2004

Report of the Fraser River Panel to the Pacific Salmon Commission on the 2004 Fraser River Sockeye Salmon Fishing Season

Prepared by the

Pacific Salmon Commission

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REPORT OF THE

FRASER RIVER PANEL

TO THE PACIFIC SALMON COMMISSION

ON THE 2004 FRASER RIVER

SOCKEYE SALMON FISHING SEASON

2004 PANEL MEMBERS AND ALTERNATES

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May 2008

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I. EXECUTIVE SUMMARY

1. On February 17, 2005, the Fraser River Panel (Panel) agreed on a revised Chapter 4, Annex IV of the Pacific Salmon Treaty. The Agreement established new methods for making management decisions and for calculating the Total Allowable Catch (TAC) for 2005 through 2010. The Panel subsequently agreed to apply the new TAC calculation method to 2002, 2003 and 2004. Whereas the traditional TAC method used post-season estimates of run size, spawning escapement and test fishing catch in the calculation, the new method uses the estimates of run size, spawning escapement target, management adjustment and test fishing catch that were in effect when the Panel relinquished control of the last U.S. Panel Area (October 2 in 2004). The new method is therefore based on in-season data rather than post-season data to calculate the total sockeye available for sharing. As set out in the Treaty, the United States (Washington) share was 16.5% of the TAC, with the balance available for Canada. The resulting in-season allocations for each country are evaluated against post-season catch estimates to assess the achievement of these objectives.

2. Prior to the fishing season, the Panel recommended a fishery regime and management plan for Panel Area fisheries to the Pacific Salmon Commission. The plan was based on forecasts of abundance and timing, and escapement targets for Fraser River sockeye salmon as provided by Canada. Fishing schedules in the plan were also based on international allocation goals set in the Agreement, domestic allocation goals set by each country, management concerns for other stocks and species identified by each country, and historic migration patterns.

3. Commercial fisheries in Canadian and United States Panel Areas were managed by the Fraser River Panel. Canadian commercial fisheries outside the Panel Area and non-commercial fisheries were to be managed by Canada in a manner that was consistent with international and domestic objectives.

4. Canada provided the Panel with final run-size forecasts on April 21, 2004 at probability levels of 25%, 50%, 75%, 80% and 90% that the given run size would be exceeded. These forecasts encompassed a range of run sizes from 1,802,000 fish (90%) to 8,663,000 fish (25%). Rules for calculating spawning escapement targets for Fraser River sockeye salmon were also provided on April 21, 2004. Pre-season spawning escapement targets at the 50% probability level forecasts were 90,000 Early Stuart, 310,000 Early Summer, 1,424,000 Summer, 89,000 Birkenhead and 85,000 True Late-run spawners.

5. On May 19 and 20, 2004, the Panel developed fishery plans for forecast run sizes at the 25% (8,663,000 fish), 50% (4,920,000 fish) and 75% (2,872,000 fish) probability levels. At the 50% probability level forecasts of abundance the projected Total Allowable Catch (TAC) was 2,252,000 fish.

6. Domestic allocation goals in Washington were as follows: Treaty Indian fishers were to receive 67.7% of the Washington TAC, while Non-Indian fishers were allocated the remaining 32.3%.

7. Sharing arrangements for the Canadian commercial TAC were 53.5% for Area B purse seines, 11.5% for Area D gillnets, 24% for Area E gillnets and 11% for Area H trollers.

8. The Management Plan focussed on the harvest of Summer-run sockeye. Fishery restrictions were anticipated early in the season to minimize harvest impacts on Early Stuart and Early Summer-run sockeye and late in the season to protect True Late-run sockeye. A 15% exploitation rate limit for True Late-run sockeye was adopted by the Panel due to their probable early river entry and associated high mortality rate. Several Fraser River and non-Fraser River chinook, chum, coho, and steelhead stocks were identified by each country as warranting conservation concerns.

9. Research studies were conducted to help determine the causes of early river-entry behaviour of True Late-run sockeye. This research included tagging, physiology, oceanography and other studies.

10. DFO's forecast diversion rate of Fraser River sockeye through Johnstone Strait was 78%. On July 9, DFO provided the Panel with run-timing forecasts (50% cumulative migration date through Canadian Area 20, i.e., Juan de Fuca Strait) of June 29 for Early Stuart sockeye and August 2 for Chilko sockeye, both timing estimates suggesting earlier than average timing. On July 15, the Chilko forecast was revised to August 6 (later than average timing), after in-season body length data from Early Stuart sockeye were included in the forecast.

11. The Stock Monitoring Program provided in-season estimates of abundance, migration timing and diversion rate of Fraser River sockeye salmon throughout the fishing season. The overall diversion rate of Fraser sockeye through Johnstone Strait was about 70%. Peak migration timing through Area 20 was July 6 for Early Stuart sockeye (seven days later than forecast), July 27 for Early Summer-run sockeye (three days later than expected), August 1 for Summer-run sockeye (five days earlier than the revised Chilko forecast) and August 8 for True Late-run sockeye (six days earlier than expected).

12. The Racial Identification Program provided estimates of stock composition for commercial, First Nations' and test fishery catches. These stock proportions were then used to estimate the catch, escapement and run size of individual stock groups. DNA analyses were the primary source of stock proportions used in 2004, although scale characteristics and length data were also employed.

13. Catches of Fraser River sockeye salmon in all fisheries totalled 2,349,000 fish. Canadian catches totalled 2,016,000 sockeye, United States catches totalled 259,000 fish (almost all in commercial fisheries), and test fishery catches totalled 74,000 sockeye. Canadian sockeye catches included commercial catches of 1,058,000 fish, First Nations' catches of 900,000 fish, recreational catches of 55,000 fish and 3,500 Weaver Creek sockeye caught in an ESSR (excess salmon to spawning requirements) fishery. The sum of commercial fishery catches in both countries was 1,317,000 fish.

14. Post-season estimates of total adult abundance by run-timing group were 137,000 Early Stuart, 1,241,000 Early Summer, 2,381,000 Summer, 158,000 Birkenhead and 267,000 True Late-run adults, for a total of 4,184,000 adult Fraser sockeye. Abundances of Early Stuart and Summer-run sockeye were 37% and 33% lower, respectively, than the 50% probability level forecasts, while abundances of Early Summer, Birkenhead and True Late-run sockeye were 40%, 8% and 83% higher than forecast. Overall, the return was 15% lower than the forecast of 4,920,000 adults at the 50% probability level. Among Early Summer-run stocks, the Nadina/Gates/Chilliwack stock-group dominated the run. Late Stuart/Stellako sockeye comprised the largest portion of the Summer run, while Weaver/Harrison sockeye dominated Late-run returns.

15. Final estimates of spawning escapements to enumerated streams in the Fraser River watershed totalled 524,000 adult sockeye. This escapement was the third smallest on the 2004 cycle since 1940 and only 22% of the brood year (2000) escapement. Spawning escapement estimates were much lower than in the brood year for Early Stuart (90% lower), Early Summer (74% lower) and Summer-run (83% lower) sockeye. Escapements of both Birkenhead and True Late-run sockeye were more than double their brood year levels, but less than half the average escapement for the preceding three cycle years. The spawning success of female sockeye in the entire watershed was 98%.

16. Large shortfalls in spawning escapements were observed across all run-timing groups. Post-season spawning escapement targets were 90,000 Early Stuart, 434,000 Early Summer, 1,424,000 Summer and 94,000 Birkenhead adult sockeye. A True Late-run target was established by the adoption of an exploitation rate limit of 15% (see Item 18, below), potentially leaving 85% of the run (227,000 fish) for spawning escapement. Actual spawning ground escapements were 9,300 Early Stuart (90% below the target), 150,000 Early Summer (65% below), 273,000 Summer (81% below), 64,000 Birkenhead (32% below) and 28,000 True Late-run sockeye (88% below). Total spawning escapements of Fraser sockeye were 1,745,000 fish or 77% below the overall target of 2,270,000 adult sockeye. Very high and record high water temperatures during their riverine migrations likely caused significant en route mortality for Early Stuart, Early Summer and Summer runs, while the large en route mortality of True Late-

run sockeye was probably due to early river entry, possibly combined with the exposure of these fish to warmer temperatures than they would typically encounter if they migrated at their historically normal time period.

17. Gross escapement targets (i.e., spawning escapement targets plus management adjustments and targets for First Nations and recreational catches in the Fraser River) were achieved with greater success than spawning escapement targets. Final in-season gross escapement targets plus management adjustments were 192,000 Early Stuart, 1,111,000 Early Summer, 2,502,000 Summer, 91,000 Birkenhead and 113,000 True Late-run sockeye, for a total of 4,009,000 Fraser sockeye. Final in-season gross escapement estimates (i.e., Mission escapements plus First Nations and recreational catches above Mission) for Early Stuart and True Late-run stocks were only 1% below the targets, and for the Early Summer run was 6% below the target, while the target for Birkenhead was exceeded by 14%. In contrast, the in-season estimate of Summer-run gross escapement was 44% below the target. The gross escapement of total Fraser sockeye was 1,154,000 fish (29%) below the target.

18. For True Late-run sockeye, an exploitation rate limit was employed to protect these stocks. The catch of 70,000 True Late-run sockeye represents an exploitation rate of 26%, which is 30,000 fish (11%) higher than the post-season limit of 40,000 fish. The magnitude of this overage is largely due to post-season revisions to stock identification estimates. The in-season catch estimate of 21,000 True Late-run sockeye was estimated indirectly by applying expected stock proportions from the Fishery Simulation Model to reported daily catch estimates, while post-season estimates of Late-run catch were derived directly from DNA samples collected from test fishing and commercial catches throughout the season.

19. Based on the revised method for calculating TACs and international shares (see Item 1), the TAC was 775,000 Fraser sockeye, with a Washington share of 128,000 fish (16.5% of TAC) and Canadian share of 647,000 fish. Both Washington and Canadian fishers caught about 50% more fish than their shares, with overages of 69,000 sockeye in Washington and 966,000 in Canada. The catch overages in both countries resulted primarily from sharply reduced run-size estimates and increased management adjustments for Summer-run stocks in mid-August, after most of the harvest had occurred.

20. In the United States, Treaty Indian fishers caught 18,000 fish less than their share (132,000 fish) of the Washington catch, while Non-Indian fishers caught 18,000 fish over their share (63,000 fish).

21. In Canada, Area B purse seines were 42,000 fish under, Area D gillnets were 33,000 fish over, Area E gillnets were 7,500 fish under and Area H trollers were 17,000 fish over their respective allocations of Fraser sockeye.

22. Panel Area fisheries resulted in moderate by-catches of other species and stocks that were identified as conservation concerns by the Parties in 2004. A catch of 13,200 chinook salmon was taken by Canadian and United States fishers, while 6,400 coho were harvested by the United States.

23. By Panel agreement, no paybacks were carried forward from 2003 to 2004, and no new paybacks were to be carried forward to 2005.

II. FRASER RIVER PANEL

Under the Pacific Salmon Treaty between Canada and the United States, the Fraser River Panel is responsible for in-season management of fisheries that target Fraser River sockeye and pink salmon within the Panel Area (Figure 1). Prior to the fishing season, the Panel recommends a fishery regime and a management plan for Panel Area fisheries to the Pacific Salmon Commission (PSC). The plan is based on: (1) abundance and timing forecasts and escapement targets for Fraser River sockeye and pink salmon stocks provided by Canada's Department of Fisheries and Oceans (DFO); (2) international catch allocation goals set by agreements between the Parties; (3) domestic

catch allocation goals of each country; (4) management concerns for other stocks and species also identified by each country; and (5) historic 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 of the Parties for other species and stocks are addressed throughout the process.

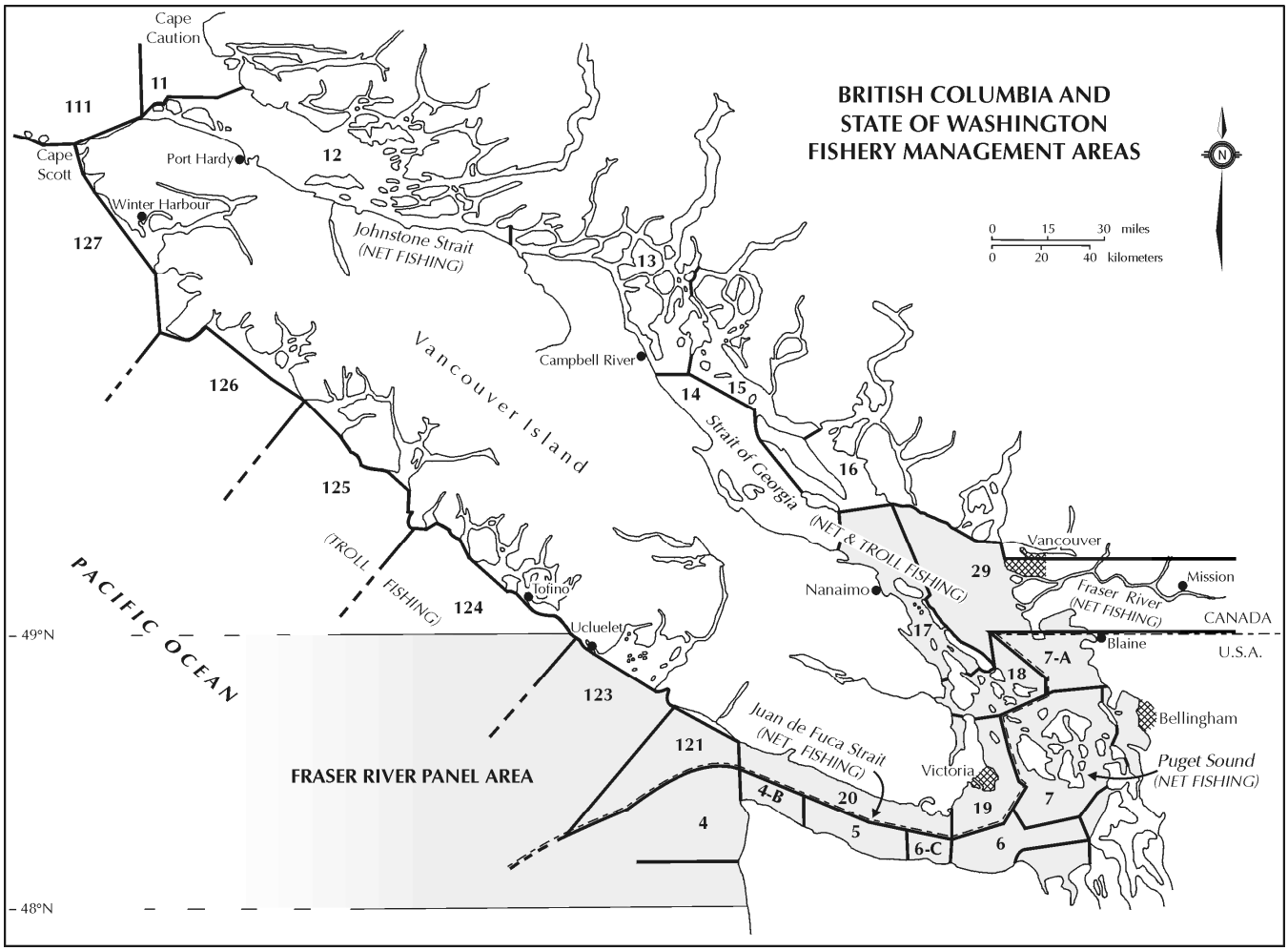

Figure 1. Fishery management areas and commercial gear used in the Fraser River Panel Area and Canadian south coast waters.

Pre-season management plans adopted by the Panel are based on fishery scenarios that are designed to achieve escapement targets and harvest available surpluses Based on these scenarios, the Panel identifies approximate dates of first openings in each Panel Area fishery. Using in-season commercial and test fishing data and analyses from PSC staff (Staff), the Panel develops weekly fishing patterns in response to in-season deviations from expectations. The Fraser River Panel Technical Committee (FRPTC), who work in conjunction with Staff, provide their respective National sections of the Panel with technical advice, which in turn facilitate the activities of the Panel.

Under the terms of the revised Chapter 4 of Annex IV of the Pacific Salmon Treaty (1999), the Panel regulates fisheries in Panel Areas only, including commercial net fisheries in both countries and the Canadian inside (Strait of Georgia) troll fishery directed at Fraser River sockeye and pink salmon. The development of management approaches for other species and stocks intercepted in south coast areas is the responsibility of the Southern Panel and the Commission. Regulation of Southern Panel related fisheries is the responsibility of the appropriate agencies in each country.

The Panel membership and their affiliations during the 2004 season were:

UNITED STATES	CANADA
Members	
Mr. R. Lincoln, Chair Washington Department of Fish and Wildlife	Mr. W. Saito, Vice-Chair Fisheries and Oceans Canada
Mr. D. Cantillon National Marine Fisheries Service	Mr. M. Chatwin Salmon processing industry
Mr. R. Kehoe Commercial salmon fishing industry	Mr. M. Griswold Troll fisher
Ms. L. Loomis Treaty Indian tribes	Mr. T. Lubzinski Gillnet fisher
	Chief K. Malloway Canadian First Nations
	Mr. L. Wick Purse seine fisher
Alternates	
Mr. R. Charles Treaty Indian tribes	Mr. B. Assu Purse seine fisher
Mr. J. Giard Commercial salmon fishing industry	Mr. T. Bird Sport fisher
Mr. J. Long Washington Department of Fish and Wildlife	Mr. R. Brahniuk Fisheries and Oceans Canada
Mr. K. Schultz National Marine Fisheries Service	Mr. L. Rombough Gillnet fisher
	Mr. P. Sakich Troll fisher Fisheries and Oceans Canada
	Mr. M. Shepert Canadian First Nations

III. INTRODUCTION

Late-run sockeye management issues continued to be a primary focus of the Fraser River Panel in 2004. Consistent with long term rebuilding efforts, the Panel restrained any directed harvest of Early Stuart sockeye in 2004. Early Summer-run stocks were also identified as warranting conservation effort, including a desire to continue rebuilding efforts for Upper Adams River sockeye that in the brood year resulted in a substantial increase in escapement. Summer-run stocks were expected to provide most opportunities for harvest in 2004. Thus, the Panel expected there would be a delicate balance between providing adequate opportunity for harvest of Summer-run sockeye while achieving conservation objectives for Early Summer and Late-run stocks.

Pre-season Planning

During pre-season planning for fisheries on Fraser River sockeye salmon in spring 2004, the focus on Late-run issues was heightened for a number of reasons. First, the 2004 Late-run return was forecast to be much smaller than average on this cycle, because brood year spawning escapements were very low due to the high en route and pre-spawning mortality associated with extremely early river entry of Late-run stocks in 2000. Second, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recommended that Cultus sockeye be listed as endangered under Canada's new Species at Risk Act (SARA). While Cultus sockeye were not formally listed under this act, the Minister of Fisheries and Oceans committed to provide Cultus sockeye special protection from harvest and other threats to its long term viability. Third, the low forecasted abundance of Late-run sockeye relative to Summer-run sockeye generated concern about the capability to directly assess Late-run sockeye in-season. Thus, during pre-season planning, the Panel recognized the likelihood of the early upstream migration behaviour of Late-run sockeye continuing, and the probability that subsequent en route and pre-spawning losses could occur. Due to low expected abundances of True Late-run sockeye, conservation concerns for Cultus sockeye and limited assessment capability for Late-run stocks generally, the Panel adopted a conservative management plan to limit incidental harvest of True Late-run sockeye in 2004.

During the pre-season planning process, the Panel directed the FRPTC and PSC staff to examine options for harvesting Summer-run stocks without adversely impacting the co-migrating sockeye from Early Summer and Late-run timing groups. These evaluations were conducted using the Fishery Simulation Model[1] developed by PSC staff. During simulation modeling, it became evident that while Summer-run stocks would provide the majority of the catch in 2004, conservation concerns for other stocks would likely result in constraints on the harvest of Summer-run fish. The degree to which harvest of Summer-run fish would be constrained was related primarily to the allowable harvest of True Late-run fish.

For fisheries planning purposes it was assumed that True Late-run sockeye would continue their early upstream migration behaviour, with a predicted 50% upstream migration date past Mission of August 26 (average migration date from recent Late Shuswap off-cycle return years). This resulted in a projected en route mortality of 80%, derived from the Management Adjustment (MA) model. As a consequence of these assumptions, the Panel adopted a True Late-run exploitation rate limit of 15%. It was recognized that in-season modifications to the plan were unlikely due to assessment limitations for Late-run sockeye.

In-season Management

In-season management in 2004 was even more difficult than anticipated during pre-season planning. Adverse migration conditions in the Fraser River, unusual fish behaviour and difficult assessment circumstances made it hard to achieve the Panel's management goals. Fraser River water temperatures reached record high and near record high levels for much of the summer (Figure 2) due to a low snowpack and warm summer air temperatures. These high river

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

temperatures dramatically increased the en route mortality of adult sockeye returning to their natal streams. To offset the anticipated mortality associated with the effects of high water temperatures, the Panel adopted MAs for Early Summer and Summer runs that increased the escapement targets, and thereby reduced the Total Allowable Catch (TAC) for these runs. The Panel also adopted a MA for Early Stuart sockeye, but this MA did not impact Panel management as no Panel fisheries were directed at this run. The MA for Early Summer-run sockeye limited fishing opportunities in late July and early August relative to those anticipated under the pre-season plan. The Summer-run MA was adopted after the majority of Panel Area fisheries had ceased. Low abundances of Summer-run stocks in the latter half of the migration (especially Chilko) resulted in a lower run-size estimate in late August. The late timing of both the run-size downgrade and adoption of the MA relative to when fisheries were conducted resulted in a gross escapement shortfall relative to the Summer-run goal.

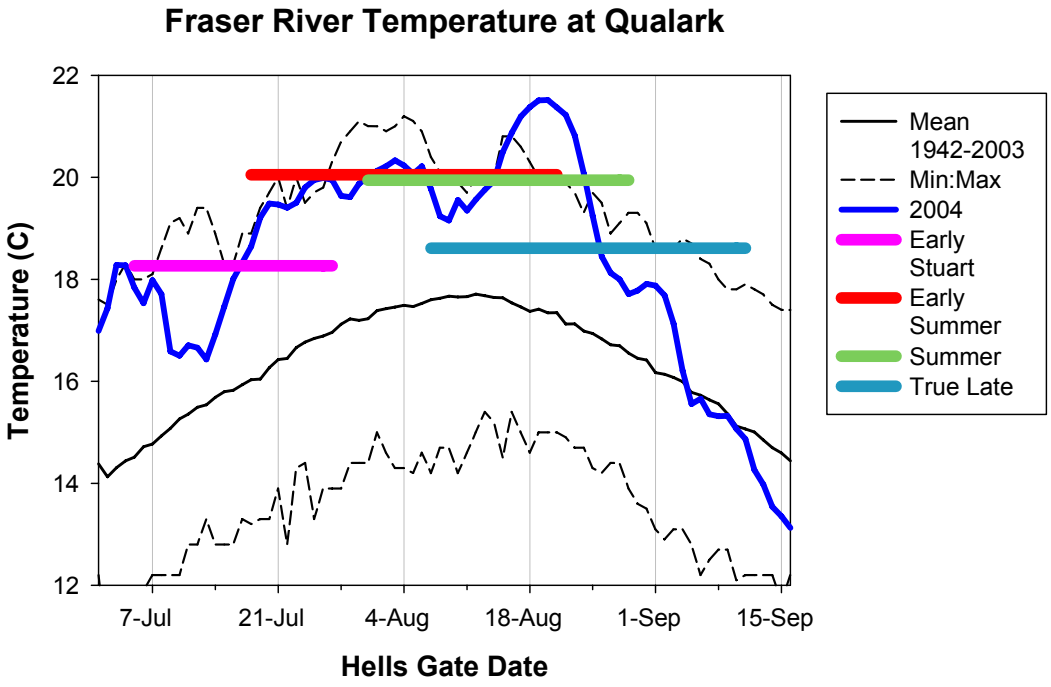

Figure 2. Fraser River water temperatures measured near Hells Gate in 2004, compared to long-term mean, minimum and maximum temperatures for 1942-2003. The approximate periods for the central 90% of the Early Stuart, Early Summer (excluding Pitt), Summer and Late-run (excluding Birkenhead) migrations are indicated.

To further complicate the Panel's management strategy, Staff were unable to accurately assess timing and abundance of Late-run stocks during the period of active in-season management, primarily due to the very low proportion of Late-run sockeye relative to co-migrating stocks (much less than 5%). While DNA-based stock identification was accurate, the low stock proportions caused increased bias and variation in the stock composition estimates. Because the magnitude of potential bias depended on the stock mixture present, corrections to stock composition estimates for bias could only be made post-season. As a consequence, the Panel estimated Late-run catches indirectly during the fishing season using the Fishery Simulation Model, which is normally a pre-season planning tool. Projections of expected stock proportions of Late-run sockeye from this model depended not only on timing and abundance assumptions for Late-run stocks, but also on timing, abundance and diversion rate assumptions for Early Summer and Summer-run stocks. Thus, as estimates for these two run-timing groups were updated with in-season assessments, the model-based estimates of Late-run stock proportions changed. This complicated the 2004 management process, because estimates of Late-run catches in past and on-going fisheries changed with each new in-season assessment, which resulted in a moving Late-run catch target. In addition, the post-season corrections for stock composition bias mentioned above resulted in a large post-season increase in the estimated catch of True Late-run sockeye.

As a final complicating factor, Late-run sockeye arrived in coastal waters earlier than expected and continued their migration upstream with little delay in the Strait of Georgia. This increased the overlap between Summer and True Late-run sockeye and amplified the difficulty of scheduling fisheries that would target Summer-run fish while minimizing the catch of Late-run fish.

