Report of the Fraser River Panel to the Pacific Salmon Commission on the 1998 Fraser River Sockeye Salmon Fishing Season

Prepared by the

Pacific Salmon Commission

August, 2000

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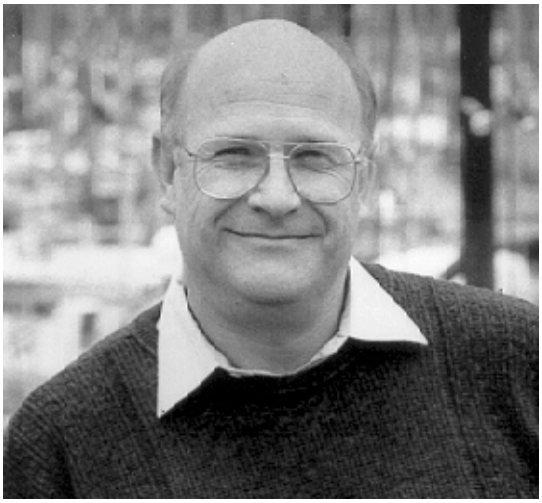
IN MEMORIAM



MICHAEL JAMES MEDENWALDT
August 21, 1946 – February 7, 1999

Mike Medenwaldt was born in Laona, Wisconsin, on August 21, 1946. He died suddenly February 7, 1999.

Mike left his Wisconsin home in 1962 to join the United States Marine Corps, where he trained as a cook and rose to the rank of Master Sergeant. He spent a year in Vietnam, and while on shore leave in Hawaii met his wife to-be, Nora Tasaka. He immigrated to Canada in 1966, and he and Nora settled in Burnaby, where their daughter Mari-Jane was born.

His employment in Canada began in the airline industry, where he became Customer Service Manager for Pacific Western Airlines. He developed a love of recreational fishing for salmon, and the lure of the sea drew him away from the airlines in 1977. He joined his brothers-in-law as a commercial troll fisherman, fishing salmon primarily off the West Coast of Vancouver Island.

Mike's interests developed beyond the boundaries of just extracting a living from the salmon resource. He joined the Pacific Troller's Association, and served as its President from 1988 to 1991. During his tenure, he assumed among other tasks, the responsibility for negotiating allocation arrangements on behalf of the Association, and became a familiar and respected figure not only among all sectors of the industry, but also in both provincial and federal government offices. He became convinced that the long term future of British Columbia's salmon industry could best be protected through direct participation by fishermen not only in the harvesting of salmon, but also in marketing and selling of the products. His efforts culminated in the formation of the British Columbia Salmon Marketing Council, bringing together fishermen, processors and government in a self-supporting organization to promote and market wild B.C. salmon nationally and internationally.

To gain a broader presence for B.C. wild salmon, Mike took the B.C. Salmon Marketing Council into the Canadian Association of Fish Exporters, bringing that organization true national representation for the first time. Mike served on CAFÉ's Board of Directors for five years and as Chairman for nearly three of those years.

Mike was a strong supporter of the Pacific Salmon Treaty, recognizing that Canada-United States cooperation in management and harvest of Pacific salmon was essential to the long term survival of this shared resource, as well as to the user groups who depend upon it for sustenance, income, and recreation. He and his vessel, the Western Sea II, were chartered by the Pacific

Salmon Commission, beginning in 1986, to conduct troll test fishing for Fraser River sockeye off the west coast of Vancouver Island, and in recent years continued this work in the southern Strait of Georgia.

In 1990, the Government of Canada appointed him to the Canadian Section of the Fraser River Panel, where he gained the respect not only of his Canadian colleagues, but also of the United States members of the Panel. His efforts on the Panel were always devoted to ensure, through negotiation, that Canada did as well as possible in obtaining a fair agreement with the United States. In his role as a member of the Panel charged with the responsibility for in-season regulation of Fraser River sockeye and pink salmon, he always recognized that both countries should realize the intent of those agreements.

Mike, in his deep concern for the future of the industry, developed the unique capacity to be accepted and respected by his fellow fishermen, to be valued for his thoughtful contributions to negotiations among all sectors of the Canadian fishing industry as well as in the Fraser River Panel's international forum, and to gain recognition in the halls of both provincial and federal governments. His contributions to the long term health of the Pacific salmon resource and his determination to bring about progress leave a legacy of which his family, friends and colleagues may truly be proud.

REPORT OF THE

FRASER RIVER PANEL

TO THE PACIFIC SALMON COMMISSION

ON THE 1998 FRASER RIVER

SOCKEYE SALMON FISHING SEASON

1998 PANEL MEMBERS AND ALTERNATES

UNITED STATES	CANADA
D. Austin, Chair	W. Saito, Vice-Chair
L. Loomis	D. Bailey
W. Robinson	M. Forrest
R. Suggs	M. Griswold
D. Cantillon	W. Otway
R. Charles	L. Wick
B. Sanford	M. Chatwin
R. Zuanich	V. Fiamengo
	C. Hunt
	T. Lubzinski
	M. Medenwaldt

Prepared by

FISHERIES MANAGEMENT DIVISION

of the

PACIFIC SALMON COMMISSION

August, 2000

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I. EXECUTIVE SUMMARY

1. The Fraser River Panel managed commercial net fisheries and the Canadian "inside" troll fishery in the Panel Area in 1998 under the terms of a July 2, 1998, Agreement between Canada and the United States. Under the Agreement, the United States catch of Fraser River sockeye salmon in Panel Area (Washington) waters was not to exceed 24.9% of the Total Allowable Catch (TAC). In addition, the Panel was to manage United States Panel Area commercial net fisheries in a pre-set pattern with gillnet and purse seine fisheries in Areas 6, 7 and 7A open Monday through Friday of each week during the period July 27 through August 21; reefnet fisheries in Areas 7 and 7A open Saturdays and Sundays from July 25 through August 23; and Treaty Indian fisheries in Areas 4B, 5 and 6C open noon Sundays through noon Fridays from July 26 through August 21. This schedule could be modified by the Panel, if necessary, to achieve spawning escapement objectives and Aboriginal food, social and ceremonial requirements based on in-season information. As well, the schedule could be modified to ensure the 24.9% catch limit was not exceeded or to avoid taking an excessive portion of the United States harvest in any weekly time period. Canadian fisheries in Panel Areas were to be managed as in prior years under a "Closed unless opened by the Panel" process. Panel Area fisheries in Canada and Canadian fisheries outside the Panel Area were to be managed in a manner that anticipated and accommodated catches in United States fisheries.

2. Canada provided the Panel with Fraser River sockeye salmon run-size forecasts and a schedule for spawning escapement targets on May 6. The forecast return was 11,218,000 fish, with a spawning escapement target of 5,770,000 adults at the forecast level. On July 21, Canada provided the Panel with its position on gross escapement targets for the purposes of calculating the United States share of the TAC. In addition to spawning escapement and in-river catch allocations, the gross escapement target included a 51,000 fish management adjustment to the Early Stuart gross escapement target (approved by the Panel July 10) to compensate for potential en route and pre-spawning mortalities of up to 56%.

3. On July 10, the Panel adopted regulations for regulatory control of Panel Areas. On July 24, the Panel adopted a fishing schedule developed using the Fishery Simulation Model. The fishing plan was to target Summer-run sockeye. Restrictions early in the season were expected to be needed to protect Early Stuart and Early Summer sockeye and restrictions late in the season to protect Late-run sockeye. United States fisheries were expected to harvest a significant portion of the TAC of Late-run sockeye. There was expected to be a narrow window of opportunity for marine fisheries in Canada. Surplus Summer-run sockeye were expected to be harvested in the Fraser River after mid August.

4. During the course of the 1998 management season, concerns developed over the potential for en route and pre-spawning mortality on sockeye stocks migrating upstream of Mission, due to abnormally high water temperatures. DFO made a series of weekly "forecasts" of potential pre-spawning mortalities associated with observed and forecast river water temperatures and the migration timing of key sockeye stocks. Canada requested that the Panel take into account the potential for elevated pre-spawning mortalities and approve increases to gross escapement targets. An upward management adjustment of 25% to the gross escapement target for Summer-run sockeye to compensate for anticipated pre-spawning mortalities was approved by the Panel on August 14.

5. United States fisheries in Panel Area waters were managed by the Panel to provide separate fishing times for Treaty Indian and Non-Indian fishers and for Non-Indian gillnet and purse seine fishers. Canadian Panel Area fishing times were restricted to two gillnet fisheries in the Fraser River portion of Area 29 and one troll fishery in Areas 18 and 29.

6. Catches of Fraser River sockeye salmon in all fisheries totalled 3,032,000 fish. Canadian catches amounted to 2,217,000 sockeye while United States fishers harvested 708,000 fish, 522,000 in Washington waters and 186,000 in Alaska. Test fishing catches totalled 107,000 sockeye. Canadian catches were 1,256,000 in commercial fisheries, 844,000 in First Nations' fisheries,

18,000 in recreational fisheries and 99,000 in an "excess salmon to spawning requirements" (ESSR) fishery in the Harrison River for surplus Weaver Creek sockeye. Commercial fishery catches summed to 1,964,000 fish.

7. The total return of Fraser River sockeye salmon in 1998 was estimated at 10,851,000 fish, just 3% less than forecast by Canada. The return abundance was near the long-term average return of 11,470,000 sockeye on the cycle. However, abundance in 1998 was the lowest on the cycle since 1978. The commercial exploitation rate was 18.1%, the lowest on record since, at least, 1946.

8. The Stock Monitoring program provided in-season estimates of abundance, run timing and migration route proportions of Fraser River sockeye salmon throughout the fishing season. Due to the low abundance and consequent low harvest of Early Stuart, Early Summer and Late-run sockeye in 1998, commercial fishing opportunities were greatly restricted. The absence of regular commercial catch data limited the use of these data in run-size estimation during the season. In-season run-size estimates in 1998 relied largely on Mission hydroacoustic estimates of daily escapement and on Juan de Fuca and Johnstone Strait purse seine test fishing catches and catch-per-unit-effort (CPUE). In-season estimates of Early Stuart sockeye returns were close to the pre-season forecast abundance of 175,000 fish. Initial estimates of Early Summer (450,000) and Summer-run (4,500,000) sockeye abundances were lower than pre-season forecasts, resulting in restricted fishing opportunities. Later, second peaks of Summer-run sockeye arrived and led to substantial increases in in-season run-size estimates. Final estimates of Early Summer and Summer-run abundances were 787,000 and 5,600,000 fish, respectively. Late-run abundance estimates decreased from a provisional estimate of 3,000,000 set on August 7 to 2,500,000 on September 1, based on lower than expected troll test fishing catches in the Strait of Georgia. Larger than projected escapements at Mission led to an end-of-season estimate of 4,200,000 Late-run sockeye.

9. Run timing was near normal for Early Stuart sockeye (July 3 in Area 20). Summer-run stocks were approximately three days later than normal (August 6 in Area 20) and Late-run sockeye peaked in migratory areas three days earlier than normal (August 15). Early in the 1998 migration, the proportion of sockeye migrating via Juan de Fuca Strait was estimated to be near normal at approximately 75% of the run. By the beginning of August, however, the migration via Johnstone Strait (diversion rate) increased to 80-90% of the migration. The diversion rate moderated in late August but the weighted average diversion rate for the season was estimated at 78% of the run, because a large fraction of the run migrated during the high diversion period in early to mid August.

10. The Racial Identification program provided estimates of stock composition for catches in commercial, Aboriginal and test fisheries. Linear discriminant function analysis (DFA) was used to establish standards from sockeye scale characteristics. For most of the period of active fishing, nine unique stock groups were incorporated into two categories of in-season models: a) models with Early Summer and Summer-run stock complexes, and b) models with Summer-run and Late-run stock complexes. The incidence of the brain parasite, *myxobolus articus*, was used to distinguish Quesnel Lake sockeye from stocks with similar scale characteristics.

11. Post-season re-analysis of samples was conducted using standards developed using spawning ground scales. Revisions to catch and gross escapement estimates led to changes in run-size estimates compared to estimates obtained in-season.

12. The total return of Early Stuart sockeye (190,000) slightly exceeded the preseason forecast. However, the return of age 4 fish (28,000) was only 19% of the pre-season forecast (150,000), while the return of age 5 sockeye (162,000) was about six times the forecast. The estimated return of Early Summer sockeye was 746,000 fish, about 16% greater than the forecast (642,000). Summer-run sockeye abundance reached 6,003,000 fish, approximately 600,000 fish less than forecast. Quesnel/Chilko sockeye (4,547,000) predominated in the Summer-run return (6,003,000), with Quesnel Lake watershed stocks (Horsefly River and Mitchell River) producing approximately 2,920,000 fish. Late-run sockeye abundance was estimated at 3,903,000 fish.

Adams River and Lower and Middle Shuswap River sockeye predominated in this group with a return of 2,570,000 fish.

13. Preliminary estimates of spawning escapements to streams in the Fraser River watershed totalled 4,419,000 adult sockeye. The escapement was 45% larger than the brood year (1994) escapement of 3,129,000 adults and was the second largest escapement recorded on the cycle. Large increases were recorded in Summer-run and Late-run escapements. A small decline was observed in Early Summer-run escapements. The Early Stuart sockeye escapement was unchanged from 1994.

14. Spawning success was quite variable in 1998. Early Stuart female sockeye suffered a 44% pre-spawning mortality. This was close to that predicted in-season based on river temperatures and arrival timing. Most other stocks had low pre-spawning mortality rates despite the abnormally high temperatures encountered during upstream migration. The weighted average success of spawning was 93.7% of the female population.

15. Adjusted gross escapement targets were nearly achieved or exceeded for each run-timing group based on lower river estimates (in-season Mission escapement plus First Nations' catch below Mission). Early Stuart and Late-run gross escapements were both 1-2% below target but gross escapements of Early Summer and Summer-run sockeye were 35% and 24% above target, respectively. The summed gross escapements exceeded the targets by a total of 925,000 fish. Most of that number (812,000) were Summer-run sockeye that escaped upriver in mid to late August when Late-run sockeye were present in the lower Fraser River.

16. Upriver estimates of gross escapement (catch plus spawning escapement) were significantly below the targets for Early Stuart, Early Summer and Late-run run-timing groups, but above the target for Summer-run stocks. The shortfalls in Early Stuart, Early Summer and Late-run escapements were due, in part, to en route mortality.

17. In 1998, in-season management of commercial fisheries in United States Panel Areas (Washington) was impacted by a high Johnstone Strait diversion rate and, in Canada, by the Panel's inability to provide access to additional catch of Summer-run sockeye due to the overlap of Late-run stocks in marine and lower Fraser River fishing areas. At the last in-season meeting that dealt with United States Panel Area fishing times, the TAC was estimated at approximately 2,600,000 fish, of which United States fishers in the Panel Area were entitled to harvest 24.9% or 647,000 fish. In-season catch estimates for United States Panel Area fisheries had reached 579,000 fish at that point (22.2% of the available TAC). Subsequent revisions of United States catch estimates for over-estimation errors, and a reduction of the TAC due to the inability to provide opportunity for further harvest of Summer-run sockeye in Canada, resulted in a similar percentage harvest in the United States. The final estimate of United States Panel Area catch was 522,000 sockeye out of a TAC of 2,426,000 fish, or 21.5%.

18. Domestic allocation goals for commercial catches existed for both user groups and area or gear groups within user groups in United States Panel Area fisheries and for gear license areas in Canada. In United States waters, Treaty Indian fishers caught 32,000 fish more than their allocation and Non-Indians were under their allocation by the same amount. Among Treaty Indians, fishers in Areas 4B, 5 and 6C harvested 26,000 fish or 8.9% of the Treaty Indian catch, which was below the maximum harvest share of 20%. Non-Indian fishers were to share the harvest as follows: 54% for purse seines, 41% for gillnets and 5% for reefnets. Of the actual Non-Indian catch of 229,000, purse seines caught 54%, gillnets caught 42% and reefnets caught 4%. Canadian gear license groups were to share the commercial fishery harvest of Fraser River sockeye as follows: Area F trollers - 75,000 fish; Area B purse seines - 41%; Area D gillnets - 11%; Area E gillnets - 21%; Area G trollers - 16%; and Area F troll - 8%. Actual catches were distributed as follows: Area F - 84,000 fish; Area B - 34%; Area D - 12%; Area E - 21%; Area G - 17%; and Area F - 8%.

II. FRASER RIVER PANEL

Under the Pacific Salmon Treaty, the Fraser River Panel is responsible for in-season management of fisheries that target on Fraser River sockeye and pink salmon within the Panel Area (Figure 1). Prior to the onset of 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 Department of Fisheries and Oceans Canada (DFO), 2) international allocation goals set by the agreements between the Parties, 3) domestic allocation goals set by each country, 4) management concerns for other stocks and species also identified by each country, and 5) historic patterns in migration and fisheries dynamics. The objectives that guide the Panel's decision-making are, in descending priority, to achieve the target for gross escapement and goals for international allocation and domestic allocation. The Parties' conservation concerns for other species and stocks are addressed throughout the process.

The pre-season management plan adopted by the PSC specifies a management scenario that is likely to achieve the escapement targets and catch goals, given the pre-season expectations. Using in-season commercial and test fishing data and various analyses from PSC staff, the Panel modifies the fishing times stated in the plan to respond to deviations from pre-season expectations.

The activities of the Panel are facilitated by the Fraser River Panel Technical Committee, who provide the respective National sections of the Panel with technical advice.

In 1998, the Panel exercised its regulatory mandate in the Panel Area only for commercial net fisheries and the Canadian inside (Strait of Georgia) troll fishery under the terms of the July 2, 1998, Agreement between Canada and the United States. Development of management plans for other species and stocks intercepted in south coast regions is the responsibility of the Southern Panel and the Commission, with actual management in each region the responsibility of the appropriate country.

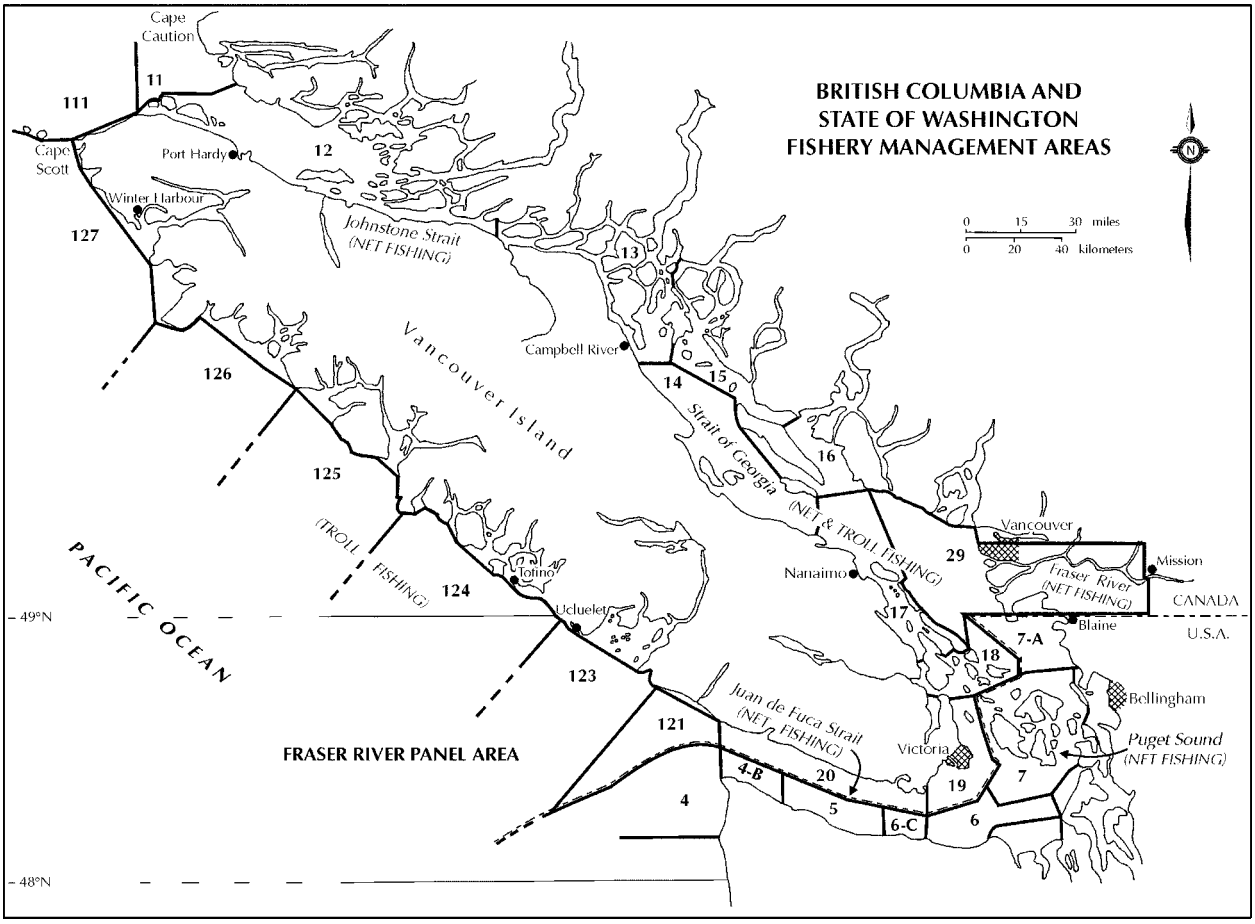


Figure 1. Fishery management areas and commercial gear used in the Fraser River Panel Area and Canadian south coast waters.

Input to the decision making process occurs primarily through the national sections of the Panel where most user groups are represented. The Panel membership and their affiliations during the 1998 season were:

UNITED STATES	CANADA
Members	
Mr. D. Austin, Chair Washington Department of Fish and Wildlife	Mr. W. Saito, Vice-Chair Fisheries and Oceans Canada
Ms. L. Loomis, Chair Treaty Indian tribes	Ms. D. Bailey Fraser River First Nation fisher
Mr. W. Robinson National Marine Fisheries Service	Mr. M. Forrest Gillnet fisher
Mr. B. Suggs Commercial salmon fishing industry	Mr. M. Griswold Troll fisher
	Mr. W. Otway Sport fisher
	Mr. L. Wick Purse seine fisher
Alternates	
Mr. D. Cantillon National Marine Fisheries Service	Mr. M. Chatwin Salmon processing industry
Mr. R. Charles Treaty Indian tribes	Mr. V. Fiamengo Purse seine fisher
Mr. B. Sanford Washington Department of Fish and Wildlife	Ms. C. Hunt Johnstone Strait First Nation fisher
Mr. R. Zuanich Commercial salmon fishing industry	Mr. T. Lubzinski Gillnet fisher
	Mr. M. Medenwaldt Troll fisher

III. INTRODUCTION

Pre-season forecasts of 1998 Fraser River sockeye abundances and spawning escapement targets by run-timing group were provided to the Panel by Fisheries and Oceans Canada (DFO) as required for planning purposes (Appendix A). The forecast for Summer-run stocks suggested these stocks could be harvested at much higher rates than preceding Early Summer stocks or following Late-run stocks. Management of the 1998 Fraser River sockeye salmon run was anticipated to be difficult because of the differential harvest regimes required for the three run-timing groups. In particular, the Panel expected that there would be a delicate balance between providing adequate opportunity for harvest of Summer-run sockeye and reaching escapement targets for Late-run stocks.

Pre-season fishing plans were developed using the Fishery Simulation Model and assumptions that the forecasts of abundance, arrival timing and migration via Johnstone Strait would be realized. Average environmental conditions in the Fraser River and normal fish behaviour were also tacitly assumed in development of the pre-season plans. United States fisheries were to be managed according to the July 2, 1998 Agreement between Canada and the United States. Because of the nature of this agreement, a significant proportion of the allowable catch of Late-run sockeye was expected to be harvested in United States fisheries targeting Summer-run stocks. Pre-season management plans recognized the limited windows of opportunity for fishing by Canadian troll, gillnet and purse seine fleets in marine areas, due primarily to Canadian domestic allocation decisions.

Actual management in 1998 proved much more difficult than the simulation model suggested. Unusual environmental conditions and fish behaviour made it difficult for the Fraser River Panel to achieve its goals. Ocean conditions in 1998 were strongly influenced by the residual effects of the 1997-98 El Nino. Water temperatures off the northwest coast of Vancouver Island remained above average in spring, 1998. A very high proportion (78%) of sockeye in 1998 returned to the Fraser River via Johnstone Strait (Figure 2), which was attributed to the high ocean temperatures. Since Johnstone Strait diversion rate controls the availability of fish in United States waters, the Panel's ability to achieve the international allocation of catch was compromised.

