Weighted based on 2008-2011, excl. 2009	NA	NA
Early Summer Aggregate	weighted average of the pMA for the non-Pitt, non-	weighted average of the pMA for the non-	NA	NA
Summer (excl. Harrison)	31-day temp and discharge	19-day temp and discharge	All	2002
Harrison	Historical Median 2004-2011	Historical Median 2004-2011	NA	2010
Summer Aggregate	weighted average of the pMA for the non-Harrison Summer group and the pMA for Harrison based on the p50 level of abundances	weighted average of the pMA for the non-Harrison Summer group and the pMA for Harrison based on the component level of abundances		
Birkenhead	Median of all years (1977-2011)	Median of all years (1977-2011)	All	1979
Late (excl. Birkenhead) ³	Mission timing model ³	Mission timing model ³	All	1977, 1979, 1980, 1981, 1983, 1984, 1985, 1987, 1988, 1989, 1991, 1992, 1993, 1995, 2006, 2010
Late Run Aggregate	weighted average of the pMA for the non-Birkenhead Late Run group and the pMA for Birkenhead based on the p50 level of abundances	weighted average of the pMA for the non-Birkenhead Late Run group and the pMA for Birkenhead based on the component level of abundances	All	1977, 1979, 1980, 1981, 1983, 1984, 1985, 1987, 1988, 1989, 1991, 1992, 1993, 1995, 2006, 2010

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

² $\ln(\text{DBE}) = a + b_1T + b_2T^2 + b_3Q + b_4Q^2$ 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 $\ln(\text{DBE}) = a + bR$ where R is Mission timing

APPENDIX G: HISTORICAL CATCH, ESCAPEMENT AND PRODUCTION DATA AND DETAILED TAC CALCULATION

Table G1. Catch by user group, spawning escapement, difference between estimates and run size of Fraser River sockeye salmon for cycle years 2000-2012.

	Fraser Sockeye Salmon			
	2000	2004	2008	2012
CANADIAN CATCH	1,860,000	2,006,700	481,100	510,300
Commercial Catch	955,200	1,057,600	16,200	0
Panel Area	422,400	256,800	11,600	0
Non-Panel Areas	532,800	800,800	4,600	0
First Nations Catch	870,300	890,500	447,300	508,100
Marine FSC	90,900	256,200	31,900	53,200
Fraser River FSC	779,400	634,300	415,400	454,900
Economic Opportunity	0	0	0	0
Non-commercial Catch	34,500	58,600	17,600	2,200
Marine Recreational	6,100	4,800	100	0
Fraser Recreational	20,200	50,300	16,400	0
Charter	7,800	0	1,200	2,200
ESSR	400	3,500	0	0
UNITED STATES CATCH	496,100	258,800	51,000	118,100
Washington Total	493,600	195,600	49,400	111,300
Commercial catch	490,200	195,500	48,000	105,200
Treaty Indian	260,100	114,400	39,000	72,800
Non-Indian	230,100	81,100	9,000	32,300
Non-commercial Catch	3,400	100	1,400	6,100
Ceremonial	3,400	100	1,400	6,100
Recreational	0	0	0	0
Alaska	2,500	63,300	1,600	6,800
TEST FISHING CATCH	94,600	73,400	41,300	33,900
PSC (Panel Areas)	72,400	24,100	36,200	26,200
Canada	72,400	24,100	26,900	17,000
United States	0	0	9,300	9,200
Canada (non-Panel Areas)	22,200	49,400	5,100	7,700
TOTAL RUN	5,201,600	4,184,900	1,741,100	2,219,200
Total Catch in All Fisheries	2,450,700	2,339,000	573,400	662,300
Adult Spawning Escapement	2,353,100	524,500	815,600	920,400
Jack Spawning Escapement	1,200	900	1,500	4,300
Difference Between Estimates	396,600	1,320,600	350,500	632,100
Percentage of Total Run	100%	100%	100%	100%
Total Catch in All Fisheries	47%	56%	33%	30%
Adult Spawning Escapement	45%	13%	47%	41%
Jack Spawning Escapement	0%	0%	0%	0%
Difference Between Estimates	8%	32%	20%	28%

Table G2. Escapements of sockeye salmon to Fraser River spawning areas for cycle years 2000-2012.