The resulting in-season estimate of True Late-run catch was 21,000 fish, which represents a 17% exploitation rate, close to the goal of 15%. However, subsequent post-season analysis of Late-run catches based on bias corrected DNA stock proportions resulted in a True Late-run catch estimate of 70,000 fish, substantially higher than the in-season estimate. The Panel's reliance on projections of Late-run stock proportions from the Fishery Simulation Model was a major contributing factor to this outcome. Compared to the assumptions that were employed in running the Fishery Simulation Model in-season, the actual return of True Late-run sockeye was larger and earlier-timed relative to Early Summer and Summer-run stocks. Consequently, the fraction of True Late-run fish harvested in mixed-stock fisheries was much higher than projected in-season, resulting in a large increase in the True Late-run catch when post-season estimates were generated.

Post-season Review

Spawning ground estimates of escapement were much lower than in-season projections of potential spawning escapement (i.e., Mission escapement minus catch above Mission). In total, the difference between estimates (DBE) was 1,312,000 fish. Only 524,000 adult sockeye were estimated to have reached the spawning grounds, the third lowest escapement since 1952 (Figure 3). The outcome stimulated controversy as to causes of the discrepancy, and resulted in public hearings and a report to the House of Commons by Canada's Standing Committee on Fisheries and Oceans. Canada's Minister of Fisheries and Oceans, appointed Judge Bryan Williams to conduct a post-season review. Testimony was accepted at several hearings throughout British Columbia. Judge Williams' review[2] concluded that:

- Abnormally high water temperatures played a role in causing greater than usual en route mortality, especially to Early Summer and Summer-run fish.
- The Mission hydroacoustic estimate was reasonably accurate in 2004 (error was likely < 10.5%), and spawning ground estimates were made in accordance with past practice.
- Improved estimates of in-river sockeye catches are necessary. Un-reported catches were believed to account for a significant number of missing sockeye, but the Committee could not quantify how many fish were attributable to this source.

The report also made a number of recommendations, a summary of which is provided in Appendix F.

Post-season estimates of adult Fraser River sockeye returns in 2004 totalled 4,184,000 fish, similar to the average return on the 2004 cycle and about 85% of the pre-season forecast of 4,920,000 fish. The Early Stuart sockeye return was 37% below the forecast, while the Early Summer-run return exceeded the forecast by 40% and the Summer-run return was 32% below the forecast. Within the Summer run, returns to Late Stuart, Quesnel and Chilko systems were particularly poor (less than half the forecast). The return of age 4 Chilko sockeye resulted in a smolt-to-adult survival rate of only 2.1%, much less (80% lower) than the average and the second lowest survival in 50 years.

[2] Williams, B. 2005. 2004 southern salmon fishery post-season review. Part one, Fraser River sockeye report. Fisheries & Oceans Canada, 91 p.

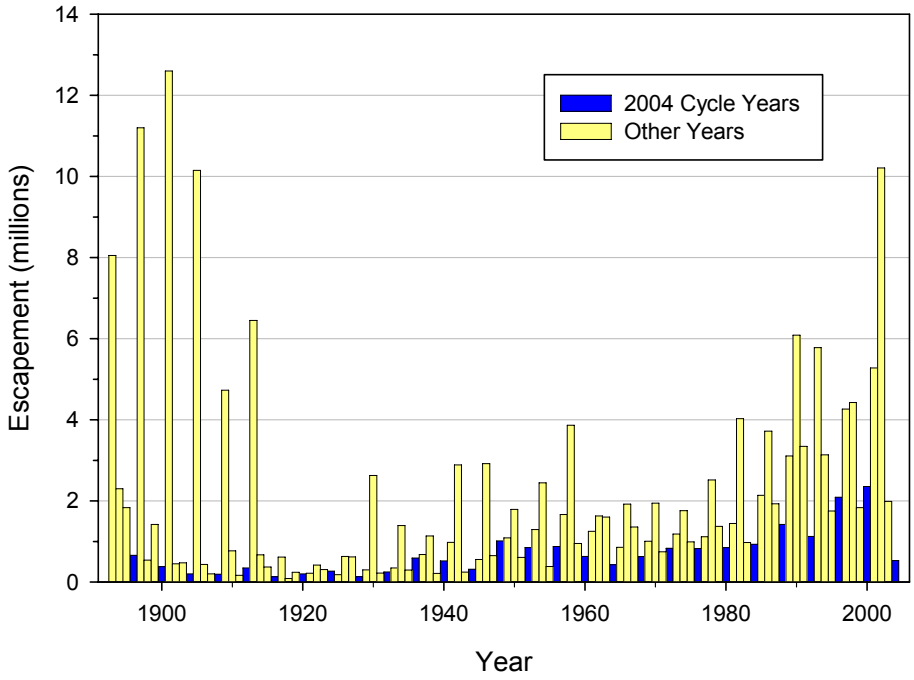

Figure 3. Total spawning escapement of Fraser River sockeye salmon between 1893-2004. Returns on the 2004 cycle are emphasized.

Migration Behaviour of Late-run Fraser River Sockeye in 2004

In 2004, as in recent past years, early entry of True Late-run sockeye stocks into the Fraser River occurred. The Late-run return was predominantly comprised of Weaver sockeye, since 2004 was an off-cycle line return (i.e., low abundance year) for the Adams River sockeye population. True Late-run sockeye were first identified (by DNA analyses) in the lower river in late July and the first Cultus sockeye passed through the Sweltzer Creek fish fence on August 23, both of which signalled the continuation of the early upstream migration behaviour of these fish. As the migration progressed, the majority of True Late-run fish entered the Fraser River with little or no delay. By August 20, half of the True Late-run escapement had passed Mission. This 50% Mission date is approximately one month earlier than the long-term average date and is the second earliest date since the early upstream migration behaviour began in 1995.

The entry pattern of True Late-run sockeye into the Fraser River was similar to the pattern in the brood year, although the brood year migration was earlier (50% Mission date of August 13 in 2000 vs. August 20 in 2004) and a smaller fraction occurred in September (6% in 2000 vs. 18% in 2004). The later upstream migration date in 2004 was associated with lower rates of en route mortality (81% in 2004 vs. 96% in 2000).

Similar to 2002 and 2003, a number of studies were undertaken that were directed at learning more about the early migration behaviour, including research that might help to more accurately describe and predict the behaviour and its impact on migration success, and possibly to identify the causal factors. These research projects were funded by the PSC's Southern Boundary Restoration and Enhancement Fund (SEF) and Canada's National Sciences and Engineering Research Council (NSERC), with further contributions of money and resources by the Canadian government and PSC's Fraser River Management Division. These projects and their preliminary findings in 2004 are described in Appendix G.

IV. MANAGEMENT ACTIONS

A. Forecasts of Returns, Escapement Targets, and Potential TAC

Canada presented the Panel with final pre-season run-size forecasts for Fraser River sockeye salmon at meetings held April 21, 2004. The forecasts were provided at the 25%, 50%, 75%, 80% and 90% probability levels (Appendix A, Table 1), where the level represents the probability that the actual run size will exceed the forecast abundance. For example, if the 50% probability level forecast was 100,000 fish, then 50% of the time the actual post-season estimate of run size would be expected to exceed 100,000 fish. At the 75% probability level, the actual run would be expected to exceed the forecast 75% of the time and to be less than the forecast the remaining 25% of the time. The run-size forecast was highly uncertain, and this uncertainty was reflected in the range of run sizes (1,802,000 to 8,663,000 fish) relative to the suite of probability levels. For planning purposes, the Panel used the 50% probability level forecasts for all sockeye run-timing groups.

Canada presented the Panel with a spawning escapement plan for Fraser sockeye at Panel meetings held April 21-22, 2004 (Appendix A, Table 2). Key components of the plan included:

1. Maintaining escapement targets for Early Stuart, Early Summer and Late-run sockeye at levels similar to recent years;
2. Establishing a maximum harvest rate of 65% on Summer-run sockeye, to maintain harvest rates below 70% on individual components of the Summer-run complex;
3. In anticipation of continued high in-river mortality associated with the early entry of True Late-run sockeye into the Fraser River, the True Late-run escapement target would be determined by a limited exploitation rate (15%) adopted by the Panel to protect these stocks.

On May 19-20, the Panel approved the 2004 Management Plan for Fraser River sockeye salmon fisheries in Panel Area waters. The Plan included documents that detailed the Principles and Constraints (Appendix B), Guidelines to Address Late Run Concerns (Appendix C) and 2004 Regulations (Appendix D). Uncertainty about the forecast abundances for sockeye stocks led the Panel to develop fishery plans at return abundances corresponding with the 25%, 50% and 75% probability level forecasts.

Also at the May Panel meeting, the Panel endorsed the use of Management Adjustments (MAs) for the 2004 management season. Taking expectations for low discharge levels and elevated river temperatures during the summer of 2004 into account, the Panel approved pre-season MAs for Early Stuart (38,000 fish, which eliminated the Early Stuart TAC for international sharing) and Early Summer sockeye (133,000 fish). The Panel also endorsed the use of in-season data to update the MAs once sufficient data became available (projected to occur on July 28 for Early Stuart sockeye). PSC staff also provided the Panel with projected daily abundances of major Fraser River sockeye stock groups in Area 20 (Figure 4).

Based on the 50% probability level forecasts and corresponding escapement targets, management adjustments, projected test fishing catches and Aboriginal Fishery Exemptions (AFE), the pre-season TAC was 2,252,000 sockeye salmon (Table 1). Pre-season targets for gross escapement totalled 2,940,000 Fraser sockeye (Table 2).

In accordance with the Treaty, the Washington share of the TAC was 16.5%. Objectives for domestic allocation of the Washington share were 67.7% for Treaty Indian and 32.3% for Non-Indian fishers.

Within Canada, pre-season expectations for non-commercial catches included 720,600 fish in Fraser River First Nations', 250,000 fish in marine First Nations', 50,000 fish in in-river recreational and 3,900 fish in marine recreational fisheries. Proportional sharing arrangements for the commercial sector were 53.5% for Area B purse seines, 11.5% for Area D gillnets, 24% for Area E gillnets, 0% for Area G trollers and 11% for Area H trollers.

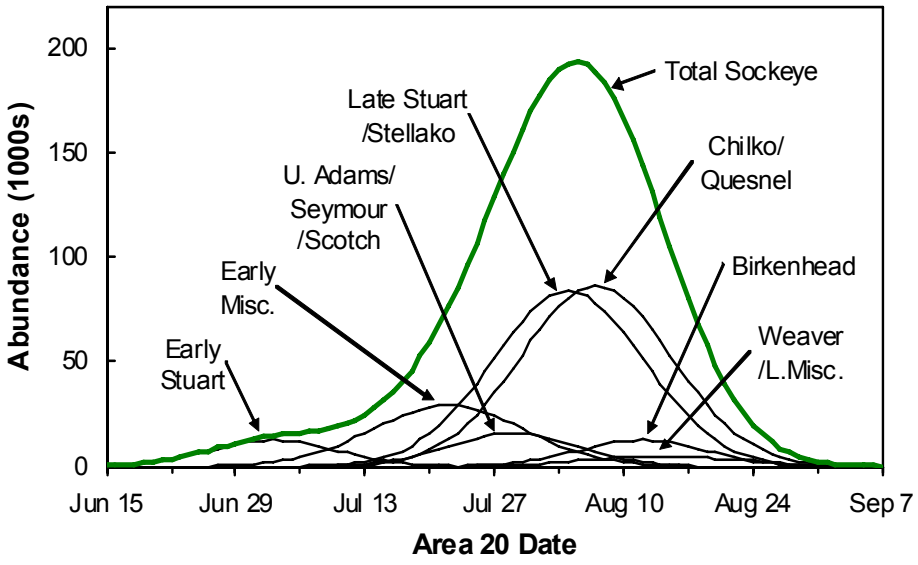

Figure 4. Expected daily abundance curves for migrating Fraser River sockeye salmon in 2004 (Area 20 date), based on forecast abundances (50% probability estimates) and timing patterns.

Table 1. Pre-season forecasts (50% probability level) of total runs, spawning escapement targets and other deductions, and total allowable catches of Fraser River sockeye salmon in 2004.

		Deductions				
Run	Forecast Run	Spawning Escapement Target	Management Adjustment	Aboriginal Exemption	Test Fishing	Total Allowable Catch
Early Stuart	216,000	90,000	38,000	80,000	5,000	3,000
Early Summer	885,000	310,000	133,000	103,000	19,000	320,000
Summer	3,501,000	1,424,000	0	213,000	70,000	1,794,000
Late	318,000	174,000	0	4,000	5,000	135,000
Birkenhead	218,000	89,000	0	3,000	4,000	122,000
"True" Lates	100,000	85,000	0	1,000	1,000	13,000
Total	4,920,000	1,998,000	171,000	400,000	99,000	2,252,000

On July 6, DFO provided a forecast of the sockeye salmon diversion rate through Johnstone Strait of 78%, which was based on mean May to June sea surface temperatures measured at Kains Island. Forecasts of peak arrival timing with associated prediction intervals for Early Stuart and Chilko sockeye stocks were provided on July 9. These forecasted 50% arrival dates in Area 20 were June 29 for Early Stuart and August 2 for Chilko sockeye, both of which representing earlier than average migration timing. On July 15, DFO revised the Chilko timing forecast to August 6 (later than average timing), after in-season body-length data from Early Stuart sockeye were included in the forecast.

B. Pre-season Regulations

Pre-season discussions by the Panel in full session and “small group” meetings that commenced in April 2004 were focussed on the development of an optimum management approach for the harvest of Summer-run sockeye in consideration of conservation concerns for True Late-run stocks.

The Fishery Simulation Model was run primarily with the 50% probability level forecast of abundance, and using the gross escapement targets and the international and domestic allocations outlined above. During the simulation modelling, DFO's forecasts of Johnstone Strait diversion rate (Figure 5), and 50% arrival timing dates for Early Stuart (to the lower Fraser River) and Chilko runs (to Area 20) were unavailable. Instead, for pre-season planning purposes the long-term average diversion rate of 50% and average marine timing (July 3 for Early Stuart, July 24 for Early Summer, August 5 for Summer, August 12 for Birkenhead and August 14 for True Late-run stocks) for all stocks were assumed. The early upstream migration behaviour of True Late-run sockeye was assumed to continue in the pre-season modelling, including: a 50% Mission date of August 26, based on recent True Late-run sockeye behaviour on the 2000 and 2001 cycle lines; and an en route mortality rate of 80% that was derived from the MA model. The 2000 and 2001 cycle lines were selected because the dynamics of True Late-run migration timing and spawning success may differ between cycle lines dominated by Late Shuswap stocks (2002 and 2003 cycle lines) versus Weaver stocks (2002 and 2003 cycle lines). As has occurred in recent years when significant Late-run conservation concerns have existed, simulation modelling focussed on harvesting Summer-run sockeye while protecting weaker co-migrating sockeye stocks. Fishing restrictions in the early part of the fishing season were modelled to protect Early Stuart and Early Summer-run sockeye stocks. However, the primary limitation to harvesting the available TAC of Summer-run fish was the 15% exploitation rate limit for True Late-run sockeye that was adopted in recognition of the likely adverse effects of early upstream migration behaviour that has occurred in recent years.

Results of the simulation modelling of the fishery at the 50% probability level forecast showed that when a 50% Johnstone Strait diversion rate was assumed, significant constraints to the harvest of Summer-run TAC existed, particularly in Canada. When an increase in the Johnstone Strait migration was modelled (77% diversion rate), additional harvest was available in Canadian fisheries, but fewer fish were available in United States fisheries. However, in each case the modelled catch of Summer-run fish was significantly below the TAC.

In the pre-season Management Plan, if abundances of both Early Summer (885,000 fish) and Summer-run sockeye (3,501,000 fish) were approximately at the 50% probability level, and their arrival timing was near historical average dates, then fisheries in Washington Panel Areas were anticipated to start during the week of July 25-31 in Areas 4B, 5 and 6C, and the week of August 1-7 in Areas 6, 7 and 7A. Canadian Panel Area fisheries in Areas 20, 17, 18 and 29 were expected to open during the week of July 25-31. If the return abundances of Early Summer and Summer-run sockeye were less than the 50% probability level forecast, the commencement and duration of fisheries could be delayed and reduced.

During the pre-season planning process, the Parties identified a number of conservation and management concerns. Species and stocks identified as being of concern to Canada included Skeena and Thompson coho salmon, Lower and Upper Georgia Strait coho salmon, Johnstone Strait coho salmon, summer-run chum salmon, Sakinaw Lake sockeye, Thompson River steelhead, and West Coast Vancouver Island and Harrison River chinook salmon. The species and stocks identified by the United States included Hood Canal and Juan de Fuca Strait summer-run chum, and Puget Sound chinook salmon.

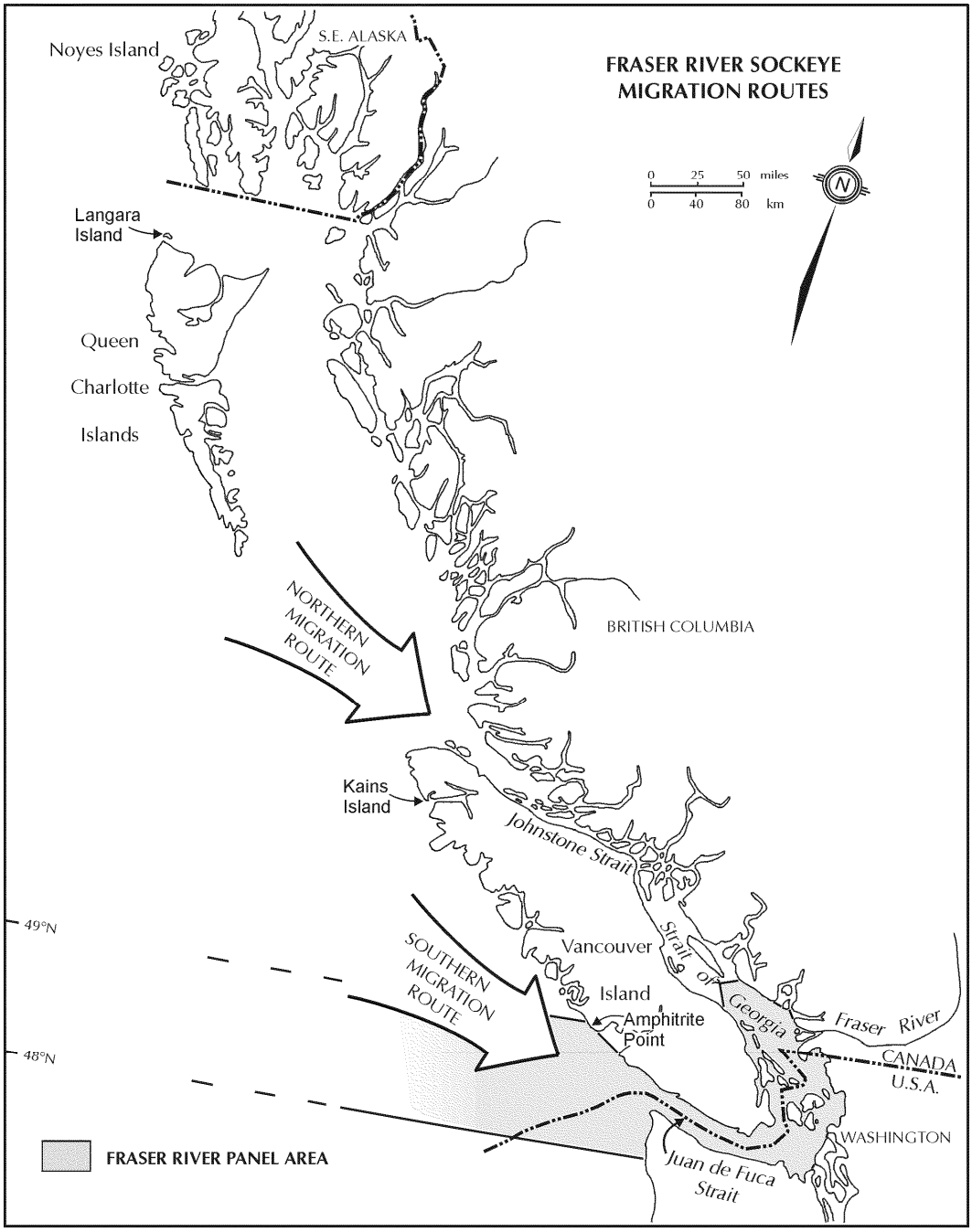

Figure 5. The northern (Johnstone Strait) and southern (Juan de Fuca Strait) routes for sockeye and pink salmon migrating to the Fraser River.

C. In-season Regulations

Between June 30 and September 15, the Fraser River Panel conferred 17 times (by telephone or in-person) to discuss run status and to enact in-season Orders (Appendix E) to regulate fisheries directed at the harvest of Fraser River sockeye salmon in Panel Areas.

Key components of the 2004 management season were very unfavourable river migration conditions for all runs, and continuation of the early upstream migration behaviour of Late-run sockeye. Water temperatures from mid-July through late-August continuously exceeded 18°C (considered the critical temperature threshold above which adverse impacts on migrating sockeye

are significant), reaching a record high of 21.5°C for several days in mid-August. The time period when temperatures were above critical levels spanned from the peak of the Early Stuart migration through the entire Early Summer, Summer and Late-run migration period (Figure 1). In addition, a large fraction of True Late-run sockeye followed the unusual migratory behaviour observed in recent years (1996-2003). Instead of delaying for an extended period (3-6 weeks) in the Strait of Georgia, they migrated directly into the Fraser River with little delay. High en route losses occurred in all run timing groups and resulted in the third lowest escapement of sockeye on the spawning grounds since 1952.

The main events of the season are summarized on a weekly basis below. This synopsis focuses on analyses and recommendations by PSC staff, and on Panel decisions.

The first in-season meeting of the Panel took place on June 30. Staff reported that the Early Stuart run was tracking between the 50% and 75% probability level forecasts, based on Area 20 gillnet test fishing CPUE (catch per unit of effort) data that were expanded using historical efficiency lines. Mission escapements were modest (5,300 fish), with numbers projected to build over the following week. Staff noted that the Fraser River discharge level was 20% below average and the water temperature (17.3°C) was 2.5°C above average for the date.

On July 8, Staff noted that the Early Stuart run was building slowly. Area 20 test fishing catches had been relatively constant over the prior week, while catches in the Whonnock test fishery had been extremely low due to substantial removal of sockeye from the net by seals. Of interest was the rapidly building proportion of Chilliwack Lake sockeye at both test fishery locations, which was anticipated given the weak forecast of Early Stuart sockeye relative to the forecast return of Early Summer stocks, including Chilliwack Lake sockeye. A provisional run-size estimate of 137,000 Early Stuart sockeye (the 75% probability level forecast, supported by model-based estimates) was adopted by the Panel. Weights of individual sockeye obtained from test fishing landings indicated that the average body size of early returning Fraser sockeye was small. The Panel was also apprised of a disturbing trend in the in-river environmental data, with discharge (4,400 cms) declining towards the level of the 1941 drought year, and temperature (17.9°C) tracking 2.7°C above normal. An updated Early Summer MA of 147,000 fish (based on updated pre-season forecast data) was adopted by the Panel.

At the meeting on July 13, it was noted that test fishing CPUEs were modest in both Area 20 and Area 12. The low CPUEs reflected the declining abundance of Early Stuart sockeye while Early Summer-run stocks were just beginning to build. Staff expressed concern that seal predation was interfering with catches in the Whonnock test fishery – seals were actively removing fish caught in test fishing nets. The predation could potentially affect species composition estimates and, consequently, daily sockeye estimates from the Mission hydroacoustic program. Low efficiencies were indicated when Area 20 gillnet test-fishing CPUEs were compared to Mission escapement estimates (with a six day time lag). This suggested daily Mission sockeye abundances were being overestimated (possibly related to seal-induced species composition issues at the Whonnock test fishing site). However, low efficiencies were also found when the CPUE of Lake Washington sockeye in Area 20 were compared to Ballard Lock counts (with a seven day time lag). These matching trends supported a conclusion that “true” efficiencies in Area 20 were low, relative to historical average efficiencies. Early Stuart run-size estimates were essentially unchanged from the previous meeting (137,000 fish), and Early Summer-run sockeye were tracking above expectations for the date. Staff apprised the Panel of a possible reason to change the pre-season MA for Early Stuart sockeye due to the inclusion of an additional model that was not initially considered. After Panel discussion, an Early Stuart MA of 29,000 fish was adopted.

At the July 16 meeting, it was noted that marine test fishery catches were slowly increasing, which was consistent with building abundances of Early Summer-run sockeye. Catches in the Johnstone Strait test fishery were modest, which indicated that the current diversion rate was low. Evaluations comparing Lake Washington and Fraser River CPUEs in Area 20 to terminal area assessments continued to show a strong similarity in apparent efficiencies. This provided evidence that daily Mission escapement estimates were reasonably accurate, and that seal predation at the Whonnock test fishing site was not causing severe assessment problems in terms of species composition estimates. Early Stuart escapement at Mission had increased in recent days and now totalled 133,000 fish. Early Stuart abundance was tracking close to the 50% probability level

forecast, and the Panel accepted a Staff recommendation to adopt a run size of 190,000 fish. Similarly, both the Early Summer and Summer-run (Late Stuart) stocks were tracking ahead of expectations for the date. While it was too early to differentiate between early timing versus larger than forecast return strength, the early indications of abundance were favourable. Based on the encouraging performance of the Early Summer-run migration compared to pre-season expectations, the Panel approved a low impact Treaty Indian drift gillnet fishery in Areas 4B, 5 and 6C.

At the July 20 meeting, it was reported that proportions of 5_2's in marine test fisheries had been increasing in recent days, largely due to contributions of Pitt River and Summer-run stocks. Diversion rates had increased, with estimates approaching 60% for the current three day period. The migration of Early Stuart sockeye was nearing completion, with a total escapement past Mission of 187,000 fish. Both Early Summer and Summer-run escapements were tracking above expected levels for the date, with the Chilliwack, Nadina and Gates stocks dominating Early Summer-run returns, and Late Stuart and Stellako stocks dominating the Summer-run migration. Environmental conditions in the Fraser River were concerning. The discharge at Hope (3,500 cms) was 35% below normal and 11% lower than the same date in 1998. The temperature (19.4°C at Qualark) was approximately 3°C above normal and 0.7°C warmer than in 1998. The Panel accepted a recommendation by Staff to adopt an accounting based estimate of 200,000 fish for Early Stuart run size. While it was too early to update the run size of Early Summer-run sockeye, Staff reported that this stock complex was either earlier or larger than forecast. The Panel approved a continuation of the Treaty Indian drift gillnet fishery in Areas 4B, 5 and 6C. All other Panel Area fisheries remained closed.