The pattern of sockeye arrivals also affected Panel management decisions. Bi-modal (two peaks) arrival timing gave initial in-season run-size estimates that were lower than pre-season forecast levels. Later when the second mode arrived, run-size estimates increased and provided a larger estimate of total allowable catch (TAC).

Fraser River water temperatures reached record high levels for much of the summer as a result of El Nino conditions. These high temperatures posed the risk of en route and pre-spawning mortality of adult sockeye migrating to natal streams. Gross escapement targets were increased to offset the anticipated mortality associated with the effects of the high water temperatures, thus, reducing the TAC. To further complicate the implementation of the Panel's management strategy, the river migration behaviour of Late-run sockeye was highly unusual and affected plans for the harvest of Summer-run sockeye in the Fraser River. Late-run Adams/Lower Shuswap sockeye entered the Fraser River beginning in mid August, several weeks earlier than normal. Full harvest of Summer-run sockeye was not possible due to conservation concerns for co-migrating Late-run stocks.

Estimates of First Nations' catches and spawning ground abundances above Mission by DFO produced much smaller sockeye escapement totals than were estimated in-season at the Mission hydroacoustic site. In total, the differences between estimates reached 3,394,000 fish, the largest difference on record. Differences between estimates were largest in Summer-run and Late-run timing groups, however, highest percentage differences were found in the Early Stuart and Early Summer groups. These differences in estimates were reviewed by the Panel on May 13-14, 1999, in an attempt to determine the causes and to make recommendations to the Parties. The environmental problems encountered by sockeye salmon in 1998 are detailed in Appendix B, along with summaries of several reviews that covered in-season estimates of escapement past

Mission, in-river fishery catches, spawning escapements and environmental influences. The findings of the Panel and recommendations for future research follow these summaries.

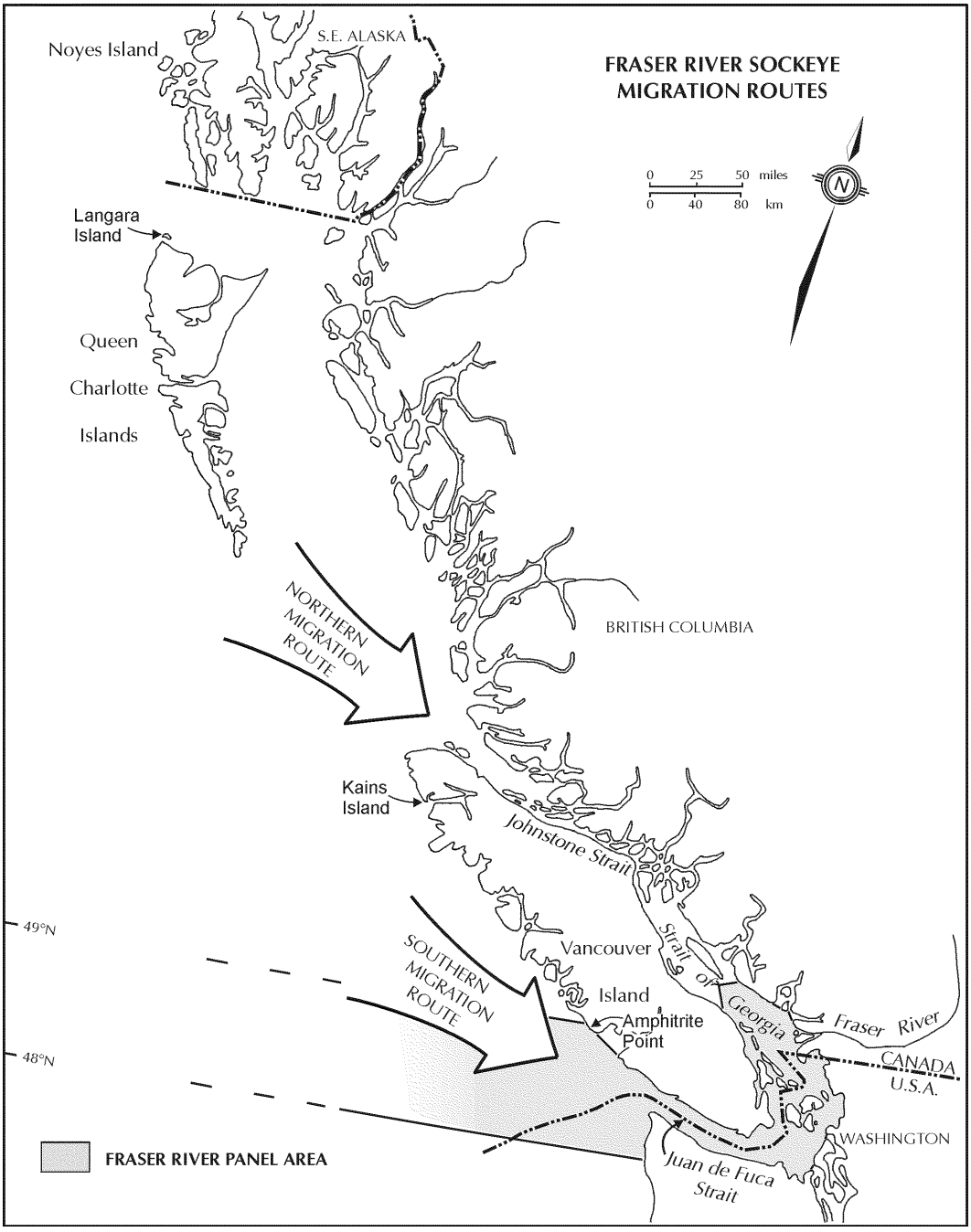


Figure 2. The northern (Johnstone Strait) and southern (Juan de Fuca Strait) routes for sockeye salmon migrating to the Fraser River.

End-of-season estimates of Fraser River sockeye salmon in 1998, including the large differences between estimates of gross escapement, totalled 10,873,000 fish, close to the pre-season forecast of 11,218,000. As well, returns by run-timing group were individually within 23% of the forecasts. The 1998 run was near the long-term average return on the cycle from 1950 to 1994 (11,470,000). However, the abundance of Fraser River sockeye salmon in 1998 was the lowest on the cycle (i.e., 1950, 1954…1994, 1998) since 1978 (Figure 3). For many years, the 1998 cycle had the largest returns of the four cycles of Fraser River sockeye, largely due to the production from the dominant cycle of Adams River/Lower Shuswap River sockeye. Lower returns of these stocks in 1998 was a major factor in the lower total abundance.

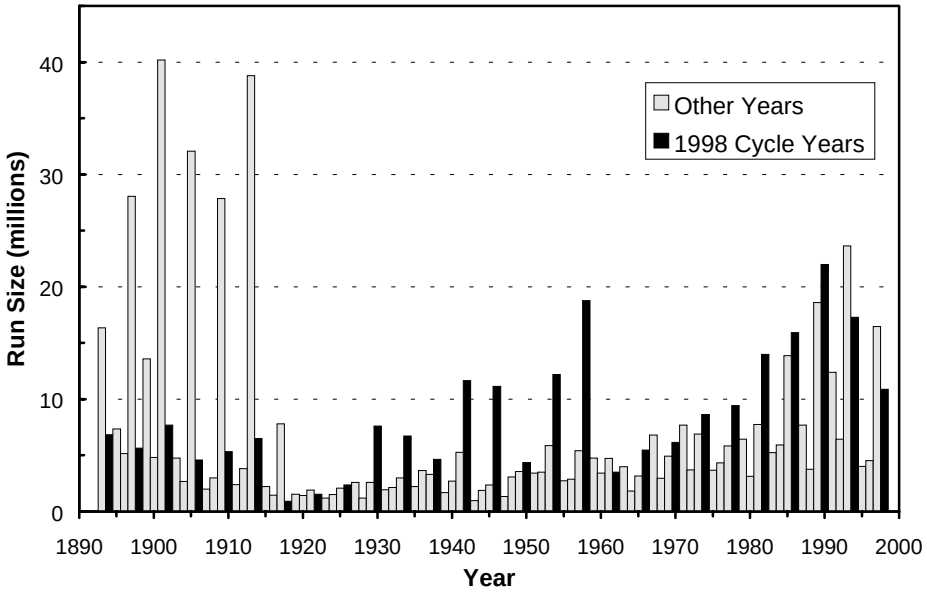


Figure 3. Total run sizes of Fraser River sockeye salmon between 1893-1998. Returns on the 1998 cycle are emphasized.

Not only was the 1998 return below recent cycle year production levels, but included in the total return were over 2,500,000 5-year-old sockeye from the successful 1993 brood spawning. The 4-year-old production in 1998 (8,300,000) from the 1994 spawning (3,129,000 fish) gave a rate of return of 2.65:1 (8,300,000/3,129,000), approximately one-half the long-term average. The low production of 4-year-old fish was observed for several major stocks, including Early Stuart, Late Stuart, Chilko, Birkenhead, Adams, and Lower Shuswap.

IV. MANAGEMENT ACTIONS

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

Canada provided the Panel with run-size forecasts and spawning escapement targets for Fraser River sockeye salmon run-timing groups on May 6, 1998 (Appendix A, Table 1). The forecast return was 11,218,000 fish, with a spawning escapement target of 5,770,000 adults. The run-size forecasts, which incorporated detailed forecasts of age-4 and age-5 returns, gave the following expectations: 175,000 Early Stuart, 642,000 Early Summer-run, 6,647,000 Summer-run and 3,754,000 Late-run sockeye.

On May 19, 1998, Canada provided a schedule for sockeye salmon spawning escapements by stock group at variable levels of returns (Appendix A, Table 2).

Peak or 50% arrival timing of major stocks and Johnstone Strait diversion rate forecasts were provided to the Panel by DFO for planning purposes. Early Stuart sockeye were expected to arrive in the lower Fraser River on July 11, approximately three days later than normal. Summer-run sockeye were forecast to have a peak arrival in Area 20 on August 9, while Late-run sockeye were expected on August 17. A Johnstone Strait diversion rate of 62% was forecast based on sea surface temperatures.

At the Panel meeting on July 21, 1998, Canada provided the Panel with gross escapement targets and the Panel approved a management adjustment, for the purposes of calculating the United States share of the Total Allowable Catch (TAC). The United States accepted Canada's allocation by run-timing group of the 400,000 Aboriginal fishery exemption, with the proviso that the allocation of the exemption was not to be used as a template for future years. The 400,000 Aboriginal fishery exemption was apportioned into the four run-timing groups as follows: 23,000 Early Stuart, 63,500 Early Summer, 303,500 Summer, and 10,000 Late-run sockeye (Table 1). In addition, on July 10, the Panel had approved a 51,000 management adjustment to the Early Stuart sockeye gross escapement to compensate for potential en route and pre-spawning mortalities of up to 56%. With these targets and test fishing catch estimates the TAC's by run-timing group were: 0 Early Stuart, 163,500 Early Summer, 3,967,500 Summer and 767,000 Late-run sockeye, for an expected total TAC of 4,898,000 sockeye salmon (Table 1). The catch goal for Washington State fishers (24.9%) was 1,220,000 fish at this TAC. The corresponding Canadian share of the TAC, which excludes the Aboriginal Fishery Exemption, was 3,678,000 fish.

Table 1. Pre-season forecasts of total runs, spawning escapement targets, other deductions and total allowable catch by run-timing group.

Run	Forecast Run	Spawning Escapement Target	Management Adjustment	Aboriginal Fishery Exemption	Test Fishery Catch	Total Allowable Catch
Early Stuart	175,000	97,000	50,000	23,000	5,000	0
Early Summer	642,000	400,000	0	63,500	15,000	163,500
Summer	6,647,000	2,326,000	0	303,500	50,000	3,967,500
Late	3,754,000	2,947,000	0	10,000	30,000	767,000
Total	11,218,000	5,770,000	50,000	400,000	100,000	4,898,000

On July 21, Canada provided gross escapement targets by run-timing group and domestic allocations of the Canadian share. The total gross escapement target was set at 6,666,000 sockeye. An anticipated catch of 275,000 sockeye was identified in marine First Nations' and recreational fisheries. Gross escapement targets were as follows: Early Stuart - 170,000; Early Summer-run - 484,000; Summer-run - 3,055,000; and Late-run - 2,957,000 fish.

Canadian domestic allocation goals for commercial catches of Fraser River sockeye salmon were set as follows: Area F troll - 75,000 fish, Area B seine - 41%, Area D gillnet - 11%, Area E gillnet - 21%, Area G troll - 16% and Area H troll - 8% of the TAC. Canada also announced an intention to provide Area B seines, as well as Areas G and H trollers, with fishing opportunities to address catch shortfalls stemming from the 1991 through 1994 fishing seasons. The amount of the 1998 payback would be limited by the principle that "no payback by any gear in any year should be greater than 10 percent of the gear type's allocation in that year on the given species", and subject to the rules and conditions in place in 1998 to ensure that conservation objectives were met.

Goals for the domestic allocation of Fraser sockeye among Washington fishers were as follows: a) Treaty Indian and Non-Indian commercial net fishers were to receive equal shares; b) Treaty Indian fishers in Areas 4B, 5 and 6C were allocated a maximum of 20% of the Treaty Indian share; and c) for Non-Indian commercial gear types, the traditional harvest sharing targets of 54% for purse seines, 41% for gillnets and 5% for reefnets were identified as the management guidelines, subject to various constraints which might prevent these goals from being realized. Potential constraints on the catch sharing guidelines in the Non-Indian fishery included: reduced

gillnet efficiency and participation due to the required use of a “seabird avoidance strip", high diversion rate with limited weekly fishing opportunity, and priority ranking of conservation, international allocation, and Treaty Indian/Non-Indian harvest sharing before Non-Indian inter-gear sharing.

B. Pre-season Regulations

The Parties reached a one-year agreement on international catch sharing and management of the 1998 Fraser River sockeye salmon run on July 2, 1998. Under the Agreement, the United States catch in Panel Area (Washington) waters was not to exceed 24.9% of the TAC. In addition, the Panel was to manage United States commercial net fisheries in Panel Area waters as follows:

i) Gillnet and purse seine fisheries in Areas 6, 7 and 7A were to open Monday through Friday of each week during the period July 27 through August 21;
ii) Reefnet fisheries in Areas 7 and 7A were to open Saturdays and Sundays July 25 through August 23; and
iii) Treaty Indian fisheries in Areas 4B, 5 and 6C were to open noon Sundays through noon Fridays July 26 through August 21.

In implementing the above schedule, the Fraser Panel was to operate according to its usual policies and practices. The schedule could be modified by the Panel, if necessary, to achieve spawning escapement objectives and Aboriginal food, social and ceremonial requirements based on in-season information. As well, the schedule could be modified to ensure the 24.9% catch limit was not exceeded, or to avoid taking an excessive portion of the United States harvest in any weekly time period.

Canadian fisheries in the Panel Area were to be managed as in past years and were "closed unless opened by the Panel". The Panel was to manage only Canadian net fisheries in Panel waters while Canada was to manage Canadian fisheries outside Panel waters in a manner that anticipated and accommodated catches in United States fisheries.

The Agreement also defined the TAC upon which catch shares would be calculated. In the pre-season planning phase, the calculations resulted in a TAC of 4,898,000 sockeye (Table 1).

On July 10, 1998, the Panel adopted regulations (Appendix C) for regulatory control of Panel Areas. The Commission accepted the regulations and submitted them to the Parties. In 1998 as in previous years, Canadian Panel Area fisheries were to be “Closed Unless Opened” by in-season orders of the Panel. However, in United States Panel Area waters, fisheries were to be open between July 25 and August 23, as per the July 2, 1998 Agreement. Bilateral Panel action was required to make changes to the pre-season management plan in United States Panel Area waters.

Fisheries in United States Panel Area waters were anticipated to start on July 25 in accordance with the pre-season management plan, although restrictions to fishing times were expected. Canadian Panel Area fisheries were not proposed to open until the week of August 9 – 15, although fisheries in non-Panel waters were anticipated beginning in the week of July 26-August 1.

On July 24, a planned fishing schedule was developed using the Fishery Simulation Model. This model uses forecasts of abundance, timing and diversion rate, and historical knowledge of fishery dynamics and harvest rates, to simulate the likely outcome of a given set of fishing regulations. The schedule was to provide guidance to staff and the Parties in formulating fishery recommendations to harvest the available TAC. The 1998 fishery plans focussed on the harvest of Chilko/Quesnel sockeye. Restrictions on fishing were expected to be needed early in the season to protect Early Summer-run sockeye and later in the season for Late-run sockeye. Timing-abundance curves for the major stock groups based on pre-season forecasts for Chilko and Adams stocks are shown in Figure 4.

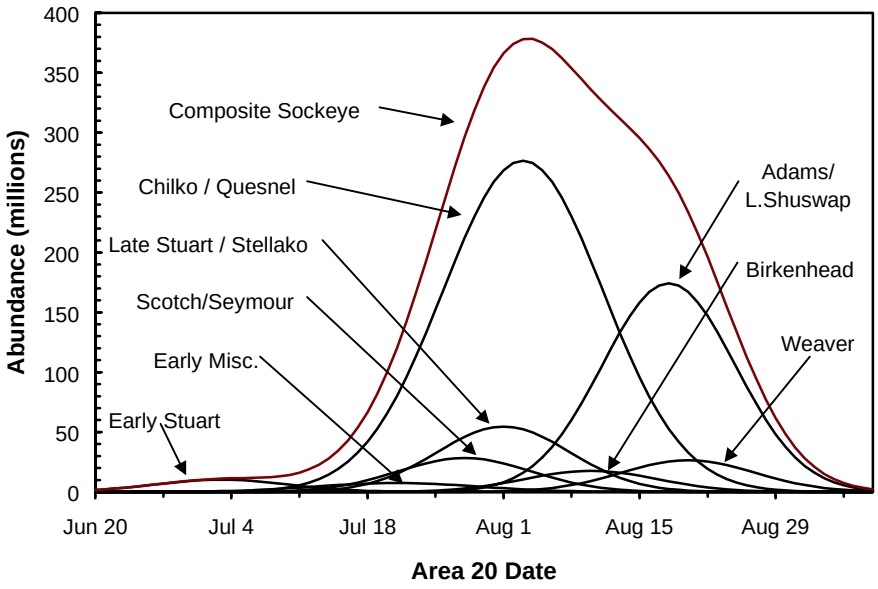


Figure 4. Expected daily abundance curves for migrating Fraser River sockeye salmon in 1998 (Area 20 date), based on forecast abundances and arrival timing.

In addition to the July 2 Agreement, Washington State and the Government of Canada entered into an agreement designed to limit interceptions of coho and chinook salmon. Canada introduced a coho salmon management plan under which there were to be no directed fisheries for coho and no retention of coho caught when fishing for other species. This policy affected Panel Area management by the required closures of Area 20 commercial net fisheries, West Coast Vancouver Island troll fisheries and, after the last week of August, of Area 29 net fisheries. While designed to protect Thompson River coho stocks, these measures were also expected to produce a substantial reduction in the Canadian harvest of Washington and Oregon stocks of coho and chinook salmon.

For its part in the Agreement, Washington State committed to measures in Non-Indian fisheries to achieve a 22% reduction in the catch of Canadian Thompson River coho salmon. In addition, Washington State took other domestic management actions that impacted Panel Area fisheries. These included a requirement that Non-Indian purse seines and reefnets release all chinook and coho salmon, and a commitment that Treaty Indians conduct their Fraser sockeye fishery in Areas 7 and 7A in such a manner that the chinook by-catch would not greatly exceed the 1980-1997 average catch (7,896 fish) without jeopardizing the achievement of the international allocation of Fraser sockeye.

C. In-season Regulations

Between July 7 and September 18, the Fraser River Panel conferred 22 times (by telephone or in-person) to enact in-season orders (Appendix D) to regulate the fisheries directed to the harvest of Fraser River sockeye in the Panel Area.

During the course of the 1998 management season, concerns developed over the potential for en route and pre-spawning mortalities occurring on sockeye migrating upstream of Mission due to abnormally high water temperatures (see Appendix B). DFO made a series of weekly “forecasts” of potential pre-spawning mortalities associated with observed and forecast river water temperatures and the migration timing of key sockeye stocks. Canada requested that the Panel take into account the potential for elevated pre-spawning mortalities and approve increases to gross escapement targets for Early Stuart and Summer-run sockeye.

The following paragraphs summarize the events of the season on a weekly basis, with an

emphasis on Commission staff analyses and Panel decisions.

Based on the pre-season forecast of the Early Stuart run, there were no expectations for commercial fisheries. Consequently, the focus during the first few in-season meetings was on run size and timing of Early Stuart sockeye. The return of Early Stuart age 4 sockeye was below the pre-season forecast, while the 5_2 return was much stronger than expected. In total, the return was very close to the pre-season forecast (175,000). The Panel was informed that the water temperatures in the Fraser River were significantly higher than normal and, consequently, Early Stuart sockeye could experience migration difficulties.

On July 10, Canada predicted that high river temperatures would cause en route and pre-spawning losses of up to 56% of the Early Stuart run. The Panel approved a management adjustment of 51,000 fish to the gross escapement target for Early Stuart sockeye to compensate for the expected losses.

On July 24, the Panel approved a reduction in the fishing time for United States Treaty Indian and Non-Indian fishers in Panel Area waters relative to the pre-season management plan. The fishing time was reduced for the week of July 26 – August 1 to avoid taking an excessive amount of the United States harvest in any weekly time period.

At the July 31 Panel meeting, Commission staff advised the Panel that the timing of Summer-run sockeye appeared to be earlier than forecast (peak arrival on August 3 in Area 20 for the Chilko/Quesnel stock group), and the diversion rate was above the 62% forecast level, possibly in the 70% range. Based on these factors and on the number of Summer-run fish accounted for through the end of July, the Panel approved an interim reduction of the Summer-run return to 4,000,000 fish. The Early Summer run size was also reduced from the pre-season forecast of 642,000 to 400,000 fish, largely due to apparent weakness in the returns of South Thompson stocks. Concerns continued to be expressed over the record high water temperatures observed by DFO in various sites throughout the Fraser River drainage basin. The Panel was informed that elevated en route and pre-spawning mortalities were likely if record water temperatures persisted. Separate fishing times for Treaty Indians and Non-Indians in United States Panel areas for the week of August 2-8 were approved.

At the August 4 meeting, concern was expressed that too many fish from the early component of the Summer run had escaped and, therefore, a fishery was required to evenly distribute the escapement across the run. Thus, the Panel approved an Area 29 gillnet fishery, which had boundary restrictions to limit coho encounter rates. An Area H troll fishery was approved in Areas 18 and 29 for domestic allocation purposes.

At a meeting on August 7, the Panel was informed that age 4 returns of Early Stuart, Early Summer and Summer-run sockeye all appeared to be below the pre-season forecast. In addition, age 4 returns of Late-run sockeye were likely to be similarly poor. Based on these indications, the Panel approved an interim reduction of Late-run abundance to 3,000,000 fish. However, age 5 returns were above forecast levels, thereby helping to augment the poor age 4 returns of Early Stuart, Early Summer and Summer-run sockeye. No compensation by age 5 fish could be expected for Adams/Lower Shuswap sockeye since the 1997 age 4 run was small. The Panel approved the following in-season run-size estimates: Early Summer – 450,000, Summer-run – 4,500,000 and Late-run – 3,000,000 (interim estimate). At these abundances, the total Fraser River sockeye run in 1998 would be 8,125,000 fish, compared to the pre-season forecast of 11,218,000 fish.

Water temperatures in the Fraser River and tributaries during early August continued to be at or above previous maxima. DFO environmental data presented to the Fraser Panel indicated that en route and pre-spawning mortality was expected to affect both Early Summer and Summer-run sockeye escapements, and had seriously impacted the Early Stuart run. On August 7, Canada requested that the Panel approve an increase in the Summer-run spawning escapement target to compensate for an expected 40% pre-spawning mortality. The United States agreed with the need to compensate for expected mortality levels, but suggested the long-term average pre-spawning mortality rate was already built into the predictive model. Thus, the United States proposed a compensation factor of 20%. The Panel could not reach agreement on changes to gross escapement

targets, and decided that the issue would be discussed further at a meeting scheduled for August 10. Treaty Indian and Non-Indian purse seine and gillnet fisheries previously scheduled for the week of August 9 to 15 in Areas 7 and 7A were delayed 24 hours, pending resolution of changes to the Summer-run sockeye escapement target.

