
**Report of the
Fraser River Panel
to the
Pacific Salmon Commission
on the
1991 Fraser River Sockeye and
Pink Salmon Fishing Season**



Prepared by the
Pacific Salmon Commission
March, 1994

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**REPORT OF THE
FRASER RIVER PANEL
TO THE PACIFIC SALMON COMMISSION
ON THE 1991 FRASER RIVER SOCKEYE AND PINK
SALMON FISHING SEASON**

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March, 1994

TABLE OF CONTENTS

	Page
I. EXECUTIVE SUMMARY	1
II. FRASER RIVER PANEL	3
III. INTRODUCTION	6
IV. MANAGEMENT ACTIONS	10
A. Pre-season TAC and Goals	10
B. Pre-season Regulations	11
C. In-season Regulations	15
V. CATCH SUMMARY	21
A. Sockeye Salmon	21
i. Canada	21
ii. United States	21
B. Pink Salmon	22
i. Canada	22
ii. United States	24
VI. STOCK MONITORING	25
A. Sockeye Salmon	26
B. Pink Salmon	28
VII. RACIAL IDENTIFICATION	30
A. Sockeye Salmon	30
B. Pink Salmon	33
VIII. ESCAPEMENT	34
A. Sockeye Salmon	34
B. Pink Salmon	36
IX. ACHIEVEMENT OF OBJECTIVES	38
A. Escapement	38
B. International Allocation	39
C. Domestic Allocation	41
D. Conservation of Other Stocks	42
X. ALLOCATION STATUS	43
XI. APPENDICES	45
Appendix A: 1991 Pre-season Forecasts and Escapement Goals for Fraser River Sockeye and Pink Salmon	45
Appendix B: 1991 Regulations	46
Appendix C: 1991 Fraser River Panel In-Season Orders	48
Appendix D: Appendix Tables 1 to 9	55
Appendix E: Fraser River Pink Salmon Escapement Estimates	61
Appendix F: Staff of the Pacific Salmon Commission in 1991	68

I. EXECUTIVE SUMMARY

1. The 1991 fishing season was the third year of the second four-year cycle (1989-92) covered by the Pacific Salmon Treaty. The pre-season forecast of run size was 14,500,000 Fraser River sockeye salmon and the Total Allowable Catch (TAC) was expected to be about 8,336,000 fish. The forecast run size and TAC of Fraser River pink salmon was 11,000,000 and 6,480,000 fish, respectively.
2. Canada set pre-season goals for 4,575,000 gross escapements and 3,775,000 net escapements of adult Fraser River sockeye salmon. The gross escapement goal for Fraser pink salmon was 4,500,000 fish; the net escapement goal was the same since small Indian food fishery catches were anticipated.
3. The United States elected to harvest 1,800,000 sockeye in Washington State waters from their remaining allocation for 1989-92. For Fraser River pink salmon, the United States allocation was forecast to be 1,666,000 fish (25.7% of the TAC) plus 241,000 fish for a partial payback of catch shortfalls in previous years, giving a total of 1,907,000 fish in 1991.
4. The United States goals for the domestic allocation of Fraser sockeye among Washington fishermen was: Treaty Indian - 90,000 in Areas 4B, 5 and 6C and 700,000 in Areas 6, 7 and 7A for a total of 790,000 fish; and Non-Indian - 500,000 to purse seines, 450,000 to gillnets and 60,000 to reefnets for a total of 1,010,000 fish. The United States harvest of pink salmon was to be divided equally between Treaty Indian and Non-Indian fishermen. Although no gear allocation goals were set for the pink salmon net fishery, the United States set a harvest quota of 160,000 pink salmon in the Washington Non-Indian troll fishery in Areas 3 and 4.
5. The Canadian share of the forecast TAC was 6,536,000 Fraser sockeye, to which was added 1,889,000 fish because they allowed 276,000 fish from their 1987 TAC to spawn in exchange for future benefits (i.e., Canadian Escapement Add-on Benefit), for a total share of 8,425,000. Out of this amount, commercial fisheries were expected to harvest 7,910,000 sockeye and 525,000 were expected in Indian food and other non-commercial fisheries. The Canadian share of Fraser River pink salmon was a catch of 4,573,000 fish in all fisheries.
6. Canadian domestic allocation goals for commercial Fraser sockeye catches were more complex than in past years, involving a different percentage allocation among the gear for the first 3,200,000 fish caught than for catches exceeding this amount, and paybacks among the gear to compensate for catch shortfalls in previous years. The allocation of southerly migrating pink salmon was: purse seines - 58%; outside trollers - 29%; gillnets - 9%; and inside trollers - 4%.
7. The Fraser River Panel established pre-season regulations and a management plan based on the forecasts for run sizes, migration timing and Johnstone Strait diversion rates; the goals for catch and escapement; and conservation concerns for other species and stocks of salmon identified by the Parties. The peaks in migration timing through Juan de Fuca Strait (Area 20) for the major sockeye stocks, Chilko and Adams/Lower Shuswap, were expected to be July 31 and August 16, respectively. Fraser River pink salmon were expected to peak close to August 26. The percentage of fish that migrate through Johnstone Strait was forecast to be 25% for Fraser sockeye and 30% for Fraser pinks.
8. To ensure that the various goals were achieved, the Panel met much more frequently than usual (39 times) throughout the fishing season to enact regulations. The numerous meetings were necessary because of the complex allocation goals and because run sizes, migration timing and diversion rates deviated widely from pre-season forecasts.
9. The total return of Fraser River sockeye salmon was about 12,378,000 fish, 2,122,000 less than forecast, but the largest return on the cycle since 1899. Total catches were 8,163,000 in

commercial fisheries, 697,000 in Indian food fisheries and 177,000 in other fisheries. United States commercial fishermen caught 1,881,000 Fraser River sockeye salmon, including 64,000 in Alaska, while Canadian fishermen caught 6,282,000 Fraser sockeye. For Fraser River pink salmon, the run size estimate of 22,333,000 fish, was 11,333,000 larger than forecast. Catches were 8,988,000 in commercial and 402,000 in non-commercial fisheries. Commercial catches in the United States and Canada were 2,806,000 and 6,182,000, respectively.

10. The Stock Monitoring program provided in-season estimates of abundance, run timing and migration route proportions of Fraser River sockeye and pink stocks throughout the fishing season. Management difficulties were encountered because of many factors: a very sharp Early Stuart migration peak combined with unrecognized changes to test fishing efficiency; the late arrival, high diversion rate and then delay of summer-run stocks off the mouth of the Fraser; the low abundance of Adams River sockeye along the coast until their relatively sudden arrival in the Panel Area at half the expected abundance and; the late arrival, unanticipated run strength and high diversion of Fraser River pink salmon through Johnstone Strait. Hydroacoustic and test fishing catch-per-unit-effort estimates of gross escapement past Mission totalled 4,089,000 sockeye and 7,526,000 pink salmon.
11. The Racial Analysis program was successful in using scale and other characteristics to identify the major stock groups of Fraser River sockeye throughout the season, except for difficulties in distinguishing between Seymour River and Chilko River sockeye. Accurate stock identification was particularly important in 1991 because of the unexpected strength of the summer-run stocks and lack of strength of the late-run stocks. The Genetic Stock Identification method was used again in 1991 to identify Fraser River and other southerly migrating pink salmon stocks in mixed-stock fisheries.
12. Spawning escapement estimates by Canada Department of Fisheries and Oceans totalled 3,341,000 Fraser sockeye and 12,943,000 pink salmon. The sockeye spawning escapement was the largest on the cycle since 1899 and was 74% above the brood year escapement. The pink salmon escapement was the largest since records began in 1957, and probably the largest since 1913 or earlier.
13. Gross escapement goals for Fraser River sockeye and pink salmon were adjusted during the season to the final goals of 3,894,000 adult sockeye and 7,000,000 pink salmon. The upriver gross escapement estimate of 3,911,000 adult sockeye, derived from spawning ground enumerations plus Indian catches, was close to the goal. Gross escapements of Early Stuart sockeye were 76,000 short of the goal and early summer-run escapements were 86,500 below the goal. The goal for summer-run stocks was exceeded by 117,000 while late-run sockeye gross escapements were 62,500 more than the goal. The upriver estimate of pink salmon gross escapement was 13,047,000 fish, almost twice the escapement goal (7,000,000) and the Mission estimate (7,526,000).
14. The final estimate of the TAC in 1991 is 7,253,000 Fraser River sockeye salmon, based on a run size of 12,378,000 fish, a Canadian Escapement Add-on Benefit of 1,279,000 and other deductions (including net escapements, the Fraser River Indian food fishery exemption, and test fishing catches) totalling 3,846,000 fish. For Fraser River pink salmon, the run size, TAC and deductions are estimated to be 22,333,000, 9,955,000 and 12,378,000, respectively.
15. Catches in Washington State fisheries were 18,000 over the goal for Fraser River sockeye salmon. United States fishermen caught 1,882,000 Fraser River sockeye, including 64,000 in Alaska fisheries. United States catches of Early Stuart, summer-run and late-run sockeye were 20,000 fish under, 84,000 over and 46,000 under the goals, respectively. United States catches of Fraser River pink salmon totalled 2,836,000 fish. No underages were assessed because 2,000 Fraser River pink salmon were inadvertent over-escapement due to management imprecision. The cumulative 1989 and 1991 United States catch of Fraser pinks is 2,214,000

fewer than the maximum of 7,311,000 (7,200,000 plus a payback of 111,000 Fraser pinks) for the 1989-92 period due to smaller than projected run sizes.

16. Canadian catches of Fraser River pink salmon were under the goal by 609,000 fish, which is a preliminary estimate of fish that Canada allowed to escape. Concerns about achievement of domestic allocation goals and conservation concerns for other species limited Canadian fisheries.
17. With respect to United States domestic allocations, the Treaty Indian harvest of Fraser sockeye was 48,000 over the goal while the Non-Indian harvest was 30,000 fish under. Within the Treaty Indian catch, the catch in Areas 4B, 5 and 6C was 3,000 fish over the allocation and the catch in Areas 6, 7 and 7A was over by 45,000 fish. Non-Indian gillnet, purse seine and reefnet fishermen, respectively, caught 33,000 under, 2,000 over and 1,000 over their allocations. Treaty Indian fishermen were about 31,000 under the catch goal for Fraser River pink salmon, while Non-Indian fishermen were over by the same amount.
18. In Canada, outside troll and inside troll fishermen were over their domestic allocations of Fraser River sockeye salmon by 379,000 and 32,000 fish, respectively. Purse seine and gillnet fishermen were 367,000 and 44,000 fish under their allocations. For southerly migrating pink salmon, purse seines exceeded their allocation by 377,000 and inside trollers by 80,000 fish. Outside trollers were under their allocation by 150,000 fish and gillnetters by 307,000 fish.
19. There were no major conflicts between the harvest of Fraser River sockeye salmon and the conservation of other species and stocks in 1991. The concerns identified by Canadian and United States agencies were taken into account during the design and implementation of the fishing plans. The planned closure of Canadian Area 29 after September 4 for the protection of chinook and steelhead stocks was relaxed to allow two fisheries at times of low abundances of these species. Catches of non-target species was low or modest in all areas.

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 fishing regime and a management plan for Panel Area fisheries to the Pacific Salmon Commission (PSC). The plan is based on abundance forecasts and escapement goals for Fraser River sockeye and pink salmon stocks provided by Canada Department of Fisheries and Oceans (DFO), international allocation goals set by the Treaty, domestic allocation goals set by each country and management concerns for other stocks and species identified by each country.

In-season, to achieve the objectives of the management plan approved by the PSC, the Panel uses commercial and test fishing data and various analyses from PSC staff to modify the fishing times in the management plan. In 1991, the Panel exercised its in-season regulatory mandate in the Panel Area only for the net fisheries, the Canadian inside (Strait of Georgia) troll fishery and the Washington Non-Indian coastal troll fishery for pink salmon.

Achievement of the domestic allocation goals of Canada and the United States is a major focus of in-season management and, in general, has been met successfully by the Panel. Resource conservation and international allocation goals take precedence over domestic allocation objectives, however, when trade-offs among these objectives are necessary.

The Fraser River Panel Technical Committee provides the Panel with data and technical advice. Development of management plans for other species and stocks intercepted in south coast regions is the responsibility of the Southern Panel and Commission, with actual management in each region the responsibility of the appropriate country.

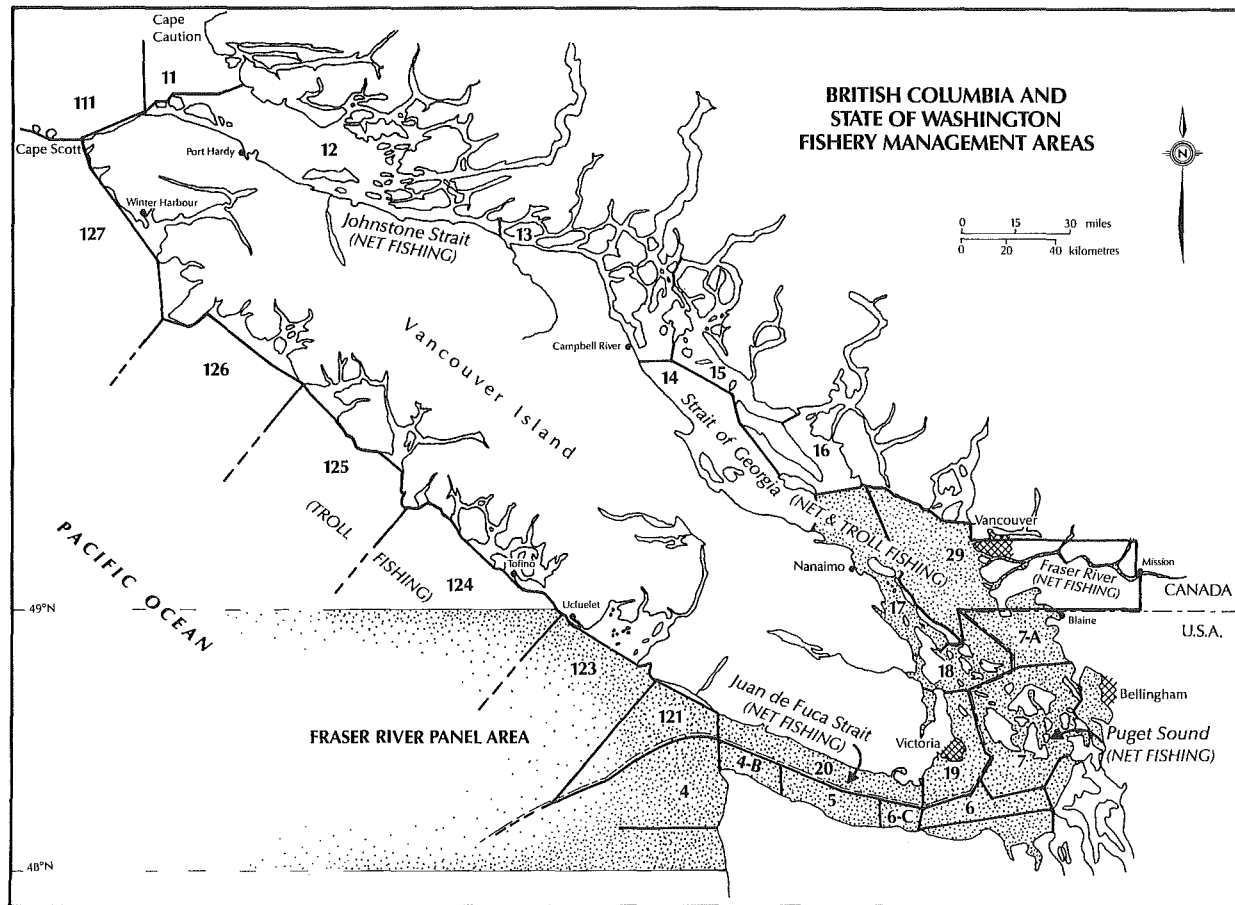


Figure 1. Fishery management areas and commercial gear used in the Fraser River Panel Area and Canadian south coast waters.

Prior to the 1991 fishing season, the Panel asked national agencies to identify their management concerns for species and stocks of salmon that occur in Panel Areas. Responses from Canadian and United States agencies resulted in plans to avoid fishing during sensitive times in some areas. Conservation concerns for Harrison River chinook salmon and Thompson River steelhead were identified and addressed in the Fraser River fishery. Lake Washington sockeye salmon were protected by an early closure of United States Areas 4B, 5 and 6C. Puget Sound and Hood Canal coho salmon were to be a major concern of management in the latter portion of the sockeye and pink salmon fishery. During the fishing season, Canada identified a management concern for Strait of Georgia origin coho salmon.

Input to the decision-making process occurs primarily through the national sections of the Panel where most user groups are represented. The Panel membership during the 1991 season was:

UNITED STATES	CANADA
Members	
Ms. L. Loomis, Chair Treaty Indian tribes	Mr. F. Fraser, Vice-Chair Department of Fisheries and Oceans
Mr. D. Austin Washington Department of Fisheries	Mr. E. Crey Fraser River Indian food fishermen
Mr. R. Schmitten National Marine Fisheries Service	Mr. M. Forrest Gillnet fishermen
Mr. R. Zuanich Commercial salmon fishing industry	Mr. J. Hill Salmon processing industry
	Ms. R. Kendall Freshwater sport fishermen
	Mr. L. Wick Purse seine fishermen
Alternates	
Mr. R. Allen Treaty Indian tribes	Mr. V. Fiamengo Purse seine fishermen
Dr. M. Barker Washington Department of Fisheries	Mr. M. Griswold Gulf troll fishermen
Mr. B. Robinson National Marine Fisheries Service	Mr. M. Medenwaldt Outside troll fishermen
Mr. B. Suggs Commercial salmon fishing industry	Ms. K. McGivney Department of Fisheries and Oceans
	Mr. R. Nugent Gillnet fishermen

III. INTRODUCTION

Fraser River sockeye salmon returns in 1991 totalled 12,378,000 fish, the largest on the cycle since 1899 (Figure 2). The 1991 run continued a trend of large returns observed over the last several years. The average return of sockeye in the four year period, 1988-1991, was 14,139,000 fish. Average run sizes in the early 1900s have been estimated at about 12,000,000 per year. Although dominant cycle runs at that time were larger than seen recently, the off-cycle runs were usually smaller.

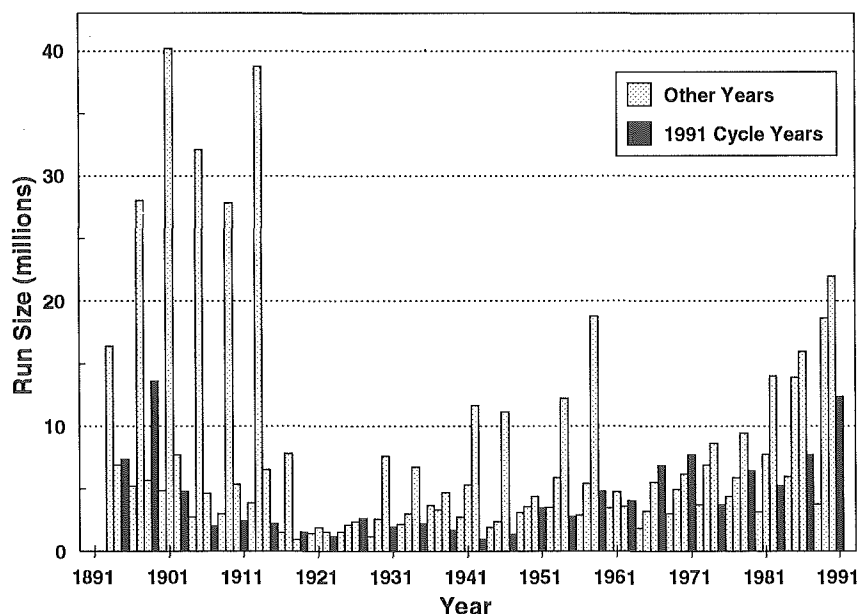


Figure 2. Total run sizes of Fraser River sockeye salmon between 1893-1991. Returns on the 1991 cycle are highlighted.

The total return of Fraser River pink salmon was 22,333,000 fish, considerably larger than the pre-season forecast of 11,000,000 and the largest since records began in 1959 (Figure 3). Marine survival was estimated at 6.2% (Appendix D: Table 7), which is almost twice the average (3.2%) for this stock. These estimates incorporate the spawning escapement estimate of 12,943,000 fish from Canada Department of Fisheries and Oceans (DFO) tag-recovery program. This amount is almost twice the gross escapement estimate (7,526,000) from the Mission echosounding program and test fishing catch-per-unit-effort models. A discussion about the discrepancy between these estimates is in Appendix E.

Fraser River sockeye and pink salmon were both small in 1991. The 2.4 kg (5.3 lb) mean weight of sockeye was smaller than the 2.6 kg (5.8 lb) cycle average. Pink salmon were the smallest on record, with a mean weight of 1.78 kg (3.9 lb): the previous record (1.86 kg) occurred in 1983, during an El Niño event. The small body size of pink salmon caught in outside fishing areas was an early indicator that the run might be larger than forecast.

Annual returns of adult Fraser River sockeye and pink salmon increased in the late 1970s and early 1980s, accompanied by smaller average fish size, later-than-normal arrival timing, more northerly coastal landfall and higher proportions of fish returning through Johnstone Strait. Some of these changes may have been influenced by the warmer-than-normal sea surface temperatures in the eastern North Pacific that were also occurring. The trend toward larger sockeye salmon returns has accelerated in the late 1980s and early 1990s. Both species continue to exhibit below-average weights and northerly landfalls occur regularly. These changing features of the Fraser

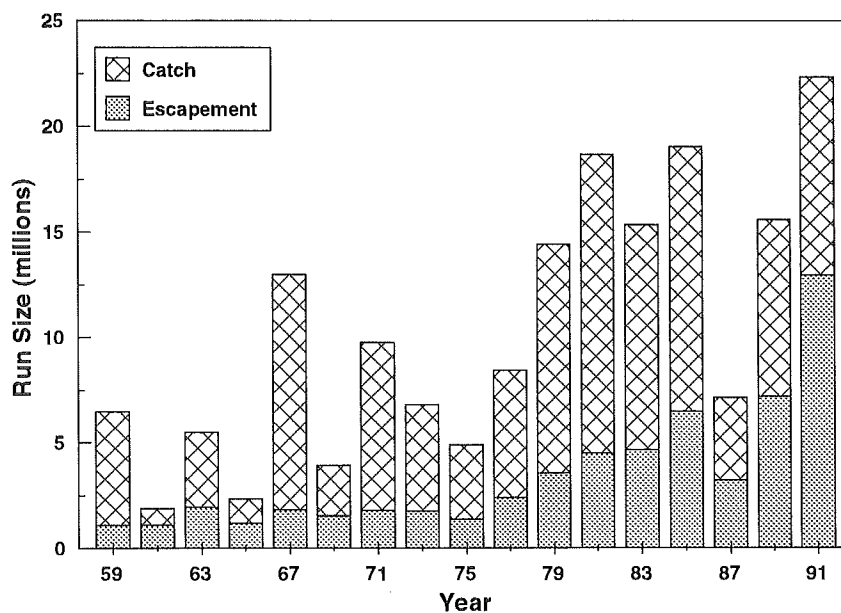


Figure 3. Catch, escapement and total returns of Fraser River pink salmon for odd years between 1959-91.

sockeye and pink runs strongly affect the management of the stocks and challenge the Fraser River Panel's ability to achieve their mandate.

The increased abundance of sockeye salmon would have led to higher annual harvest rates had escapement goals remained at fixed levels. However, beginning in 1985, Canada increased the goals with the result that the average harvest rate remained about the same (Figure 4). In the 1969-1984 period (16 years = 4 cycles) the average commercial harvest rate was 74% compared to 69% in the 1985-91 period (72% without 1988; the 1988 harvest rate was extremely low because of the poor return and need for escapement of the Chilko River stock).

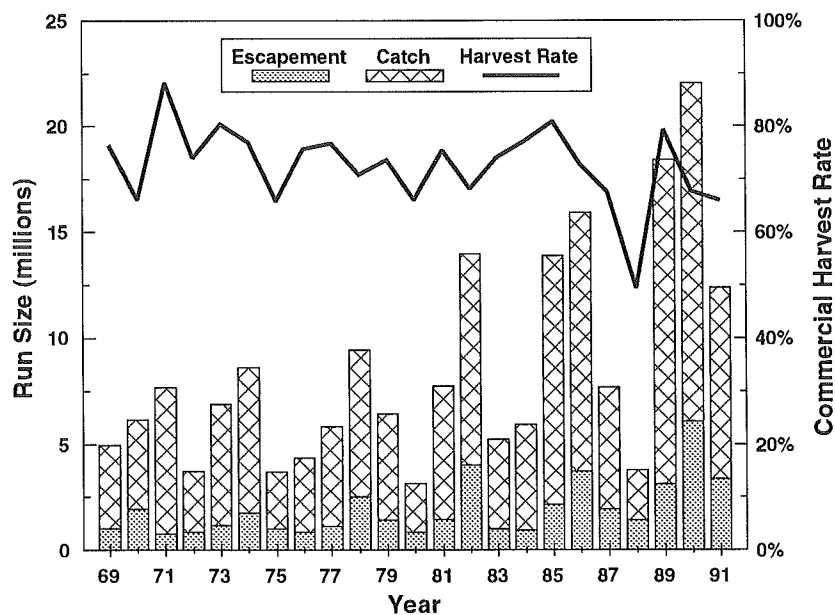


Figure 4. Catch, escapement and annual commercial harvest rate for Fraser River sockeye salmon in all fisheries.