On July 23, Staff reported that the sockeye migration through Juan de Fuca Strait remained relatively constant. In recent days the migration in Johnstone Strait had begun to increase, perhaps signalling a further increase in the diversion rate. Test fishing CPUEs in the Fraser River remained low, with predation by seals affecting catches at both the Whonnock and Cottonwood in-river test fishing sites. In contrast, Mission split-beam hydroacoustic estimates indicated the escapement during the past few days was relatively strong. The early-timed Early Summer-run migration was tracking 5-days early (relative to the 50% probability level forecast). However, Staff advised the Panel that the early-timed component of the Early Summer-run stock complex appeared to have normal or later than normal timing, and consequently was likely returning above the 50% probability forecast. In contrast, the Seymour stock group was not appearing in expected numbers, and Staff reported it was either returning later than expected or at lower than forecasted abundance. Similarly, Summer-run sockeye were tracking slightly below expected abundance levels, although Late Stuart sockeye appeared to be strong. Staff reported that sockeye returns were increasing sufficiently (with respect to the pre-season criteria established by the Panel) to allow for fishing during the coming week. The Panel approved Canadian fisheries in Panel Area waters for Area B purse seines in Area 20, Area H trollers in Areas 18 and 29, and Area E gillnets in Area 29, which was consistent with the pre-season fishing plan. In Washington Panel Areas, Treaty Indian fisheries were approved for drift gillnets in Areas 4B, 5 and 6C, and net fishing in Areas 6, 7 and 7A. Non-Indian purse seine, reefnet and gillnet fisheries were also approved for Areas 7 and 7A.

By July 27, the sockeye abundance in Area 20 was showing a modest increase, with Early Summer and Summer-run stocks present in relatively equal proportions. In Johnstone Strait, test fishing operations had been adversely affected by weather, making it difficult for Staff to evaluate abundance trends. In-river test fishing continued to perform poorly due to predation by seals. However, escapement numbers were building favourably, with early-timed Early Summer-run sockeye returning above forecast, and with timing appearing to be either normal or late. The Seymour stock-group was tracking behind schedule at Mission, but was building in marine waters. Late Stuart and Stellako stocks appeared to be returning above forecast abundance levels, while Chilko and Quesnel stocks were either later than expected, or were returning below their 50% probability level forecasts. The Panel approved a provisional run-size estimate of 1,100,000 Early Summer-run sockeye, which was approximately 25% higher than the 50% probability level forecast. This increase in run size resulted in a larger Early Summer-run spawning escapement target (385,000 fish) and larger MA (182,000 fish). In-river environmental conditions continued to be detrimental to successful sockeye migration, with temperatures at Qualark reaching 19.7°C, approximately 2°C above normal. Panel Area fisheries continued as per the openings announced at

the July 23 meeting, although an extension to the Treaty Indian fishery in Areas 4B, 5, and 6C was approved.

On July 30, the Panel approved a run-size increase for Early Summer-run sockeye to 1,200,000 fish. They also approved an increase in the Early Summer MA to 263,000 fish, based on applying in-season temperature data to the revised escapement target. The Fraser sockeye migration in United States Panel waters was steady, but catches in the on-going fisheries were below levels expected from pre-season planning runs of the Fishery Simulation Model. In contrast, catches in Johnstone Strait fisheries had either met or in some cases exceeded expectations relative to the planning model. Staff advised the Panel that the diversion rate was increasing and was likely in the 70% range for the week. Mission escapement continued to build at a steady pace. Early Summer-run stocks were tracking at close to expected levels, given a run size of 1,200,000 fish. The Late Stuart and Stellako stocks continued to migrate above expected numbers and appeared to be stronger than forecast, while the escapement of Chilko and Quesnel stocks was lower than expected for the date. Based on the strength of the Early Summer return and the satisfactory increase in Summer-run abundance levels, the Panel approved Canadian fisheries in Panel Area waters for Area B purse seines in Area 20 and in Areas 18 and 29 (under special Scientific Licence), for Area H trollers in Areas 18 and 29, and for Area E gillnets in Area 29. In United States Panel Areas, Treaty Indian fisheries were approved for drift gillnets in Areas 4B, 5 and 6C, and for net fishing in Areas 6, 7 and 7A. Non-Indian purse seine, reefnet and gillnet fisheries were also approved for Areas 7 and 7A.

On August 3, Staff reported that catch trends provided strong evidence that the diversion rate was continuing to increase. Actual catches were significantly below modelled catches in United States fisheries, while catches in Johnstone Strait fisheries had exceeded expectations, even compared to model runs with diversion rates in excess of 80%. Reconstructed abundances indicated that the Early Summer-run migration was flatter and later than forecast. Based on Staff advice, the Panel approved an increase in the Early Summer run size to 1,300,000 fish, which resulted in an increased Early Summer MA to 286,000 fish. Staff also reported that Late Stuart and Stellako stocks continued to track above the 50% forecast, while Chilko and Quesnel stocks were either weak or late. In-river temperature conditions continued to be adverse for migrating sockeye. Temperatures at Qualark had exceeded 18°C continuously since mid-July, and the current temperature was 20.3°C. No changes to Panel Area regulations were announced.

At the August 6 meeting, the Panel was informed that catches in the numerous fisheries over the past week in Johnstone Strait had exceeded modelled expectations, reflecting an extremely strong northern diversion. In addition, escapement estimates at Mission had exceeded projected levels for the past few days. Reconstructed abundances supported the conclusion that the migration of sockeye through marine areas over the past week had been under-estimated based on prior test-fishing catches. In somewhat of a contradiction to the above, Summer-run stock proportions were concerning. Stellako and Late Stuart proportions remained high, but Chilko and Quesnel proportions, which should have been dominating the fishery samples, were declining in recent DNA samples. Late timing could be an explanation, but this was becoming less likely as additional data confirmed the proportional weakness of the Chilko and Quesnel stocks. In addition, recent DNA results from marine area samples showed Late-run proportions were higher than expected based on pre-season forecasts of abundance and timing. This indicated either weakness in the back half of the Summer-run migration, increased Late-run strength, or a surge of Late-run fish (which would not persist). While the elevated Late-run proportions did not necessarily equate to higher than modelled Late-run exploitation rates, the Panel was apprised that based on recent DNA results, future fisheries could be expected to harvest higher proportions of True Late-run fish than had been projected in pre-season modelling exercises. The current estimate of True Late-run catch in all fisheries was 5,359 fish (a seasonal exploitation rate of 5.4%). Based on Staff advice, the Panel approved a run-size increase for Early Summer-run sockeye to 1,500,000 fish (this resulted in an increased MA of 330,000 fish). The Panel also adopted a provisional run size of 4,000,000 fish for Summer-run sockeye. Staff noted that the run may be larger than 4,000,000 fish if migration timing was later than forecast (August 6 in Area 20), but smaller if Chilko and Quesnel stocks did not materialize in forecasted abundances. Canadian Panel Area waters were closed to fishing. In United States Panel Areas, the Panel approved Treaty Indian fisheries for drift gillnets in Areas 4B, 5 and 6C, and for net fishing in Areas 6, 7 and 7A. Non-Indian purse seine, reefnet and gillnet fisheries were also approved for Areas 7 and 7A.

By August 9, the catch and escapement of Early Summer-run sockeye totalled 1,200,000 fish. DNA analyses confirmed the continued presence of these stocks in marine area waters. These data supported a run size of 1,500,000 fish. The catch and escapement of Summer-run sockeye totalled 1,500,000 fish to date. Strong purse seine test fishing catches in Johnstone Strait over the weekend suggested continued strength in the marine migration of Summer-run sockeye, however, the escapement of fish past Mission over the weekend was below expectations. Additional data were required to confirm the provisional run size of 4,000,000 Summer-run sockeye. At the August 9 meeting, the Panel was informed of an error that had been found in the calculated Late-run impacts presented on August 6. The correction resulted in a 20% increase in the calculated catch-to-date of True Late-run fish, with a revised estimate of 7,456 fish (a 7.5% seasonal exploitation rate). It was also noted that True Late-run fish continued to be identified in DNA samples at levels above those anticipated during the pre-season planning process. No changes to Panel Area regulations were announced. On August 10, the Panel approved a short-duration Area E fishery in Area 29 with a catch target of 15,000 sockeye.

On August 13, Staff provided the Panel with an update on the current migration status of Fraser River sockeye salmon. Area 20 purse seine test fishing catches, along with catches in United States Panel waters over the past week, indicated a sustained, but low daily migration of fish via Juan de Fuca Strait. An increase in daily fish passage through Juan de Fuca Strait was indicated by increased catches reported in United States fisheries. However, catches in the Johnstone Strait purse seine test fishery were generally lower than anticipated, and below those required to support the provisional Summer-run run-size estimate of 4,000,000 fish. Similarly, Mission escapement numbers continued to track below the level required to support the current Summer-run estimate. In general, the data showed that Chilko and Quesnel stocks were not returning in expected numbers, and the weakness of these stocks was the primary reason for the drop-off in the Summer-run migration. The Panel approved a reduction in Summer-run run-size to 3,500,000 fish. Late-run sockeye, dominated by the Weaver Creek stock group, continued to comprise higher than expected proportions in DNA samples collected in marine and in-river test fisheries. Discharge in the Fraser River at Hope was near record lows for the date (2,510 cms, 23% lower than normal) and water temperatures in the Fraser River continued to be dangerously warm (19.8°C at Qualark Creek). The Panel was apprised of reports of large numbers of sockeye in the Fraser River that appeared to be sick, and were exhibiting abnormal migratory behaviour. The Panel was notified that a MA for the Summer-run stock group was warranted given the extremely adverse in-river migration conditions. The Panel took the recommendation under advisement. In order to harvest available Summer-run TAC, and because the United States had True Late-run catch available under their share of the 15% harvest ceiling, the Panel approved United States Treaty Indian fisheries for drift gillnets in Areas 4B, 5 and 6C, and for net fishing in Areas in Areas 6, 7 and 7A.

At an August 16 Panel meeting, the Panel adopted a run-size estimate of 3,200,000 Summer-run fish. The Summer-run estimate had declined from earlier estimates due to a rapid reduction in the marine area migration of Summer-run sockeye. Catches in United States fisheries exceeded projections, which suggested a decline in the diversion rate. Due to the reduced Summer-run run size and larger than anticipated catches in United States fisheries, the Panel announced that further commercial fishing in Panel Areas was unlikely for the balance of the season. In-river temperature conditions for Fraser River sockeye continued to be adverse for migrating sockeye, and the Panel was informed of the likelihood of high in-river mortality. The Fraser River discharge at Hope was 2,400 cms (26% lower than average for the date), and the water temperature at Qualark was 21.1°C (3.2°C above average). Acting on the advice of PSC staff, the Panel adopted a Summer-run MA of 571,000 fish.

On August 20, Staff reported that the marine migratory abundance of Summer-run sockeye continued to decline rapidly, and a further reduction in the run size of Summer-run sockeye may be warranted. Recent DNA analyses indicated that True Late-run and Birkenhead sockeye currently comprised a low proportion of the Fraser sockeye migration in marine and Fraser River assessment areas. Staff reported that preliminary in-season catch estimates in United States fisheries were increasing as fish-ticket totals confirmed higher landings than had been projected. The water temperature of the Fraser River at Qualark was 21.3°C, and over the prior five days had

set new record high temperatures on each of those dates since recordings were initiated in 1942. Severe en route mortalities were anticipated as a result of the extreme water temperatures.

At the last in-season Panel meeting on August 27, the Panel approved a further reduction in the Summer-run run size to 2,500,000 fish, with a corresponding 50% timing date in Area 20 of August 2 (four days earlier than average). Previously approved run-size estimates were also reviewed for Early Stuart (200,000 fish), Early Summer-runs (1,500,000 fish) and Late-runs (318,000 fish). At the meeting, Staff reported that Canadian and United States commercial catches for the season totalled 1,517,000 fish, while an additional 714,000 fish had been harvested in non-commercial fisheries. As agreed during pre-season planning, no run-size updates were provided for True Late-run sockeye. The pre-season forecast of 100,000 fish remained as the operational number for management. Similarly, the forecast estimate of 218,000 Birkenhead sockeye was unchanged. The potential spawning escapement (Mission escapement minus catch removals upstream of Mission) was 2,179,000 fish, and the in-season projection of total Fraser sockeye returns was approximately 4,518,000 fish.

The final in-season estimate of the Fraser sockeye return, coinciding with the best available information on October 2 when the Panel relinquished control of United States Panel Areas, was 4,438,000 fish. This total includes accounted runs of 195,000 Early Stuart, 1,549,000 Early Summer, and 2,422,000 Summer-run stocks, and changes to the projected run sizes of Birkenhead (145,000 fish) and True Late-run sockeye (127,000 fish).

Fishing times for commercial net fisheries in Canadian and United States Panel Areas are summarized in Tables 2 and 3, as are the dates when the Panel relinquished regulatory control of these areas. Fisheries in both countries were generally conducted with the objective of achieving international and domestic allocation goals. Canada regulated commercial fisheries in non-Panel Areas in coordination with Panel management. Regulatory control of Panel Areas was relinquished in accordance with the pre-season schedule.

Week-ending dates when Canadian Panel Areas were open for sockeye retention are shown in Table 2. No gillnet fishing was scheduled in Area 20 due to coho conservation concerns. Two two-day purse seine fisheries were scheduled in Area 20 for international and domestic sockeye allocation purposes during the weeks of July 25-31 and August 1-7. These fisheries had limited vessel participation, and were monitored by DFO to control coho and chinook salmon encounters (there was a mandatory release of all coho and chinook encountered in the fishery, with boats directed away from sub-areas where encounter rates were too high). A two-day selective fishery consisting of two vessels was also conducted in the week of July 25-31. Three days of fishing were scheduled for gillnet fisheries in Area 29 for international and domestic sockeye allocation purposes, during the weeks of July 25-31, August 1-7 and August 8-14. The last of these was a limited two hour fishery on August 11, designed to catch a small remaining commercial sockeye allocation that existed at the time of the opening. Area H troll fisheries were scheduled in Area 18, coincidentally with non-Panel Area H troll fisheries, for the period spanning July 26-August 3.

Net fishing periods in United States Panel Areas are shown in Table 3. These fisheries were conducted to meet the international and domestic allocation obligations of the Panel. The Treaty Indian fishery in Areas 4B, 5 and 6C was open for a total of 660 hours between noon on July 18 and 11:59 p.m. on August 14. The Treaty Indian fishery in Areas 6, 7 and 7A was open for 436 hours during regularly scheduled fisheries spanning from July 26 to August 14. The Non-Indian gillnet fishery in Areas 7 and 7A was open for a total of 176 hours spanning a three week period from July 28 to August 13. Similarly, Non-Indian purse seine fisheries (176 hours) and reefnet fisheries (192 hours) were scheduled during the same period.

Table 2. Actual fishing times (days) in major Canadian fisheries in the Fraser River Panel Area in 2004.

	Area 20		Areas 18, 29	Area 29	
Date	Purse Seine	Gillnet	Troll	Gillnet	
Jun.27-Jul.17	Closed	Closed	Closed	Closed	
Jul.18-Jul.24	Closed	Closed	Closed	Closed	
Jul.25-Jul.31	2 *1*	Closed	6	1	*3*
Aug.1-Aug.7	2 *2*	Closed	3	1	
Aug.8-Aug.14	Closed	Closed	Closed	1	*4*
Aug.15-Aug.21	Closed	Closed	Closed	Closed	
Aug.22-Aug.28	Closed	Closed	Closed	Closed	
Aug.29-Sep.4	Relinq.	Relinq.	Closed	Closed	
Sep.5-Sep.11			Closed	Closed	
Sep.12-Sep.18			Closed	Closed	
Sep.19-Sep.25			Closed	Closed	
Sep.26-Oct.2			Relinq.	Closed	
Oct.3-Oct.9			Relinq.	Relinq.	
Total	4	0	9	3	

1 Assessment fishery.
2 Small fleet, fishery ended early.
3 12 hour opening.
4 2 hour opening.

Table 3. Actual fishing times (hours) in major United States net fisheries in the Fraser River Panel Area in 2004.

	Treaty Indian		Non-Indian		
	Areas	Areas	Areas 7 and 7A		
Date	4B, 5, 6C	6, 7, 7A	Purse Seine	Gillnet	Reefnet
Jun.27-Jul.17	Closed	Closed	Closed	Closed	Closed
Jul.18-Jul.24	156	Closed	Closed	Closed	Closed
Jul.25-Jul.31	168	104	48	48	48
Aug.1-Aug.7	168	164	64	64	80
Aug.8-Aug.14	168	168	64	64	64
Aug.15-Aug.21	Closed	Closed	Closed	Closed	Closed
Aug.22-Aug.28	Closed	Closed	Closed	Closed	Closed
Aug.29-Sep.4	Relinq.	Closed	Closed	Closed	Closed
Sep.5-Sep.11		Relinq.	Closed	Closed	Closed
Sep.12-Sep.18			Closed	Closed	Closed
Sep.19-Sep.25			Closed	Closed	Closed
Sep.26-Oct.2			Relinq.	Relinq.	Relinq.
Total	660	436	176	176	192

* Times recorded to the nearest hour.

Table 4. Preliminary estimates of fishery catches, spawning escapement and total run of Fraser River sockeye salmon during the 2004 fishing season, by country and area.

	Number of Fish	% of Run
CANADA		
COMMERCIAL CATCH		
Fraser River Panel Area		
Areas 121-124 Troll	0	
Area 20 Net	10,600	
Areas 17-18 and 29 Troll	0	
Area 29 Net	246,300	
Total	256,900	6.2%
Non-Panel Areas		
Areas 1-10 Troll and Net	0	
Areas 11-16 Troll and Net	787,700	
Areas 124-127 Troll	0	
Total	787,700	19.1%
Selective Fisheries	13,100	0.3%
Commercial Total	1,057,700	25.7%
FIRST NATIONS CATCH		
Marine Areas - food, social, ceremonial		
Areas 12-16, 18, 20, and 123-126	249,200	
Area 29-1 to 7	7,000	
Total	256,200	6.2%
Fraser River - food, social, ceremonial		
Below Sawmill Creek	225,300	
Above Sawmill Creek	150,400	
Total	375,700	9.1%
Economic Opportunity (all areas)	268,000	6.5%
First Nations Total	899,900	21.8%
NON-COMMERCIAL CATCH		
ESSR *	3,500	
Weaver Channel Surplus Harvest	0	
Charter	0	
Recreational - Marine	4,800	
Recreational - River	50,300	
Non-Commercial Total	58,600	1.4%
CANADIAN TOTAL	2,016,200	48.9%
UNITED STATES		
COMMERCIAL CATCH		
Fraser River Panel Area		
Areas 4B, 5 and 6C Net	15,100	
Areas 6 and 7 Net	128,600	
Area 7A Net	53,000	
Total	196,700	4.8%
Non-Panel Areas		
Alaska Net	0	0.0%
Commercial Total	196,700	4.8%
NON-COMMERCIAL CATCH		
Ceremonial & Subsistence	100	0.0%
UNITED STATES TOTAL	196,800	4.8%
TEST FISHING		
COMMISSION		
Areas 20 and 29	24,100	
Area 7	0	
Commission Total	24,100	0.6%
CANADA		
Areas 12 and 13	49,400	1.2%
TEST FISHING TOTAL	73,500	1.8%
TOTAL CATCH	2,286,500	55.5%
SPAWNING ESCAPEMENT	525,300	12.7%
DIFFERENCE BETWEEN ESTIMATES **	1,311,400	31.8%
TOTAL RUN	4,123,200	100.0%

* Harvest of Weaver sockeye in terminal areas that were Excess Salmon to Spawning Requirements (ESSR).

** [Mission escapement + First Nations catch below Mission] - [total Fraser River First Nations catch, in-river recreational catch & spawning escapement].

V. CATCH SUMMARY

The total return in 2004 of 4,185,000 Fraser River sockeye salmon (Table 4) was between the pre-season run-size forecasts at the 50% (4,920,000 fish) and 75% (2,872,000 fish) probability levels. In the previous 13 returns on the 2004 cycle line (1952 to 2000), sockeye abundance has ranged from a low of 1,825,000 fish in 1964 to a high of 6,442,000 fish in 1992. The 2004 return was slightly above the average return for the cycle line of 3,968,000 fish (Figure 6). The commercial exploitation rate (32%) was close to the lowest previously recorded for this cycle over the period of record (i.e., since 1952). The return years 1996 and 2000 each had commercial exploitation rates of 28%.

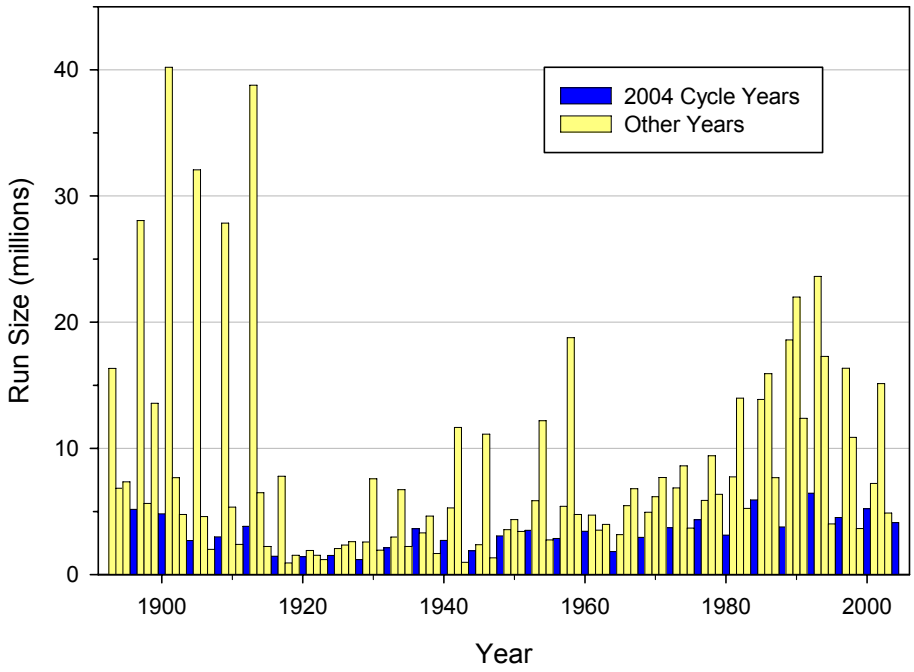

Figure 5. Total run sizes of Fraser River sockeye salmon between 1893-2004. Returns on the 2004 cycle are emphasized.

Consistent with the low exploitation rate, the potential spawning escapement of 1,837,000 fish (assuming no en route loss occurred) was the third highest percentage (44%) of the run on record (the 1996 and 2000 return years had potential spawning escapements of 53% of the run). The spawning escapement component of the potential spawning escapement was 525,000 fish, however, while the difference between estimates (DBE) component was 1,311,000 fish (71% of the potential escapement). Under the assumption that most of this difference was due to en route mortality caused by the extremely high river temperatures that migrating sockeye were exposed to in 2004, this was the highest proportional loss of fish on record between Mission and the spawning grounds. In a technical sense, DBEs result from a variety of sources including en route mortality and assessment errors in the components used to calculate DBEs: Mission escapement, spawning ground escapement, in-river catch, and stock composition for each of these. In years of adverse migratory conditions, however, Mission-based estimates are often assumed to be more accurate estimates of in-river migration than the total of spawning escapements plus in-river catch estimates upstream of Mission. In these cases the DBEs become part of the total production and thus are assumed to reflect en-route mortality.

Catches of Fraser River sockeye salmon in all fisheries totalled 2,349,000 fish (Table 4). Canadian catches of 2,016,000 sockeye were comprised of a commercial harvest of 1,058,000 fish, which included a selective fishery catch of 13,000 fish, a First Nation's catch of 900,000 fish, an ESSR catch of 3,500 fish and marine and in-river recreational catches of 55,000 sockeye. United

States fishers caught 196,000 fish in Panel Area waters, and an additional 63,000 sockeye in purse seine fisheries conducted in District 104, Alaska. Almost all of the catch in United States fisheries was harvested by the commercial sector. In addition to the catches outlined above, test fisheries authorized by the Fraser River Panel landed 74,000 sockeye.

A. Canada

The commercial catch in Canada was 1,058,000 fish, including 257,000 fish in Panel Areas, 788,000 fish in Non-Panel Areas, and an additional selective fishery catch of 13,000 fish in non-Panel Areas. Non-commercial catches included recreational catches of 5,000 fish in marine areas and 50,000 fish in the Fraser River.

Preliminary estimates of Canadian commercial catches of Fraser River sockeye salmon by gear type and area are presented in Table 5. Area B (southern) purse seines caught 524,000 sockeye, including a selective fishery catch of 14,000 fish and assessment fishery catch of 10,500 fish. Area D (Johnstone Strait) gillnets caught 155,000 sockeye, including 6,500 fish caught in assessment fisheries. Area E (Fraser River) gillnets caught 246,000 fish. Within the troll gear sector, Area G (outside) trollers did not have a sockeye allocation, while Area H (inside) trollers caught 133,000 sockeye. Weekly catches in Canadian fishing areas are shown in Appendix H (Tables 1-4).

First Nations' fishers caught 900,000 sockeye, including 256,000 fish harvested in marine fisheries and 644,000 fish harvested in the Fraser River (Appendix H, Table 5). The catch distribution in the Fraser River was as follows: 199,000 fish in the Fraser River below Mission; 294,000 fish in the Fraser River between Mission and Sawmill Creek; and 150,000 fish in the mainstem of the Fraser River and in tributaries upstream of Sawmill Creek. Economic opportunity fisheries accounted for 268,000 of the catch below Sawmill Creek. The in-river harvest between the Vedder/Fraser confluence and Steveston (where Cultus Lake sockeye are vulnerable to harvest) was 234,000 fish.