At a meeting on August 10, Canada presented additional arguments on the need to apply an adjustment to the Summer-run spawning escapement target to compensate for projected en route and pre-spawning mortalities of 40% of the run. By this meeting, it was apparent that Early Stuart spawning escapements would be well below the number that migrated upstream of Mission. The United States acknowledged a need to increase the escapement target, and were willing to consider an adjustment to compensate for a mortality of up to 25% of the spawners if Canada implemented cutbacks to its in-river First Nations' fisheries. There was no agreed-to technical basis on which to set a specific percentage reduction and the positions taken by each country were based on the judgement of managers. The Panel modified United States fisheries to provide for separate Treaty Indian and Non-Indian fisheries in United States waters for August 11 to 13 with the expectation that catches would not exceed 120,000. No fisheries were scheduled for Canadian Panel Area waters. The Panel scheduled a meeting for August 13 to review a potential fishery in United States Panel Area waters on August 14, and agreed to a further review of the en route mortality issue at the August 14 meeting.

Early Summer and Summer-run escapements past Mission from August 10 to 12 exceeded expectations, likely due to sockeye migrating upstream after a short-term delay in the Strait of Georgia. Also, test fishing catches and racial analyses from Johnstone Strait indicated a sustained migration of Summer-run sockeye along the northern approach route. The Panel approved an increase in the Early Summer-run sockeye return to 600,000, and were alerted to the possibility that the Summer-run return would exceed 4,500,000 if the outside migration remained strong. At this date, the available information suggested that Late-run abundance was not larger than the pre-season forecast, and could be close to the 3,000,000 interim run-size projection in use by the Panel. Given the above information, staff pointed out that the United States still had shares of Summer-run and Late-run TAC remaining and, therefore, there was no reason to curtail fishing in United States Panel Area waters for the remainder of the week. Consequently, the Panel approved a Non-Indian purse seine and gillnet fishery for August 14.

At the August 14 meeting, Canada argued that record high water temperatures would have severe impacts on Summer-run sockeye, and particularly on Quesnel Lake stocks. DFO projected a pre-spawning mortality rate of 35% for Horsefly River sockeye. Consequently, the Panel agreed on a management adjustment (increase) to compensate for anticipated Summer-run pre-spawning mortalities of 25% of the escapement. Based on the escapement target for Summer-run stocks, this adjustment amounted to 665,000 fish. This 25% management adjustment was used for the purpose of calculating the United States TAC of Summer-run sockeye. Taking the revised gross escapement target into account, the Panel modified Treaty Indian and Non-Indian fisheries in United States Panel waters for the first part of the week of August 16-22. Canadian Panel Area waters remained closed for the early part of the week.

At the August 17 meeting, the Panel approved a staff recommendation for an increase in the Summer-run return to 5,000,000 fish. However, Canada announced that it was unilaterally implementing a management adjustment to the Summer-run gross escapement goal to compensate for an expected loss of 35% of the spawning escapement. The revised target, which was used to calculate Canadian TAC, resulted in no remaining Canadian TAC of Summer-run sockeye, even with the increased run size. On August 18, larger than expected test fishing catches in the Fraser River, combined with strong Summer-run catches in the Johnstone Strait test fisheries, prompted the staff to recommend another change to the Summer-run abundance estimate, this time to 6,000,000 fish. The Late-run return remained at 3,000,000 fish. Consequently, while a Summer-run TAC was now calculated for Canadian commercial fisheries, there was not sufficient Late-run sockeye TAC remaining to permit outside fisheries to proceed. The Panel did approve an Area 29 commercial fishery on August 20 for the purpose of harvesting Summer-run sockeye. This fishery had boundary restrictions to limit the catch of Late-run sockeye and to minimize coho encounter rates.

On August 19, the staff apprised the Panel of likely changes to Adams/Lower Shuswap racial composition estimates in outer area samples. Based on revised scale standards developed from Strait of Georgia troll test fishing samples, revised analyses were to be conducted. Changes to run-size assessments based on the revised scale standard were to be reviewed at the August 21 Panel meeting. Based on the run-size assessments that were available, sufficient TAC remained for fisheries to proceed in United States Panel Area waters for the remainder of the week. The Panel modified United States fisheries to close reefnet fisheries on August 22 and 23. In a letter to the United States dated August 19, Canada announced it would use a pre-spawning mortality prediction of 27% to obtain the management adjustment used to calculate the Canadian TAC.

Run-size estimates presented at the August 21 meeting were as follows: Early Stuart – 175,000; Early Summer – 850,000; Summer-run – 6,000,000; and Late-run – 3,000,000 fish. Adjustments made to Adams/Lower Shuswap catches and escapements did not result in changes to the Late-run abundance estimate. At these returns, the total Fraser River sockeye abundance in 1998 was projected at 10,025,000 fish compared to the pre-season forecast of 11,218,000 fish. Environmental conditions in the Fraser River continued to raise concerns for the health of migrating and spawning sockeye. With the estimate of only 3,000,000 Late-run sockeye, the remaining abundance was insufficient to allow additional harvest without jeopardizing escapement targets. This, in conjunction with the July 2 Agreement, resulted in the Panel announcing that all Panel Area waters would remain closed until further notice.

At the August 25 meeting, the Panel was informed that test fishing results and racial analyses provided indications that the 1998 Late-run sockeye return was smaller than the pre-season forecast. Consequently, no change was made to the 3,000,000 estimate of Late-run sockeye return, and no TAC remained for this timing group. Catch estimates showed that some TAC remained for Summer-run sockeye. The presence of significant numbers of Late-run sockeye in the Fraser River, however, precluded further harvest opportunities in Area 29.

At its August 28 meeting, the Panel downgraded the run-size estimates of Summer-run sockeye to 5,700,000 fish, and of Late-run sockeye to 2,800,000 fish, based on lower-than-anticipated escapements past Mission and poor catches in outside area test fisheries. This reduced the projected total Fraser sockeye return to 9,470,000 fish. Of the Late-run total, only 1,700,000 to 2,000,000 fish were projected to be from the Adams/Lower Shuswap stock group. Exacerbating the poor return of Late-run sockeye was the very early timing of their upstream migration, raising concerns of possible pre-spawning mortality associated with the combination of early timing and continued high water temperatures in the Fraser River and tributaries. In response, the Panel announced that all Panel Area waters would be closed to commercial fishing for the balance of the 1998 season.

On September 1, the Panel approved a staff recommendation, based on Strait of Georgia troll test fishing results, to further reduce the estimate of Late-run sockeye return to 2,500,000 fish. Of this total, the Adams/Lower Shuswap stock group was estimated at 1,600,000, with other Late-run stocks comprising the remaining 900,000. This reduced the total expected Fraser River sockeye return to 9,167,000 fish.

At the final in-season management meeting on September 18, the Panel was advised by Commission staff that unexpectedly large numbers of Late-run sockeye had migrated upstream past the Mission hydroacoustic site over the September 11-17 period. Based on these escapements, the Panel approved a run-size increase to 4,300,000 Late-run sockeye. However, the migration was virtually complete at that date. In retrospect, the unusual spatial distribution and migratory behaviour of Late-run sockeye in the Strait of Georgia may have resulted in troll test fishing estimates of abundance that were significantly lower than subsequently observed at Mission. In-season accounting for other run-timing groups included: Early Stuart – 174,000; Early Summer – 793,000; and Summer-run – 5,646,000. The total abundance of 1998 Fraser River sockeye was estimated to be 10,900,000.

Net fishing times in Canadian Panel Areas are shown in Table 2. No fishing was scheduled in Area 20 due to coho conservation concerns. Two gillnet fisheries were conducted in Area 29 to

harvest Summer-run sockeye. Area 29 gillnet fisheries were precluded after August 21 due to the presence of Late-run sockeye in the Fraser River.

United States fishing times are shown in Table 3.

Table 2. Actual fishing times (days) in major Canadian net fisheries in the Fraser River Panel Area in 1998.

	Area 20		**Area 29 ***
Date	Purse Seine	Gillnet	Gillnet
Jun.21-Aug.1	Closed	Closed	Closed
Aug.2-Aug.8	Closed	Closed	1
Aug.9-Aug.15	Closed	Closed	Closed
Aug.16-Aug.22	Closed	Closed	1
Aug.23-Aug.29	Closed	Closed	Closed
Aug.30-Sep.5	Closed	Closed	Closed
Sep.6-Sep.12	Relinq.	Relinq.	Closed
Sep.13-Oct.10			Closed
Oct.11			Relinq.
Total	0	0	2

* Area 29 fishing times are measured in 20-30 hour days.

Table 3. Actual fishing times (hours) in major United States net fisheries in the Fraser River Panel Area in 1998.

	Treaty Indian		**Non-Indian**		
	Areas	Areas	Areas 7 and 7A		
Date	4B, 5, 6C	6, 7, 7A	Purse Seine	Gillnet	Reefnet
Jul.12-Jul.18	Closed	Closed	Closed	Closed	Closed
Jul.19-Jul.25	Closed	Closed	Closed	Closed	16
Jul.26-Aug.1	120	27	16	17	32
Aug.2-Aug.8	120	77	32	34	32
Aug.9-Aug.15	120	29	48	50	32
Aug.16-Aug.22	120	77	32	33	16
Aug.23-Sep.5	Closed	Closed	Closed	Closed	Closed
Sep.6-Sep.12	Relinq.	Closed	Closed	Closed	Closed
Sep.13-Sep.19		Relinq.	Relinq.	Relinq.	Relinq.
Total	480	210	128	134	128

* Times recorded to the nearest hour.

V. CATCH SUMMARY

A. Sockeye Salmon

Catches of Fraser River sockeye salmon in all fisheries totalled 3,054,000 fish (Table 4). Canadian catches amounted to 2,239,000 sockeye (Table 5). United States fishers caught 522,000 in Washington waters and 186,000 in Alaska. Catches in test fisheries authorized by the Fraser River Panel totalled 107,000 sockeye. Commercial fishery catches summed to 1,986,000 fish.

Mean body weights in Canadian Area 20 purse seine catches are usually reported in this section of the Annual Report. In 1998, however, no commercial fisheries were permitted in Area 20 due to coho conservation concerns. Therefore, other average weight sources were used. The average weight for Fraser sockeye (all ages) caught in commercial and test purse seine fisheries in Areas 12 and 13 was 2.94 kg (6.49 lb). The average weight of fish caught in Area 29 (Fraser River) was 2.82 kg (6.22 lb). Five-year-old fish from the 1993 brood contributed approximately 23% of the 1998 return, contributing to the relatively large average weight.

The gross landed value of the commercial catch was approximately $31,000,000 (Can), with a weight of approximately 5,700,000 kg (12,600,000 lb).

The total return of 10,873,000 Fraser River sockeye salmon (Tables 4 and 5) was close to the pre-season forecast of 11,218,000 fish. The total return was near the long-term average return on the cycle (11,470,000). However, the abundance in 1998 was the lowest on the cycle since 1978 (Figure 3). The commercial exploitation rate (18%) was the lowest on record since at least 1946. The total harvest rate (28%) was also the lowest on record.

Table 4. Comparison of recent run sizes, harvests and spawning escapements for Fraser River sockeye salmon on the 1998 cycle.

		Commercial Catch		Total Catch		Spawning Escapement	
Year	Run Size	Fish	%	Fish	%	Fish	%
1974	8,616,000	6,636,000	77%	6,859,000	80%	1,757,000	20%
1978	9,432,000	6,660,000	71%	6,918,000	73%	2,514,000	27%
1982	13,985,000	9,523,000	68%	9,953,000	71%	4,024,000	29%
1986	15,927,000	11,574,000	73%	12,210,000	77%	3,717,000	23%
1990	21,984,000	14,868,000	68%	15,899,000	72%	6,085,000	28%
1994	17,285,000	12,172,000	70%	13,366,000	77%	3,133,000	18%
1998	10,873,000	1,986,000	18%	3,054,000	28%	4,425,000	41%

* Differences Between Estimates account for remaining fish.

i. Canada

A total of 2,239,000 Fraser River sockeye salmon were harvested in commercial, First Nations' and non-commercial fisheries in Canada (Table 5). The commercial catch was 1,278,000 fish, 283,000 in the Panel Area and 995,000 in non-Panel Area waters.

Table 5. Preliminary estimates of fishery catches and total run of Fraser River sockeye salmon during the 1998 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	0	
Areas 17-18 and 29 Troll	15,000	
Area 29 Net	268,000	
Total	283,000	2.6%
Non-Panel Areas		
Areas 1-10 Troll and Net	93,000	
Areas 11-16 Troll and Net	902,000	
Areas 124-127 Troll	0	
Total	995,000	9.2%
Commercial Total	1,278,000	11.8%
FIRST NATIONS CATCH		
Marine Areas		
Areas 12-16, 18, 20, and 123-126	79,000	
Area 29-1 to 7	121,000	
Total	200,000	1.8%
Fraser River		
Below Sawmill Creek	455,000	
Above Sawmill Creek	189,000	
Total	644,000	5.9%
First Nations Total	844,000	7.8%
NON-COMMERCIAL CATCH		
ESSR Fishery *	99,000	
Recreational Fishery In-river	18,000	
Marine	0	
Non-Commercial Total	117,000	1.1%
CANADIAN TOTAL	2,239,000	20.6%
UNITED STATES		
COMMERCIAL CATCH		
Fraser River Panel Area		
Areas 4B, 5 and 6C Net	26,000	
Areas 6 and 7 Net	255,000	
Area 7A Net	241,000	
Total	522,000	4.8%
Non-Panel Areas		
Alaska Troll and Net	186,000	1.7%
UNITED STATES TOTAL	708,000	6.5%
TEST FISHING		
COMMISSION		
Areas 20 and 29	74,000	
Area 7	0	
Commission Total	74,000	0.7%
CANADA		
Areas 12 and 13	33,000	0.3%
TEST FISHING TOTAL	107,000	1.0%
TOTAL CATCH	3,054,000	28.1%
SPAWNING ESCAPEMENT	4,425,000	40.7%
DIFFERENCE BETWEEN ESTIMATES **	3,394,000	31.2%
TOTAL RUN	10,873,000	100.0%

* Harvest of Weaver Creek sockeye in the terminal area that were Escapement Surplus to Spawning Requirement (ESSR).

** [In-season estimate of escapement past Mission plus First Nations' catch below Mission plus Upper Pitt River spawning escapement] minus [total Fraser River First Nations' catch, ESSR catch, in-river recreational catch and spawning escapement].

Preliminary estimates of Canadian commercial catches of Fraser River sockeye salmon by gear type and area are presented in Table 6. Area B (southern) purse seines caught 35% of the commercial catch, Area D (Johnstone Strait) gillnets caught 12%, and Area E (Fraser River) gillnets caught 21%. Within the troll gear sector, Area F (northern) trollers caught 7% of the commercial harvest, while Area G (outside) and H (inside) trollers caught 16% and 9%, respectively. Weekly catches in Canadian fishing areas are shown in Appendix E (Tables 1-4).

Table 6. Preliminary estimates of Canadian commercial catches of Fraser River sockeye salmon by gear type, license designation and statistical area during the 1998 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	9,000		0			84,000			93,000
11-16		443,000		156,000			201,000	102,000	902,000
121-127		0		0			0		0
20		0			0		0		0
17, 18, 29		0			268,000			15,000	283,000
Total Catch	9,000	443,000	0	156,000	268,000	84,000	201,000	117,000	1,278,000
% of Catch	0.7%	34.7%	0.0%	12.2%	21.0%	6.6%	15.7%	9.2%	100.0%

* Catch data from DFO ticket sales slips.

First Nations' catches totalled 844,000 sockeye, 200,000 of which were harvested in marine fisheries and 644,000 in the Fraser River (Table 5). Most of the in-river catch was taken in the mainstem below Sawmill Creek (455,000), while 189,000 were harvested in the Fraser River above Sawmill Creek and in tributaries (Appendix E: Table 5).

Canadian non-commercial catches totalled 117,000 Fraser River sockeye, including 18,000 fish in recreational fisheries and 99,000 Weaver Creek sockeye in an ESSR (Excess Salmon to Spawning Requirements) fishery in Harrison River, Morris Slough and Weaver Creek (Table 5). The latter fishery was carried out by the Chehalis First Nation under contract with Fisheries and Oceans Canada.

ii. United States

Fraser River sockeye catches in United States waters summed to 708,000 fish in 1998, 522,000 in Panel Areas and 186,000 in Alaska District 104 (Table 5). Sockeye catches in United States Panel Area waters were limited by the high diversion rate via Johnstone Strait that resulted in low daily abundances of fish in United States waters, and by the July 2 Agreement which resulted in a cessation of fishing after August 21.

Treaty Indian catches were 26,000 fish in Areas 4B, 5 and 6C and 267,000 fish in Areas 6, 7 and 7A, for a total of 293,000 Fraser River sockeye (Table 7). Non-Indian catches totalled 229,000 sockeye, 123,000 fish by purse seines, 97,000 by gillnets and 9,000 by reefnets. Weekly catches of Fraser River sockeye salmon in United States Panel Areas are shown in Appendix E (Table 6).

Table 7. Preliminary estimates of United States commercial catches of Fraser River sockeye salmon by user group, gear type and statistical area during the 1998 fishing season.*

Areas	Purse Seine	Gillnet	Reefnet	Total
Treaty Indian				
4B, 5 and 6C	0	26,000	0	26,000
6 and 7	80,000	67,000	0	147,000
7A	40,000	80,000	0	120,000
6, 7 and 7A Total	120,000	147,000	0	267,000
% of Catch	44.9%	55.1%	0.0%	100.0%
Total Catch	120,000	173,000	0	293,000
% of Catch	41.0%	59.0%	0.0%	100.0%
Non-Indian				
7	43,000	56,000	9,000	108,000
7A	80,000	41,000	0	121,000
Total Catch	123,000	97,000	9,000	229,000
% of Catch	53.7%	42.4%	3.9%	100.0%
United States				
Panel Area Total	243,000	270,000	9,000	522,000
Alaska Catch				186,000
Total Catch				708,000

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

VI. STOCK MONITORING

The purpose 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 developing fishing plans to attain annual escapement and catch allocation objectives. Commercial catches usually provide much of the data used in the analyses. In addition, test fisheries (Table 8) conducted by the Commission or by DFO at the request of the Commission provide important data before and after the commercial fishing season and between fishing periods. Information about upstream migration in the river is obtained by echosounding at Mission, B.C., visual observations at Hells Gate and analysis of catches in Fraser River First Nations' fisheries.

The upstream passage of sockeye was monitored at Mission from June 24 to September 21. Estimates of daily sockeye salmon escapements were derived by combining Mission hydroacoustic data with species composition data from gillnet test fishing at Whonnock (Area 29-16). In addition, the fourth year of an experimental split-beam hydroacoustic program was jointly conducted by the PSC and DFO.

Daily visual observations at Hells Gate between July 2 and September 26 supplied qualitative information on the success of upstream fish passage.

Table 8. Test fishing operations that were approved by the Fraser River Panel for the 1998 fishing season.

Area	Gear	Dates	Operated by
Canadian Panel Areas			
20	Purse Seine	July 24 - August 25	PSC
20	Gillnet	June 21 - August 21	PSC
29-13	Gillnet	July 7 - September 17	PSC
29-16	Gillnet	June 22 - September 21	PSC
29-1 to 6	Troll	August 11 - September 14	PSC
Canadian non-Panel Areas			
12	Gillnet	July 14 - August 13	DFO
12	Purse Seine	July 22 - August 29	DFO
13	Purse Seine	July 22 - August 29	DFO
United States Panel Areas			
7	Reefnet	July 19 - July 24	PSC

A. Sockeye Salmon

Run-size estimation for Fraser River sockeye by stock group is based primarily on catch, effort, escapement, racial composition and diversion rate data, which are analyzed using purse seine catch, catch-per-unit-effort, cumulative-normal and cumulative-passage-to-date models. Most of these methods are described in the Pacific Salmon Commission's Technical Report No. 6[1] and in the Fraser River Panel's 1995 Annual Report[2]. Traditionally, much of these data come from commercial fisheries. However, in 1998, data from these sources were scarce because of limited commercial fishing. Therefore, test fishing catch and CPUE data were used more extensively in assessing stock group abundances than in previous years.

Each year, the first Fraser River sockeye run to arrive in coastal waters is the Early Stuart. Analyses early in July indicated the run size to be at or slightly higher than the pre-season forecast (175,000). By July 10, while some of the estimates of run size were near 200,000, there was insufficient justification to change the run-size estimate and the run was considered to be at or slightly above the pre-season forecast. Staff also raised concerns about high water temperatures in the Fraser River and expressed their opinion that losses could be expected due to en route and pre-spawning mortality. The 50% point in the migration was July 3 (Area 20 date), which is the long-term average date of peak abundance. At the end of the season, Early Stuart estimates included a run size of 174,000 fish and a gross escapement of 168,000. While the total run returned as had been forecast by DFO, approximately 81% of the run was comprised of age 5 fish from the 1993 spawning and only 19% age 4 fish from the cycle spawning in 1994, the reverse of the forecast. The low production of age 4 Early Stuart fish signalled a concern about the production from the 1994 brood year spawning.

[1] 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 Com. Tech. Rep. No. 6: 179p.

[2] 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, BC

Later in July and in early August, Panel management focussed on Early Summer-run sockeye. Assessment of the abundance of this timing group was complicated by the higher abundance of co-migrating Summer-run sockeye and uncertainty in stock identification between Scotch/Seymour and Late-run Adams/Lower Shuswap stock groups. In late July, the run size was estimated at approximately 500,000 fish, slightly below the pre-season forecast of 642,000. On August 5, the projection of abundance was increased to 600,000. Final in-season estimates of Early Summer-run abundance and gross escapement were 787,000 and 599,000 fish, respectively.

In 1998, assessment of Summer-run sockeye abundance was based primarily on reconstruction of catches and escapements at Mission (cumulative-normal and cumulative-passage models) rather than on commercial catch and effort models. Early estimates indicated a run size less than forecast and with the likelihood of earlier than forecast (August 9 in Area 20) timing. On August 7, estimates of Summer-run abundance ranged between 4,000,000 and 5,000,000 sockeye and an initial estimate of 4,500,000 was adopted for in-season management. The projected abundances increased to 5,000,000 on August 17 with the development of a second mode of abundance migrating principally via Johnstone Strait. On August 18, the run size was upgraded to 6,000,000. By August 28, the run size was adjusted down slightly to 5,700,000. By the end of the season, the total run was estimated at 5,600,000 with a gross escapement of 4,200,000 fish. The age 4 production was estimated to be approximately 65% of the forecast. The 50% migration date for the Summer run in Area 20 was August 6.

The assessment of Late-run sockeye abundance was complicated by the higher abundance of co-migrating Summer-run sockeye, uncertainty in stock identification and the closures to commercial fisheries. A provisional run-size estimate of 3,000,000 (down from 3,754,000) was adopted by the Panel on August 7, based on staff advice that there appeared to be a general weakness of age 4 fish in the Fraser sockeye run to date. This pessimism was supported by lower than anticipated catches of Late-run sockeye in the Area 29 (Strait of Georgia) troll test fishery. On August 28, the abundance projection was revised to 2,800,000 and on September 1 to 2,500,000. However, the estimates of Adams/Lower Shuswap and Weaver Creek sockeye abundance at the Mission hydroacoustic site plus recorded catches showed greater abundance than had been estimated using troll test fishery data. At the end of the season, total Late-run abundance was estimated at 4,200,000 with a gross escapement of 3,500,000. The 50% migration date (Area 20) was estimated to be August 15.

Early in the migration of sockeye salmon in 1998, the proportion of fish migrating via Johnstone Strait was estimated to be near normal (25%). By the beginning of August the migration via Johnstone Strait increased to 80-90% of the onshore run, where it remained through August. During September, there was evidence that the diversion rate moderated to less than 70%. The average diversion rate for the season was estimated at 78%, because of the high fraction of fish that migrated in August.

Cottonwood test fishing CPUE's are plotted with the daily hydroacoustic estimates of sockeye passage at Mission in Figure 5. Cottonwood data are lagged one day, which is the estimated travel time for sockeye between Cottonwood and Mission sites. Relative day-to-day abundance changes at Cottonwood were closely matched by Mission abundance the following day.

Observations at Hells Gate indicated the passage of sockeye was below expectations during the July-August period, although the speed of travel from Mission to Hells Gate appeared to be near normal. No evidence of delay in the Fraser Canyon was observed at Hells Gate.

