

D R A F T  
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FRASER RIVER SOCKEYE  
MANAGEMENT AND ENHANCEMENT PLAN  
Summary Report

Prepared by  
Fraser River Sockeye Task Force

for

Area Planning Committee  
Fraser River, Northern B.C. and Yukon Division

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*broader uncertainty regarding the dialogue*

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## EXECUTIVE SUMMARY

The Fraser River Sockeye Task Force was established in May, 1987 to develop a management and enhancement plan that would maximize sockeye salmon production in the Fraser River. The impetus for this initiative was the Pacific Salmon Treaty, signed in 1985, which limits the United States catch of Fraser sockeye and ensures that Canadians receive benefits resulting from increases in the size of runs.

Historical catch, stock recruit and habitat capacity information all indicate that the Fraser River has the potential to produce sockeye runs much larger than current levels. The spawning grounds of the watershed were estimated to support approximately 12 million sockeye which could theoretically produce runs of up to 30 million or more. Lake rearing capacity was estimated to be sufficient for the fry produced by 33 million spawners.

*lower interim goals are more realistic*

*may be*

However, the Task Force concluded that, while it was theoretically possible to produce runs of 30 million or more, it would be too risky and difficult to increase all cycles to dominant year levels. This conclusion is based on uncertainty about cyclic dominance and the current low escapement levels of many stocks. Therefore, more conservative interim escapement goals are recommended for each of the main stocks and two experimental windows are identified to address the cyclic dominance questions. The interim escapement goals are expected to produce average cycle year runs ranging from 8 million to 23 million (16 million average for all cycles).

Alternative strategies to rebuild to interim escapement goals were evaluated through computer modeling. The strategies were compared for their total economic benefits, initial harvest reductions required and ability to meet interim escapement goals. Recommended approaches were developed for each cycle, common to each recommendation are long term reductions in harvest rates.

The modeling to develop basic recommendations for rebuilding was based on averages which does not account for variations in annual run size. An approach to implement the rebuilding strategy was developed which accounts for variation in the annual run size. The recommended approach is based on target stock harvest rates and involves a flexible escapement schedule. Escapement goals will vary with run size between pre-determined minimum and maximum escapement levels. Surplus escapements are likely for some stocks with this plan and require a policy to handle them.

The Task Force also examined enhancement technology as a complement to natural rebuilding, carried out preliminary analysis of the effects of the plan on other species and identified research and monitoring requirements to resolve uncertainty.

The key elements of the Task Force findings are as follows:

- Fraser sockeye production can be increased substantially on all four cycles in 4 to 16 years (1 to 4 cycles).
- The Task Force feels that it is too risky and impractical to achieve the same level of production on all four cycle years at this time. However, it recommends experimental reduction in harvest rates on selected timing periods in two cycles as a method of learning about the mechanisms behind cyclic dominance.

*3.* The basic approach involves cutting back harvests during the first four years to increase escapements, then stabilizing ~~harvest~~ rates at about 70%, 10 percentage points below the current levels, ~~at least 80%.~~

4. An implementation plan was recommended by the Task Force that takes into account annual variation in run size. Likely surplus escapements generated from this plan require that new policy be developed for dealing with them.
5. The Task Force, although confident that objectives can be met, identified a number of uncertainties which include cyclic dominance, freshwater and marine carrying capacity, climatic change, disease and enhancement technology. The Task Force strongly recommends that a monitoring program be implemented as an integral part of the program to assess, evaluate and, if necessary, modify the plan as it proceeds.
6. The Task Force assumed in the analysis that habitat quality and quantity would be maintained at present levels. The Task Force recommends that the habitat planning work that is just beginning, and projected to take two years to complete, be pursued with top priority.
7. The Task Force *due to short term reductions in harvest rates* found that the initial impact of the plan would be positive on other species. However, changes to existing patterns of fishing will have to be made, affecting allocations by gear and area, in order to harvest rebuilt stocks in later years. These adjustments must be planned in consultation with industry.
8. Enhancement is an important component of the rebuilding process. Tentative suggestions for projects to assist rebuilding are provided along with major production activities. Further work is necessary to prioritize and evaluate these projects.

The Task Force believes Fraser River sockeye production can increase substantially. Achieving this potential will require alterations from current sockeye management. As these changes affect resource users, public consultation is essential to the further development and acceptance of any rebuilding scheme.

*Species*

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## INTRODUCTION

The Fraser River is the greatest sockeye salmon producing river in British Columbia and possibly the world. The recent (1981-88) commercial catch of Fraser sockeye averaged 7.4 million fish per year for Canada and the U.S. combined, of which 5.4 million were taken by Canada. The Canadian catch of Fraser River sockeye for this period was 71% of the total sockeye catch for British Columbia and had an average wholesale value in the order of \$124 million. As well, Fraser sockeye are of paramount importance to the Indian food fishery with the catch in recent years averaging 453,000.

It has long been a desire of Canadians to develop Fraser River sockeye runs to their full potential for the benefit of Canada. The Pacific Salmon Treaty between Canada and the United States, signed in 1985, ensured that Canada would reap the benefits of increased production because limits were now placed on the United States catch. To begin to capitalize on this opportunity, the Area Planning Committee of the Fraser River, Northern B.C. and Yukon Division formed the Fraser River Sockeye Task Force in May, 1987. The Task Force was instructed to develop a plan to increase the Fraser River sockeye stocks to an average run size of at least 30 million fish. Specific objectives were to:

1. maximize production from natural habitat and supplement with enhancement as appropriate
2. identify effects on other species
3. identify uncertainty of outcomes, and
4. identify changes to current fishing patterns.

The Task Force first approached the assignment by assessing the feasibility of achieving the 30 million production goal. This was done by examining and analyzing data collected mainly by the former International Pacific Salmon Fisheries Commission. This is generally considered to be one of the most complete salmon data bases in the world. Even so, the Task Force recognized that there were some limitations with the data and took this into account when drawing conclusions.

The next phase of the assignment focused on development of a plan for achieving the objectives. Extensive computer modelling was undertaken to evaluate alternative rebuilding strategies. The results of these analyses and the management approach recommended by the Task Force are presented in this report along with a scheme for implementing the plan on an annual basis. Preliminary enhancement recommendations that would augment wild stock rebuilding in a complementary manner are also included. The report discusses areas of uncertainty that could affect the outcome of the plan, comments on potential effects on other species and implications on fishing patterns, and provides recommendations for monitoring and assessment. To aid readers unfamiliar with Fraser River sockeye, brief overviews of their stock status and management are included.

The plan presented here is essentially a framework around which specific annual plans will be developed. Since the full potential of the watershed is not known with certainty, the plan must have the flexibility to respond to new information as it becomes available.

## STOCK STATUS

Sockeye spawn in approximately 100 tributaries throughout the Fraser River watershed (Fig. 1) and the resultant fry rear in about 20 lakes for one year (occasionally two) before migrating seaward as smolts. The majority of stocks and the largest individual populations spawn in the upper Fraser beyond Hope, where most rearing lakes are situated. The 7 largest stocks comprise 85% of the total spawning population. Major stocks include Adams, Late Stuart, Early Stuart, Chilko, Stellako, Birkenhead and Weaver (Fig. 2). Fraser River sockeye rear in the Gulf of Alaska and mature mainly at age 4 (approximately 90%) with the remainder returning at age 3 (jacks) and age 5. Each spawning sockeye produces an average of 5 adult sockeye with wide annual variations.

Many Fraser River sockeye populations have a four year pattern of adult returns characterized by one strong year (dominant) followed by a moderately abundant year (sub-dominant) then two relatively weak years. This pattern is often referred to as cyclic dominance. It is largely confined to stocks spawning upstream from Hope. Until early this century all upriver stocks were dominant on the 1985 cyclic. Since then, following the collapse and rebuilding of runs, dominance has developed on different cycles for the various stocks. In the Stuart and Quesnel systems, for example, it has been re-established on the original 1985 cycle whereas in the Shuswap system it now occurs on the 1986 cycle, dominated by the Adams River run (Table 1).

Table 1. Dominant cycles for major Fraser River sockeye stocks.

	1985 cycle	1986 cycle	1987 cycle	1988 cycle
Early Stuart	X			
Late Stuart	X			
Horsefly	X			
Stellako		X	X	X
Chilko			X	X
Birkenhead	X	X		
Adams		X		
Shuswap		X		
Weaver	X		X	X

Although cyclic dominance has been observed in Fraser sockeye returns since the early 1800's, the mechanism behind it remains a subject of much debate. Several hypotheses have been advanced to explain the occurrence of cyclic dominance. Ward and Larkin (1964) and Larkin (1971) analyzed historical returns of Lower Adams River sockeye and conducted computer model simulation studies to arrive at the hypothesis that cyclic dominance was the result of depensatory mortality of sockeye juveniles due to predation in Shuswap Lake. Another hypothesis is that cyclic dominance is a function year class interactions related to food supply in the lakes, i.e. that most lakes are only capable of supporting

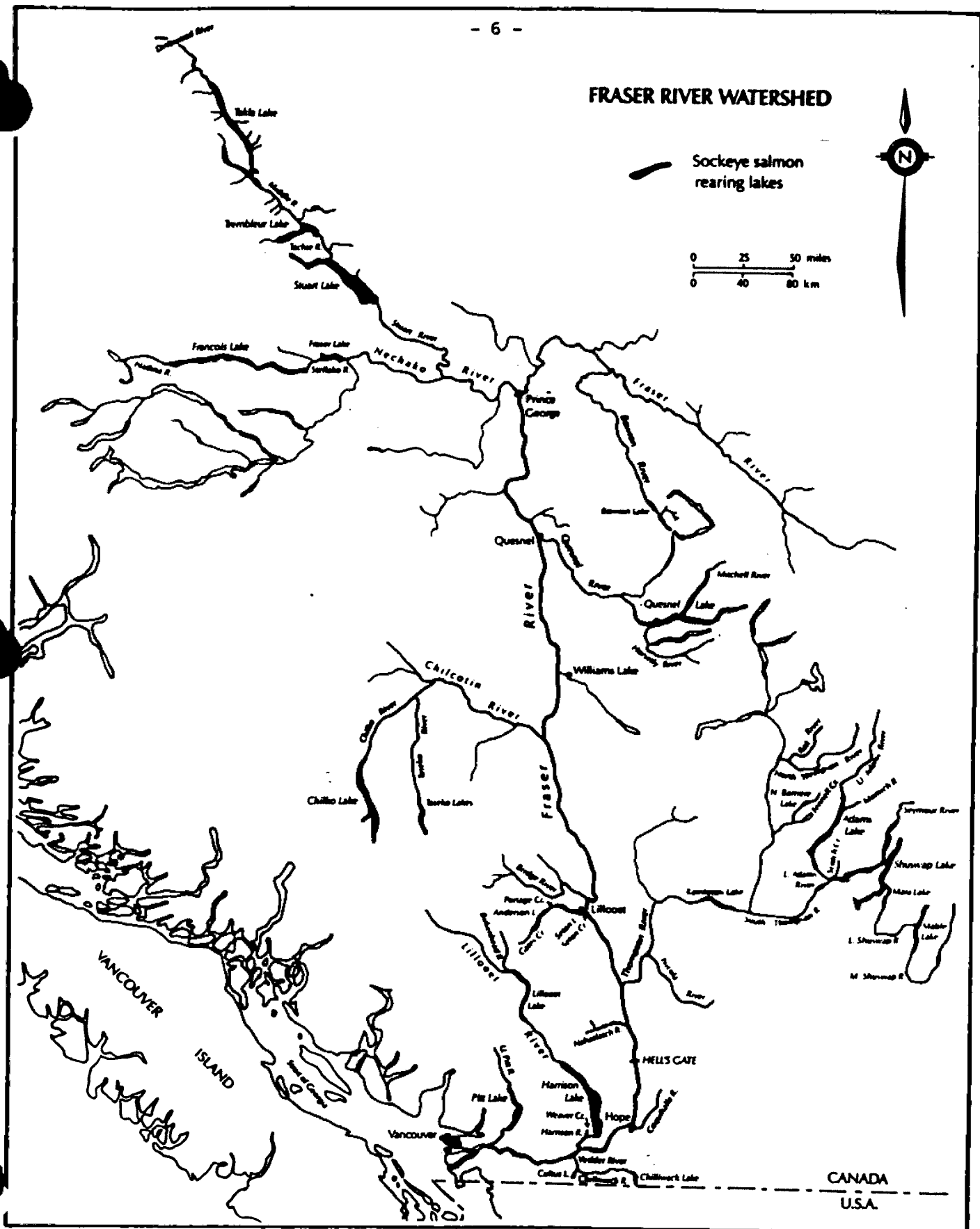
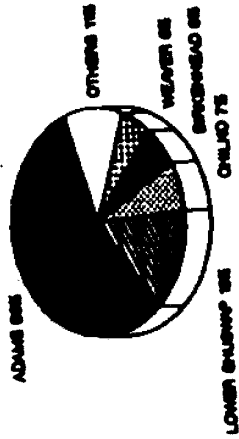
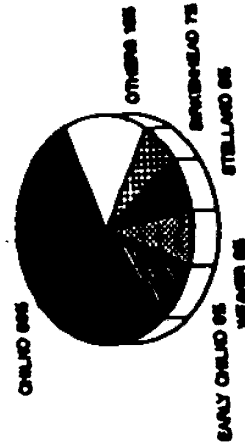


Figure 1. Sockeye salmon spawning grounds in the Fraser River watershed (adapted from Report of the Fraser River Panel to the Pacific Salmon Commission on the 1987 Fraser River sockeye and pink salmon fishing season).

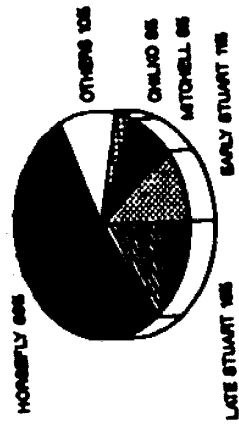
1986 CYCLE YEAR  
1982 & 1983



1988 CYCLE YEAR  
1980 & 1984



1985 CYCLE YEAR  
1981 & 1986



1987 CYCLE YEAR  
1983 & 1987

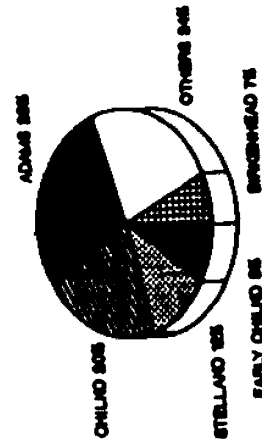


Figure 2. Relative spawning escapements of major Fraser River sockeye stocks by cycle.

only large year in every four. A third hypothesis is that cyclic dominance is maintained by depensatory fishing pressure (Walters and Staley, 1987). Understanding the reasons controlling cyclic dominance is extremely important from a stock rebuilding perspective. If it does not have a biological basis, substantially greater production should be possible on off cycle years by increasing spawning escapements. If there is a biological mechanism involved, the potential for expansion is much less.