Table 5. Preliminary estimates of Canadian commercial catches of Fraser River sockeye salmon by gear type, license designation and statistical area during the 2004 fishing season. *

	Purse Seine		Gillnet			Troll			
Areas	Area A	Area B	Area C	Area D	Area E	Area F	Area G	Area H	Total
1-10	0		0			0			0
11-16		500,000		154,700	0		0	133,000	787,700
121-127		0		0			0		0
20		10,600			0		0		10,600
17, 18, 29		0			246,300			0	246,300
Selective	0	13,100	0	0	0	0	0	0	13,100
Total Catch	0	523,700	0	154,700	246,300	0	0	133,000	1,057,700
% of Catch	0.0%	49.5%	0.0%	14.6%	23.3%	0.0%	0.0%	12.6%	100.0%

* DFO preliminary post-season catch estimates.

B. United States

Catches of Fraser River sockeye in the United States Panel Area fisheries totalled 196,000 fish, almost all of which were harvested commercially (Table 6). Treaty Indian fishers harvested 115,000 fish in commercial fisheries, including a catch of 14,000 fish in Areas 4B, 5 and 6C, and 101,000 fish in Areas 6, 7 and 7A. Non-Indian catches totalled 81,000 sockeye, including 35,000 fish by purse seines, 29,000 fish by gillnets and 17,000 fish by reefnets. Weekly catches of Fraser River sockeye salmon in United States Panel Areas are shown in Appendix H (Table 6). In addition to Panel Area sockeye catches, purse seine fisheries in District 104, Alaska, harvested an estimated 63,000 Fraser River sockeye salmon.

Table 6. Preliminary estimates of United States commercial catches of Fraser River sockeye salmon by user group, gear type and statistical area during the 2004 fishing season. *

Areas	Ceremonial & Subsistence	Purse Seine	Gillnet	Reefnet	Total
Treaty Indian					
4B, 5 and 6C	100	0	15,100	0	15,200
6 and 7	0	46,600	22,600	0	69,200
7A	0	9,300	22,000	0	31,300
6, 7 and 7A Total	0	55,900	44,600	0	100,500
% of Catch	0.0%	55.6%	44.4%	0.0%	100.0%
Total Catch	100	55,900	59,700	0	115,700
% of Catch	0.1%	48.3%	51.6%	0.0%	100.0%
Non-Indian					
4B, 5 and 6C	0	0	0	0	0
7	0	16,700	25,800	16,900	59,400
7A	0	18,300	3,100	300	21,700
Total Catch	0	35,000	28,900	17,200	81,100
% of Catch	0.0%	43.2%	35.6%	21.2%	100.0%
United States					
Panel Area Total	100	90,900	88,600	17,200	196,800
Alaska (District 104) Catch					0
Total Catch					196,800

* Washington catches from Washington Department of Fish and Wildlife "soft system".

VI. STOCK MONITORING

The goal of the stock monitoring program is to assess run size, daily abundance, timing and diversion rate of Fraser River sockeye salmon at different points along their migration route. This information is required for the development of fishing plans that aid in meeting escapement and catch allocation objectives. Commercial catches usually provide much of the data used in the analyses. Test fisheries (Table 7) conducted by the Commission or by DFO (at the Commission's request) provide important data before and after the commercial fishing season and between fishing periods. In addition, reduced-effort "assessment" fisheries in Canadian waters were conducted by Area D gillnets (Area 12) and Area B purse seines (Area 12) for the purpose of augmenting the data on which assessments of sockeye abundance, migration route and timing are based. Information about upstream migration in the Fraser River is primarily obtained by the hydroacoustic program at Mission, B.C., visual observations at Hells Gate and analysis of First Nations' catches in the Fraser River.

The upstream passage of sockeye in 2004 was monitored using Whonnock test fishing data from June 23 to September 21, and using hydroacoustic data from June 25 to September 6. Between June 26 and September 6, estimates of daily sockeye escapements were calculated by applying species composition data collected from gillnet test fishing at Whonnock to the hydroacoustic estimates. Prior to June 26 and after September 6, upstream passage was monitored solely using Whonnock test fishing data. In addition, the PSC and DFO jointly conducted the ninth year of an experimental split-beam hydroacoustic program.

Daily observations at Hells Gate between July 2 and September 2 provided qualitative information about the success of upstream fish passage and abundance. The observations also provided a rough index for projecting the relative abundance of sockeye migrating through Hells Gate.

Table 7. Test fishing operations that were approved by the Fraser River Panel for the 2004 fishing season.

Area	Gear	Dates	Operated by
		Canadian Panel Areas	
20	Purse Seine	July 20 - August 13	PSC
20	Gillnet	June 22 - August 9	PSC
29-13	Gillnet	July 8 - August 29	PSC
29-16	Gillnet	June 23 - October 5	PSC
29-1 to 6	Troll	August 12 - September 2	PSC
		Canadian non-Panel Areas	
12	Gillnet	July 9 - August 4	DFO
12	Purse Seine	July 19 - August 25	DFO
13	Purse Seine	July 19 - August 25	DFO
		United States Panel Areas	
7	Reefnet	July 19 - August 19	PSC

A. Sockeye Salmon

Run-size estimation of Fraser River sockeye by stock group is primarily based on catch, effort, escapement, racial composition and diversion rate data. These data are analysed using catch-per-unit-effort (CPUE), cumulative-normal, cumulative-passage-to-date and Bayesian[3] models, which are described in the Pacific Salmon Commission's Technical Report No. 6[4] and in the Fraser River Panel's 1995 Annual Report[5]. Much of the data used in these models are obtained from commercial fisheries. In 2004, however, commercial fishing was very restricted. Therefore, test fishing data (with additional information from assessment fisheries) were used more extensively than normal in assessing sockeye abundances.

Early Stuart sockeye are the first Fraser River sockeye run to arrive in coastal waters off British Columbia and in 2004 were forecast to return at an abundance of 216,000 fish (50% probability level forecast). In late June, although it was early in the migration, Early Stuart sockeye were tracking close to this forecast abundance. By July 8, however, Early Stuart abundance was tracking considerably below the forecast level, and estimates ranged from 131,000 to 156,000 fish. The Panel approved a provisional run-size estimate of 137,000 fish (75% probability level forecast). By July 16, run-size estimates ranged from 180,000 to 189,000 fish due to the sustained migration of Early Stuart sockeye, and the Panel adopted an Early Stuart run-size estimate of 190,000 fish. The estimated escapement of Early Stuart sockeye past Mission was 133,000 fish. On July 20, the Panel agreed to increase the Early Stuart run size from 190,000 to 200,000 fish. The estimated 50% migration timing of Early Stuart sockeye through Area 20 was July 6 (three days later than expected pre-season). Final in-season estimates of Early Stuart abundance and gross escapement (past Mission) were 195,000 and 191,000 fish, respectively.

By late July, Early Summer-run sockeye predominated in the marine approach areas, resulting in a shift in management focus to these sockeye. Early Summer sockeye were forecast to return at an abundance of 885,000 fish in 2004. The higher forecasted return of these stocks relative to the recent cycle-year average was primarily due to large spawning escapements in the brood year (2000).

[3] Gazey, W.J. and Cave, J.D. 2000. A Bayesian inseason estimation model for Fraser River sockeye salmon. Unpublished report available from the Pacific Salmon Commission, Vancouver, B.C.

[4] 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.

[5] 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.

Preliminary assessments in mid-July suggested that Early Summer-run sockeye were tracking above the 50% probability level forecast of 885,000 fish. Run-size estimates on July 26 ranged from 760,000 to 1,100,000 fish. On July 27, the Panel adopted a provisional run-size estimate of 1,100,000 Early Summer-run sockeye, almost 25% higher than forecast. By July 30, estimates ranged between 1,200,000 and 1,350,000 fish, and the Panel approved a further increase to 1,200,000 fish. The strong abundance of returning Nadina, Pitt and Chilliwack sockeye (in the early-timed component of this run) contributed to the larger-than-forecast return of Early Summer-run sockeye. By the end of July, run-size estimates of the later-timed Scotch/Seymour component ranged between 206,000 and 289,000 fish. As these sockeye transited Johnstone and Juan de Fuca Straits and entered the Fraser River, the marine migration of Early Summer-run sockeye was projected to decline rapidly. The Panel approved an increase in the run-size estimate for Early Summer stocks to 1,300,000 fish on August 3, and a further increase to 1,500,000 fish on August 6. At this time, the marine migration of these stocks was declining. The estimated migration of Early Summer-run sockeye past Mission to August 19 was 932,000 fish. By August 27, the accounting-based estimate of Early Summer-run sockeye was 1,550,000 fish. The estimated 50% migration timing of Early Summer-run sockeye through Area 20 was July 27 (three days earlier than expected pre-season). Final in-season estimates of Early Summer-run sockeye abundance and gross escapement were 1,549,000 fish and 1,045,000 fish, respectively. The Scotch and Seymour components of the Early Summer complex comprised 17% and 19% of these estimates, respectively.

Similar to recent years, the assessment of Summer-run abundance was based primarily on projections of abundance through the test fisheries and on the reconstruction of catches and escapements past Mission (cumulative-normal, cumulative-passage and Bayesian models), rather than on commercial catch and effort models.

Summer-run sockeye were forecast to return at an abundance of 3,501,000 fish (higher than the recent cycle-year average), which was over 70% of the total Fraser River sockeye run. By late July, Summer-run sockeye were tracking at approximately the 50% probability level forecast of abundance in marine assessment areas: run-size estimates ranged from 3,200,000 to 4,900,000 fish. On August 6, the Panel approved an increase in the provisional run-size estimate to 4,000,000 Summer-run sockeye. By August 13, run-size estimates ranged from 2,600,000 to 3,700,000 fish, and the Panel approved a reduction to 3,500,000 fish. Following a rapid decline in the Summer-run marine area migration, there was a further decrease to 3,200,000 fish on August 16.

Analyses continued to indicate strength in Late Stuart and Stellako stock abundance, while estimates of Chilko and Quesnel sockeye were lower than expected. The peak migration of Summer-run sockeye through Area 20 was estimated to be August 1 (five days earlier than expected pre-season). The early timing of Summer-run sockeye resulted in initial run-size estimates being too large. Weakness in the later-timed portions (Chilko and Quesnel) of the Summer-run migration was also evident. By early September, the abundance of early-timed stocks (Late Stuart and Stellako) was estimated at 1,650,000 fish, while the abundance of Chilko and Quesnel stocks was estimated at 850,000 fish. These returns contrasted with the pre-season forecast in which the Late Stuart/Stellako and Chilko/Quesnel groups were expected in roughly equal proportions. Continued weakness in the Summer-run migration prompted the Panel to decrease the run size to 2,500,000 fish (29% lower than forecast) on August 27. By the end of the season, Summer-run sockeye abundance was estimated at 2,422,000 fish with a gross escapement of 1,403,000 fish.

Abundance updates for True Late-run sockeye were not provided in-season due to stock identification difficulties associated with the small proportion of these sockeye relative to co-migrating stocks, and overlap in marine migratory timing of Summer and Late-run stocks. The Area 29 troll test fishery in the southern Strait of Georgia caught few sockeye in areas where True Late-run sockeye typically delay prior to entering the Fraser River.

The 50% probability level forecast of True Late-run sockeye (100,000 fish) was about one sixth of the recent cycle-year average due to a shortage of successful spawners in the brood year. Although an estimated 300,000 True Late-run sockeye migrated into the Fraser River in 2000, the en route and pre-spawning mortality of these fish was approximately 90%. This high in-river

mortality was associated with abnormally early entry of these Late-run sockeye into the Fraser River. The forecast of Birkenhead-type sockeye was 218,000 fish, approximately half of the recent cycle-year average since 1980. By early August, analyses indicated that Birkenhead and True Late-run sockeye were present in low proportions in marine assessment areas. By mid-August, the return abundance of Late-run sockeye through marine assessment areas was tracking higher than pre-season expectations. By August 20, estimates of True Late-run and Birkenhead sockeye remained at the forecast levels of 100,000 fish and 218,000 fish, respectively. By the end of the season, True Late-run and Birkenhead sockeye abundances remained unchanged at 100,000 and 218,000 fish, respectively, with gross escapements of 104,000 Birkenhead and 112,000 True Late-run sockeye. The established 50% migration timing of True Late-run sockeye through Area 20 was August 8 (six days earlier than expected pre-season).

The pre-season forecast of the proportion of Fraser sockeye that would divert through Johnstone Strait was 78%. It was therefore expected that relatively few sockeye would migrate through U.S waters. By late July, the migration in Johnstone Strait had begun to increase, which may have indicated a further increase in diversion rate. By early August, the proportion of Fraser sockeye migrating through Johnstone Strait increased from approximately 70% in late July to approximately 90%, as evidenced by catch trends in the test fisheries. The average diversion rate for the season was 70%, slightly lower than the pre-season forecast.

Cottonwood test fishing CPUEs are plotted against the daily hydroacoustic estimates of sockeye passage at Mission in Figure 7. Cottonwood data are lagged one day during the Summer-run period and two days commencing September 1 during the Late-run period to adjust for the period of migration between Cottonwood and Mission.

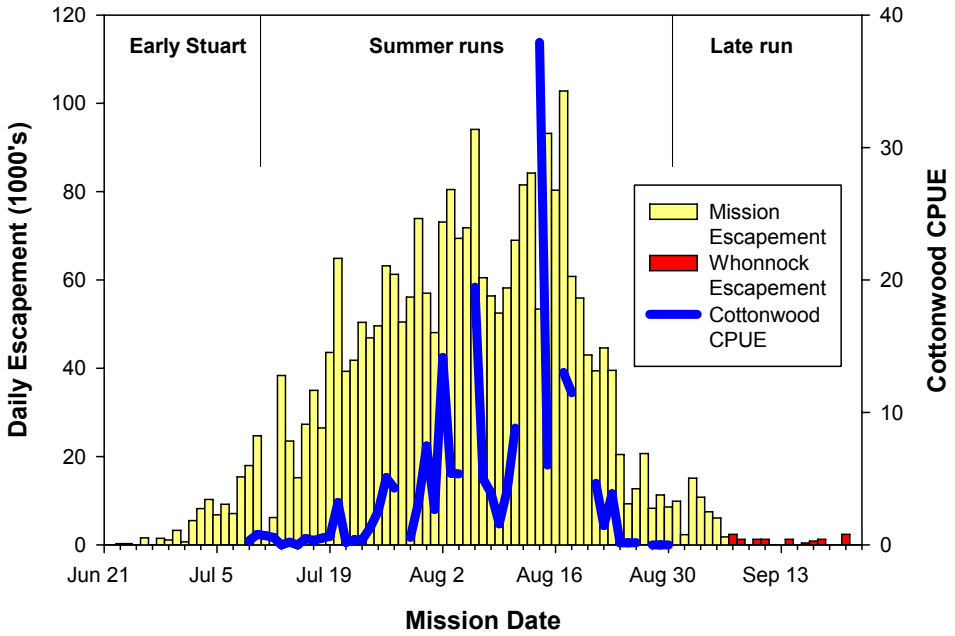

Figure 6. Daily Mission escapements of sockeye salmon estimated by Mission echosounding (after June 25) and Whonnock test fishing CPUE (after September 6), compared with test fishing CPUEs at Cottonwood one to two days earlier.

Due to low snowpack levels in the Fraser River watershed, lower than normal flows and periodic high water temperatures were projected for the summer of 2004. Fraser River water temperatures exceeded 19°C after mid-July and were at record levels (between 20°C and 21°C) for most of the period between late July and late August. Only by early September did temperatures decrease from the record high on August 18 and 19 (21.5°C) to temperatures more satisfactory (less than 18°C) for successful sockeye migration. Such a long interval of extremely high water temperatures coupled with almost record low discharge levels likely resulted in severe mortality of

Early Stuart, Early Summer and Summer-run sockeye en route to their spawning grounds. There were several reports by DFO of large numbers of sockeye in the Fraser River that appeared physically stressed and unhealthy, and exhibited abnormal migratory behaviour. In addition, a large mudslide in late August blocked the Chilcotin River for 10 hours on August 29, which likely caused further mortality of Chilko sockeye.

Observations at Hells Gate indicated that significant numbers of sockeye were unhealthy, likely due to the long period of adverse conditions in the Fraser River. By August 31, observations at Hells Gate were minimal due to extremely poor visibility. By September 1, the full impact of the Chilcotin slide was evident in the extremely muddy water at Hells Gate, which precluded observation of migrating Fraser River sockeye. The hydroacoustic program was terminated on September 2.

B. Split-Beam Hydroacoustic Study at Mission

Following feasibility studies and in-season testing since 1999, PSC staff received approval from the Fraser River Panel to replace the single-beam hydroacoustic system with the split-beam system as the official source of Mission escapement estimates, starting with the 2004 management season. The primary goal of the split-beam hydroacoustics program at Mission was to provide near real-time estimates of daily total salmon migratory abundance past Mission for in-season management use. Another important project was to test the use of a dual-frequency identification sonar system (DIDSON) in the Fraser River at Mission to estimate fish abundance and behaviour, for comparison to estimates from the split-beam system. The DIDSON trials and associated experiments were conducted with funding provided by the Southern Boundary Restoration and Enhancement Fund and the Pacific Salmon Commission. Some of the main results of the 2004 season were:

1. The split-beam estimation system produced near real-time daily estimates for management use for the entire season;
2. Staff detected and rectified a target recognition bias in visual cleaning of the raw data in early July;
3. DIDSON imaging sonar was successfully tested at Mission, resulting in a large amount of high-quality image data for study purposes as outlined in the 2004 DIDSON proposal to the Southern Boundary Restoration and Enhancement Fund;
4. Split-beam estimates of fish passage and behaviour during a 36 hour period near the south bank were verified with data from the DIDSON sonar. The DIDSON system can verify split-beam acoustic estimates of fish abundance at Mission, where the river is too murky to employ a visual counting method.

In the months following the field-season, Staff carried out detailed analyses of in-season data to assess the performance of the split-beam system in providing in-season estimates of the number of salmon migrating past Mission. The results of these analyses were presented at meetings with DFO's Applied Technologies group, the Fraser River Panel Technical Committee and the Fraser River Panel. The split-beam estimation program was reviewed by internal and external experts. Based on the post-season analyses, split-beam estimates were more accurate and precise than single-beam estimates. Three potential sources of biases were identified for further investigation:

- Variation among in-season Staff in their ability to accurately identify targets;
- Whether estimates of upstream migration are biased by the application of south-bank measurements of fish speed, depth and direction of travel to fish that migrate in other parts of the river (middle and north bank); and
- Fish avoidance of the transecting vessel during soundings, especially in near-shore areas.

These findings were provided to the 2004 Southern Salmon Fishery Post-Season Review chaired by the Honourable Bryan Williams, Q.C. In summary, the split-beam system was successfully implemented at the Mission hydroacoustic station as an in-season tool for the 2004 management season. Staff are taking steps to improve the future use of this system as a reliable tool for in-season management of Fraser River sockeye and pink salmon.

VII. RACIAL IDENTIFICATION

PSC staff conduct programs designed to identify the stock proportions of Fraser River sockeye salmon in commercial, test and First Nations' catches. These data provide information on the abundance and timing of sockeye stocks as they migrate to their natal rivers in the Fraser River watershed. Racial data are also used to account for Fraser River sockeye salmon wherever they may be caught, and to apportion the daily estimates of sockeye escapement past Mission into discrete stock groups.

Racial analysis methods for sockeye salmon in 2004 were similar to those employed in 2002 and 2003 with scales for scale pattern analysis[6] and tissue samples for DNA analysis[7] collected regularly from marine, river and test fisheries. Both scale and DNA data were analyzed to generate racial composition estimates but, because of overlap in scale characteristics, management decisions were primarily based on DNA analyses. Late-run proportions in fisheries were expected to be low and a minor correction was applied to Late-run estimates (based on simulation work) to address small-stock bias.

Analyses of scale samples from catches in commercial and test fisheries were conducted daily, beginning in late June and continuing through mid-September. Commission staff sampled test fishing catches and commercial sockeye landings at sites in Greater Vancouver, Port Hardy, Port Renfrew and Campbell River in British Columbia, and at Bellingham in Washington State. The Alaska Department of Fish and Game (ADF&G) collected samples for the PSC from the District 104 purse seine fishery at landing sites in Petersburg and Ketchikan, Alaska. DFO provided samples to the PSC from Johnstone Strait purse seine and gillnet test-fisheries. In addition, the PSC requested that DFO and First Nations' personnel coordinate weekly scale sampling of Fraser River First Nations' fisheries from six regions along the Fraser River between Chilliwack and Prince George.

Tissue samples for DNA analysis were collected and analyzed from nearly 8,000 sockeye from test, assessment, and commercial fisheries in United States Areas 7, 7A, and in Canadian Areas 12, 13, 20 and 29. The samples were collected from catches made between early July and early September, however, 80% of the samples were from catches made between July 20 and August 10. The collection of opercular tissue punches, scales and other data from the same fish (i.e., matched samples) provided stock-specific age composition and size information from mixed-stock catches of sockeye.

A. Analyses

In 2004, the most abundant stocks were Pitt, Chilliwack, Nadina, North Thompson stocks, Chilko, Quesnel, Late Stuart, Stellako and Weaver. These stocks, along with less abundant stocks comprised eleven stock-groups that were separated using DNA and scale data: Early Stuart, Fennell/Bowron/Raft, Pitt, Scotch/Seymour, Miscellaneous Early Summers (Nadina/Gates/Chilliwack), Chilko, Quesnel, Late Stuart/Stellako, Birkenhead, Late Shuswap/Portage, and Weaver/Miscellaneous Late-run sockeye (Table 8). Both scale-based and DNA-based analyses included model adjustments on the basis of assumptions about the migratory timing of sockeye stocks. Application of models to scale data used *a priori* adjustment, i.e., inclusion of stock groups in models was based on the likelihood of their presence (e.g., samples collected from Area 20 in July were not examined with models that included Birkenhead sockeye scale standards). Adjustments of DNA-based allocations were made *a posteriori* by examination of unadjusted results and consideration of predicted misallocation rates among stock groups (e.g., allocations to Early Stuart sockeye populations in samples collected from marine areas in August were interpreted as misclassification of Late Stuart sockeye).

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

[7] 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.

Table 8. Individual stocks comprising the stock groups used in 2004.

Stock Group	Component Stocks
	Early Stuart
Early Stuart	Early Stuart stocks
	Early Summer
Misc. Early Summers	Fennell, Bowron, Raft, Nahatlatch
Nadina/Gates/Chilliwack	Nadina, Gates, Chilliwack
Pitt	Pitt
Seymour/Scotch	Scotch, Seymour, early Eagle, Cayenne, Upper Adams
	Summer
Chilko	Chilko, south end Chilko Lake
Quesnel	Horsefly, McKinley, Mitchell, Roaring, Wasko, Blue Lead
Late Stuart/Stellako	Stellako, Tachie, Middle River, Pinchi, Kuzkwa
	Late
Birkenhead	Birkenhead, Big Silver, Douglas
Late Shuswap/Portage	Lower Adams, Portage, Lower Shuswap, Middle Shuswap, Little Shuswap, Shuswap Lake, late Eagle
Weaver/Harrison/Cultus	Weaver, Harrison, Cultus, Widgeon

Stock-specific baseline standards for in-season scale analyses were developed from two sources. The preferred source was scales from previous year age 3 and age 4 siblings of current year age 4 and age 5 sockeye, respectively, because they reared together in the same nursery lake environment and thus had similar freshwater scale patterns. A second, less preferred source (due to higher variability in scale characteristics) was used when sibling data from the previous year were unavailable. In this second method, baseline standards were developed using data from the same age class but from prior years. Because of the low return of age 3 fish in 2003 to Fraser River sockeye spawning grounds (with the exception of Gates and Weaver creeks and Chilko and Stellako rivers) the majority of scales used in the construction of standards for in-season models came from age 4 returns in other years. Age 5 sockeye were examined in-season using standards developed from siblings via spawning ground samples of age 4 sockeye in 2003.

Catches of Fraser River sockeye in District 104 purse seine fisheries are usually estimated by the PSC using discriminant function analysis of age 4_2 sockeye based on length data and data from four scale variables. The ADF&G examines fewer scales per sample collection than the PSC but examines the scales for more characteristics and they do not use length in their analyses. In 2004, unlike most previous years, estimates of Fraser River sockeye proportions yielded by the ADF&G and by the PSC were different from each other and inconsistent with the age composition of contributing stocks. More consistent results were obtained by using the proportions of Fraser River age 4_2 sockeye estimated by the ADF&G, then expanding those proportions based on the age composition of Fraser River sockeye to account for the catch of other age sockeye. The catch estimate for age 4_2 sockeye in District 104 was 259,000 fish, of which 51,000 (20%) were estimated to be of Fraser River origin. Approximately 80% of returning Fraser River sockeye in 2004 were age 4_2. Accounting for the other ages gives a total Fraser River sockeye catch in District 104 of 63,000 fish.

B. Microsatellite DNA Program

Baselines for DNA analysis in 2004 were similar to those used in 2003. The results of simulation analyses as well as the consistency of DNA-based estimates of stock contribution with radio-tagged sockeye in the Fraser River indicated that sample sizes of 96 individuals usually provided reliable estimates of stock proportions in mixed samples of sockeye. Late-run sockeye were expected to occur in very low proportions in Panel Area catches until late August, which prompted concerns regarding potentially high small-stock estimation bias. Therefore, an in-season management approach for estimating True Late-run proportions was based on projections from the Fishery Simulation Model. DNA estimates of Late-run stock proportions were adjusted post-season to correct for the over-estimation bias. Identification of Harrison sockeye, which have a

distinct age composition, was confirmed using scale characteristics. Estimates of Weaver, Late Shuswap and Portage sockeye proportions were adjusted using a regression approach. Simulation analyses of similar mixtures provided estimates of the probable degree of over-estimation bias. For Weaver sockeye, there was negligible bias in the estimates, while for Late Shuswap and Portage stocks estimates of their contributions were decreased substantially.