While overall harvest rates of Fraser sockeye have been relatively stable and annual returns have increased, harvest rates in United States waters declined in the 1989-91 period because the cumulative 1989-92 catch is limited by the Treaty to 7,000,000 sockeye. United States Panel Area fishery harvests averaged 20% of the 1977-84 returns and the same percentage between 1985-88 (i.e., the first four years under the Treaty). Obtaining the comparatively low 1989-91 harvest rate of 12% presented the Panel with difficulties in developing annual United States management strategies. For example, reduced-hours openings were needed to maintain a low harvest rate, particularly on summer-run sockeye, and yet provide weekly fishing opportunities in both Treaty Indian and Non-Indian fisheries. Fishing time decreased in both sectors (Table 1).

Table 1. Average hours of fishing in United States net fisheries in the Fraser River Panel Area during sockeye and odd-year pink salmon fisheries.

Time Period	Treaty Indian		Non-Indian *	
	Sockeye	Pink	Sockeye	Pink
1981-84	458	659	371	139
1985-88	276	387	202	102
1989-91	110	203	99	130

* Total purse seine and/or gillnet openings.

In Canada, harvest rates increased in 1989-91 as United States rates dropped. In these three years, the Canadian commercial harvest averaged 58% of the total run versus 53% in 1977-84 and 47% in 1985-88. This increase occurred despite increasing restrictions on fisheries that occurred in recent years because of changes in allocation requirements and due to concerns for the conservation of other species and stocks of salmon. Increases in gear efficiency (e.g., net materials, electronics, techniques) and numbers of fishing vessels (due to increased mobility and reduced fishing opportunities in other areas) have further reduced the frequency and length of openings.

Restrictions in Canadian fisheries are most noticeable in outside troll fisheries: directed effort on sockeye is now so intense that fisheries, which until 1986 were open for the entire sockeye season, were in 1991 restricted to only ten days of fishing. In contrast, sockeye fishing time for Fraser River gillnets was slightly higher than during the 1981-88 period (Table 2). The river gillnet fishing time during odd-year pink salmon fisheries has declined in recent years, however, because Canada wished to restrict fishing during Harrison River chinook salmon and Thompson River steelhead migrations in the lower Fraser River.

Table 2. Average days of fishing in Canadian net fisheries during sockeye and odd-year pink salmon fisheries.

Time Period	Area 29 *		Area 20 **	
	Sockeye	Pink	Sockeye	Pink
1977-80	14.75	2.50	5.75	7.50
1981-84	11.00	7.50	5.75	7.00
1985-88	9.25	1.50	7.50	3.50
1989-91	11.67	1.00	8.67	2.50

* Usually 24-hour periods but includes shorter openings.

** Purse seine fishing periods of 12 hours duration.

Canadian purse seines in Area 20 have had more sockeye fishing time in recent years (Table 2) because of changes to their allocation goals. In contrast, pink salmon directed openings have been more restricted, offsetting the increase in sockeye fishing time.

Changes to management strategies have also affected the amount of fishing time. Fraser River (Area 29) openings are more frequently split-week openings, in which two days of fishing are separated by one or two days of closure, compared to the former practice of scheduling three consecutive days of fishing. This pattern was adopted to distribute catches more equally among Fraser River fishing areas without reducing total catches and to reduce the harvest of chinook salmon. Success in achieving these goals resulted in fewer "days" fishing.

Smaller fish sizes appear to be correlated with high ocean abundances and warm ocean temperatures. The Panel has responded to the reduced size only in minor ways, such as suggesting that gillnet fishermen use nets with smaller mesh-sizes. The smaller body size of pink salmon (1.8 kg) was addressed by Canada through an in-season increase in spawning escapement goals from 6,000,000 to 7,000,000 spawners, to compensate for the reduced fecundity of smaller females.

Deviations from normal migration timing in recent years have severely affected management of the fishery. Late timing of summer-run stocks coupled with relatively normal timing of late-run sockeye in 1990 and 1991 produced greater overlap of these groups and larger daily abundances of fish over shorter time-frames than in prior cycle years. Harvest requirements for sockeye and conservation concerns for coho and chinook salmon dictated that openings occur when sockeye or pink salmon were abundant, to minimize the proportion of non-target species in the catch. Thus, fisheries were concentrated into fewer weeks, but with larger daily catches. Delays in the first openings of the season have occurred in several recent years because the summer runs have arrived one to two weeks late at the fishing areas.

In several years (1978, 1980, 1981 and 1983), northerly landfall and other environmental conditions in coastal areas combined to cause 58-80% of these sockeye runs to approach the Fraser River via Johnstone Strait, compared to a normal rate of 25%. High proportions of the runs migrating through Johnstone Strait in these years led, at times, to large catches there and to severe restrictions in Canadian Area 20 (Juan de Fuca Strait) fisheries to insure that adequate numbers of fish were available in United States waters. In 1991, Area 20 remained closed during the week of August 11-17, when a high rate of Johnstone Strait migration jeopardized both United States and Area 29 harvests.

Landfall of significant numbers of Fraser River sockeye salmon in southeastern Alaska and sockeye and pink salmon in northern British Columbia have resulted in sizeable catches in these areas in recent years. Catches in these fisheries have affected international and domestic allocations in southern areas for both countries.

In recent years, Fraser River pink salmon have also migrated through Johnstone Strait at higher-than-normal (30%) rates, with 35-40% of the run approaching by this route. Fortunately, the arrival of pink salmon in fishery areas was late in both 1989 and 1991, allowing some separation between fisheries directed at major sockeye and pink salmon runs.

Variability in the many factors described above can dramatically affect management of the fishery. The Panel must accommodate these unforecastable events by in-season alteration of the pre-season plans to achieve the escapement goals and allocation objectives of the countries. In 1991, the Panel dealt with later-than-normal arrival, very small fish size and high (40%) proportions of Fraser sockeye and pink runs migrating via Johnstone Strait, plus significant catches of Fraser sockeye in northern areas. A major factor in the Panel's success in adapting to unique conditions each year is the flexibility to modify regulations on short notice in reaction to updates in abundance estimates and fish behaviour.

IV. MANAGEMENT ACTIONS

A. Pre-season Forecasts, Goals and TAC

Canada provided the Panel with run size forecasts and escapement goals for Fraser River sockeye and pink salmon stocks in January, 1991 (Appendix A). The forecast return of Fraser River sockeye salmon was 14,500,000 adults, with goals for gross and net escapements set at 4,575,000 and 3,775,000 adults, respectively. For Fraser River pink salmon, 11,000,000 fish were expected to return and the gross escapement goal was 4,500,000 fish. The forecast run size for pink salmon was lower than the recent average return of 15,000,000 fish because flooding in the fall of 1989 was believed to have reduced fry production from this brood (Appendix D: Table 7).

Based on these forecasts and goals, the total allowable catches (TACs) were 8,336,000 Fraser sockeye and 6,480,000 Fraser River pink salmon (Table 3). The United States set a sockeye catch goal for Washington fisheries of 1,800,000 fish. Canada's share was the remaining 8,425,000 Fraser sockeye, which included a benefit of 1,889,000 fish for allowing 276,000 additional fish from their 1987 allocation to spawn.

Table 3. Pre-season estimates of the total allowable catches and international catch goals and allocations of Fraser River sockeye and pink salmon in 1991.

	<u>Sockeye</u>	<u>Pink</u>
TOTAL ALLOWABLE CATCH		
Total Run Size	14,500,000	11,000,000
Canadian Escapement Add-on Benefit	1,889,000 *	0
Total Available to Share:	12,611,000	11,000,000
Deductions		
Adult Escapement Goal	3,775,000	4,500,000
Jack Escapement	25,000	0
Fraser River Indian Food Fishery Exemption	400,000	0
Test Fishing	75,000	20,000
Total Deductions	4,275,000	4,520,000
Total Allowable Catch:	8,336,000	6,480,000
UNITED STATES		
Initial Allocation	1,800,000 **	1,666,000 ***
Payback	---	241,000 ****
United States Share:	1,800,000	1,907,000
CANADA		
TAC - United States Share	6,536,000	4,573,000
Escapement Add-on Benefit	1,889,000 *	0
Canadian Share:	8,425,000	4,573,000

* Method of calculation agreed-to by Fraser River Panel on February 8, 1991.

** The United States sockeye allocation was the amount requested by the United States section of the Panel for Washington fisheries.

*** The initial United States pink salmon allocation was calculated by the formula:
Allocation = TAC x 3.6 / 14.0.

**** Partial payback of fish owed the United States due to a catch shortfall in 1989.

In accordance with a Commission agreement (July 17, 1990), United States catches of Early Stuart, early summer-run, summer-run and late-run stock groups were to be in proportion to the TACs of these groups. The anticipated United States catches of these stock groups were: Early Stuart - 46,000; summer-run fish - 448,000; and late-run fish - 1,306,000.

The pre-season United States catch goal of Fraser River pink salmon was 1,907,000 fish, which included 241,000 fish (5% of the Canadian share of the TAC) for a partial payback of a catch shortfall in 1989. The remaining 4,573,000 fish comprised Canada's share.

Domestic allocation goals for Fraser River sockeye in Canada were more complex in 1991 than in previous years. Each commercial gear was allocated different percentages for the first 3,200,000 fish caught (base catch) and for catches exceeding this number (incremental catch) (Table 4). As well, because of the policy of "Catch up/Make up" announced by the Minister of Fisheries on May 31, 1991, the allocations were adjusted to account for an overage of 264,000 sockeye in the 1990 gillnet catch.

Table 4. Domestic allocation plan for Canadian commercial catches of Fraser River sockeye and southerly migrating pink salmon in 1991.

Fraser River Sockeye Salmon				Southerly Migrating Pink Salmon Allocation
Gear Type	Allocation		Payback	
	Base Catch *	Incremental Catch **		
Inside Troll	2.2%	3.0%	24,000	
Outside Troll	10.8%	18.5%	237,000	
Purse Seine	52.0%	47.0%	3,000	
Gillnet	35.0%	31.5%	(264,000)	
Total	100.0%	100.0%	0	

* Base catch: First 3,200,000 sockeye in Canadian commercial catch.

** Incremental catch: Canadian commercial catch in excess of the base catch.

The Canadian allocation of southerly migrating pink salmon among the commercial gear types was 4% for inside troll, 29% for outside troll, 58% for purse seine and 9% for gillnet. No specific goals were set for catches of Fraser River pink salmon.

In the United States, Treaty Indian fishermen were allocated 790,000 Fraser sockeye: 90,000 in Areas 4B, 5 and 6C, and 700,000 in Areas 6, 7 and 7A. Non-Indian fishermen were allocated the remaining 1,010,000 fish in the United States catch goal, with 500,000 of these allocated to purse seines, 450,000 to gillnets and 60,000 to reefnets. United States catches of pink salmon were to be divided equally between Treaty Indian and Non-Indian fishermen. Within the Non-Indian share, commercial trollers in Areas 3 and 4 had a harvest quota of 160,000 Fraser pinks.

Given the various forecasts and goals, the projected distribution of adult Fraser River sockeye was 9,875,000 in commercial, test and non-Fraser Indian food fishery catches, 800,000 in Fraser River Indian food fishery catches and 3,775,000 spawning escapements (Table 5). For Fraser River pink salmon, the distribution was expected to be 6,500,000 in catches and 4,500,000 in escapements.

B. Pre-season Regulations

The 1991 Regulations and Management Plan for the Panel Area were developed to achieve the catch and escapement goals described above. The timing and sequence of the proposed fisheries in the Plan were determined using the pre-season forecasts for run sizes (Appendix A), timing (Figure 5) and migration route (Figure 6). These were inputs for the fishery model used to evaluate the impacts of management options on the goals of the Panel. The major targets of this year's sockeye fishery, the Chilko and Adams/Lower Shuswap stocks, were expected to peak in Area 20 about July 31 and August 16, respectively, and 25% of the Fraser River run was forecast to migrate through Johnstone Strait. The forecasts for Fraser River pink salmon were for an Area 20 peak migration date of about August 26 and a diversion rate of 30%. Substantial overlap in the sockeye and pink salmon runs were expected to complicate management of the fisheries.

Table 5. Pre-season (January 16, 1991) forecasts of catches and escapements of Fraser River sockeye and pink salmon runs in 1991.

Run	River & Ocean Catch *	Fraser IFF ** Catch	Net Escapement	Gross *** Escapement	Total Run
Sockeye Salmon					
Early Stuart	100,000	200,000	200,000	400,000	500,000
Early Summer	455,000	133,500	313,500	447,000	902,000
Summer	1,697,000	300,000	903,000	1,203,000	2,900,000
Late	7,623,000	166,500	2,358,500	2,525,000	10,148,000
Total Adults	9,875,000	800,000	3,775,000	4,575,000	14,450,000
Jacks	25,000	0	25,000	25,000	50,000
Total Sockeye	9,900,000	800,000	3,800,000	4,600,000	14,500,000
Pink Salmon					
Total Pink Salmon	6,500,000	0	4,500,000	4,500,000	11,000,000

* Includes ocean and river catches in commercial, test and other fisheries, excluding the Fraser River Indian food fishery.

** IFF = Indian food fishery.

*** Gross Escapement = IFF Catch + Net (Spawning) Escapement

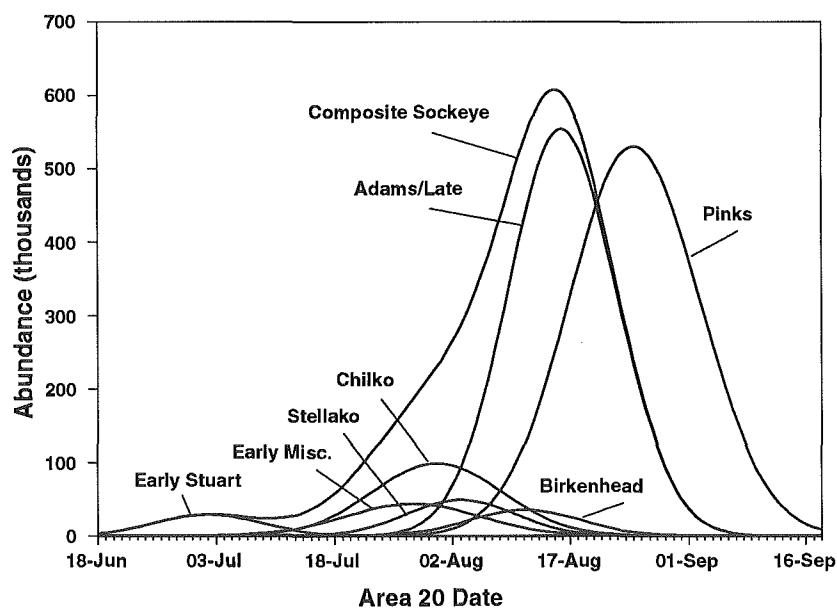


Figure 5. Pre-season expectations of the abundances of migrating Fraser River sockeye and pink salmon in Area 20 in 1991.

The sockeye catch was expected to consist mostly of late-run fish (about 75%), primarily from the Adams River/Lower Shuswap stock group. Chilko and Stellako River sockeye were projected to comprise the second largest component of the catch. Early Stuart and early summer-run fish were expected to be sufficiently abundant to support fisheries in Canadian Area 29 and United States Areas 7 and 7A in early July.

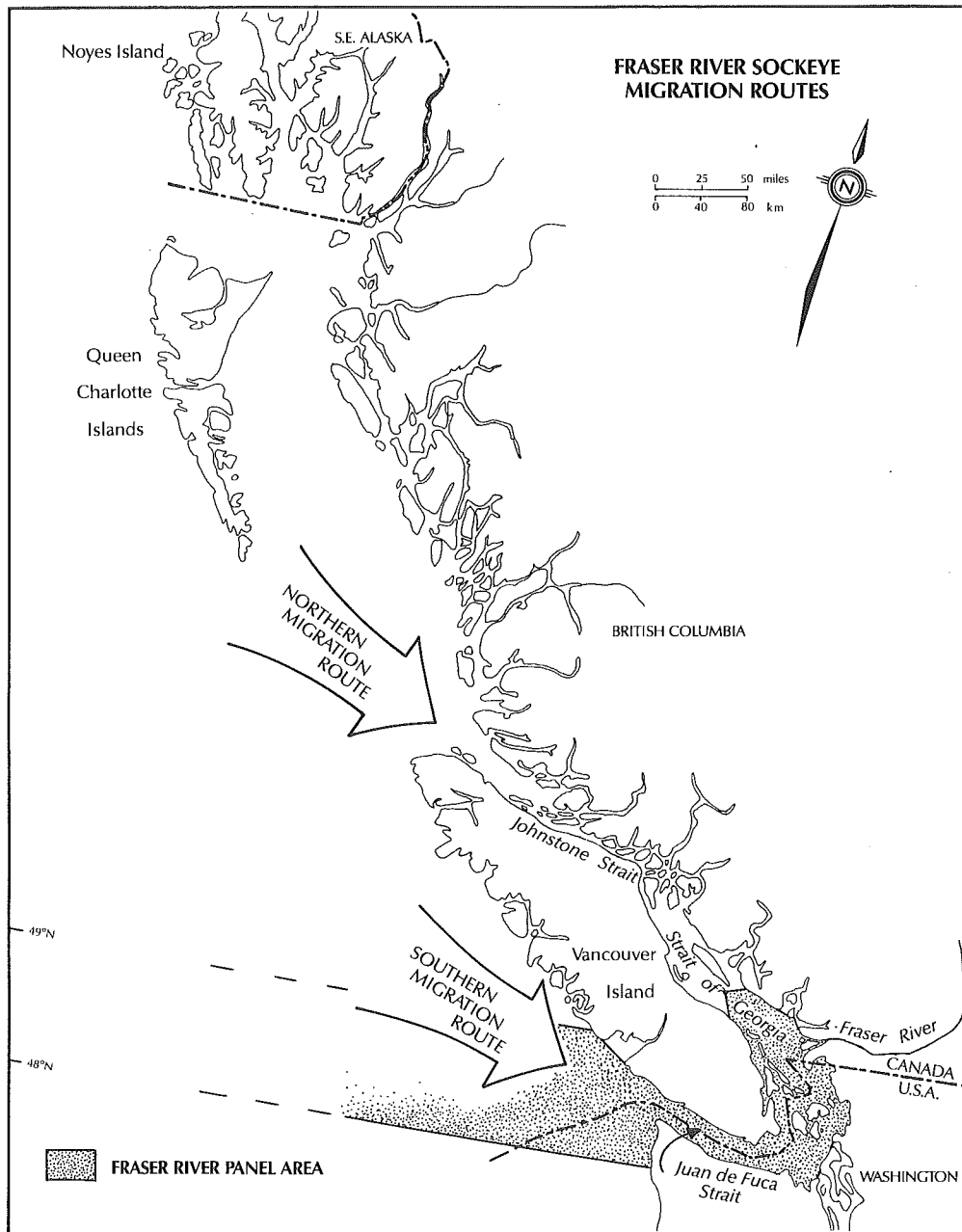


Figure 6. The northern (Johnstone Strait) and southern (Juan de Fuca Strait) routes for sockeye and pink salmon migrating to the Fraser River.

The United States submitted a fishing schedule for the Non-Indian commercial troll fishery for pink salmon in Areas 3 and 4 on April 25. This plan specified a harvest quota of 160,000 Fraser River pinks and catch guidelines of 35,000 coho and 3,500 chinook salmon. The fishery was to close when the pink catch quota was achieved or when the coho or chinook catch guidelines were reached.

Both Canada and the United States identified stocks for which conservation or management concerns existed. The stocks identified by the United States were: Skagit River sockeye, natural coho and summer chinook salmon; Lake Washington sockeye salmon; Hood Canal natural coho salmon; and coho and chinook salmon from the Stillaguamish and Snohomish Rivers. Canada

identified concerns for Harrison River and early Fraser River chinook salmon stocks, Thompson River steelhead, chinook by-catch in purse seine fisheries in Area 20 and coho by-catch in Area 20 after September 7. The Management Plan accommodated these concerns in the following ways:

1. Commercial fisheries in United States Areas 4B, 5, and 6C were to remain closed until the third week of July and Canadian Area 20 was to be closed until the last week of July to help protect the Lake Washington and Skagit River sockeye runs.
2. To address United States and Canadian concerns, the by-catch of coho and chinook salmon was to be monitored in Panel Area fisheries, particularly in Area 20 purse seine fisheries, and reported in-season.
3. Areas 4B, 5 and 6C were to be closed to Non-Indian net fishing after August 16 to reduce the by-catch of coho salmon. This fishery could be extended if the Non-Indian cumulative coho catch was less than 600 fish on August 16.
4. Area 6A was closed throughout the season to protect Skagit River sockeye, natural coho and chinook salmon, and limit the catch of Stillaguamish and Snohomish River coho and chinook salmon.
5. If early chinook salmon runs to the Fraser River appeared to be weak, then the provision was made to delay the opening date of sockeye fisheries.
6. To protect the Harrison River chinook and Thompson River steelhead, sockeye fisheries in Area 29 were designed to "front-end load" the gillnet catch and to close after September 4.

Stocks frequently deviate from pre-season expectations of run size, timing and migration route, which leads to management difficulties if the Management Plan is not adjusted to compensate for this variation. To align the timing of commercial troll fisheries with the migration of the stocks they were intended to target on, Canada notified the Panel of criteria that DFO would use to objectively decide when to begin fishing. The coastwide outside troll opening for retention of sockeye was to occur when 1) the majority of summer-runs were in the net areas (Area 20 and Johnstone Strait), 2) summer-run abundance was declining and late-run abundance was increasing in test fishing catches on the west coast of Vancouver Island, and 3) racial analysis indicated that late-run fish were more abundant than summer-run fish. Similar to 1990, this strategy was designed so that inside (Area 29) gillnets would take most of their catch from the Canadian share of Early Stuart, early summer- and summer-run sockeye, and outside net and troll fisheries would take primarily late-run sockeye.

In early May, the Panel adopted regulations (Appendix B) for regulatory control of the Panel Areas. The Commission accepted the regulations and submitted them to the Parties on May 6. As in previous years, fisheries regulated by the Panel were to be "Closed Unless Opened" by in-season Orders of the Panel.

The Panel finalized the Management Plan for 1991 on June 25. Under this plan, the goals for United States harvests were 1,800,000 Fraser River sockeye and 1,907,000 Fraser pinks in Washington fisheries. Canadian commercial catches were forecast at 7,845,000 sockeye and 4,353,000 pink salmon.

In the Management Plan, the proposed first openings for fisheries in Canadian Panel Areas were the week of June 30-July 6 for gillnets in Area 29, July 28-August 3 for gillnets in Area 20, August 4-10 for purse seines in Area 20 and trollers in Area 18-4, and August 18-24 for trollers in Areas 18-1 and -11.

Proposed first openings of Treaty Indian fisheries in United States Panel Areas were the week of July 7-13 in Areas 6, 7 and 7A and July 21-27 for Areas 4B, 5 6C. For Non-Indian fisheries the dates were July 7-13 in Areas 6, 7 and 7A, July 28-August 3 in Areas 4B, 5 and 6C and August 16-19 for troll fishing in Areas 3 and 4.

C. In-season Regulations

The Fraser River Panel conferred 39 times, by telephone or in-person, between June 27 and October 4 to enact in-season orders (Appendix C) to regulate the fisheries on Fraser River sockeye and pink salmon in the Panel Area. The frequency of these meetings (as many as six in one week) in late August through mid September, attest to the difficulty of managing the fisheries in 1991. In many cases the data the Panel used to make decisions differed widely from pre-season forecasts (e.g., Chilko and Adams River run sizes) and even from estimates made the previous day or week (e.g., run size estimates for Early Stuart sockeye and Fraser River pink salmon). Also, normally reliable historical migration patterns did not materialize, for example: a very sharply peaked migration of Early Stuart sockeye; the late arrival and unexpected high abundance of summer-run stocks; the subsequent atypical delay of summer-run fish off the mouth of the Fraser River and; the low abundance of Adams River fish on the coast until they arrived in the Panel Area at half the expected abundance. These events combined to fuel many Panel discussions and resulted in a very demanding season. Domestic allocation goals were often of major concern and extra meetings were required to insure the data needed for appropriate decisions were at hand.