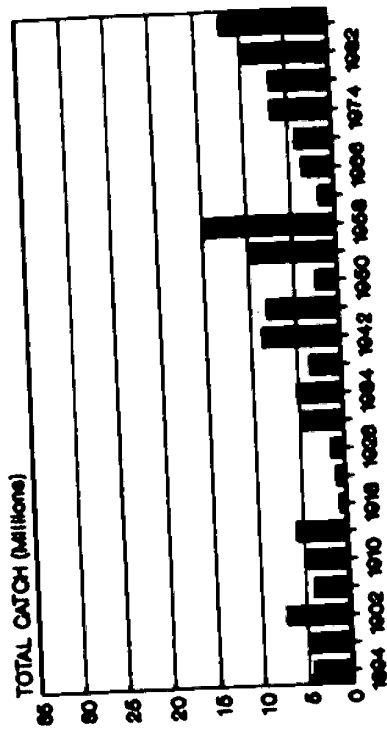
Since early this century, Fraser sockeye have gone from a level of high abundance to sudden low abundance followed by a long period of rebuilding (Fig. 3). The size of the Fraser sockeye runs in the early years of the fishery is difficult to determine because catch records are incomplete and reliable information on spawning escapements is lacking. From an analysis of the canned pack records, the IPSFC estimated that for the period 1894 to 1913 the average catch on the 1985 cycle was 23 million sockeye while on the other cycles the catch averages ranged from 3.5 million to 5 million fish (IPSFC, 1972). The catch for all years combined averaged 10 million. These estimates may be conservative because many sales were apparently not recorded and there was extensive wastage of fish, particularly on the big years (Ricker, 1987). A blockage in Hell's Gate Canyon in 1913 destroyed a substantial part of the dominant sockeye run by limiting access to the upriver spawning grounds. This blockage, coupled with an intensive fishery in 1917, which allowed only a small escapement, reduced the 1985 cycle to approximately the level of other cycles and eliminated the dominance feature (Aro and Shepard, 1967). In addition to the Hell's Gate obstruction, a logging splash dam at the outlet of Adams Lake and a placer mining storage dam at the outlet of Quesnel Lake contributed to the decline of the Fraser sockeye populations. For the 10 year period of 1918-27, following the collapse of the runs due to the Hell's Gate slide and other factors, the total run was estimated to be average only 1.6 million sockeye per year. Removal of dams, subsequent construction of fish passage facilities at Hell's Gate and at several other locations, and regulatory control of the fishery to increase escapements, have led to increased production (IPSFC, 1972).

More recently (1977-78), the total runs of Fraser River sockeye averaged 8.2 million, with a range from 3.1 million in 1980 to 15.9 million in 1986. Averages for the individual cycles ranged from 4.3 million on the 1984 cycle to 13.1 million on the 1986 cycle. The 1986 cycle runs have been larger on each subsequent year since 1962, when the run declined sharply to 3.4 million from 18.7 million in 1958. The 1985 cycle reached a modern-day record of 13.9 million in 1985, predominated by a return of over 8 million Quesnel Lake sockeye. Returns on the 1984 and 1987 cycles have also increased. These larger runs are the result of increasing spawning escapements although above average productivity rates in recent years have contributed to the improved returns.

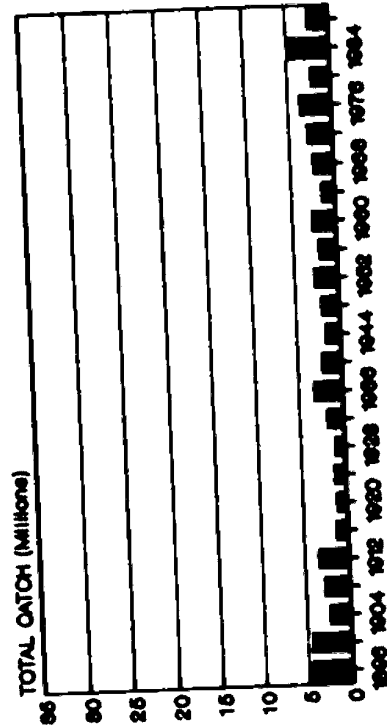
Spawning escapements of Fraser sockeye have averaged 1.9 million over the past 12 years. Cycle averages range from 1.1 million for the 1988 cycle to 3.4 million for the 1986 cycle. Two stocks have been particularly notable for their rate of growth: Horsefly on the 1985 cycle and Lower Shuswap on the 1986 cycle. Escapements to the Horsefly River increased from 1,100 in 1941 to 1.1 million in 1985, while the Lower Shuswap escapements rose from 17,000 in 1954 to 600,000 in 1986.

Along with total runs and escapements, catches have also increased. For the past 12 years the total commercial catch of Fraser sockeye has averaged 5.9

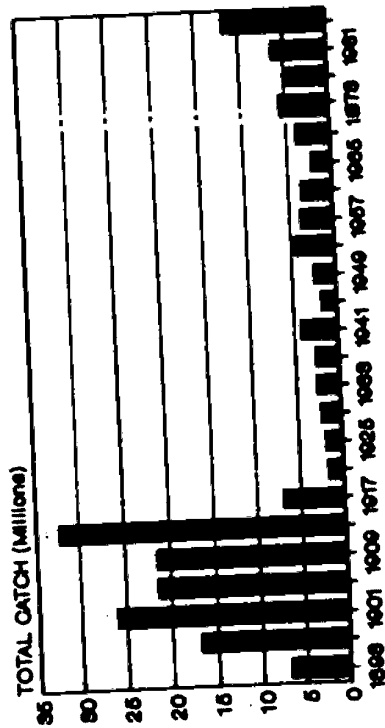
# 1986 CYCLE



# 1988 CYCLE



# 1985 CYCLE



# 1987 CYCLE

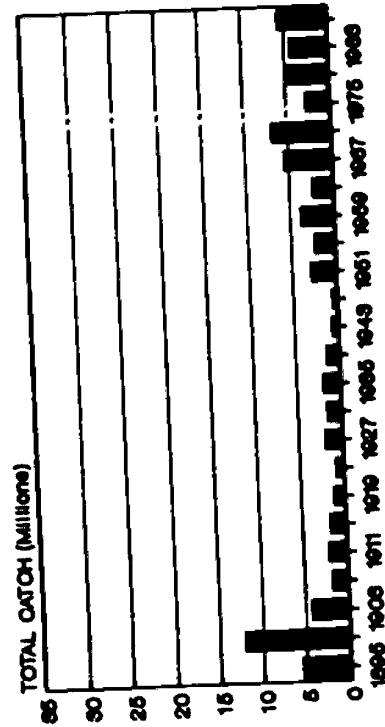


Figure 3. Commercial catches of Fraser River sockeye by cycle.

million fish, with Canada harvesting 4.7 million and the U.S. 1.7 million. Catches in 1985 and 1986 were the highest since 1958 at approximately 12 million. Within Canada, the most important fishing area in the last twelve years has been Johnstone Strait (1.8 million average) which has benefitted from several years of high diversion, followed by the Fraser River (1.0 million average) and Juan de Fuca Strait (0.8 million average). The troll fishery off the west coast of Vancouver Island is also a major catch area for Fraser sockeye (average of 0.6 million), particularly on the big Adams River years. Catches in the Indian food fishery have been increasing, reaching 555,000 in 1986 of which 534,000 were taken in the Fraser River.

Exploitation rates on Fraser sockeye have averaged 75-80%. On some years the exploitation rate has reached 85%, and rates over 80% are not uncommon. The average exploitation rate on the 1986 cycle is about 5-7 percentage points lower than on the other cycles. There has been little change in the average commercial exploitation rate over the past 35 years, but the Indian food fishery rate has more than doubled (to an 1977-88 average of about 5%). Although the Indian food fishery exploitation rate is low overall, it may be high on some stocks.

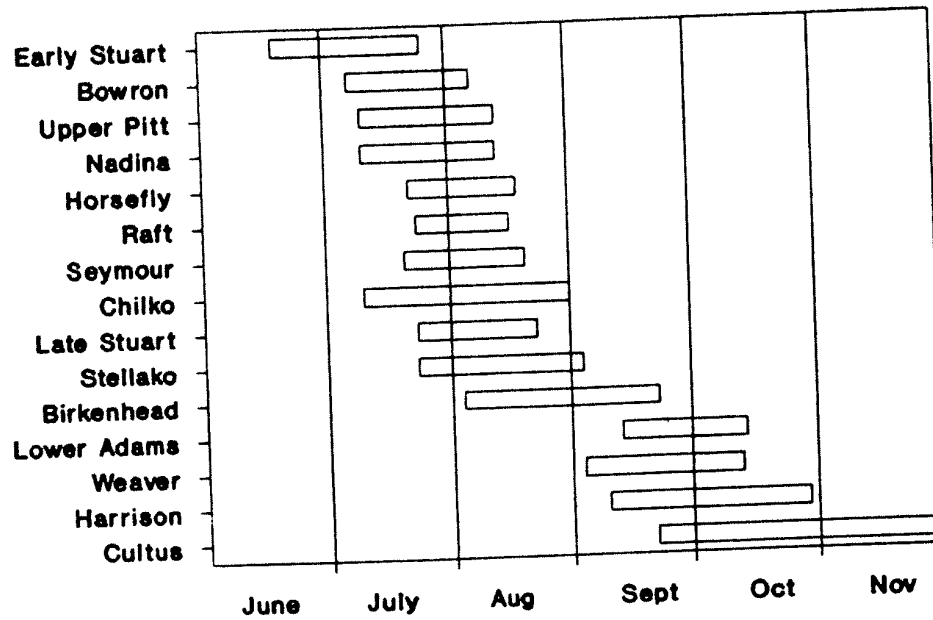
### CURRENT MANAGEMENT PRACTICES

Fraser River sockeye are harvested in a number of fisheries as they migrate from the offshore ocean rearing areas to the spawning tributaries. The first major fishery encountered is the troll fishery off the West Coast of Vancouver Island. Entry into the Strait of Georgia is through Johnstone Strait and the Strait of Juan de Fuca where fishing by seines and gillnets occurs. The proportion of the run migrating through Johnstone Strait averages 24% but varies substantially from year to year with up to 80% of the sockeye taking this route in some years. Once in the Strait of Georgia, Fraser sockeye are again subject to troll fishing and as well as to gillnet fishing off the mouth of the Fraser River. Some are also caught in the Indian food and sport fisheries within the Strait of Georgia. The gillnet fishery within the Fraser River is the last major commercial fishery encountered. Indian food fisheries for sockeye operate throughout the Fraser River watershed.

There are three basic objectives in managing Fraser River sockeye: 1. achievement of spawning escapement goals for each major stock or stock group and 2. allocation of catches between Canada and United States, and 3. allocation of catches amongst major user groups. Management of the runs is influenced by many factors making it a highly complex process.

The primary tools used for managing the fishery are knowledge of the size of the major runs and their migration timing through the fishing areas. There is substantial overlap in migration timing of sockeye stocks making it impossible to manage most of them independently (Fig. 4). Typically, management is based on five or six of the largest stocks. Openings and closures in each of the fisheries are planned to achieve escapement targets on these stocks. This results in co-migrating stocks being harvested at the same rate. If the harvest rate on co-migrating stocks become excessive, the fishing plan is sometimes adjusted to minimize impacts to the extent practicable. During the fishing season estimates of run size and stock composition are constantly revised to enable more precise management to occur.

Fig. 4. Approximate migration timing  
of Sockeye stocks through the lower  
Fraser River.





Incidental catches of other stocks and species are taken while fishing for Fraser River sockeye. In recent years, some adjustments in fishing patterns and gear have been made to limit catches of other species, primarily chinook. Given growing concerns regarding non-target species this could become more of a management constraint in the future. The problem is primarily confined to net fisheries as trolling for sockeye is conducted with specialized gear and techniques which result in minimal by-catch of other species.

Until 1986, management of Fraser sockeye was primarily the jurisdiction of the IPSFC which was required to divide the catch taken in a Convention Area equally between Canada and the United States. Fraser sockeye caught outside of the Convention Area, in fisheries managed by Canada (e.g. Johnstone Strait and much of the West Coast troll), were not subject to the international sharing arrangements. Under the Pacific Salmon Treaty, sharing arrangements now include Fraser sockeye caught in all fisheries. Within the Fraser Panel Area (equivalent to the former IPSFC Convention Area) (Fig. 5) in-season management is conducted by the Fraser Panel. DFO is responsible for managing Canadian fisheries outside the Panel Area but must coordinate management actions with those of the Fraser Panel to ensure that escapement and allocation objectives are met. The U.S. catch is limited to an agreed upon percent of the total allowable catch each year until 1988 and to an aggregate maximum of 7 million sockeye from 1989-92. It is anticipated that the U.S. catch will be constrained by a ceiling after 1992 as well. Such an arrangement is extremely beneficial to Canada as it ensures that benefits from rebuilding and enhancement accrue to Canadians. wa

#### ASSESSMENT OF REBUILDING POTENTIAL

To assess the production potential of the Fraser River for sockeye three approaches were taken: 1. a review of historical catches and run sizes; 2. examination of the relationship between spawners and subsequent returns (stock-recruit analysis); and 3. an assessment of spawning and rearing capacity. The results are briefly summarized as follows:

##### Historical Catch Review

The historical information on catches (Fig. 3) indicates that one cycle produced minimum catches in the order of 30 million fish while catches on the other three cycles were much lower. In the early years all stocks were dominant on the same cycle that produced the big catches, whereas, at present, dominance of the various stocks occurs on different cycles. This has the effect of distributing production amongst cycles so that one cycle does not dominant to the extent it did in the early years. While this makes interpretation of rebuilding potential less clear, if catch estimates are conservative, as some believe, it is hard to escape the conclusion that the potential for increasing sockeye production is substantial. Potential runs of 30 million on at least one cycle, seem consistent with the available data.