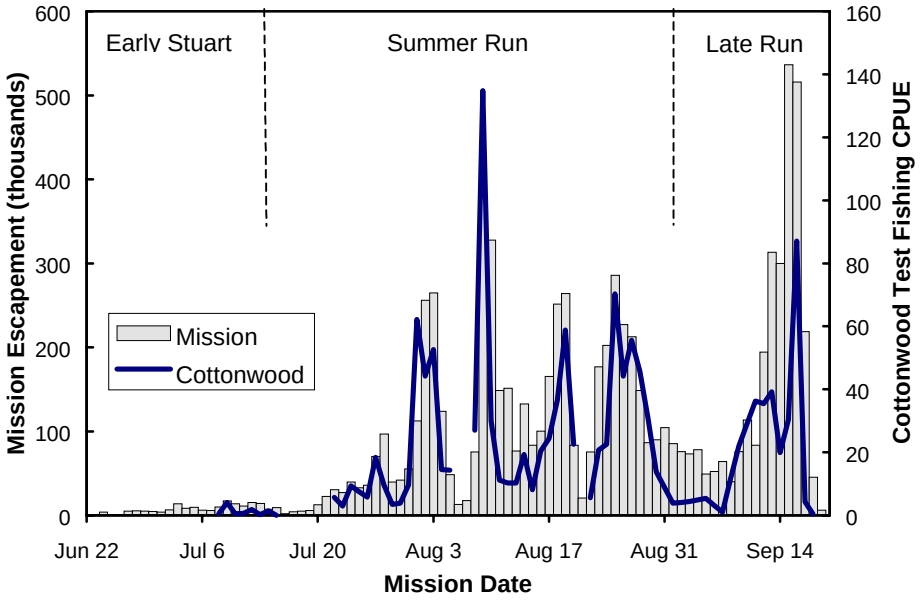


Figure 5. Daily escapements of sockeye salmon estimated at Mission by echosounding compared with test fishing CPUE's at Cottonwood one or two days earlier.

B. Split-Beam Echosounding Study at Mission

As a result of recommendations by the Mission Hydroacoustic Facility Working Group of the Fraser River Sockeye Public Review Board after the 1994 season, a joint PSC and DFO program that employs a shore-based split-beam echosounder was conducted at the Mission hydroacoustic site from 1995 to 1998. The initial objective of the program was to examine assumptions regarding salmon behaviour and distribution that are implicit to the standard (single-beam) echosounding method used to estimate escapement past Mission. These assumptions are:

1. all fish migrate upstream;
2. all fish are in areas of the river where they can be acoustically detected; and
3. fish do not avoid the transecting vessel.

In 1998, the split-beam echosounder system was used to collect information on 24-hour per day sockeye migration at Mission. Most of the data were collected from fixed locations on the south shore using two side-scanning transducers. The equipment was also deployed from the PSC transect vessel for two days with the transducer oriented vertically downward as with the single-beam system.

As well, an active-tracking split-beam system was employed to examine salmon migration behaviour over longer distances (i.e., approximately 20 m) than are possible with the fixed-position side-scanning system. The purpose was to determine if vessel avoidance was detectable.

Digitized data from the single-beam downward looking (standard) echo sounder was recorded on digital tapes. Analysis of these recordings using target tracking computer programs provided target distribution data with which to compare split-beam data. Also, these analyses provided data on river-wide salmon distribution throughout the season.

Preliminary analysis of 1998 data indicated the following:

- Most targets that were successfully tracked (96%) were found to be moving upstream.
- Salmon upstream swimming speed ranged between 0.7 m/s early in July and 0.9 m/s at the end of August.
- The vertical distribution of fish showed a strong response to tidal effects, with a tighter concentration of fish targets close to the river bottom during ebb tides and a greater spread to the distribution of targets during flood tides. The majority of fish targets were observed close to the bottom over each 24-hour period, however.
- Fish distribution was concentrated on the south shore but extended to mid-channel during low flow periods in late summer.
- Vertical and horizontal target distributions were obtained from the split-beam and the single-beam systems in the overlap area on the south shore.
- Average daily fish passage rates from the split-beam data were well correlated with PSC daily escapement data (correlation coefficient = 0.81).
- The active-tracking split-beam system did not indicate extensive vessel avoidance, up to the point where turbulence from the vessel interfered with measurement of the tracks of individual fish.
- Data from the active-tracking split-beam echosounder deployed on the south shore during August indicated that target strength (acoustic size) of a fish varies significantly with the aspect angle between the sound beam and swimming vector of the fish. This can result in target strength variability of up to 10 dB.
- Fish distribution data obtained when the split-beam system was operated from the transect vessel showed that the regular transecting system is incapable of sampling fish targets in near-shore waters of less than 2 meters depth.

VII. RACIAL IDENTIFICATION

PSC staff conduct programs designed to identify the stock proportions of Fraser River sockeye salmon in commercial and test fishing catches. These data provide information on the abundance and timing of sockeye stocks as they migrate to the Fraser River. Racial data are also used to account for international and domestic catches of Fraser River sockeye salmon in coastal waters, and to apportion the daily Mission sockeye escapement estimates into discrete stock groups. Racial analysis methods in 1998 were similar to past years.[3,4]

Analyses of scale samples from commercial and test fishery catches were conducted daily, beginning in late June and continuing through mid-September. Commission staff sampled commercial sockeye landings at sites in Bellingham and Blaine, Washington, and Vancouver, Steveston, Port Renfrew, and Port Hardy, B.C. Alaska Department of Fish and Game (ADF&G) collected samples from the District 104 net fishery at landing sites in Petersburg and Ketchikan, Alaska. J. O. Thomas and Associates provided samples from Queen Charlotte Island troll and net fisheries. DFO provided samples from Johnstone Strait purse seine test fisheries. In addition, DFO co-ordinated weekly scale sampling from Fraser River First Nations' fisheries at four fishing areas: Chilliwack, Yale, Lytton and Bridge River.

[3] Gable, J.H. and S.F. Cox-Rogers. 1998. Stock identification of Fraser River sockeye salmon: methodology and management application. Pacific Salmon Comm. Tech. Rep. No. 5: 36 p.

[4] Pacific Salmon Commission. 1999. Report of the Fraser River Panel to the Pacific Salmon Commission on the 1997 Fraser River sockeye and pink salmon fishing season. Vancouver, B.C.

A. Analyses

In 1998, the numerically dominant stocks were Scotch/Seymour, Quesnel, Chilko, Late Stuart, Stellako, Birkenhead, Adams/Lower Shuswap and Weaver. These stocks, in combination with other numerically smaller stocks, were pooled to form nine unique stock groups: Early Stuart, Fennell/Bowron, Scotch/Seymour, Nadina/Gates, Quesnel/Chilko, Late Stuart/Stellako, Birkenhead, Adams/Lower Shuswap and Weaver/Portage. For most of the period of active commercial fishing in 1998, the nine stock groups were incorporated into two categories of in-season models: 1) models with Early Summer-run and Summer-run stock complexes, and 2) models with Summer-run and Late-run stock complexes.

Discriminant Function Analysis (DFA) classification matrices from standards developed pre-season predicted that most key stock groups would be well distinguished from each other. However, some problems were anticipated. The first difficulty in the application of the 1998 DFA models was the relatively high rate of misclassification (24% and 18%, respectively) between the two abundant Summer-run groups (Quesnel/Chilko and Late Stuart/Stellako) and the much less abundant Early Summer-run groups (Fennell/Bowron and Nadina/Gates/Pitt). To correct for misclassifications between stock groups, bias correction (Cook and Lord, 1978) was applied. However, even with bias correction, when stocks with similar scale characters differ greatly in abundance, DFA models (and other analytical techniques such as Maximum Likelihood Analysis) tend to overestimate stocks present in low proportions and underestimate stocks present in high proportions. Therefore, we used four strategies to minimize the over-estimation of the Early Summer run: 1) we identified the earliest time for inclusion of Summer-run sockeye in age 4 DFA models using age 5_2 models and data on the prevalence of the brain parasite *Myxobolus articus* (an indicator of the presence of Quesnel sockeye, see below); 2) individual classifications were used to identify fish that had high probabilities of belonging to the Early Summer-run timing group; 3) data summaries were examined to identify groups of fish that had length and/or circuli patterns that were distinct from the Summer-run standards; and 4) estimates were compared to expected proportions derived from pre-season forecasts of timing and abundance.

The second problem involved the necessity to uniquely identify the Quesnel and Chilko stocks for Canada's in-season gross escapement objectives. Since these two stocks could not be distinguished using scale characters, we used the same methods as in past years to achieve separation based on the presence or absence of the brain parasite, *Myxobolus articus.*[5]

Thirdly, we were concerned about the ability of DFA models to accurately identify the Seymour/Adams complex for three reasons. First, because of low jack returns in 1997, only six jack scales were available for the Scotch/Seymour stock group and none were available for the Adams/Lower Shuswap group. Second, 1994 brood year escapements and resulting fry estimates were more similar to sub-dominant than dominant cycle lines. Third, scales from the Seymour/Adams complex returning on Adams sub-dominant years tend to have a higher first year count and less spring growth than scales from Adams dominant year returns. Several steps were taken prior to and during the 1998 season to accurately identify the Seymour/Adams complex.

First, scale standards were selected from prior years (1990, 1991) that had a higher count to the annulus and less spring growth than scales from 1994 (the brood year dominant return). Second, based on past years' data, we derived three alternative estimates by varying the expansion factor applied to the proportion of scales in the sample with four or more spring growth circuli. Estimates of the Seymour/Adams complex from the DFA model were then compared to alternative estimates derived from the spring growth expansion method. Third, length and circuli count frequency distributions were examined for shifts that might signal an increasing proportion of the Seymour/Adams complex or a decreasing proportion of Summer-run stocks. Fourth, we updated the standard for the Seymour/Adams complex using a sample taken August 20 from the Scotch Creek fence by fisheries technicians from the Shuswap Nation. While revised standards came too late in the season to impact management of Scotch/Seymour, it was

valuable in subsequent analyses affecting the management of Adams/Lower Shuswap, including documenting the early upstream migration of Adams/Lower Shuswap sockeye.

The fourth problem concerned the separation of Scotch/Seymour sockeye from Adams/Lower Shuswap sockeye. Because juveniles from both groups rear in Shuswap lake, they cannot be distinguished based on freshwater scale patterns. Therefore, methods to estimate the proportions of these two stocks have been developed based on variation in their migration behavior.[5]

The body cavity parasite, *Philonema oncorhynchi*, is virtually absent from most Fraser River sockeye stocks but has a high prevalence in stocks from northern British Columbia and Southeast Alaska. In 1998, *Philonema* prevalence and age composition data were used to provide in-season estimates of Fraser River sockeye contribution rates in District 104, Alaska, purse seine fisheries. From past years' data, it has been shown that *Philonema*-based estimates of Fraser proportions are similar to estimates based on post-season DFA analysis of scale patterns.

In 1998, PSC staff began a study in collaboration with the DFO to assess the potential use of microsatellite DNA markers to distinguish among Fraser River sockeye stocks. Microsatellite DNA markers are the latest in a suite of genetic markers to be investigated in Fraser River sockeye. One principal advantage of genetic markers over scales is that the genetic baseline should not vary inter-annually. Thus, shifts in stock composition estimates resulting from changes between in-season and post-season standards would be eliminated. Unfortunately, the genetic-based techniques examined to date (i.e., allozymes, mitochondrial DNA, minisatellite DNA) have provided insufficient resolution of sockeye stocks within the Fraser to be of value in management. Microsatellite markers offer greater potential for stock discrimination, but further testing is needed to determine whether this potential will be realized in practice.

Post-season racial analyses were performed using baseline standards derived from the 1998 spawning ground scale samples. The major component stocks in each stock group were the same in the post-season and in-season DFA models. Shifts in scale characteristics between pre-season and post-season standards resulted in decreased estimates of Scotch/Seymour, Quesnel/Chilko, Birkenhead, and Adams/L. Shuswap contributions, but increased estimates of Early Stuart, Nadina/Gates, Late Stuart/Stellako, and Weaver contributions.

B. Estimates of Escapement and Production by Stock

To isolate the effects of in-season to post-season changes in racial composition estimates, estimates of gross escapement (hydroacoustic and CPUE-based) by stock group based on in-season racial data were compared to estimates in which post-season racial standards were applied (Table 9). The largest percentage shifts in estimates were in the Late Stuart/Stellako, Nadina/Gates and Birkenhead groups. However, percentage changes for the remainder of the stock groups were less than 16%.

The total return of Early Stuart sockeye (190,000; Table 10) slightly exceeded the pre-season forecast level. However, the return of age 4 sockeye (28,000) was only 19% of the pre-season forecast (150,000), while the return of age 5 sockeye (162,000) was about six times the pre-season forecast (26,000). Recorded catches for this run included 6,000 fish in test and miscellaneous non-commercial fisheries. There was also a catch of 15,000 in Fraser River First Nations' fisheries. The exploitation rate for all catch areas was 11%.

[5] Pacific Salmon Commission. 1997. Report of the Fraser River Panel to the Pacific Salmon Commission on the 1994 Fraser River sockeye salmon fishing season. Vancouver, B.C.

Table 9. Comparison of in-season to post-season estimates of gross escapement (hydroacoustic and CPUE-based) of Fraser River sockeye salmon by stock group in 1998.

Run	Gross Escapement		Difference	
Stock Group	In-season	Post-season	Fish	%
Early Stuart	168,000	184,000	16,000	10%
Early Summer				
Fennell/Bowron	59,000	57,000	(2,000)	(3%)
Nadina/Gates	83,000	120,000	37,000	45%
Scotch/Seymour	457,000	389,000	(68,000)	(15%)
Total	599,000	566,000	(33,000)	(6%)
Summer				
Quesnel/Chilko	3,501,000	3,354,000	(147,000)	(4%)
Late Stuart/Stellako	666,000	1,156,000	490,000	74%
Total	4,167,000	4,510,000	343,000	8%
Late				
Birkenhead	545,000	314,000	(231,000)	(42%)
Adams/L. Shuswap	2,321,000	2,203,000	(118,000)	(5%)
Weaver	718,000	793,000	75,000	10%
Total	3,584,000	3,310,000	(274,000)	(8%)
Total	8,518,000	8,570,000	52,000	1%

The estimated return of Early Summer-run stocks was 748,000, about 17% greater than the pre-season forecast of 642,000. Catch estimates for this timing group include a commercial catch of 166,000, plus 11,000 in test fisheries and 5,000 in miscellaneous non-commercial fisheries, for a total of 182,000. In addition, there was a catch of 57,000 in Fraser River First Nations' fisheries. The exploitation rate on Early Summer-run stocks was 32% (Table 10).

The estimated return of Summer-run stocks was 6,021,000 fish, about 626,000 fish less than the pre-season forecast of 6,647,000. The Quesnel/Chilko stock group dominated the production of Summer-run sockeye with a total return of 4,562,000. The second Summer-run stock group, Late Stuart/Stellako, had a total return of 1,459,000. The combined Canadian and United States commercial catch of all Summer-run stocks was 1,375,000. Other miscellaneous catches included 63,000 in test fisheries and 86,000 in miscellaneous non-commercial fisheries (including 72,000 in outside area First Nations' catch). In addition, the catch in Fraser River First Nations' fisheries was 533,000. The adult exploitation rate for Summer-run stocks in all fisheries was 34% (Table 10).

The pre-season forecast for Late-run stocks was 3,754,000 fish. The estimated return was 3,906,000, approximately 152,000 fish greater than the pre-season forecast. The Adams/Lower Shuswap stock group dominated the Late-run production with an estimate of 2,571,000 fish. The remainder of Late-run production was split between Birkenhead (414,000) and Weaver (921,000) stocks. The estimated commercial catch of Late-run stocks was 444,000 fish. Additional catches included a test fishery harvest of 29,000, miscellaneous non-commercial catches of 225,000 (including 123,000 in outside area First Nations' catch and 99,000 in an ESSR fishery) and 39,000 in the Fraser River First Nations' fishery. The exploitation rate on Late-run stocks was 19% (Table 10).

The total return of adult Fraser River sockeye in 1998 was estimated to be 10,865,000 fish. Catches in all fisheries accounted for 28% of the fish while 72% of the fish were available for spawning escapement requirements. Of the 28% harvest component, commercial fisheries harvested 18%, non-commercial fisheries, including test fisheries, harvested 4%, and Fraser River First Nations' fisheries accounted for approximately 6% (Table 10).

Table 10. Catches, escapements and exploitation rates for Fraser River sockeye salmon by stock group in 1998.

Run Stock Group	River & Ocean Catch *	Gross Escapement: Fraser Indian Catch	Gross Escapement: Recreational Catch Above Mission	Gross Escapement: Spawning Escapement	Gross 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	6,000	15,000	0	31,000	138,000	190,000	0	2%	3%	11%
Early Summer-run										
Fennell/Bowron/Raft	3,000	2,000	0	30,000	25,000	60,000	0	1%	5%	8%
Nadina/Gates/Pitt	19,000	7,000	1,000	88,000	24,000	139,000	2,000			
Scotch/Seymour	160,000	48,000	1,000	108,000	232,000	549,000	100	5%	29%	38%
Total	182,000	57,000	2,000	226,000	281,000	748,000	2,100	7%	24%	32%
Summer-run										
Quesnel/Chilko	1,208,000	399,000	8,000	2,059,000	888,000	4,562,000	2,800	42%	26%	35%
Late Stuart/Stellako	303,000	134,000	2,000	322,000	698,000	1,459,000	1,400	13%	21%	30%
Total	1,511,000	533,000	10,000	2,381,000	1,586,000	6,021,000	4,200	55%	25%	34%
Late-run										
Birkenhead	100,000	7,000	1,000	302,000	4,000	414,000	500	4%	24%	26%
Adams/L. Shuswap	368,000	29,000	1,000	1,390,000	783,000	2,571,000	500			
Weaver/Portage/Misc.	128,000	102,000 [1]	0	89,000	602,000	921,000	500	8%	14%	25%
Total	596,000	138,000	2,000	1,781,000	1,389,000	3,906,000	1,500	36%	15%	19%
Total Adults	2,295,000	743,000	14,000	4,419,000	3,394,000	10,865,000	7,800	100%	21%	28%
Total Jacks	2,200	0	0	5,600	0	7,800				
Total	2,297,200	743,000	14,000	4,424,600	3,394,000	10,872,800				
Portion of Total Run	21%	7%	0%	41%	31%	100%				

* Includes catches in all fisheries, excluding the Fraser River Indian fishery and recreational fisheries above Mission.

** Differences between gross escapement estimates are the in-season estimates (Mission + IF catch, PSC) minus the post-season estimates (spawning escapement + IF catch, DFO).

[1] Includes ESSR catch of 99,000 Weaver sockeye.

VIII. ESCAPEMENT

Canada Department of Fisheries and Oceans estimates the annual escapements to sockeye spawning grounds in the Fraser River watershed (Figure 6). These data along with biological samples from the spawners are provided to Commission staff so they can revise in-season racial analyses, estimate total production for each stock and assess Commission programs for stock monitoring.

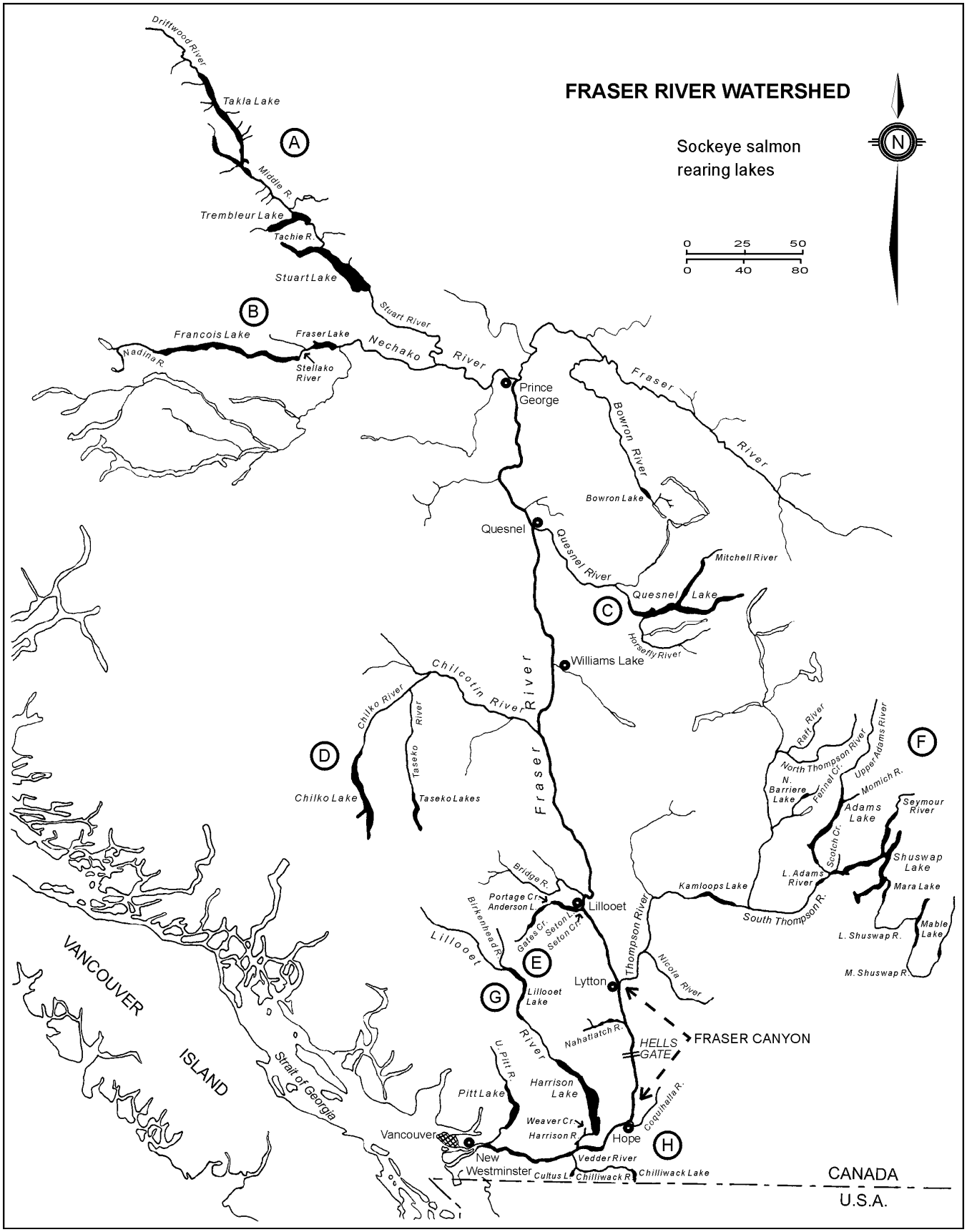


Figure 6. Sockeye salmon spawning grounds in the Fraser River watershed.

A. Sockeye Salmon

Preliminary estimates of the 1998 sockeye salmon escapement to streams in the Fraser River watershed total 4,425,000 fish, including 4,419,000 adults (4 and 5-year-old fish) and 6,000 jacks (3-year-old fish) (Appendix E: Table 7). The escapement was 45% larger than the brood year (1994) escapement of 3,129,000 adult sockeye (Table 11) and was the second largest recorded on the cycle. Large increases were recorded in Summer-run and Late-run escapement totals. A small decline was observed in the Early Summer group and the Early Stuart escapement total was unchanged from 1994.

Table 11. Adult sockeye escapements by run-timing group on the 1998 cycle for 1982-1998.

	Spawning Escapement				
Run	1982	1986	1990	1994	1998
Early Stuart	5,000	29,000	97,000	30,000	31,000
Early Summer	100,000	225,000	441,000	248,000	226,000
Summer	376,000	581,000	1,597,000	1,352,000	2,381,000
Late	3,527,000	2,823,000	3,929,000	1,499,000	1,781,000
Adults	4,008,000	3,658,000	6,064,000	3,129,000	4,419,000

During the 1998 management season, the Panel recognized the high probability of en route and pre-spawning mortality in sockeye migrating to spawning areas above Hells Gate due to the impacts of high river water temperatures during migration. Returns of Early Stuart and most Early Summer-run stocks were too small to provide enough extra fish to compensate for the expected mortality. However, there were sufficient Summer-run fish to allow an adjustment of the gross escapement target to compensate for expected losses. Additionally, the Panel could not set regulations to harvest Summer-run sockeye entering the Fraser River after August 21 because of the presence of Late-run sockeye in the fishing areas. These two factors resulted in a gross escapement of 4,167,000 Summer-run fish compared to a requirement of less than 3,000,000 fish for the actual run size. These extra fish compensated for the en route losses suffered by the stocks migrating upstream and provided for spawning escapements of Summer-run sockeye stocks that were larger than the target.