C. Estimates of Escapement and Production by Stock

The microsatellite DNA traits that distinguish stocks varies little among years. Differences between in-season and post-season estimates of gross escapement are therefore typically smaller using DNA than using scale pattern analysis. Similar to 2003, changes to in-season estimates of gross escapement due to re-evaluation of stock identification data were relatively minor. Much larger changes in estimates were due to use of an indirect Late-run estimation procedure that was used in-season (which underestimated the abundance of True Late-run sockeye) and due to re-evaluation of hydroacoustic data (especially early in the run). The largest post-season change in estimates of gross escapement for a run-timing group in 2004 was a 77% increase for True Late-run sockeye. The second largest change was a 31% decrease in the estimate of Early Stuart gross escapement (Table 9).

Table 9. Comparison of hydroacoustic-based gross escapement estimates for Fraser River sockeye salmon stocks in 2004, using in-season versus post-season stock composition estimates.

Run	Gross Escapement *		Difference	
	In-season	Post-season	Fish	%
Early Stuart	191,300	132,200	(59,100)	(31%)
Early Summer				
Misc. Early Summers	194,900	189,900	(5,000)	(3%)
Nadina/Gates/Chilliwack	506,000	360,300	(145,700)	(29%)
Pitt	163,200	70,900	(92,300)	(57%)
Seymour/Scotch	181,300	147,700	(33,600)	(19%)
Total	1,045,400	768,800	(276,600)	(26%)
Summer				
Chilko	341,700	301,600	(40,100)	(12%)
Quesnel	194,100	184,100	(10,000)	(5%)
Late Stuart/Stellako	867,300	841,100	(26,200)	(3%)
Total	1,403,100	1,326,800	(76,300)	(5%)
Late				
Birkenhead	104,000	107,800	3,800	4%
Late Shuswap/Portage	n/a	30,300 *2*	n/a	n/a
Weaver/Harrison/Cultus	n/a	167,300 *2*	n/a	n/a
"True" Lates (Fishery model)	111,900 *1*	n/a	n/a	n/a
"True" Lates	111,900	197,600	85,700	77%
Total	215,900	305,400	89,500	41%
Total	2,855,700	2,533,200	(322,500)	(11%)

* Escapement past Mission plus First Nations catches below Mission.
1 In-season estimates based on theoretical components in fishery model.
2 Post-season estimates based on direct DNA and scale evidence.

The total return of Early Stuart sockeye (137,000 fish, Table 10) was 63% of the pre-season forecast. Recorded catches for this run included 4,900 fish in test and marine fisheries, and 36,000 fish in Fraser River recreational and First Nations' fisheries combined. The estimated exploitation rate for all catch areas was 30%. An additional 87,000 Early Stuart sockeye are estimated to have died en route to their spawning grounds.

Table 10. Post-season estimates of catches, escapements, differences between estimates, run sizes and exploitation rates for Fraser River sockeye salmon (by stock group) in 2004.

Stock Group	River & Ocean Catch *	Gross Escapement: In-river FN, Recreational, & ESSR Catch **	Gross Escapement: Spawning Escapement	Difference*** Between Estimates	Run Size: Adult	Run Size: Jacks	Portion of Run	Adult Exploitation Rate: River & Ocean	Adult Exploitation Rate: All Areas
Early Stuart	4,900	35,800	9,300	87,100	137,100	5	3%	4%	30%
Early Summer-run									
Misc. Early Summers	134,600	55,800	12,700	121,400	324,500	0	8%	41%	59%
Nadina/Gates/Chilliwack	141,600	94,900	72,500	192,900	501,900	327	0%	28%	47%
Pitt	89,100	7,100	60,900	2,800	159,900	0	4%	56%	60%
Seymour/Scotch	106,600	49,600	3,900	94,300	254,400	0	6%	42%	61%
Total	471,900	207,400	150,000	411,400	1,240,700	327	30%	38%	55%
Summer-run									
Chilko	245,000	98,900	91,900	110,800	546,600	243	13%	45%	63%
Quesnel	87,700	55,800	10,200	118,100	271,800	44	6%	32%	53%
Late Stuart/Stellako	721,700	274,300	171,100	395,700	1,562,800	30	0%	46%	64%
Total	1,054,400	429,000	273,200	624,600	2,381,200	317	57%	44%	62%
Late-run									
Birkenhead	50,000	5,500	60,000	42,300	157,800	58	4%	32%	35%
Late Shuswap/Portage	9,600	9,400	4,300	16,600	39,900	117	1%	24%	48%
Weaver/Harrison/Cultus	60,100	10,200 *1*	27,600 *2*	129,500	227,400	59	5%	26%	31%
Total	119,700	25,100	91,900	188,400	425,100	234	10%	28%	34%
Total Adults	1,650,900	697,300	524,400	1,311,500	4,184,100	883	100%	39%	56%
Total Jacks *3*	13	19	851	0	883				
Total	1,650,900	697,300	525,300	1,311,500	4,185,000				
Portion of Total Run	39%	17%	13%	31%	100%				

* Includes catches in all fisheries, excluding Fraser River First Nations, recreational, ESSR and SCS fisheries.

** FN = First Nations; ESSR = Excess Salmon to Spawning Requirements.

*** Differences between estimates of potential spawning escapement (Mission escapement minus catch above Mission) and spawning escapement.

1 In-river catches of Weaver sockeye include ESSR catches of 3,538.

2 Includes 38 Cultus Lake sockeye taken for broodstock purposes.

3 Jack ratios were not estimated for fisheries; estimates include only those jacks that were actually observed.

The return of Early Summer-run stocks was 1,241,000 sockeye, about 40% greater than the pre-season forecast of 885,000 fish. Nadina and Chilliwack stocks were abundant and returned as the earliest component of the Early Summer run in 2004. Early Summer-run sockeye comprised substantial proportions of North Thompson River sockeye stocks that were assessed in samples collected later in the season. Catch estimates for Early Summer-run sockeye included 472,000 fish in commercial, test and miscellaneous fisheries, and 207,000 fish in Fraser River recreational and First Nations' fisheries. The estimated exploitation rate on Early Summer-run stocks was 55%, with a lower exploitation rate estimated for the early-timed stocks (Table 10). Estimates for Early Summer-run sockeye include a difference between estimates (gross escapement versus spawning ground enumeration plus expected catch) of 411,000 fish.

The run size of Summer-run sockeye was 2,381,000 sockeye (68% of the pre-season forecast) (Table 10). The run sizes by stock group were: Chilko, 547,000 fish; Quesnel, 272,000 fish; and Late Stuart/Stellako, 1,563,000 fish. Commercial, test, and miscellaneous fishery catches totalled 1,054,000 sockeye, while Fraser River sport and First Nations' fisheries caught an estimated 429,000 sockeye. The exploitation rate for all fishing areas was 62%. The estimated en route mortality of Summer-run sockeye was 625,000 sockeye.

The estimated return of Late-run sockeye included 158,000 Birkenhead and 267,000 True Late-run sockeye for a total of 425,000 Late-run sockeye (Table 10), which was 34% greater than

the pre-season forecast of 318,000 fish. Weaver sockeye returned much stronger than forecast and were the largest component of the Late-run return. Commercial, test, and miscellaneous catches of Late-run stocks totalled 120,000 sockeye and an additional 25,000 sockeye were caught in Fraser River recreational and First Nations' fisheries (including 3,500 fish in ESSR fisheries at Weaver Creek). Harvests totalled 56,000 Birkenhead and 89,000 True Late-run sockeye, yielding post-season exploitation rate estimates of 35% for Birkenhead and 33% for True Late-run sockeye. Within the True Late-run group, exploitation rates were highest for Late Shuswap/Portage and Harrison sockeye and lowest for Weaver/Cultus sockeye. En route mortality estimates include 42,000 Birkenhead and 146,000 True Late-run fish, for a total of 188,000 fish. Differences between lower-river and up-river estimates of escapement were lowest for Birkenhead (41% loss) and highest for Harrison sockeye (94% loss), with the remaining True Late-runs sockeye in between (80% loss).

The total return of adult Fraser River sockeye in 2004 was estimated to be 4,184,000 sockeye (21% fewer than in 2000). Catches in all fisheries totalled 2,348,000 or 56% of the run, potentially leaving 44% available for spawning escapement requirements (Table 10).

VIII. ESCAPEMENT

Enumeration of sockeye salmon escapements to spawning grounds in the Fraser River watershed (Figure 8) is conducted annually by DFO. These escapement data are used to generate estimates of total production for individual stocks and stock groups, and are required for forecasting sockeye returns four years hence. The Fraser River Panel relies on the spawning ground estimates to determine how successfully escapement goals have been met. Further, DFO's escapement estimates help in the post-season evaluation of stock identification and stock monitoring programs conducted by PSC staff.

In 2004, the preliminary escapement estimate of adult (4 and 5-year-old) sockeye totalled 524,000 fish (Appendix H: Table 7). Only 851 jacks (3-year-old fish) were estimated in 2004, which was a major decrease from the average of 43,000 jacks over three past cycle line years (1988, 1992, 1996), but only slightly lower than the most recent cycle line year in 2000 (1,200 jacks). The total escapement of 525,000 sockeye was the third smallest escapement on this cycle since records of spawning escapements began in 1940, and only 22% of the brood year escapement in 2000 (2,354,000 fish).

Table 11. Adult sockeye salmon escapements by run-timing group on the 2004 cycle for years 1988-2004.

	Spawning Escapement				
Run	1988	1992	1996	2000	2004
Early Stuart	180,000	66,000	88,000	90,000	9,300
Early Summer	218,000	102,000	363,000	574,000	150,000
Summer	745,000	635,000	1,411,000	1,650,000	273,200
Late	228,000	266,000	165,000 *1*	39,000	91,900
Birkenhead	168,000	190,000	60,000	24,000	60,000
"True" Lates	60,000	76,000	105,000 *1*	15,000	31,900
Adults	1,371,000	1,069,000	2,027,000	2,353,000	524,400

1 Weaver Channel estimate in 1996 does not include 33,193 sockeye removed for hatchery rack sales.

The Early Stuart escapement of 9,300 sockeye was 90% less than the brood year (2000) when the escapement was 90,000 fish (Table 11). The escapement of Early Stuart sockeye in 2004 was only a small fraction of the potential escapement that was estimated at Mission. The latter portion of the Early Stuart sockeye run was exposed to unusually high water temperatures in the Fraser River from mid-July onwards, which likely caused elevated levels of en route mortality.

Escapements of Early Summer-run stocks decreased to 150,000 fish, 74% fewer than the 2000 escapement, but the fourth largest escapement on this cycle. Summer-run escapements were 84%

lower than 2000, with 273,000 sockeye reaching their spawning grounds, which was the third lowest return on this cycle. Early Summer-run and in particular Summer-run sockeye were exposed to adverse in-river migration conditions in 2004, including low river levels and high water temperatures throughout their migrations, including record high temperatures above 21°C during August 17-20 (measured at Hells Gate). The extended exposure of Fraser sockeye to these extreme temperatures likely contributed to the high en route mortality observed in most stocks in 2004. Throughout much of August, there were several reports in the Fraser Canyon of sockeye exhibiting lethargic behaviour and gill and body lesions that were consistent with prolonged exposure to high water temperatures. Many of these sick sockeye were observed along the banks of the Fraser River and holding in cold water refuges where tributary streams enter the Fraser River. Low escapements of Late-run stocks were again recorded in 2004. Late-run sockeye escapements increased to 92,000 fish in 2004, which was over double the brood year escapement of 39,000 fish, 60% of the long-term average escapement and the sixth lowest for this cycle.

Of the 9,300 Early Stuart sockeye that reached their natal areas, the distribution of spawning was fairly even with 3,400 fish to tributaries of Takla Lake (37%, including Driftwood River), 3,800 fish to the Middle River (41%) and 2,000 fish to tributaries of Trembleur Lake (22%) (A; Figure 8). The Driftwood River, which flows into the north end of Takla Lake, was the destination of 400 fish or approximately 4% of the Early Stuart run. The period of peak spawning activity (August 5 - 9) was normal. The spawning escapement of 9,300 fish was the sixth lowest on the cycle since 1940. The spawning success of fish that arrived on the spawning grounds was 99%, which was higher than the long-term average of 91%.

Returns of Late Stuart sockeye to Tachie and Middle Rivers and to Kazchek, Kuzkwa and Pinchi Creeks decreased more than five-fold from their brood year return of 454,000 fish to 83,000 fish. The low escapement of sockeye to the Tachie River (61,000 fish versus 369,000 fish in the brood year) was the major reason for the decline in Late Stuart escapement relative to brood year levels. The overall spawning success of the 51,400 Late Stuart female spawners was excellent (99.8%).

Sockeye escapement to the Nadina River (B; Figure 8) decreased about nine-fold from the 2000 brood year escapement of 200,000 fish to 23,000 fish, and was approximately 43% of the cycle-year average (53,000 fish). Nadina River sockeye were reported to be lethargic, with many fish exhibiting body lesions and scarring. Despite the apparent poor physical condition of many Nadina sockeye, the spawning success was much higher (98.9%) than the cycle-year average. The other major stock in the Nechako River watershed spawns in the Stellako River, where the escapement of 87,000 fish represented a four-fold decrease from the brood year return of 372,000 sockeye. The spawning success of Stellako River sockeye was excellent (99.9%) and was higher than the cycle-year average (93%).

The escapement of 10,000 sockeye to the Quesnel Lake watershed (C; Figure 8) was a decrease of over 84% relative to the brood year escapement of 64,000 fish in 2000. The Mitchell River escapement of 5,500 sockeye was about five times lower than the brood year return of 27,000 fish. A high proportion of the escapement to the Horsefly and Mitchell Rivers were age 5 fish. The overall spawning success of Quesnel sockeye was excellent (99.5%).

The escapement of Bowron River sockeye in 2004 was the lowest on record for this stock. Escapements decreased from about 13,000 fish in 2000 to 800 fish in 2004. An estimate of Bowron sockeye spawning success was not possible due to a lack of carcasses available for sampling (due to consumption by bears).

Chilko escapements (D; Figure 8) in 2004 (92,000 fish) were the lowest on record and decreased 88% from the brood year escapement of 759,000 fish, and were only 14% of the 1984-2000 cycle-year average of 646,000 fish. A large portion of Chilko sockeye were exposed to very high water temperatures in the Fraser River in 2004. Compounding the probable high en route mortality of Chilko sockeye in 2004 was a large mud slide in Farwell Canyon (15 kilometres upstream of the Chilcotin/Fraser confluence) on August 29, that blocked the Chilcotin River for 14 hours. Although many Chilko sockeye were likely upstream of the slide site when it occurred, those sockeye downstream probably experienced elevated en route mortality. The spawning success of female sockeye was estimated at 98.2%, which exceeded the long-term average. The

high spawning success suggests that Chilko sockeye that successfully arrived, despite the adverse river conditions, were in good physical condition.

Early Summer-run escapements to Gates Creek and spawning channel (E; Figure 8) declined about 89%, from 89,000 fish in 2000 to 9,600 fish in 2004. Only 800 sockeye escaped to Gates Creek in 2004 versus 56,000 in the brood year. Sockeye arriving at the Gates Creek spawning channel were in poor physical condition with numerous lesions and scars. Spawning success was relatively high in both the spawning channel and creek, with 87.2% of females spawning successfully. The 2004 escapement of Late-run sockeye to Portage Creek was the same as in the brood year (1,300 fish) and spawning success was excellent.

Sockeye stocks in the Thompson River watershed spawn in the North Thompson and South Thompson River systems (F; Figure 8). In the South Thompson system, Upper Adams River sockeye (an Early Summer-run stock) have been the focus of long-term rebuilding efforts. Conditions for visual enumeration of Upper Adams River sockeye were poor in 2004 due to high glacial turbidity and high flows. Consequently, the estimated escapement of 400 sockeye is considered a minimum estimate. However, even if the escapement was substantially higher, it still represents an extremely large decline from the brood year escapement of 71,000 fish. Other Early Summer stocks, Eagle River (200 fish) and Seymour River (1,300 fish), experienced significant escapement declines when compared with the brood-year: Eagle River (14,000 fish) and Seymour River (25,000 fish). Late-run escapements to the South Thompson area (primarily the Lower Adams and Lower Shuswap Rivers) increased from only 800 fish in the brood year to 3,000 fish in 2004.

Low escapements of sockeye were observed in the North Thompson River watershed. The Raft River had an escapement of 5,600 fish, which was only 8% of the record-high return of 66,000 fish in the brood year. Approximately 99.5% of these fish spawned successfully. The escapement of 2,700 sockeye to Fennel Creek was only 27% of the brood year return of 10,000 fish. Fennel Creek spawners also achieved a high spawning success rate (99.3%).

There was an increase in spawning escapements in the Harrison-Lillooet area (G; Figure 8) with 87,000 spawners observed, compared to a brood year escapement of 35,000 fish. The 2004 escapement, however, was lower than the recent (1988-1996) cycle-year average of 216,000 fish. The spawning success of sockeye that arrived at their natal areas was 98%. Weaver Creek and spawning channel had an escapement of 25,000 fish compared to the brood year escapement of 6,600 fish, however, this escapement was 25% lower than the cycle-year average of 34,000 fish. Birkenhead River escapements of 38,000 fish exceeded the escapement of 14,000 fish in 2000. The Harrison River sockeye escapement of 2,100 fish was lower than the brood year escapement of 4,300 fish. The escapement of sockeye to Big Silver Creek, a tributary to Harrison Lake, was estimated at a record-high of 20,000 fish.

Escapements of sockeye to Lower Fraser River tributaries (H, Figure 8), including Chilliwack Lake, Cultus Lake, Nahatlatch River and Upper Pitt River, totalled 102,000 fish in 2004, which is a 79% increase over the brood year escapement of 57,000 fish. The spawning success averaged 97%. Upper Pitt River and Chilliwack escapements (61,000 fish and 40,000 fish, respectively) were the highest on record for this cycle line and both achieved a 99% spawning success rate. Nahatlatch River and Lake escapements totalled 1,100 fish, which was only 21% of the brood-year escapement and the lowest on record since 1981. An estimated 90 sockeye escaped to Cultus Lake (including 38 fish kept for captive brood stock), which is the lowest escapement on record for this stock.

The overall spawning success for female sockeye in the Fraser River watershed in 2004 was 98.4%. In 2004, approximately 294,000 female sockeye spawned successfully, which represents the third lowest escapement on record for the 2004 cycle line.

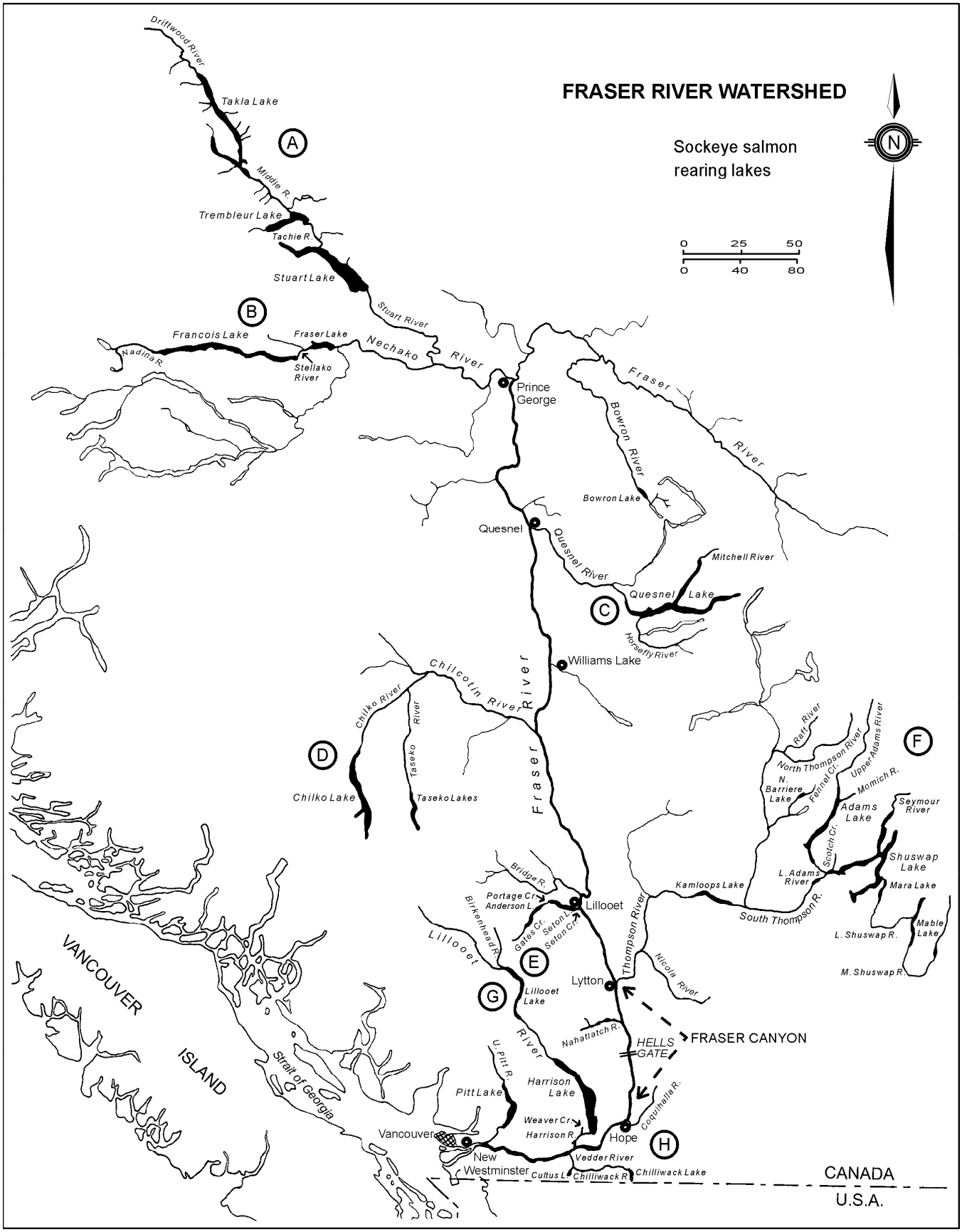

Figure 8. Sockeye salmon spawning grounds in the Fraser River watershed.

IX. ACHIEVEMENT OF OBJECTIVES

The mandate of the Fraser River Panel is to manage commercial fisheries in the Panel Area to achieve a hierarchy of annual goals. In order of importance, the goals are to: (a) achieve spawning escapement targets for Fraser River sockeye and pink salmon that are set by Canada or modified by Panel agreement; (b) achieve targets for international sharing of the TAC as defined in the Treaty or by agreement of the Parties; and (c) achieve domestic catch allocation goals within each country. In the process of achieving these objectives, the Panel must consider conservation concerns for other stocks and species of salmon when planning and conducting the fisheries. Panel management strategies are assessed after each season to determine whether the goals were achieved and to identify management techniques and data collection programs that could be improved.

In 2004, the Panel agreed to special provisions to protect True Late-run sockeye, which have suffered high en route losses related to early entry into the Fraser River in recent years. The agreement specified that the harvest of True Late-run sockeye be limited to a maximum of 15% of the total in-season run. The achievement of this objective is assessed in a separate section, below. Based on this exploitation rate limit, the True Late-run spawning escapement target was set to be the remaining 85% of the in-season run size.

On February 17, 2005, the Panel agreed on a revised Chapter 4, Annex IV of the Pacific Salmon Treaty. The revised Annex established new methods for making management decisions, and for calculating the TAC and paybacks from 2005 onward. Associated with the agreement was a decision by the Panel to apply the new calculation method to 2002, 2003 and 2004. Whereas the traditional method used post-season estimates of run size, spawning escapement and test fishing catch in the calculation, the new method uses the estimates of run size, spawning escapement target, management adjustment and test fishing catch that were in effect when the Panel relinquished control of the last U.S. Panel Area (October 2 in 2004). The new method is therefore based on in-season data rather than post-season data to calculate the total sockeye available for sharing. In the context of assessing the achievement of objectives, this premise is applied not only to TAC and catch allocation targets, but also to escapement and True Late-run objectives.

A. Escapement

The Panel's first objective is to achieve the spawning escapement targets for each run-timing group. Spawning escapement targets for Early Stuart, Early Summer, Summer and True Late-run sockeye were determined by applying Canada's spawning escapement plan (Appendix A, Table 2) to the post-season run-size estimates for each run-timing group. The objective (as a percentage of run size) established for Summer-run sockeye was applied to the Birkenhead run.

Post-season spawning escapement targets are shown in Table 12, along with spawning ground estimates of escapement. Spawning escapements were far below the targets for all timing groups. Early Stuart sockeye showed the largest shortfall (90% lower than the escapement target), followed by True Late-run (88% below), Summer-run (81% below), Early Summer-run (65% below) and Birkenhead stocks (32% below). Total spawning escapements of Fraser sockeye were 77% lower than the overall target.

In-season escapement targets may include additional fish in a category called a "Management Adjustment" (MA). Management adjustments are designed to increase the likelihood of successfully achieving the spawning escapement targets. They are based on statistical models that consider the historical differences between in-season projections of spawning escapement based on estimates of Mission escapement minus catch above Mission (i.e., potential spawning escapement"), and post-season estimates based on spawning ground enumeration programs. For Early Stuart, Early Summer and Summer-run stocks, the models relate historical differences between estimates (DBEs) to the severity of river conditions measured near Hells Gate. When discharge levels or temperatures are high, then differences between estimates also tend to be high. In addition, for Early Stuart and Early Summer runs, in-season estimates are consistently higher than spawning ground estimates even when migration conditions are in a normal range, and this

tendency is also captured by the MA models. For True Late-run sockeye, historical differences between estimates are related to the date when half the run has migrated past Mission (i.e., 50% date), which captures the effect of the early migration observed in recent years on the migration success of these stocks.