##### Stock Recruit Analysis

Stock recruit analysis is the use of statistical methods to study the relationship between spawners and the resultant returns. Historical observations of these two variables are used to derive a mathematical function. This function can be used to estimate the level of escapement which will result in a maximum sustained catches. This analysis was carried out on data gathered for all Fraser

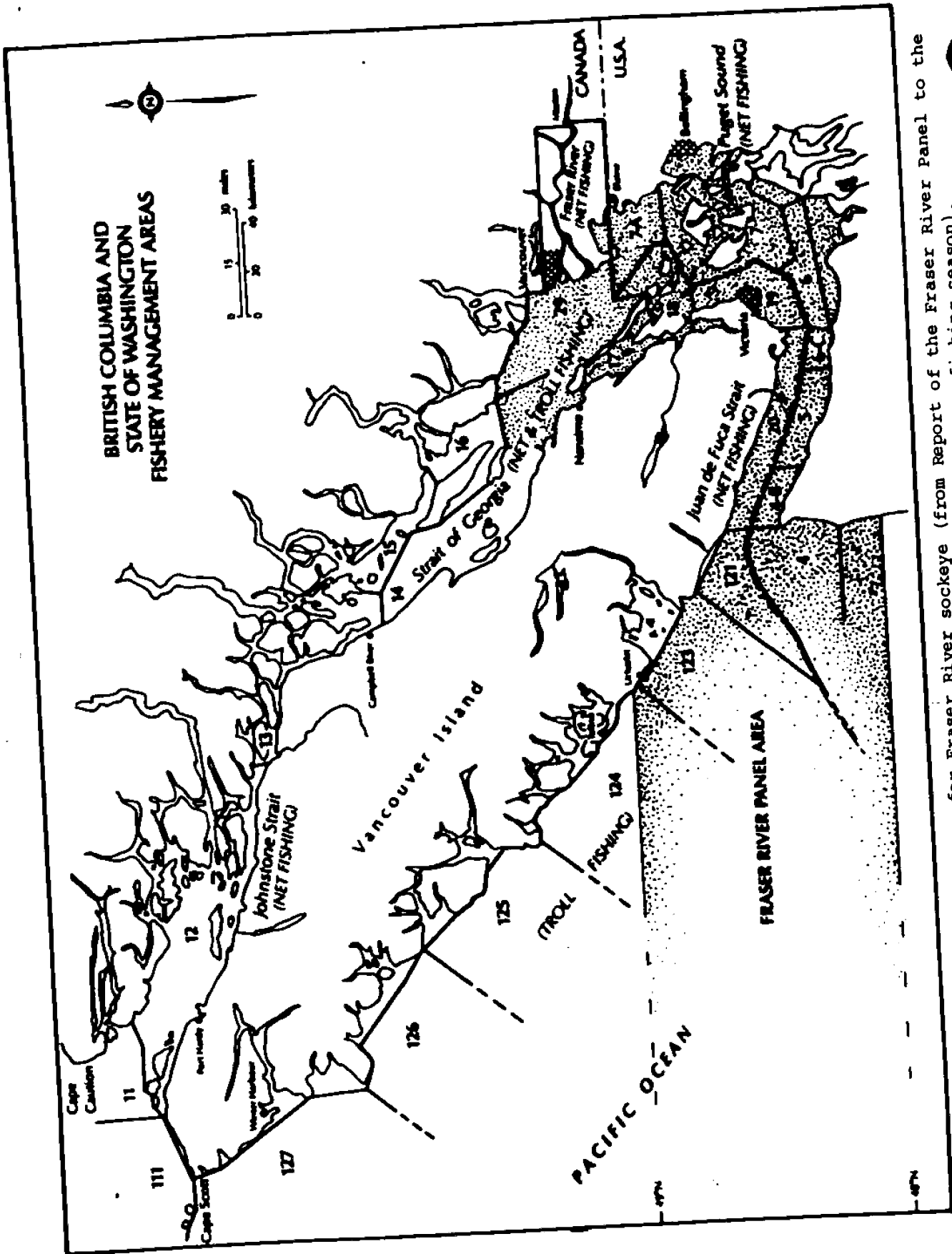


Figure 5. Fishery management areas for Fraser River sockeye (from Report of the Fraser River Panel to the Pacific Salmon Commission on the 1987 Fraser River sockeye and pink salmon fishing season).

sockeye stocks from 1948-87. All cycle years were combined because of insufficient data for the individual cycles. The results, summarized in Table 2, indicate a watershed optimum escapement of approximately 8 million spawners, of which the Adams and Lower Shuswap aggregate comprise half. The Quesnel optimum of 2 million is based on a habitat capacity estimate as there is insufficient data to develop a stock recruit curve at present. The total return generated by this level of spawners is approximately 28 million fish. Production from the upper Adams River stock, which is believed to have been one of the largest producers in historical times, is not included in this estimate because no stock recruit data is available.

Table 2. Optimum escapement estimates for Fraser River sockeye based upon IPSFC spawner-recruit data from 1948 to 1986.

Stock group	Optimum escapement	Expected return
Early Stuart	270,000	800,000
Early miscellaneous	195,000	860,000
Quesnel	2,135,000	7,080,000 <sup>a</sup>
Late Stuart	342,000	1,230,000
Chilko	667,000	2,250,000
Stellako	346,000	1,140,000
Birkenhead	107,000	590,000
Adams/Shuswap	4,161,000	13,010,000
Weaver	19,000	360,000
Late miscellaneous	65,000	240,000
Total	8,307,000	27,560,000

<sup>a</sup> No estimate possible for optimum escapement. Habitat capacity was used. Expected return estimate based on average productivity for the rest of the watershed.

### Spawning and Rearing Capacity

Estimates of usable spawning area were made for 80 spawning areas by analyzing data collected by the former IPSFC. Optimum spawning densities were computed for index streams within four biogeoclimatic zones and applied to the usable spawning areas for individual streams throughout the Fraser watershed to estimate the number of sockeye that the spawning grounds could support. For the entire Fraser watershed it is estimated that there are 5.5 million m<sup>2</sup> of usable gravel capable of supporting 12 million spawning sockeye (Table 3; see Appendix 3 for individual stream estimates). Assuming a return per spawner of 3, if the spawning grounds of the Fraser were filled to capacity, average runs of 36 million sockeye could theoretically be produced. It is very unlikely that all spawning grounds would be completely filled in the same year, as not all stocks are dominant on the same cycle, so lower average production should be expected.

Table 3. Estimated capacity of Fraser River spawning grounds for sockeye salmon.

Watershed	Usable area (m <sup>2</sup> )	Capacity (Total spawners)
Pitt	85,000	70,000
Cultus	28,000	56,000
Harrison	447,000	428,000
Seton/Anderson	16,000	29,000
Nahatlatch	150,000	281,000
Adams	637,000	1,557,000
Kamloops	124,000	237,000
North Barriere	8,000	15,000
Shuswap	1,182,000	3,132,000
Mable	209,000	546,000
Chilko	334,000	593,000
Taseko	17,000	31,000
Quesnel	892,000	2,405,000
Francois	102,000	21,000
Fraser	235,000	434,000
Stuart	253,000	465,000
Trembleur	518,000	962,000
Takla	260,000	544,000
Bowron	18,000	45,000
Total	5,515,000	11,851,000

Comparison of current escapements with capacity estimates provides an indication of the potential for growth. Total escapements during the last four years have ranged from 1.4 million to 3.7 million indicating a large potential on all four cycles. On the dominant years the greatest areas for potential growth are in the Upper Adams, Lower Shuswap, Middle Shuswap, Little, Horsefly, Tachie, Middle and Driftwood rivers.

While there are many spawning areas that are presently underutilized, others appear to be currently filled to capacity. Future returns will help to determine whether or not these field observations are correct.

Lake rearing capacities were estimated using two methods. The first method involved examination of the relationship between sockeye fry growth and survival and rearing temperatures, food supply and population density. The second method involved the relationship between potential adult production and the volume of water in which photosynthesis occurs (euphotic zone volume).

Using the first method, the total sockeye rearing capacity of the Fraser River watershed is estimated to be equivalent to the fry produced by 33 million spawners (Table 4). The lakes could, therefore, theoretically rear three times as many fry as the spawning grounds could produce. All lakes, with the possible exception of Nahatlatch, have rearing capacities exceeding those of the spawning grounds. The lakes with the largest potential for rearing fry are Stuart, Takla,

Francois, Quesnel and Harrison. Results from the euphotic zone method were consistent with those from the first method. Fig. 6 shows the relationship developed for Alaskan lakes and the production potential predicted for selected Fraser River lakes when applied to this model.

Table 4. Estimated sockeye rearing capacity of Fraser watershed lakes.

Lake	Area (km <sup>2</sup> )	Rearing capacity (Spawner equivalents)
Pitt	53.8	663,000
Cultus	6.3	80,000
Harrison	217.8	3,831,000
Seton/Anderson	52.6	429,000
Nahatlatch	3.8	35,000
Adams	137.6	1,923,000
Kamloops	55.8	50,000
North Barriere	5.2	124,000
Shuswap	309.6	4,019,000
Mable	58.7	809,000
Chilko	200.3	686,000
Quesnel	271.9	4,712,000
Francois	257.8	2,805,000
Fraser	54.6	1,091,000
Stuart	364.2	7,642,000
Trembleur/Takla	382.9	3,406,000
Bowron	10.1	108,600
McKinley	5.1	61,000
Total	2,448.1	32,474,000

The results of the three approaches to measuring potential run sizes can be summarized briefly as follows:

Method	Potential Run Size
Historical Review	minimum of 30 million on at least one cycle
Stock-Recruit	28 million
Spawning and Rearing Capacity	36 - 100 million

In conclusion, historical, stock recruit and habitat capacity information all strongly indicate that the Fraser River has the theoretical potential to produce runs in the order of 30 million or more. Whether or not runs of this magnitude can be produced and sustained on all cycles remains to be determined. Because not all runs are dominant on the same cycle, it is probably more realistic to expect average runs of less than 30 million but at levels greater than are now being experienced.

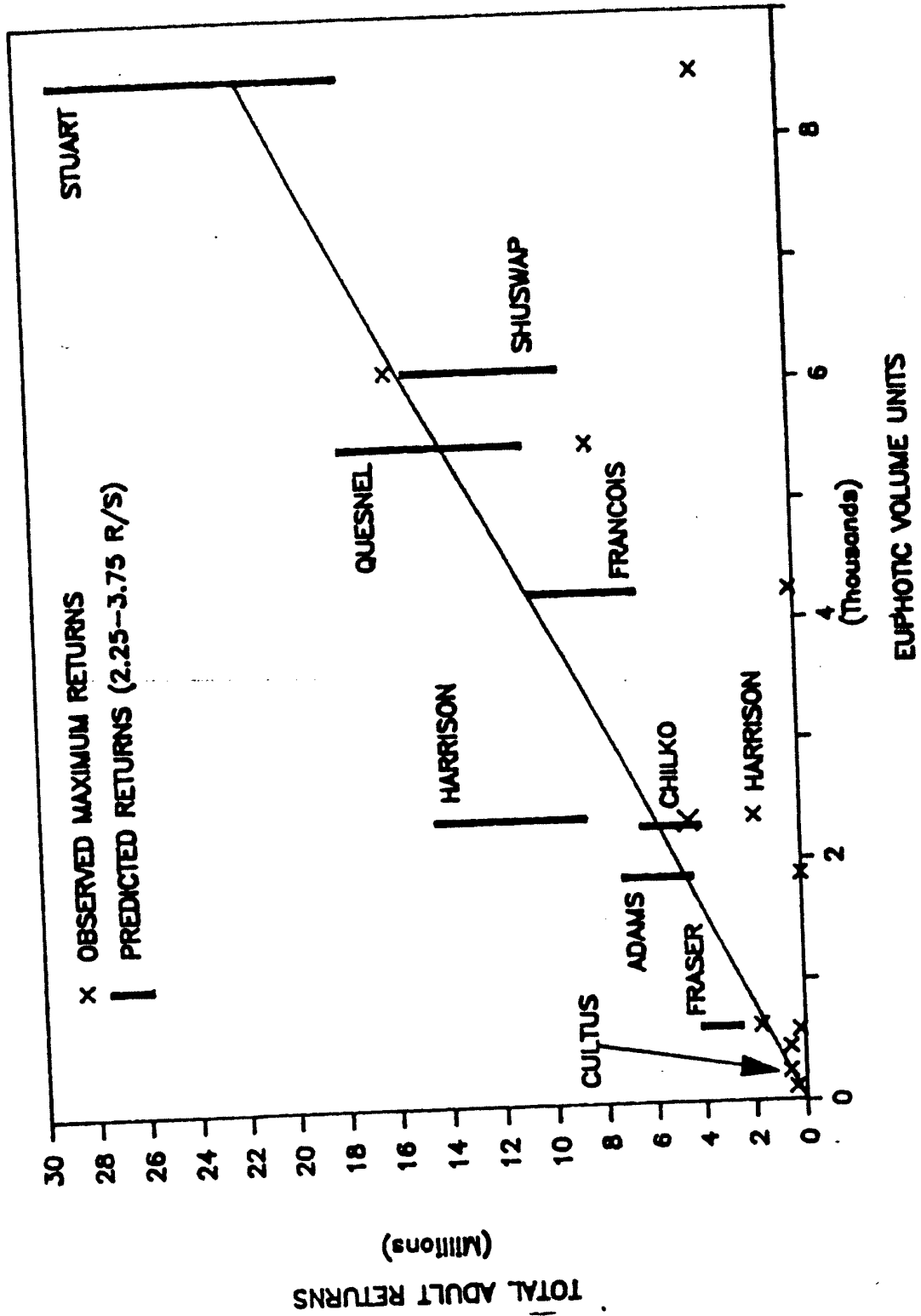


Figure 6. Sockeye rearing capacity of selected Fraser River watershed lakes in relation to euphotic volume.

## Interim Escapement Goals

The Task Force was faced with two difficulties in developing escapement goals for rebuilding. The first difficulty was that the optimum escapements derived from the stock recruit and habitat capacity analyses were different. The second was that current escapements are so low in some off-cycle years that it would not be realistic to reach those optimums within 4 cycles.

Interim escapement goals for each stock and cycle were developed by considering current stock levels, estimated optimums based on stock recruit analysis and habitat capacity estimates and professional judgement. Generally, interim goals for the dominant and sub-dominant cycles equal the habitat capacity estimates. In the off year cycles, where a large difference exists between optimums and current levels, professional judgement was the main factor used to establish interim goals. Judgements were based on providing opportunities for increasing production and setting goals that could realistically be achieved within 4 cycles. For example, the Adams 1988 cycle has recent escapements of 6,000. The stock recruit optimum is 3.6 million spawners and the habitat capacity estimate is 2.0 million spawners. It is unrealistic to expect that this stock could reach 2 to 3 million spawners within 4 cycles. An interim goal of 100,000 was considered to be realistic and, while well below the dominant year level, still provides for considerable growth over current levels.

Given the uncertainty regarding the mechanism for cyclic dominance, it was deemed too risky to try to bring escapements up to the dominant year levels on all cycles. A separate analysis was conducted to examine harvest management options for testing the cyclic dominance issue.

The interim escapement goals are shown in Table 5 by run timing and cycle (see Appendix 4 for individual stream estimates). Compared to current escapement levels, significant rebuilding potential exists in each cycle. The increase is different for different stocks but on average interim escapement goals are more than double current levels. The expected production (run size) from interim goals is shown on Table 6. Average runs of 16 million sockeye are expected if interim goals are met.

Table 5. Current and interim target escapements by timing group (thousands of fish).

Timing group	1985 Cycle		1986 Cycle		1987 Cycle		1988 Cycle	
	Current	Interim	Current	Interim	Current	Interim	Current	Interim
Early	234	500	29	150	148	280	110	150
Summer	1,834	3,750	1,145	3,700	1,023	2,100	805	2,150
Late	59	330	2,483	3,710	723	3,710	85	330
Total	2,127	4,580	3,657	7,560	1,894	6,090	1,000	2,630

Table 6. Current and interim target escapements and production (millions of fish).

Cycle Year	Escapement		Production	
	Current	Interim	Current	Interim
1985	2.1	4.6	7.0	14.0
1986	3.7	7.6	14.3	22.9
1987	1.9	6.1	9.0	18.5
1988	1.0	2.6	4.2	8.1
Average	2.2	5.2	8.6	15.9

Source:

Escapements - Current : actual escapements for 1985 to 1988

- Interim : goals based on stock recruit, habitat analysis and professional judgement

Production - based on Ricker curve with common 'a' value (2.63) for all stocks and 'b' value relating to interim goal

### EVALUATION OF REBUILDING OPPORTUNITIES

With interim escapement goals established for major stocks or stock aggregates, the Task Force evaluated the several options for rebuilding to these goals. This evaluation answers the following questions. How quickly do we rebuild? What stocks are targeted on? To answer to these questions, the Task Force evaluated six rebuilding strategies (Appendix 5). Each strategy was analyzed in the South Coast Management Model, which estimates the effect of rebuilding on Fraser River sockeye and pink stocks<sup>1</sup>. The individual strategies were evaluated using the following criteria:

1. total economic benefits,
2. initial harvest reductions, and
3. success in achieving interim escapement goals.

These criteria are described below. This section also summarizes the results of the analysis of rebuilding options for each of the four cycles. Further details are provided in Appendix 5.