DISTRICT <u>Stock Group</u>	Stream/Lake	Year			
		2000	2004	2008	2012
NORTHEAST					
	Upper Bowron R.	13,440	916	1,005	59
STUART					
<u>Early Stuart</u>					
	Driftwood R.	3,553	398	683	234
	Takla L. Streams	29,624	3,005	5,476	4,218
	Middle R. Streams	30,049	3,822	17,330	18,020
	Trembleur L. Streams	25,684	2,041	6,378	3,758
	Miscellaneous	948	15	0	0
<u>Late Stuart</u>					
	Kazchek Cr.	441	207	194	241
	Kuzkwa Cr.	15,604	2,198	7,268	5,630
	Middle R.	51,426	12,938	5,616	13,147
	Tachie R.	368,834	60,838	122,929	68,557
	Miscellaneous	18,092	7,237	10,562	5,544
NECHAKO					
	Nadina R. (Late)	164,529	14,276	32,724	22,840
	Nadina Channel	34,852	8,327	33,251	8,102
	Stellako R.	371,708	86,738	159,737	137,992
QUESNEL					
	Horsefly R.	34,545	4,379	5,324	536
	Horsefly Channel	1,125	0	0	0
	McKinley Cr.	457	124	77	0
	Mitchell R.	27,069	5,452	1,564	58
	Miscellaneous	507	267	126	11
CHILCOTIN					
	Chilko R. & L.	758,941	91,909	249,863	245,522
	Chilko Channel	0	0	0	0
	Taseko L.	3,000	320	60	100
SETON-ANDERSON					
	Gates Cr.	56,226	757	5,420	12,600
	Gates Channel	32,421	8,849	9,418	15,884
	Portage Cr.	1,269	1,287	97	25
NORTH THOMPSON					
	North Thompson R.	10,762	1,964	3,879	1,096
	Raft R.	66,292	5,611	10,406	10,003
	Fennell Cr.	10,465	2,763	2,270	1,967
SOUTH THOMPSON					
<u>Early Summer-run</u>					
	Scotch Cr.	3,765	783	654	2,005
	Seymour R.	25,465	1,323	1,350	822
	Upper Adams / Momich / Cayenne	79,656	1,090	1,257	256
	Miscellaneous	17,498	692	1,727	411
<u>Late-run</u>					
	Adams R.	754	2,672	149	0
	Little R.	27	175	2	2
	Lower Shuswap R.	50	144	11	9
	Miscellaneous	24	3	2	1
HARRISON-LILLOOET					
	Birkenhead R.	13,842	37,617	19,500	55,321
	Big Silver Cr. & misc. Birk. types	10,034	22,386	2,763	3,722
	Harrison R.	4,343	2,106	6,717	70,904
	Weaver Cr.	1,237	912	1,309	345
	Weaver Channel	5,376	24,467	1,447	573
LOWER FRASER					
	Nahatlatch R. & L.	5,165	1,097	573	4,065
	Cultus L.	1,227	90	509	1,082
	Upper Pitt R.	42,638	60,942	16,921	78,038
	Chilliwack L./Dolly Varden Cr.	8,160	40,329	67,822	126,164
MISCELLANEOUS					
		2 1,957	1,030	1,271	551
ADULTS		2,353,081	524,496	815,641	920,415
JACKS		1,179	851	1,548	4,348
TOTAL NET ESCAPEMENT		2,354,260	525,347	817,189	924,763

* Estimates are from DFO.

1 Cultus estimates include broodstock removals of 38 adults in 2004, 169 adults in 2008, and 247 adults + 16 jacks in 2012.

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

Table G3. Detailed calculation of total allowable catch (TAC) and achievement of international catch shares for Fraser sockeye salmon by management group in 2012. 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 (September 2), in accordance with Annex IV of the Treaty and the February 17, 2011 Commission Guidance.