The following paragraphs attempt to summarize the events of the season on a weekly basis, with an emphasis on what the Panel decided and why.

During the first in-season meeting on June 27, the proposed gillnet fishery in Canadian Area 29 during the week of June 30-July 6 was delayed because the Early Stuart run appeared to be late in arriving and lower in abundance than expected.

On July 5, Canada announced a reduction in the gross escapement goal from 4,600,000 to 4,235,000 Fraser River sockeye salmon. This change was expected to increase the Canadian commercial catch of Fraser sockeye from 7,870,000 to 8,235,000 fish and lower the escapement of sockeye to the spawning grounds from 3,800,000 to 3,435,000 fish.

Record test fishing catches of Early Stuart sockeye in Area 20 (July 4-6) prompted the Panel on July 8 to double the run size estimate for this stock from 500,000 to 1,000,000 fish, with a corresponding increase in the total Fraser sockeye run to 15,000,000 fish. To begin harvesting these fish and achieve the international and domestic allocation goals, Area 29 was opened to gillnets during the week of July 7-13. At meetings on July 9 and 10, the Area 29 fishery was extended and Areas 7 and 7A were opened for net fishing by Treaty Indian and Non-Indian fishermen.

The July 8 run size increase led Canada to raise gross escapement goals to 560,000 Early Stuart sockeye and 4,315,000 total Fraser sockeye on July 9. However, by July 12, lower-than-expected catches in the Area 29 and Areas 7 and 7A fisheries had raised doubts that the Early Stuart run would reach the revised estimate. All Panel Area fisheries remained closed during the week of July 14-20 to ensure that escapement goals for the Early Stuart run would be achieved.

On July 15, the weakness of the latter portion of the Early Stuart run caused the Panel to return the run size estimate to the pre-season forecast of 500,000 fish. Canada responded by reducing the gross escapement goal for this stock to 400,000 fish as in the pre-season plan. At the July 19 and 22 meetings, the Panel decided to maintain the closures on all Panel Areas to allow the latter portion of the Early Stuart stock to escape. Also, early summer- and summer-run sockeye appeared to be late.

By July 26, analyses of test fishing data suggested that the main summer-run stocks (Chilko and Stellako River runs) were arriving about one week later than normal, while late-run stocks still were not evident on the west coast of Vancouver Island. However, due to adequate escapements of Early Stuart sockeye and the need to harvest summer-run sockeye, the Panel opened Areas 20 and 29 for gillnets and Areas 4B, 5 and 6C to Treaty Indian gillnet fishing during the week of July

28-August 3. Concerns that an oil spill at the mouth of Juan de Fuca Strait would require changes to these plans were fortunately not realized.

Summer-run sockeye were present in good abundances along the coast by August 2 and, although about ten days late, were expected to peak in Area 20 near August 10. However, there was a very weak showing of the late-run stocks that should have been present and were expected to provide most of the commercial catch in 1991. To continue harvesting summer-run sockeye, Areas 20 and 29 were opened for gillnets and Areas 4B, 5, 6, 6C, 7 and 7A were opened for Treaty Indian and Non-Indian net fishing during the week of August 4-10. The Area 29 fishery and Treaty Indian fishery in Areas 4B, 5 and 6C were extended at the August 6 meeting of the Panel.

The situation was still unclear by August 9. The run size of summer-run sockeye appeared to be larger than forecast but, because of the continued lack of late-run sockeye and particularly of Adams River/Lower Shuswap sockeye, the total run of Fraser River sockeye was thought to be less than the pre-season forecast of 14,500,000 fish. Meanwhile, the diversion rate through Johnstone Strait had increased from a normal level of 25% to about 50%, which potentially made it difficult for the United States to catch their allocation. To continue harvesting summer-run sockeye during the week of August 11-17, the Panel assumed regulatory control of Canadian Area 18-4 and opened it for trolling, opened Area 29 to gillnets, and opened Areas 4B, 5, 6, 6C, 7 and 7A for Treaty Indian and Non-Indian net fishing. Area 20 remained closed to ensure that sufficient fish were available in United States areas for international allocation purposes. The Panel also opened Areas 3 and 4 to Non-Indian trollers from August 16 to 19 to harvest pink salmon. On August 12, the Panel closed the Treaty Indian fishery in Areas 4B, 5 and 6C two days earlier than planned because they were close to their catch allocation of 90,000 Fraser sockeye.

The estimated total run size for Fraser River sockeye salmon was reduced from the pre-season forecast of 14,500,000 to 11,000,000 fish on August 16. The Early Stuart run appeared to be close to the 500,000 estimate, while summer-run stocks (5,000,000 fish) were more abundant than forecast (3,800,000 fish) and late-run fish (5,500,000 fish) were considerably less abundant than forecast (10,148,000 fish). The Johnstone Strait diversion rate remained high but showed signs of moderating. To take the available TAC of late-run sockeye and the remaining catch of summer-run fish, Area 20 was opened for purse seines and gillnets, Area 18-4 remained open for trolling, Areas 4B, 5, 6, 6C, 7 and 7A were opened for Treaty Indian nets and Areas 7 and 7A were opened for Non-Indian net fishermen during the week of August 18-24. Area 29 remained closed to allow the summer-run sockeye delaying off the mouth of the Fraser River to escape upstream. At the August 19 meeting of the Panel, the Area 20 fishery was extended to harvest additional late-run fish. However, to limit the catch of summer-run sockeye, the last day of the scheduled Non-Indian gillnet opening in Areas 7 and 7A was cancelled, the Treaty Indian fishery in Areas 6, 7 and 7A was cut short by eleven hours and the inside troll fishery in Area 18-4 was closed until further notice. The Area 20 purse seine fishery was extended another day at the Panel meeting on August 20. The Panel also opened Areas 7 and 7A to Non-Indian purse seines. At yet another Panel meeting the next day, the Non-Indian troll fishery in Areas 3 and 4 was opened.

On August 23, the Panel increased the run size estimate to 12,000,000 Fraser sockeye, which would be a record high for recent years on this cycle. Canada notified the Panel on August 26 of changes to escapement goals based on the revised run size: a total gross escapement goal of 3,894,000 adult sockeye was set. Fraser River pink salmon were now increasing in abundance in Juan de Fuca and Johnstone Straits, with indications that the run was larger than the pre-season forecast of 11,000,000 fish and arriving later than normal. To harvest sockeye and pink salmon the Panel opened the net fishery in Area 20, the troll fishery in Area 18-4, and the Non-Indian reefnet and purse seine fisheries in Areas 7 and 7A during the week of August 25-31. The Panel met again on August 25 to open Area 29 to gillnets. The Panel extended the Area 20 and 18-4 fisheries at an August 26 meeting, and cancelled the last day of the scheduled Non-Indian reefnet opening in Areas 7 and 7A. At a subsequent meeting on August 28, Area 18-4 was closed and Areas 3 and 4 were opened to troll fishing.

Large catches of pink salmon by a record fleet of 223 purse seines in Area 20 prompted the Panel to increase the run size estimate for Fraser pinks to 13,000,000 fish on August 30. Canada responded to this increase by raising the gross escapement goal to 6,000,000 fish, consistent with their pre-season plan to raise the escapement goal if the run size increased. Pink salmon were expected to peak in Area 20 in the upcoming week, while sockeye abundance continued to decrease. For the week of September 1-7, the Panel scheduled openings in Areas 20 and 29 for gillnet fishing, Area 18-4 for inside trollers, Areas 4B, 5, 6, 6C, 7 and 7A for Treaty Indian net fishermen and Areas 7 and 7A for Non-Indian reefnets. Area 20 remained closed to purse seines because they had exceeded their sockeye allocation. At a subsequent Panel meeting on September 2, the Panel cancelled the Area 29 gillnet fishery because of escapement concerns for summer-run and Birkenhead sockeye, and reopened the Non-Indian reefnet fishery in Areas 7 and 7A. At four other meetings on September 3, 4 and 5, the Panel extended the Treaty Indian net fishery in Areas 4B, 5, 6, 6C, 7 and 7A, opened the Non-Indian net fishery in Areas 7 and 7A, and opened Areas 3 and 4 to Non-Indian troll fishing.

By September 6, the United States was close to their allocation of Fraser sockeye. Meanwhile, Canadian fisheries had been restricted because summer-run and Birkenhead sockeye had ceased to migrate into the River and because purse seines had taken their pink salmon allocation at the ambient run size estimate of 13,000,000 Fraser pinks. At the September 6 meeting, the Panel increased the run size estimate of Fraser River pink salmon to 15,000,000, although the resulting increase in TAC was small because Canada raised the escapement goal to 7,000,000 fish. The rationale for increasing the escapement goal was that the large population of Fraser pinks was composed of very small fish, which have lower fecundities and are therefore less productive. Therefore, more spawners were necessary to approximate the production potential of 6,000,000 normally-sized pink salmon. Also by September 6, the summer-run and Birkenhead stocks that were delaying in the Strait of Georgia resumed their flow into the River. To take the remaining TAC of pink and sockeye salmon, the Panel opened Area 29 for gillnets, Areas 6, 7 and 7A for Treaty Indian nets and Areas 7 and 7A for Non-Indian reefnets during the week of September 8-14. United States Areas 4B, 5 and 6C and Canadian Area 20 remained closed due to concerns for coho salmon. A subsequent meeting on September 9 resulted in an extension to the Treaty Indian fishery and opening of the Non-Indian fishery to gillnets and purse seines. At another meeting on September 11, at which the estimated run size of Fraser River pink salmon was increased to 16,000,000, the Panel opened Area 18-4 to Canadian trollers, extended the Treaty Indian and Non-Indian fisheries, and relinquished control of United States Areas 3 and 4. At this time, the Fraser pink migration appeared to be at least two weeks late and with a diversion rate of 40-45% through Johnstone Strait compared to the normal 30%.

Continued strong catches of Fraser River pink salmon in Canadian and United States fisheries led the Panel to increase the run size estimate for Fraser pinks to 17,000,000 on September 13. To harvest the remaining allocations of sockeye and pink salmon, the Panel opened the Area 29 troll fishery, extended the Treaty Indian net fishery in Areas 6, 7 and 7A, and opened the Non-Indian reefnet fishery during the week of September 15-21. The Panel relinquished control of Canadian Area 20 and United States Areas 4B, 5 and 6C on September 15. At September 17, 18 and 19 meetings of the Panel, discussion focused on an issue that affected the United States share of the TAC. This issue was the subject of an official protest by the United States and is explained later in the "International Allocation" section of the chapter on "Achievement of Objectives". Also at the September 18 and 19 meetings, the Panel extended regulatory control of Areas 7 and 7A and scheduled additional openings for Treaty Indian net and Non-Indian reefnet fishermen.

The Panel met on September 23 and relinquished control of Canadian Area 18-4 effective September 24, and Areas 17 and 18 and United States Areas 7 and the southern portion of 7A effective September 29.

On September 30, the Panel increased the run size estimate of Fraser River sockeye to 12,700,000 fish. The Panel also scheduled a final gillnet opening in Area 29 during the week of

September 29-October 5. Regulatory control of the remaining portion of United States Area 7A was relinquished on October 6 and of Canadian Area 29 on October 13.

The amount of net fishing time in Canadian Panel Areas (Table 6) was similar to the proposed sums, even though actual openings did not closely match the proposed openings. In particular, purse seines in Area 20 opened two weeks late and fished only two of the four weeks proposed, because of the lateness of the summer- and late-run sockeye stocks and because allocation objectives were achieved quickly once fishing commenced.

Net fishing times in United States Panel Areas are shown in Table 7. Precise amounts of fishing time were not proposed in United States waters at the beginning of the season, thus the actual schedule of fishing cannot be compared with specific expectations.

Table 6. Proposed versus actual fishing times (days) by gear type in major Canadian net fisheries in the Fraser River Panel Area in 1991.

Date	Area 20 *				Area 29 **	
	Purse Seine		Gillnet		Gillnet	
	Proposed	Actual	Proposed	Actual	Proposed	Actual
June 30-July 6	Closed	Closed	Closed	Closed	1	Closed
July 7-13	Closed	Closed	Closed	Closed	Closed	1.5
July 14-20	Closed	Closed	Closed	Closed	1	Closed
July 21-27	Closed	Closed	Closed	Closed	1	Closed
July 28-Aug.3	Closed	Closed	2	2	1	2
Aug. 4-10	1	Closed	4	2	1	1.5
Aug. 11-17	3	Closed	4	Closed	1	1
Aug. 18-24	3	3	4	4	1	Closed
Aug. 25-31	1	3	4	4	Closed	1
Sept. 1-7	Closed	Closed	Closed	2	Closed	Closed
Sept. 8-14	Closed	Closed	Closed	Closed	Closed	1
Sept. 15-21	Relinq.	Relinq.	Relinq.	Relinq.	Closed	Closed
Sept. 22-28					Closed	Closed
Sept. 29-Oct. 5					Closed	0.5
Oct. 6-12					Closed	Closed
Oct. 13-19					Relinq.	Relinq.
Total	8	6	18	14	7	8.5

* Area 20 fishing times are measured in 12- or 13-hour days to correspond with the duration of openings.

** Area 29 fishing times are measured in 24-hour days.

Table 7. Actual fishing times [periods(hours)] by area in major United States net fisheries in the Fraser River Panel Area in 1991.

Date	Treaty Indian		Non-Indian		
	Areas		Areas 7, 7A		
	4B, 5, 6C	6, 7, 7A	Purse Seine	Gillnet	Reefnet
July 7-13	Closed	1 (4)	1 (5)	1 (7)	Closed
July 14-20	Closed	Closed	Closed	Closed	Closed
July 21-27	Closed	Closed	Closed	Closed	Closed
July 28-Aug.3	4 (96)	Closed	Closed	Closed	Closed
Aug. 4-10	4 (96)	1 (12)	1 (5) *	1 (8) *	1 (15)
Aug. 11-17	2 (52)	2 (43)	2 (30) *	2 (30) *	2 (33)
Aug. 18-24	1 (6)	1 (19)	1 (8)	1 (21)	Closed
Aug. 25-31	Closed	Closed	1 (7)	Closed	1 (17)
Sept. 1-7	4 (91)	2 (57)	2 (26)	2 (33)	4 (64)
Sep. 8-14	Closed	5 (115)	1 (11)	2 (29)	3 (48)
Sep. 15-21	Relinq.	4 (77)	Closed	Closed	3 (48)
Sep. 22-28		Closed	Closed	Closed	Closed
Sep. 29-Oct. 5		Relinq.	Relinq.	Relinq.	Relinq.
Total	15 (341)	16 (327)	9 (92)	9 (128)	14 (225)

* Areas 4B, 5, 6 and 6C were also open.

Table 8. Preliminary estimates of fishery catches and total run of Fraser River sockeye salmon during the 1991 fishing season, by country and area.

	<u>Number of Fish</u>	<u>% of Run</u>
COMMERCIAL CATCH		
CANADA		
Fraser River Panel Area		
Areas 121-124 Troll *	275,000	
Area 20 Net	1,278,000	
Areas 17-18 and 29 Troll	124,000	
Area 29 Net	811,000	
Total	2,488,000	20.1%
Non-Panel Areas		
Areas 1-10 Troll and Net	257,000	
Areas 11-16 Troll and Net	2,420,000	
Areas 124-127 Troll *	1,117,000	
Total	3,794,000	30.7%
CANADA TOTAL	6,282,000	50.8%
UNITED STATES		
Fraser River Panel Area		
Areas 4B, 5 and 6C Net	99,000	
Areas 6 and 7 Net	932,000	
Area 7A Net	786,000	
Total	1,817,000	14.7%
Non-Panel Areas		
Alaska Net	64,000	0.5%
UNITED STATES TOTAL	1,881,000	15.2%
COMMERCIAL TOTAL	8,163,000	65.9%
NON-COMMERCIAL CATCH		
CANADA		
Areas 12-13, 18, 20, 29, 123-124 Indian Food Fishery	91,000	
Area 12 Test Fishing	5,000	
Other Catches (Charters, etc.)	47,000	
Fraser River Indian Food Fishery	606,000	
Recreational Fishery	24,000	
Total	773,000	6.2%
UNITED STATES		
Ceremonial and Test Fishing	1,000	0.0%
COMMISSION		
Areas 123-127, 20 and 29 Test Fishing	87,000	
Areas 7 and 7A Test Fishing	13,000	
Total	100,000	0.8%
NON-COMMERCIAL TOTAL	874,000	7.1%
TOTAL CATCH	9,037,000	73.0%
SPAWNING ESCAPEMENT		
	3,341,000	27.0%
TOTAL RUN	12,378,000	100.0%

* Troll catch in Area 124 is divided between Panel and non-Panel Areas.

V. CATCH SUMMARY

A. Sockeye Salmon

The total return of 12,378,000 Fraser River sockeye salmon (Table 8) was 2,122,000 less than the pre-season forecast of 14,500,000 fish. The total catch of 9,037,000 sockeye was consequently also less than the projected 10,700,000 (Table 5). Despite being less than expected, this is the largest catch on the 1991 cycle since 1899. The commercial catch component in the total catch was 8,163,000 fish while the non-commercial catch was 874,000 fish.

The gross landed value of the commercial catch was approximately \$66,000,000 (CDN) with a weight of 20,000,000 kg (44,000,000 lb).

i. Canada

Canada caught a total of 7,055,000 Fraser River sockeye salmon (Table 8) in commercial and non-commercial fisheries. The commercial catch was 6,282,000 Fraser sockeye, 2,488,000 in Panel Areas and 3,794,000 in non-Panel Areas. The largest catches occurred in Areas 11-16, Area 20, Areas 121-127 and Area 29. Purse seines took the largest share (43.8%) of the commercial catch, followed by gillnets (28.4%), outside trollers (24.4%) and inside trollers (3.5%) (Table 9). Weekly catches in Canadian fishing areas are shown in Appendix D (Tables 1-4).

Table 9. Preliminary estimates of Canadian catches* of Fraser River sockeye salmon by gear type and area during the 1991 fishing season.

Areas	Inside Troll	Outside Troll	Purse Seine	Gillnet	Total
1-10	0	132,000	124,000	1,000	257,000
11-16	94,000	8,000	1,806,000	512,000	2,420,000
121-127	0	1,392,000	0	0	1,392,000
20	0	0	819,000	459,000	1,278,000
17, 18, 29	124,000	0	0	811,000	935,000
Total Catch	218,000	1,532,000	2,749,000	1,783,000	6,282,000
% of Catch	3.5%	24.4%	43.8%	28.4%	100.0%

* Preliminary catch data from fish sales slips from Canada Department of Fisheries and Oceans.

The non-commercial catch of 773,000 fish was split among the Fraser River Indian Food Fishery (606,000 fish), the non-Fraser Indian Food Fishery (91,000 fish), DFO charter catches (47,000 fish), recreational catches (24,000 fish) and Area 12 test fishing catches (5,000 fish). The Fraser River Indian Food Fishery catch was the largest recorded for the 1991 cycle and the second largest of any year on record. Most of the 1991 catch (333,000 fish) was taken between Mission and North Bend (Appendix D: Table 5). Indian Food Fishery catches in marine areas (91,000 Fraser sockeye) were also the second highest recorded, close to the record 114,000 fish in 1990. Catches in this fishery in 1987 were 39,000 sockeye salmon.

ii. United States

The United States caught 1,882,000 Fraser River sockeye salmon in 1991, 1,817,000 in commercial Panel Area fisheries, 64,000 in Alaska District 104 and 1,000 in non-commercial fisheries (Table 8). The majority of the catch was taken in net fisheries in Area 6, 7 and 7A. Treaty Indian catches were 93,000 fish in Areas 4B, 5 and 6C and 745,000 fish in Areas 6, 7 and 7A for a total of 838,000 Fraser sockeye (Table 10). The distribution among gear types of the Non-Indian catch of 980,000 fish was 502,000 fish in purse seines, 417,000 in gillnets and 61,000 in reefnets. Weekly catches of Fraser River sockeye salmon in United States Panel Areas are shown in Appendix D (Table 6).

Table 10. Preliminary estimates of United States catches* of Fraser River sockeye salmon by user group, gear type and area during the 1991 fishing season.

Areas	Test and Ceremonial	Purse Seine	Gillnet	Reefnet	Total
Treaty Indian					
4B, 5 and 6C	0	0	93,000	0	93,000
6 and 7	1,000	166,000	186,000	0	353,000
7A	0	103,000	289,000	0	392,000
6, 7 and 7A Total	1,000	269,000	475,000	0	745,000
% of Catch	0.1%	36.1%	63.8%	0.0%	100.0%
Total Catch	1,000	269,000	568,000	0	838,000
% of Catch	0.1%	32.1%	67.8%	0.0%	100.0%
Non-Indian					
4B, 5 and 6C		0	6,000	0	6,000
6 and 7		294,000	225,000	61,000	580,000
7A		208,000	186,000	0	394,000
Total Catch		502,000	417,000	61,000	980,000
% of Catch		51.2%	42.6%	6.2%	100.0%
United States					
Panel Area Total	1,000	771,000	985,000	61,000	1,818,000
Alaska (District 104) Catch					64,000
Total Catch					1,882,000

* Preliminary Washington catch data from Washington Department of Fisheries "soft system" totals.

B. Pink Salmon

The large return of 22,333,000 Fraser River pink salmon led to a total catch of 9,390,000 fish (Table 11), which was 2,890,000 fish more than the pre-season catch projection of 6,500,000 fish (Table 5). Although this catch is substantial, it is slightly smaller than the average catch since 1979 (10,100,000 fish). Six of the largest catches recorded for pink salmon have been taken from the seven pink runs since 1979 (Figure 3). Included in the 1991 total are commercial catches of 8,988,000 fish and non-commercial catches of 402,000 fish.

The gross landed value of the commercial catch was approximately \$13,300,000 (CDN) with a weight of 16,200,000 kg (35,600,000 lb).

i. Canada

Canada's catch of 6,518,000 Fraser River pink salmon (Table 11) consisted of a commercial catch of 6,182,000 fish and a non-commercial catch of 336,000 fish. The commercial catch was divided between 1,478,000 fish in Panel Areas and 4,704,000 in other areas. Most of the catch (3,366,000 fish) was concentrated in commercial net fisheries in Areas 11-16. The distribution of the commercial catch among the gear was 64.3% in purse seines, 25.4% in outside troll fisheries, 5.3% in inside troll fisheries and 4.9% in gillnets (Table 12).

The non-commercial catch consisted of a recreational catch of 202,000 fish, a Fraser River Indian Food catch of 104,000 and other catches totalling 30,000 fish.

Table 11. Preliminary estimates of fishery catches and total run of Fraser River pink salmon during the 1991 fishing season, by country and area.

	<u>Number of Fish</u>	<u>% of Run</u>
COMMERCIAL CATCH		
CANADA		
Fraser River Panel Area		
Areas 121-124 Troll *	278,000	
Area 20 Net	1,003,000	
Areas 17-18 and 29 Troll	115,000	
Area 29 Net	82,000	
Total	1,478,000	6.6%
Non-Panel Areas		
Areas 1-10 Troll and Net	534,000	
Areas 11-16 Troll and Net	3,366,000	
Areas 124-127 Troll *	804,000	
Total	4,704,000	21.1%
CANADA TOTAL	6,182,000	27.7%
UNITED STATES		
Fraser River Panel Area		
Areas 4B, 5 and 6C Net	24,000	
Areas 6 and 7 Net	1,689,000	
Area 7A Net	1,048,000	
Washington Troll **	45,000	
Total	2,806,000	12.6%
Non-Panel Areas		
Alaska Net	0	0.0%
UNITED STATES TOTAL	2,806,000	12.6%
COMMERCIAL TOTAL	8,988,000	40.2%
NON-COMMERCIAL CATCH		
CANADA		
Areas 12-13, 18, 20, 29, 123-124 Indian Food Fishery	0	
Area 12 Test Fishing	9,000	
Other Catches (Charters, etc.)	21,000	
Fraser River Indian Food Fishery	104,000	
Recreational Fishery	202,000	
Total	336,000	1.5%
UNITED STATES		
Ceremonial and Test Fishing	0	
Recreational Fishery	30,000	
Total	30,000	0.1%
COMMISSION		
Areas 123-127, 20 and 29 Test Fishing	34,000	
Areas 7 and 7A Test Fishing	2,000	
Total	36,000	0.2%
NON-COMMERCIAL TOTAL	402,000	1.8%
TOTAL CATCH	9,390,000	42.0%
SPAWNING ESCAPEMENT		
	12,943,000	58.0%
TOTAL RUN	22,333,000	100.0%

* Troll catch in Area 124 is divided between Panel and non-Panel Areas.