The South Coast Model is a valuable tool to evaluate the complex issue of rebuilding as it shows the general trends over the long term. It assumes average

<sup>1</sup> For a description of the South Coast Management Model see Volume 17, South Coast, of the Salmon Stock Management Plan Discussion Document.



returns and does not, therefore, simulate annual stock variations (these are dealt with in the rebuilding plan). Monitoring of results as rebuilding proceeds, and a flexible implementation plan, are necessary to adapt the recommended option to actual events.

### **Evaluation Criteria**

#### **1. Economic Benefits**

The net present value of each rebuilding option represents its economic benefit. Net present value is an indicator showing the long-term effect of rebuilding. The south coast model calculates the change in Canadian commercial harvest values over 40 years. The net present value puts these future benefits and costs of rebuilding into comparable terms. Thus the economic effect of different rebuilding strategies can be compared.

#### **2. Initial Harvest Reductions**

This indicator is the harvest reduction required in the first cycle to start the rebuilding process. Fishermen and processors forgo catch in the short-term to benefit from larger runs and harvests later. Although the net present value includes these costs, the harvest reduction is still important because it represents the initial impact of rebuilding on the fishing industry.

#### **3. Rebuilding Goals**

As the purpose of the plan is to rebuild stocks, an indicator is necessary to show whether interim escapement goals are reached within a reasonable period (4 cycles). This indicator shows how other stocks in the run timing rebuild as the target stock is always rebuilt to interim goals.

### **Analysis of Rebuilding Options**

The analysis of rebuilding options often clearly indicates that one or two options are better than others. Choosing between these options is difficult because a trade-off between different criteria is usually required. Most often, high economic benefit was associated with a large harvest reduction in the first cycle. The recommended option attempts to balance these trade-offs. Thus the recommended option is rarely the best according to any one criteria, but reflects a balance of all three.

The analysis is split into two sections to highlight the benefits of each:

1. rebuilding to interim goals, and
2. an experimental approach to acquire additional knowledge about cyclic dominance.

The analysis includes Fraser pinks as well as sockeye. Fraser pink runs are strongly affected by the late sockeye runs, with the potential of high economic gains or losses. Other species are also affected and are discussed in a later section.

Changes in escapements, catch and economic performance were compared to a base case which assumed that current Treaty escapement goals would be

more-or-less maintained. For the purposes of this analysis, the Indian food fishery catch was fixed at 500,000 per year and the United States Fraser sockeye catch was set at the current Pacific Salmon Treaty level of 7 million fish over four years. Harvest rate reductions in the Canadian commercial fishery were applied throughout the entire fishery and current allocation sharing arrangements were maintained as nearly as practicable.

## Rebuilding Strategy

### 1985 Cycle

Unlike the other cycle years, sockeye rebuilding in the 1985 cycle has little economic benefit relative to the base case (Table 7). As well, the initial harvest reductions are large and late run stocks only rebuild slowly. There are three reasons for the poor results.

1. Stocks in the 1985 cycle, particularly Horsefly and Mitchell, are already approaching their interim goals. Even greater harvest reductions are required to initiate more rebuilding, reducing economic returns.
2. Harvests by U.S. fishermen are below levels negotiated in the Pacific Salmon Treaty. They will share from rebuilding until they reach their limit.
3. Rebuilding late run sockeye is hampered because the Weaver stock is near its interim goal. Rebuilding other stocks requires fishermen to forego a portion of the Weaver harvest. Given the low runs of other stocks and little rebuilding gains from Weaver, rebuilding other stocks does not increase economic benefits. To rebuild late stocks either requires enhancement of other late run stocks or a terminal harvest for a portion of the Weaver run.

Table 7. Economic benefit and catch reductions for recommended options.

Cycle	Economic Benefit: (millions of \$)		Catch Reduction: (thousands of fish)	
	Sockeye	Pink	Sockeye	Pink
1985	2	40	-530	-800
1986	50	50	-650	0
1987	105	151	-1,320	-1,777
1988	21	21	-330	0

Table 8. Escapement at current levels and after four cycles as a percent of interim goals.

Cycle	Early	Summer	Late	Total
<b>Current Levels</b>				
1985	47	48	18	46
1986	19	31	67	48
1987	52	49	19	31
1988	73	37	26	38
<b>After Four Cycles of Rebuilding</b>				
1985	100	92	76	91
1986	100	79	100	91
1987	100	89	82	85
1988	100	78	80	80

Rebuilding only has a significant economic benefit when pink stocks are included in the evaluation. Rebuilding and subsequent higher harvest levels for pinks add nearly \$40 million in economic benefits. The recommended option rebuilds the target stocks over 3 to 4 cycles. This strategy increases the economic benefits from pink rebuilding with a relatively small harvest reduction. The strategy results in some over-escapement of Weaver stocks, but still the late run stocks rebuild to only 76 percent of interim goals.

#### 1986 Cycle

The 1986 cycle is already the largest because of the dominant Adams River run. The recommended option increases the size of this cycle by slowly building up the Horsefly run to the same level as Adams over 5 cycles. This long rebuilding period is the result of the large difference between current and interim escapements (181,000 to 2.2 million). Even at the slow rebuilding rate, there is a significant harvest reduction for this cycle.

The recommended strategy rebuilds Early Stuart and late runs to interim levels. Slower Horsefly rebuilding reduces the rebuilding speed of summer runs.

#### 1987 Cycle

The greatest economic benefit from rebuilding comes in the 1987 cycle which results from the large difference between current and target escapements, particularly for late run stocks. For example, Adams builds to dominant year-1986 levels. This rebuilding requires a substantial reduction in first year harvest.

The recommended option attempts to lower the initial harvest reductions. Unfortunately, to rebuild to interim goals requires substantial harvest reductions.

## 1988 Cycle

The recommended option for 1988 is to rebuild the dominant stocks in 1 to 2 cycles. The stocks can be rebuilt quickly as the target stocks (Early Stuart, Chilko, and Weaver) are relatively close to interim goals. The non-dominant stocks rebuild as well, but slower than the dominant stocks. Options to rebuild these stocks higher will both reduce the economic value and increase the harvest reduction in the first year.

One of the reasons late stocks do not rebuild quickly is the high harvest rate (close to 80 percent) required to keep Weaver escapement at the interim goal. Other stocks rebuild slowly at that rate. This appears to be an opportunity to test the interim goals. If the potential of the other stocks is higher than their interim goals, further rebuilding may be beneficial. This is examined in the next section.

## Experimental Design

The foregoing analysis was based on a set of interim escapement goals that assumed that not all cycles could produce at the dominant cycle levels. If this assumption is incorrect, the production potential of the Fraser River could be underestimated by a large margin. The true potential depends to a large degree on whether historic cyclic trends in abundance were caused by overfishing or by biological processes. If the cause of these cycles in abundance were known this would provide guidance on the most appropriate management strategy to pursue.

The causes of cyclic dominance are unlikely to be discovered within the next few years because of the extensive natural variability in sockeye return rates. Nevertheless, a well designed management plan should lead to a much better understanding of the issue within 10-20 years since the response of the stocks will provide improved information. The above rebuilding analysis provides for considerable potential for increasing production. However, because of the pattern of interim goals that is being recommended, answers to the questions regarding cyclic dominance will be slow to emerge. A well designed approach to increasing spawning escapements through management and enhancement actions will increase the likelihood of resolving the mystery of cyclic dominance within a reasonable time frame. Failure to address this issue could result in foregoing large catches in the future.

A separate analysis was conducted to address whether or not cyclic dominance is maintained by overfishing. This approach involves additional harvest reductions on some stock groups to increase spawning escapements on the off cycle years. There are twelve discrete management components that can be harvested more or less independently: the early, summer and late run-timing windows in each of the four cycles. These timing windows were examined to determine which would be most suitable for further harvest reductions. Suitability was based on where greatest benefits and knowledge could accrue with the least disruption to the fisheries. Alternative harvest proposals were simulated based on differing assumptions about the cause of cyclic dominance.

It appears that the best options for addressing the cyclic dominance controversy would be to reduce harvest rates to 50% in the mid-timing 1987 cycle and the late-timing 1988 cycle for three to four cycles. The potential costs and benefits of this proposal are shown in Table 9.

Table 9. Evaluation of options for accelerating rebuilding to investigate cyclic dominance (values represent difference from base).

	Rebuilding Schedule	Late '88 Cycle	Summer '87 Cycle	Late '88/ Summer '87
<b>Assumption: No biological basis for cyclic dominance (UBC model)</b>				
Catch Reduction in First 4 Cycles (millions)	2.9	3.1	3.3	3.5
Average Catch over 40 years (millions)	3.8	4.2	4.0	4.4
Net Present Value (\$ millions)	362.0	456.7	367.6	462.4
<b>Assumption: Biological basis for cyclic dominance (South Coast model)</b>				
Catch Reduction in First 4 Cycles (millions)	2.8	3.1	3.3	3.5
Average Catch over 40 years (millions)	1.80	1.75	1.85	1.85
Net Present Value (\$ millions)	178.0	165.0	178.0	165.0

### 1. Late timing 1988 Cycle

This timing window offers an excellent opportunity to address cyclic dominance because it focuses on a cycle in which the Adams stock is at a very low level. The interim escapement goals for Adams run were established at 2.3 million spawners in the dominant and subdominant cycles but only at 100,000 for the off-cycles. Obviously there is considerable potential for increased production if the dominant level can be achieved in the 1988 cycle.

The late-timing 1988 cycle presents the opportunity for the greatest possible gain. If cyclic dominance is not limited by biological factors, the potential benefits are in the order of \$95 million greater than would be achieved by the recommended rebuilding schedule alone (\$457 million). However, if cyclic dominance is biologically limited, the benefits of reducing harvest rates to 50% on the late 1988 cycle are about \$13 million less than expected with the rebuilding schedule (\$165 million) but are still higher than no rebuilding.

The foregone catch in the first cycle would be an additional 200,000 to 300,000 compared to the previously described rebuilding schedule. The average catch over the 40 year period would be 400,000 more per year if there is no biological cause for cyclic dominance and could be 50,000 less if there is, compared to the potential benefits. The trade-offs of foregone catch and risk of not being able to rebuild the off-cycle are relatively minor compared to the potential benefits.

In addition to increased production from accelerated rebuilding, the response of the stocks will provide improved information regarding cyclic dominance. Because of high variance in return rates, statistical tests are required to determine whether observed increases in run size truly reflect a rebuilding trend. The accelerated rebuilding of the Adams in the 1988 cycle improves the chance of determining whether the off-cycle can be increased above the Task Force interim goals. Preliminary analysis shows the risk of concluding incorrectly that off-cycle runs can be rebuilt improves to 10-24% compared to 17-29% without accelerated rebuilding.

## 2. Summer Run 1987 Cycle

This timing window also offers an excellent opportunity to address the cyclic dominance issue because it is focused on the off-cycle Horsefly, and Late Stuart stocks and subdominant Chilko stock. The interim escapement goals for the Horsefly and Late Stuart runs were established at 2.2 and 0.5 million spawners, respectively in the dominant cycle, whereas the interim target in the 1987 cycle is 250,000 and 200,000 spawners. Again there is considerable potential for increased production if the dominant level can be achieved in the 1987 cycle.

The mid-timing 1987 cycle has the potential for modest gains in the long term with essentially no long term cost. The NPV is projected to be better than the base regardless of whether cyclic dominance exists or not (\$178- \$368 million). If cyclic dominance is not limited by biological factors, the potential benefits are in the order of \$ 5.6 million over the rebuilding schedule (\$368 million). However, if cyclic dominance is biologically limited, the benefits of reducing harvest rates to 50% on this option are the same as expected with the rebuilding schedule (\$178 million).

The foregone catch in the first cycle would be an additional 400,000 compared to the previously described rebuilding schedule. The average catch over the 40 year period would be 400,000 more per year if there is no biological cause for cyclic dominance and could be 50,000 more if there is, compared to the potential benefits. The foregone catch is significant but would be compensated for by higher future catches.

The principle benefit of this option is the increased knowledge regarding cyclic dominance because several stocks are included. Accelerated rebuilding of the summer run-timing stocks in the 1987 cycle in combination with the accelerated rebuilding of the late timing 1988 stocks lowers the risk of concluding incorrectly that off-cycle runs can be rebuilt to 6-19% compared to 17-29% without accelerated rebuilding.

## Summary

The recommended strategy involves managing the dominant stocks in each run timing group to a schedule of increasing escapements related to the interim escapement goals specific to each cycle. Increasing escapements are achieved by decreasing exploitation rates. The recommended strategy reduces exploitation rates, from 75-85% in the base to 65-70% in most timing groups Table 10. The projected run, escapements, and Canadian catch are shown in Fig's 7, 8 and 9.

Table 10. Recommended exploitation rates for the first year of rebuilding.

Year	Target stock	Base harvest rate	Recommended harvest rate
1985	Early Stuart	78	70
	Horsefly	77	70
	Weaver	69	63
1986	Early Stuart	33	52
	Horsefly	75	54
	Adams	71	70
1987	Early Stuart	83	67
	Chilko	82	50
	Adams	85	70
1988	Early Stuart	75	64
	Chilko	78	71
	Weaver	87	50

*US rates drawn down*

If all stocks were at optimum, the best exploitation rate would theoretically average about 66%. This is a result of using the common productivity value in the stock recruit relationship. While the fastest way to rebuild is to decrease harvest rates below 66%, this would cause undo disruptions to industry if applied across all stock groups. Therefore, we are recommending slightly higher harvest rates averaging approximately 70% on the dominant stocks. However, on stocks with the greatest potential (e.g. Horsefly 1986), we recommend greater harvest rate reductions to achieve this potential sooner.

The change in catch from the base indicates that most of the sockeye catch foregone in the first 4 years is more than repaid in the following 8 years (Fig. 10). The greatest sockeye rebuilding benefits come from the 1987 cycle. Comparable long-term benefits could occur in 1988 if accelerated harvest reductions successfully build up off-cycle Adams. Moderate sockeye increases occur in the 1986 cycle and only marginal increases in the 1985 cycle. Pink salmon catches also increase substantially in the long term (Fig. 11). This increase makes rebuilding of the 1985 cycle worthwhile.

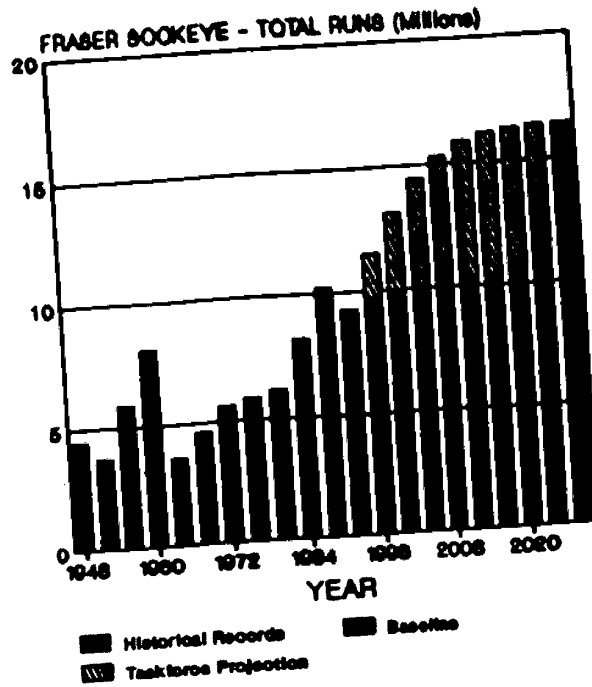


Figure 7. Total runs of Fraser River sockeye predicted from base case and recommended approach.