The 1998 Early Stuart sockeye return was close to the forecast of 175,000 fish, but despite conservation efforts to ensure that the escapement target (97,000) was reached, arrivals on the spawning grounds totalled only 31,000 fish. This was similar to the escapement of 30,000 fish in 1994. Early Stuart sockeye spawn in tributaries to Middle River, Trembleur Lake, Takla Lake and in the Driftwood River and its tributaries (A; Figure 6). Historically, a high percentage of sockeye use Middle River tributaries on this cycle (e.g., 58% in 1994). In 1998, however, the largest escapements were to Driftwood River (10,900; 35%) and to tributaries of Takla Lake (10,400; 34%). Only 22% of the escapement spawned in the Middle River tributaries. The unusual distribution was likely due to the predominance of 5-year-old sockeye in 1998 escapement. Approximately 81% of Early Stuart sockeye were age 5 fish from the dominant line spawning in 1993. In that year, 63% of adult sockeye spawned in Driftwood River, 21% in Takla Lake tributaries and only 7% in Middle River tributaries. Homing of 5-year-old sockeye to natal streams produced the unusual distribution of spawners observed in 1998 compared to past cycle years.

Many of the 1998 Early Stuart sockeye failed to reach their natal streams due to the accumulated stress associated with extremely high water temperatures in the Fraser River, lower Nechako River and Stuart River. In late July and early August, Early Stuart sockeye were sighted in several streams of the upper Fraser area that do not support sockeye runs. These fish appear to have diverted into non-natal streams because of the stress of migration at high temperatures. Moreover, of the sockeye that did manage to reach their natal streams, 44% of the females died prior to spawning. The pre-spawning mortality observed in the Early Stuart sockeye run in 1998

was close to that predicted by the relationship between river water temperature and arrival timing and pre-spawning mortality rates in past years. However, the en route mortality component could not be forecast due to the inability to estimate the annual level of en route loss in past years. Early Stuart sockeye have often experienced en route losses due to high discharge (e.g., 1997), high temperature (1994), or a combination of the two (1982).

River water temperatures were slightly lower when Late Stuart sockeye migrated upstream in August. The escapement of 136,000 sockeye was 78% higher than observed in the 1994 spawning. However, here as well, the majority (82%) of spawning sockeye were 5-year-old fish from the 1993 brood. The distribution of spawning in the stock group approximated the recent-year pattern with the larger fraction spawning in Tachie River (93,000) and less in Middle River (37,000). Spawning success of Late Stuart sockeye was high with 98% of females successfully depositing their eggs.

Nechako River watershed stocks (B; Figure 6) include the Early Summer run to Nadina River and the Summer run to Stellako River. Late Nadina sockeye escapement increased to 3,700 sockeye from 2,000 in the brood year. Most of these fish (3,000) entered the spawning channel. At Stellako River, the spawning population also increased substantially from 138,000 in 1994 to 186,000 in 1998. Spawning success rates were high for female sockeye in both Nadina River (95%) and Stellako River (99%). Age 5 fish were important in the 1998 spawning of both Nadina (35%) and Stellako (29%) sockeye populations.

Quesnel Lake watershed (C; Figure 6) sockeye stocks provided the largest total return amongst the major runs in 1998. Escapements to Quesnel Lake tributaries and lake beach spawning areas reached 1,179,000 adult sockeye, which is the largest population on record for the cycle and amounted to 63% of the dominant cycle escapement in 1997 (1,859,000). The spawning in 1998 was a 72% increase over the 1994 brood year. Spawning was concentrated in Horsefly River (844,000) and Mitchell River (310,000). Female success of spawning was moderately high at 88% in Horsefly River and 97% in Mitchell River.

The escapement to Chilko River and Lake spawning areas (D; Figure 6) was estimated at 879,000 adult sockeye. The total was nearly double the 1994 escapement of 451,000 fish and was the fifth largest escapement on record. The 1998 escapement was the third consecutive large spawning (879,000-974,000). Female sockeye spawning success was 91.5%, which was only slightly lower than the recent-year average.

Seton-Anderson watershed sockeye stocks (E; Figure 6) showed increases over brood year levels for both Gates Creek and Portage Creek populations. The escapement to Gates Creek was 7,000 adult sockeye, of which 6,300 entered the spawning channel. Success of spawning was lower than average at 61% for the combined channel and creek spawning female sockeye. Portage Creek sockeye are a Late-run stock that migrates upstream in September and spawns in October-November. The escapement in 1998 was 25,000, which was nearly three times the brood year level (1994 - 9,300). This total was also the second largest spawning recorded for Portage Creek, which is a short stream connecting Anderson and Seton Lakes.

Thompson River watershed sockeye stocks (F; Figure 6) are major contributors to the 1998 cycle returns, particularly the South Thompson (Shuswap Lake) stocks. Early Summer sockeye runs to Seymour River, Scotch Creek and Eagle River and Late-run sockeye returns to Lower Adams River and to Lower and Middle Shuswap Rivers normally reach their four-year highs on this cycle. North Thompson River stocks produce well but are dominant on other cycle lines. Escapements to Fennell Creek and Raft River on the North Thompson were larger than in 1994. Fennell Creek had 8,700 sockeye spawners compared to 5,900 in 1994. The Raft River sockeye abundance (7,200) was over four times the brood year (1,700). High proportions of the fish at Fennell Creek (70%) and Raft River (69%) were 5-year-old sockeye.

Most Early Summer sockeye populations in the South Thompson River watershed were lower than observed in the brood year (1994). Whereas the 4-year-old components of spawning populations in other areas of the Fraser were augmented by returns of 5-year-old fish from the successful 1993 brood, low returns to the South Thompson in 1993 (off cycle line) did not

generate many 5-year-old fish of these stocks. Consequently, poor returns of 4-year-old sockeye were not mediated by fish of other ages. The Seymour River escapement was estimated at 34,000 compared with 64,000 in 1994. Scotch Creek had 36,000 sockeye spawners compared to 73,000 in the brood year. Eagle River had 30,000 fish compared to 54,000 in 1994. In total, the 1998 escapement of Early Summer-run stocks in the South Thompson watershed totalled 105,000 adult sockeye compared with an escapement of 198,000 in 1994.

Late-run sockeye escapements to the South Thompson watershed were similar to those observed in 1994. The total abundance was 1,390,000 fish compared to 1,371,000 in the brood year. Spawning was concentrated in the Adams River-Little River area (1,047,000) and in the Lower and Middle Shuswap (307,000). Despite the unusually early migration timing, few sockeye entered the Adams River until the main group of September-migrating fish arrived. This was even more clearly shown by the entry of fish into the Lower Shuswap River. The success of spawning was initially low in the Adams River but the proportionately more abundant, later-arriving fish had normal spawning success with a mean of 98%. Lower Shuswap sockeye were similar at 96% success of spawning.

Late-run sockeye spawning in the Harrison-Lillooet Lake watershed (G; Figure 6) showed large escapement increases in 1998 compared to the spawning four years earlier. The Birkenhead River was populated by 296,000 sockeye, the largest escapement since 1986 and the second largest on record. This escapement was about eight times the 1994 spawning abundance (39,000). Approximately 94% of the Birkenhead escapement were 5-year-old sockeye from the 1993 spawning. An estimated 68% of the 1993 brood returned as 5-year-old fish compared to the 1948-1990 brood year average of 21% (range: 3%-78%). Spawning success averaged 95% of females.

The escapement of sockeye to Weaver Creek also was substantially larger than in the 1994 run. A total of 161,000 fish arrived in the Weaver Creek/Harrison River area. Of these, approximately 99,000 were harvested in a First Nations' ESSR (Excess Salmon to Spawning Requirements) fishery. In total, 28,000 fish spawned in Weaver Creek and 29,000 in the spawning channel. Spawning success was slightly below average at 92% of the females. Other stocks in the Harrison River system had mixed escapements in 1998. Big Silver Creek is a tributary on the east side of Harrison Lake. The escapement of 6,000 sockeye was the largest since 1960. The Harrison River below Harrison Lake supports a unique population of Late-run sockeye. As juveniles, these fish forage in sloughs along the lower Fraser River, then migrate to the Strait of Georgia in summer of their first year rather than as yearlings the following spring as do most other Fraser River sockeye stocks. Escapement of adults in 1998 was estimated at 4,500 fish. This was approximately one-half the escapement recorded in 1994 (9,500).

Lower Fraser River tributary stocks include sockeye migrating into Upper Pitt River, Chilliwack Lake, Cultus Lake and Nahatlatch Lakes and River (H; Figure 6). Upper Pitt River sockeye reached a modern-year record of 77,000 adults. A very high proportion (95%) of the run in 1998 was 5-year-old fish from the 1993 brood year spawning of 23,000. Chilliwack Lake sockeye decreased substantially in number from 8,000 in 1994 to 1,100 in 1998. The abundance of sockeye at Nahatlatch Lakes and River increased from 6,000 in 1994 to 8,000 in 1998. Cultus Lake sockeye spawn on beaches at the south end of the lake where the eggs incubate in upwelling ground water. The escapement in 1998 of 2,000 fish was a decline from 1994 when 4,400 sockeye arrived.

The weighted average success of spawning was 93.7%, giving an effective female population of 2,213,000 fish. This was the second highest spawning total on the cycle after the large escapement recorded in 1990. While the escapement was large, the viability of eggs deposited by female sockeye that experienced record high water temperatures in the Fraser River during migration remains a question. Experimental studies on egg viability conducted by DFO in Forfar, Gluske and Kynock Creeks (Early Stuart) and in Horsefly River showed that non-viable eggs were present.

IX. ACHIEVEMENT OF OBJECTIVES

The mandate of the Fraser River Panel is to manage commercial fisheries in Panel Area waters to achieve a hierarchy of annual goals. In order of importance, these goals are as follows: 1) to achieve gross escapement targets for Fraser River sockeye and pink salmon set by Canada or modified by Panel agreement; 2) to achieve international sharing of the TAC as per the Treaty or agreement of the Parties; and 3) to achieve domestic allocation goals for the catch within each country. In the process of achieving these objectives, the Panel must consider the 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 met and to improve management techniques and data collection programs.

A. Gross Escapement

The Panel's primary objective is to achieve Canada's gross escapement targets by run-timing group. Gross escapement targets include fish for spawning and fish for First Nations' harvest in the Fraser River. In recent years, a third category referred to as "Management Adjustments" has been added to gross escapement targets to ensure spawning escapement targets are reached. Calculation of these adjustments comes from either: 1) bias in the relationship between lower river gross escapement (Mission escapement estimate + Fraser First Nations' catch below Mission) and upstream estimates (Fraser First Nations' catch + spawning escapement); or 2) in-season predictions of en route or pre-spawning mortality. Spawning escapement targets for each run-timing group are set by Canada prior to the season based, in part, on the pre-season forecast of return abundance of one or more stocks or stock groups within each timing group. In 1998, Canada provided a spawning escapement target formula to the Panel for use in adjusting the spawning escapement target based on in-season run-size estimates (Appendix A; Table 2). Each time a change in abundance estimates was approved by the Panel, the spawning and gross escapement targets changed. On July 10, the Panel agreed to a Management Adjustment of 51,000 fish to the gross escapement target for Early Stuart sockeye to compensate for potential en route and pre-spawning mortality of up to 56%. Later, on August 14, the Panel agreed to a Management Adjustment of 665,000 fish to the Summer-run sockeye gross escapement target to compensate for a potential en route and pre-spawning mortality of 25%.

Panel management can be assessed by: 1) whether in-season gross escapement estimates meet the adjusted gross escapement targets; and 2) whether upriver escapement estimates meet the actual in-season targets. By the first measure, adjusted gross escapement targets were achieved or were exceeded in each timing group based on lower river estimates (Table 12). The summed gross escapements exceeded the target by a total of 925,000 fish. Most of that number (812,000) were Summer-run sockeye that escaped upriver in mid to late August when Late-run sockeye were also present in the lower Fraser River. Further harvest of Summer-run sockeye was not possible due to conservation concerns for the Adams/Lower Shuswap component of the Late run. Early Stuart and Late-run gross escapements were both 1-2% below target, but Early Summer-run and Summer-run escapements were 35% and 24% above target, respectively.

Table 12. Comparison of in-season adjusted goals and in-season gross escapement estimates for Fraser River sockeye salmon in 1998.

	Gross Escapement				
Run	In-season Target	+ Adjustment*	= Adjusted Target	In-season Estimate**	Difference
Early Stuart	120,000	51,000	171,000	168,000	(3,000)
Early Summer	445,000	0	445,000	599,000	154,000
Summer	2,690,000	665,000	3,355,000	4,167,000	812,000
Late	3,622,000	0	3,622,000	3,584,000	(38,000)
Adults	6,877,000	716,000	7,593,000	8,518,000	925,000

* Panel-agreed gross escapement adjustment.

** Includes 179,000 sockeye salmon caught in Fraser River Indian fisheries below Mission, B.C.

Upriver estimates of gross escapement were significantly below the targets for Early Stuart, Early Summer and Late runs but were above the target for Summer-run stocks (Table 13). The shortfalls in the Early Stuart, Early Summer and Late-run run-timing groups may be associated with en route mortality.

Table 13. Comparison of in-season unadjusted goals and upriver gross escapement estimates for Fraser River sockeye salmon in 1998.

	Gross Escapement *		
Run	In-season Goal	Upriver Estimate	Difference
Early Stuart	120,000	46,000	(74,000)
Early Summer	445,000	285,000	(160,000)
Summer	2,690,000	2,924,000	234,000
Late	3,622,000	2,020,000 **	(1,602,000)
Adults	6,877,000	5,275,000	(1,602,000)

* Spawning escapements plus Fraser River First Nations' and recreational fishery catches.

** Includes ESSR harvest of 99,000 Weaver sockeye.

B. International Allocation

The Panel's second priority is to achieve objectives for international allocation of the TAC, which is based on in-season estimates of run abundance. In 1998, in-season management of commercial fisheries was impacted by the Panel's inability to provide access to additional catch of Summer-run sockeye in Canada due to the overlap of Late-run stocks in marine and lower Fraser River fishing areas. At the last in-season meeting that dealt with United States Panel Area fishing times (August 21), the TAC was approximately 2,600,000 fish of which the United States fishers were entitled to harvest 24.9% or 647,000 fish. United States Panel Area fisheries had harvested an estimated 579,000 fish at that point (22.2% of the available TAC). Subsequent revisions of United States Panel Area catches for over-estimation errors and a reduction of the TAC due to the inability of the Panel to provide opportunity for further harvest of Summer-run sockeye in Canada resulted in a similar percentage harvest in the United States fishery. The final estimate of United States catch was 522,000 sockeye out of a TAC of 2,448,000 (Table 14) or 21.3%. Canadian catches, excluding the Fraser River First Nations' exemption of 400,000 fish and ESSR catch of 99,000 fish, amounted to 1,740,000 Fraser sockeye (71.1%). The Alaska District 104 catch of 186,000 accounted for the remaining 7.6%.

Table 14. Preliminary calculations of total allowable catch and international shares of Fraser River sockeye salmon in 1998.

		Sockeye
TOTAL ALLOWABLE CATCH		
Total Run Size		10,873,000
Deductions		
Escapement		4,425,000
Difference Between Estimates		3,394,000
ESSR Fishery Catches	*	99,000
Fraser River Aboriginal Fishery Exemption		400,000
Test Fishing		107,000
Total Deductions:		8,425,000
Total Allowable Catch:		2,448,000
UNITED STATES		
Washington Catch		522,000
Washington Share	**	610,000
Deviation:		(88,000)
Alaska Catch		186,000
Total United States Catch:		708,000
CANADA		
Canadian Catch - Aboriginal Fishery Exemption		1,740,000
Canadian Share		1,652,000
Deviation:		88,000

* Terminal catch of Weaver sockeye taken under contract for an Excess Salmon to Spawning Requirements (ESSR) fishery.

** Washington allocations according to agreement between the Parties: 24.9% of TAC.

C. Domestic Allocation

The third priority of the Panel is to achieve domestic allocation goals of the Parties. The Panel's ability to achieve such goals is limited because the Panel manages only those fisheries in Panel Areas that are directed at Fraser River sockeye and pink salmon. In 1998, these included sockeye-directed net fisheries in Canadian Areas 20 and 29, troll fisheries in Canadian Areas 18-1, 4 and 11 and Area 29, and United States net fisheries in Areas 4B, 5, 6, 6C, 7 and 7A. Canadian outside troll fisheries, net fisheries in non-Panel areas such as Johnstone Strait, and all fisheries north of Vancouver Island were regulated by Canada.

In 1998, allocation goals existed for both user groups and area or gear groups within user groups in United States Panel Areas and for gear license areas in Canada. Between Treaty Indian and Non-Indian fishers in the United States, Treaty Indians caught 32,000 fish more than their allocation and Non-Indians were under their allocation by the same amount (Table 15). Among Treaty Indians, fishers in Areas 4B, 5 and 6C harvested 26,000 fish or 8.9% of the Treaty Indian catch which placed the catch below the maximum harvest share of 20%. Non-Indian fishers were to share the harvest as follows: 54% for purse seines, 41% for gillnets and 5% for reefnets. Purse seiners caught 54%, gillnetters 42% and reefnetters 4%. Translated into catches, purse seiners were 1,000 fish under, gillnetters were 3,000 over and reefnetters were 2,000 under their allocations.

Canadian gear license groups were to share the commercial fishery harvest of Fraser River sockeye as follows: Area F troll - 75,000 fish; Area B purse seines - 41%; Area D gillnets - 11%; Area E gillnet - 21%; Area G troll - 16%; and Area H troll - 8%. Actual catches were distributed as follows: Area F - 84,000; Area A - 1%; Area B - 35%; Area D - 12%; Area E - 21%; Area G - 16%; Area H - 9% (Table 16).

Table 15. Preliminary estimates of domestic overages and underages in Washington catches of Fraser River sockeye salmon in 1998.

User Category	Actual Catches Fish	Actual Catches %	Catch Goals Fish	Catch Goals %	Overage/ (Underage)
Treaty Indians: by Area					
Treaty Indian					
Areas 4B, 5 and 6C	26,000	8.9%	59,000	20.0% *	(33,000)
Areas 6, 7 and 7A	267,000	91.1%	234,000	80.0%	33,000
Total:	293,000	100.0%	293,000	100.0%	0
Non-Indians: by Gear					
Purse Seine	123,000	53.7%	124,000	54.0%	(1,000)
Gillnet	97,000	42.4%	94,000	41.0%	3,000
Reefnet	9,000	3.9%	11,000	5.0%	(2,000)
Total:	229,000	100.0%	229,000	100.0%	0
Washington: between Treaty Indian and Non-Indian Users					
Treaty Indian	293,000	56.1%	261,000 *	50.0%	32,000
Non-Indian	229,000	43.9%	261,000 *	50.0%	(32,000)
Washington Total:	522,000	100.0%	522,000	100.0%	0

* Maximum percentage share.

Table 16. Preliminary estimates of domestic overages and underages in Canadian catches of Fraser River sockeye salmon in 1998.

Gear License Area	Actual Catches Fish	Actual Catches %	Catch Goals Fish	Catch Goals %	Overage/ (Underage)
Purse Seine					
A Northern	9,000	0.7%	0	0.0%	9,000
B Southern	443,000	34.7%	508,000	41.0%	(65,000)
Total	452,000	35.4%	508,000	41.0%	(56,000)
Gillnet					
D Johnstone Strait	156,000	12.2%	136,000	11.0%	20,000
E Fraser River	268,000	21.0%	260,000	21.0%	8,000
Total	424,000	33.2%	396,000	32.0%	28,000
Troll					
F Northern	84,000	6.6%	75,000	n/a	9,000
G Southern	201,000	15.7%	198,000	16.0%	3,000
H Inside	117,000	9.2%	99,000	8.0%	18,000
Total	402,000	31.5%	372,000	24.0%	30,000
Total	1,278,000	100.0%	1,276,000	97.0%	

D. Conservation of Other Stocks

Due to the very restricted fishing in Canadian and United States Panel Areas, catches of non-target species and stocks in fisheries directed at Fraser River sockeye were low (Table 17). Under terms of the agreement between Canada and the State of Washington regarding conservation of chinook and coho, United States Non-Indian purse seine and reefnet fishers were not permitted to retain coho. Canadian Area 20 remained closed to net fishing for the 1998 season and Canadian fishers in all areas were required to release coho, accounting for the low catch.

Table 17. 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 1998.*

Area and Gear	Non-Fraser Sockeye	Non-Fraser Pink	Chinook	Coho	Chum	Steelhead
Areas 4B, 5 and 6C Net	0	0	300	1,100	100	-
Areas 6, 7 and 7A Net	0	200	2,700	100	0	-
Total	0	200	3,000	1,200	100	0
Area 20 Net	0	0	0	0	0	-
Area 29 Net	0	0	4,400	0	0	-
Total	0	0	4,400	0	0	0
Total	0	200	7,400	1,200	100	0

* Estimates provided by the WDFW and DFO.

X. ALLOCATION STATUS

Because the 1998 Agreement for international sharing concerned only 1998, there is no allocation status to report for Fraser River sockeye and pink salmon.

XI. APPENDICES

APPENDIX A: PRE-SEASON FORECASTS AND SPAWNING ESCAPEMENT TARGETS FOR FRASER RIVER SOCKEYE SALMON IN 1998.

Table 1. Pre-season forecasts and spawning escapement targets for Fraser River sockeye salmon. (Provided to the Panel by Fisheries and Oceans Canada on May 6, 1998).

Run	Forecast Return	Spawning Escapement Target
Early Stuart	175,000	97,000
Early Summer	642,000	400,000
Summer	6,647,000	2,326,000
Late	3,754,000	2,947,000
Total Adult	11,218,000	5,770,000

Table 2. Preliminary Fraser River sockeye salmon escapement target plan (in thousands of fish) for 1998. (Provided to the Panel by Fisheries and Oceans Canada on May 19, 1998).

Run	Stock group	Range of returns	Escapement target		Harvest rate plan	
		0 - 66	0 - 66	*a*	0%	
Early Stuart		67 - 114	-		Max 15%	
		115 - 277	97		15 to 85%	
		278 - 743	-		65%	
		>743	260	*c*	>65%	*d*
		0 - 471	-		Max 15%	
Early Summer (*c*)		472 - 1,143	400		15 to 65%	
		1,144 - 1,486	-		66%	
		>1,486	520	*b*	>65%	*d*
Summer						
	Chilko/Quesnel	0 - 1,816	-		Max 15%	
		1,817 - 4,411	1,544		15 to 65%	
		4,412 - 11,232	-		65%	
		>11,232	3,931	*b*	>85%	*d*
	Stellako/Late Stuart		328	*f*	65%	
Late						
	Adams/Shuswap	0 - 2,765	-		Max 15%	
		2,766 - 6,714	2,350		15 to 65%	
		6,715 - 11,571	-		65%	
		>11,571	4,050	*b*	>85%	*d*
	Birkenhead		238	*f*	22%	
	Weaver		359	*g*	22%	

a Floor level at 66,000 is proposed only and subject to consultation.
b Interim goal plus 30%.
c The stock group will be passively managed to meet Early Stuart and Summer Run management objectives.
d Maximum harvest rate dependent on in-season estimates of co-migrating stocks and species.
e Based on the 1994 escapement target plan and post-season estimates sof run size.
f Passively managed within the stock group.

APPENDIX B: FRASER RIVER SOCKEYE ESCAPEMENT REVIEW

The differences between estimates of gross escapement obtained at Mission via hydroacoustic methods and from upstream estimates of catch and escapement amounted to 3,394,000 fish in 1998. All run-timing groups, Early Stuart, Early Summer, Summer and Late were affected. The Fraser River Panel conducted a post-season review in an attempt to determine causes of the differences between estimates and to make recommendations to the Parties. Below is a summary of environmental and fish behavioural observations and the impacts on the stocks. Summaries of the findings of groups studying in-season estimation of escapement, in-river fishery catches, spawning escapement and environmental influences follow. Finally, the findings of the Panel and its letter to the Commission conclude this Appendix.

Environmental and Behavioural Anomalies

Below is a description of the sequence of unusual environmental conditions that sockeye salmon faced in returning to natal streams in the watershed in 1998.