** Includes 3,000 fish caught in non-Panel areas in Washington, Oregon and California.

Table 12. Preliminary estimates of Canadian commercial catches* of Fraser River pink salmon by gear type and area during the 1991 fishing season.

Areas	Inside	Outside	Purse Seine	Gillnet	Total
	Troll	Troll			
1-10	0	439,000	93,000	2,000	534,000
11-16	216,000	52,000	2,956,000	142,000	3,366,000
121-127	0	1,082,000	0	0	1,082,000
20	0	0	928,000	75,000	1,003,000
17, 18, 29	115,000	0	0	82,000	197,000
Total Catch	331,000	1,573,000	3,977,000	301,000	6,182,000
% of Catch	5.4%	25.4%	64.3%	4.9%	100.0%

* Preliminary catch data from fish sales slips from Canada Department of Fisheries and Oceans.

ii. United States

The United States caught a total of 2,836,000 Fraser River pink salmon (Table 11), 2,806,000 in commercial and 30,000 in non-commercial fisheries. The large majority were caught in net fisheries in Areas 6, 7 and 7A. Treaty Indian fishermen caught 1,387,000 fish, 22,000 in Areas 4B, 5 and 6C, 1,360,000 in Areas 6, 7 and 7A and 5,000 in the coastal troll fishery (Table 13). Non-Indian commercial fishermen caught 1,419,000 Fraser pinks, with 1,048,000 of these caught in purse seines, 185,000 in reefnets, 146,000 in gillnets and 40,000 by trollers. The non-commercial catch of 30,000 fish was taken by sport fishermen in Washington and Oregon coastal waters and in Puget Sound Areas 4B, 5, 6, 6C, 7 and 7A.

Table 13. Preliminary estimates of United States commercial catches* of Fraser River pink salmon by user group, gear type and area during the 1991 fishing season.

Areas	Gillnet	Purse Seine	Reefnet	Troll	Total
Treaty Indian					
Washington Troll	0	0	0	5,000	5,000
4B, 5 and 6C	22,000	0	0	0	22,000
6 and 7	56,000	852,000	0	0	908,000
7A	134,000	318,000	0	0	452,000
6, 7 and 7A Total	190,000	1,170,000	0	0	1,360,000
% of Catch	14.0%	86.0%	0.0%	0.0%	100.0%
Total Catch	212,000	1,170,000	0	5,000	1,387,000
% of Catch	15.3%	84.4%	0.0%	0.4%	100.0%
Non-Indian					
Calif./ Ore./ Wash.	0	0	0	40,000	40,000
4B, 5 and 6C	2,000	0	0	0	2,000
6 and 7	68,000	528,000	185,000	0	781,000
7A	76,000	520,000	0	0	596,000
Total Catch	146,000	1,048,000	185,000	40,000	1,419,000
% of Catch	10.3%	73.9%	13.0%	2.8%	100.0%
United States					
Panel Area Total	358,000	2,218,000	185,000	45,000	2,806,000
Alaska (District 104)					0
Total Catch					2,806,000

* Preliminary Washington catch data from Washington Department of Fisheries "soft system" totals.

VI. STOCK MONITORING

The purpose of the stock monitoring program is to assess run size, daily abundance, timing and migration pathways of Fraser River sockeye and pink salmon stocks at different points along their migration route during the fishing season. These data are required for developing fishing plans to attain annual escapement and catch allocation objectives. Commercial catches provide much of the data used in the analyses, however, the Commission conducts test fisheries to provide data before and after the commercial fishing season and between fishing periods. Test fisheries conducted by DFO in Canadian non-Panel areas also provide important data. Information about the upstream migration in the river is obtained by echo sounding at Mission and visual observations at Hells Gate.

Test fishing operations in 1991 were conducted by the Commission in the following areas:

Canadian Panel Areas		
Areas 123-124	Troll	July 24 - August 27
Area 20	Gillnet	June 20 - September 1
Area 20	Purse Seine	August 7 - September 18
Area 29-13	Gillnet	June 25 - October 11
Area 29-16	Gillnet	June 25 - October 9
Areas 29-1 to 6	Troll	August 8 - October 5
Areas 29-1 to 6	Gillnet	September 4-5
Canadian Non-Panel Areas		
Areas 125-127	Troll	July 24 - August 25
United States Panel Areas		
Area 7	Gillnet	July 22-September 1

The test fishing operations in Canadian non-Panel areas were conducted with the approval of DFO. Also, at the request of the Commission, DFO operated test fisheries in Area 12 between July 16-August 17 by gillnet and July 31-September 20 by purse seine.

The upstream passage of sockeye was monitored by echo sounding at Mission between June 26-October 9. A wide-beam, 50 KHz echo sounder was used during the summer-run sockeye migration period. During the late-run sockeye and pink salmon migrations in September and October, a narrower beam, 400 KHz sounder was used. Estimates of daily gross escapements of sockeye and pink salmon were derived by combining Mission echo sounding data with information from gillnet test fishing at Cottonwood (Area 29-13).

Daily visual observations at Hells Gate between July 8-October 17 supplied information on the success of upstream fish passage.

Run size estimation for Fraser River sockeye salmon by stock group and for total pink salmon is based primarily on catch, effort, racial composition and diversion rate data, which are analyzed using catch-per-unit-effort (CPUE) and cumulative-normal models. Catch-per-unit-effort models relate run sizes in previous years to commercial or test fishing catch and effort data from purse seine or gillnet fisheries in Canadian Area 20 and Johnstone Strait. These regression models assume that run size is directly related to the magnitude of the largest daily or weekly catch of a particular stock group in each year, and that the migration pattern is consistent from year to year. Consequently, CPUE estimates are sensitive to unusual migration patterns. In-season, the current best estimates of catches, effort and racial composition are "plugged" into these models to generate

run size estimates, which tend to stabilize one or two weeks after the peak catch of a given stock group.

Cumulative-normal models are essentially a combination of "accounting" and linear regression programs. Estimates of catches and escapements for each stock group are accumulated for each day of migration. The number of these accounted fish are compared, using regression models, to estimates from normally-distributed simulated migrations which differ in abundance and timing parameters. For each stock group, the simulated migration that most closely matches the observed abundance pattern represents estimates of both run size and timing. As with the CPUE models, the estimates are sensitive to unusual migration patterns.

A. Sockeye Salmon

Each year, the first Fraser River sockeye stock to arrive in coastal waters is the Early Stuart run. In 1991, the run initially appeared to be considerably later than normal or much smaller than the forecast 500,000 fish. The former conclusion seemed justified when record test fishing catches of Early Stuart sockeye in Area 20 between July 4-6 (Figure 7) indicated a large run size of about 1,000,000 fish. However, subsequent catches in test and commercial fisheries and escapement estimates from echo sounding as the peak passed through the lower river indicated a much smaller abundance, close to the forecast number. The initial large overestimate was due to unusually high test fishing efficiencies in Area 20 just as the peak arrived, possibly because lower-than-usual phosphorescence ("fire") in the water made gillnets less visible to fish. Timing of the peak Early Stuart sockeye migration was three days later than normal and the run had an elongated "tail": Early Stuart fish were still passing Mission one week beyond the normal date. The Mission estimate of Early Stuart gross escapement was 369,000 fish (Table 14).

Later in July and early August, the focus was on early summer- and summer-run sockeye stocks. Troll test fishing catches in Area 127 peaked on July 29 and August 3 and later in Areas 124 and 123, indicating that summer-run abundance would peak about August 10 in Area 20 (Figure 8), approximately ten days later than normal. However, gillnet CPUE in the Area 20 test fishery was highest on July 21-24 and August 1-4 (August 10 would later prove to be the actual date of peak summer-run migration through Area 20). Area 20 CPUE subsequently declined and

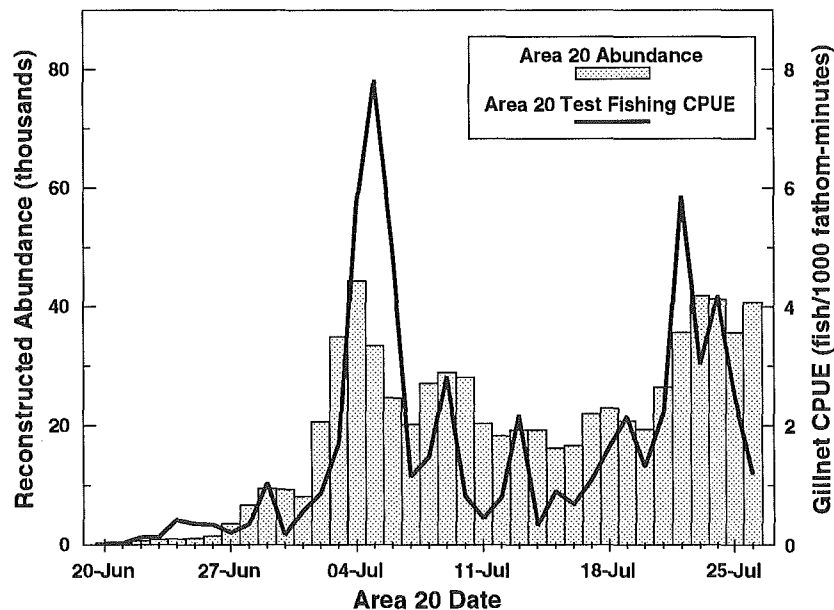


Figure 7. Reconstructed abundances of Fraser River sockeye salmon and gillnet test fishing CPUE in Area 20 during the Early Stuart sockeye migration.

Table 14. Comparison of Mission and upriver (spawning escapements plus Indian catches) gross escapement estimates for Fraser River sockeye (adults) and pink salmon in 1991.

Run	Gross Escapement	
	Mission	Upriver *
Sockeye Salmon (Adults)		
Early Stuart	369,000	324,000
Early Summer	555,000	361,000
Summer	1,414,000 **	1,533,000
Late	1,751,000	1,693,000
Total	4,089,000	3,911,000
Pink Salmon		
Pink Salmon	7,526,000	13,047,000

* Includes 84,000 sockeye caught in Fraser River Indian food fisheries below Mission, B.C.

** Includes Chilko Lake - South End sockeye.

on August 8, only sixteen sockeye were caught by two test fishing boats. During this period, catches in the Treaty Indian gillnet fishery in United States Areas 4B, 5 and 6C were very high, indicating the migration had shifted to the southern portion of Juan de Fuca Strait. Test catches in Area 20 later rebounded as the sockeye migration shifted to the Canadian side of Juan de Fuca Strait. An unusual delay by summer-run sockeye off the mouth of the Fraser River in mid August led to a one-week closure to allow the accumulation to proceed upstream, which they did around August 22-24 (Figure 9). Throughout most of August, returns of early summer- and summer-run sockeye were estimated at 5-6,000,000 fish. By the end of the season the Mission estimate of gross escapement was 1,969,000 fish (Table 14).

Catch-per-unit-effort in the Area 20 gillnet test fishery increased until August 14 and remained high through August 25 as late-run stocks contributed to the migration. Although test fishing CPUE and commercial catches indicated a good late-run return, they were not high enough to be consistent with the very large forecast return of 10,148,000 fish. Consequently, on August 16 the

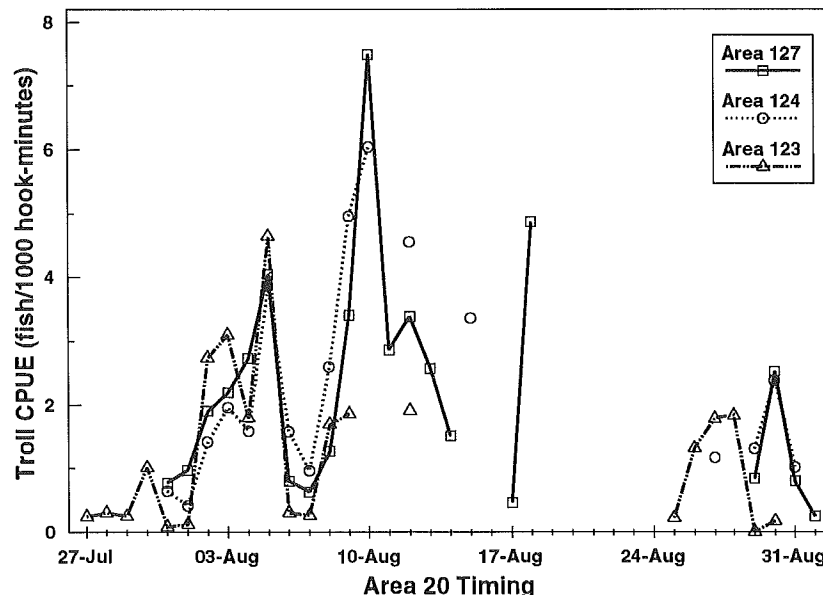


Figure 8. Sockeye salmon CPUE at three troll test fishing sites with date of catch adjusted to Area 20 timing.

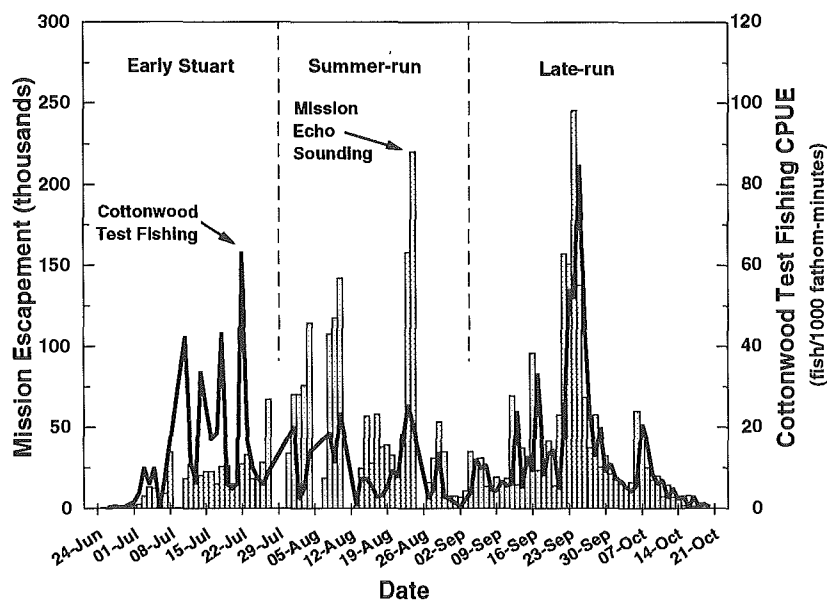


Figure 9. Daily escapements of sockeye salmon estimated at Mission, B.C., by echo sounding compared with prior-day test fishing CPUE at Cottonwood in 1991.

estimated late-run return was reduced to 5,500,000 fish. The peak of the run through Area 20 occurred on August 20. End of season estimates of late-run sockeye escapements to the Strait of Georgia and past the Cottonwood test fishing site were 1,900,000 and 1,751,000 fish (Table 14), respectively. Gross escapements were estimated using Cottonwood test fishing CPUE because of potential errors in the Mission echo-sounding estimate, due to large numbers of pink salmon migrating up the river at the same time. For the first time, troll test fishing in Area 29 was used to directly estimate the abundance of late-run sockeye delaying in the Strait of Georgia from late September through early October. Late-run abundance in the Strait decreased after mid September as these fish migrated up the river.

The diversion rate of Fraser sockeye through Johnstone Strait in early August was approximately 50-60% of the weekly run, substantially higher than the pre-season forecast of 25%. Later, troll test fishing catches indicated a larger proportion of the run was migrating via the southern approach. This shift subsequently resulted in large catches along the Juan de Fuca Strait route. Of the total run, about 40% migrated via Johnstone Strait.

Mission and upriver (spawning escapements plus Indian catches) estimates of adult gross escapements totalled 4,089,000 and 3,911,000 sockeye, respectively (Table 14). Upriver estimates for each run were less than the Mission estimates, except for the summer run. However, the upriver estimate of combined early summer- and summer-run escapement was also lower than the Mission estimate.

Observations at Hells Gate indicated the passage of sockeye proceeded normally, with large abundances of summer-run sockeye observed during the last two weeks of August. A strong migration of late-run sockeye passed Hells Gate in late September and early October. No delays were evident in the migration.

B. Pink Salmon

The migration of Fraser River pink salmon arrived later than normal, with the result that fisheries directed toward pink salmon were accomplished without a large sockeye by-catch. Assessment of the pink salmon run began during the last week in August with purse seine test fishing in Areas 12 and 20. The estimation of run size was based primarily on commercial catch

and effort data using CPUE and cumulative-normal models. Estimates of escapement to the Strait of Georgia were derived from catch and effort data and exploitation rates. Purse seine test fishing was used to provide estimates for periods when commercial catch data were unavailable. The proportions of Fraser River pink salmon in these catches were initially estimated using pre-season forecasts of racial composition. Approximately one week after each fishery, these proportions were replaced by estimates from genetic stock identification (GSI) analyses of muscle tissue samples taken after each fishery.

At the end of August, the estimate of pink salmon run size was 13,000,000 with a peak Area 20 timing of August 31. During early September, assessments were hampered by the lack of purse seine fisheries in Johnstone Strait and Area 20, so purse seine test fishing was used to provide surrogate information. The final in-season estimate of run size was 17,000,000 pink salmon with an Area 20 peak migration on September 5. Based on estimates of total run size minus fishery catches, the escapement of pink salmon to the Strait of Georgia was approximately 8,000,000 fish. Approximately 40% of the run migrated through Johnstone Strait, slightly higher than the normal 30%.

Daily echo-sounding estimates of total (i.e., all species) escapement past Mission were apportioned to the five species of salmon according to the percentage of each species in variable-mesh gillnet catches at the Area 29-16 test fishing site. For pink salmon, because estimates of gross escapement from echo sounding are usually much less than from spawning ground enumerations, the echo-sounding estimates were multiplied by the historical ratio (1.69) between these estimates. The sum of these adjusted daily estimates (Figure 10), combined with estimates from test fishing CPUE models after the echosounding program terminated, was 7,526,000 pink salmon. This was the largest escapement estimate obtained in the years of echo sounding. However, it is much less than the upriver estimate of 13,047,000 fish (Table 14), which was derived from tag-recovery programs and monitoring of Indian catches in the Fraser watershed. The discrepancy between these numbers is the topic discussed in Appendix E.

Pink salmon migrated upstream past Hells Gate without accumulation or delay. Improved fish passage facilities constructed by DFO at Hells Gate and other points of difficult passage in the Fraser Canyon have contributed to the successful passage of pink salmon into the upper watershed. Although designed to aid pink salmon, these facilities also assist sockeye salmon migrating to their spawning streams.

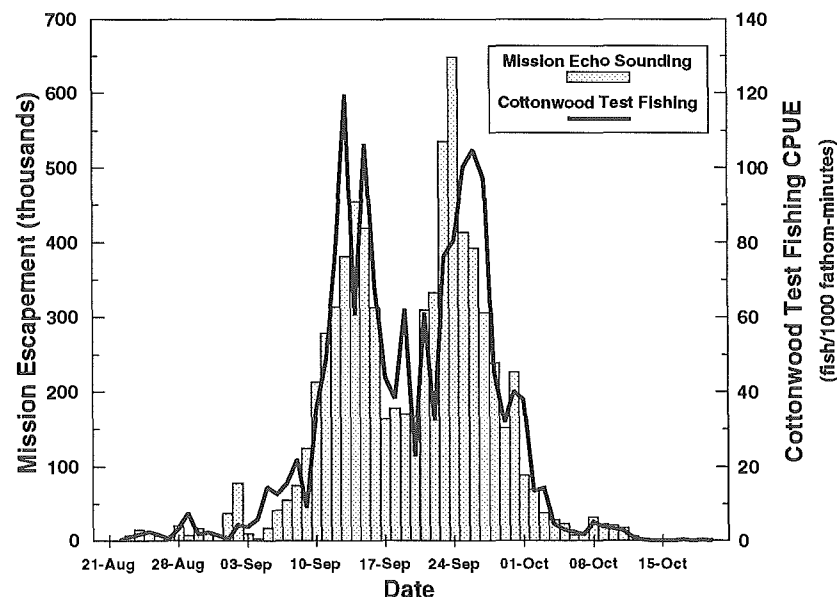


Figure 10. Daily escapements of pink salmon in 1991, estimated at Mission, B.C., by echo sounding compared with test fishing CPUE at Cottonwood two days prior.

VII. RACIAL IDENTIFICATION

As in past years, Commission staff conducted programs designed to identify the racial contributions of Fraser River sockeye and pink salmon in both commercial and test fishing catches. Data collected from the racial identification programs provide information on the abundance and timing of Fraser River sockeye and pink salmon stocks as they migrate through coastal waters en route to the Fraser River, and to account for the catch of Fraser stocks in both Panel Area and non-Panel Area waters.

A. Sockeye Salmon

In 1991, scale pattern analysis was used to identify stock groups of Fraser River sockeye salmon in mixed-stock fishery samples. Age-specific stock classification models were developed from prior-years' spawning ground data and, based on these models, twenty-one separate stocks were amalgamated into eleven stock groups. Each stock group consisted of one or more individual stocks exhibiting similar scale traits and migratory timing.

Linear discriminant function analysis was used to determine the rules for combining individual sockeye stocks into stock groups and, subsequently, for estimating the contribution rates of each stock group in mixed-stock fishery samples. To identify the Fraser sockeye catch by stock group, four scale variables were selected from the freshwater growth zone of individual scales sampled from each fish of interest. The four scale variables used were: circuli count to the first freshwater annulus, circuli count in the freshwater spring growth zone, distance from the focus to the fifth circulus and distance from the focus to the first freshwater annulus. The scale variable data were supplemented with information about age composition, fish length and historical patterns of stock-specific timing and behaviour. In northern British Columbia and southeast Alaska, fish length was used as a discriminating variable for the in-season analyses.

The use of scale characters from the freshwater growth zone of scales is useful in the racial identification of sockeye because these characters are shaped by environmental conditions and population densities within each sockeye nursery lake. Annual sampling of spawning ground populations is conducted to generate "learning standards" for the formation of annual stock groupings and for post-season revision of in-season analyses.

Scale analyses of commercial and test fishing catches were conducted daily beginning in late June and continuing through early October. Commission staff sampled commercial sockeye landings at sites in Bellingham, Blaine, Vancouver, Steveston, Ucluelet and Winter Harbour. Commercial sockeye landings in northern area fisheries were sampled by DFO in Prince Rupert and Masset, and by Alaska Department of Fish and Game in Petersburg and Ketchikan. In total, approximately 32,000 sockeye scales were aged and digitized to obtain readings for the four scale variables. Samples were analyzed for Fraser River stock contributions and the resulting estimates were multiplied by the catch in each fishery to generate summaries of catch by stock group by area.

The challenge for the scale analysis program in 1991 was to successfully identify and separate early summer-run stocks (dominated by Seymour River fish) from summer-run stocks (dominated by Chilko River and Stellako River fish), and summer-run stocks from late-run stocks (dominated by Adams River fish).

Scale pattern analysis performed well in achieving the above objectives, although some difficulty was experienced in separating Seymour River and Chilko River stock groups. Post-season revisions to preliminary in-season analyses will be conducted using 1991 spawning ground scale samples obtained by DFO.

In recent years, greater effort has been directed at obtaining scale samples from the Fraser River Indian food fishery. In 1991, at the request of the Commission, DFO arranged for weekly

scale samples to be obtained from five fishing areas in the Fraser River watershed: Chilliwack, North Bend, Lytton, Lillooet and Prince George. In total, scale samples from 2,143 fish were obtained, with the majority coming from the Chilliwack, Lytton and Lillooet sites. A post-season analysis will be conducted to compare the stock composition estimates derived from the scale samples with those generated through reconstruction modelling techniques.

The Early Stuart stock arrived approximately three days late and with a very compressed migration pattern. There were 511,000 fish in total with catches of 187,000 in commercial and other fisheries and 183,000 in Fraser River Indian food fisheries (Table 15). The overall harvest rate was 72%. The early summer-run stocks, including Bowron, Fennell, Gates, Pitt, Nadina, Scotch and Seymour, arrived approximately one week later than normal. Abundances of these early-timed stocks were close to pre-season forecasts, with the exception of the Seymour group which returned above pre-season expectations at 669,000 fish. Exploitation of these stocks in commercial and Indian fisheries reached 73%.

The return to the Chilko system was approximately ten days late and double the pre-season forecast. In total, 3,984,000 Chilko River and Chilko Lake fish returned to coastal areas. This was the third largest return on record and was the second consecutive year of exceptionally large returns to this system.

The Adams/Lower Shuswap stock group arrived about five days later than normal for the cycle and at less than one-half the pre-season forecast of 9,300,000. However, the return of 4,425,000 fish was the largest on record for the cycle.