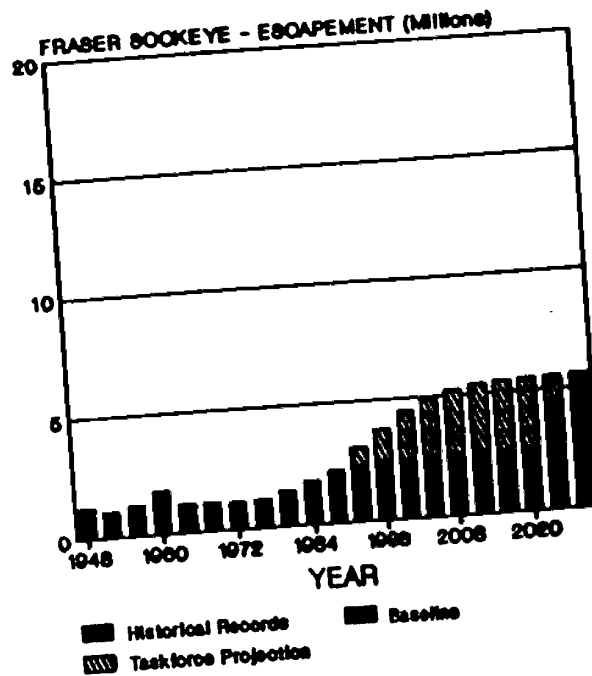
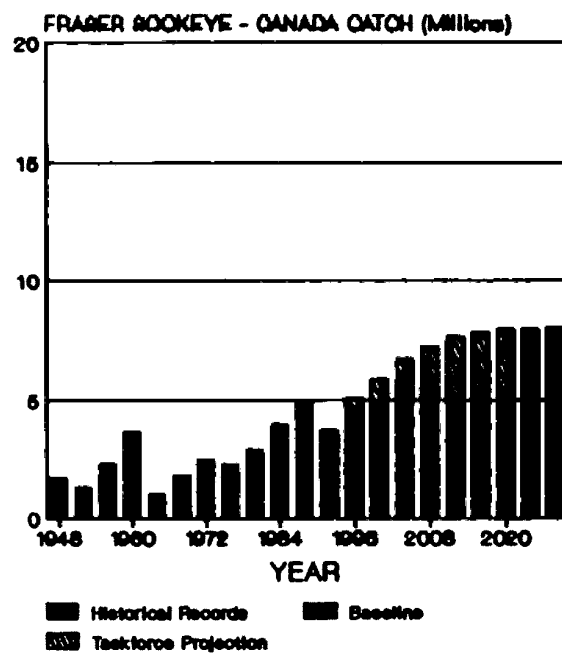


Figure 8. Spawning escapement of Fraser River sockeye predicted from base case and recommended approach.





Four year annual averages

Figure 9. Canadian commercial catch of Fraser River sockeye predicted from base case and recommended approach.

Figure 10. **Fraser Sockeye Catch**  
Recommended Rebuilding minus Base

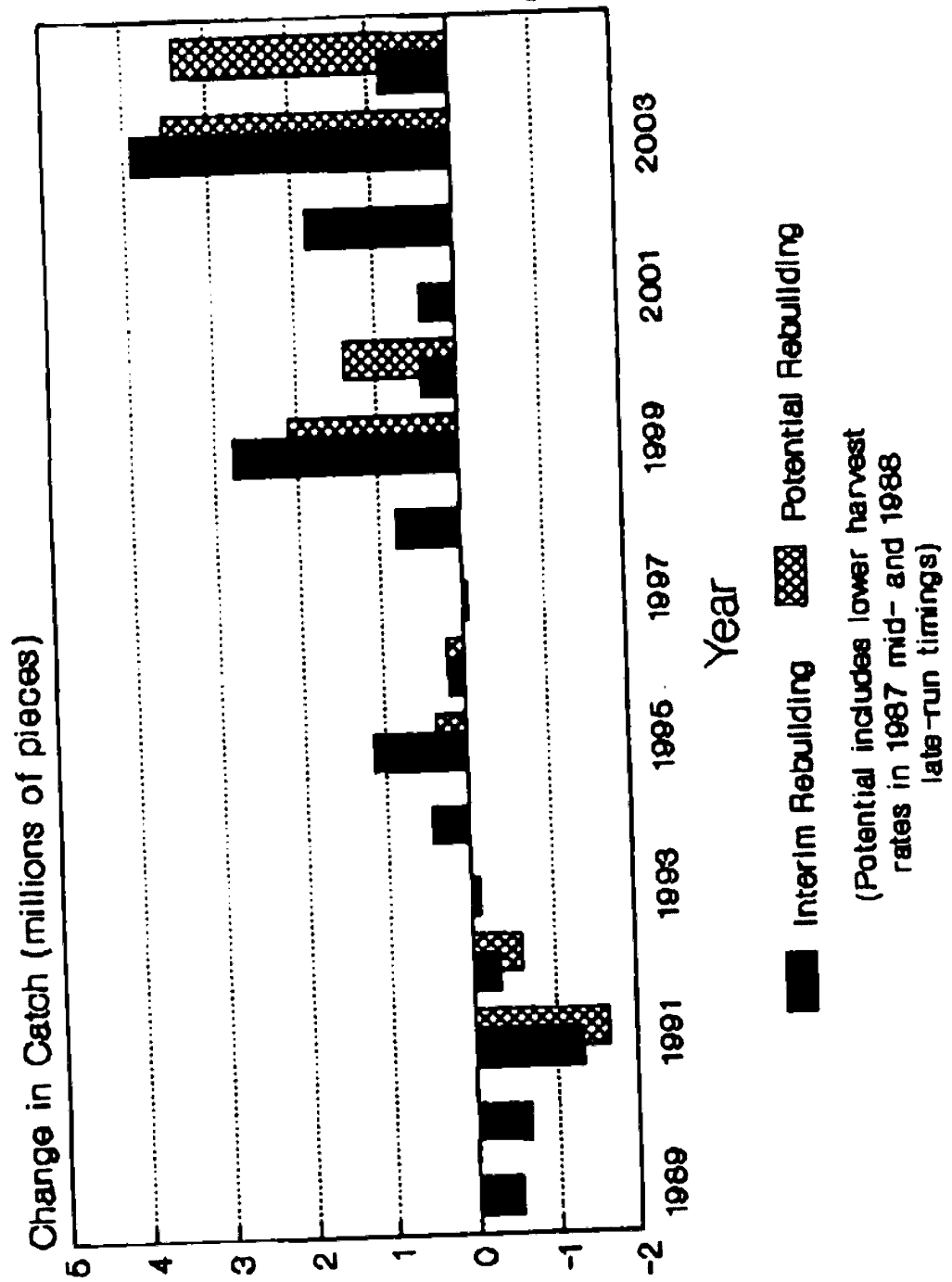
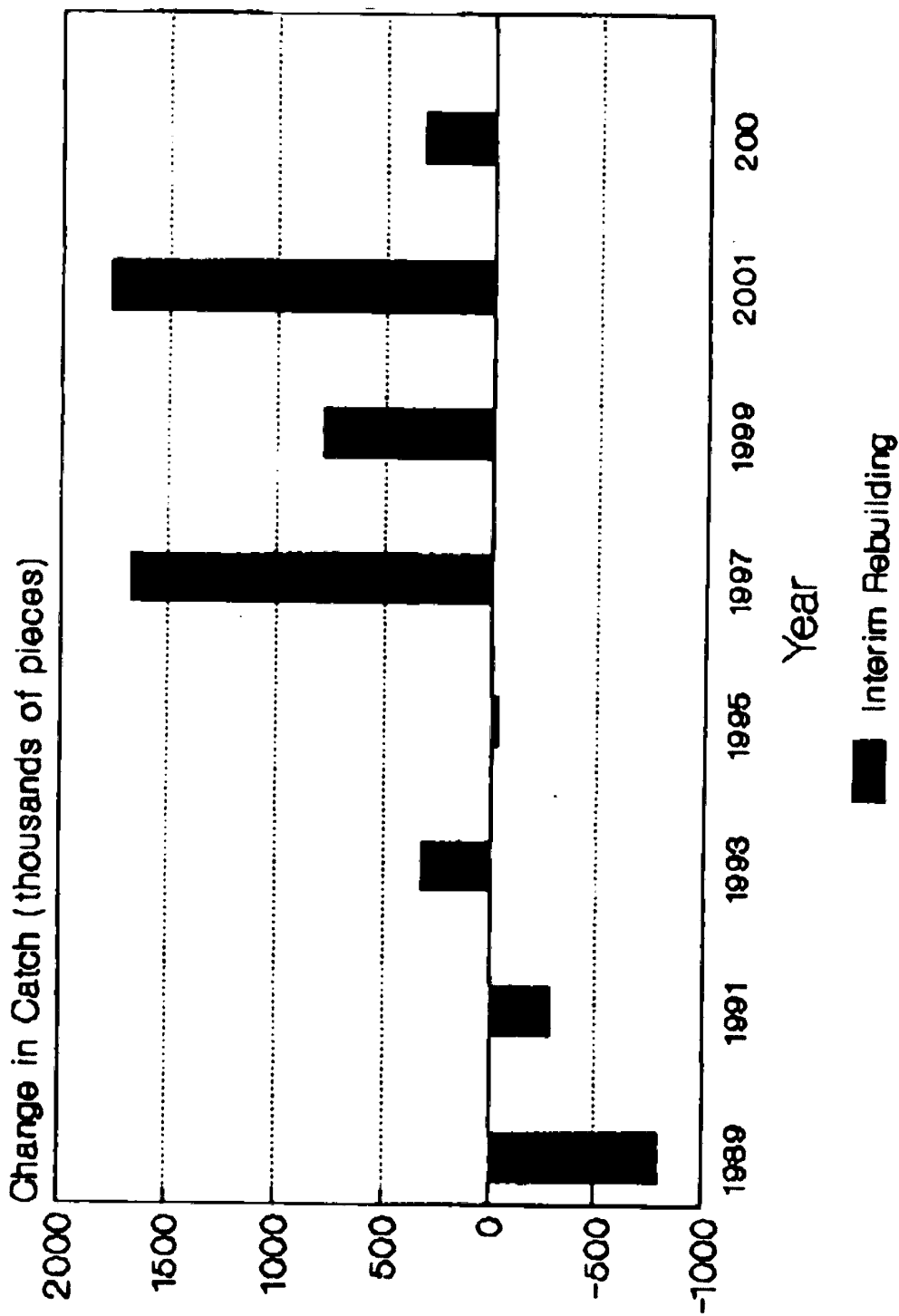


Figure 11.  
**Fraser Pink Catch**  
Recommended Rebuilding minus Base



The plan includes the opportunity to explore the ultimate potential of the Fraser River watershed to produce sockeye. A greater reduction in harvest rate to 50% is recommended in two timing windows, the mid-timing 1987 and late-timing 1988 cycles. Stocks in these timing windows would not be limited to interim goals. This approach provides opportunities for substantial benefits and will enable the off-cycle runs to respond to reduced harvest pressure and help to resolve the questions of cyclic dominance.

#### ENHANCEMENT

Enhancement will play an important role in the development of Fraser River sockeye to their full potential. Close integration with the overall management plan will be required. The main roles for enhancement are to assist the rebuilding of natural stocks, and to pursue production opportunities which allow the fisheries to maintain wild stock harvest rates on co-migrating stocks. Enhancement technology may also be valuable in assisting in the investigation of cyclic dominance.

Rebuilding activities, such as the Upper Adams project, should be designed to rebuild stocks as quickly as possible. Mobile hatcheries, and projects with short to medium life spans, fit well within the rebuilding strategy. These projects may have very favourable benefit/cost ratios, if they are credited with the entire stream of benefits from stocks which may not have rebuilt without assistance.

Production activities are those which produce substantial returns in addition to those generated by natural spawning. For these projects, the scale and technology are critical. Desirable projects are those with natural productivity rates (e.g. habitat restoration/improvement or access to new spawning grounds) and those with high productivity rates (e.g. spawning channels or hatcheries, including central incubation facilities from which to transplant fry to inaccessible, barren nursery areas) but whose returns are collectively small relative to the co-migrating wild stocks.

For high-productivity, large-scale projects, there are few opportunities to avoid mixed stock/species fishery problems without resulting in over-escapements. If such projects are considered, then the need for new selective harvest strategies, terminal harvests, or the acceptance of surplus spawning escapements should be realized in advance.

Lake fertilization is a major component of the sockeye enhancement strategy, suitable both for rebuilding and production purposes. It is well suited to investigating cyclic dominance since it does not involve capital investment in facilities which might be unused in selected cycle years.

In anticipation of adult migration delays resulting from larger escapements and crowding at bottlenecks, fish passage projects are being carried out along the major migration routes (e.d. Saddle Rock and Hell's Gate lower fishway). Several potential slides and delays to migration still exist. When the stock rebuilding targets are finalized, the stock vs river discharge patterns can be compared and future fish passage work planned.

The Task Force has identified a number of potential enhancement opportunities (Table 11) but further investigation is required to determine production levels, feasibility and benefit costs. Additional discussion is provided in Appendix 6.

Table 11. Potential Fraser sockeye enhancement projects.

Stock/Area	Description
Early Stuart	<ul style="list-style-type: none"> <li>- central incubation facility to handle several stocks simultaneously for low level rebuilding enhancement</li> <li>- possible spawning channel on Driftwood River; needs further discussion and bioreconnaissance.</li> <li>- transplant from Middle River tributaries to Driftwood on off cycle years</li> </ul>
Late Stuart	<ul style="list-style-type: none"> <li>- spawning channel on Tachie River</li> <li>- gravel addition to Middle River</li> </ul>
Nadina River	<ul style="list-style-type: none"> <li>- incubation facility for early run</li> <li>- gravel addition for late run</li> </ul>
Stellako River	<ul style="list-style-type: none"> <li>- spawning channel with fry transport to Francois Lake</li> </ul>
Quesnel Lake watershed	<ul style="list-style-type: none"> <li>- spawning channel on lower Horsefly River</li> <li>- airlift of sockeye above falls on dominant years and fish ladder eventually</li> <li>- flow control on Mitchell River and possibly a spawning channel</li> <li>- enrichment of Quesnel Lake</li> </ul>
Bowron River	<ul style="list-style-type: none"> <li>- enhancement to stabilize production</li> </ul>
Portage Creek	<ul style="list-style-type: none"> <li>- improve channel stability around mouth of stream</li> <li>- potential community involvement project</li> </ul>
Thompson Watershed	<ul style="list-style-type: none"> <li>- possible enhancement of Fennell Creek stock if surplus fish policy developed</li> <li>- addition of gravel and flow control structure on "display area" channel of Lower Adams River</li> <li>- continuation of hatchery operation on upper Adams River</li> <li>- possible small spawning channels in Seymour River and Scotch Creek or satellite using upper Adams hatchery</li> <li>- enhancement of Middle Shuswap River stock to take advantage of Mabel Lake rearing capacity</li> </ul>
Lower Fraser	<ul style="list-style-type: none"> <li>- incubation facility and predator control to increase Cultus sockeye production</li> <li>- gravel addition to Widgeon Slough</li> <li>- enhancement of Harrison River sockeye - possible incubation facility</li> <li>- remedial work on Big Silver Creek to restore flow to lower right channel</li> <li>- incubation facility and/or spawning channel for Pitt River sockeye</li> </ul>

## IMPACTS ON OTHER STOCKS AND SPECIES

Fraser River sockeye coincide in migration timing with other species of salmonids and, to a limited extent, with other sockeye stocks in the main net fishing areas of Johnstone Strait, Juan de Fuca Strait and the Fraser River (Fig. 12. As indicated in this figure, chinook and coho are present throughout the period of sockeye migration (except in the Fraser River where coho are concentrated at the end of the season) while pink, chum and steelhead are present mainly during the latter half of the sockeye run. A few non-Fraser sockeye stocks coincide with the early portion of the Fraser sockeye run. As well, the stock composition within each species varies between the different fishing areas.