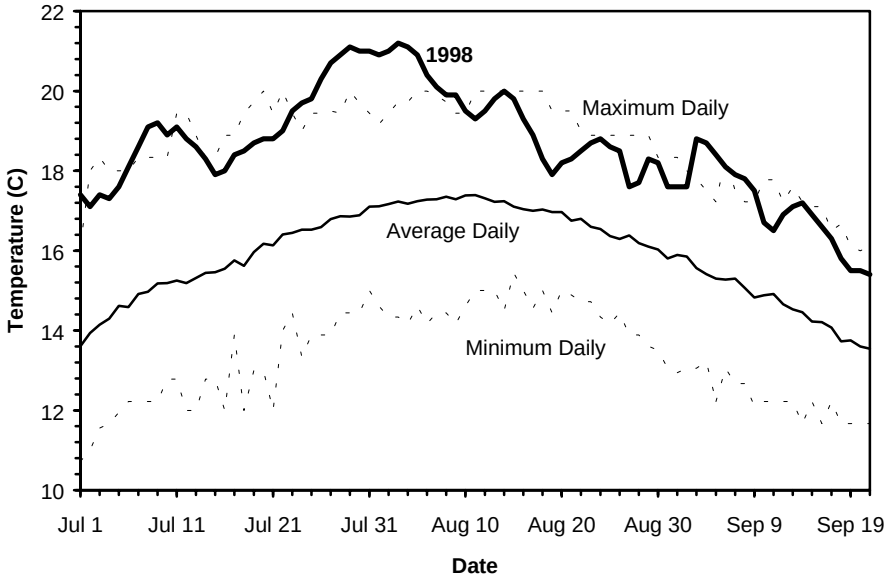
By late spring, 1998, the 1997-98 El Nino was declared to be over by oceanographers and climatologists. However, the residual effects of this event remained evident in the summer of 1998. Warm, low nutrient water advected from southern areas to the coasts of Washington, British Columbia and Alaska in 1997 remained the dominant feature in the eastern North Pacific in spring/summer, 1998. This water formed a deep, stable layer of low density, warm water over the cold, nutrient-rich waters that normally upwell along the coast during summer. Historically, Fraser River sockeye salmon migration via Johnstone Strait is positively correlated with sea surface temperatures in the region on northwest Vancouver Island and offshore areas. Apparently because of the warm sea surface temperatures this year, approximately 78% of Fraser River sockeye salmon migrated to the Fraser River via Johnstone Strait. The consequence of the high Johnstone Strait migration in 1998 was that a low proportion of the sockeye run was available for catch in United States waters.

The 1997-98 El Nino also produced one of the mildest winters in western Canada in several years. Low fall-winter precipitation combined with the mild temperatures to produce low snow packs throughout the Fraser watershed. Summer weather was hot and dry in coastal and interior British Columbia. The low snow pack, early runoff and high summer air temperatures combined to produce low flows of high temperature water in the Fraser River and tributaries throughout the summer. Average water temperature at Hells Gate during the 1998 sockeye migration (Figure 1) was the highest on record (July 8-September 8 = 19.1°C or 0.8°C above the previous record for 1942-1997) and, on August 3, a new daily record high was reached at 21.2°C. During the sockeye migration, PSC and DFO staff recognized the potential for elevated en route and pre-spawning mortality of sockeye salmon entering the Fraser River during the summer period. Measurements of pre-spawning mortality on the spawning grounds in past years have been related to migration timing and Fraser River temperatures during migration. Analyses of these data by DFO led to recommendations that the Panel increase the gross escapement targets for Summer-run sockeye to compensate for expected losses. The Panel adopted increases of 51,000 Early Stuart sockeye and increased the Summer-run gross escapement target to compensate for an expected abnormal loss of 25% of the spawning escapement.

The third circumstance influencing the management of Fraser sockeye fisheries in 1998 was the early entry of Adams River and Lower Shuswap sockeye into the Fraser River. Normally, these stocks migrate into the Strait of Georgia between about August 10 and September 5 where they hold for a period of several (3-4) weeks or more. River entry and upstream migration normally occurs from September 10 to 30. This behaviour pattern allows the Panel to develop harvest strategies for Summer-run sockeye that include targeted fishing in the Fraser River (Area 29) in the latter two weeks of August without endangering escapements to Adams River or Lower Shuswap River. However, in 1998, an estimated 615,000 Adams/Lower Shuswap sockeye passed the Mission hydroacoustic site during the period, August 16-September 7, despite the high river water

temperatures prevailing at the time. Sampling at Qualark Creek in the lower Fraser Canyon confirmed that these fish proceeded upstream rather than milling in the lower river as has been observed in some past years. The presence of significant proportions of Late-run sockeye in lower Fraser River test fishing catches precluded the Panel from scheduling fisheries to harvest the surplus Summer-run sockeye then present in the lower river.

Figure 1. Hells Gate daily temperature profile for 1998 compared to daily maximum, minimum and average temperatures for 1942-1997.



Escapement Impacts

In total, PSC staff estimated that 184,000 Early Stuart sockeye, 567,000 Early Summer, 4,512,000 Summer-run and 3,313,000 Late-run sockeye (total = 8,575,000 fish) escaped the commercial and First Nations' marine area fisheries and migrated upstream (Table 1). This total was the largest gross escapement of sockeye since the early 1900's. Based on these in-season estimates of entry into the river, gross escapement targets were exceeded for Early Summer and Summer-run sockeye stocks while the Early Stuart escapement was just slightly short of the target. Gross escapements of Late-run stocks were also only slightly below desired levels based on the goal for Adams/Lower Shuswap sockeye. However, data supplied by DFO indicates that gross escapement targets measured upstream (First Nations' and recreational fishery catches plus spawning escapements) were met only for the Summer-run stock group. Upstream estimates of gross escapement for Early Stuart, Early Summer and Late-run stock groups were below the in-season targets for 1998.

Out of the gross escapement of 184,000 Early Stuart sockeye (Mission estimate plus First Nations' fishery catches below Mission), only 46,000 (25%) were accounted for in upstream catch and spawning escapement (Table 1). In addition to fish on the Early Stuart spawning grounds, DFO staff reported observing sockeye in tributaries to the upper Fraser River and in the Nechako and Stuart Rivers where sockeye normally do not spawn. Carcasses were also observed floating in Takla Lake. The loss of Early Stuart sockeye was clearly associated with observations of fish diverting to non-natal streams or dying en route. DFO also recorded a 44% pre-spawning mortality of females that reached their natal streams in the Stuart Lake watershed, further attesting to the severe stresses these fish experienced while migrating upstream.

Table 1. Comparison of Mission to upstream (catch plus spawning escapement) estimates of sockeye salmon gross escapement in 1998.

Run	Stock Group	Mission *	Upstream **	Difference Fish	Difference %
Early Stuart		184,000	46,000	138,000	75%
Early Summer					
	Bowron/Fennell	57,000	32,000	25,000	44%
	Nadina/Gates	43,000	19,000	24,000	56%
	Pitt ***	78,000	78,000	0	0%
	Seymour/Scotch	389,000	158,000	231,000	59%
	Total	567,000	287,000	280,000	49%
Summer					
	Chilko	1,125,000	1,040,000	85,000	8%
	Quesnel	2,230,000	1,427,000	803,000	36%
	Late Stuart/Stellako	1,157,000	459,000	698,000	60%
	Total	4,512,000	2,926,000	1,586,000	35%
Late					
	Birkenhead	315,000	311,000	4,000	1%
	Adams/Lower Shuswap	2,204,000	1,421,000	783,000	36%
	Weaver/Portage	794,000	191,000	603,000	76%
	Total	3,313,000	1,923,000	1,390,000	42%
	Total	8,576,000	5,182,000	3,394,000	40%

* Post-season racial identification estimates applied to Mission hydroacoustic estimates (PSC) plus First Nations' catches below Mission and Upper Pitt River spawning escapements (DFO).

** Sum of in-river catches (First Nations' and recreational) and spawning escapements (DFO).

*** DFO spawning ground escapement estimate plus First Nations' catch below Mission.

The difference between Mission and upstream estimates of Early Summer sockeye escapement was also very large, but pre-spawning mortality of fish on the spawning grounds was quite variable. Out of the spawning escapement of 228,000 adults in this stock group, 77,000 were in the Upper Pitt River, a cool water tributary of the Fraser River entering approximately 33 km upstream of the river mouth. These fish would have only briefly experienced the high Fraser River water temperatures that most other Early Summer stocks were subjected to for several days or weeks in their migrations to natal streams in the middle and upper Fraser River watershed. The gross escapement of Early Summer sockeye, excluding Upper Pitt River sockeye, was estimated at 490,000 fish. Estimates of the First Nations' fishery catch and spawning escapements amounted to 210,000 fish. The difference between the two estimates of gross escapement was 280,000 fish or 57% of the gross escapement. Spawning ground pre-spawning mortality varied from 4-39% and averaged 8% for Early Summer sockeye.

Large differences in the estimates of Summer-run sockeye were also recorded. The post-season gross escapement estimate at Mission was 4,512,000 adult sockeye compared to 2,926,000 fish in First Nations' fishery catches, sport fishery and spawning grounds arrivals. The difference between estimates was 35% of the gross escapement at Mission.

Summer-run sockeye that were bound for streams in different parts of the watershed experienced variable levels of differences between estimates. Chilko River/Lake sockeye arrivals were 8% below expected numbers based on Mission while Quesnel (-36%), Stellako and Late Stuart (-60%) sockeye escapements were substantially lower than expected (Table 1). This large difference between stocks in apparent success of migration is not easily explained, however, geography and tributary conditions may be involved. The Chilko/Chilcotin River enters the Fraser downstream of other major tributaries, except the Thompson River. The shorter distance may have

led to lower stress for Chilko sockeye compared to other Summer-run stocks.. As well, water temperatures recorded in the lower Chilcotin River were lower (14.8°C) than in the tributary streams used for migration by other Summer-run sockeye in 1998. Fish entering the Chilko/Chilcotin River may have suffered lower mortality due to having shorter migration in the high temperature waters of the Fraser River and then, may have found a refuge in the cool waters of the Chilko/Chilcotin.

The Quesnel, Stellako and Late Stuart sockeye migrated greater distances in the warm waters of the main Fraser River and then had to migrate through tributaries that were all much warmer than the Chilko/Chilcotin system. This may have increased the stress-related mortality rates for these stocks.

The increasing proportions of loss with distance travelled to spawning grounds and with temperature exposure strongly indicates that there was a link between these observations. Differences between estimates were greatest for those Summer-run stocks that travelled the greatest distances in the warmest water.

Pre-spawning mortality was slightly elevated at Chilko River/Lake and Horsefly River (Quesnel) but was only 1-2% at Stellako River and in Late Stuart sockeye. Overall, 8% of Summer-run sockeye that arrived at natal streams died unspawned.

Gross escapements of Late-run sockeye totalled 3,312,000 fish through the lower Fraser River. However, upstream estimates of catch and spawning ground arrivals were 1,922,000 fish.

The loss of Late-run sockeye in 1998 was estimated at 1,390,000 fish. Of this total, approximately 783,000 were of the Adams/Lower Shuswap stock group and 603,000 were estimated to be from the Weaver/Portage and miscellaneous Late-run stock group. The Birkenhead River sockeye gross escapement was estimated at 315,000 at Mission and 311,000 were estimated in upstream catch and spawning escapements.

Both the Birkenhead River sockeye and Weaver Creek sockeye migrate into the Harrison River, some 102 km upstream. While the Birkenhead migrated in mid August to early September, the major portion of the Weaver/Portage stock group migrated upstream in mid-September. The differential success of migration is unexplained. An ESSR (Excess Salmon to Spawning Requirements) fishery was conducted by the Chehalis First Nation in the Harrison River. A weir constructed at the outlet of Morris Slough (Weaver Creek) was designed to also allow capture of fish at that point.

While the differences between estimates of gross escapement summed to 42%, there was a large variation between stocks. Birkenhead sockeye arrived in expected numbers: Adams/Lower Shuswap sockeye showed a difference of 36%; and, the Weaver/Portage group were 76% lower in upstream estimates compared to Mission gross escapement.

The large difference between Birkenhead and Weaver sockeye was not easily understood. Both stocks migrate into the Harrison River system, which allows them to avoid the difficult migration through the Fraser Canyon. Whereas Birkenhead fish migrate through Harrison Lake to Lillooet Lake and hence to the Birkenhead River, Weaver sockeye delay in the Fraser and lower Harrison Rivers before moving into Weaver Creek. Exposure to conditions in this latter area may be important to understanding the observed differences between estimates.

In the post-season review of the 1998 Fraser River sockeye salmon escapement, reports were received from groups working on (1) Mission hydroacoustic and the PSC programs (in-season escapement estimates), (2) in-river catch estimation, (3) spawning escapement estimation, and (4) environmental influences. The summaries of the findings of each group are presented below.

Executive Summaries from Working group Reports

Mission hydroacoustics and other PSC programs

1. Achievement of sockeye spawning escapement targets became the focus of the 1998 management season after Fraser River water temperatures rose to dangerously high levels in late July. Fisheries and Oceans Canada (DFO) reported in early August that Early Stuart sockeye had not reached their natal streams in expected numbers and, also, that high pre-spawning mortality had occurred. Canada also predicted that Summer-run sockeye, particularly the Horsefly River stock, would suffer elevated pre-spawning mortality. To address these concerns for Summer-run sockeye, on August 14, the Panel approved a Canadian request for an increase in the gross escapement target to compensate for an expected 25% pre-spawning mortality.

2. Though Summer-run sockeye run-size estimates increased when a second mode of the migration arrived, harvest of the available TAC was limited to United States waters and river portions of Area 29 because of the presence of significant proportions of Late-run stocks in migratory areas and in the Strait of Georgia. Unfortunately, Late-run sockeye began migrating upstream in significant numbers after August 20, which prevented further harvest of Summer-run sockeye that were surplus to the revised gross escapement target. The gross escapement target for Summer-run sockeye was exceeded.

3. The unusually early arrival of Adams/Lower Shuswap sockeye in the river led staff to warn that en route or pre-spawning mortality might also occur on the Adams/L. Shuswap stocks, which normally show only very low, if any, en route or pre-spawning mortality. Concerns about potential en route mortality were realized when DFO staff reported to the Fraser River Panel at its meeting in Kamloops on October 15, 1998, that significantly fewer sockeye of all stock groups had reached their spawning grounds than anticipated based on Mission hydroacoustic estimates. At the January 13-14, 1999, Panel meeting, PSC staff reported that the difference between estimates obtained at Mission and from catches and spawning escapements upstream was 3,391,000 fish, or 40% of the estimated gross escapement. The Panel requested that PSC staff and Fraser River Panel Technical Committee members organize a post-season review of the 1998 sockeye salmon escapement.

4. In this report PSC staff provide the following: 1) reviews of the racial identification and test fishing data relative to the escapement of sockeye, 2) PSC assessment of the difference between Mission and upstream estimates of gross escapement, 3) assessment of the Mission hydroacoustic program performance in 1998, 4) ancillary data on the issue of differences between estimates, and 5) a discussion of the probable causes of the difference between estimates in 1998. Other reports will be provided by DFO staff on programs conducted relative to DFO's areas of responsibility.

5. We reviewed the racial identification data to document changes from in-season to post-season analyses and to determine the accuracy of post-season estimates of escapement by stock group. Post-season estimates of gross escapement at Mission were within 10% of their in-season values for all stock groups and most stocks within stock groups. The largest change occurred in the L. Stuart/Stellako group that increased 74% relative to its in-season value (1,123,000 vs. 644,000). However, even with these changes, upstream estimates of gross escapement were less than Mission estimates for all stock groups. The accuracy of the post-season estimates was examined through simulations. In one simulation we found that the Adams/L. Shuswap was underestimated when present in low proportions. However, the small amount of bias observed in the other simulations confirmed the over-all accuracy of the age 4 post-season models. A consistent pattern of bias was found in age 5 simulations; the L. Stuart/Stellako component was overestimated and the Chilko/Quesnel proportion was underestimated. However, correction for the bias would only shift approximately 100,000 fish from the L. Stuart/Stellako group to the Chilko/Quesnel group.

An examination of potential bias in estimates of Late-run stock proportions concluded that racial identification error was not likely the cause of the observed difference between Mission and upstream estimates for the Adams/L. Shuswap and Weaver/Portage stock groups.

6. Our emphasis in the analysis commercial and test fishing catch data was to compare projections of terminal abundance of sockeye based on marine area data with lower Fraser River commercial catches and estimates of gross escapement. Estimates of terminal abundance from commercial and marine area test fishing data obtained in 1998 generally agreed with Mission estimates for Summer-run sockeye. However, much of the data obtained were not independent of the Mission estimates of gross escapement. Late-run sockeye abundance estimates obtained in Areas 12, 13 and 20 test fisheries and from the Strait of Georgia, all projected lower total abundance and terminal escapement than estimated at Mission. However, the heavy dependence on test fishing data throughout these analyses casts doubt on the accuracy of estimates compared with years in which commercial catches provide the basic data for analyses.

7. Fraser River test fishery catches of Summer-run sockeye were consistent with patterns of reconstructed catches and escapement. Both Cottonwood and Whonnock variable-mesh gillnet test fishing operations in 1998 gave evidence of low efficiency, but were both within the ranges of previous observation. The test catches of Late-run sockeye in 1998 were low relative to Mission hydroacoustic estimates of escapement. However, the efficiency of the test nets may have been low due to fish behaviour (i.e., offshore and deep migration) and due to the unusual upstream migration wherein over 50% of the migration of these stocks occurred over four days in mid September.

8. We examined the Mission hydroacoustic estimates to ensure that they were unbiased estimates of the actual gross escapements. First, the 1998 estimates were compared to the historical relationships between Mission hydroacoustic estimates and upstream estimates of catch and spawning escapement. Estimates of gross escapement from upstream catch and spawning abundance were regressed on the corresponding Mission estimates to produce a predictive relationship for each of three stock groups: (1) Early Stuart, (2) Early Summer plus Summer run and (3) Late run sockeye. The estimates for Early Summer and Summer-run sockeye stocks were combined to minimize the effects of stock composition error that could confound the interpretation of the results. The observed upstream estimate for Early Stuart was less than expected but within the 95% prediction intervals from the regression. However, the observed upstream estimates for the latter two groups were less than the lower 95% prediction intervals from the historical regressions. Summing the three stock group estimates, the predicted upstream total would have been 8,421,000 given the Mission estimate of 8,575,000 fish. However, the estimated in-river catch and spawning escapement totalled only 5,181,000 sockeye. The difference between estimates, 3,394,000 fish, is the largest on record. The probability that all three stock groups would show such large negative discrepancies simultaneously due to random chance is very small (i.e., $p<0.01$). Further, it is clear that the differences between Mission hydroacoustic estimates and upstream estimates of catch and escapement were not the result of racial identification error since differences for all stock groups were in the same direction. The most plausible explanation for these large negative differences is that en route mortality is large in years, like 1998, when environmental conditions are severe.

9. The relationship between daily hydroacoustic estimates of abundance obtained by the PSC at Mission and by DFO at Qualark Creek, two days later, were examined to determine the validity of the Mission estimates in 1998. The comparison of the two independent hydroacoustic estimates of sockeye abundance should have pointed to biases, if they existed. The daily abundance estimates at the two sites were very similar until mid August. For the period June 26-August 11 (at Mission), the total passage at Qualark Creek was estimated to be 2,222,000 sockeye, which was only about 7% lower than expected based on Mission. After August 13, Qualark estimates were biased low because of the unusual fish distribution associated with the low water level in the river. The reasonably good agreement between the two independent hydroacoustic estimates during the upstream migrations of Early Stuart,

Early Summer and the first half of the Summer-run stock groups in 1998 strongly supports the validity of the Mission estimates.

10. The 1998 Mission single-beam hydroacoustic program estimates were examined in more detail using two tests of the 1998 program. The first diagnostic test confirmed that the estimates produced in 1998 spreadsheet were not biased by an error in the spreadsheet. An evaluation of estimates from recent past years of close agreement between Mission and upstream estimates of gross escapement also confirmed that the algorithm used for the 1998 calculations appeared to be correct. In the second test, daily estimates of sockeye escapement obtained via the standard visual method of target identification were compared with estimates obtained by analysis of computer digitized images. The digitized method gave estimates that were, on average, 5 % larger than the estimates obtained by means of manual target identification and measurement. The consistency between estimates produced by the two analysis methods suggests that the 1998 estimates from the manual method were valid.

11. The Pacific Salmon Commission and Fisheries and Oceans Canada have conducted a co-operative split-beam hydroacoustic program at Mission from 1995-1998. The objectives of the split-beam program are to examine the assumptions inherent in the standard single-beam hydroacoustic program. The results of 1998 studies do not suggest that estimates of sockeye salmon abundance in 1998 from the Mission single-beam program would be biased high by 40%, the amount needed to explain the discrepancy.

12. Mission and Qualark sockeye escapement estimates by stock group were compared with upstream estimates from DFO spawning escapement and First Nations' catches upstream of Qualark. The combined Early Stuart and Early Summer totals based on Mission and at Qualark were nearly identical: 641,000 via Mission and 632,000 at Qualark; however, both estimates were substantially larger than the upstream estimate. The Qualark estimate for Summer-run stocks was substantially lower than obtained at Mission, but still larger than the upstream total despite the under-estimation bias in the Qualark estimates after August 13 (approximately the 50% point in the Summer-run migration). The underestimation bias at Qualark prevented comparisons for Late-runs.

13. Mission daily escapement profiles were compared to profiles derived from spawning ground enumeration fences and/or bridge counts where available for specific stock groups. The Early Stuart and Quesnel comparisons suggested that the large difference between Mission and upstream estimates were distributed throughout their upstream migration periods. Small differences between estimates for the Chilko group were apparently confined to the early period of migration. The large differences for the Quesnel stock compared to Chilko suggest that either Chilko was inherently less susceptible to the environmental stress, or that the en route losses experienced by the Quesnel stock occurred primarily upstream of the Fraser/Chilko confluence. The Adams/L. Shuswap stock group comparisons suggested that losses may have been concentrated in the early portions of the migration.

14. The differences between Mission and upstream estimates of gross escapement were examined by stock group. With a few exceptions, the data provided evidence that the rates of en-route mortality were related to the distances individual stocks migrated in the extremely warm water temperatures present in the Fraser River in 1998. Stocks that migrate the farthest tended to have the largest differences between estimates. The Chilko and Quesnel stocks experienced very different en route loss proportions, even though their total migration distance is similar. A possible explanation is that Quesnel sockeye spent greater amounts of time in the Fraser River and then entered the warm Quesnel River while Chilko sockeye experienced much lower water temperatures in the Chilcotin/Chilko system (i.e., approx. 3 °C lower).

15. The data supporting higher en route mortality for upper Fraser Summer-run sockeye stocks did not extend to Late-run sockeye. The Birkenhead stock arrived at the spawning grounds in expected numbers. However, the “apparent” en route loss on the Weaver Creek stock was very high (76%), even though it migrates a very short distance upstream of Mission . The apparent loss for the Adams/Lower Shuswap, which migrated the farthest of the late runs was

intermediate (36%). No apparent explanation exists for the very high level of en route loss apparently experienced by the Weaver stock group.

16. To investigate the apparent en-route loss of Weaver in more detail, we compared the relative proportions of Adams/Late Shuswap and Weaver/Portage derived from racial analysis of test fishery and commercial samples with those derived from upstream estimates. The ratio of Weaver/Portage to the total Adams/Late Shuswap and Weaver/Portage based on the river test fishery samples used to apportion Mission gross escapement was about 25%. The same ratio based on upstream estimates was 12%. Ratios derived from samples taken from migratory areas (purse test fishery catches and commercial troll fisheries) including the Gulf troll test fishery were very similar to Mission based ratio. None of the sample ratios were consistent with the upstream ratios. The Mission and sample ratios either imply that there was much less Adams/Late Shuswap than observed upstream or that there had been a differentially higher mortality of Weaver/Portage sockeye. Data support the latter conclusion.

17. Since 1990, salmon carcasses observed on the surface of the river near Mission have been counted and reported by the crew of the PSC hydroacoustic vessel. The Mission carcass counts are only the "tip of the iceberg", in that a very low but unknown proportion, of the downstream drift of dead fish would be observed. The 1998 carcass counts were the largest on record both in terms of total number and as a percent of gross escapement. The daily carcass counts fluctuated in a manner similar to the pattern of daily escapement at Mission with approximately a 6-day lag between upstream passage and downstream drift. One possible explanation of this put forward for consideration is that carcasses were from drop-outs and discarded fish from the First Nations' fishery in the area above Mission. However, the fact that carcass drift occurred during periods of First Nations' fishery closures strongly suggest that the drifting carcasses were primarily due to en route mortality. The largest previous sockeye carcass drift was observed in 1997, when approximately 728,000 Early Stuart and Early Summer sockeye were estimated to have perished in the Fraser Canyon due to high river discharge. The carcass count in 1998 was 1.65X the 1997 count, the only year for which an estimate of en route mortality is available. Simple expansion of the 1997 estimates for the 1998 observations would indicate approximately 1,200,000 fish died en route in 1998.