Scale pattern analysis performed well in separating Chilko and Adams stocks. This was extremely important since pre-season fishing plans had to be adjusted to compensate for the unexpected strength of the summer-run stocks relative to the late-run stocks. The exploitation rates for summer- and late-run stocks were similar, at 75% and 72%, respectively.

The total 1991 return of Fraser River sockeye was estimated at 12,378,000 fish. Catches in all fisheries accounted for 73% of the fish while 27% reached the spawning grounds. Commercial fisheries harvested 66% of the 1991 return while Indian food catches accounted for 6%. The commercial harvest rate was slightly below the average for recent years (69%). Of the 12,378,000 fish, 91.9% were age 4₂, 7.2% were age 5₂, 0.5% were age 5₃ and 0.4% were age 3₂.

Two pilot studies were conducted by the Racial Identification Group in 1991. The first was a continuation of a parasite, *Philonema oncorhynchi*, screening project initiated in 1990; the second was a sockeye morphometric measurement project begun in 1988. The objective of these programs is to assess the utility of additional variables for stock identification of Fraser River sockeye salmon.

Philonema oncorhynchi is a nematode parasite found near the swim-bladder in adult sockeye salmon. The parasite is not believed harmful to the fish and since it is eliminated during evisceration, it also does not affect the marketability of the fish. Previous studies have established that Fraser River sockeye salmon show a low prevalence of *Philonema* compared to most north coast sockeye stocks (e.g., Skeena, Nass and southeast Alaskan stocks). In 1991, at Prince Rupert and Vancouver sampling sites, PSC staff screened purse seine and gillnet catches for *Philonema* prevalence (Canadian Areas 1, 2W, 3, 4, 12, 20 and 29 and Alaska District 104). For each sample, 115 fish were examined for *Philonema* during regular sampling for scales, sex and length data.

The intent of this pilot study was to determine whether *Philonema* prevalence could be used to distinguish between Fraser River and north coast sockeye salmon in fisheries where intermingling occurs. The eventual goal is to include the prevalence of *Philonema* as a discriminating variable, along with scale characters, in future discriminant function analyses.

Table 15. Catches, escapements and exploitation rates for Fraser River sockeye salmon by stock group in 1991.

Stock Group	River & Ocean Catch *	Fraser IFF ** Catch	Net Escapement	Total Adults	Portion of Total Run	Exploitation Rate	
						River & Ocean	All Areas
Sockeye Salmon							
Early Stuart	187,000	183,000	141,000	511,000	4.1%	37%	72%
Early Summer-run							
Fennell/Bowron/Raft	38,000	16,000	28,000	82,000	0.7%	46%	66%
Nadina/Gates/Pitt	115,000	47,000	103,000	265,000	2.1%	43%	61%
Scotch/Seymour	502,000	24,000	143,000	669,000	5.4%	75%	79%
Total	655,000	87,000	274,000	1,016,000	8.2%	64%	73%
Summer-run							
Horsefly/Late Stuart	162,000	29,000	123,000	314,000	2.5%	52%	61%
Chilko	2,720,000	226,000	1,038,000	3,984,000	32.3%	68%	74%
Stellako	557,000	22,000	95,000	674,000	5.5%	83%	86%
Total	3,439,000	277,000	1,256,000	4,972,000	40.3%	69%	75%
Late-run							
Birkenhead	573,000	8,000	294,000	875,000	7.1%	65%	66%
Adams/Lower Shuswap	3,122,000	47,000	1,256,000	4,425,000	35.9%	71%	72%
Weaver/Portage	287,000	2,000	50,000	339,000	2.8%	85%	85%
Misc. Late-run Stocks	152,000	1,000	35,000	188,000	1.5%	81%	81%
Total	4,134,000	58,000	1,635,000	5,827,000	47.3%	71%	72%
Total Adults	8,415,000	605,000	3,306,000	12,326,000	100.0%	68%	73%
Total Jacks	16,000	1,000	35,000	52,000			
Total	8,431,000	606,000	3,341,000	12,378,000			
Pink Salmon							
Pink Salmon	9,286,000	104,000	12,943,000	22,333,000		42%	42%

* Includes ocean and river catches in commercial, test and other fisheries, excluding the Fraser River Indian food fishery.

** IFF = Indian food fishery.

Although additional work is required, preliminary results indicate that *Philonema* prevalence alone gave similar results as scale pattern analyses for determining Fraser River sockeye salmon contributions in north coast fisheries. Prior to the full integration of *Philonema* data as a variable in the discriminant function models, the consistency of prevalence data between years must be confirmed, as must the rates of *Philonema* prevalence in all major stocks potentially contributing to north coast catches.

Morphometric variation refers to differences in body shape among stocks. Several studies have shown that morphometric measurements can be a useful stock identification tool. Initial spawning ground assessments conducted by the Racial Identification Group in 1988 and 1989 showed that morphometric variation exists for Fraser River sockeye salmon, especially in the posterior body region. Morphometric screening in 1991 was conducted at several sockeye spawning streams: Stellako River, Chilko River, Horsefly River, Birkenhead River and Weaver Creek. In addition, morphometric data were collected from sockeye salmon caught in the August 15, 1991 Canadian Area 20 purse seine fishery. Investigations into the utility of incorporating morphometric variation among stocks as a distinguishing variable in discriminant function models will continue in future years.

B. Pink Salmon

In 1991, as in the 1987 and 1989 fishing seasons, genetic stock identification (GSI) was used to identify catches of Fraser River pink salmon harvested in mixed-stock fisheries from northern British Columbia to Washington. The results of GSI analyses of commercial catch samples provided catch estimates and information on timing and relative abundance of Fraser River pink salmon, which were used for analyses of run size and migrational patterns.

The GSI technique requires knowledge of the genetic differences among stocks that potentially contribute to the fisheries of interest. Electrophoretic analysis is conducted on tissue samples from pink salmon collected on the spawning grounds to establish a "baseline" of genetic standards. To estimate the most likely composition of stocks in the mixtures, the genetic composition of tissue samples taken from pink salmon caught in mixed-stock fisheries are compared to the baseline standards using "maximum likelihood" computer models.

GSI analyses of commercial and test fishing catches were conducted beginning in mid July and continuing through late September. Commission staff sampled commercial pink salmon landings at Bellingham, Blaine, Vancouver, Steveston, Ucluelet, Tofino, Winter Harbour and Prince Rupert. Commercial pink salmon landings from Johnstone Strait fisheries were sampled by DFO personnel in Port Hardy, Alert Bay and Quathiaski Cove. Washington State commercial troll samples were obtained by Washington Department of Fisheries personnel. In total, approximately 14,700 pink salmon in 104 collections were analyzed for Fraser River stock contributions. Stock composition estimates for both Fraser and non-Fraser stocks were multiplied by the catch in each fishery to generate summaries of catch by stock by area and gear type.

The results of in-season GSI analyses were incorporated in staff assessments of Fraser River pink salmon return strength. The results of these analyses assisted the Fraser River Panel in making adjustments to the pre-season fishing plan for the purposes of achieving international and domestic catch allocations and the gross escapement goal. The final in-season estimate of Fraser River pink salmon run size was 16,565,000 fish, significantly larger than the pre-season forecast of 11,000,000. The run was approximately one week late in its migration timing. The calculated exploitation rate using the post-season estimate of run size was 42%.

Catches of Fraser River pink salmon in northern fisheries (north of Cape Caution) were low (< 5%) throughout July. During the first two weeks of August the proportion of Fraser pinks caught in the Canadian Area 101 and 142 troll fisheries and the Area 1 and 2W net fisheries, increased from approximately 4% to 26% of the catch. Northern catches of Fraser pinks peaked during the week of August 11-17 when they contributed 59% and 90% to the Canadian Areas 101 and 142 troll fisheries, respectively. After mid August, catches of Fraser pinks in these fisheries declined rapidly as the fish continued on their southerly migration.

Fisheries that occurred south of Cape Caution were characterized by contributions of Fraser pinks that varied considerably during August. For example, Fraser pinks caught in the Canadian Areas 123-127 troll fishery during this time constituted approximately 85% of the catch, compared to only 42% of the catch in the Johnstone Strait (Canadian Areas 12 and 13) net fishery. After the week of August 18-24, the proportion of Fraser pinks in all major south coast fisheries (i.e., Canadian Areas 123-127 troll, Areas 12, 13 and 20 net and United States Areas 7 and 7A net) was relatively consistent at 80-95% of the catches.

VIII. ESCAPEMENT

Canada Department of Fisheries and Oceans estimates the annual escapements to sockeye and pink salmon spawning grounds in the Fraser River watershed (Figure 11). These data along with biological samples from the spawners are provided to the Panel so that Commission staff can revise in-season racial analyses, estimate total production for each stock and assess Commission programs for stock monitoring.

A. Sockeye Salmon

Sockeye salmon escapements to Fraser River spawning grounds totalled 3,341,000 fish, including 3,306,000 adult (4- and 5-year-olds) and 35,000 jack (3-year-old) spawners (Appendix D: Table 8). This escapement was 7% above the in-season goal of 3,094,000 adult sockeye and 4% below the pre-season goal of 3,435,000. This was the largest spawning population on the cycle since 1899 and was 74% above the brood-year escapement of 1,896,000 adults in 1987. The distribution of spawners by watershed was generally close to the goals established by Canada, which addressed long-term objectives such as rebuilding late-run Shuswap Lake stocks on the sub-dominant cycle. However, the numbers that spawned in the Chilko Lake watershed exceeded the goal by 300,000 fish.

Both the Early Stuart and Late Stuart stocks produced strong returns for the cycle. Early Stuart sockeye spawn in tributaries to Takla and Trembleur Lakes (A; Figure 11). The escapement estimated in 1991 was 141,000 spawners, slightly below the brood-year escapement of 148,000 fish and substantially below the goal of 200,000 spawners. Of the total escapement, some 28,600 (20.3%) spawned in tributaries to Takla Lake, similar to the 27,600 (18.6%) in 1987. Building these latter spawning populations has been a priority in Canada's long-term escapement plan.

Late Stuart sockeye produced the largest escapement for the cycle on record, with 77,000 adults reaching the spawning grounds. The majority of these fish spawned in Tachie (51,000) and Middle Rivers (16,000). Juvenile sockeye from these two streams reside for one year in Stuart and Trembleur Lakes, respectively. Most of the escapements were 4-year-olds (82%) while 18% were 5-year-olds from the 1986 brood.

Stocks in the Nechako River watershed (B; Figure 11) showed moderate to good escapements. The Late Nadina escapement was the largest on record at 61,000 adults. Of these, 56,000 entered the spawning channel. The Stellako River received 95,000 spawners, down 55% from the brood year (211,000) and 155,000 fish below the goal. Although this was the lowest dominant cycle escapement since 1971, spawning success was high and will provide a good nucleus for rebuilding.

Quesnel area stocks (C; Figure 11), principally from the Horsefly River, have had few spawners on the cycle with a maximum of 20,500 fish in 1987. The escapement of 46,000 in 1991 was 125% larger. Many of these fish (41%) were 5-year-old spawners from the successful 1986 brood. Of the total, 19,000 fish were diverted into the Horsefly spawning channel. The abundance of these stocks have been increasing on all four cycles, particularly the 1989 (dominant) and 1990 (sub-dominant) cycles. The 1991 cycle is an off-cycle year but recently has had significant returns.

Chilko River and Lake spawning areas (D; Figure 11) received 1,038,000 spawners in 1991, the largest total recorded in any year. Escapements to the river and north-end lake areas and to south-end Lake spawning grounds were not separated. The total was 48% above the goal set by Canada (700,000) and 147% above the brood-year (1987) level (421,000). Spawning success was high at over 95%. Approximately 20,000 fish entered the spawning channel.

Escapements to the Seton-Anderson system (E; Figure 11) included 9,000 adult spawners at Gates Creek, the same number as in 1987. Approximately 8,000 of these entered the spawning channel. Portage Creek sockeye increased to 12,000 spawners from 7,000 in the brood year.

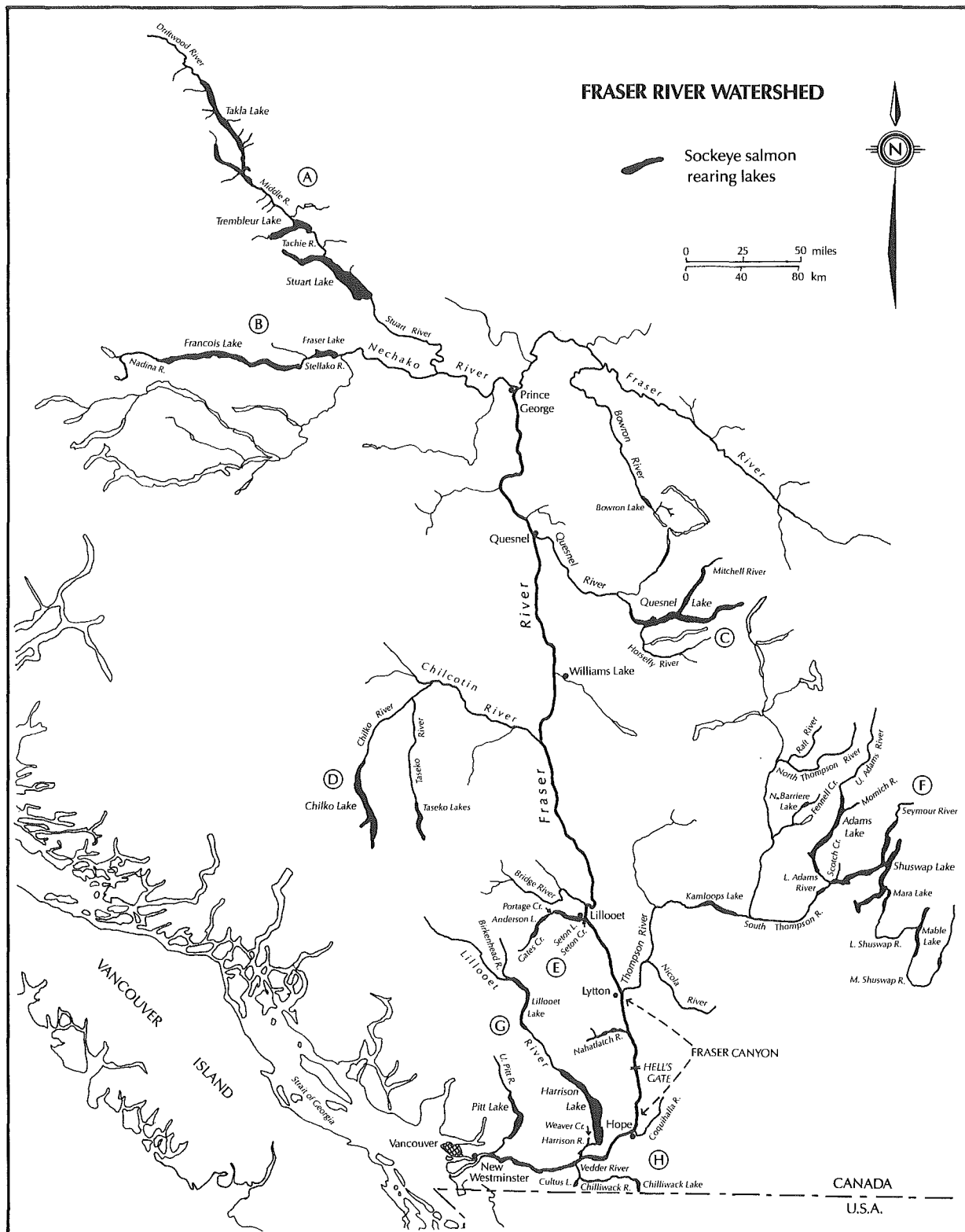


Figure 11. Sockeye and pink salmon spawning grounds in the Fraser River watershed.

The Thompson River watershed (F; Figure 11) is divided into the North Thompson and South Thompson districts. North Thompson stocks are minor sockeye producers due to spawning ground and rearing area limitations. In 1991, the Fennell Creek escapement of 20,000 spawners was 23% above the brood-year escapement. The Raft River spawning stock declined from 1,400 fish in 1987 to 500 in 1991.

Most sockeye salmon from the South Thompson watershed spawn in tributaries to Shuswap Lake, which is the main rearing lake for juvenile fish. Foremost among these stocks is the late-run Adams River population. The 1991 return of 1,240,000 late-run fish was the largest recorded for the cycle. Most spawned in the Lower Adams River (1,204,000) and adjacent Little River (14,000). Additional spawning occurred along Shuswap Lake beaches and in smaller tributaries. The total was double the brood-year escapement in 1987.

Lower Shuswap River sockeye also rear in Shuswap Lake and have similar migration and spawning times as Adams sockeye. The escapement of 16,000 spawners was 50% above the 1987 brood-year escapement. An additional 600 sockeye spawned in Middle Shuswap River.

Early-timed stocks in the South Thompson watershed also had strong escapements in 1991. Seymour River (128,000 spawners), Scotch Creek (10,000), Anstey River (5,000) and Eagle River (4,000) populations were all the largest recorded for the cycle. Just twelve years earlier, in 1979, no sockeye were observed at Scotch Creek on the cycle. The population growth has been very rapid assisted by the spawning of 5-year-old fish from the dominant cycle line (40% 5-year-olds in 1991).

In the Harrison-Lillooet system (G; Figure 11), the Birkenhead River had the second largest adult spawning (294,000) since escapements have been enumerated. Escapement of the second major stock in this watershed, Weaver Creek sockeye, was 38,000 spawners, of which 28,000 entered the spawning channel. The spawning escapement of Harrison River sockeye was 15,000 fish, a three-fold increase from 5,000 in 1987.

Significant numbers spawned in lower Fraser River tributaries (H; Figure 11) such as the Upper Pitt River (23,000 adults) and Cultus Lake (20,000). Both escapements were near the average for recent cycle years.

Water levels were normal and stable in most spawning areas in 1991. Water temperatures were generally lower than normal, as were pre-spawning mortalities. Of the total escapement of 1,786,000 females, 1,751,000 (98%) spawned successfully, the highest percentage recorded on the cycle.

B. Pink Salmon

Mission and spawning ground estimates of Fraser River pink salmon escapements differ substantially. The estimate of escapement past Mission, based on hydroacoustic and test fishing CPUE data and incorporating the 1.69 expansion ratio described in the Stock Monitoring section, was 7,526,000 fish. This is only 58% of the spawning escapement estimate (12,943,000 fish) from DFO's tag-recovery program (Appendix D: Table 9). Appendix E contains a discussion of this discrepancy.

Whichever estimate is used, this is the largest pink salmon escapement recorded for the Fraser River system and is higher than both the pre-season goal of 4,500,000 and the in-season goal of 7,000,000. The enumeration procedure employed by DFO to estimate the total watershed escapement is to tag passing fish at a site near Fort Langley. Extensive mark-recapture programs in tributary streams provide estimates of escapement for these tributaries. To estimate the number of spawning escapements in the mainstem Fraser River, the number of tagged fish accounted for in all tributaries are subtracted from the total number tagged. These remaining tagged fish are assumed to be present in the mainstem, and when combined with the mainstem tagged:untagged

ratio, produce the mainstem population estimate. The estimated number of mainstem spawners in 1991 was 9,288,000, which is the largest on record and almost twice the previous record of 5,249,000 in 1985.

The major pink salmon spawning areas in the upper Fraser River system are in the Seton Creek area and the Thompson River below Kamloops Lake (Figure 11) while smaller numbers use tributary streams below Prince George. Escapements to these areas totalled 2,426,000 pink salmon, compared to 1,357,000 in 1989. This was the largest number recorded at spawning grounds above Hells Gate since records began in 1957 (Figure 12) and was probably the largest since 1911, which was the last successful migration above Hells Gate prior to 1913 when rock dumped from railway construction blocked the river to both sockeye and pink salmon.

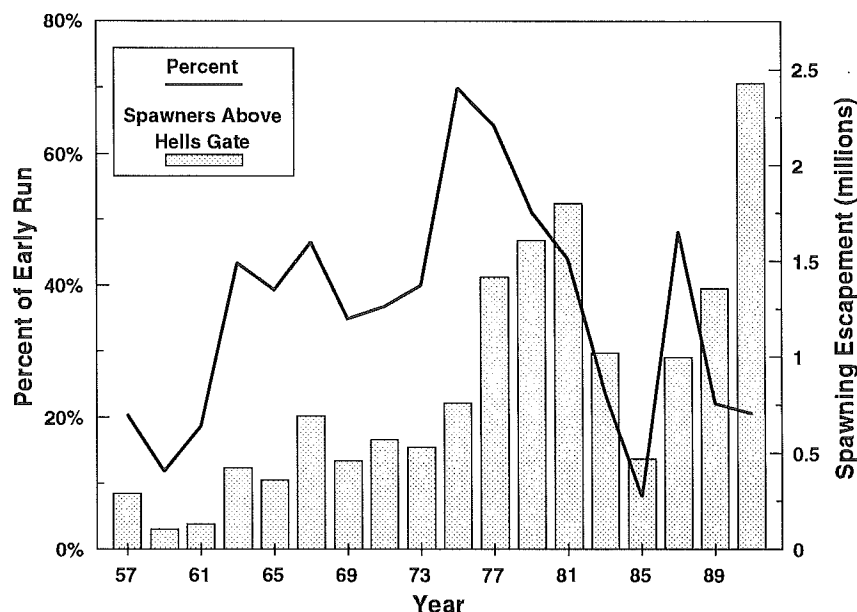


Figure 12. Escapements of Fraser River pink salmon above Hells Gate, 1957-91, and the proportions these represent of early-run pink salmon escapements.

The majority of upper Fraser pink salmon (1,619,000) spawned in the Seton Creek/Bridge River area. Bridge River pink salmon numbered 184,000 fish. Seton Creek and the two spawning channels were used by 1,318,000 pink salmon, also the largest number on record. The escapement to the Thompson River was estimated at 770,000 pink salmon, three times the brood-year level and slightly below the range of escapements recorded in the 1977-81 period (891,000 to 1,167,000). The recovery of the Thompson River population after four cycles of reduced numbers may be related to improvements in passage conditions in the Fraser Canyon. The proportion of early pink salmon that migrated above Hells Gate was 21% of the escapement (Figure 12).

Beginning in the early 1980s, migrating pink salmon appear to have had difficulty traversing the Fraser Canyon, possibly due to their small body size during this period (less than 2.3 kg [5 lb]). From 1979 to 1985, the proportion and number of early pink salmon escapements that spawned above Hells Gate decreased from 51% to 8%. This trend culminated in 1985, when the majority of fish that attempted to migrate above Hells Gate were blocked in the Fraser Canyon. Extensive fish passage work by DFO appears to have alleviated this problem for pink salmon and upriver escapements have been recovering since 1987. The large escapement above Hells Gate in 1991 occurred despite the fact that Fraser River pinks weighed only 1.78 kg (3.9 lb), the smallest size on record.

In the lower Fraser area, Harrison River pink salmon escapements increased 39% to 947,000 spawners from 682,000 in 1989. The Chilliwack-Vedder River population was down to 159,000 fish from 328,000 in 1989 due to severe flooding in November-December, 1989. However, the decrease was less than predicted based on fry output information.

Spawning conditions were excellent in all areas with low, stable stream flows during spawning. Escapements in most areas were large for the first time in several years. In addition, pink salmon reportedly spawned in the Nechako River near Prince George for the first time on record. These positive signs were observed despite the small average size of pink salmon.

IX. ACHIEVEMENT OF OBJECTIVES

The mandate of the Fraser River Panel is to manage fisheries in the Panel Area to achieve the annual goals for gross escapement of Fraser River sockeye and pink salmon, for allocation of the catch between the countries, for domestic allocation of the catch within each country's share, and to consider conservation concerns for other stocks and species of salmon when planning and conducting the fisheries. Panel management strategies are assessed after each season to determine if the goals were met, to estimate catch deficiencies that require future attention and to improve management techniques and data collection programs.

A. Escapement

The primary objective of the Fraser River Panel is to ensure that escapement goals are achieved. In February 1991, Canada set an initial gross escapement goal of 4,600,000 sockeye salmon, including 4,575,000 adults and 25,000 jacks. This gross escapement provided for an anticipated catch of 800,000 in the Fraser River Indian food fishery and an adult spawning escapement of 3,775,000 adults (Table 2). The total gross escapement goal was revised on July 5 to 4,235,000 sockeye to accommodate adjustments to the late-run goal. On July 9, Canada adjusted the total upwards to 4,315,000 based on in-season estimates of a larger-than-forecast Early Stuart sockeye run. This change was rescinded on July 15 after the Early Stuart run size was revised downward to the pre-season forecast. Due to an increase in the estimated run size of summer-run stocks and a decrease in the estimate for late-run stocks, Canada further adjusted the gross escapement goal to 3,894,000 adults on August 26 (Table 16). Of these, approximately 3,094,000 were expected to reach the spawning grounds.