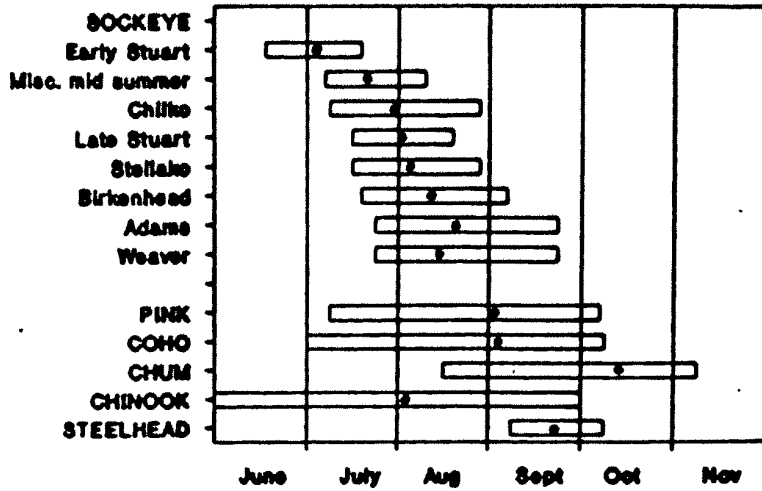
As a result of these timing overlaps, changes in the harvesting patterns for Fraser sockeye will inevitably affect co-migrating stocks. The effects are dependant on fishing patterns (number of days, fleet size, timing of the openings and type of gear). Impacts on other stocks and species can be minimized; however, this may require alterations to fishing patterns and allocations. Fishing patterns are developed annually and must consider the status of the other non target stocks. Consultation with the fishing industry is necessary prior to making decisions on the fishing plans. However, although specific implications of harvesting Fraser sockeye remain to be determined, some general comments regarding potential impacts can be made as well as suggestions on how some impacts could be minimized.

*This needs to be fixed up*  
The impacts on other species are generally expected to be reduced because the Task Force recommendation involves lowering harvest rates by approximately 10 percentage points, even when the sockeye runs are rebuilt to interim goals. However, during some periods which are now closed or have minimal effort, fishing may be increased as runs rebuild and this could affect other species. The catch ceiling on the U.S. fisheries will have the effect of increasing the proportion of the catch in Canada. As some of the largest stocks achieve optimum production, additional fishing days may be required even though the harvest rate remains lower than at present. *overall FR*

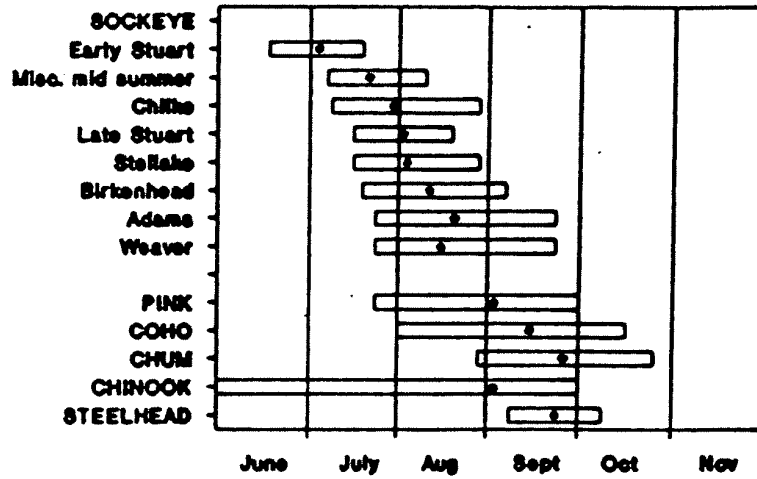
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*C ✓*  
In general, during the initial years of the program, the number of fishing days should be lower than if the program were not in place because of the reduction in harvest rates. As the stocks rebuild, additional fishing days ~~may~~ be needed to harvest the available surpluses if the traditional allocations and fishing patterns are retained. It is not anticipated that this additional effort will be large, and, in most cases, it will be still less than if the rebuilding program were not in place. However, in some years, effort could rise, thereby increasing the impact on species such as chinook, making it difficult to attain a 20% reduction in harvest rate as required by the Strait of Georgia chinook rebuilding program. There are some actions that could be taken to minimize impacts on chinook. Most of these require changes to the current allocations. For example, increased troll allocations of sockeye would reduce the number to be taken by the net fleet with consequent reduction in fishing days. Fishing days in Johnstone Strait could be limited to a maximum per week regardless of run size. This would reduce the catch of Strait of Georgia and passing Fraser chinook and make additional sockeye available to Area 20 or Area 29 where more fishing days may be required to catch them. Additional fishing effort in Area 29 would increase the incidental catch of Fraser River chinook and other species. Other new opportunities may also be considered.

*need to*

A. Johnstone Strait:



B. Strait of Juan de Fuca:



C. Lower Fraser River:

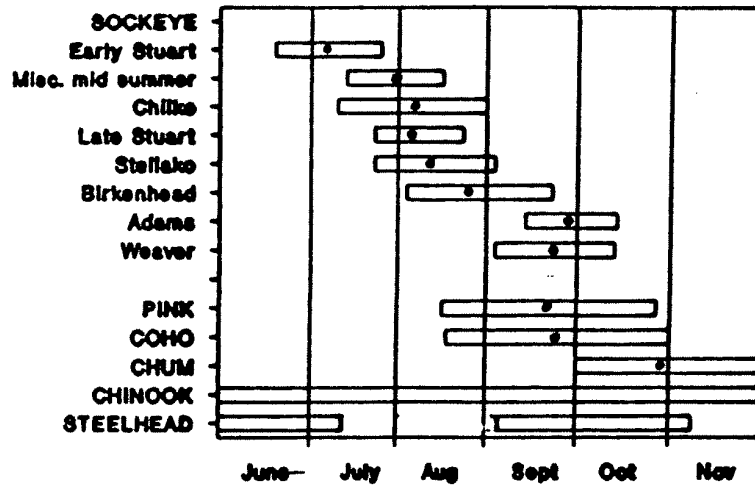


Figure 12. Approximate migration timing of salmonids through three major fishing areas for Fraser River sockeye. Peak periods are indicated by a "•".

It should be noted that, as a result of larger spawning escapements in recent years, reinstatement of directed commercial fisheries for Early Stuart sockeye, can be expected as early as 1991. This will increase incidental catches of other species such as chinook and summer steelhead. These fisheries for Early Stuart sockeye are expected to occur regardless of whether the Task Force plan is implemented.

While general impacts on the implications of the sockeye rebuilding plan can be noted at this time, further analysis is still required to determine specific effects. The Task Force has computer models available to assess some of these impacts. Allocation options need to be developed through consultation with user groups before analysis can continue.

### UNCERTAINTIES TO ACHIEVING POTENTIAL

Any time that plans of this nature are developed there will be gaps in our understanding of the biological system upon which they depend. Further, our plans depend on future events and developments, some of which cannot be foreseen. However we must not remain frozen in the status quo and miss opportunities because of these uncertainties. Instead we must develop approaches for dealing with uncertainty that allow us to move forward with an acceptable level of confidence.

The Task Force recommends adaptive management as the general approach to uncertainty. The Task Force strongly recommends that a sound evaluation program be implemented as an integral part of the rebuilding plan. Such a program will not only provide a measure of progress but will help to avoid going too far down unproductive pathways. By evaluating progress it should be possible to "fine tune" the plan to take advantage of knowledge gained and to maximize benefits.

In this section, the uncertainties identified by the Task Force are outlined in order to direct future research. Monitoring and assessment requirements are also identified to address uncertainties and assess the progress of the plan. These general recommendations should form the basis of a detailed monitoring program yet to be developed.

The uncertainties identified by the Task Force not in order of priority are presented as follows:

- Freshwater Carrying Capacity and Productivity
- Co-migrating Stocks and Species
- Habitat Stability
- Marine Carrying Capacity
- Climatic Change
- Migration/Passage Problems
- Cyclic Dominance
- Disease
- Some Enhancement Technologies

### Freshwater Carrying Capacity and Stock Productivity

Freshwater carrying capacity, is the fundamental basis of the rebuilding program. It is the Task Force's estimate of the capability of the Fraser sockeye to return to or exceed historical production levels. There are two equally



important components to the freshwater life history of the Fraser sockeye, spawning capacity and rearing capacity.

Estimates have been made of the capacities of most spawning grounds, although few have been evaluated thoroughly. Intensive research and investigations should be conducted to confirm the estimates of total spawnable gravel and the correct loading densities for sockeye spawners throughout the Fraser watershed. Programs such as physical surveys of all major sockeye spawning streams and egg-to-fry survival studies need to be encouraged to confirm or correct the stated estimates. It is important to acquire data on egg-to-fry survival at a range of spawning levels to help determine the optimum escapements for various stocks. Additional fry enumeration studies to provide this information are recommended. Stock recruit analysis will also assist in determining optimum escapement.

Estimates of the rearing capacity of the Fraser lakes suggest the progeny of 33 million spawners could be successfully reared to the smolt stage. As in the case of the spawning habitat capacity, confirmation of the estimates of rearing capacity are very important. Equally important is the need for a more thorough understanding of the optimum numbers of fry to be loaded into a lake system with and the optimum size of smolts that lake should produce. Assumptions regarding the probable effects of varying levels of fry production on smolt size, lucustrine survival rate and, ultimately, adult production need to be tested.

Since the basic approach recommended by the Task Force involves increases in spawning escapements to bolster production, a program to accurately and consistently estimate escapement levels is essential. The current spawning enumeration program is sufficient at current escapement levels although it will have to be progressively expanded with more intensive methods (e.g. tag and recapture, counting fences) on some stocks and cycles as the spawning populations increase over time. This same information will also help to answer questions regarding cyclic dominance by assessing the relationship between spawners and returns on the different cycles.

#### **Co-Migrating Stocks and Species**

Analysis of the impact of these plans on co-migrating stocks and species have been carried out using the best data available. Further analysis will be conducted in developing detailed implementation plans. Research is necessary to confirm the migration timing and behavior of sockeye and other species through the various fisheries. Additional information is required on harvest rates by fishing area and gear type. With improved knowledge, fishing pattern adjustments can be made with a minimum of disruption.

#### **Habitat Stability**

The Task Force has made its recommendations with the assumption that habitat capacity will remain in its current condition through the life of the plan. A comprehensive habitat planning initiative is now under way to ensure that the Fraser River watershed remains relatively undisturbed and productive. What may require additional studies are some of the unknown long term impacts of previous industrial activity such as logging, pulp mills and sewage treatment plants.

## **Marine Carrying Capacity**

Assuming the rebuilding program is as successful as expected, the result will be an increase of migrant smolts to levels experienced only before the turn of the century. There is the potential for density-dependent effects on marine survival although this is largely an unknown effect at present. Presumably, these effects could be particularly acute if the coast-wide rebuilding program is generally successful for all stocks and species and there is a competition for a limited marine food supply.

## **Climatic Change**

Another serious concern is the likelihood of long term shifts in climate associated with the "greenhouse" effect. Many scientists now predict that warming of the earth's atmosphere due to the high level of carbon dioxide and other gases is a certainty within the next few years. This could result in reductions in marine carrying capacity for sockeye. More important, it may have impacts on the freshwater environment by increasing temperatures and reducing flows.

The Science Branch of DFO is taking action to assemble information. This will also be a major focus of the habitat planning initiative that is getting underway to complement the Task Force work. Models to predict the impacts on fisheries production should be developed.

## **Migration/passage problems**

The Fraser River and some tributaries have had long histories of obstacles to migration for sockeye and pink salmon. These obstacles have either entirely blocked or delayed sockeye migration to the point where pre-spawning mortalities were noted. Recent events have demonstrated the inadequacy of some existing facilities. Given a target production of 30 million sockeye per year, the annual escapements would be expected to reach 8 million spawners. Coupled with spawner population increases of other species such as pink salmon, there will be a critical need to identify all current and future points of difficult passage. If the re-building program is to succeed, impediments to migration must be minimized at all water levels and passage conditions.

## **Cyclic dominance**

The cyclic dominance issue has been discussed throughout this document. Needless to say it is a major study topic. As outlined in a previous section a specific plan has been developed to gain a greater understanding of this phenomenon as quickly as possible.

## **Disease**

Disease related problems within salmon populations are generally associated with higher than optimal densities or with situations that encourage elevated stress levels. Many diseases passively reside within salmon populations, but do not manifest themselves until high density-stress situations provide the right environment. With the proposed sockeye production target levels, the frequency of higher density situations will increase markedly and hence disease outbreaks such as IHN, etc., may become more prevalent.

## Enhancement Technology

Over one hundred potential enhancement projects have been identified that could assist in the sockeye rebuilding program or provide additional production. Many of the proposed projects focus on proven techniques that have relatively good possibilities for success. Other projects are experimental or unconventional and their effectiveness is not proven.

The Science Branch is in the process of developing long term research priorities for sockeye. Once this is done, greater details will be available on the proposed research program. The Task Force also encourages participation of University research on specific aspects of Fraser sockeye. If directed into the appropriate areas of research this could be of considerable benefit in answering some of the outstanding questions regarding Fraser sockeye.

## IMPLEMENTATION OF THE REBUILDING PLAN

The run sizes and catches projected from the rebuilding plan recommended in the previous sections assume average rates of return. They give an indication of the expected trend, not what will occur in specific years. Implementation of the plan must take into account the natural variations in run size, timing and stock composition which are characteristic of salmon. The plan must, therefore, be flexible to allow managers to respond on short notice to observed changes in the returns of the target stocks in a manner that maintains the momentum of the rebuilding program yet is fair to fishermen.

The overall objective is to increase spawning escapements to the interim goals as a means of improving production and catches. Although the strategy is to focus on target stocks, increases of all stocks contribute to the overall benefits. Implementation of the plan must, therefore, ensure that non-target stocks also have the opportunity to build.

### Recommended Approach

Two basic approaches to implementing the rebuilding plan were considered (Appendix 5). These include:

1. a strict adherence to the escapement schedule projected in the long term plan, and
2. an adjustable escapement schedule that varies with run size.

The second option is recommended since it is more flexible and allows for an adjustment of the escapement schedule in relation to the run size. The adjustment would be based on the required harvest rate on the target stock in the recommended option. If run size is much higher than average, the escapement goal would be increased proportionately, up to some predetermined maximum. Similarly, if returns are much lower than average, the escapement goal would be lowered proportionately down to a predetermined minimum. Fig. 13 illustrates this approach conceptually.