18. Close examination of information analyzed by PSC staff relative to the Mission hydroacoustic estimates of sockeye gross escapement suggests that Mission estimates were valid and that significant upstream mortality of all stock groups occurred in 1998. The cause of the high en route mortality was likely associated with the record high river water temperatures observed in 1998. Large en route losses of Early Stuart, Early Summer and Summer-run stock groups also occurred in 1994, the brood year for the 1998 run. High river temperatures were implicated in that en route mortality, as well. Both these recent cases and similar situations in 1941 and 1958 were associated with large El Nino events.

In- River Catch Estimation

1. An aerial-access survey was implemented to estimate catch for the area between Mission and Sawmill Creek. Thirteen access sites were surveyed by catch monitors. One to two monitors were stationed at each access site every day the fishery was open for the entire duration of the open periods. Fishermen returning to the access sites were interviewed to obtain information on catch and the length of time their net was fishing. Estimates of catch per unit of effort (CPUE) were generated from this data. Total effort was estimated from aerial over-flights and 24-hour effort surveys.

2. The area from Mission to Sawmill Creek was open for 5 consecutive weeks between July 30 and August 30. The in-season estimate of catch was 248,971 sockeye.

3. The survey methodology and catch estimates between Mission and Sawmill Creek were reviewed by Alexander (1999) and deemed to be a valid method of estimating fishing effort

and catch rates. The design was appropriate because it was able to cope with the dispersed access and large area.

4. Alexander (1999) detected a calculation error in the catch estimate for the week ending August 2nd. The corrected estimate resulted in an increase of 16,431 for that week ending estimate. The post-season total estimate was 265,402 sockeye.

5. A mixed aerial-access and aerial-roving survey was implemented to estimate catch between Sawmill Creek and Kelly Creek in the Fraser River mainstem and in the Thompson River below the Bonaparte River confluence. Catch monitors obtained CPUE information from interviews with fishermen at seven access sites and during roving surveys by boat, vehicle, and foot patrols.

6. Sockeye openings between Sawmill Creek and Kelly Creek varied by gear and area. Dip nets were generally open for 7 days/wk, and set gill nets were generally open for shorter periods. The in-season estimate of catch was 157,013 sockeye.

7. Alexander (1999) reviewed the survey methodology and catch estimates between Sawmill Creek and Kelly Creek and concluded that the mixed survey design was a valid method of estimating fishing effort and catch rates. The design was appropriate because it was able to cope with the dispersed access and large area.

8. Alexander (1999) recommended a change to the in-season calculation procedure of CPUE. By selecting a "means of ratio" CPUE estimator, the post-season estimate of catch increased to 264,098 sockeye.

9. The fishery in the tributaries and mainstem above Kelly Creek, and in the Thompson River above the Bonaparte River was estimated by a census program. Fishermen were interviewed both on and off site by catch monitors and band and tribal groups. The census-based catch estimate was 66,812 sockeye.

10. Fisheries in the Lillooet River system, and in the Fraser mainstem between Kelly Creek and Deadman Creek and between Marguerite Ferry and Naver Creek were not covered by the catch monitoring programs. Catch projections were made for these areas based on recent historical levels of catch and harvest rates. The catch projection for these areas combined was 12, 500 sockeye.

11. The sockeye catch by the Sto:lo dry-rack fishery between Hope and Sawmill Creek was not covered by a structured catch monitoring program. The in-season estimate of 3,023 was deemed to be an under-estimate, and was increased to 8,600 sockeye based on a recent upper range of catch as documented from historical catch information.

12. An unauthorized gill net fishery, between Mission and Hope from June 25 to July 11 was not covered by the catch monitoring programs. Based on effort obtained by aerial overflights, and vehicle and boat patrols, and analyses of historical CPUE and harvest rate information, a catch projection of 5,000 sockeye was made for the fishery.

13. The catch estimates and projections totalled 622,412 sockeye for the aboriginal fishery above Kelly Creek.

14. The recreational fishery between Mission and Alexandria Bridge was open for sockeye retention from August 1-10, and August 19-26. Selected areas were closed in the period of July 9-26. The Harrison River was open from September 1 to November 30. The daily sockeye catch limit was 2/day.

15. The recreational catch was estimated by an aerial-access survey design. Catch monitors surveyed bars in the Fraser mainstem from Sumas River to Hope, and sites in the lower Harrison River.

16. The estimated recreational sockeye harvest and release between Mission and Alexandra Bridge was 9,655 fish and 6,219 fish respectively. The estimated recreational sockeye harvest and release in the Harrison River was 1,800 fish and 2,340 fish respectively.

17. CPUE information for the recreational fishery on the number of sockeye released during the sockeye non-retention period from August 11-18 was not obtained and was not projected. No estimate of catch and release mortality for sockeye released was made.

18. DFO enforcement staff reviewed enforcement activity and statistics for 1998. In the area between Mission and Sawmill Creek, 242 vehicle patrols, 61 vessel patrols, and 24 aircraft patrols were conducted. Ninety gill nets were seized, the majority during the closed period of the fishery. 970 sockeye were enumerated from the seized nets. In the area above Sawmill Creek, the number of patrols were: 258 vehicle, 18 vessel, and 20 aircraft. A total of 956 sockeye were seized.

19. Based on the level of enforcement coverage and the illegal activity observed, enforcement staff were of the opinion that large illegal removals were unlikely.

Escapement Estimation

1. The Working Group reported the following distribution of total estimated escapement (number of stocks) by estimation technique: visual surveys – 4% of the total estimated escapement (144 stocks); spawning channels - 2% (6); enumeration fences – 7% (11); and mark-recapture – 87% (13). They noted that, given the large proportion of the total estimated escapement surveyed using the mark-recapture technique, an understanding of its potential biases is critical to the evaluation of the total system-wide escapement estimate. They also noted that, because mark-recapture is also the only technique that physically affects the fish, an evaluation of the role of stress is also critical to an evaluation of the estimated escapement. The report was then evaluated the escapements by technique.

2. Visual Surveys: The streams were surveyed periodically, live and dead fish were counted, and escapement was estimated based on the sum of the peak live and the cumulative dead to the date of peak live, and an expansion factor. The working group concluded that the study design was well implemented in most cases. They noted that the in-season, within-system calibration of the Stuart Early Run likely produced accurate estimates, but that the use of an historic calibration factor for the balance of the stocks likely introduced random errors of ±30% into individual estimates that may have balanced over the range of stocks. They noted the following deficiencies likely resulted in negative biases: the use of visual surveys on one stock (Portage Creek) whose escapement exceeded the maximum 25,000 stock size intended for this technique; the single survey of the Driftwood River that might have missed the live peak; glacial silt in the upper Adams River; and spawning in deep water in the Harrison and South Thompson rivers. Overall, the Working Group concluded that there was likely a negative bias of unquantifiable size for the stocks estimated using visual surveys, but noted that its impact was small given that only 4% of the escapement was estimated using this technique.

3. Enumeration Fences: The Working Group concluded that the enumeration fence studies (spawning channels included) were well executed in 1998: they were in place and fish-tight for the entire immigration of the stocks; they did not cause sockeye to hold or die downstream from the fence; and peak daily abundances were anticipated and unlikely to have introduced error in the counts. The Working Group concluded that these stocks may have been estimated with a small negative bias, but that it was unlikely to have been as high as 5%.

4. Mark-Recapture Studies: The Working Group provided a detailed description of operational and analytic procedures by stock, and outlined significant operational improvements implemented since 1994. They described a three-step process they developed to evaluate potential bias in the estimates: a) study design execution; b) evaluation of biases in complementary two-sample data stratifications; and c) comparison of maximum likelihood

(MLE) and pooled Petersen (PPE) estimates. In an evaluation of (a), the Working Group concluded that the studies were well designed and executed in 1998 and included substantial improvements over recent years. Despite deficiencies in the Eagle and Pitt studies, they concluded that there were no overall problems in the implementation of the studies that were likely to introduce serious bias in the overall estimates. In an evaluation of (b), the Working Group noted that there was a potential for both positive and negative biases in the sex-specific population estimates. This is inconsistent with the traditional understanding of the mark-recapture bias structure, a structure that the Working Group concluded is related to a decreasing probability of tagging with distance upstream and a complementary increasing probability of recovery. The Working Group concluded that study design changes since 1994 attempted to make tag incidence spatially representative and have changed the bias structure of the estimates. In an evaluation of (c), the Working Group concluded that the comparison of MLE and PPE estimates may provide an indication of the maximum possible error in the PPE but that the magnitude of error was certainly overstated. The Working Group concluded that the magnitude of the bias in the mark-recapture studies was not quantifiable but, because the biases across studies was bi-directional, its overall magnitude was likely to have been small.

Environmental Influences

1. The purpose of this report is to examine the possible effects of Fraser River environmental conditions on mortality of sockeye salmon from each of the stock groups during the 1998 spawning migration (Fig. 1). A portion of the discrepancy between sockeye numbers estimated at the Mission hydroacoustic facility (Fig. 2) and numbers counted on the spawning grounds may be attributed to severe migration conditions and associated en-route losses. This report will address many hypotheses and predictions, and provide background physiological, ecological and behavioural information pertinent to sockeye salmon during their spawning migration. A summary of our predictions and findings follows:

2. In the migration Condition Section we examine water levels and temperatures in 1998 throughout the Fraser system and found them to be severe compared to past years when levels exceeded those thought to be conducive for reliable spawning migrations. In-season ten day forecasts of water levels and temperatures have been made following a recommendation from the Fraser Report (1994). Their reliability and usefulness for predicting migration conditions in the Fraser watershed was examined and found to be dependent on watershed location. We examined the influence of several factors on migration conditions, including rainfall levels in the upper basin, forest harvesting in first and second order tributaries, summer artificial cooling flows from the Skins spillway and the McKinley Lake siphon, and large lakes throughout the basin.

3. After spawning ground information was compiled in the fall of 1998 a negative discrepancy of 3,393,800 sockeye salmon, with discrepancies contributed from every run of the season, was calculated from the comparison of Mission and upstream estimates (En-route Mortality Section). This is the largest loss on record for a single season. An analysis of the relationship between upstream and Mission estimates for each stock group since 1977 indicates that our estimation techniques provide an expected pattern (positive correlation with a slope of 1), but absolute reliability declines with increasing run size. An analysis of the residuals indicates that flow rates and water temperatures on the migration route can explain much of the discrepancy pattern.

4. In 1998, seven of eight Fraser sockeye stocks had average or below average pre-spawning mortality rates (PSM) in a comparison with data records back to 1974 (Pre-spawning Mortality Section). With the exception of the early Stuart run, PSM estimates do not support the hypothesis that upstream migration in the Fraser River was stressful to the point of precipitating catastrophic mortality among spawners. Correlations between PSM across years for different stocks within the same run timing group (e.g. Summer run) suggests that PSM in stocks that enter the Fraser River at about the same time may be influenced by a factor(s) common to these stocks. For 6 of 8 sockeye stocks, mean Hell's Gate water temperature

explains only a small amount of the variation in PSM rates. Thus the data does not generally support the hypothesis that Hell's Gate water temperature can be used to predict PSM. A case can be made for using temperature to predict PSM in early Stuart sockeye (but this relationship relies heavily on the outlying 1998 data point) and the Adams stock (but overall low PSM to date make this unnecessary). More data points for years with extreme water temperatures will be needed to confirm the utility of this relationship. Across all 8 stocks, earlier peak run timing was associated with increased PSM. However, peak run timing only explains a small amount of variation in PSM, except for Chilko and late summer runs. Consequently, the data for Early Stuart or summer run sockeye does not support the hypothesis that peak run timing is a useful indicator of PSM losses (besides, it is difficult to make pre-season predictions). A re-analysis of Gilhousen's multiple regression analysis with recent data, indicates that a combination of peak run timing at Hell's Gate and mean Hell's Gate temperatures account for only a small portion of the variation in PSM observed. As a result, these indicators have limited utility for predicting potential pre-spawning mortality losses in Fraser sockeye. We recommend a reconstruction of the run-timing data prior to 1974 using commercial and test fishery records to make use of 26 years of pre-spawning mortality and Hell's Gate temperature data from 1948-1973. Additional indicators, particularly from the ocean environment, should be examined for there potential utility in explaining PSM.

5. During their up-river migration, sockeye salmon are oriented to the shore (Migration Behaviour Section) but show distinct changes in behaviour during rising Fraser River water levels and when exposed to in-river gillnet fisheries. The turbidity during rising water promotes surface orientation, while nets cause the fish to move from shore and towards the bottom; frequently into higher current areas. Rising water temperature, even to the extreme levels seen in 1998, has no apparent effect on the migration orientation or location.

6. Sockeye salmon carcass counts at the Mission facility, when presented as a percent of the run size, were the largest on record (Sockeye Carcass Counts Section). The largest mortality was associated with mid-summer gillnet fisheries and the highest river temperatures and in coincidence with the early Stuart and summer stock groups. In contrast, substantial observation efforts throughout the Fraser Basin by fisheries officers, local residents and scientific staff did not indicate a large en-route mortality. Based on the timing of observation records, mortality and abnormal behaviour that was observed were likely distressed early Stuart fish that were eventually lost en-route. Observation reports consistently emphasized that 1997 was a far worse year than 1998 in regards to abnormal behaviour and counts of moribund fish. There were many reports of distressed chinook salmon and mortality from throughout the watershed but there was reason for particular concern in the Thompson watershed.

7. We suspected there may have been arrival timing delays on the spawning grounds in response to the extreme conditions along the migration route, but found little evidence in that there was little annual variation (Life Span Analysis Section). However, once on the spawning grounds several indicators, including length of time to death, recovery from tagging operations and estimates of spawning success, indicated that both the early Stuart and (to a lesser extent) the Horsefly runs were in poorer condition than the other runs. Net mark incidence was not unusually high in 1998.

8. Laboratory examination of gill, liver, kidney and head kidney samples from Horsefly salmon, in the late stages of migration, indicated no unusual levels of damage. A detailed histological comparison of fish with and without obvious external damage indicated the limited value of superficial observations of fish condition on the spawning ground. A review of the subject, emphasizes the role of temperature, density and length of exposure to diseases as being critical to the understanding the relationship between disease and migration related mortality (Disease Observations Section).

9. Four stress parameters and three reproductive parameters measured from Horsefly sockeye during the last stages of migration and during spawning, indicated that fish were suffering from chronic stress from their up-river migrations (IRND's) and acute stress associated with the extreme water temperatures and low water levels in the Horsefly watershed (cortisol)

(Stress Section). High lactate levels in some migrants suggested higher than expected energy expenditure considering the water levels, and some sources of energy (e.g. glucose) were being used prematurely. Reproductive parameters followed a predictable pattern, declining estradiol and increasing 17,20P with the onset of maturity and spawning. Of great potential significance was an indication that both fertilization success and hatching rates were impaired as a result of high temperatures during migration and spawning in an early portion of the Horsefly spawners. A finding presented from a laboratory study using early Stuart sockeye suggests that high temperatures can reduce plasma sex hormone concentrations.

10. From a physiological perspective, the results of the experiments reported in this document suggest that the high water temperatures adversely affected the Fraser River sockeye migrants in 1998 (Stress Section). Both diseases associated with high temperature and stress associated with disease, can adversely affect swimming performance. High temperatures can also increase metabolism reducing energy use efficiency, and reducing a fish's ability to recover from fatigue and stress, a situation made particularly acute when accompanied with even mild hypoxia. The hazards of hypoxia during migration also include potential impairment of sexual maturation, but the physiological and behavioural processes are poorly understood.

11. There are a number of compelling reasons to believe that severe migration conditions caused the very large en-route losses that were seen during the 1998 sockeye season. High water temperature records were being established throughout the Fraser Basin and water levels were near record lows. Past experience has indicated a plethora of hazards face migrating sockeye exposed to these conditions. Migration blockages, susceptibility to diseases, impaired maturation processes, increases to stress parameters, reduced efficiency of energy use and reduced swimming performance are all factors that become more hazardous as temperatures exceed 17°C. The early Stuart group, having further to swim than all other stocks and being in the river during the period when temperature deviations from normal were greatest (Fig. 6), quite likely succumbed in large numbers en-route. There is much support for this conclusion: a) en-route losses were accompanied with large pre-spawn losses on the spawning grounds, an indication that similar mechanisms influenced both types of mortality (Table 4), b) according to our residual analysis, if temperatures were benign, the small size of the Stuart run and the low flow conditions would likely have led to a much smaller discrepancy, probably in a positive rather than in a negative direction (Fig. 17a), c) record numbers of carcasses were observed at Mission in late July-early August, the same period that carcass observations recorded from the rest of the watershed were highest (although in-river fisheries confounded the cause)(Tables 9 and 10), d) fish condition and life span of Stuart fish, upon arrival at the spawning grounds, were particularly poor (Figs. 26, 27), e) stress and reproductive parameters were not measured for Stuart fish, but other 1998 runs (e.g. Horsefly) were distressed (Figs. 29, 30, 31). We have reviewed the many types of physiological impairment that may result from the extreme temperatures that were recorded in the Fraser Basin during the summer of 1998.

12. An explanation of the en-route losses suffered by later run groups present a more complicated problem. Temperatures remained at record setting levels through late July, August and September, yet deviation from long-term mean temperatures declined substantially (Fig. 6). In-river fishery discards complicated carcass counts at Mission (Fig. 25) and there were fewer reports of abnormal behavior and mortality from up-river locations as the summer proceeded. Pre-spawn mortality was below in-season expectation (and below average – Table 4) for all but the Stuart stock, forcing us to consider the possibility that no clear connection exists between en-route and PSM (Table 8). It is apparent that a complicated group of interacting factors influence both types of mortality, and existing modeling approaches are not adequate to provide accurate or even useful predictions. While stress and reproductive parameters (and intergenerational effects) indicated large numbers of distressed migrants during the early portion of the Horsefly run, histological samples were normal and other estimates of fish condition on almost all of the spawning grounds, indicated condition was generally good (Figs. 26, 27). Finally, there is evidence to suggest that our run-size estimation capabilities decline as the runs increase in size (Figs. 16a, b, c). Heterogeneity of variance is not unusual in biological data sets; with the summer and late runs of 1998, it likely explains a portion of the estimated discrepancy (Fig. 15). Historically, extreme flow and temperature have also

influenced the pattern of discrepancy (Figs. 17a, b, c) and were also responsible for some en-route loss in all stock groups in 1998. Ultimately, our ability to inventory our resource is not only fundamental to it's management, but is also necessary if we are to better understand the causal factor(s) responsible for pre-spawn and en-route mortality.

Workshop Report to the Pacific Salmon Commission:

After receiving the reports of the groups studying the various aspects of the 1998 Fraser River sockeye salmon gross escapement difference between estimates, the Panel arrived at its conclusions and made recommendations to the Pacific Salmon Commission as follows:

"At the January 13-14, 1999, Panel meeting, PSC staff reported a 3,391,000 fish, or 40% difference between gross escapement estimates obtained at Mission and from catches and spawning escapements upstream. The Panel requested that PSC staff and Fraser River Panel Technical Committee members organize a post-season review of the 1998 sockeye salmon escapement. On May 11-12, 1999 a Fraser River Technical Committee workshop was held at the Commission office. This Workshop was subsequently followed on May 13-14, 1999 by a Fraser River Panel workshop, at the Executive Inn in Richmond, B.C., in order to review the technical workshop results, to agree on conclusions from the review and to develop recommendations to the Commission.

What follows is a summary of the conclusions and a set of recommendations agreed to by the Panel. You will find attachments which:

1) list the Panel Members;
2) outline the agenda for the workshop;
3) list the documents that were reviewed, followed by the respective executive summaries; and
4) list the participants at the respective workshops.

Copies of the complete technical documents can be provided to you if you so desire. The Panel acknowledges the extensive time and effort that was expended by members of the Technical Committee, Commission staff, and outside experts in finalizing analyses, and preparing the reports and discussion materials required for the workshop.

WORKSHOP CONCLUSIONS

In summary, the technical workshop participants concluded that, with the exception of Early Stuart sockeye, that there was no direct evidence to conclusively determine what was responsible for the difference between the Mission and the up-stream estimates of abundance of Fraser River sockeye. There was agreement that the evidence supported the conclusion that the difference for Early Stuart sockeye was likely caused by en route mortality due to record high temperatures in the Fraser River. For the other stocks, there was no consensus as to the primary cause of the difference between estimates, mainly due to the circumstantial nature of the available evidence. Participants agreed that the existence of some combination of biases in the Mission and upstream estimates of abundance could account for at least some of the differences between estimates. However, there was no consensus as to the level of these biases. An examination of all estimation procedures did not reveal biases of the magnitude that would explain the observed differences in estimates. Participants agreed that some level of en route mortality occurred and accounted for at least some of the difference between estimates. However, there was no consensus on the magnitude of this mortality. For some participants the numbers of observed carcasses did not support the conclusion of substantial en route losses. Other participants argued that the lack of observed carcasses is not necessarily contrary to the likelihood of en route loss.

Following the workshop sessions the Fraser Panel met in national sections and a conference call was subsequently held on May 20, 1999 to review and agree on a list of Panel recommendations.

RECOMMENDATIONS

The discussion of recommendations began with the explicit understanding that current PSC and DFO escapement monitoring programs would continue at the levels reported in 1997-98. This assumption is critical to the expectation that if the Panel's recommendations are implemented, at least in part, this will result in an improved understanding of the Fraser River sockeye resource and thus, improved conservation and management of the resource. Without the continuation of the current level of escapement monitoring, this expectation cannot be realized.

Because the Panel found no biases in any of the escapement monitoring programs that could account for the difference between the two abundance estimates, the Panel's recommendations are directed toward additional monitoring programs and studies which will allow the Panel to predict en route and pre-spawning mortality in such a manner to allow harvest compensation to occur if appropriate. The expected result will be to improve both the sustainability of the resource and the fishery dependent upon the resource. The recommendations are listed as follows:

Hydroacoustic Programs:

There are currently two hydroacoustic estimation programs in the river, one at Mission which is conducted by the PSC and one at Qualark which is conducted by DFO.

Mission – It is recommended that the integration of the side-scanning split-beam with the transecting program occur as currently scheduled (3 year program, 1999-2001). While there was no consensus as to the causes for the differences between the two estimates of abundance, workshop participants re-affirmed their support for the Mission hydroacoustic program and the plans to improve this methodology by the addition of the near shore side-scanning split-beam system. The Mission hydroacoustic program is critical to the Panel's in-season management by providing daily escapement estimates which are the foundation for Fraser River sockeye salmon escapement management.

Qualark – It is recommended that this program be relocated above the Fraser Canyon. Without this tool, it is unlikely that en route losses can be quantified with sufficient accuracy to make appropriate adjustment during in-season management or develop predictable migration losses associated with varying flows and temperatures. During the transition phase at Mission it would be preferable to consider maintaining the Qualark facility.

En route Mortality Studies:

Of the four categories of review that occurred in an attempt to determine the most likely cause for losses, this category had the least quantifiable observations associated with it. For some, it was difficult to envision a loss of 3,400,000 sockeye without substantial numbers of carcasses being observed as occurred in 1997.

Thus, it is recommended that a program of carcasses monitoring (with associated stock composition) be established and studies be conducted to understand behaviour of carcasses in the river (drift and deposition relative to flow and temperature).

In-season Stress Monitoring:

Again, the objective is to identify the relationship between measurable stress and the ultimate survival of the fish though the spawning act. Once stress is detected, the goal is to be able to take corrective management actions to improve the attainment of the spawning target.

Thus, it is recommended that 1) past data be used to ascertain the ability to estimate the impacts of temperature and discharge on the stress of sockeye, 2) a in-season fish stress monitoring program be established, and 3) studies be conducted to determine the relationship between en route and pre-spawning mortality.

In addition to the programs and studies recommended above, the Panel also considered it important to investigate the following:

Disease Studies –

- Establish a regular screening for diseases during migration.
- Study the impact of fish density on disease incidence during upstream migration.
- Monitor fish health on the spawning grounds.
- Intergenerational Studies
- Conduct egg/sperm viability studies related to stress.
- Measure hatching success relative to stress and time of arrival.