Table 12. Comparison of post-season spawning escapement targets and upriver spawning escapement estimates for Fraser River sockeye salmon (adults) in 2004.

	Spawning Escapement			
	Post-season	Upriver	Difference	
Run	Target *	Estimate **	Fish	%
Early Stuart	90,000	9,300	(80,700)	(90%)
Early Summer	434,200	150,000	(284,200)	(65%)
Summer	1,424,000	273,200	(1,150,800)	(81%)
Late	321,600	91,900	(229,700)	(71%)
Birkenhead	94,400	64,300	(30,100)	(32%)
"True" Lates	227,200	27,600	(199,600)	(88%)
Adult sockeye	2,269,800	524,400	(1,745,400)	(77%)

* Post-season targets calculated by applying DFO's Escapement Plan to post-season run-size estimates.
** DFO's spawning escapements estimates.

In-season management is based on targets for gross escapement (i.e., spawning escapement targets plus management adjustments and allocations for First Nations and recreational catches in the Fraser River), rather than spawning escapement. This is partly because the Panel's mandate extends only to commercial fisheries, which have an upriver boundary of the railway bridge at Mission, BC, in the lower Fraser River. Furthermore, in-season monitoring of the progress toward gross escapement targets is more practical because of the large time lags that occur between management actions and arrivals on the spawning grounds. Based on final in-season estimates of gross escapement (i.e., Mission escapement plus First Nations and recreational catches above Mission), Early Stuart and True Late-run gross escapement targets were achieved (1% below the target), Early Summer and Summer-run gross escapements were lower than the targets (6% and 44% below), and the gross escapement of Birkenhead sockeye exceeded the target (14% above) (Table 13).

Table 13. Comparison of in-season adjusted targets and gross escapement estimates for Fraser River sockeye salmon in 2004.

	Gross Escapement					
	In-season	Management	Adjusted	In-season	Difference	
Run	Target	Adjustment*	Target	Estimate**	Fish	%
Early Stuart	163,000	29,000	192,000	191,000	(1,000)	(1%)
Early Summer	770,000	341,000	1,111,000	1,045,000	(66,000)	(6%)
Summer	1,932,000	570,000	2,502,000	1,403,000	(1,099,000)	(44%)
Late	204,000	0	204,000	216,000	12,000	6%
Birkenhead	91,000	0	91,000	104,000	13,000	14%
"True" Lates	113,000	0	113,000	112,000	(1,000)	(1%)
Adult sockeye	3,069,000	940,000	4,009,000	2,855,000	(1,154,000)	(29%)

* Adjustment of gross escapement targets to achieve spawning escapement goals.
** Includes 199,000 sockeye caught in Fraser River First Nations' fisheries below Mission, B.C.

These results show that the Panel was reasonably successful in delivering fish from the main stocks of concern (Early Stuart, Early Summer and True Late runs) into the river in the form of gross escapements. However, the severe shortfalls in spawning escapement reflect the hostile environment through which these fish subsequently migrated en route to the spawning grounds. River temperatures were in record or near record high ranges for most of the migration period, which likely caused substantial en route mortality across all run-timing groups of Fraser sockeye. For Summer-run sockeye the shortfall on the spawning grounds also reflects a shortfall in the Panel's achievement of gross escapement goals: final in-season catch targets were exceeded for

Summer-run sockeye, in part because of decreases to abundance estimates that occurred after the period of most intense harvest.

B. Late-run Objective

To protect the spawning escapement of True Late-run sockeye against the negative effects of the early in-river migration observed since about 1996, the Panel agreed to limit the harvest of these stocks to a maximum of 15% of the total return. At the post-season run-size estimate of 267,000 fish and a corresponding harvest limit of 40,000 fish, the catch of True Late-run fish (70,000 fish) was 30,000 fish or 11% above the target (Table 14). This catch overage was largely due to post-season adjustments to stock composition estimates, which resulted in a dramatic increase in the True Late-run catch estimate from 21,000 fish in-season to the post-season estimate of 70,000 fish. The divergence between in-season and post-season stock composition estimates resulted from the different estimation methods employed in the in-season versus post-season period. In-season, the Panel used the Fishery Simulation Model combined with in-season estimates of abundance to project the Late-run stock proportions used to estimate Late-run catches. This in-season method was used because of the known tendency of stock discrimination methods to overestimate the proportions of stocks present in low proportions and the inability to completely correct for this bias with in-season data. Post-season, DNA estimates were used, after conducting simulations to correct for the known biases.

Table 14. Comparison of total catch to the 15% exploitation rate limit for True Late-run sockeye in 2004.

Item	% of Run	Fish
True Late run (post-season)		267,000
Exploitation rate limit	15%	40,000
Catch	26%	70,300
Deviation	11%	30,300

C. International Allocation

The Panel's second priority is to achieve the goals for the international allocation of the Total Allowable Catch (TAC). For 2002, 2003 and 2004, a new method of calculating the TAC was implemented as a result of the February 17, 2005 agreement. The key element of the new calculation method is that the final in-season spawning escapement target replaces the actual spawning escapement estimate as the escapement deduction. This agreement led to TAC and share calculations that differed from past practices in the following ways:

1. The run size is the in-season accounted run-size estimate on the date that the Panel relinquished control of the last U.S. Panel Area (October 2 in 2004), rather than the final post-season estimate.
2. The spawning escapement deduction is the in-season spawning escapement target, instead of the post-season spawning escapement estimate as in past years.
3. In-season management adjustments are included as deductions. In past years, the management adjustment was removed from the post-season TAC calculation when the actual spawning escapement became the escapement deduction.

With the final in-season run size of 4,438,000 Fraser sockeye minus the deductions for spawning escapement, management adjustment, Fraser River Aboriginal Exemption and test fishing catch, the TAC in 2004 was 775,000 sockeye (Table 15). Washington's share was 128,000 sockeye (16.5% of the TAC). Subtracting the Washington catch of 197,000 fish from this share leaves a catch overage of 69,000 sockeye. Canadian fishers caught 1,613,000 sockeye (excluding the Fraser River Aboriginal Exemption of 400,000 sockeye and an ESSR catch of 4,000), leaving

a catch overage of 966,000 sockeye. The catch overages in both countries resulted primarily from a reduced Summer-run TAC late in the season after most fisheries had been closed by the Panel. The lower late-season TAC was due not only to declining Summer-run run-size estimates, but to larger Summer-run MAs caused by the extended high water temperatures in the river.

Table 15. Preliminary calculations of total allowable catch and international shares for Fraser River sockeye salmon in 2004. In-season estimates of run size, spawning escapement target, management adjustment and test fishing catch at the time the Panel relinquished control of the last U.S. Panel Area (Oct. 2) were used, according to the revised Annex IV agreed to on Feb. 17, 2005.

		Sockeye
TOTAL ALLOWABLE CATCH		
In-season Total Run Size		4,438,000
Deductions		
In-season Spawning Escapement Target	*1*	2,249,000
In-season Management Adjustment	*1*	940,000
Aboriginal Fishery Exemption		400,000
In-season Test Fishing Catch		74,000
Total Deductions:		3,663,000
Total Allowable Catch:		775,000
UNITED STATES		
Washington Catch		197,000
Washington Share		
Washington Share	*2*	128,000
Payback		0
Total Share:		128,000
Deviation:	*3*	69,000
In-season Alaska Catch		0
Total United States Catch:		197,000
CANADA		
Canadian Catch - AF Exemption - ESSR Catch		1,613,000
Canadian Share		647,000
Deviation:	*3*	966,000

1 By Panel agreement (Feb. 17, 2005), the TAC calculation was fixed on the date the Panel relinquished control of the last U.S. Panel Area (Oct. 2). This means the run size, spawning escapement target, management adjustment, Aboriginal Fishery Exemption and test fishing deduction were frozen on this date. The one exception to this practice occurs if total in-river and marine Aboriginal Fishery catches are less than 400,000 fish, in which case the Treaty-defined Exemption of 400,000 fish is replaced by the actual Aboriginal Fishery catch.

2 United States share according to revised Annex IV of the Pacific Salmon Treaty:
Sockeye: 16.5% of the TAC - payback (maximum 5% of share).
Pink: 25.7% of the TAC - payback (maximum 5% of share).

3 By agreement of the Parties (Feb. 17, 2005), no paybacks of overages or underages are to be carried forward to 2005.

D. Domestic Allocation

The third priority of the Panel is to achieve domestic allocation goals as specified by the Parties. Similar to the achievement of escapement goals, the Panel's ability to achieve these goals is limited because the Panel manages only commercial fisheries in Panel Areas that are directed at Fraser River sockeye and pink salmon. Most United States fisheries that target Fraser sockeye and pink salmon are in this category of Panel managed fisheries. Canada regulates Canadian commercial net fisheries in non-Panel areas such as Johnstone Strait, and First Nations and recreational fisheries in all fishery areas.

In 2004, the Panel was moderately successful in achieving sockeye allocation targets between Treaty Indian and Non-Indian fishers in Washington. Treaty Indian fishers caught 18,000 fish less than their target of 132,000 fish, while Non-Indian fishers caught 18,000 fish over their target of 63,000 fish (Table 16). There were no specific inter-tribal allocations within Treaty Indian fishers.

Table 16. Preliminary estimates of domestic overages and underages in Washington catches of Fraser River sockeye salmon in 2004.

User Category	Actual Catches		Catch Goals		Deviation	
	Fish	%	Fish	%	Fish	%
Washington: between Treaty Indian and Non-Indian Users						
Treaty Indian *	115,700	58.8%	133,200	67.7%	(17,500)	(13%)
Non-Indian	81,100	41.2%	63,600	32.3%	17,500	28%
Washington Total:	196,800	100.0%	196,800	100.0%	0	

In Canada, Area B purse seines were 42,000 fish under, Area D gillnets were 33,000 fish over, Area E gillnets were 7,500 fish under and Area H trollers were 17,000 fish over their respective allocations of Fraser sockeye (Table 17).

Table 17. Preliminary estimates of domestic overages and underages in Canadian catches of Fraser River sockeye salmon in 2004.

Gear License Area	Actual Catches		Catch Goals		Deviation	
	Fish	%	Fish	%	Fish	%
Purse Seine						
A Northern	0	0.0%	0	0.0%	0	
B Southern	523,700	49.5%	565,900	53.5%	(42,200)	(7%)
Total	523,700	49.5%	565,900	53.5%	(42,200)	
Gillnet						
D Johnstone Strait	154,700	14.6%	121,600	11.5%	33,100	27%
E Fraser River	246,300	23.3%	253,800	24.0%	(7,500)	(3%)
Total	401,000	37.9%	375,400	35.5%	25,600	
Troll						
F Northern	0	0.0%	0	0.0%	0	
G Southern	0	0.0%	0	0.0%	0	
H Inside	133,000	12.6%	116,300	11.0%	16,700	14%
Total	133,000	12.6%	116,300	11.0%	16,700	
Total	1,057,700	100.0%	1,057,600	100.0%		

E. Conservation of Other Stocks

Due to restricted fishing in Canadian areas in Juan de Fuca Strait (Area 20) and other areas, Panel Area fisheries resulted in moderate by-catches of other species and stocks that were identified as conservation concerns by the Parties in 2004 (Table 18). The recorded by-catches totalled 1,700 non-Fraser sockeye, 740 non-Fraser pink, 13,000 chinook, 6,400 coho, 230 chum and 60 steelhead.

Table 18. Preliminary estimates of catches of non-Fraser sockeye and pink salmon and of other salmon species in commercial fisheries regulated by the Fraser River Panel in 2004.

Area and Gear	Non-Fraser		Fraser and Non-Fraser			
	Sockeye	Pink	Chinook	Coho	Chum	Steelhead
United States *						
Areas 4B, 5 and 6C Net	1,600	510	550	5,800	160	58
Areas 6, 7 and 7A Net	0	140	5,100	600	4	1
Total	1,600	650	5,650	6,400	164	59
Canada **						
Area 20 Net	100	72	0	0	0	0
Area 29 Net	0	16	7,500	0	65	0
Total	100	88	7,500	0	65	0
Total	1,700	738	13,150	6,400	229	59

* Estimates are from the WDFW "soft-system".

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

X. ALLOCATION STATUS

By Panel agreement no paybacks were carried forward from 2003 to 2004, and no new paybacks were to be carried forward from 2004 to 2005 (Table 19).

Table 19. Allocation status of Fraser River sockeye and pink salmon for 1999-2004.

	Sockeye						Pink		
	1999	2000	2001	2002	2003	2004	1999	2001	2003
TOTAL ALLOWABLE CATCH									
Total Run Size	3,643,000	5,217,000	7,213,000	15,312,000	5,408,000	4,438,000	3,616,000	21,293,000	26,000,000
Escapement and other deductions	3,438,000	3,198,000	6,132,000	9,568,000	3,159,000	3,663,000	3,468,000	19,881,000	7,843,000
Total Allowable Catch:	205,000	2,019,000	1,081,000	5,744,000	2,249,000	775,000	148,000	1,412,000	18,157,000
UNITED STATES									
Washington Catch	20,000	494,000	241,000	449,000	244,000	197,000	17,000	445,000	811,000
Washington Share *	46,000	412,000	241,000	496,000	362,000	128,000	38,000	445,000	4,687,000
Deviation:	(26,000)	82,000	0	(47,000)	(118,000)	69,000	(21,000)	0	(3,876,000)
Cumulative Allocation Status:	(26,000)	56,000	56,000	9,000	0 **	0 ***	(21,000)	(21,000)	0 **

* Washington share of the TAC according to Annex IV of the Pacific Salmon Treaty:
1999: Shall not exceed 22.4% for Fraser sockeye and 25.7% for Fraser pinks.
2000: Shall not exceed 20.4% for Fraser sockeye.
2001: Washington share equals Washington catch for Fraser sockeye and pink salmon, by agreement between the Parties on June 12, 2002.
2002: The Washington share equals the Washington catch plus the maximum payback, in accordance with the Feb. 12-13, 2003, Panel agreement.
2003: Shall not exceed 16.5% for Fraser sockeye minus the payback, and 25.7% for Fraser pinks plus the payback.
2004: Shall not exceed 16.5% for Fraser sockeye.

** By Panel agreement, no paybacks are to be carried forward to 2004 for either sockeye and pink salmon because of the large unharvested shares in both countries.

*** By Panel agreement, no paybacks are to be carried forward to 2005.

XI. APPENDICES

APPENDIX A: 2004 PRE-SEASON FORECASTS AND SPAWNING ESCAPEMENT TARGETS FOR FRASER RIVER SOCKEYE SALMON

Table 1. Pre-season forecasts for Fraser River sockeye salmon (in thousands of fish). (Provided to the Panel by Fisheries and Oceans Canada on April 21, 2004).

Sockeye Stock/Timing	Probability of Achieving Specified Run Sizes [a]				
	0.25	0.5	0.75	0.8	0.9
Early Stuart	**341,000**	**216,000**	**137,000**	**122,000**	**90,000**
Early Summer	**1,586,000**	**885,000**	**486,000**	**422,000**	**280,000**
Fennell	72,000	39,000	22,000	19,000	12,000
Bowron	52,000	28,000	15,000	13,000	9,000
Raft	213,000	119,000	66,000	57,000	39,000
Gates	334,000	194,000	112,000	98,000	68,000
Nadina	225,000	123,000	67,000	57,000	38,000
Pitt	110,000	66,000	40,000	35,000	25,000
Seymour	44,000	29,000	18,000	17,000	12,000
Scotch	34,000	15,000	6,000	5,000	3,000
Miscellaneous [b]	502,000	272,000	140,000	121,000	74,000
Summer	**6,152,000**	**3,501,000**	**2,078,000**	**1,834,000**	**1,335,000**
Chilko	1,609,000	1,164,000	842,000	777,000	627,000
Quesnel	1,136,000	611,000	329,000	281,000	187,000
Stellako	1,144,000	737,000	475,000	425,000	318,000
Late Stuart	2,263,000	989,000	432,000	351,000	203,000
Late	**584,000**	**318,000**	**171,000**	**146,000**	**97,000**
Birkenhead	307,000	172,000	96,000	83,000	57,000
Late Shuswap	18,000	10,000	5,000	4,000	3,000
Cultus	<500	<500	<500	<500	<500
Portage	24,000	11,000	5,000	4,000	2,000
Weaver	108,000	56,000	29,000	24,000	16,000
Misc. Shuswap [c]	7,000	4,000	2,000	2,000	1,000
Misc. non-Shuswap [c]	120,000	65,000	34,000	29,000	18,000
Total	**8,663,000**	**4,920,000**	**2,872,000**	**2,524,000**	**1,802,000**

a Probability that the actual run size will exceed the specified projection.
b Unforecasted miscellaneous Early Summer stocks.
c Unforecasted miscellaneous Late stocks.

* Breakdown of Birkenhead and True Late-run types subsequently provided on May 17, 2004.

Probability	0.25	0.50	0.75	0.80	0.90
Birkenhead Types	392,000	218,000	120,000	103,000	70,000
True Late-run Types	192,000	100,000	51,000	43,000	27,000
Total Lates	584,000	318,000	171,000	146,000	97,000

Table 2. Fraser River sockeye salmon escapement plan (in thousands of fish) for 2004. (Provided to the Panel by Fisheries and Oceans Canada on April 21, 2004).

Stock Group	Run Size Estimate	Run Size Reference Points *a*	Escapement Target at Run Size	Exploitation Rate Guidelines	Management Adjustment	Exploitation Rate after Mgmt. Adj.
Early Stuart		0 - 75		0		
		75 - 129		0 - 30%		
	216	129 - 257	90	30 - 65%	38	41%
		257		65 - 65%		
Early Summer		0 - 235		0 - 15%		
		235 - 571		15 - 65%		
	885	571	310	65 - 65%	105	53%
Summer		0 - 2,034		0 - 30%		
	3,501	2,034 - 4,069	1,424	30 - 65%	0	59%
		4,069		65 - 65%		
Birkenhead		0 - 104		0 - 15%		
(inclds. Birk.	218	104 - 253	89	15 - 65%	0	59%
type Lates)		253		65 - 65%		
Late				0 - 15%		
(excldes.				15 - 15%		
Birkenhead)	100		85	15 - 15%	0 *b*	15%
Totals	4,920		1,998			
	Est. Return					

a Reference points based on harvest rate targets

b In anticipation of continued high mortality associated with early entry of the Late run into the Fraser River, actual exploitation rate will reflect measures to protect Late run stocks.

APPENDIX B: 2004 FRASER RIVER PANEL MANAGEMENT PLAN PRINCIPLES AND CONSTRAINTS

1. Fisheries and Oceans Canada (DFO) have provided the Panel with run-size forecasts for Fraser River sockeye by run timing group. For pre-season planning purposes, the Panel used the 50% probability (p) level of abundance. At the 50% p-level there is a 50% probability that the return will reach or exceed 4,920,000 fish.
2. The Panel has identified a priority objective in 2004, which is to achieve Late-run sockeye[8] objectives as indicated in the document, "Guidelines for Pre-season Fraser Sockeye Fishing Plans to Address Late-Run Concerns".
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 early and a significant proportion will not survive to spawn.
4. TAC and international shares will be calculated according to the February 10, 2004 Commission Guidelines and the 1999 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, while the Canadian share of the TAC is 83.5%. Based upon the 50% probability (p) levels of abundance, for the purposes of computing TAC shares by stock management grouping in 2004, the Panel agreed to a Fraser River Aboriginal Exemption for Early-Stuart sockeye of 80,000, Early Summer sockeye of 103,200, Summer-run sockeye of 212,600, Birkenhead sockeye of 2,600, and Late-run sockeye of 1,600. There are no catch overages of Fraser River sockeye from prior years.
5. The Panel has adopted 50% probability level forecasts for Early Stuart, Early Summer, Summer and Late-run sockeye for planning fisheries. When sufficient information is available in-season, the Panel will update the run size estimate of Fraser River sockeye salmon stocks, as appropriate.
6. In-season decisions of the Panel will follow guidance outlined by the Pacific Salmon Commission agreement of February 10, 2004 (see attached). In addition, in-season management planning and decision making processes will follow the operating principles outlined in the "Domestic Compliance Strategies" document of February 9, 2004 (see attached).

Regulations

i) If the abundance of Early Summer-run sockeye salmon is approximately at the 50% probability level (885,000 fish) and the abundance of Summer-run sockeye salmon is approximately at the 50% probability level (3,501,000 fish) and the runs arrive at near normal dates, fisheries would be expected to commence as follows: United States Areas 4B, 5, and 6C - week of July 25-31; Areas 6, 7 and 7A week of August 1-7; Canadian Panel Waters - week of July 25-31 in Areas 20, 17, 18 and 29. If the return abundances of Early Summer and Summer-run sockeye are less than the 50% probability level forecast, this could delay the commencement of, or shorten the duration of fisheries.

ii) The Parties' conservation concerns for other species and stocks will be taken into account throughout the 2004 management season.

[8] Late-run here refers to the Late-run timing group, excluding Birkenhead and a few minor miscellaneous sockeye stocks.

APPENDIX C: GUIDELINES FOR PRE-SEASON FRASER SOCKEYE FISHING PLANS TO ADDRESS LATE-RUN[1] CONCERNS

The 2004 cycle is the first off-line cycle for Adams River sockeye, and "true" Late-run sockeye have historically experienced small returns on this cycle line relative to Summer-run sockeye, with the Weaver Creek stock group the predominant Late-run stock. All Late-run stocks were impacted severely by early upstream migration and mortality in the brood year (2000). As a consequence, the total forecast for late-run sockeye in 2004 (50% probability level) is less than 25% of the average for the cycle. In addition, there is special concern for Cultus sockeye for which recovery plans are being developed by Canada to ensure this stock's long-term viability. A co-coordinated approach to management will be developed that reflects both Parties sharing the burden of conservation of Late-run sockeye. Additional measures to reduce the fishing impact on Cultus sockeye will be taken by Canada in 2004.

ASSUMPTIONS

1. For fisheries planning purposes, it was assumed that Late-run sockeye will continue the early upstream migration behaviour and associated en route mortality that has occurred in recent years. A 50% upstream migration of August 26 was adopted based on recent Late-run behaviour observed in 2000 and 2001 cycle lines, along with the associated en route mortality of 80%, as derived from the Environmental Management Adjustment model.
2. There is good capability to assess key parameters in-season, such as run size, migration timing, etc. for Summer-run sockeye, however, it is unlikely that run size updates will be generated during the period of active Panel Area management. There will be limited capacity to assess these parameters for Late-run sockeye because of their low abundance relative to Summer-run sockeye. In addition, the PSC staff will be unable to advise the Panel on the in-river migration timing and associated en route mortality of Late-run sockeye during the period when Panel Area fishery openings are being contemplated.
3. In-season assessment limitations with respect to monitoring the run strength and migration timing of Late-run stocks in 2004 necessitate an approach to management based on pre-season planning. The intent will be to optimize fishing opportunities to harvest surplus Early Summer and Summer-run stocks, while coincidentally minimizing the harvest of Late-run stocks.
4. The pre-season fishing plan will assume an 8 day separation in the 50% marine migration timing between Summer-run and Late-run sockeye (historical average timing difference for the years 1980 to 2003).

ELEMENTS OF THE PLAN

- Based upon pre-season information and assumptions, fishery impacts on Late-run sockeye will be limited to 15% of the total return, and the United States limit will be 2% Late-run exploitation rate. Based upon the 50% probability (p) levels of abundance, for the purposes of computing TAC shares by stock management grouping in 2004, the Panel agreed to a Fraser River Aboriginal Exemption for Early-Stuart sockeye of 80,000, Early Summer sockeye of 103,200, Summer-run sockeye of 212,600, Birkenhead sockeye of 2,600, and Late-run sockeye of 1,600.
- In order to ensure that Late-run conservation objectives are met and as a consequence of the limited assessment capability for Late-run sockeye in 2004, the in-season decisions regarding fisheries directed at Summer-run sockeye will be based largely on the decision criteria developed from pre-season model runs (as modified if necessary by DFO's preseason forecasts for Chilko timing and diversion rate).
- During the period of active fishing, the fisheries directed at Summer-run sockeye may be adjusted, relative to those referenced in the pre-season plan. Changes to the pre-season plan will be based on assessments of catch and exploitation rates relative to weekly target levels, using a combination of in-season data and pre-season planning model evaluations. However, since the planned Panel Area fisheries are situated before the peak of the Summer-run migration in order to minimize the by-catch of Late-run sockeye stocks, it is

unlikely that significant increases in Panel Area fishing could take place without increasing the probability of exceeding Late-run conservation limits.

- Termination of fisheries in Panel waters will be referenced to the pre-season fishing plan to ensure a reasonable probability that the Late-run objective is met, while at the same time providing fishing opportunities to harvest surplus Early Summer and Summer-run stocks. In the absence of in-season data indicating fishing could continue beyond the dates referenced in the pre-season plan, it is expected that fisheries will close as per the final bilaterally agreed Fraser Panel pre-season plan.

APPENDIX D: 2004 REGULATIONS

The Fraser River Panel approved regulations for the management of the Fraser River sockeye and pink salmon fishery in Panel Area waters and submitted these to the Pacific Salmon Commission. The Commission approved the Fishery Regime and Regulations and submitted these to the respective national governments for approval on June 1, 2004.

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 27th day of June, 2004, to the 4th day of September, 2004, both dates inclusive.

   b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 20-1, 3 and 4 from the 27th day of June, 2004, to the 4th day of September, 2004, both dates inclusive.

2. a) No person shall commercially fish for sockeye or pink salmon in Pacific Fishery Management Areas 17 and 18 with nets from the 27th day of June, 2004, to the 2nd day of October, 2004, both dates inclusive.

   b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 18-1, 4 and 11 from the 27th day of June, 2004, to the 2nd day of October, 2004, both dates inclusive.