For each year, escapement goals would be initially based on pre-season expectations. These could be redefined during the fishing season to reflect actual estimates of the magnitude of returning stocks. To practically implement

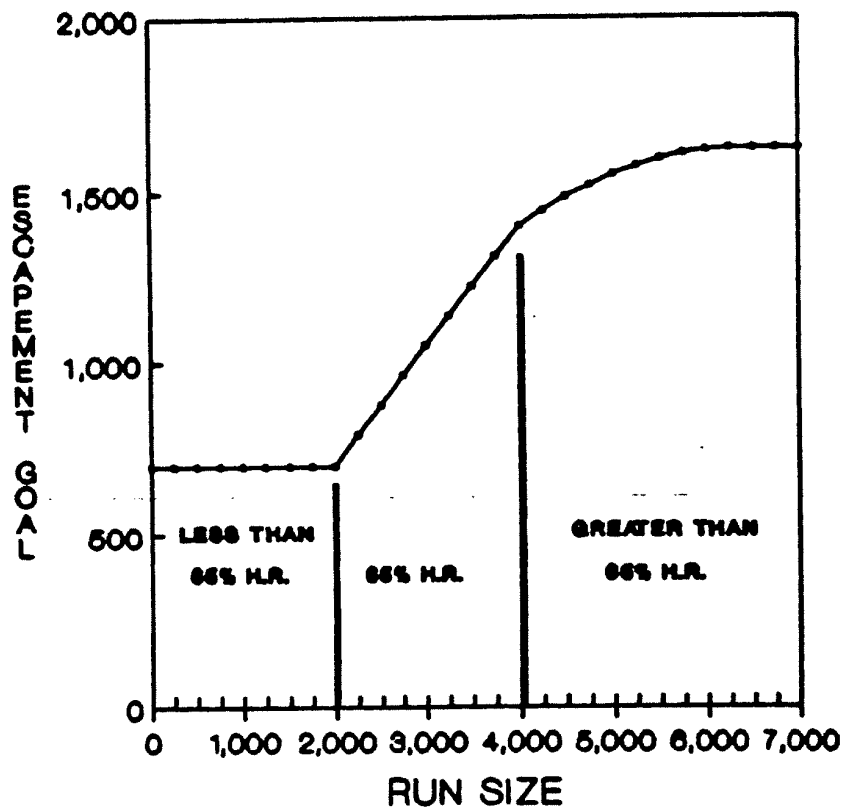


Figure 13. Conceptual relationship between run size, spawning escapement goals and exploitation rate for management of Fraser River sockeye.

this approach, the escapement goals would be stepped in relation to predetermined ranges in run size. A minimum and maximum escapement could be identified to put some bounds on the variation. The minimum could reflect current levels to ensure that we would not step backwards from where we are now. The maximum could reflect the interim goal. These bounds would only be altered if the harvest rate associated with them becomes unacceptable. For example, if the run was extremely large and the harvest rate necessary to achieve the interim goal was 90%, this could be viewed as being unacceptable for co-migrating stocks and species. To avoid this problem, harvest rates in mixed stock fisheries could be limited to a level considered acceptable for the other stocks and species. The remaining harvestable surplus of the target stocks could then be taken in more terminal areas. △

### Consequences of the Recommended Approach

With the recommended approach, the users and the resource share the costs and benefits associated with variability. In years of poor returns, the escapement goal and catch are lowered proportionately. In good years, the escapement goal is increased and the users receive higher catches. —B

Since acceptable harvest rates are the basis for the goals, this approach allows for the rebuilding of other sockeye stocks and other species. Since the status of the other stocks and species will also vary, the maximum acceptable harvest rate in the mixed stock fisheries needs to be evaluated annually.

Escapements surplus to the interim goals are anticipated on occasion with this approach. If the dominant stock returns at a much higher rate than average, the escapement goal would be limited to it's interim goal, until the point where harvest rates in mixed stock fisheries became unacceptably high for co-migrating stocks. In this case the escapement of the dominant stock could exceed the interim goal if selective harvest alternatives were unavailable. If the dominant stock returns at a lower than average rate, and the other stocks return at a higher rate, the escapements of some stocks may exceed their interim goals. —NO  
over

This has the effect of changing the rate of rebuilding compared to the recommended schedule in response to the variability in return rates. This is a positive aspect of this approach since it allows the rebuilding plan to take into account the long term cycles in salmon productivity.

### Surplus Escapements

Due to the variability in salmon production and the need to take co-migrating stocks into account while fishing in mixed stock areas, some escapements surplus to the interim goals can be expected. Adjustments to the allocation of catch between fishery areas and gear types may help to minimize such surpluses. Development of new opportunities for selective harvest could take advantage of some of the surplus.

Dealing with surpluses will be quite stock specific because of differences in migratory behaviour and the geographical location of spawning areas. Surpluses may be useful for testing the interim goals and the habitat capacity estimates. Although the interim goals are based on the best available information, there is still much uncertainty associated with them. By allowing escapements to exceed

*fishery data*

these goals and observing the response, we can achieve a better understanding of the limitations to production in specific systems.

However, in cases where it has been demonstrated that escapements over a certain level are disadvantageous and actually risk future production, terminal harvests could be implemented. Since it is assumed that the return rate difference is due to the variability in survival and not a true difference in average productivity of the stocks, these opportunities for terminal fisheries will occur randomly. The surpluses will not be consistent. Therefore, these fisheries would have to operate in response to the available abundance and locations.

#### Summary

It is recognized that it is unlikely that the escapement schedule as projected in the long term plan will be followed exactly because of the variability in returns for each of the stocks. Some stocks will proceed ahead of schedule and others will fall behind. A major management objective will be to keep harvest rates in the mixed stock fisheries near the levels required by the plan so that there is an opportunity for all stocks and species to rebuild. Consequently, the recommended approach to implementing the plan is to have flexible escapement goals (within specified bounds) based on actual returns.

Managers should manipulate fisheries by focussing on the target stocks but trying to provide relief for other stocks where necessary, if opportunities arise. This may involve adjustments to the current allocations, dislocation of some fisheries and creation of new harvest opportunities. In addition, in some cases it could result in escapements exceeding the interim goals which would provide opportunities to test the interim goals or to harvest terminally. Since user groups will be directly affected by these decisions, consultation is necessary to develop the details of the implementation plan.

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Appendix 1. Fraser River sockeye catches, by major fishery areas for the years 1953 to 1988.

YEARS	JOHNSTONE STRAIT (A11-16)	STRAIT OF JUAN DE FUCA (AREA 20)	FRASER RIVER (AREA 29)	WEST COAST TROLL (A21-27)	NORTH COAST (A1-11)	CANADIAN COMMERCIAL TOTAL FISHERY	INDIAN FOOD	CANADA TOTAL	U.S.	TOTAL COMMERCIAL	GRAND TOTAL	NET ESCAPEMENT	TOT R
1953	422,000	658,000	1,335,000	2,000	0	2,417,000	113,000	2,530,000	2,032,000	4,449,000	4,562,000	1,295,000	5,854,000
1954	124,000	1,706,000	3,003,000	21,000	0	4,854,000	95,000	4,949,000	4,806,000	9,660,000	9,755,000	2,448,000	12,198,000
1955	158,000	578,000	529,000	4,000	0	1,269,000	66,000	1,335,000	1,007,000	2,276,000	2,342,000	383,000	2,747,000
1956	127,000	310,000	584,000	1,000	0	1,022,000	65,000	1,087,000	907,000	1,929,000	1,994,000	873,000	2,867,000
1957	588,000	707,000	652,000	7,000	0	1,954,000	97,000	2,051,000	1,689,000	3,643,000	3,740,000	1,662,000	5,401,000
1958	4,312,000	2,833,000	2,404,000	24,000	0	9,573,000	83,000	9,656,000	5,257,000	14,830,000	14,913,000	3,867,000	18,779,000
1959	354,000	598,000	960,000	34,000	0	1,946,000	65,000	2,011,000	1,810,000	3,756,000	3,821,000	949,000	4,770,000
1960	231,000	543,000	710,000	6,000	0	1,490,000	84,000	1,574,000	1,199,000	2,689,000	2,773,000	628,000	3,421,000
1961	583,000	627,000	723,000	15,000	0	1,948,000	137,000	2,085,000	1,378,000	3,326,000	3,463,000	1,250,000	4,714,000
1962	141,000	295,000	536,000	21,000	0	993,000	137,000	1,130,000	759,000	1,752,000	1,889,000	1,624,000	3,512,000
1963	189,000	146,000	536,000	8,000	0	879,000	190,000	1,069,000	1,314,000	2,193,000	2,383,000	1,602,000	3,985,000
1964	97,000	35,000	477,000	10,000	0	619,000	146,000	765,000	508,000	1,127,000	1,273,000	426,000	1,825,000
1965	125,000	165,000	865,000	16,000	0	1,171,000	121,000	1,292,000	1,026,000	2,197,000	2,318,000	852,000	3,167,000
1966	677,000	698,000	631,000	43,000	0	2,049,000	154,000	2,203,000	1,337,000	3,386,000	3,540,000	1,919,000	5,460,000
1967	1,296,000	855,000	882,000	224,000	0	3,257,000	107,000	3,364,000	2,087,000	5,344,000	5,451,000	1,354,000	6,804,000
1968	369,000	56,000	827,000	75,000	0	1,327,000	124,000	1,451,000	882,000	2,209,000	2,333,000	627,000	2,956,000
1969	444,000	628,000	986,000	151,000	0	2,209,000	159,000	2,368,000	1,575,000	3,784,000	3,943,000	1,007,000	4,941,000
1970	1,017,000	830,000	568,000	305,000	0	2,720,000	151,000	2,871,000	1,350,000	4,070,000	4,221,000	1,943,000	6,164,000
1971	543,000	1,549,000	1,378,000	585,000	0	4,055,000	154,000	4,209,000	2,750,000	6,805,000	6,959,000	748,000	7,596,000
1972	530,000	543,000	526,000	29,000	0	1,628,000	135,000	1,763,000	1,124,000	2,752,000	2,887,000	830,000	3,598,000
1973	331,000	1,426,000	1,100,000	129,000	0	2,986,000	164,000	3,150,000	2,560,000	5,546,000	5,710,000	1,181,000	6,791,000
1974	1,209,000	1,219,000	934,000	823,000	0	4,185,000	222,000	4,407,000	2,460,000	6,645,000	6,867,000	1,757,000	8,516,000
1975	130,000	87,000	530,000	132,000	0	879,000	253,000	1,132,000	1,556,000	2,435,000	2,688,000	991,000	3,684,000
1976	495,000	686,000	669,000	150,000	0	2,000,000	233,000	2,233,000	1,320,000	3,320,000	3,553,000	823,000	4,358,000
1977	728,000	626,000	1,313,000	67,000	0	2,734,000	244,000	2,978,000	1,730,000	4,464,000	4,708,000	1,113,000	5,779,000
1978	3,447,000	568,000	596,000	712,000	0	5,323,000	238,000	5,561,000	1,360,000	6,683,000	6,921,000	2,514,000	9,433,000
1979	1,010,000	329,000	1,101,000	331,000	194,000	2,965,000	292,000	3,257,000	1,769,000	4,734,000	5,026,000	1,408,000	6,427,000
1980	1,062,000	123,000	326,000	20,000	79,000	1,610,000	217,000	1,827,000	465,000	2,075,000	2,292,000	848,000	3,103,000
1981	3,271,000	291,000	852,000	42,000	92,000	4,548,000	460,000	5,008,000	1,293,000	5,841,000	6,301,000	1,443,000	7,722,000
1982	1,806,000	1,684,000	862,000	2,185,000	107,000	6,644,000	430,000	7,074,000	2,863,000	9,507,000	9,937,000	4,024,000	13,966,000
1983	2,547,000	15,000	557,000	35,000	270,000	3,424,000	362,000	3,786,000	464,000	3,888,000	4,250,000	976,000	5,222,000
1984	1,268,000	567,000	895,000	44,000	100,000	2,874,000	356,000	3,230,000	1,640,000	4,514,000	4,870,000	932,000	5,896,000
1985	3,149,000	2,762,000	1,311,000	990,000	83,000	8,295,000	441,000	8,736,000	2,925,000	11,220,000	11,661,000	2,139,000	13,875,000
1986	2,195,000	2,003,000	2,535,000	1,816,000	37,000	8,586,000	555,000	9,141,000	2,746,000	11,332,000	11,887,000	3,717,000	15,898,000
1987	1,572,000	463,000	600,000	485,000	79,000	3,199,000	503,000	3,702,000	1,942,000	5,141,000	5,644,000	1,913,000	7,650,000
1988	135,000	229,000	708,000	43,000	2,000	1,117,000	419,000	1,536,000	676,000	1,793,000	2,212,000	1,418,000	3,769,000

HISTORICAL PERSPECTIVE (1953 - 1988)

12 YEAR  
AVERAGES

1953-1964	611,000	753,000	1,037,000	13,000	0	2,414,000	107,000	2,520,000	1,889,000	4,303,000	4,409,000	1,417,000	5,839,000
1965-1976	597,000	729,000	825,000	222,000	0	2,372,000	165,000	2,537,000	1,669,000	4,041,000	4,206,000	1,169,000	5,369,000
1977-1988	1,849,000	805,000	971,000	564,000	87,000	4,277,000	376,000	4,653,000	1,656,000	5,933,000	6,309,000	1,870,000	7,722,000

Notes: 1. For some years small test fishing, recreational and on-route losses have not been included.

Notes: 2. Small catches of non-Fraser sockeye included in some figures. In addition, some figures are preliminary.



Appendix 2. Production of Fraser River sockeye for separate stocks and all stocks combined.