Preliminary TAC Calculations	Fraser Sockeye					Total
	Early Stuart	Early Summer	Summer	Late		
RUN STATUS, ESCAPEMENT NEEDS & AVAILABLE SURPLUS						
In-season Abundance Estimate	185,000	530,000	1,300,000	260,000		2,275,000
Spawning Escapement Target (SET)	74,000	212,000	651,000	260,000		1,197,000
<i>%SET from TAM rules</i>	40%	40%	50%	100%		
Management Adjustment (MA)	236,100	103,900	58,600	252,200		650,700
<i>Proportional MA (pMA)</i>	3.19	0.49	0.09	0.97		
Test Fishing Catch (TF, post-seas. est.)	1,800	8,300	20,000	3,700		33,900
Surplus above Adjusted SET & TF *	0	205,800	570,400	0		776,200
DEDUCTIONS & TAC FOR INTERNATIONAL SHARING						
Aboriginal Fishery Exemption (AFE)	10,000	94,700	271,700	23,600		400,000
Total Deductions (Adj.SET + TF + AFE)	196,800	418,900	1,001,300	287,300		1,904,400
Available TAC (Abundance - Deductions)	0	111,100	298,700	0		409,800
UNITED STATES (Washington) TAC						
Propor. distrib. TAC - Payback	0	18,300	49,300	0		67,600
Proportionally distributed TAC **	0	18,300	49,300	0		67,600 16.5%
U.S. Payback	0	0	0	0		0
Washington Catch	0	8,300	90,500	12,500		111,300
Deviation from TAC - Payback	0	10,100	-41,200	-12,500		-43,700
CANADIAN TAC						
Propor. distrib. TAC + Payback + AFE	10,000	187,500	521,100	23,600		742,200
Propor. distrib. TAC + U.S. Payback	0	92,800	249,400	0		342,200 83.5%
AFE	10,000	94,700	271,700	23,600		400,000
Canadian Catch excluding ESSR Catch	7,300	64,700	405,900	32,400		510,300
Deviation from TAC + Payback + AFE	2,700	122,700	115,200	-8,800		231,800
TOTAL						
Available TAC + U.S. Payback + AFE	10,000	205,800	570,400	23,600		809,800
Total Catch excluding ESSR Catch	7,300	73,000	496,400	44,900		621,700
Deviation from TAC + U.S. Payback + AFE	2,700	132,800	73,900	-21,300		188,100

* The surplus cannot exceed the estimated abundance.

** Washington sockeye and pink shares according to Annex IV of the Pacific Salmon Treaty and the February 17, 2011 Commission Guidance to the Fraser River Panel.

**APPENDIX H: MEMBERS OF THE FRASER RIVER PANEL TECHNICAL COMMITTEE
IN 2012**

Canada	United States
A. Huang, Co-Chair <i>Fisheries and Oceans Canada</i>	G. Graves, Co-Chair <i>Northwest Indian Fisheries Commission</i>
S. Grant <i>Fisheries and Oceans Canada</i>	A. Dufault <i>Washington Department of Fish and Wildlife</i>
J. Scroggie <i>Fisheries and Oceans Canada</i>	P. Mundy <i>National Marine Fisheries Service</i>
M. Staley <i>First Nations Advisor</i>	

APPENDIX I: STAFF OF THE PACIFIC SALMON COMMISSION IN 2012

EXECUTIVE OFFICE

John Field, Executive Secretary
Kimberly Bartlett, Secretary/Receptionist
Sandie Gibson, Information Technology Support Specialist
Vicki Ryall, Meeting Planner
Teri Tarita, Records Administrator/Librarian

FINANCE AND ADMINISTRATION

Ken Medlock, Controller
Bonnie Dalziel, Accountant
Angus Mackay, Manager, Restoration & Enhancement Funds
Victor Keong, Program Assistant, Restoration & Enhancement Funds

FISHERIES MANAGEMENT DIVISION

Mike Lapointe, Chief Biologist

QUANTITATIVE ASSESSMENT GROUP

Catherine Michielsens, Quantitative Fisheries Scientist
Merran, Hague, Quantitative Fisheries Biologist

STOCK IDENTIFICATION GROUP

Ian Guthrie, Head
Holly Anozie, Scale Analyst (Acting)
Catherine Ball, Scale Lab Assistant (Term)
Maxine Forrest, Senior Scale Analyst
Steve Latham, Sockeye Stock Identification Biologist
Julie Sellars, Senior Scale Analyst (Acting)
Bruce White, Pink Stock Identification Biologist
Erica Jenkins, Salmon Technician

STOCK MONITORING GROUP

Jim Cave, Head
Keith Forrest, Test Fishing Biologist
Fiona Martens, Senior Hydroacoustic Technician
Jacqueline Nelitz, Hydroacoustic Technician
Mike Bartel-Sawatzky, Hydroacoustic Technician (Term)
Yunbo Xie, Hydroacoustics Scientist