The upriver estimate (spawning escapements plus Indian catches) of gross escapement in 1991 was 3,911,000 adult sockeye, which was only 17,000 above the goal (Table 16). Of these, 3,306,000 reached the spawning grounds. The accounted gross escapement of Early Stuart sockeye was 324,000, 76,000 short of the goal. Early summer-run escapements totalled 361,000, 87,000 short of the goal. Summer-run and late-run escapements exceeded the goals by 117,000 and 63,000, respectively.

DFO notified the Panel of an increase in the Fraser pink gross escapement goal from 4,500,000 to 6,000,000 on August 30 and to 7,000,000 on September 6. These actions were taken because of the larger-than-forecast pink return, the pre-season plan to raise the goal to 6,000,000 fish if the estimated run size increased sufficiently and because the small females in 1991 would have lower fecundities and correspondingly lower potential egg depositions. The Mission estimate of pink salmon gross escapement was 7,526,000 fish, 526,000 over the goal. The upriver estimate was 13,047,000 fish (12,943,000 net escapements plus 104,000 Fraser River Indian catches), 6,047,000 over the goal. Refer to Appendix E for a discussion of the large discrepancy between these estimates.

Table 16. Comparison of 1991 in-season goals and upriver (spawning escapements plus Indian catches) estimates of gross escapements of Fraser River sockeye and pink salmon runs.

Run	Gross Escapement		
	In-season	Upriver	Deviation
	Goals	Estimates *	
Sockeye Salmon			
Early Stuart	400,000	324,000	(76,000)
Early Summer	447,500	361,000	(86,500)
Summer	1,416,000	1,533,000	117,000*
Late	1,630,500	1,693,000	62,500
Adults	3,894,000	3,911,000	17,000
Jacks	25,000	36,000	11,000
Total	3,919,000	3,947,000	28,000
Pink Salmon			
Pink Salmon	7,000,000	13,047,000	6,047,000

* Includes 84,000 sockeye salmon caught in Fraser River Indian food fisheries below Mission, B.C.

B. International Allocation

Achieving the international catch-allocation objectives of the Treaty is the second priority of the Fraser River Panel during the fishing season. The preliminary estimate of the Canadian Add-on Escapement Benefit of Fraser sockeye is 1,279,000 fish, based on the 12,378,000 Fraser sockeye run size (Table 17). Including these estimates of add-on benefit and run size as well as other deductions totalling 3,846,000, the TAC in 1991 was 7,253,000 sockeye.

For 1991, the United States set a catch goal of 1,800,000 Fraser River sockeye in Washington State. Actual United States catches were 1,818,000 fish in Washington fisheries and 64,000 in Alaska District 104. The United States catch was less than the maximum proportion (34.2%) of the TAC they could have taken in 1991.

The United States catch in Washington waters was to be taken in proportion to the TAC's of the stock groups. In-season changes to run-size estimates caused revision of the United States shares. Early Stuart, summer-run and late-run catches in the United States amounted to 39,000, 1,035,000 and 744,000 sockeye, respectively. These catches were 20,000 under, 84,000 over and 46,000 under the goals.

In 1991, unusual circumstances affected the achievement of the pink salmon catch objectives. First, the in-season run-size estimate of 16,565,000 (using the in-season escapement estimate of 7,400,000 fish) was 5,565,000 larger than the forecast return of 11,000,000. As estimates of the larger run developed, DFO advised the Panel of increases to the gross escapement goal. The TAC increased from 6,500,000 prior to the season to 9,000,000 in-season. Canada chose not to catch its full pink salmon allocation because purse seines had reached their allocation and there was concern for other species, which limited fishing opportunities in Area 20 and Johnstone Straits during September. In addition, Canadian fish buyers announced in early September that they would refuse to accept pink salmon at negotiated prices.

Canada's choice to allow a larger number of fish to escape to the Strait of Georgia would have reduced the TAC, thereby limiting the United States allocation of Fraser pink salmon. The United States protested this result. To address this concern, on September 17, Canada advised the Panel that on the basis of a 17,000,000 run and a gross escapement goal of 7,000,000 pink salmon, the United States could harvest its allocation even if Canada did not fully harvest its share of the TAC (estimated at approximately 835,000 fish on September 17), without generating a payback to

Table 17. Preliminary calculations of total allowable catches and international allocations of Fraser River sockeye and pink salmon in 1991.

	<u>Sockeye</u>	<u>Pink</u>
TOTAL ALLOWABLE CATCH		
Total Run Size	12,378,000	22,333,000
Canadian Escapement Add-on Benefit	1,279,000 *	---
Total Available to Share:	11,099,000	22,333,000
Deductions		
Adult Escapement	3,306,000	7,000,000 **
Jack Escapement	35,000	0
Inadvertent Escapement	0	5,333,000 **
Fraser River Indian Food Fishery Exemption	400,000	0
Test Fishing	105,000	45,000
Total Deductions:	3,846,000	12,378,000
Total Allowable Catch:	7,253,000	9,955,000
UNITED STATES		
Washington Catch	1,818,000	2,836,000
Alaska Catch	64,000	0
Inadvertent Escapement	0	2,000 **
Total:	1,882,000	2,838,000
Initial Allocation		2,560,000 ***
Payback		278,000 ****
Catch Goal:		2,838,000
Deviation:		0
CANADA		
Actual Catch		6,509,000
Unharvested Portion of Share		608,000 **
TAC - U.S. Catch + Add-on Benefit:	6,650,000	7,117,000
Catch Goal (TAC - United States Share):		7,117,000
Deviation:		0

* Preliminary estimate based on Fraser Panel agreement (February 8, 1991) on methodology for calculating sockeye escapement add-on benefits.

** To account for the unharvested portion of the Canadian share of pink salmon, the Panel agreed on September 17, 1991 to set the escapement goal to 7,000,000 and the TAC (excluding the test fishing catch) to 10,000,000 if the run reached 17,000,000. The inadvertent escapement deduction is the pink escapement over 7,000,000, excluding the unharvested Canadian share. The inadvertent escapement under the United States heading is due to management imprecision.

*** U.S. pink salmon allocation = TAC * 3.6 / 14.0.

**** Payback of pink salmon to the U.S. = 5% of the Canadian share, to a maximum of 278,000.

Canada. United States fishermen caught 2,836,000 Fraser River pink salmon compared to the allocation of 2,838,000, which included a payback of 278,000 fish (different than the pre-season estimate because of updates to previous years' data) due to catch shortfalls in past years. However, there was no underage because the difference was associated with imprecision in the management of fisheries in United States Panel Areas. An inadvertent escapement of 2,000 fish occurred through this source because these fish passed to the spawning grounds rather than being harvested in Canada. The final run size estimate was 22,333,000, with an inadvertent escapement of 5,333,000 Fraser pinks (Table 17).

C. Domestic Allocation

The third priority of the Panel is to achieve the domestic allocation goals of the Parties. The ability of the Panel to meet this objective is somewhat limited because the Panel manages only those fisheries that occur within the Panel Area. In 1991, this included the Canadian Areas 20 and 29 net fisheries, Area 18-1, -4 and -11 and Area 29 troll fisheries, United States net fisheries in Areas 4B, 5, 6, 6C, 7 and 7A and Non-Indian troll fishing in Area 4 and Area 3 north of 48°00'15"N directed at Fraser River sockeye and pink salmon. The Canadian outside troll fisheries, including the fisheries within the Panel Area (Areas 121-124), were regulated by Canada. DFO regulates fisheries in non-Panel areas with the objective of ensuring that the combined fisheries achieve the Canadian domestic allocation goals.

Canadian catches of Fraser River sockeye by gear type deviated from the goals set by the Minister of Fisheries (Table 18). The largest discrepancies were for outside trollers, who caught 379,000 sockeye more than their allocation of 1,153,000 (18.4%), and purse seine fishermen who caught 367,000 less than their allocation of 3,116,000 (49.6%). Gillnetters caught 44,000 sockeye less than their allocation of 1,827,000 (29.1%) and inside trollers caught 32,000 more than their allocation of 186,000 (3.0%) sockeye.

Table 18. Preliminary estimates of domestic overages and underages in Canadian and Washington catches of Fraser River sockeye salmon in 1991.

User Category	Actual Catches		Catch Goals		Overage/ (Underage)
	Fish	%	Fish	%	
Canada: by Gear					
Inside Troll	218,000	3.5%	186,000	3.0%	32,000
Outside Troll	1,532,000	24.4%	1,153,000	18.4%	379,000
Purse Seine	2,749,000	43.8%	3,116,000	49.6%	(367,000)
Gillnet	1,783,000	28.4%	1,827,000	29.1%	(44,000)
Canadian Total:	6,282,000	100.1%	6,282,000	100.0%	0
Washington: by Area or Gear					
Treaty Indian					
Areas 4B, 5 and 6C	93,000	11.1%	90,000	11.4%	3,000
Areas 6, 7 and 7A	745,000	88.9%	700,000	88.6%	45,000
Total:	838,000	100.0%	790,000	100.0%	48,000
Non-Indian					
Purse Seine	502,000	51.2%	500,000	49.5%	2,000
Gillnet	417,000	42.6%	450,000	44.6%	(33,000)
Reef Net	61,000	6.2%	60,000	5.9%	1,000
Total:	980,000	100.0%	1,010,000	100.0%	(30,000)
Washington Total:	1,818,000		1,800,000		18,000

Pre-season, the United States requested that the Panel divide their 1991 Washington catch goal of 1,800,000 sockeye: 1,010,000 to Non-Indian fishermen and 790,000 to Treaty Indian fishermen. Non-Indian fishermen caught 980,000 sockeye or 30,000 less than their allocation and Treaty Indian fishermen caught 838,000 sockeye or 48,000 more than their allocation (Table 18). An additional 64,000 sockeye were caught in Alaska District 104. Domestically, Treaty Indian fishermen in Areas 4B, 5 and 6C caught 93,000 sockeye, 3,000 over their allocation. Treaty Indians in Areas 6, 7 and 7A caught 745,000 fish, 45,000 over their allocation. Among Non-Indian fishermen, purse seine fishermen caught 51.2% of the Non-Indian catch, gillnet fishermen caught 42.6%, and reefnet fishermen caught 6.2%, which represent 2,000 over, 33,000 under and 1,000 over the respective allocations for these gear based on the pre-season catch goal of 1,010,000 fish.

Pink salmon allocation in Canada was for all "southerly migrating pink salmon stocks", including Fraser River, southern British Columbia and Washington State stocks. The largest discrepancy from the goals set by Canada was in the purse seine catch, which exceeded the allocation of 4,414,000 by 377,000 fish (Table 19). Gillnetters caught 307,000 fish less than their allocation of 685,000. Outside trollers caught 150,000 fewer fish than their allocation of 2,207,000. Inside trollers caught 80,000 pinks over their allocation of 304,000.

Table 19. Preliminary estimates of domestic overages and underages in the catches of a) southerly migrating pink salmon in Canada and b) Fraser River pink salmon in the United States in 1991.

User Category	Actual Catches		Catch Goals		Overage/ (Underage)
	Fish	%	Fish	%	
a) Southerly Migrating Pink Salmon					
Canada: by Gear					
Inside Troll	384,000	5.0%	304,000	4.0%	80,000
Outside Troll	2,057,000	27.0%	2,207,000	29.0%	(150,000)
Purse Seine	4,791,000	63.0%	4,414,000	58.0%	377,000
Gillnet	378,000	5.0%	685,000	9.0%	(307,000)
Canadian Total:	7,610,000	100.0%	7,610,000	100.0%	0
b) Fraser River Pink Salmon					
United States: by Group					
Treaty Indian	1,387,000	48.9%	1,418,000	50.0%	(31,000)
Non-Indian	1,449,000	51.1%	1,418,000	50.0%	31,000
Total:	2,836,000	100.0%	2,836,000	100.0%	0

In United States waters, the Fraser River pink catch was to be divided equally between Treaty-Indian and Non-Indian fishermen. Of the actual catch, Treaty Indians caught 1,387,000 pinks, 31,000 under their allocation and Non-Indians (including recreational catch) caught 1,449,000, 31,000 over their allocation (Table 19). The catch quota of 160,000 pink salmon in the Areas 3 and 4 Non-Indian troll fishery was not taken, although weekly fishing opportunities were provided.

D. Conservation of Other Stocks

Part of the mandate of the Fraser River Panel is to accommodate the conservation and management needs of other salmon species and stocks during the management of Fraser River sockeye and pink salmon fisheries in Panel Areas. Total catches of other species and non-Fraser stocks of sockeye and pink salmon during Panel control are summarized in Table 20.

Conservation concerns about the Lake Washington sockeye catch in United States Areas 4B, 5 and 6C led to restricted fishing in these areas during early July. Similar concerns about coho by-catch in Areas 4B, 5 and 6C led to late-season restrictions of fisheries. Canada requested limitation of fisheries in Area 20 after September 7 to minimize the by-catch of Strait of Georgia origin coho salmon. Similarly, Canada requested that no gillnet fisheries take place in Area 29 after September 4 to reduce the by-catch of Harrison River chinook salmon and Thompson River steelhead trout. Although the closure period was modified to allow two fisheries, these occurred at times and in areas where low by-catches were expected. The catches of other species in all Panel Area net fisheries were low or moderate. About 39,000 chinook, 261,000 coho and 10,000 chum salmon were caught. In addition, 471,000 non-Fraser pink salmon were harvested in Panel Area fisheries targeting Fraser River stocks.

Table 20. Preliminary estimates of catches of non-Fraser sockeye and pink salmon and of other salmon species in commercial net fisheries regulated by the Fraser River Panel in 1991. *

Area	Non-Fraser		Chinook	Coho	Chum
	Sockeye	Pink			
United States					
Areas 4B, 5 and 6C Net	0	11,800	2,400	30,100	0
Areas 6, 7 and 7A Net	0	299,200	13,500	52,800	1,500
Total	0	311,000	15,900	82,900	1,500
Canada					
Area 20 Net	0	159,800	11,000	175,600	1,000
Area 29 Net	0	0	12,300	2,000	7,300
Total	0	159,800	23,300	177,600	8,300
Total Catch	0	470,800	39,200	260,500	9,800

* Estimates are provided by the Washington Department of Fisheries and Canada Department of Fisheries and Oceans.

X. ALLOCATION STATUS

Under the terms of the Treaty, the United States catch is limited to 7,000,000 sockeye and 7,200,000 pink salmon for the period 1989-92, plus adjustments for catch shortfalls of 103,000 sockeye and 111,000 pink salmon that occurred during the four-year management period ending in 1988. Within a given year, the United States can harvest up to a pre-determined percentage of the TAC (34.2% of the TAC for sockeye and 25.7% of the TAC for pink salmon in 1991).

To retain fish for commercial harvest in 1992, the United States elected to harvest below its maximum permissible share of sockeye in 1989, 1990 and 1991. In 1991, the United States selected a Panel Area catch goal of 1,800,000 Fraser River sockeye salmon. The actual United States harvest of Fraser sockeye was 1,818,000 in Panel Area waters and 64,000 in Alaska District 104, for a total harvest of 1,882,000 fish. This leaves an outstanding balance of either 356,000 or 881,000 sockeye for harvest in 1992, pending the resolution of discussions between the Parties on whether the Alaska District 104 sockeye catch counts towards the United States 7,103,000 catch ceiling (7,000,000 plus payback of 103,000 fish) for the years 1989-92.

The larger-than-forecast return of Fraser River pink salmon in 1991 permitted the United States to harvest their maximum permissible share of the TAC of Fraser River pink salmon (TAC * 3.6/14.0 = 2,560,000 fish) and the full repayment of 278,000 fish for the 1989 catch shortfall, for a total of 2,838,000 fish. The actual harvest of Fraser River pink salmon by United States fishermen was 2,836,000. The unharvested portion of their share was 2,000 fish, which became inadvertent escapement due to imprecision in the management of Panel Area fisheries. Since these fish were not caught in Canada, they did not generate a payback to the United States in 1993.

For the 1989-91 period, cumulative United States catches of Fraser sockeye were 6,222,000 in Panel Areas and 525,000 in Alaska waters, for a total of 6,747,000 Fraser sockeye (Table 21). Cumulative catches of Fraser River pink salmon in the same period totalled 5,097,000, which is 2,214,000 less than the maximum cumulative United States catch of 7,311,000 Fraser pinks (7,200,000 plus 111,000 payback) for the 1989-92 period.

Table 21. Preliminary calculations of total allowable catches, and international allocations and catches of Fraser River sockeye and pink salmon in 1989-91.

	Sockeye Salmon			Pink Salmon	
	1989	1990	1991	1989	1991
TOTAL ALLOWABLE CATCH					
Total Run Size	18,618,000	22,024,000	12,378,000	16,667,000	22,333,000
Canadian Escapement Add-on Benefit <i>a</i>	367,000	1,053,000	1,279,000	0	0
Total Available to Share:	18,251,000	20,971,000	11,099,000	16,667,000	22,333,000
Deductions					
Adult Escapement <i>b</i>	2,500,000	5,360,000	3,306,000	6,000,000	7,000,000
Jack Escapement	47,000	21,000	35,000	0	0
Inadvertent Escapement <i>b</i>	52,000	0	0	1,189,000	5,333,000
Escapement Over Goal	0	700,000	0	0	0
Fraser River IFF Exemption	400,000	400,000	400,000	0	0
Test Fishing	68,000	79,000	105,000	36,000	45,000
Total Deductions:	3,067,000	6,560,000	3,846,000	7,225,000	12,378,000
Total Allowable Catch:	15,184,000	14,411,000	7,253,000	9,442,000	9,955,000
UNITED STATES					
Washington Catch	2,247,000	2,157,000	1,818,000	2,261,000	2,836,000
Alaska Catch	191,000	270,000	64,000	0	0
Inadvertent Escapement <i>b</i>	0	0	0	0	2,000
Catch:	2,438,000	2,427,000	1,882,000	2,261,000	2,838,000
Initial Allocation <i>c</i>				2,428,000	2,560,000
Payback <i>d</i>	103,000			111,000	278,000
Goal:				2,539,000	2,838,000
Deviation:				(278,000)	0
CANADA					
Actual Catch					6,509,000
Unharvested Portion of Share <i>b</i>					608,000
TAC + Add-on - U.S. Catch:	13,113,000	13,037,000	6,650,000	7,181,000	7,117,000
Goal (TAC + Add-on - U.S. Share):				6,903,000	7,117,000
Deviation:				278,000	0

a Canadian Escapement Add-on Benefit: Calculation methodology from Fraser Panel agreement on February 8, 1991.

b For 1991, to account for the unharvested portion of the Canadian share of pink salmon, the Panel agreed on September 17, 1991, to set the escapement goal to 7,000,000 and the TAC (excluding the test fishing catch) to 10,000,000 if the run reached 17,000,000. The inadvertent escapement deduction is the pink escapement over 7,000,000, excluding the unharvested Canadian share. The inadvertent escapement under the United States heading is due to management imprecision.

c U.S. allocation of Fraser sockeye: Amount selected by the U.S. out of their cumulative maximum of 7,000,000 for 1989-92.

U.S. allocation of Fraser pinks: Amount = TAC x 3.6 / 14.0, out of a cumulative maximum of 7,200,000 for 1989-92.

d Paybacks are for catch shortfalls in previous years. In 1991, the payback of Fraser pinks was limited to 5% of the Canadian share.

XI. APPENDICES

APPENDIX A: 1991 PRE-SEASON FORECASTS AND ESCAPEMENT GOALS FOR FRASER RIVER SOCKEYE AND PINK SALMON. (Provided to the Fraser River Panel by Canada Department of Fisheries and Oceans).

Stock	Forecast Adult Return	Spawner Escapement Goal	Gross Escapement Goal	Expected Catch
Early Stuart	500,000	200,000	400,000	100,000
Bowron	60,000	24,000	33,000	27,000
Upper Pitt	30,000	12,000	16,000	14,000
Gates	50,000	20,000	27,000	23,000
Lake Nadina	105,000	42,000	58,000	47,000
Quesnel System	100,000	35,000	45,000	55,000
Late Stuart	50,000	18,000	23,000	27,000
Scotch	15,000	5,000	7,000	8,000
Seymour	550,000	179,000	261,000	289,000
Chilko System	1,900,000	600,000	797,000	1,103,000
Stellako	850,000	250,000	338,000	512,000
Birkenhead	600,000	200,000	210,000	390,000
Adams/Lower Shuswap	9,300,000	2,100,000	2,252,000	7,048,000
Weaver	105,000	24,000	26,000	79,000
Portage	20,000	5,000	5,000	15,000
Harrison	20,000	5,000	5,000	15,000
Cultus	100,000	23,000	25,000	75,000
Early Miscellaneous	92,000	31,500	45,000	47,000
Late Miscellaneous	3,000	1,500	2,000	1,000
Total Adults	14,450,000	3,775,000	4,575,000	9,875,000
Jacks	50,000	25,000	25,000	25,000
Total Sockeye Return	14,500,000	3,800,000	4,600,000	9,900,000

Stock Grouping	Forecast Adult Return	Spawner Escapement Goal	Gross Escapement Goal	Expected Catch
Early Stuart	500,000	200,000	400,000	100,000
Early Summer	902,000	313,500	447,000	455,000
Summer	2,900,000	903,000	1,203,000	1,697,000
Late	10,148,000	2,358,500	2,525,000	7,623,000
Total Adult	14,450,000	3,775,000	4,575,000	9,875,000
Jacks	50,000	25,000	25,000	25,000
Total Sockeye Return	14,500,000	3,800,000	4,600,000	9,900,000
 Total Pink Return	 11,000,000	 4,500,000	 4,500,000	 6,500,000

APPENDIX B: 1991 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 May 6, 1991. The United States Government acknowledged receipt of the Fishing Regime and Regulations on May 30, 1991. The recommendations for Canadian waters were implemented under the Fisheries Act, Pacific Commercial Salmon Fishery Regulations.

Canadian Fraser River Panel Area

In accordance with Article VI, Paragraph 5 of the Pacific Salmon Treaty, the Commission recommends to Canada the adoption of the following Fishing Regime developed by the Fraser River Panel as per Annex IV, Chapter 4 (1) (d) of the Treaty, namely:

1. a) No person shall fish for sockeye or pink salmon in Pacific Fishery Management Area 20-1, 3 and 4 with nets from the 16th day of June, 1991 to the 14th day of September, 1991, 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 16th day of June, 1991 to the 14th day of September, 1991, 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 16th day of June, 1991 to the 28th day of September, 1991, 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 16th day of June, 1991 to the 28th day of September, 1991, both dates inclusive.
3. a) No person shall commercially fish for sockeye or pink salmon with nets in Pacific Fishery Management Area 29 from the 16th day of June, 1991 to the 12th day of October, 1991, both dates inclusive.
b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 29 from the 16th day of June, 1991 to the 12th day of October, 1991, both dates inclusive.
4. The following Fraser River Panel Area waters are excluded:
 - a) High Seas westerly of the Bonilla Point-Tatoosh Island Lighthouse Line.
 - b) Pacific Fishery Management Area 19, Area 20-2 and 5 to 7 and Area 29-8.
 - c) Commercial troll fishing in Pacific Fishery Management Area 17, Area 18-2, 3 and 5 to 10 and Area 29-5.

During the 1991 season, the Fraser River Panel will adopt Orders establishing open fishing periods based on a 1991 Management Plan (to be adopted on or about June 11, 1991). This Plan will be 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, the Commission recommends to the United States Government the adoption of the following Fishing Regime developed by the Fraser River Panel as per Annex IV, Chapter 4 (1) (d) of the Treaty, 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 16th day of June, 1991 to the 14th day of September, 1991, both dates inclusive.
2. No Treaty Indian shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 6A, 7 and 7A with nets from the 16th day of June, 1991 to the 21st day of September, 1991, both dates inclusive.
3. No Treaty Indian shall commercially fish for sockeye or pink salmon with nets in that portion of Puget Sound Salmon Management and Catch Reporting Area 7A lying westerly of a straight line drawn from the low water range marker in Boundary Bay on the International Boundary through the east tip of Point Roberts in the State of Washington to the East Point Light on Saturna Island in the Province of British Columbia from the 22nd day of September, 1991 to the 28th day of September, 1991, both dates inclusive.

All-Citizen Fisheries:

1. No person shall troll commercially for sockeye or pink salmon in Coastal Salmon Management and Catch Reporting Area 4 and that part of Area 3 north of 48°N latitude (Carroll Island) from the 14th day of July, 1991 to the 7th day of September, 1991, both dates inclusive.
2. 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 16th day of June, 1991 to the 14th day of September, 1991, both dates inclusive.
3. No person shall fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 6A, 7 and 7A with nets from the 16th day of June, 1991 to the 21st day of September, 1991, both dates inclusive.
4. 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 22nd day of September, 1991 to the 28th day of September, 1991, both dates inclusive.