3. a) No person shall commercially fish for sockeye or pink salmon with nets in Pacific Fishery Management Area 29 from the 27th day of June, 2004, to the 9th day of October, 2004, both dates inclusive.

   b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 29 from the 27th day of June, 2004, to the 9th day of October, 2004, 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 2004 season, the Fraser River Panel will adopt Orders establishing open fishing periods based on a 2004 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 27th day of June, 2004 to the 4th day of September, 2004, both dates inclusive.

2. No Treaty Indian shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 6A, 7 and 7A with nets from the 27th day of June, 2004, to the 11th day of September, 2004, 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 12th day of September, 2004, to the 2nd day of October, 2004, both dates inclusive.

All-Citizen Fisheries:

1. No person shall fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 4B, 5, and 6C with nets from the 27th day of June, 2004, to the 4th day of September, 2004, both dates inclusive.

2. No person shall fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 6A, 7 and 7A with nets from the 27th day of June, 2004, to the 11th day of September, 2004, both dates inclusive.

3. No person shall fish for sockeye or pink salmon with nets in that portion of Puget Sound Salmon Management and Catch Reporting Area 7A lying westerly of a straight line drawn from the low water range marker in Boundary Bay on the International Boundary through the east tip of Point Roberts in the State of Washington to the East Point Light on Saturna Island in the Province of British Columbia from the 12th day of September, 2004, to the 2nd day of October, 2004, both dates inclusive.

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

Treaty Indian and All-Citizen Fisheries:

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

2. Puget Sound Salmon Management and Catch Reporting Areas 6B, 6D, 7B, 7C, 7D and 7E.

During the 2004 season, the Fraser River Panel will adopt Orders establishing open fishing periods based on a 2004 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: 2004 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 in 2004.

July 16 United States:

Treaty Indian Fishery

Areas 4B, 5 and 6C:

Open to drift gillnets 12:00 p.m. (noon), Sunday, July 18, 2004, to 12:00 p.m. (noon) Wednesday, July 21, 2004.

July 20 United States:

Treaty Indian Fishery

Areas 4B, 5 and 6C:

Extended for drift gillnets from 12:00 p.m. (noon), Wednesday, July 21, 2004, to 12:00 p.m. (noon) Saturday, July 24, 2004.

July 23 Canada:

Area 20-1, 3, and 4:

Open to Area B purse seines authorized by a Scientific Licence from 6:00 a.m. to 7:00 p.m., Wednesday, July 28, 2004.

Area 18-1, 4 and 11; and Area 29-3, 4, and 6 (outside of a 27 fathom contour boundary):

Open to Area B purse seines authorized by a Scientific Licence from 6:00 a.m. to 9:00 p.m., Wednesday, July 28, 2004.

Area 18-1, 4 and 11; and Area 29-1 to 6:

Open to Area H troll 12:01 a.m., Monday, July 26, 2004, until further notice.

Area 29-1 to 7 and 9 to 17:

Open to Area E gillnets from 9:00 a.m. to 9:00 p.m., Tuesday, July 27, 2004.

United States:

Treaty Indian Fishery

Areas 4B, 5 and 6C:

Extended for drift gillnets from 12:00 p.m. (noon) Saturday, July 24, 2004 to 12:00 p.m. (noon), Wednesday, July 28, 2004.

Areas 6, 7, and 7A:

Open to net fishing from 4:00 a.m., Monday, July 26, 2004 to 8:00 a.m., Wednesday, July 28, 2004.

All-Citizen Fishery

Areas 7 and 7A:

Open to purse seines and reefnets from 5:00 a.m. to 9:00 p.m., Wednesday, July 28, 2004, and from 5:00 a.m. to 9:00 p.m., Thursday, July 29, 2004.

Areas 7 and 7A:
Open to gillnets from 8:00 a.m. to 11:59 p.m., Wednesday, July 28, 2004, and from 8:00 a.m. to 11:59 p.m., Thursday, July 29, 2004.

July 27 United States:

Treaty Indian Fishery

Areas 4B, 5 and 6C:
Extended for drift gillnets from 12:00 p.m. (noon), Wednesday, July 28, 2004, to 12:00 p.m. (noon) Saturday, July 31, 2004.

Areas 6, 7, and 7A:
Open to net fishing from 4:00 a.m., Thursday, July 29, 2004 to 8:00 a.m., Saturday, July 31, 2004.

All-Citizen Fishery

Areas 7 and 7A:
Open to purse seines from 5:00 a.m. to 9:00 p.m., Friday, July 30, 2004.

Areas 7 and 7A:
Open to gillnets from 8:00 a.m. to 11:59 p.m., Friday, July 30, 2004.

Areas 7 and 7A:
Open to reefnets from 5:00 a.m. to 9:00 p.m. Friday, July 30, 2004 and from 5:00 a.m. to 9:00 p.m., Sunday, August 1, 2004

July 28 Canada:

Area 20-1, 3, and 4:
Open to Area B purse seines authorized by a Scientific Licence from 6:00 a.m. to 7:00 p.m., Thursday, July 29, 2004.

July 30 Canada:

Area 20-1, 3, and 4:
Open to Area B purse seines authorized by a Scientific Licence from 6:00 a.m. to 7:00 p.m., daily on Sunday, August 1, and Monday, August 2, 2004 (fishery may close after 1 day depending on effort).

Area 18-1, 4 and 11; and Area 29-3, 4, and 6 (outside of a 27 fathom contour boundary):
Open to Area B purse seines authorized by a Scientific Licence from 6:00 a.m. to 9:00 p.m., daily on Sunday, August 1, and Monday, August 2, 2004 (fishery may close after 1 day depending on effort).

Area 18-1, 4 and 11; and Area 29-1 to 6:
Closes to Area H troll 11:59 p.m., Tuesday, August 3, 2004.

Area 29-1 to 7 and 9 to 17:
Open to Area E gillnets from 7:00 a.m., Wednesday, August 4 to 8:00 a.m., Thursday, August 5.

United States:

Treaty Indian Fishery

Areas 4B, 5 and 6C:
Extended for drift gillnets from 12:00 p.m. (noon), Saturday July 31, 2004, to 12:00 p.m. (noon) Saturday, August 7, 2004.

Areas 6, 7, and 7A:
Open to net fishing from 4:00 a.m., Sunday, August 1, 2004 to 11:59 p.m., Friday, August 6, 2004.

All-Citizen Fishery

Areas 7 and 7A:

Open to purse seines and reefnets daily from 5:00 a.m. to 9:00 p.m., Tuesday, August 3, 2004 through Friday, August 6, 2004.

Areas 7 and 7A:

Open to gillnets daily from 8:00 a.m. to 11:59 p.m., Tuesday, August 3, 2004 through Friday, August 6, 2004

August 6 United States:

Treaty Indian Fishery

Areas 4B, 5 and 6C:

Extended for drift gillnets from 12:00 p.m. (noon), Saturday August 7, 2004, to 12:00 p.m. (noon) Saturday, August 14, 2004.

Areas 6, 7, and 7A:

Extended for net fishing from 11:59 p.m., Friday, August 6, 2004 to 11:59 p.m., Friday, August 13, 2004.

All-Citizen Fishery

Areas 7 and 7A:

Open to purse seines and reefnets daily from 5:00 a.m. to 9:00 p.m., Tuesday, August 10, 2004 through Friday, August 13, 2004.

Areas 7 and 7A:

Open to gillnets daily from 8:00 a.m. to 11:59 p.m., Tuesday, August 10, 2004 through Friday, August 13, 2004.

August 10 Canada:

Area 29-13 to 29-17 and a portion of 29-9 (see DFO FN0618 for further details):

Open to Area E gillnets from 1:00 p.m. to 3:00 p.m., Wednesday, August 11, 2004.

August 13 United States:

Treaty Indian Fishery

Areas 4B, 5 and 6C:

Extended for drift gillnets until from 12:00 p.m. (noon), Saturday, August 14, 2004 to 11:59 p.m., Saturday, August 14, 2004.

Areas 6, 7, and 7A:

Extended for net fishing from11:59 p.m., Friday, August 13, 2004 to 11:59 p.m., Saturday, August 14, 2004.

APPENDIX F: CONCLUSIONS AND RECOMMENDATIONS FROM THE 2004 SOUTHERN SALMON FISHERY POST-SEASON REVIEW

This report (Part One) is concerned only with the return of Fraser sockeye in the year 2004. In many of the past years, sockeye returns have been reasonably close to the original forecast numbers or to the adjustments made during the fishing season. Also, in many of those years, estimates of spawning abundance have not been too far off the Mission estimates, taking into account the predicted degree of natural in-migration mortality in the river and the catch upstream of Mission.

In some years, however, there have been major discrepancies. For example, a very large number of fish were unaccounted for in 1994 and an overabundance reached the spawning grounds in 2002. It will not be possible in every year for DFO and the FRP to make accurate predictions, and this is not because of bad management. In some case the fault will be with nature, attributable to natural phenomena such as low ocean survival, extremely high or low river flows, and high water temperatures.

It is obvious that during the 2004 migration season, environmental factors, and especially abnormally high water temperatures, played a role in causing greater than usual en route mortality especially to Early Summer and Summer run fish.

From the evidence before us it would seem that in 2004 the Mission estimate was reasonably accurate, perhaps within a 10.5% range, and the count on the spawning grounds through both fence and visual observation programs was in accordance with past practice although hampered by declining stock assessment resources.

We do find, however, that much more could have been done and must be done to improve the accuracy of catch numbers. The Committee very much doubts the accuracy of both the 2004 catch monitoring numbers and DFO's estimate of the number of fish caught illegally and/or unreported. This lack of important information reflects both a lack of resources in DFO and a failure of management policies and practices.

It also accounts for a significant number of missing sockeye. The fact that this Committee is left with no idea of how many sockeye failed to make it to the spawning grounds because of high temperature and how many because of inadequate catch monitoring or enforcement, clearly demonstrates the need for better management.

The Committee heard repeated complaints from both DFO staff and fisheries stakeholders about the inadequate level of financial resources available to the Department. Since our Committee has not had the time nor expertise to undertake an objective examination of the region's financial situation, we recommend strongly that such a task be undertaken by an appropriate outside agency. It must never be overlooked that there is a strong public perception that the reductions in the Pacific region budget are not consistent with good management. The apparent fiscal crisis in the Pacific region needs urgent attention.

Finally, we wish to express our appreciation to all the members of DFO, the FRP members and staff of the PSC, and the many First Nations people, other members of the public and representatives of fisheries organizations who either gave evidence or made submissions or suggestions. The Committee worked well together and we sincerely hope that our report will be of value for the preservation and rehabilitation of Fraser River sockeye stocks. We believe that the changes we recommend must take place if the Canadian public is to continue enjoying the social and economic benefits that flow from abundant salmon stocks.

RECOMMENDATIONS

The primary goal of Fraser sockeye management must be to ensure adequate spawning escapement.

a) To facilitate this, there must be an escapement goal and harvest plan that applies to all sectors. Ideally, this should be the result of consensus among all harvest sectors, but ultimately the setting of a sustainable goal is the responsibility of the Minister of Fisheries and Oceans. At present there is at least the perception of different goals for different groups.

b) If there is no harvestable surplus beyond the sustainable conservation goal, then there can be no fisheries.

c) If there is a harvestable surplus, First Nations FSC needs have priority. It is the responsibility of DFO to negotiate the size of each First Nations' harvest and to impose a catch number failing agreement.

d) Since the largest part of the First Nations' harvest will be taken in the Fraser River system, these FSC numbers need to be defined clearly along with an agreed harvest process that avoids undue damage to the structure of the run. In order to achieve agreements on these harvest numbers and any economic opportunity fisheries DFO should employ a team of skilled and experienced negotiators.

e) The remaining harvestable surplus must then be allocated among commercial and recreational fisheries including First Nations economic opportunity fisheries with each user group accountable for its share.

Pre-Season, In-Season, Mission and Post-Season Estimates

1. It is recommended that a cost benefit analysis be done to determine the utility and feasibility of an additional counting station at either Boston Bar or Qualark.
2. A further site at the confluence of the Harrison might also be beneficial if it could be installed in order to establish run-size, catches, escapements and timing on late run-timed sockeye (i.e., Birkenhead, Harrison, Weaver, etc.)
3. That sufficient funding needs to be ensured to keep and expand on existing assessment programs. A continuation of "realtime monitoring" (12-hour turnaround) is needed to give PSC and DFO faster and accurate data of the migrating stocks. The continuation of funding from both Canada and the U.S. is needed to pay for the above.
4. That a further split-beam be installed on the north shore of the Fraser at the Mission Site.
5. The use of the First Nations FSC harvest in marine waters should be incorporated as part of the test fishing program on a long-term basis. This requires secure long-term funding for the catch monitoring carried out during the First Nations Marine Society FSC fishery.

Catch Monitoring

6. That DFO convene a meeting with First Nations, fisheries stakeholders, and Conservation and Protection staff to assess the province-wide state of catch monitoring. The participants should examine budgets, personnel needs, transparency, accuracy (bias), problem areas, and ways to improve monitoring programs in all sectors.
7. That DFO, First Nations and stakeholders establish a semi-regular (perhaps annual) review of the status and adequacy of the province-wide catch monitoring program.
8. That an estimate of total mortality be included in the catch monitoring of all fisheries.
9. That DFO develop, on an annual basis, a strategy pre-season to develop some estimate of unauthorized fishing and fish harvest.
10. That resources for catch monitoring be restored to an adequate level in commercial, recreational, and First Nations fisheries as determined through the process in recommendation 6.
11. That DFO retain the ultimate authority and responsibility for auditing catch monitoring reports and performance.

Temperature

12. The EMA model should consider the newly developed mortality criteria related to in-river water temperatures.
13. The estimate of accumulated degree days should be considered as an approximation of the environmental stress experienced by migrating Fraser River sockeye salmon to inform in-season management decisions.
14. The factors contributing to the discrepancy between gross escapement at Mission and spawning ground escapement (river temperature, river flow, unreported catch, catch estimation, errors in Mission and spawning ground escapement estimates, etc.) should be separated through improved data collection and modeling. In the interim, the EMA model should be renamed to eliminate the perception that it only accounts for environmental factors.
15. New and properly designed research is required on Early Stuart, Early Summer and Summer run adult sockeye to complement the work done on Late run sockeye to determine any stock-specific effects of high temperature on migration and spawning success.
16. That riparian habitat in tributary watersheds throughout the Fraser basin be protected and restored to reverse the warming effect that lack of cover creates through the disruption of the hydrologic cycle.
17. The feasibility should be investigated of modifying existing flow control/hydro facilities and water use agreements that might decrease Fraser mainstem and tributary temperatures during high temperature years.
18. Fisheries management action should be responsive and proportional to the direct relationship between increasing water temperature and decreasing survival to spawning. In extreme warm water years additional management actions need to be taken to ensure adequate and appropriate numbers of fish enter the river. Once in the river, management action, such as a time and area conservation corridor, is needed to create the opportunity for sockeye to migrate with a minimal amount of additional stress caused by fishing in the river.
19. Given the challenge posed to fisheries management by high water temperature and associated impacts on fish mortality, more systematic collection of data on the number of fish observed floating in the river or dead on the banks downstream of the spawning grounds would prove useful for comparative purposes.

Gear Impacts

20. When designing the annual fishing plan, DFO must take into account not only the harvest impact of each fishery and gear type, but also the cumulative effect each fishery and its associated gear has on total fishing mortality.
21. Research must be undertaken to verify whether the selective placing of set nets can have an adverse impact on upstream migration by depriving fish of resting places or forcing them to swim in the faster and more turbulent mid-stream waters. DFO policy should be to ensure the existence of a “conservation corridor” for the fish destined for the spawning grounds.
22. Research is needed into the relationship between gill net mesh size and the desired spawning ground gender ratio.
23. Approval of a change in gear type, such as the 2004 approval of the use of drift gill nets by the Cheam First Nation, should not take place in the absence of an objective determination of the comparative fishing power of the different gear.
24. DFO should set goals and objectives with respect to the number of nets allowed.
25. The regulation requiring that all nets be clearly marked as to their ownership should be vigorously enforced. Unidentified nets should be subject to immediate removal and confiscation. The penalty for leaving nets where they can continue to fish during closed periods should be substantial.

Enforcement

26. At the present time, DFO through its C&P Division is not maintaining a credible enforcement presence and not properly enforcing the *Fisheries Act* and *Regulations* including those that relate to habitat protection. Accordingly, DFO must ensure that adequate resources are available and that the budget and staffing available for enforcement be increased.
27. DFO should focus on empowering user groups with the responsibility of providing enforcement within their own sectors. Of course, ultimately such activity must be overseen by DFO.
28. C&P Division urgently needs a clear policy mandate and the resources with which to implement it. Morale will remain low among enforcement officers until this issue is addressed
29. Illegal fishing in the Fraser River has been described as rampant and out of control. This is unacceptable. DFO must properly enforce the *Fisheries Act* and *Regulations* and initiate measures to provide a reasonable estimate of the scope of this illegal activity and the number of fish actually taken.
30. Enforcement must also include adequate presence to deter the concealing of over harvesting of fish by participants from all sectors.
31. Throughout the South Coast there is an ongoing problem with the illegal sale of fish, both fish that have been caught as part of an FSC entitlement and fish that have been illegally harvested. We heard little evidence of any serious effort to prevent this activity. This situation is intolerable and must be addressed by DFO.
32. DFO should develop and have in place as early as possible in 2005 a system to more accurately record illegal nets and fishing in the Fraser River and the approach waters. This system should include over-flights at varying times during closed periods of all waters in order to provide for accurate assessment of the number of illegal activities.
33. DFO should maintain a complete record, by species, of all fish found in confiscated nets.
34. Night patrols should be undertaken on a regular but variable basis, particularly in those areas where illegal fishing is being reported.
35. DFO should increase and enhance the Restorative Justice program and apply it to all sectors.
36. Pacific Region enforcement should be organized as a separate branch ultimately reporting to a senior person with enforcement experience and line authority throughout B.C. This person must be a member of the Regional Management Committee.
37. The Committee heard testimony from a number of C&P officers who felt their enforcement powers had been undermined by their inability to conduct vehicle checks at roadblocks. This issue as well as their law-enforcement status should be reviewed by the department.
38. In view of the threat to the resource posed by illegal activity DFO should review the level of penalties it can impose and consider requesting increases commensurate with the infraction and administrative sanctions, including licence suspensions, which can act as an effective deterrent.
39. A higher level of traceability needs to be in place. DFO should work with stakeholders to identify their harvest.

Management and Budget

40. DFO Pacific region should reassess its core mandate with respect to management of Fraser River sockeye (and indeed all Pacific fisheries resources) and devise a management organizational structure that best supports that mandate. We recommend that an independent consultant be hired to review the situation and provide guidance to senior management.
41. Integrated management plans should be developed within a framework that sets measurable goals, analyses options and evaluates results. Where possible goals should be quantifiable. This will provide public accountability.
42. Public involvement is a good thing. Ultimately the public expect DFO to maintain responsibility for good resource management and will hold DFO accountable. Collaborative approaches and consultation are costly and should be

evaluated explicitly against the goals set for fisheries management and compared with the costs and benefits of in-house or independent delivery of programs.

43. DFO's budgeting process should be informed by explicit evaluation of the impact of various budget proposals on results. Where critical elements of DFO's programs have budget issues they should be explained and funds sought. This information should be shared both within and outside DFO to provide stakeholders' views on budget priorities. In the Committee's view DFO has insufficient resources to meet its core mandate for developing, managing and controlling fisheries for Fraser River sockeye and conserving the resource. DFO should be directed to make a submission for additional funds, particularly in the areas of deficiency identified by this review.

44. The PSC FRP is the critical link in management of Fraser sockeye. The Canadian consultative and management structures for all fisheries impacting on Fraser sockeye should be integrated with the Canadian section of the FRP. In particular, First Nations' consultative processes must be fully engaged with that process. In addition, the Canadian chair of the FRP should be the senior authority on all fisheries management decisions relating to Fraser sockeye throughout the South Coast and be empowered to make those decisions on a timely basis.

45. DFO should vigorously pursue solutions to resource sharing and aboriginal claim accommodation.

46. The Committee heard repeated complaints by both DFO staff and fisheries stakeholders about the inadequate level of financial resources available to the department. There exists a strong public perception that reductions in the Pacific region budget are not consistent with good management. Since our Committee has not had the time nor expertise to undertake an objective examination of the region's financial situation, we recommend strongly that such a task be undertaken by an appropriate outside agency.

Recommendations of 1992, 1994 and 2002 Sockeye Management Review Panels: Themes, Lessons, Actions

47. That DFO form a cross-sectoral committee, and produce a work plan for addressing the completeness of responses to past recommendations, and for responding to 'new' recommendations contained in the current review.

APPENDIX G: LATE-RUN SOCKEYE STUDIES IN 2004

(Note: information in this Appendix was extracted from reports made to the Southern Boundary Restoration and Enhancement Fund of the Pacific Salmon Commission and from presentations provided to the Fraser River Panel by Late-run researchers at the January 2005 and February 2005 meetings)

Introduction

Background

Late-run sockeye have historically delayed in the lower Strait of Georgia for four to six weeks prior to entering the Fraser River en route to their spawning grounds. Since 1995, Late-run sockeye (excluding Birkenhead sockeye) have often entered the Fraser River with little or no delay, which has resulted in mortality rates of some Late-run sockeye stocks exceeding 90% in some years. The cause(s) of this early entry behaviour have not yet been identified, despite intensive and on-going research studies. Some of the most serious implications of this early entry behaviour of Late-run sockeye are that: (1) the future viability of some Late-run stocks may be jeopardized; and (2) substantially lower harvest rates on Late-run and Summer-run sockeye (a portion of which overlap in their migration timing with Late-run fish) have been necessary in recent years to help ensure that Late-run sockeye stocks are conserved. The greatly reduced harvest rate on Fraser River sockeye is having significant adverse impacts on the multitude of commercial and non-commercial users of this resource. The severe curtailment of harvest has been necessary to protect the sustainability of Late-run stocks, including the famous Adams River sockeye run.

Because of the low abundance of Late-run sockeye relative to Summer-run sockeye on the 2004 cycle line, large scale tagging programs were not conducted in 2004. However, four smaller-scale projects related to Late-run issues totalling $251,000 were funded by the Pacific Salmon Commission's Southern Boundary Restoration and Enhancement Fund (SEF): (1) evaluation and reduction of the impacts of Northern Pike-minnow predation on Cultus Lake sockeye fry; (2) survival, behaviour and physiology of migrating adult Late-run Fraser River sockeye: identifying the cues and causes of abnormally high mortality prior to spawning; (3) investigating the relationship between Summer-run sockeye abundance and migration timing, with Late-run sockeye river entry timing; and (4) a biophysical mechanism for the early entry of Late-run Fraser River salmon: anomalous oceanic conditions trigger an accelerated change in fish physiology. Canada allocated approximately $50,000 as recommended by the Committee on Scientific Cooperation (CSC) for analysis of samples collected in past years and oceanographic studies related to project 4 above. In addition, 2004 was the second year of a five year National Sciences and Engineering Research Council Grant (NSERC) to Dr. Scott Hinch of the University of British Columbia to investigate the Late-run mortality problem. Abstracts or summaries from reports of projects funded by the SEF along with summaries of additional research conducted in 2004 are presented below. Copies of the full reports for the SEF projects are available from the PSC secretariat.

Southern Fund Project Summaries

(1) Evaluation and Reduction of the Impacts of Northern Pikeminnow Predation on Cultus Lake Sockeye Fry

Summary

Predation by northern pikeminnow and other predators on juvenile fry and smolts may be a significant cause of freshwater mortality on Cultus Lake sockeye. In the 1930's, a 90% reduction in northern pikeminnow abundance resulted in a 3-fold increase in freshwater survival, but later

analysis questioned how long these benefits to survival would be sustained into the future without ongoing predator control. This study expanded on preliminary work funded by Fisheries and Oceans Canada and included estimation of pike minnow populations via tagging, removal of pike minnow, and construction of a model to assess the effect of pikeminnow removal on sockeye freshwater survival. Most of the project extended into 2005, including the removal of pike minnow prior to emergence of the 2004 brood Cultus sockeye fry in the spring of 2005. Thus, most of these results will be reported in the 2005 Fraser River Panel Annual report. Some results from work conducted in 2004 are provided below.

- Information of past predator reduction programs from published reports and data from the archives of the International Pacific Salmon Fisheries Commission (IPSFC) and Fisheries and Oceans Canada was summarized and compiled in the below document.

- Mossop, B. M.J. Bradford, and J. Hume. 2004. Review of northern pikeminnow (*Ptychocheilus oregonensis*) control programs in western North America with special reference to sockeye salmon (*Oncorhynchus nerka*) production in Cultus Lake, British Columbia. Report prepared for the Cultus Sockeye Recovery Team. Vancouver. 58 p.

- 3,552 northern pikeminnow were captured by angling and trap nets. Of these fish, 2,026 were tagged and released, and 1,526 were killed as part of the predator control program. Of the 1,526 fish that were killed, 1,199 were caught via angling as part of the 2004 northern pikeminnow derby. The highest catches occurred in June.

- A computer model was constructed of the population dynamics of northern pikeminnow using data from past studies to assess the effectiveness of alternative northern pikeminnow removal strategies.

- Samples of northern pike minnow stomach contents were also obtained from fish captured at the lake outlet.

(2) Survival, Behaviour and Physiology of Migrating Adult Late-run Fraser River Sockeye: Identifying the Cues and Causes of Abnormally High Mortality Prior to Spawning

Summary

In recent years, large numbers of Late-run Fraser River sockeye salmon have died in freshwater before reaching the spawning grounds. The purpose of this investigation was to examine the extent and causes of mortality in Late-run Fraser River sockeye salmon. The investigations focused on the pre-spawning behaviour and survival of Late-run sockeye returning to Weaver Creek and the lower Harrison River. The study included two components, 1) a field-based assessment of fish behaviour, mortality, and thermal biology, and 2) an experimental assessment of these issues using laboratory interventions and field releases. We were particularly interested in the relationship between water temperature and mortality. Earlier controlled-experiments in our lab have shown that moderate increases in migratory temperatures elicit high levels of mortality, even when temperatures at spawning were cooled to reflect normal conditions. Mechanisms of mortality have not yet been elucidated, but leading candidates include increases in parasitic infection and higher rates of energy use. Recent lab work has identified a 350-450 degree-day threshold for high rates of parasitic infection and mortality.