As the Chair and Vice-Chair of the Fraser Panel we would request that the Commission acknowledge the extensive work that was conducted, in preparation for the workshop, by the Panel, PSC staff, the Technical Committee members, DFO staff and outside experts We are prepared and expect to develop programs to implement these recommendations as we develop annual management plans through the bilateral process. Finally, we would request that you convey these recommendations to the Government of Canada, for the consideration of DFO, as resource monitoring programs within the river are being developed."

APPENDIX C: 1998 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 July 10, 1998.

Canadian Fraser River Panel Area

In accordance with Article VI, Paragraph 5 of the Pacific Salmon Treaty and the 1998 Agreement, the Commission recommends to Canada 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 8th day of July, 1998 to the 5th day of September, 1998, 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 8th day of July, 1998 to the 5th day of September, 1998, 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 8th day of July, 1998 to the 3rd day of October, 1998, 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 8th day of July, 1998 to the 3rd day of October, 1998 , both dates inclusive.

3. a) No person shall commercially fish for sockeye or pink salmon in Pacific Fishery Management Area 29 with nets from the 8th day of July, 1998 to the 10th day of October, 1998, both dates inclusive.

   b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 29 from the 8th day of July, 1998 to the 10th day of October, 1998, both dates inclusive.

4. The following Fraser River Panel Area waters are excluded from regulatory jurisdiction of the Panel:

   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 1998 season, the Fraser River Panel will adopt Orders establishing open fishing periods based on the attached 1998 Management Plan adopted on July 10, 1998 by the Panel. This Plan is designed to achieve Pacific Salmon Treaty-mandated 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 and the 1998 Agreement, 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 8th day of July, 1998 to the 25th day of July, 1998, and from the 22nd day of August, 1998 to the 5th day of September, 1998, all dates inclusive.

2. 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 26th day of July, 1998 to the 21st day of August, 1998, except from 12:00 p.m. (noon) Sunday to 12:00 p.m. (noon) Friday of each week.

3. No Treaty Indian shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Area 6A with nets from the 8th day of July, 1998 to the 12th day of September, 1998, both dates inclusive.

4. No Treaty Indian shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 7 and 7A with nets from the 8th day of July, 1998 to the 26th day of July, 1998 and from the 22nd day of August, 1998 to the 12th day of September, 1998, all dates inclusive.

5. No Treaty Indian shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 7 and 7A with drift gillnets or purse seine from the 27th day of July to the 21st day of August, 1998, except from 12:01 a.m. Monday to 11:59 p.m. Friday of each week.

6. 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 13th day of September, 1998 to the 3rd day of October, 1998, 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 8th day of July, 1998 to the 5th day of September, 1998, both dates inclusive.

2. No person shall fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6 and 6A with nets from the 8th day of July, 1998 to the 12th day of September, 1998, both dates inclusive.

3. No person shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 7 and 7A with nets from the 8th day of July, 1998 to the 24th day of July, 1998 and from the 24th day of August, 1998 to the 12th day of September, 1998, all dates inclusive.

4. No person shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 7 and 7A with drift gillnets or purse seine from the 25th day of July to the 23rd day of August, 1998, except from 12:01 a.m. Monday to 11:59 p.m. Friday of each week.

5. No person shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 7 and 7A with reef nets from the 25th day of July to the 23rd day of August, 1998, except from 12:01 a.m. Saturday to 11:59 p.m. Sunday of each week.

6. No person shall fish for sockeye or pink salmon with nets in that portion of Puget Sound Salmon Management and Catch Reporting Area 7A lying westerly of a straight line drawn from the low water range marker in Boundary Bay on the International Boundary through the east tip of Point Roberts in the State of Washington to the East Point Light on Saturna Island in the Province of British Columbia from the 13th day of September, 1998 to the 3rd day of October, 1998, both dates inclusive.

The following Fraser River Panel Area waters and fisheries are excluded from regulatory jurisdiction of the Panel:

Treaty Indian and All-Citizen Fisheries:

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

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

APPENDIX D: 1998 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 1998:

July 24 United States

Treaty Indian Fishery

Areas 6, 7 and 7A:

Closed to net fishing from 12:01 a.m. July 27 to 4:00 a.m. July 28 and from 7:00 a.m. July 29 to 11:59 p.m. July 31.

This permitted, net fishing from 4:00 a.m. July 28 to 7:00 a.m. July 29.

All-Citizen Fishery

Area 6:

Closed to gillnets and purse seines from 12:01 a.m. July 27 to 11:59 p.m. July 31.

Areas 7 and 7A:

Closed to reef nets from 12:01 a.m. to 5:00 a.m. and from 9:00 p.m. to 11:59 p.m. July 25 and July 26.

This permitted, fishing with reef nets from 5:00 a.m. to 9:00 p.m. July 25 and July 26.

Closed to gillnets from 12:01 a.m. July 27 to 7:10 a.m. July 29 and from 12:00 a.m. (midnight) July 30 to 11:59 p.m. July 31.

This permitted, fishing with gillnets from 7:10 a.m. to 11:59 p.m. July 29.

Closed to purse seines from 12:01 a.m. July 27 to 5:00 a.m. July 30 and from 9:00 p.m. July 30 to 11:59 p.m. July 31.

This permitted, fishing with purse seines from 5:00 a.m. to 9:00 p.m. July 30.

July 31 United States

Treaty Indian Fishery

Areas 6, 7 and 7A:

Closed to net fishing from 5:00 a.m. August 6 to 11:59 p.m. August 7.

This permitted, net fishing from 12:01 a.m. August 3 to 5:00 a.m. August 6.

All-Citizen Fishery

Area 6:

Closed to gillnets and purse seines from 12:01 a.m. August 3 to 11:59 p.m. August 7.

Areas 7 and 7A:

Closed to reef nets from 12:01 a.m. to 5:00 a.m. and from 9:00 p.m. to 11:59 p.m. August 1 and August 2.

This permitted, fishing with reef nets from 5:00 a.m. to 9:00 p.m. August 1 and August 2.

Closed to gillnets from 12:01 a.m. August 3 to 7:20 a.m. August 6 and from 12:00 a.m. (midnight) to 7:20 a.m. August 7.

This permitted, fishing with gillnets from 7:20 a.m. to 11:59 p.m. August 6 and August 7.

Closed to purse seines from 12:01 a.m. August 3 to 5:00 a.m. August 6; from 9:00 p.m. August 6 to 5:00 a.m. August 7; and from 9:00 p.m. to 11:59 p.m. August 7.

This permitted, fishing with purse seines from 5:00 a.m. to 9:00 p.m. Thursday, August 6 and Friday, August 7.

August 4 Canada

Area 29: 3, 4, 6, 7 and 9-17:

Gillnets open 12:00 p.m. (noon) August 5 to 6:00 p.m. August 6 in that portion of sub-Areas 3 and 4 easterly known as the Banana.

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

Open for commercial trolling 12:01 a.m. to 11:59 p.m. Friday, August 7.

August 7 United States

Treaty Indian Fishery

Areas 6, 7 and 7A:

Closed to net fishing from 12:01 a.m. August 10 to 12:01 a.m. August 11.

All-Citizen Fishery

Area 6:

Closed to gillnets and purse seines from 12:01 a.m. August 10 to 12:01 a.m. August 11.

Areas 7 and 7A:

Closed to reef nets from 12:01 a.m. to 5:00 a.m. and from 9:00 p.m. to 11:59 p.m. August 8 and August 9.

This permitted, fishing with reef nets from 5:00 a.m. to 9:00 p.m. August 8 and August 9.

Closed to gillnets and purse seines from 12:01 a.m. August 10 to 12:01 a.m. August 11.

August 10 United States

Treaty Indian Fishery

Areas 6, 7 and 7A:

Closed to net fishing from 5:00 a.m. August 12 to 11:59 p.m. August 13.

This permitted, net fishing from 12:01 a.m. August 11 to 5:00 a.m. August 12.

All-Citizen Fishery

Area 6:

Closed to gillnets and purse seines from 12:01 a.m. August 11 to 11:59 p.m. August 13.

Areas 7 and 7A:

Closed to gillnets from 12:01 a.m. August 11 to 7:30 a.m. August 12 and from 12:00 a.m. (midnight) to 7:30 a.m. August 13.

This permitted, fishing with gillnets from 7:30 a.m. to 11:59 p.m. August 12 and August 13.

Closed to purse seines from 12:01 a.m. August 11 to 5:00 a.m. August 12; from 9:00 p.m. August 12 to 5:00 a.m. August 17; and from 9:00 p.m. to 11:59 p.m. August 13.

This permitted, fishing with purse seines from 5:00 a.m. to 9:00 p.m., August 12 and August 13.

August 13 United States

Treaty Indian Fishery

Areas 6, 7 and 7A:

Closed to net fishing from 12:00 a.m. (midnight) to 11:59 p.m. August 14.

All-Citizen Fishery

Area 6:

Closed to gillnets and purse seines from 12:00 a.m. (midnight) to 11:59 p.m. August 14.

Areas 7 and 7A:

Closed to gillnets from 12:00 a.m. (midnight) to 7:30 a.m. August 14.

This permitted, fishing with gillnets from 7:30 a.m. to 11:59 p.m. August 14.

Closed to purse seines from 12:00 a.m. (midnight) to 5:00 a.m. and from 9:00 p.m. to 11:59 p.m. August 14.

This permitted, fishing with purse seines from 5:00 a.m. to 9:00 p.m. August 14.

August 14 United States

Treaty Indian Fishery

Areas 6, 7 and 7A:

Closed to net fishing from 12:01 a.m. to 11:59 p.m. August 17.

This permitted, net fishing from 12:01 a.m. August 18 to 5:00 a.m. August 20.

All-Citizen Fishery

Areas 7 and 7A:

Closed to reef nets from 12:01 a.m. to 5:00 a.m. and from 9:00 p.m. to 11:59 p.m. August 15 and August 16.

This permitted, fishing with reef nets from 5:00 a.m. to 9:00 p.m. August 15 and August 16.

Closed to gillnets from 12:01 a.m. to 7:35 a.m. August 17 and from 12:01 a.m. August 18 to 5:00 a.m. August 20.

This permitted, fishing with gillnets from 7:35 a.m. to 11:59 p.m. August 17.

Closed to purse seines from 12:01 a.m. to 5:00 a.m. August 17 and from 9:00 p.m. August 17 to 5:00 a.m. August 20.

This permitted, fishing with purse seines from 5:00 a.m. to 9:00 p.m. August 17.

August 18 <u>Canada</u>

Area 29: 3, 4, 6, 7 and 9-17

Gillnets open 12:00 p.m. (noon) August 20 to 8:00 a.m. August 21 in that portion of sub-Areas 3 and 4 easterly known as the Banana.

August 19 <u>United States</u>

Treaty Indian Fishery

Areas 6, 7 and 7A:

Closed to net fishing from 5:00 a.m. to 11:59 p.m. August 21.
Extended for net fishing from 5:00 a.m. August 20 to 5:00 a.m. August 21.

All-Citizen Fishery

Areas 7 and 7A:

Closed to gillnets from 5:00 a.m. August 20 to 7:35 a.m. August 21.

This permitted, fishing with gillnets from 7:35 a.m. to 11:59 p.m. August 21.

Closed to purse seines from 5:00 a.m. August 20 to 5:00 a.m. August 21 and from 9:00 p.m. to 11:59 p.m. August 21.

This permitted, fishing with purse seines from 5:00 a.m. to 9:00 p.m. August 21.

August 21 <u>United States</u>

All-Citizen Fishery

Areas 7 and 7A:

Closed to reef nets from 12:01 a.m. August 22 to 11:59 p.m. August 23.

All times herein cited are Pacific Daylight Savings Time.

APPENDIX E: TABLES 1-7

Table 1. Commercial net catches of Fraser River sockeye salmon in Canadian Area 20 (Juan de Fuca Strait) by week for cycle years 1986-1998.

Date *	1986	1990	1994	1998
Jun. 28-Jul. 4	0	0	0	0
Jul. 5-Jul. 11	0	0	0	0
Jul. 12-Jul. 18	0	0	0	0
Jul. 19-Jul. 25	0	0	0	0
Jul. 26-Aug. 1	0	0	0	0
Aug. 2-Aug. 8	0	1,000	399,000	0
Aug. 9-Aug. 15	208,000	787,000	378,000	0
Aug. 16-Aug. 22	961,000	2,163,000	69,000	0
Aug. 23-Aug. 29	719,000	428,000	0	0
Aug. 30-Sep. 5	115,000	0	0	0
Sep. 6-Sep. 12	1,000	0	0	0
Sep. 13-Sep. 19	0	0	0	0
Sep. 20-Sep. 26	0	0	0	0
Sep. 27-Oct. 3	0	0	0	0
Oct. 4-Oct. 10	0	0	0	0
Total	2,004,000	3,379,000	846,000	0

* Dates for 1998. For other years, data from the nearest week were used.

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 1986-1998.

Date *	1986	1990	1994	1998
Jun. 28-Jul. 4	0	0	0	0
Jul. 5-Jul. 11	0	0	0	0
Jul. 12-Jul. 18	0	0	0	0
Jul. 19-Jul. 25	0	0	0	0
Jul. 26-Aug. 1	2,000	0	0	0
Aug. 2-Aug. 8	508,000	310,000	104,000	147,000
Aug. 9-Aug. 15	307,000	960,000	472,000	0
Aug. 16-Aug. 22	139,000	738,000	454,000	136,000
Aug. 23-Aug. 29	179,000	866,000	279,000	0
Aug. 30-Sep. 5	143,000	467,000	341,000	0
Sep. 6-Sep. 12	33,000	9,000	0	0
Sep. 13-Sep. 19	0	1,000	0	0
Sep. 20-Sep. 26	967,000	0	0	0
Sep. 27-Oct. 3	467,000	5,000	0	0
Oct. 4-Oct. 10	0	0	0	0
Total	2,745,000	3,356,000	1,650,000	283,000

* Dates for 1998. For other years, data from the nearest week were used.

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 1986-1998. The landing dates shown lag an average of five days behind catch dates.

Date *	1986	1990	1994	1998
Jun. 28-Jul. 4	0	0	0	0
Jul. 5-Jul. 11	2,000	0	0	0
Jul. 12-Jul. 18	4,000	4,000	0	0
Jul. 19-Jul. 25	1,000	2,000	0	0
Jul. 26-Aug. 1	28,000	0	0	0
Aug. 2-Aug. 8	344,000	57,000	171,000	0
Aug. 9-Aug. 15	1,030,000	1,359,000	146,000	0
Aug. 16-Aug. 22	329,000	461,000	27,000	0
Aug. 23-Aug. 29	25,000	13,000	7,000	0
Aug. 30-Sep. 5	0	7,000	1,000	0
Sep. 6-Sep. 12	0	2,000	0	0
Sep. 13-Sep. 19	0	1,000	0	0
Sep. 20-Sep. 26	0	0	0	0
Sep. 27-Oct. 3	0	0	0	0
Oct. 4-Oct. 10	0	0	0	0
Total	1,763,000	1,906,000	352,000	0

* Dates for 1998. 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 1986-1998.

Date *	1986	1990	1994	1998
Jun. 28-Jul. 4	0	0	0	0
Jul. 5-Jul. 11	2,000	0	0	0
Jul. 12-Jul. 18	1,000	1,000	0	0
Jul. 19-Jul. 25	3,000	3,000	0	0
Jul. 26-Aug. 1	4,000	27,000	0	163,000
Aug. 2-Aug. 8	118,000	135,000	93,000	657,000
Aug. 9-Aug. 15	354,000	824,000	1,324,000	67,000
Aug. 16-Aug. 22	858,000	817,000	2,509,000	15,000
Aug. 23-Aug. 29	800,000	807,000	1,574,000	0
Aug. 30-Sep. 5	99,000	117,000	526,000	0
Sep. 6-Sep. 12	2,000	4,000	14,000	0
Sep. 13-Sep. 19	5,000	3,000	2,000	0
Sep. 20-Sep. 26	1,000	0	0	0
Sep. 27-Oct. 3	3,000	0	0	0
Oct. 4-Oct. 10	0	0	0	0
Total	2,250,000	2,738,000	6,042,000	902,000

* Dates for 1998. For other years, data from the nearest week were used.

Table 5. Catches of Fraser River sockeye salmon in the Canadian Fraser River Indian fishery by area (Fraser River mainstream or tributary areas) for cycle years 1986-1998.*

Fishing Area		1986	1990	1994 **	1998
Fraser River Mainstem					
Below Port Mann	*1*	25,200	70,800	147,600	101,300
Port Mann to Mission	*1*	12,400	34,400	103,300	77,300
Mission to Hope		142,300	252,700	194,900	88,100
Hope to Sawmill Cr.	*2*	165,200	232,800	201,800	187,900
Sawmill Cr. to Kelly Cr.	*2*	86,400	109,000	232,200	126,700
Kelly Creek to Naver Cr.	*3*	16,100	22,400	10,600	8,100
Above Naver Cr.	*3*	3,900	2,300	1,500	5,400
Total		451,500	724,400	891,900	594,800
Tributaries					
Harrison/Lillooet System		10,800	n/a	n/a	n/a
Thompson System		10,000	12,400	3,400	4,400
Chilcotin System		39,400	57,000	27,200	36,300
Nechako System		17,100	8,300	3,700	3,400
Stuart System		5,400	5,500	1,600	4,700
Total		82,700	83,200	35,900	48,800
Total Catch		534,200	807,600	927,800	643,600

* Data supplied by DFO.

** Catch estimates from the report of the In-river Catch Estimation Work Group to the Fraser River Sockeye Public Review Board, 1994.

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.

Table 6. Commercial net catches of Fraser River sockeye salmon in United States Areas 4B, 5, 6, 6C, 7, 7A, and 7B (Juan de Fuca Strait and northern Puget Sound) by week for cycle years 1986-1998.*

Date *	1986	1990	1994	1998
Jun. 28-Jul. 4	0	0	0	0
Jul. 5-Jul. 11	0	0	0	0
Jul. 12-Jul. 18	0	0	0	0
Jul. 19-Jul. 25	4,000	18,000	12,000	1,000
Jul. 26-Aug. 1	6,000	10,000	65,000	37,000
Aug. 2-Aug. 8	388,000	443,000	220,000	209,000
Aug. 9-Aug. 15	552,000	0	269,000	99,000
Aug. 16-Aug. 22	714,000	711,000	320,000	176,000
Aug. 23-Aug. 29	593,000	542,000	205,000	0
Aug. 30-Sep. 5	372,000	426,000	669,000	0
Sep. 6-Sep. 12	1,000	0	68,000	0
Sep. 13-Sep. 19	0	0	0	0
Sep. 20-Sep. 26	0	6,000	0	0
Sep. 27-Oct. 3	104,000	0	0	0
Oct. 4-Oct. 10	0	0	0	0
Total	2,734,000	2,156,000	1,828,000	522,000

* Dates for 1998. For other years, data from the nearest week were used.

Table 7. Escapements of sockeye salmon to Fraser River spawning areas for cycle years 1982, 1986, 1990, 1994 and 1998. *

DISTRICT	Estimated Number of Adult Sockeye *					Jacks
Stream/Lake	1982	1986	1990	1994	1998	1998
NORTHEAST						
Upper Bowron R.	1,647	3,118	7,860	4,380	4,751	26
STUART						
Early Runs						
Takla L. Streams	438	4,820	25,197	6,847	21,235	0
Middle R. Streams	3,595	19,882	55,114	17,094	6,911	20
Trembleur L. Streams	524	3,882	16,723	5,890	2,806	0
Early Stuart Total	4,557	28,584	97,034	29,831	30,952	20
Late Runs						
Middle R.	7,450	9,940	76,500	29,573	36,675	11
Tachie R.	7,528	13,617	94,570	42,571	92,947	1,010
Miscellaneous	1,780	5,158	17,979	4,318	6,531	3
Late Stuart Total	16,758	28,715	189,049	76,462	136,153	1,024
NECHAKO						
Nadina R. (Late)	194	130	359	86	756	4
Nadina Channel	2,155	3,415	5,674	1,922	2,949	15
Stellako R.	69,420	77,177	93,920	137,982	185,592	56
QUESNEL						
Horsefly R.	30,317	144,751	398,468	494,552	743,171	0
Horsefly Channel	-	-	29,274	19,597	24,934	0
McKinley Cr.	5,657	5,635	11,743	35,747	75,829	0
Mitchell R.	3,829	30,827	43,755	129,235	310,331	0
Miscellaneous	38	254	4,404	7,280	24,984	0
Quesnel Total	39,841	181,467	487,644	686,411	1,179,249	0
CHILCOTIN						
Chilko R. & L.	249,578	293,804	815,904	448,815	879,017	1,934
Chilko Channel	-	-	9,934	1,930	-	-
SETON-ANDERSON						
Gates Cr.	101	394	993	0	935	161
Gates Channel	829	3,178	4,381	3,360	6,312	1,316
Portage Cr.	23,867	14,291	18,336	9,270	25,179	26
NORTH THOMPSON						
Raft R.	2,992	2,095	630	1,712	7,198	31
Fennell Cr.	1,132	6,024	11,862	5,919	8,741	0
SOUTH THOMPSON						
Summer Runs						
Seymour R.	63,271	126,166	272,041	64,038	34,024	11
Scotch Cr.	4,709	26,624	83,388	73,180	35,937	7
Anstey R.	767	7,080	25,297	7,380	4,741	0
Eagle R.	1,642	7,138	4,147	53,796	30,211	0
Late Runs						
Adams R./Little R.	2,309,158	1,551,867	2,432,828	878,381	1,047,134	312
Adams Channel	-	-	6,824	2,031	-	-
Lower Shuswap R.	513,897	600,370	983,481	367,661	291,637	0
Middle Shuswap R.	40,300	80,529	96,441	31,806	15,262	0
Miscellaneous	196,880	112,464	198,099	90,799	36,132	0
Late Total	3,060,235	2,345,230	3,717,673	1,370,678	1,390,165	312
HARRISON-LILLOOET						
Birkenhead R.	119,738	335,630	166,773	39,234	295,677	369
Harrison R.	9,189	7,265	4,515	9,515	4,496	0
Weaver Cr.	236,288	65,846	5,969	20,017	28,021	22
Weaver Channel	57,795	44,892	10,396	44,939	29,071	46
LOWER FRASER						
Nahatlatch R. & L.	2,734	8,996	7,044	6,042	7,993	0
Cultus L.	16,725	3,256	1,860	4,399	1,959	207
Upper Pitt R.	8,708	29,177	12,202	9,500	76,888	0
Chilliwack L.	3,980	1,164	2,230	7,966	1,068	4
MISCELLANEOUS	8,868	6,882	7,170	9,766	10,963	8
ADULTS	4,007,720	3,657,738	6,064,285	3,128,530	4,418,998	5,599
JACKS	16,541	59,706	20,546	4,096	5,599	
TOTAL NET ESCAPEMEN	4,024,261	3,717,444	6,084,831	3,132,626	4,424,597	

* 1982 data are from the PSC. Estimates for 1986, 1990, 1994 and 1998 are from DFO.

APPENDIX F: STAFF OF THE PACIFIC SALMON COMMISSION IN 1998

EXECUTIVE OFFICE

Mr. I. Todd, Executive Secretary
Ms. J. Abramson, Secretary
Mrs. V. Ryall, Meeting Planner
Ms. T. Tarita, Librarian/Records Administrator

FINANCE AND ADMINISTRATION

Mr. K. Medlock, Comptroller
Ms. B. Dalziel, Accountant

FISHERIES MANAGEMENT DIVISION STAFF

Dr. J. Woodey, Chief

BIOMETRICS / CATCH STATISTICS GROUP

Mr. I. Guthrie, Head
Mr. D. Stelter, Catch Statistician

COMPUTER SERVICES GROUP

Ms. K. Mulholland, Computer System Manager

RACIAL IDENTIFICATION GROUP

Mr. J. Gable, Head
Ms. J. Andersen, Senior Scale Analyst
Ms. H. Derham, Scale Lab Assistant
Mr. K. Forrest, Racial Data Biologist
Mr. M. Lapointe, Sockeye Racial Analysis Biologist
Ms. M. Reichardt, Scale Analyst
Mr. B. White, Pink Racial Analysis Biologist

STOCK MONITORING GROUP

Mr. J. Cave, Head
Ms. S. Allison, Test Fishing Biologist (Term)
Mr. P. Cheng, Hydroacoustics Biologist
Mr. A. Gray, Hydroacoustics Biologist (Term)
Dr. Y. Xie, Hydroacoustic Scientist