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

Treaty Indian Fisheries:

1. Coastal Salmon Management and Catch Reporting Area 4 and that Part of Area 3 north of 48°N latitude (Carroll Island).

Treaty Indian and All-Citizen Fisheries:

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

During the 1991 season, the Fraser River Panel will adopt Orders establishing open fishing periods based on a 1991 Management Plan (to be adopted on or about June 11, 1991). This Plan will be designed to achieve Pacific Salmon Treaty-mandated international allocations of the catch and domestic goals of the Parties.

APPENDIX C: 1991 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, to the fishermen of the United States and Canada and (b) domestically, to the commercial user groups in Canada and the United States, the Fraser River Panel formulated the following orders to regulate Panel Area fisheries in 1991:

- June 25 Canada
Area 18-4:
Relinquish regulatory control effective June 25.
- July 8 Canada
Area 29-1 to 7 and 9 to 17:
Gillnets open 8:00 a.m. July 9 to 8:00 a.m. July 10.
- July 9 Canada
Area 29-1 to 7 and 9 to 17:
Gillnets extended from 8:00 a.m. to 8:00 p.m. July 10.
- July 10 United States
Treaty Indian Fishery
Areas 7 and 7A:
Open to net fishing 5:00 a.m. to 9:00 a.m. July 11.
- All-Citizen Fishery
Areas 7 and 7A:
Gillnets open 1:00 p.m. to 8:00 p.m. July 11.
Purse seines open 7:00 a.m. to 12:00 noon July 12.
- July 26 Canada
Area 20-1, 3 and 4:
Gillnets open 7:00 p.m. July 29 to 8:00 a.m. July 30 and 7:00 p.m. July 30 to 8:00 a.m. July 31.
- Area 29-1 to 7 and 9 to 17:
Gillnets open 8:00 a.m. July 29 to 8:00 a.m. July 30.
- United States
Treaty Indian Fishery
Areas 4B, 5 and 6C:
Drift gillnets open 12:00 noon July 28 to 12:00 noon August 1.
- July 29 Canada
Area 29-1 to 7 and 9 to 17:
Gillnets extended from 8:00 a.m. July 30 to 8:00 a.m. July 31.
- August 2 Canada
Area 20-1, 3 and 4:
Gillnets open 7:00 p.m. August 5 to 8:00 a.m. August 6 and 7:00 p.m. August 6 to 8:00 a.m. August 7.
- Area 29-1 to 7 and 9 to 17:
Gillnets open 8:00 a.m. August 6 to 8:00 a.m. August 7.

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C:

Drift gillnets open 12:00 noon August 5 to 12:00 noon August 7 and 4:00 a.m. to 4:00 p.m. August 8.

Areas 6, 7 and 7A:

Open to net fishing 4:00 a.m. to 4:00 p.m. August 8.

All-Citizen Fishery

Areas 4B, 5, 6, 6C, 7 and 7A:

Reefnets open 6:00 a.m. to 9:00 p.m. August 6.

Purse seines open 6:00 a.m. to 11:00 a.m. August 7.

Gillnets open 12:00 noon to 8:00 p.m. August 7.

August 6

Canada

Area 29-1 to 7 and 9 to 17:

Gillnets extended from 8:00 a.m. to 8:00 p.m. August 7.

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C:

Drift gillnets extended from 12:00 noon August 7 to 12:00 noon August 9.

August 9

Canada

Area 29-1 to 7 and 9 to 17:

Gillnets open 8:00 a.m. August 12 to 8:00 a.m. August 13.

Area 18-4:

Assume regulatory control effective 12:01 a.m. August 10.

Open to commercial trolling 12:01 a.m. August 10 until further notice.

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C:

Drift gillnets open 12:00 noon August 10 to 12:00 noon August 14.

Areas 6, 7 and 7A:

Open to net fishing 5:00 p.m. August 12 to 12:00 noon August 14.

All-Citizen Fishery

Area 4 and Area 3 north of 48° 00'15" N.:

Open to commercial trolling 12:01 a.m. August 16 to 11:59 p.m. August 19, westerly of the 100 fm. contour.

Areas 4B, 5, 6, 6C, 7 and 7A:

Reefnets open 5:00 a.m. to 9:30 p.m. August 11 and August 12.

Gillnets open 6:00 p.m. August 14 to 9:00 a.m. August 15 and 6:00 p.m. August 15 to 9:00 a.m. August 16.

Purse seines open 6:00 a.m. to 9:00 p.m. August 15 and August 16.

August 12

United States

Treaty Indian Fishery

Areas 4B, 5 and 6C:

Drift gillnets close 4:00 p.m. August 12.

August 16

Canada

Area 20-1, 3 and 4:

Purse seines open 7:00 a.m. to 7:00 p.m. August 19.

Gillnets open 7:00 p.m. August 19 to 7:00 a.m. August 20 and 7:00 p.m. August 20 to 7:00 a.m. August 21.

United States
Treaty Indian Fishery
Areas 4B, 5 and 6C:
Drift gillnets open 6:00 p.m. August 19 to 11:00 a.m. August 20.

Areas 6, 7 and 7A:
Open to net fishing 5:00 a.m. August 19 to 11:00 a.m. August 20.

All-Citizen Fishery:
Areas 7 and 7A:
Gillnets open 12:00 noon August 20 to 9:00 a.m. August 21 and 6:00 p.m. August 21 to 9:00 a.m. August 22.
Purse seines open 6:00 a.m. to 9:00 p.m. August 21.

August 19(a) Canada
Area 20-1, 3 and 4:
Purse seines open 7:00 a.m. to 7:00 p.m. August 20.
Gillnets open 7:00 p.m. August 20 to 7:00 a.m. August 21 and 7:00 p.m. August 21 to 7:00 a.m. August 22.

United States
All-Citizen Fishery
Areas 7 and 7A:
Cancel gillnet opening previously scheduled for 6:00 p.m. August 21 to 9:00 a.m. August 22.

August 19(b) Canada
Area 18-4:
Close to commercial trolling at 11:59 p.m. August 20.

United States
Treaty Indian Fishery
Areas 4B, 5, 6, 6C, 7 and 7A:
Close to net fishing at 12:00 midnight August 19.

August 20 Canada
Area 20-1, 3 and 4:
Purse seines open 7:00 a.m. to 7:00 p.m. August 21.
Gillnets open 7:00 p.m. August 21 to 8:00 a.m. August 22 and 7:00 p.m. August 22 to 8:00 a.m. August 23.

United States
All-Citizen Fishery
Areas 7 and 7A:
Purse seines open 9:00 a.m. to 5:00 p.m. August 21.

August 21 United States
All-Citizen Fishery
Area 4 and Area 3 north of 48° 00'15" N.:
Open to commercial trolling 12:01 a.m. August 23 to 11:59 p.m. August 26, westerly of the 100 fm. contour.

August 23 Canada
Area 20-1, 3 and 4:
Purse seines open 7:00 a.m. to 7:00 p.m. August 26 and August 27.
Gillnets open 7:00 p.m. August 26 to 7:00 a.m. August 27; 7:00 p.m. August 27 to 7:00 a.m. August 28; 7:00 p.m. August 28 to 8:00 a.m. August 29; and 7:00 p.m. August 29 to 8:00 a.m. August 30.

Area 18-4:
Open to commercial trolling 12:01 a.m. August 25 to 11:59 p.m. August 26.

United States
All-Citizen Fishery
Areas 7 and 7A (Iwersen's Dock Line):
Reefnets open 5:00 a.m. to 9:30 p.m. August 25 and August 27.
Purse seines open 9:00 a.m. to 4:00 p.m. August 26.

August 25 Canada
Area 29-1 to 7 and 9 to 17:
Gillnets open 8:00 a.m. August 26 to 8:00 a.m. August 27.

August 26 Canada
Area 20-1, 3 and 4:
Purse seines open 7:00 a.m. to 7:00 p.m. August 27 and August 28.

Area 18-4:
Extended for commercial trolling until further notice.

United States
All-Citizen Fishery
Areas 7 and 7A:
Cancel reefnet opening previously scheduled for August 27.

August 28 Canada
Area 18-4:
Closed to commercial trolling 11:59 p.m. August 28.

United States
All-Citizen Fishery
Area 4 and Area 3 north of 48° 00'15" N.:
Open to commercial trolling 12:01 a.m. August 30 to 11:59 p.m. September 2,
westerly of the 100 fm. contour.

August 30 Canada
Area 20-1, 3 and 4:
Gillnets open 7:00 p.m. September 2 to 8:00 a.m. September 3 and 7:00 p.m.
September 3 to 8:00 a.m. September 4.

Area 29-1 to 4 and 6:
Gillnets open 8:00 a.m. September 3 to 8:00 a.m. September 4.

Area 18-4:
Open to commercial trolling 12:01 a.m. August 31 to 11:59 p.m. September 2.

United States
Treaty Indian Fishery
Areas 4B, 5 and 6C:
Open to drift gillnets 5:00 a.m. September 2 to 5:00 a.m. September 4.

Areas 6, 7 and 7A (Iwersen's Dock Line):
Open to net fishing 5:00 a.m. to 5:00 p.m. September 2.

Areas 6, 7 and 7A (East Point Line):
Open to net fishing 5:00 p.m. September 2 to 5:00 p.m. September 3.

All-Citizen Fishery
Areas 7 and 7A:
Reefnets open 5:00 a.m. to 9:00 p.m. September 1.

September 2 Canada
Area 29-1 to 4 and 6:
Cancel gillnet opening scheduled for September 3.

- United States
All-Citizen Fishery
Areas 7 and 7A:
Reefnets open 5:00 a.m. to 9:00 p.m. September 3 and September 4.
- September 3(a) United States
Treaty Indian Fishery
Areas 6, 7 and 7A (Iwersen's Dock Line):
Extended for net fishing 5:00 p.m. September 3 to 2:00 p.m. September 4.
- All-Citizen Fishery
Areas 7 and 7A (Iwersen's Dock Line):
Gillnets open 3:00 p.m. September 4 to 9:00 a.m. September 5 and 6:00 p.m. September 5 to 9:00 a.m. September 6.
Purse seines open 6:00 a.m. to 9:00 p.m. September 5 and 6:00 a.m. to 5:00 p.m. September 6.
- September 3(b) United States
Treaty Indian Fishery
Areas 4B, 5 and 6C:
Extended for drift gillnets 5:00 a.m. to 9:00 a.m. September 4.
- September 4 United States
Treaty Indian Fishery
Areas 4B, 5 and 6C:
Drift gillnets open 6:00 p.m. September 4 to 9:00 a.m. September 6.
- All-Citizen Fishery
Area 4 and Area 3 north of 48° 00'15" N.:
Open to commercial trolling 12:01 a.m. September 6 to 11:59 p.m. September 9, westerly of the 100 fm. contour.
- September 5 United States
All-Citizen Fishery
Areas 7 and 7A (East Point Line):
Purse seines open 6:00 a.m. to 5:00 p.m. September 6.
- September 6 Canada
Area 29-1 to 6:
Gillnets open 8:00 a.m. September 8 to 8:00 a.m. September 9.
- United States
Treaty Indian Fishery
Areas 6, 7 and 7A (East Point Line):
Open to net fishing 6:00 a.m. September 8 to 6:00 p.m. September 9.
- All-Citizen Fishery
Areas 7 and 7A:
Reefnets open 5:00 a.m. to 9:00 p.m. September 7, September 8, and September 9.
- September 9 United States
Treaty Indian Fishery
Areas 6, 7 and 7A (East Point Line):
Extended for net fishing 6:00 p.m. September 9 to 9:00 a.m. September 11.
- All-Citizen Fishery
Areas 7 and 7A (Iwersen's Dock Line):
Gillnets open 3:00 p.m. September 11 to 7:00 a.m. September 12.
- Areas 7 and 7A (East Point Line):
Purse seines open 7:00 a.m. to 1:00 p.m. September 12.

September 11 Canada
 Area 18-4:
 Open to commercial trolling 12:01 a.m. September 12 until further notice.

United States
 Treaty Indian Fishery
 Areas 6, 7 and 7A (East Point Line):
 Open to net fishing 8:00 a.m. September 13 to 6:00 p.m. September 15.

 All-Citizen Fishery
 Area 4 and Area 3 north of 48° 00' 15" N.:
 Relinquish regulatory control effective 12:45 p.m. September 11.

 Areas 7 and 7A (Iwersen's Dock Line):
 Gillnets open 6:00 p.m. September 12 to 7:00 a.m. September 13.

 Areas 7 and 7A (East Point Line):
 Purse seines open 7:00 a.m. to 6:00 p.m. September 12.

 Areas 7 and 7A:
 Reefnets open 5:00 a.m. to 9:00 p.m. September 14, September 15, and September 16.

September 13 Canada
 Area 20:
 Relinquish regulatory control effective September 15.

 Area 29- 1 to 4 and 6:
 Open to commercial trolling 12:01 a.m. to 11:59 p.m. September 16.

United States
 Treaty Indian and All-Citizen Fisheries
 Areas 4B, 5 and 6C:
 Relinquish regulatory control effective September 15.

 Treaty Indian Fishery
 Areas 6, 7 and 7A (East Point Line):
 Extend for net fishing from 6:00 p.m. September 15 to 6:00 p.m. September 16.

September 18 United States
 Treaty Indian Fishery
 Areas 7 and 7A (East Point Line):
 Open to net fishing 7:00 a.m. to 3:00 p.m. September 19.

 All-Citizen Fishery
 Areas 7 and 7A:
 Reefnets open 5:00 a.m. to 9:00 p.m. September 20.

September 19 United States
 Treaty Indian and All-Citizen Fisheries
 Areas 7 and 7A:
 Extend regulatory control until further notice.

 Treaty Indian Fishery
 Areas 7 and 7A (East Point Line):
 Extend for net fishing from 3:00 p.m. September 19 to 6:00 p.m. September 20.

- September 23 Canada
Area 18-4:
Relinquish regulatory control effective September 24.
- Areas 17 and 18:
Relinquish regulatory control effective September 29.
- United States
Treaty Indian and All-Citizen Fisheries
Areas 7 and 7A:
Relinquish regulatory control of those waters lying southerly and easterly 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, effective September 29.
- September 30 Canada
Area 29-1 to 5:
Gillnets open 7:00 a.m. to 7:00 p.m. October 2.
- October 4 United States
Treaty Indian and All-Citizen Fisheries
Area 7A:
Relinquish regulatory control of remaining area effective October 6.

The Fraser River Panel relinquished regulatory control of the remaining Panel Areas on October 14, as scheduled. This completed the Panel's responsibility in the Panel Area for the 1991 fishing season.

All times herein cited are Pacific Daylight Savings Time.

APPENDIX D: TABLES 1-9

Table 1. Commercial net catches of Fraser River sockeye salmon in Canadian Area 20 (Juan de Fuca Strait) by week for cycle years 1979-1991.

Date *	1979	1983	1987	1991
June 23-29	700	100	0	0
June 30-July 6	1,300	300	0	0
July 7-13	300	300	0	0
July 14-20	1,100	400	0	0
July 21-27	3,700	2,000	0	0
July 28-Aug.3	4,900	3,100	0	52,000
Aug. 4-10	156,700	1,900	0	134,000
Aug. 11-17	105,300	300	209,800	0
Aug. 18-24	33,400	500	123,800	801,000
Aug. 25-31	15,000	3,700	124,000	285,000
Sept. 1-7	1,300	500	5,200	6,000
Sept. 8-14	0	0	0	0
Sept. 15-21	0	0	0	0
Sept. 22-28	0	0	0	0
Sept. 29-Oct. 5	0	0	0	0
Oct. 6-12	0	0	0	0
Total	323,700	13,100	462,800	1,278,000

* Dates for 1991. For other years, data from the nearest week was 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 1979-1991.

Date *	1979	1983	1987	1991
June 23-29	1,400	0	0	0
June 30-July 6	1,500	100	0	0
July 7-13	32,100	500	0	125,000
July 14-20	9,700	300	0	0
July 21-27	39,300	1,500	0	0
July 28-Aug.3	155,600	79,700	0	118,000
Aug. 4-10	470,600	110,800	145,400	242,000
Aug. 11-17	117,200	1,500	185,200	156,000
Aug. 18-24	127,100	2,100	179,800	17,000
Aug. 25-31	82,100	146,000	37,800	152,000
Sept. 1-7	22,200	16,100	61,500	19,000
Sept. 8-14	34,500	34,000	12,700	63,000
Sept. 15-21	1,000	73,500	11,200	33,000
Sept. 22-28	300	89,900	0	1,000
Sept. 29-Oct. 5	2,300	500	0	8,000
Oct. 6-12	0	600	0	1,000
Total	1,096,900	557,100	633,600	935,000

* Dates for 1991. For other years, data from the nearest week was 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 1979-1991.

Date **	1979	1983	1987	1991
June 23-29	700	0	0	0
June 30-July 6	400	100	0	0
July 7-13	2,200	300	0	0
July 14-20	9,300	100	0	0
July 21-27	13,700	100	0	1,000
July 28-Aug.3	188,500	2,500	0	29,000
Aug. 4-10	74,300	9,600	10,200	77,000
Aug. 11-17	24,800	2,500	203,500	334,000
Aug. 18-24	11,600	8,800	245,800	929,000
Aug. 25-31	3,500	6,800	4,400	20,000
Sept. 1-7	200	1,900	0	0
Sept. 8-14	900	1,800	0	0
Sept. 15-21	200	600	0	2,000
Sept. 22-28	200	0	0	0
Sept. 29-Oct. 5	100	0	0	0
Oct. 6-12	800	0	0	0
Total	331,400	35,100	463,900	1,392,000

* Landings lag behind actual catches by an average of five days.

** Dates for 1991. For other years, data from the nearest week was 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 1979-1991.

Date *	1979	1983	1987	1991
June 23-29	0	0	0	0
June 30-July 6	7,100	0	0	0
July 7-13	1,100	2,800	0	0
July 14-20	8,500	8,300	100	0
July 21-27	52,800	47,900	500	4,000
July 28-Aug.3	340,200	172,900	200	85,000
Aug. 4-10	280,800	496,300	332,600	455,000
Aug. 11-17	160,300	692,300	689,500	876,000
Aug. 18-24	38,800	537,000	362,500	689,000
Aug. 25-31	26,500	450,400	172,800	231,000
Sept. 1-7	5,800	101,900	33,300	15,000
Sept. 8-14	1,600	31,700	0	62,000
Sept. 15-21	100	44,900	0	1,000
Sept. 22-28	0	0	0	2,000
Sept. 29-Oct. 5	0	0	0	0
Oct. 6-12	0	0	0	0
Total	923,600	2,586,400	1,591,500	2,420,000

* Dates for 1991. For other years, data from the nearest week was used.

Table 5. Catches of Fraser River sockeye salmon in the Canadian Fraser River Indian food fishery by area (Fraser River mainstream and tributary areas) for cycle years 1979-1991. *

Fishing Area	1979	1983	1987	1991
Fraser River Mainstem				
Steveston	8,471	6,023	26,501	70,115
Deas to Mission	12,426	5,647	8,458	15,461
Mission to Hope	79,745	72,018	89,917	142,932
Hope to North Bend	45,936	87,356	158,359	190,380
North Bend to Churn Creek	71,046	87,285	100,277	94,977
Churn Creek to Hixon	4,618	23,850	11,645	31,196
Above Hixon	750	3,085	2,534	5,004
Total	222,992	285,264	397,691	550,065
Tributaries				
Harrison/Lillooet System	14,000	10,081	7,680	1,806
Thompson System	2,860	1,255	3,525	261
Chilcotin System	20,926	44,600	28,134	34,593
Nechako System	21,294	15,241	22,311	11,562
Stuart System	9,637	5,115	8,682	7,643
Total	68,717	76,292	70,332	55,865
Total Catch	291,709	361,556	468,023	605,930

* Data supplied by Canada Department of Fisheries and Oceans.

Table 6. Commercial net catches of Fraser River sockeye salmon in United States Areas 4B, 4, 6, 6C, 7 and 7A (Juan de Fuca Strait and northern Puget Sound) by week for cycle years 1979-1991.

Date *	1979	1983	1987	1991
June 23-29	0	0	0	0
June 30-July 6	1,700	0	0	0
July 7-13	600	0	0	43,000
July 14-20	15,700	0	0	0
July 21-27	214,100	1,200	0	0
July 28-Aug.3	211,600	54,400	15,800	17,000
Aug. 4-10	939,200	122,300	341,300	126,000
Aug. 11-17	154,700	74,200	354,700	659,000
Aug. 18-24	171,900	38,300	853,400	564,000
Aug. 25-31	43,000	61,000	277,700	139,000
Sept. 1-7	2,000	10,300	92,800	163,000
Sept. 8-14	1,800	1,500	100	78,000
Sept. 15-21	0	4,800	0	27,000
Sept. 22-28	0	600	0	1,000
Sept. 29-Oct. 5	0	100	0	0
Oct. 6-12	0	0	0	0
Total	1,756,300	368,700	1,935,800	1,817,000

* Dates for 1991. For other years, data from the nearest week was used.

Table 7. Fraser River pink salmon production for odd brood years between 1961-1989.

Brood Year	Spawners		Potential Egg	Fry	Adult Returns (Catch +	% Survival	
	Total (millions)	Female (millions)	Deposition (millions)	Production (millions)	Escapement) (millions)	Freshwater	Marine
1961	1.094	0.654	1,569	143.6	5.477	9.2%	3.8%
1963	1.953	1.216	2,435	284.2	2.320	11.7%	0.8%
1965	1.191	0.692	1,488	274.0	12.968	18.4%	4.7%
1967	1.831	0.973	2,132	237.6	3.928	11.1%	1.7%
1969	1.529	0.957	2,018	195.6	9.767	9.7%	5.0%
1971	1.804	1.096	1,923	245.4	6.789	12.8%	2.8%
1973	1.754	1.009	1,865	292.4	4.894	15.7%	1.7%
1975	1.367	0.781	1,493	279.2	8.209	18.7%	2.9%
1977	2.388	1.362	2,960	473.3	14.404	16.0%	3.0%
1979	3.561	2.076	3,787	341.5	18.685	9.0%	5.5%
1981	4.488	2.560	4,814	590.2	15.346	12.3%	2.6%
1983	4.632	2.931	4,702	554.8	19.104	11.8%	3.4%
1985	6.461	3.561	5,900	256.1	7.172	4.3%	2.8%
1987	3.224	1.845	3,471	406.9	16.631	11.7%	4.1%
1989	7.189	4.374	7,152	360.0	22.333	5.0%	6.2%
Average	3.588	2.131	3,181	329.0	11.202	11.8%	3.4%

Table 8. Escapements of sockeye salmon to Fraser River spawning areas for cycle years 1979, 1983, 1987 and 1991. *

DISTRICT Stream/Lake	1991 Period of Peak Spawning	Estimated Number of Adult Sockeye				Jacks 1991
		1979	1983	1987	1991	
NORTHEAST	na					
Upper Bowron River		35,000	6,451	11,071	4,919	0
STUART						
Early Runs						
Takla Lake Streams	Aug.10-15	6,318	3,130	27,614	28,603	0
Middle River Streams	Aug.10-15	75,949	18,491	100,706	81,071	33
Trembleur Lake Streams	Aug.10-15	10,479	2,246	19,874	31,445	0
Early Stuart Total		92,746	23,867	148,194	141,119	33
Late Runs						
Middle River	na	18,111	639	2,441	16,331	0
Tachie River	na	10,940	853	2,398	50,841	410
Miscellaneous	na	2,867	754	1,633	9,688	52
Late Stuart Total		31,918	2,246	6,472	76,860	462
NECHAKO						
Nadina River (Early)		1,809	1,337	891	0	0
Nadina River (Late)	na	14,474	3,035	7,890	5,000	0
Nadina Channel	na	41,207	23,841	29,734	56,074	0
Stellako River	na	290,042	121,692	211,085	94,884	47
QUESNEL						
Upper Horsefly River	na	511	1,998	14,531	14,000	0
Lower Horsefly River	na	-	-	2,201	5,754	0
Horsefly Channel	na	-	-	-	18,815	0
McKinley Creek	-	0	38	63	0	0
Mitchell River	na	-	119	3,751	7,690	0
Quesnel Total		511	2,155	20,546	46,259	0
CHILCOTIN						
Chilko River	na	234,924	329,220	239,601	1,017,242	1,874
Chilko Channel	na	-	-	-	20,495	13
Chilko Lake-South End	na	23,467	53,613	181,414	**	**
SETON-ANDERSON						
Gates Creek	Sep.1-6	572	811	1,725	952	566
Gates Channel	Sep.1-6	3,256	6,573	7,692	8,088	8,063
Portage Creek	Nov.15-20	3,575	7,747	6,820	12,053	158
NORTH THOMPSON						
Raft River	Sep.15-19	1,758	2,780	1,436	464	0
Fennell Creek	Aug.30	15,565	4,977	16,633	20,466	0
SOUTH THOMPSON						
Summer Runs						
Seymour River	Aug.31-Sep.8	49,306	29,831	84,315	128,253	0
Scotch Creek	Sep.4-8	0	239	2,089	9,954	0
Anstey River	Sep.9-12	41	382	2,257	5,011	0
Late Runs						
Adams River	Oct.16-26	275,383	201,610	567,989	1,204,153	1
Little River	Oct.16-26	10,410	***	17,998	13,500	0
Lower Shuswap River	Oct.20-28	10,048	7,308	10,343	15,678	0
Misc. Late Runs		3,418	2,447	20,995	22,460	0
HARRISON-LILLOOET						
Birkenhead River	Oct.1-7	60,988	44,029	164,849	293,626	22,843
Harrison River	na	45,615	4,239	5,228	15,000	0
Weaver Creek	na	24,428	20,727	26,272	10,179	434
Weaver Channel	na	20,598	18,614	33,696	27,942	658
LOWER FRASER						
Nahatlatch River	na	2,648	2,186	13,501	2,755	0
Cultus Lake	na	32,031	19,944	32,184	20,157	34
Upper Pitt River	na	37,542	16,852	13,637	22,500	0
MISCELLANEOUS		4,859	6,164	9,390	10,229	5
ADULTS		1,368,139	964,917	1,895,947	3,306,272	
JACKS		39,689	10,984	18,796	35,191	
TOTAL NET ESCAPEMENT		1,407,828	975,901	1,914,743	3,341,463	

* 1979 and 1983 data are from the Pacific Salmon Commission. Estimates for 1987 and 1991 are from Canada Department of Fisheries and Oceans.