The first component of the project involved tagging sockeye salmon captured in the Harrison River downstream from Weaver Creek with acoustic depth tags (n=39) and radio tags (N=58). Tagging was conducted in cooperation with the Chehalis First Nations Band at the “Park” between August 25 and September 29, 2004, when river temperatures varied from 15 to 18.5 ºC. DNA analyses at capture and terminal spawning ground recoveries revealed that 46 of the 58 radio-tagged fish were estimated to be Weaver Creek sockeye, while nine were estimated to be Harrison River sockeye and, three were Big Silver sockeye. Data from four fixed radio-telemetry stations and numerous mobile tracking surveys were used to track the movements of sockeye into, within, and out of Harrison Lake. These data were also used to determine when the fish entered spawning

areas and assess overall survival rates. The median travel times between the release sites in the lower Harrison River and a fixed-station located near the outlet of Harrison Lake was 0.2 days. Of the 46 radio-tagged Weaver sockeye, 28 fish were detected in the upper Harrison River, of which 19 entered Harrison Lake. Four of those 19 later emerged from the lake and were subsequently tracked to Weaver Creek. Survival to spawning for Weaver Creek sockeye (N=8) was 0% for fish tagged in late August, 24% for those tagged in the first half of September (N=25), and 85% for those tagged late September (N=13). The water temperatures in Harrison River were near 18.5ºC in late August, but were between 15 and 16ºC for most of September. We noted a strong relationship between water temperature in the lower Fraser River at time of river entry and mortality. Fish that migrated in late August and early September experienced water temperatures in the Lower Fraser in excess of 20ºC and had high levels of mortality (over 90%). Later migrants (late September) experienced low water temperatures (approximately 14ºC) during migration and exhibited low mortality (<10%).

Because radio telemetry is ineffective in large lakes, we also implanted an additional 39 fish with acoustic transmitters containing pressure sensors which allowed us to determine both the depth and position of fish in Harrison Lake. Using data from these acoustic transmitters and temperature-depth profiles generated by temperature loggers placed throughout the watershed, we were able to reconstruct the thermal history of individual fish. A total of 11 fixed-station acoustic receivers were used to assess fish behaviour, residency and fate. DNA analysis estimated that all 39 fish were from the Weaver stock-group. Of these fish, only 25.6% (N = 10) reached spawning grounds. When examined temporally, fish released between August 30 and September 3 had low survival to spawning grounds (5.3%, 1 of 19) whereas survival improved to 45% (9 of 20) after that period (i.e., September 20 to September 29). The only fish from the early-tagging group that survived resided primarily in Harrison Lake and spent much of the time below the thermocline and accrued less than 450 degree days of exposure. The majority of the fish that died accumulated degree days in excess of 600 and/or experienced water temperature during their Fraser River migration that exceeded 19ºC. Conversely, fish that migrated in later September experienced lower water temperatures and spawned soon after arriving in the Harrison system. In addition to elucidating thermal biology and behaviour, the depth transmitter provided novel information on the location of mortalities. Our depth tags indicated that in Harrison Lake and Harrison River, all dead salmon tended to sink. In the lake, mortalities were often observed at depths exceeding 100 m (as indicated by static depth reporting from the tag). While conducting our research on the Harrison system, sockeye were not observed floating in Harrison Lake or Harrison River.

The second experiment involved a series of field interventions. For this component, we tested the hypothesis that migratory salmon accruing >400 riverine degree days would exhibit inefficient behaviours (swim speeds) and signs of energetic and physiologic stress relative to fish that had accrued <350 riverine degree days. To test this, we intercepted salmon en route to a natal spawning stream and biopsied them non-lethally for plasma biochemistry and somatic energy status. Fish were then held in large experimental tanks at one of two different temperature regimes (8 and 18º C), reflecting a range of natural temperatures, until they had accumulated 320 or 510 riverine degree days. Salmon were biopsied a second time and fitted with gastric acoustic transmitters (N=61) prior to release back to the river, and migratory behaviours were monitored using a fixed telemetry array leading to spawning grounds. Salmon with >400 degree days suffered higher mortality, both during the experimental holding period (70% warm vs. 15% cold) and when migrating to spawning areas (60% warm vs. 28% cold). Salmon exposed to >400 degree days also had delayed migration rates and fewer individuals were detected on spawning grounds. Somatic energy values upon release did not correlate with degree days or ultimate fate, but additional physiological plasma assays are pending. These results suggest that ‘normal’ timed migrants, if chronically exposed to warm river temperatures, can have their migratory performance and survival negatively affected.

Collectively, the findings from these studies emphasize the pivotal role of water temperature on the behaviour and survival of sockeye salmon. Thermal experience during early phases of migration (an acute stressor) can be important as we observed a strong relationship between high water temperature at Fraser River entry and subsequent mortality. Similarly, prolonged exposure to warm temperatures (a chronic stressor) can also be detrimental as degree days accumulate and accelerate disease development, energy use, and senescence. Future work should focus on

exploring these relationships in other stocks and in other seasons. In addition, experimental manipulations should be encouraged to validate patterns observed in the field.

(3) Investigating the Relationship Between Summer-run Sockeye Abundance and Migration Timing, with Late-run Sockeye River Entry Timing

Abstract

Early river entry timing and high pre-spawning mortality rates for Late-run Fraser sockeye has been a significant concern for fisheries managers since 1995. Several studies were initiated in 2002 to provide quantitative estimates of in-river mortality by run timing-group and examine alternative explanations for the early entry phenomenon. In this report, we examined one of these potential explanations: the "Stay with the school" (SWTS) hypothesis, where the portion of Late-run sockeye that enter the Fraser River during the migration period of Summer-run sockeye is influenced by the run timing and abundance of Summer-run sockeye relative to Late-run stocks. We present the basis for this hypothesis and examine data from 1978 to 2003 to assess whether this hypothesis is consistent with variation in early entry behaviour observed in recent years and the possibility that early entry could have occurred prior to 1995. We describe a model that could be used prior to, and during, the fishing season to predict the extent to which Late-run stocks will enter the Fraser River early based on the relative timing and abundance of Summer-run and Late-run stocks from pre-season forecasts or in-season test fishing data. We compared the SWTS model estimates of the number of Late-run sockeye in Lower Georgia Strait (LGS) at the end of the Summer-run migration with the reported Pacific Salmon Commission (PSC) estimates for Late-run sockeye escapement past Mission after the end of the Summer-run migration. The PSC estimates varied from 12,000- 4,143,000 fish for the years examined and the annual estimates derived from the model were similar to the PSC estimates in most years. The model estimates ranged from 6,000 to 5,550,000 fish and tended to be slightly lower than the Mission estimates in years when the numbers of Late run sockeye entering LGS was less than 800,000 fish. In years when Late-run sockeye entering LGS were between 800,000 and 4,100,000 fish, the model estimates were similar to the Mission values with no consistent bias. In 2002, when the Late-run abundance arriving in LGS was estimated to exceed 6,900,000 fish, the model estimate (5,500,000) was higher than the PSC estimate (4,100,000). The Model estimates of the daily escapement during the Summer-run period were combined with river water temperature data and timing-specific survival curves from the 2002 and 2003 radio-telemetry studies to compute an estimate of the expected en route mortality for Late-run sockeye stocks. These mortality rates ranged from a low of 18% for 1991 to a high of 83% for 2000.

(4) A Biophysical Mechanism for the Early Entry of Late-run Fraser River Salmon: Anomalous Oceanic Conditions Trigger an Accelerated Change in Fish Physiology

Summary

Oceanographic work in 2004 continued to focus on the Brackish Layer model developed by Dr. Rick Thomson and Roy Houston from Fisheries and Oceans Institute of Ocean Sciences in Sidney, B.C. The working hypothesis of the Brackish Layer model is that early entry is dependent on upper ocean conditions in ocean migratory areas as adults enter the Strait of Georgia. The hypothesis contends that Late-run Fraser sockeye are more likely to proceed up-river during late summer in years which have high freshwater retention and weak vertical mixing in the upper layer. Environmental variables were used to assess processes affecting migration timing based on the concept that the upper layer of the Strait of Georgia system is, to varying degrees, an extension of the Fraser River estuary. This has been called the "Brackish Layer Depth Model" and focuses on environmental conditions in near-surface depths where salmon migrate. A long-term time series of properties or spatial extent of the surface brackish layer in the Georgia Basin does not exist. Therefore, proxy variables were used to characterize the surface brackish layer, notably surface temperature and salinity from lighthouses, but also wind and water level. To determine the temperature and salinity conditions that Late-run sockeye experience in Georgia Strait, a Conductivity, Temperature, Depth sensor (CTD) was attached to one of the lines of a PSC troll

test vessel. The CTD measured temperature salinity and dissolved oxygen. Towing the CTD during the test fishing process and raising and lowering it periodically through the water column generated depth profiles of the environmental variables that were associated with the capture depth of sockeye.

2004 Results

- Only 3 sockeye were caught during the period of troll test fishing because most fish migrated upstream early in 2004, and thus were not vulnerable for to troll capture in Georgia Strait.
- As a consequence of the low catch rate, the troll lines were lowered and raised fewer times than in 2003. Thus only 61 CTD profiles (compared to 191 in 2003) for temperature, oxygen, and salinity were extracted from the data set collected over a 3 week period of troll test fishing.
- Mission estimates of daily passage for Late-run sockeye were related to measurement for the CTD sensor:
    - No relationships were found between daily estimates and temperature, unlike 2003 when higher daily estimates were associated with period of higher Strait of Georgia temperatures.
    - Higher daily estimates were associated with periods of higher salinity in the surface waters similar to the pattern found in 2003.
    - Higher daily estimates were also associated with periods of lower dissolved oxygen, unlike 2003 when there was no apparent relationship between oxygen and the daily estimates.
- The CTD profiles from the 2002 and 2003 and 2004 data sets collected during the troll fishery will be compared to historical profiles from Nanoose Bay to refine the environmental variables used in the Brackish Layer model. Significant relationships were found between the mixed layer depth (at Nanoose Bay) and peak or 50% migration timing for Weaver, Adams and Cultus sockeye. Shallower, mixed-layer depths were associated with years of earlier entry.

NSERC Grant Investigations

This was the second year of the NSERC Strategic Grant of Dr. Scott Hinch and his colleagues. The $1,100,000 (Cdn.) grant will focus on three main objectives during the next five years:

1. Examine hypotheses about the physiological conditions that may be responsible for initiating up-river migrations. In particular we will focus on osmoregulation, reproductive hormones, photoreception, energy state, and parasite infection.

2. Examine hypotheses about the immediate consequences of earlier than normal migrations in order to understand why early migrants have high en route and pre-spawning mortalities.

3. Examine hypotheses about the intergenerational (e.g. fitness) consequences of earlier than normal migrations on sockeye that successfully spawn.

2004 Results

The NSERC team was the proponent of project no. 2 above and considerable, “in-kind” support was provided to that project from the NSERC grant and its partners. In addition to that program, some studies were done relating to sample analysis as summarized below.

Physiological and Energetic Assessments

One of the most important techniques developed by the Hinch NSERC team was the ability to non-destructively sample fish for physiological measurements. The technique allows physiological measurements to be taken from fish prior to radio tagging and release so that the physiology could

then be linked to subsequent behaviour (e.g. early entry vs. normal holding) and fate (e.g. successful migration and spawning vs. en route loss and/or death prior to successful spawning on the spawning grounds). A concerted effort was made in 2004 to analyze the physiological results taken from fish sampled during prior-year radio and acoustic tagging projects.

The analyses conducted in 2004 focused on three main questions:

1. What are the physiological and energetic correlates of estuarine holding behaviour?

2. What are the physiological and energetic correlates of migration timing and fate (survival or mortality) for fish tagged in the estuary?

3. What are the physiological and energetic correlates of entry timing and fate (survival or mortality) for fish tagged upriver?

Behaviour Results

Analysis of marine-tagged fish found that Late-run fish that migrated upstream early had lower body energy, were more advanced in their maturity (higher levels of reproductive hormones) and had more variable levels of a gill enzyme (ATPase) than fish that showed more normal delay behaviour. The analysis of fish tagged in the river found that early entry fish had more energy than fish that delayed. Though this result appears to be contradictory to the marine samples, it can be explained as follows: fish that hold in the estuary start with more energy but use much of it prior to river entry, so that when these fish reach a given location in the river, they have less energy than fish that migrated directly upstream.

Fate Results

For marine tagged fish, fish with lower energy and more variable levels of the gill enzyme (ATPase) were more likely to die en route. For fish tagged in the Thompson River, fish that die en route had lower energy, higher levels of plasma lactate (a factor related to stress) and were more mature than fish that survived to the spawning grounds.

APPENDIX H: APPENDIX TABLES 1 TO 7

Table 1. Commercial net catches of Fraser River sockeye salmon in Canadian Area 20 (Juan de Fuca Strait) by week for cycle years 1992-2004.

Date *	1992	1996	2000	2004 **
Jun. 27-Jul. 3	0	0	0	0
Jul. 4-Jul. 10	0	0	0	0
Jul. 11-Jul. 17	0	0	0	0
Jul. 18-Jul. 24	0	0	0	0
Jul. 25-Jul. 31	0	0	0	10,000
Aug. 1-Aug. 7	0	0	0	1,000
Aug. 8-Aug. 14	113,000	0	0	0
Aug. 15-Aug. 21	497,000	69,000	0	0
Aug. 22-Aug. 28	252,000	0	0	0
Aug. 29-Sep. 4	18,000	0	0	0
Sep. 5-Sep. 11	0	0	0	0
Sep. 12-Sep. 18	0	0	0	0
Sep. 19-Sep. 25	0	0	0	0
Sep. 26-Oct. 2	0	0	0	0
Oct. 3-Oct. 9	0	0	0	0
Total	880,000	69,000	0	11,000

* Dates for 2004. For other years, data from the nearest week were used.
** Includes selective fishery catches.

Table 2. Commercial net and troll catches of Fraser River sockeye salmon in Canadian Areas 17, 18, and 29 (Strait of Georgia and lower Fraser River) by week for cycle years 1992-2004.

Date *	1992	1996	2000	2004 **
Jun. 27-Jul. 3	0	0	0	0
Jul. 4-Jul. 10	0	0	0	0
Jul. 11-Jul. 17	0	0	0	0
Jul. 18-Jul. 24	0	0	0	0
Jul. 25-Jul. 31	0	0	175,000	52,000
Aug. 1-Aug. 7	0	0	1,000	157,000
Aug. 8-Aug. 14	93,000	69,000	226,000	36,000
Aug. 15-Aug. 21	42,000	642,000	4,000	1,000
Aug. 22-Aug. 28	124,000	0	16,000	0
Aug. 29-Sep. 4	2,000	0	0	0
Sep. 5-Sep. 11	0	1,000	0	0
Sep. 12-Sep. 18	0	0	0	0
Sep. 19-Sep. 25	0	0	0	0
Sep. 26-Oct. 2	0	0	0	0
Oct. 3-Oct. 9	0	0	0	0
Total	261,000	712,000	422,000	246,000

* Dates for 2004. For other years, data from the nearest week were used.
** Includes selective fishery catches.

Table 3. Commercial troll landings of Fraser River sockeye salmon in Canadian Areas 121 to 127 (west coast of Vancouver Island) by week for cycle years 1992-2004.

Date *	1992	1996	2000	2004
Jun. 27-Jul. 3	0	0	0	0
Jul. 4-Jul. 10	0	0	0	0
Jul. 11-Jul. 17	0	0	0	0
Jul. 18-Jul. 24	2,000	0	0	0
Jul. 25-Jul. 31	25,000	0	0	0
Aug. 1-Aug. 7	65,000	0	0	0
Aug. 8-Aug. 14	0	0	0	0
Aug. 15-Aug. 21	77,000	1,000	0	0
Aug. 22-Aug. 28	0	0	0	0
Aug. 29-Sep. 4	0	0	0	0
Sep. 5-Sep. 11	0	0	0	0
Sep. 12-Sep. 18	0	0	0	0
Sep. 19-Sep. 25	0	0	0	0
Sep. 26-Oct. 2	0	0	0	0
Oct. 3-Oct. 9	0	0	0	0
Total	169,000	1,000	0	0

* Dates for 2004. For other years, data from the nearest week were used.

Table 4. Commercial net and troll catches of Fraser River sockeye salmon in Canadian Areas 11 to 16 (Johnstone Strait and northern Strait of Georgia) by week for cycle years 1992-2004.

Date *	1992	1996	2000	2004 **
Jun. 27-Jul. 3	0	0	0	0
Jul. 4-Jul. 10	0	0	0	0
Jul. 11-Jul. 17	0	0	0	0
Jul. 18-Jul. 24	1,000	0	0	58,000
Jul. 25-Jul. 31	6,000	0	0	435,000
Aug. 1-Aug. 7	15,000	0	140,000	302,000
Aug. 8-Aug. 14	314,000	70,000	342,000	6,000
Aug. 15-Aug. 21	1,103,000	102,000	39,000	0
Aug. 22-Aug. 28	565,000	1,000	12,000	0
Aug. 29-Sep. 4	43,000	0	0	0
Sep. 5-Sep. 11	2,000	0	0	0
Sep. 12-Sep. 18	0	0	0	0
Sep. 19-Sep. 25	0	0	0	0
Sep. 26-Oct. 2	0	0	0	0
Oct. 3-Oct. 9	0	0	0	0
Total	2,049,000	173,000	533,000	801,000

* Dates for 2004. For other years, data from the nearest week were used.

** Includes selective fishery catches.

Table 5. Catches of Fraser River mainstem sockeye salmon in the Canadian First Nations' fisheries by area (Fraser River mainstream or tributary areas) for cycle years 1992-2004.*

Fishing Area		1992	1996	2000	2004
Fraser River Mainstem					
Below Port Mann	*1*	64,100	93,700	100,400	109,300
Port Mann to Mission	*1*	16,700	71,100	61,000	89,800
Mission to Hope		110,900	77,200	135,300	90,300
Hope to Sawmill Cr.	*2*	116,900	219,400	165,300	203,700
Sawmill Cr. to Kelly Cr.	*2*	12,000	144,200	252,700	118,300
Kelly Creek to Naver Cr.	*3*	5,100	7,000	13,700	11,500
Above Naver Cr.	*3*	2,800	4,200	5,000	4,200
Total		328,500	616,800	733,400	627,100
Tributaries					
Harrison/Lillooet System		7,600	n/m *4*	n/m *4*	n/m *4*
Thompson System		0	400	1,100	3,400
Chilcotin System		23,000	52,100	38,000	9,200
Nechako System		3,700	6,000	6,000	n/m *4*
Stuart System		4,900	2,300	7,300	3,800
Total		39,200	60,800	52,400	16,400
Total Catch		367,700	677,600	785,800	643,500
Marine Areas		52,000	76,000	91,000	256,000

* Data supplied by DFO.
1 Prior to 1995, the divisions were Steveston, and Deas to Mission.
2 Prior to 1993, the divisions were Hope to North Bend, and North Bend to Churn Creek.
3 Prior to 1994, the divisions were Churn Creek to Hixon, and above Hixon.
4 No monitoring of fisheries was conducted.

Table 6. Commercial net catches of Fraser River sockeye salmon in United States Areas 4B, 5, 6, 6C, 7, and 7A (Juan de Fuca Strait and northern Puget Sound) by week for cycle years 1992-2004.

Date *	1992	1996	2000	2004
Jun. 27-Jul. 3	0	0	0	0
Jul. 4-Jul. 10	0	0	0	0
Jul. 11-Jul. 17	0	0	0	0
Jul. 18-Jul. 24	0	0	1,000	6,000
Jul. 25-Jul. 31	4,000	0	110,000	56,000
Aug. 1-Aug. 7	23,000	20,000	108,000	54,000
Aug. 8-Aug. 14	110,000	59,000	260,000	76,000
Aug. 15-Aug. 21	349,000	174,000	11,000	4,000
Aug. 22-Aug. 28	109,000	4,000	0	0
Aug. 29-Sep. 4	13,000	0	0	0
Sep. 5-Sep. 11	0	0	0	0
Sep. 12-Sep. 18	0	0	0	0
Sep. 19-Sep. 25	0	0	0	0
Sep. 26-Oct. 2	0	0	0	0
Oct. 3-Oct. 9	0	0	0	0
Total	608,000	257,000	490,000	196,000

* Dates for 2004. For other years, data from the nearest week were used.

Table 7. Escapements of sockeye salmon to Fraser River spawning areas for cycle years 1988-2004.

DISTRICT	Estimated Number of Adult Sockeye *					Jacks
Stream/Lake	1988	1992	1996	2000	2004	2004
NORTHEAST						
Upper Bowron R.	12,780	2,560	8,176	13,440	836	0
STUART						
Early Runs						
Takla L. Streams	23,453	11,789	24,064	34,075	3,428	5
Middle R. Streams	114,216	41,059	36,339	29,988	3,812	0
Trembleur L. Streams	42,138	12,769	27,168	25,684	2,041	0
Early Stuart Total	179,807	65,617	87,571	89,747	9,281	5
Late Runs						
Middle R.	1,203	1,832	9,290	51,426	12,938	0
Tachie R.	3,137	15,056	48,795	368,834	60,838	24
Miscellaneous	2,777	2,625	4,909	34,137	9,642	5
Late Stuart Total	7,117	19,513	62,994	454,397	83,418	29
NECHAKO						
Nadina R. (Late)	794	862	8,908	165,442	14,276	0
Nadina Channel	7,950	6,866	29,746	34,852	8,327	0
Stellako R.	367,702	97,979	332,207	371,564	86,688	0
QUESNEL						
Horsefly R. area	5,876	5,862	34,241	36,634	4,017	42
Mitchell R.	954	-	6,946	27,069	5,452	0
CHILCOTIN						
Chilko R.	254,668	511,267	974,846	758,941	91,909	234
Chilko L.-South End	108,721	- *1*	- *1*	- *1*	- *1*	-
Taseko L.	11,138	970	1,470	3,000	320	0
SETON-ANDERSON						
Gates Cr.	17,512	2,774	69,270	56,226	757	25
Gates Channel	27,401	38,973	30,728	32,421	8,849	290
Portage Cr.	1,068	2,706	3,422	1,269	1,287	25
NORTH THOMPSON						
Raft R.	19,851	8,236	46,592	66,292	5,611	0
Fennell Cr.	26,927	9,139	32,279	10,155	2,718	0
SOUTH THOMPSON						
Early Runs						
Seymour R.	16,781	5,742	21,101	25,465	1,323	0
Scotch Cr.	1,060	2,156	4,609	3,765	783	0
Eagle R.	31	482	4,700	14,166	155	0
Upper Adams R.	7,169	2,990	24,948	71,332	419	0
Momich / Cayenne Cr.	5,912	2,486	9,353	8,334	32	0
Late Runs						
Lower Adams R.	4,578	12,270	11,333	754	2,665	67
Lower Shuswap R.	194	240	635	50	144	0
HARRISON-LILLOOET						
Birkenhead R.	166,591	185,908	56,112	13,842	37,617	56
Big Silver Cr.	257	3,228	3,518	8,956	19,831	0
Harrison R.	1,544	313	15,379	4,343	2,106	0
Weaver Cr.	23,958	22,851	38,059	1,237	912	0
Weaver Channel	25,299	35,835	34,011 *2*	5,376	24,467	50
LOWER FRASER						
Nahatlatch R. & L.	16,446	4,120	13,537	5,165	1,097	0
Cultus L.	861	1,203	2,022	1,227	52	0
Upper Pitt R.	37,747	9,129	50,081	42,638	60,942	0
Chilliwack L.	6,565	3,888	4,260	8,160	40,329	0
MISCELLANEOUS	5,080	2,641	4,490	16,671	7,788	28
ADULTS	1,370,339	1,068,806	2,027,544	2,352,930	524,408	
JACKS	47,960	51,367	28,651	1,179	851	851
TOTAL NET ESCAPEMENT	1,418,299	1,120,173	2,056,195	2,354,109	525,259	

* Estimates are from DFO.

1 Included in Chilko River estimate.

2 Weaver Channel estimate in 1996 does not include 33,193 sockeye removed for hatchery rack sales.

APPENDIX I: STAFF OF THE PSC IN 2004

EXECUTIVE OFFICE

Mr. D. Kowal, Executive Secretary
Ms. K. Bartlett, Secretary
Ms. S. Gibson, Information Technology Support Specialist
Ms. K. Mulholland, Computer System Manager
Mrs. V. Ryall, Meeting Planner
Ms. T. Tarita, Librarian/Records Administrator

FINANCE AND ADMINISTRATION

Mr. K. Medlock, Controller
Ms. B. Dalziel, Accountant
Mr. A. Mackay, Fund Coordinator

FISHERIES MANAGEMENT DIVISION STAFF

Mr. M. Lapointe, Chief

BIOMETRICS / CATCH STATISTICS GROUP

Mr. I. Guthrie, Head

RACIAL IDENTIFICATION GROUP

Mr. J. Gable, Head
Ms. H. Anozie, Scale Lab Assistant
Ms. J. Boffey, Scale Analyst (Term)
Mr. K. Forrest, Racial Data Biologist
Mr. V. Keong, Resource Management Technician (Term)
Mr. S. Latham, Sockeye Racial Analysis Biologist
Ms. M. Reichardt, Senior Scale Analyst
Ms. J. Sellars, Scale Lab Assistant
Mr. B. White, Pink Racial Analysis Biologist

STOCK MONITORING GROUP

Mr. J. Cave, Head
Mr. P. Cheng, Hydroacoustics Biologist
Mr. A. Gray, Hydroacoustics Biologist
Ms. F. Martens, Hydroacoustics Technician (Term)
Ms. C. Tovey, Test Fishing Biologist
Dr. Y. Xie, Hydroacoustics Scientist