** Included in Chilko River estimate.

*** Included in Lower Adams River population.

na - Not yet available.

Table 9. Escapements of pink salmon to Fraser River spawning areas for 1985, 1987, 1989 and 1991. *

<u>RUN</u>	<u>1991 Period</u>	<u>Estimated Number of Pink Salmon</u>			
<u>DISTRICT</u>	<u>of Peak</u>				
<u>River/Stream</u>	<u>Spawning</u>	<u>1985</u>	<u>1987</u>	<u>1989</u>	<u>1991</u>
<u>EARLY RUNS</u>					
<u>LOWER FRASER</u>					
Main Fraser	Oct.5-12	5,248,742	1,065,710	4,780,703	9,281,051
<u>FRASER CANYON</u>					
Coquihalla River	Oct.6-10	118,921	6,029	13,559	71,555
Jones Creek	Oct.6-10	3,095	1,404	4,958	3,558
Nahatlatch River	Oct.6-12	1,170	1,170	9,334	35,100
Miscellaneous Tributaries		46,672	3,455	13,194	18,333
Total		169,858	12,058	41,045	128,546
<u>SETON-ANDERSON</u>					
Seton Creek	Oct.13-20	169,957	627,966	872,460	1,272,395
Upper Seton Channel	Oct.12-17	4,485	13,060	21,522	13,056
Lower Seton Channel	Oct.12-17	33,807	36,696	40,041	32,059
Cayoosh Creek	Oct.8-12	-	-	-	87,388
Portage Creek	Oct.8-12	4,116	21,117	21,096	29,008
Bridge River	Oct.7-13	61,755	44,200	104,000	184,327
Gates Creek	na	0	247	372	595
Total		274,120	743,286	1,059,491	1,618,828
<u>THOMPSON</u>					
Thompson River and Tributaries	Oct.17-22	193,448	253,109	281,640	769,800
<u>UPPER FRASER TRIBUTARIES</u>		530	496	6,535	2,309
<u>EARLY-RUN TOTAL</u>		5,886,698	2,074,659	6,169,414	11,800,534
<u>LATE RUNS</u>					
<u>LOWER FRASER TRIBUTARIES</u>		16,273	1,359	1,056	6,929
<u>HARRISON</u>					
Harrison River	Oct.21-28	438,022	1,028,892	681,572	947,812
Weaver Creek	Oct.15-20	3,583	5,212	3,315	12,419
Weaver Channel	na	4,772	1,168	2,493	2,391
Total		446,377	1,035,272	687,380	962,622
<u>CHILLIWACK-VEDDER</u>					
Chilliwack-Vedder Rivers	Oct.24-31	95,556	106,410	328,020	158,876
Sweltzer Creek	Oct.25-31	14,712	5,467	3,290	5,364
Total		110,268	111,877	331,310	164,240
<u>MISCELLANEOUS</u>		-	1,000	354	8,210
<u>LATE-RUN TOTAL</u>		573,918	1,148,862	1,019,772	1,142,001
<u>TOTAL NET ESCAPEMENT</u>		6,460,616	3,223,521	7,189,186	12,942,535

* 1985 data from the Pacific Salmon Commission. Estimates for 1987, 1989 and 1991 are from Canada Department of Fisheries and Oceans.

APPENDIX E: FRASER RIVER PINK SALMON ESCAPEMENT ESTIMATES

Accurate estimates of spawning salmon populations are vitally important to fishery managers and to Pacific Salmon Treaty objectives. In the short term, accurate spawning enumerations are reflected in post-season and final estimates of run size, TAC and the catch shares due each country and user-group. In the mid term, they lead to reliable forecasts of returns in the next cycle. In the longer term, accurate estimates lead to reliable models for forecasting returns and for in-season estimation of run size that reflect actual abundances.

Spawning population estimates that are consistently low (negative bias), lead to a tendency to under-harvest fish and allow too many spawners, while estimates that are consistently high (positive bias) lead to a tendency to over-harvest fish and allow too few spawners. It is this latter scenario that the PSC staff is most concerned about, in the context of spawning enumerations of Fraser River pink salmon.

In 1991, there was a 73% discrepancy between the PSC's estimate of gross escapement at Mission (7,526,000 fish) and Canada's estimate (13,047,000 fish) of spawning escapement (12,943,000 fish) plus Fraser River Indian catch (104,000 fish) of Fraser River pink salmon. The PSC's estimate was derived from a hydroacoustic program at Mission, B.C., that has been conducted annually since 1977. Canada's estimate was based on mark-recovery and catch monitoring programs undertaken by the Department of Fisheries and Oceans (DFO).

The magnitude of the discrepancy raises several concerns, the most immediate being which value to use for estimating the total run size of Fraser pinks in 1991. The answer to this question is important because the amount of the TAC and Canadian and United States' catch shares depend on the outcome.

Of longer term importance, the 1991 data used by PSC staff in constructing mathematical models will influence in-season run-size estimates in future years. If the 13,047,000 gross escapement value substantially overestimates the true run size, then in-season estimates in future years will also be too high. The consequences could be over-fishing and poor achievement of escapement and catch allocation goals.

The PSC staff is concerned that there is a positive bias in the 1991 mark-recapture estimates of pink salmon spawning escapement. PSC staff analyzed data from the tagging program and from ancillary sources to derive alternative estimates of pink salmon escapement in 1991. The results of these analyses are discussed below.

A. Spawning Ground Enumeration

The program to estimate spawning escapements of pink salmon in the Fraser River watershed was devised and implemented in the late 1950's and has continued through 1991 relatively unchanged. The program is based on mark-recapture methods. Fish are captured at Duncan Bar (DB) near Ft. Langley via beach seine, tagged with a 1.7 cm Petersen disk tag and released to continue their migration to the spawning grounds. Recovery of DB tags and estimation of tagged:untagged ratios are conducted on spawning grounds in over twenty tributary streams and the mainstem Fraser River.

To estimate the number of tributary spawners, DFO conducts secondary tagging programs on the four major spawning tributaries: Seton, Thompson, Harrison and Chilliwack-Vedder. Smaller escapements in other tributaries are visually estimated.

The number of DB tags present in the tributary streams is estimated by multiplying the DB tagged:untagged ratio from carcass recoveries on each tributary, by the tributary population estimate derived from the secondary tagging programs or visual estimates.

To estimate the number of DB tagged fish that spawned in the mainstem, the estimated number of DB tags in all tributaries is subtracted from the total tag release. Another 5% of DB tagged fish are subtracted because they are assumed to die or lose their tags before reaching their natal areas and, therefore, are not recoverable for population estimation. Tagged fish that are estimated to have been captured in Fraser River Indian fisheries area also removed. The result of these subtractions from the initial number of tags released represent the DB tagged fish that are assumed to be present in the mainstem Fraser River spawning population. The estimate of mainstem DB tagged fish is multiplied by the DB tagged:untagged ratio obtained from recovered fish in the mainstem population to determine the mainstem numerical escapement. The total watershed population of pink salmon spawners is the sum of the estimates for the mainstem Fraser, the four major tributaries and the visually assessed abundances in minor tributaries.

Using these methods, DFO estimates for 1991 were 3,662,000 tributary and 9,281,000 mainstem spawners, for a total of 12,943,000 pink spawners in the Fraser River watershed (Appendix D: Table 9).

Such trunk-stream (non-spawning ground) tagging programs have the advantage of ensuring that all fish that spawn above the tagging site are included in the estimate. Rather than relying on tagging or visually enumerating individual spawning populations, trunk-stream tagging programs encompass all upstream stocks, including stocks that are inaccessible or otherwise not amenable to individual population assessments. For example, pink salmon that spawn in the mainstem Fraser are difficult to locate due to turbidity of the water. Although the Fraser River pink salmon enumeration program is a variant of the normal trunk-stream tagging program, in that the mainstem Fraser population is the only stock specifically estimated by Duncan Bar tagging (rather than the watershed total), errors and biases inherent in this program are reflected in the mainstem population estimate.

Reviews of tagging programs in other areas suggest that trunk-stream mark:recapture programs or any program conducted downstream of the spawning grounds have subtle biases that are not easily detected or measured. These biases arise from the violation of the basic assumption that tagged and untagged fish are equally available for recapture. In fact, this assumption is often violated because of 1) shedding of tags, 2) immediate or delayed mortality of tagged fish and 3) non-random time or area distribution of tagged fish carcasses in dead recoveries.

Loss of tags (shedding loss) may be due to mechanical forces such as by entanglement in nets, aggressive behavior of spawners and removal from carcasses by birds or humans. Loose tags are occasionally found in spawning ground surveys. For example, DFO field staff recovered 104 loose tags in 1991, suggesting that significant tag loss was occurring. Studies of tag loss by double-tagging fish in 1989 revealed a modest level of loss for Duncan Bar tagged fish, estimated at 5.6% in single-tagging programs. However, tag loss for double-tagged pink salmon recovered in lower Fraser River spawning areas was estimated to be at least double the above rate, which is a very high loss rate compared to other areas.

Measurement of immediate and delayed mortality is difficult without experimental facilities. Simpson (1985) reported an average positive bias of 43% in several tagging studies where fish were also enumerated at weirs located short distances upstream of the tagging sites. A portion of the bias may be due to shedding of tags, but since the migration distances and times were short, tag loss would likely be minor. The most likely explanation for the bias was loss of tagged fish from the population. Trauma or stress from tagging procedures may cause some tagged fish to die before reaching the upstream monitoring point. Other fish may survive, but then move only a short distance from the tagging site and spawn in non-natal areas. Pink salmon are relatively susceptible to straying and may, therefore, accept a non-natal spawning habitat if unduly stressed. If these alternate spawning areas are not surveyed for tagged fish, there would be an unaccounted-for net loss to the population of tagged fish. Pella et al. (1992) also records evidence of high loss rates from trunk-stream tagging programs. While not separating tagging mortality from tag loss, Pella

(pers. comm.) suggests that some of the loss is due to short-term mortality imparted by stress from the tagging program.

The third source of bias in trunk-stream tagging programs results either from non-random temporal distribution of the post-spawning die-off of tagged fish or from non-random spatial distribution of tagged fish in the spawning area. In 1991, higher proportions of Duncan Bar tagged fish were present during the early segments of dead recovery activities in most tributary streams and in the mainstem Fraser River (A. Cass and T. Whitehouse, pers. comm.). This, combined with lateness in the commencement of dead recovery efforts, may have produced significant bias in the population estimate.

The effect of these sources of bias may be a problem in all years, but more significant than usual in 1991. Secondary tagging programs on the four major tributaries capture fish for tagging by dip netting, brailing and beach seining. Among the captured fish are ones with DB tags, which are counted and their tag identification numbers recorded. Ratios of DB tagged fish to untagged fish were consistently found to be higher for these recaptured fish than in recoveries of fish carcasses from upstream of the secondary tagging sites. Reductions of 50% or more in the proportion of tagged fish in carcass recoveries were indicated. For example, the ratio of DB tagged:untagged fish in the Thompson Canyon tagging program in 1991 was 1:156, while on the spawning grounds upstream the ratio was 1:577. If the Thompson tagging site recaptures were representative of the DB tagged:untagged ratio for fish entering the Thompson River, then only 27% of the expected number of tagged fish were recovered. This represents a 73% error in the number of Thompson River DB tagged fish that were removed from the estimate of mainstem tags.

The DB tagged:untagged ratio is inversely related to the distance between the secondary tagging sites and the recovery areas. The long-term (1979-91) ratio of DB tagged:untagged pink salmon at Seton Creek (1:218) and Thompson Canyon (1:229) secondary tagging sites is nearly identical, as expected, since these stocks migrate simultaneously through the lower Fraser River. However, the average ratio from the spawning ground dead recovery at Seton Creek is 1:318, a 31% loss of tags or tagged fish, compared to the Thompson River ratio of 1:647, a 65% loss. The magnitude of these losses correlate with the distances between the secondary tagging sites and the spawning grounds, which are 1-6 km for Seton Creek and 17-66 km for Thompson River. Thompson River fish may be subject to additional loss of tags or tagged fish due to stress from migrating through the sometimes difficult Thompson Canyon.

B. Analysis of Ancillary Data

1. Data from Run-size Estimates

Relationships that use commercial purse seine catch and catch per unit effort (CPUE) have been used successfully for several years to estimate the incoming abundance of Fraser River pink salmon through Juan de Fuca and Johnstone Straits. These regression models rely on accurate estimates of total abundance, derived by summing catches and escapements in past years. Escapements in these years averaged 32.5% of the total runs, compared to the estimate of 58% in 1991. Biases may exist in the escapement estimates. However, because escapements were lower fractions of the total returns, only a small bias in the total run estimates probably occurred. Thus, these escapement biases may have only minor impacts on regressions of run size on catch or CPUE. In 1991, peak-week purse seine CPUE data were used to estimate the runs via Juan de Fuca and Johnstone Straits. The resulting estimate of total run size, including catches in outside waters (north coast net and troll and outside troll), totalled 15,000,000 fish. This run-size estimate minus the total catch estimate of 9,400,000 fish, leaves an escapement estimate of 5,600,000 Fraser pinks.

The cumulative-normal model uses daily abundance data derived from reported catches and exploitation rates in net fisheries. The model depends on the accuracy of the calculated exploitation rates, which are derived from historical catch and escapement data. The cumulative

model also assumes that the temporal distribution of the run fits a normally distributed curve. The cumulative-normal model estimate of total run minus catch results in a gross escapement estimate of 7,600,000 pink salmon in 1991.

Density-dependent growth during the first year of ocean residence results in smaller growth increments when run sizes are large. Thus, measurements taken from the first-year growth zone of pink salmon scales are used in regression models to estimate run size. Scale measurements in 1991 suggested that the total run was 17,100,000. Removal of the catch estimate from this run size gives a 7,700,000 gross escapement estimate.

2. Data from Lower Fraser River Abundance Indicators

A historical relationship between upstream abundance and CPUE in the Cottonwood test fishery can be used in-season to estimate the daily and seasonal escapement of Fraser pink salmon. In 1991, the model provided an escapement estimate of 8,800,000 pink salmon.

Pink salmon escapement can also be estimated by multiplying CPUE from the Duncan Bar tagging program by the average ratio (1400:1) between upstream escapement and CPUE in past years. In 1991, record pink salmon CPUE's at Duncan Bar suggested large numbers of pink salmon were migrating. The corresponding escapement estimate was 14,500,000 pink salmon. However, with an average weight of 1.8 kg (3.9 lb), Fraser River pinks in 1991 were the smallest on record. We speculate that small fish migrate closer to shore, where they are more vulnerable to the beach seine used at Duncan Bar. The results of such a phenomenon would be elevated CPUE's and overestimates of escapement. Evidence that pink salmon in 1991 were more available to being caught at Duncan Bar is seen in the DB tag ratios in secondary tagging program recoveries. The 1991 ratio of DB tagged fish was 1:156 (0.64%) compared to the 6-year mean of 1:190 (0.53% tagged), a 21% increase over the average tagging rate at Duncan Bar

The Mission hydroacoustic program in past years has consistently provided estimates of pink salmon escapement that were lower than spawning ground estimates. PSC staff believed that hydroacoustic sampling was missing a portion of the population because of the tendency for near-shore migration of pink salmon. To compensate, the PSC formulated a scaling factor of 1.69, based on spawning ground and echo-sounding estimates in 1987 and 1989. In 1991, the scaled echo sounding estimate (7,411,000 fish) plus the test fishing CPUE estimate (115,000 fish) totalled 7,526,000 fish. However, if the smaller-than-normal fish migrated closer to shore than in 1987 and 1989, then the scaling factor and the scaled estimate would both be too low.

3. Data from Hells Gate Observations

Migrating pink salmon are observed at a location approximately 100 m upstream of the fishways at Hells Gate. Visual counts of the hourly abundance of untagged and DB tagged fish are recorded. These data provide an estimate of the tagged:untagged ratio which, when combined with the number of tagged fish released, can generate an estimate of total escapement. The 1991 gross escapement estimate from this source was 5,700,000 pink salmon.

4. Data from Local Tagging Programs

Another method of estimating the watershed tagged:untagged ratio is to use the ratios in the secondary tagging program recoveries of DB tagged fish to untagged fish. In 1991, this ratio times the number of fish tagged at Duncan Bar provided a total escapement estimate of 6,400,000 pink salmon.

5. Data from the Genetic Stock Identification Program

Estimates of the relative contribution of stocks that migrate to areas above Hells Gate were obtained by the 1991 Genetic Stock Identification (GSI) program. The estimated abundance of spawners above Hells Gate (2,427,000) divided by the proportion of upriver stocks caught in commercial and test fisheries (27%), yields a total escapement estimate of 9,000,000 pink salmon. Because the proportion is applied to the sum of all upper Fraser tributary population estimates, the total escapement estimate would be biased high if the secondary mark:recapture estimates of tributary populations were also biased high.

6. Spawning Ground Recovery Data

Dead recovery programs are carried out each year by DFO staff on the four major tributaries and the main Fraser River spawning grounds. Recoveries of fish tagged in the tributaries provide estimates of tributary population sizes. The 1991 recovery rate of secondary tagged pink salmon carcasses in tributary streams (14.4%) approximated the long term mean (17.0%) and showed that recovery effort and the availability of carcasses was near normal. However, recoveries of DB tagged fish on the mainstem spawning grounds accounted for only 0.94% of the estimated population, compared with an average of 7.0%. Reduced sampling effort in 1991 is one cause of the lower recovery rate: only 100 m of every 400 m stretch of river bank was sampled in 1991, compared to the entire stretch in previous years. However, assuming the recovery rate would have tripled if the shoreline had been sampled as in the past (note: the rate would not have quadrupled because some of the time saved by sampling every fourth 100 m stretch would be profitably spent covering a greater total length of shoreline), yields an estimated recovery rate of 2.8% ($0.94\% \times 3$). This rate is less than one-half the prior 6-year average, which suggests that the mark:recapture population estimate is biased high. While this may have occurred because of a very large population, it is significant that the total carcass recovery of 87,510 fish was the lowest total in the past seven cycles (1979-93) and less than half the number recovered in three of the prior six cycles. Multiplying the number of recovered carcasses by three (262,530), and using the average percentage dead recovery in the previous six cycles, a population total of about 3,750,000 is indicated. Including the total tributary population of 3,662,000, the total Fraser estimate would then be approximately 7,400,000 pink salmon.

A further indication that the mark:recovery estimate was high in 1991 was the recovery in the mainstem Fraser of twelve pink salmon that had been tagged at Seton tailrace. Extrapolating the recovery of these twelve carcasses by the estimated recovery rate in the mainstem (0.94%) yields an estimate of 1,276 Seton tagged fish (14% of the tagged population) in the pink salmon recovery area in the mainstem Fraser. One possible conclusion from this analysis is that there was a severe loss (i.e., immediate mortality) of tagged Seton Creek fish caused by the trauma of tagging. Alternatively, the population estimated in the main Fraser (9,400,000) was so severely biased that the extrapolation grossly overestimated the downstream drift or movement of Seton Creek pink salmon.

7. Data from Survival Estimates

The marine survival of a given brood of Fraser River pink salmon is estimated by dividing the total return by the total out-migrating fry population estimated by sampling at Mission, B.C. (Appendix D: Table 7). For the 1989 brood of pink salmon (adult return in 1991) the marine survival rate was 6.2%, using the run size of 22,333,000 fish which includes DFO's estimate of spawning escapement (12,943,000 fish). This is the highest survival rate for the fifteen years of data available: it is 13% above the previous high (5.5%) and nearly double the long-term average prior to 1991 (3.2%). In contrast, a regression model that uses coastal salinity levels to estimate fry-to-adult survival rate for Fraser pinks, forecast a 3.1% rate for the 1991 return. Adding Gulf of Alaska sea surface temperatures to the model raised the forecast to the 3.4 to 3.8% range. These forecast rates of survival are slightly more than half the current estimate of 6.2%. If DFO's

escapement estimate is biased high, then some of the observed deviation from normal survival rates would be explained.

While the estimated Fraser River pink salmon run size (16,790,000 fish) using PSC in-season estimates of escapement (7,526,000 fish) would also yield an above average survival rate (4.7%), this rate would be more consistent with historical rates and the pre-season forecast.

C. Summary

Fraser River pink salmon population estimates are undoubtedly biased high in all years. However, the magnitude of the bias appears to have increased dramatically in recent years, which were marked by large escapements of small fish. Whether the bias is due to tag loss and mortality, to non-random spatial or temporal distributions of tagged fish, or to a combination of these factors cannot be positively identified from the available data. Higher proportions of Duncan Bar tagged fish were found in recoveries at the secondary tagging sites than on the upstream spawning grounds. The trauma or stress of tagging may shorten the life span of tagged fish. Recovery data in 1991 showed that DB tagged fish died earlier than untagged fish in tributary streams. Such premature death may have rendered the tagged fish less vulnerable to recovery because of the delayed onset of dead recovery activities. Fewer tagged fish than expected would have been recovered, resulting in a diminished ratio of DB tagged to untagged fish and an overestimate of the spawning population.

Most ancillary assessments point to a substantial positive bias in the tag recovery estimate of the 1991 pink salmon escapement. The above discussions of these alternate assessments constitute a synopsis of more extensive analyses that PSC staff conducted when first apprised of the DFO estimate. While none of the assessments prove the escapement estimates are biased, collectively these independent data strongly suggest that biases are sufficiently large to require reassessment of the 1991 spawning ground estimate of Fraser River pink salmon escapements.

D. Recommendations

The maintenance of standardized, high quality escapement data from pink salmon spawning grounds is of foremost importance in the management of Fraser River pink salmon. Without these data, models for run-size estimation would deteriorate and management actions of the Panel would have unforeseeable impacts. There would be a tendency to overestimate run sizes and, hence, to over-harvest the returns. Achievement of objectives would become more difficult to assess. The Panel, therefore, urges Canada to maintain and improve pink salmon enumeration programs to obtain direct estimates of escapement for accounting and population analysis activities.

Pacific Salmon Commission staff recommended that future pink salmon tagging programs be conducted on reaches of streams where spawning actively takes place, rather than along the migration routes to these areas (trunk streams). Such tagging would avoid or minimize the non-random mixing of tagged fish, by time and area, in the dead recovery. Double-tagging experiments should be conducted regularly to assess tag loss for each spawning area. Experimental tagging of carcasses may be performed to assess tag loss due to bird activity in mainstem Fraser River spawning areas.

A second recommendation is that estimation of bias in historical spawning population estimates should be undertaken to correct these estimates and, thus, correct the run-size estimates (i.e., catch plus escapement). PSC in-season run-size estimation models can then be updated using the new dataset, to improve future management of the fisheries and to achieve spawning escapement and catch allocation goals. Such data would also be valuable to DFO biologists who use stock-recruitment models to forecast run size and set escapement goals.

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APPENDIX F: STAFF OF THE PACIFIC SALMON COMMISSION IN 1991

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

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Mr. B. White, Pink Racial Analysis Biologist
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Ms. J. Parkin, Scale Analyst
Ms. H. Derham, Scale Lab Assistant
Mr. K. Forrest, Racial Data Biologist (term)

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Mr. D. Stelter, Catch Statistician

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