FRASER RIVER (TOTAL) SOCKEYE

ALL YEARS				1984 CYCLE YEAR				1985 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner	Brood Year	Adult Escapement	Total Return	Return Per Spawner	Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	966,557	3,278,908	3.39	1948	966,557	3,278,908	3.39	1949	1,066,120	5,019,371	4.71
1949	1,066,120	5,019,371	4.71	1952	793,603	2,694,958	3.40	1953	1,058,917	4,614,668	4.36
1950	1,737,559	12,829,594	7.38	1956	858,398	3,475,179	4.05	1957	1,340,150	4,415,267	3.29
1951	564,250	2,922,620	5.18	1960	620,915	1,713,845	2.76	1961	1,160,439	3,121,160	2.69
1952	793,603	2,694,958	3.40	1964	388,300	3,206,742	8.26	1965	774,253	4,406,026	5.69
1953	1,058,917	4,614,668	4.36	1968	592,773	3,644,628	6.15	1969	923,071	6,994,997	7.58
1954	2,415,020	19,598,497	8.12	1972	760,641	4,323,183	5.68	1973	1,044,355	5,604,080	5.37
1955	361,443	4,689,641	12.97	1976	781,040	3,243,859	4.15	1977	1,014,014	7,648,192	7.54
1956	858,398	3,475,179	4.05	1980	829,754	5,294,354	6.38	1981	1,384,102	13,560,816	9.80
1957	1,340,150	4,415,267	3.29	1984	922,059			1985	2,077,686		
1958	3,822,300	3,696,304	0.97	=====				=====			
1959	927,364	4,030,988	4.35	AVG:	751,404	3,430,628	4.63 (GM)	AVG:	1,184,311	6,153,842	5.27 (GM)
1960	620,915	1,713,845	2.76	MAX:	966,557	5,294,354	8.26	MAX:	2,077,686	13,560,816	9.80
1961	1,160,439	3,121,160	2.69	MIN:	388,300	1,713,845	2.76	MIN:	774,253	3,121,160	2.69
1962	1,575,446	5,380,035	3.41								
1963	1,577,943	6,879,196	4.36	1986 CYCLE YEAR				1987 CYCLE YEAR			
1964	388,300	3,206,742	8.26								
1965	774,253	4,406,026	5.69								
1966	1,797,994	6,387,909	3.55								
1967	1,331,836	7,679,145	5.77								
1968	592,773	3,644,628	6.15								
1969	923,071	6,994,997	7.58								
1970	1,860,400	8,494,129	4.57								
1971	719,639	3,814,409	5.30								
1972	760,641	4,323,183	5.68								
1973	1,044,355	5,604,080	5.37								
1974	1,656,552	9,952,207	6.01								
1975	920,793	6,194,389	6.73								
1976	781,040	3,243,859	4.15								
1977	1,014,014	7,648,192	7.54								
1978	2,484,805	14,420,431	5.80								
1979	1,368,139	5,013,251	3.66								
1980	829,754	5,294,354	6.38								
1981	1,384,102	13,560,816	9.80								
1982	4,007,720	15,040,100	3.75								
1983	964,917										
1984	922,059										
1985	2,077,686										
=====											
AVG:	1,301,349	6,379,517	4.88 (GM)								
MAX:	4,007,720	19,598,497	12.97								
MIN:	361,443	1,713,845	0.97								

03-Feb-88

CULTUS LAKE SOCKEYE

ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	12,746	76,559	6.01
1949	9,055	97,875	10.81
1950	29,928	278,991	9.32
1951	12,677	207,031	16.33
1952	17,833	67,147	3.77
1953	11,543	114,272	9.90
1954	22,036	127,133	5.77
1955	25,922	397,965	15.35
1956	13,718	37,285	2.72
1957	20,375	28,920	1.42
1958	13,324	71,552	5.37
1959	47,779	82,109	1.72
1960	17,640	41,009	2.32
1961	13,396	13,083	0.98
1962	26,997	60,111	2.23
1963	20,303	322,265	15.87
1964	11,067	75,808	6.85
1965	2,455	32,600	13.28
1966	16,919	133,772	7.91
1967	33,198	150,058	4.52
1968	25,314	54,800	2.16
1969	5,942	7,963	1.34
1970	13,941	44,807	3.21
1971	9,128	49,467	5.42
1972	10,366	31,462	3.04
1973	641	749	1.17
1974	8,984	29,917	3.33
1975	11,349	115,787	10.20
1976	4,435	6,129	1.38
1977	82	1,571	19.16
1978	5,076	49,624	9.78
1979	32,031	97,737	3.05
1980	1,657	11,667	7.04
1981	256	1,336	5.22
1982	16,725		
1983	19,944		
1984	994		
1985	424		

AVG: 14,374 85,840 4.66 (GN)  
 MAX: 47,779 397,965 19.16  
 MIN: 82 749 0.98

1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	12,746	76,559	6.01
1952	17,833	67,147	3.77
1956	13,718	37,285	2.72
1960	17,640	41,009	2.32
1964	11,067	75,808	6.85
1968	25,314	54,800	2.16
1972	10,366	31,462	3.04
1976	4,435	6,129	1.38
1980	1,657	11,667	7.04
1984	994		
=====			
AVG:	11,577	44,652	3.41 (GN)
MAX:	25,314	76,559	7.04
MIN:	994	6,129	1.38

1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	29,928	278,991	9.32
1954	22,036	127,133	5.77
1958	13,324	71,552	5.37
1962	26,997	60,111	2.23
1966	16,919	133,772	7.91
1970	13,941	44,807	3.21
1974	8,984	29,917	3.33
1978	5,076	49,624	9.78
1982	16,725		
=====			
AVG:	17,103	99,488	5.20 (GN)
MAX:	29,928	278,991	9.78
MIN:	5,076	29,917	2.23

1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	9,055	97,875	10.81
1953	11,543	114,272	9.90
1957	20,375	28,920	1.42
1961	13,396	13,083	0.98
1965	2,455	32,600	13.28
1969	5,942	7,963	1.34
1973	641	749	1.17
1977	82	1,571	19.16
1981	256	1,336	5.22
1985	424		
=====			
AVG:	6,417	33,152	4.07 (GN)
MAX:	20,375	114,272	19.16
MIN:	82	749	0.98

1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	12,677	207,031	16.33
1955	25,922	397,965	15.35
1959	47,779	82,109	1.72
1963	20,303	322,265	15.87
1967	33,198	150,058	4.52
1971	9,128	49,467	5.42
1975	11,349	115,787	10.20
1979	32,031	97,737	3.05
1983	19,944		
=====			
AVG:	23,592	177,802	6.91 (GN)
MAX:	47,779	397,965	16.33
MIN:	9,128	49,467	1.72

UPPER PITT RIVER SOCKEYE

ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	55,380	122,720	2.22
1949	9,290	20,778	2.24
1950	40,061	146,337	3.65
1951	37,837	120,302	3.18
1952	48,899	72,178	1.48
1953	18,673	25,807	1.38
1954	17,624	51,094	2.90
1955	17,950	166,937	9.30
1956	32,094	70,323	2.19
1957	12,335	29,207	2.37
1958	10,381	16,535	1.59
1959	15,731	62,493	3.97
1960	24,510	33,314	1.36
1961	11,158	103,035	9.23
1962	16,580	57,275	3.45
1963	12,680	142,935	11.27
1964	13,756	192,094	13.96
1965	6,966	38,984	5.60
1966	20,842	77,701	3.73
1967	10,282	67,780	6.59
1968	16,988	105,588	6.22
1969	25,073	61,083	2.44
1970	6,642	55,398	8.34
1971	15,452	217,474	14.07
1972	13,412	138,157	10.30
1973	11,895	43,163	3.63
1974	20,581	118,137	5.74
1975	39,920	65,701	1.65
1976	36,525	105,700	2.89
1977	13,852	26,137	1.89
1978	24,786	30,643	1.24
1979	37,542	29,312	0.78
1980	17,101	17,974	1.05
1981	25,327	2,416	0.10
1982	8,708		
1983	16,852		
1984	15,797		
1985	3,560		

AVG: 20,606 77,492 3.06 (GM)  
 MAX: 55,380 217,474 14.07  
 MIN: 3,560 2,416 0.10

1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	55,380	122,720	2.22
1952	48,899	72,178	1.48
1956	32,094	70,323	2.19
1960	24,510	33,314	1.36
1964	13,756	192,094	13.96
1968	16,988	105,588	6.22
1972	13,412	138,157	10.30
1976	36,525	105,700	2.89
1980	17,101	17,974	1.05
1984	15,797		

AVG: 27,446 95,339 3.10 (GM)  
 MAX: 55,380 192,094 13.96  
 MIN: 13,412 17,974 1.05

1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	40,061	146,337	3.65
1954	17,624	51,094	2.90
1958	10,381	16,535	1.59
1962	16,580	57,275	3.45
1966	20,842	77,701	3.73
1970	6,642	55,398	8.34
1974	20,581	118,137	5.74
1978	24,786	30,643	1.24
1982	8,708		

AVG: 18,467 69,140 3.26 (GM)  
 MAX: 40,061 146,337 8.34  
 MIN: 6,642 16,535 1.24

1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	9,290	20,778	2.24
1953	18,673	25,807	1.38
1957	12,335	29,207	2.37
1961	11,158	103,035	9.23
1965	6,966	38,984	5.60
1969	25,073	61,083	2.44
1973	11,895	43,163	3.63
1977	13,852	26,137	1.89
1981	25,327	2,416	0.10
1985	3,560		

AVG: 13,813 38,957 2.04 (GM)  
 MAX: 25,327 103,035 9.23  
 MIN: 3,560 2,416 0.10

1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	37,837	120,302	3.18
1955	17,950	166,937	9.30
1959	15,731	62,493	3.97
1963	12,680	142,935	11.27
1967	10,282	67,780	6.59
1971	15,452	217,474	14.07
1975	39,920	65,701	1.65
1979	37,542	29,312	0.78
1983	16,852		

AVG: 22,694 109,117 4.46 (GM)  
 MAX: 39,920 217,474 14.07  
 MIN: 10,282 29,312 0.78

# BIRKENHEAD RIVER SOCKEYE

## ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	83,787	206,696	2.47
1949	70,504	308,662	4.38
1950	64,440	242,740	3.77
1951	21,296	216,719	10.18
1952	47,041	244,678	5.20
1953	42,491	156,143	3.67
1954	18,213	175,704	9.65
1955	14,553	280,383	19.27
1956	49,754	279,109	5.61
1957	14,536	75,666	5.21
1958	15,166	130,934	8.63
1959	26,159	268,572	10.27
1960	36,838	168,936	4.59
1961	31,681	131,851	4.16
1962	26,369	103,783	3.94
1963	48,893	455,775	9.32
1964	48,908	365,993	7.48
1965	16,230	163,901	10.10
1966	20,116	317,710	15.79
1967	39,876	492,216	12.34
1968	57,947	285,925	4.93
1969	37,382	791,710	21.18
1970	30,656	736,305	24.02
1971	24,629	371,401	15.08
1972	54,516	515,310	9.45
1973	56,653	328,391	5.80
1974	119,637	918,986	7.68
1975	61,538	127,367	2.07
1976	77,305	632,531	8.18
1977	23,845	460,202	19.30
1978	94,782	776,704	8.19
1979	60,988	511,892	8.39
1980	78,613	170,015	2.16
1981	49,023	109,423	2.23
1982	119,738	1,231,700	10.29
1983	44,029		
1984	38,644		
1985	11,905		

AVG: 46,807 364,401 7.12 (GM)  
 MAX: 119,738 1,231,700 24.02  
 MIN: 11,905 75,666 2.07

## 1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	83,787	206,696	2.47
1952	47,041	244,678	5.20
1956	49,754	279,109	5.61
1960	36,838	168,936	4.59
1964	48,908	365,993	7.48
1968	57,947	285,925	4.93
1972	54,516	515,310	9.45
1976	77,305	632,531	8.18
1980	78,613	170,015	2.16
1984	38,644		
AVG:	57,335	318,799	5.02 (GM)
MAX:	83,787	632,531	9.45
MIN:	36,838	168,936	2.16

## 1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	70,504	308,662	4.38
1953	42,491	156,143	3.67
1957	14,536	75,666	5.21
1961	31,681	131,851	4.16
1965	16,230	163,901	10.10
1969	37,382	791,710	21.18
1973	56,653	328,391	5.80
1977	23,845	460,202	19.30
1981	49,023	109,423	2.23
1985	11,905		
AVG:	35,425	280,661	6.42 (GM)
MAX:	70,504	791,710	21.18
MIN:	11,905	75,666	2.23

## 1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	64,440	242,740	3.77
1954	18,213	175,704	9.65
1958	15,166	130,934	8.63
1962	26,369	103,783	3.94
1966	20,116	317,710	15.79
1970	30,656	736,305	24.02
1974	119,637	918,986	7.68
1978	94,782	776,704	8.19
1982	119,738	1,231,700	10.29
AVG:	56,569	514,952	8.76 (GM)
MAX:	119,738	1,231,700	24.02
MIN:	15,166	103,783	3.77

## 1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	21,296	216,719	10.18
1955	14,553	280,383	19.27
1959	26,159	268,572	10.27
1963	48,893	455,775	9.32
1967	39,876	492,216	12.34
1971	24,629	371,401	15.08
1975	61,538	127,367	2.07
1979	60,988	511,892	8.39
1983	44,029		
AVG:	37,996	340,541	9.39 (GM)
MAX:	61,538	511,892	19.27
MIN:	14,553	127,367	2.07

# HARRISON RIVER SOCKEYE

## ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	26,162	43,283	1.65
1949	8,000	37,073	4.63
1950	33,044	78,099	2.36
1951	17,145	122,022	7.12
1952	25,794	23,054	0.89
1953	21,030	9,784	0.47
1954	28,800	14,797	0.51
1955	5,595	141,038	25.21
1956	2,586	96,972	37.50
1957	3,793	60,554	15.96
1958	14,701	59,892	4.07
1959	27,868	41,545	1.49
1960	17,210	29,451	1.71
1961	42,773	13,225	0.31
1962	8,162	50,812	6.23
1963	22,258	87,825	3.95
1964	2,202	51,204	23.25
1965	15,034	20,432	1.36
1966	32,646	55,444	1.70
1967	20,548	50,935	2.48
1968	5,379	17,838	3.32
1969	14,959	7,302	0.49
1970	12,666	39,763	3.14
1971	3,790	84,459	22.28
1972	1,346	1,963	1.46
1973	3,060	34,273	11.20
1974	16,920	61,696	3.65
1975	5,987	79,412	13.26
1976	5,130	24,781	4.83
1977	2,246	24,058	10.71
1978	19,717	31,658	1.61
1979	45,615	15,910	0.35
1980	5,092	8,542	1.68
1981	3,193	31,673	9.92
1982	9,189	4,275	0.47
1983	4,239		
1984	1,267		
1985			

=====

AVG:	14,463	44,430	3.05 (GM)
MAX:	45,615	141,038	37.50
MIN:	1,267	1,963	0.31

## 1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	26,162	43,283	1.65
1952	25,794	23,054	0.89
1956	2,586	96,972	37.50
1960	17,210	29,451	1.71
1964	2,202	51,204	23.25
1968	5,379	17,838	3.32
1972	1,346	1,963	1.46
1976	5,130	24,781	4.83
1980	5,092	8,542	1.68
1984	1,267		
=====			
AVG:	9,217	33,010	3.54 (GM)
MAX:	26,162	96,972	37.50
MIN:	1,267	1,963	0.89

## 1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	33,044	78,099	2.36
1954	28,800	14,797	0.51
1958	14,701	59,892	4.07
1962	8,162	50,812	6.23
1966	32,646	55,444	1.70
1970	12,666	39,763	3.14
1974	16,920	61,696	3.65
1978	19,717	31,658	1.61
1982	9,189	4,275	0.47
=====			
AVG:	19,538	44,048	1.97 (GM)
MAX:	33,044	78,099	6.23
MIN:	8,162	4,275	0.47

## 1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	8,000	37,073	4.63
1953	21,030	9,784	0.47
1957	3,793	60,554	15.96
1961	42,773	13,225	0.31
1965	15,034	20,432	1.36
1969	14,959	7,302	0.49
1973	3,060	34,273	11.20
1977	2,246	24,058	10.71
1981	3,193	31,673	9.92
1985			
=====			
AVG:	12,676	26,486	2.73 (GM)
MAX:	42,773	60,554	15.96
MIN:	2,246	7,302	0.31

## 1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	17,145	122,022	7.12
1955	5,595	141,038	25.21
1959	27,868	41,545	1.49
1963	22,258	87,825	3.95
1967	20,548	50,935	2.48
1971	3,790	84,459	22.28
1975	5,987	79,412	13.26
1979	45,615	15,910	0.35
1983	4,239		
=====			
AVG:	17,005	77,893	4.77 (GM)
MAX:	45,615	141,038	25.21
MIN:	3,790	15,910	0.35

# WEAVER CREEK SOCKEYE

## ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	19,431	131,635	6.77
1949	12,725	55,002	4.32
1950	30,539	184,157	6.03
1951	12,856	117,511	9.14
1952	28,050	11,006	0.39
1953	8,789	218,207	24.83
1954	28,137	235,297	8.36
1955	21,636	72,848	3.37
1956	8,690	21,608	2.49
1957	20,237	8,842	0.44
1958	35,939	31,072	0.86
1959	8,363	39,259	4.69
1960	7,033	4,623	0.66
1961	4,246	57,809	13.61
1962	15,924	47,938	3.01
1963	14,469	166,479	11.51
1964	1,196	25,040	20.94
1965	17,924	205,659	11.47
1966	19,489	76,161	3.91
1967	22,581	88,405	3.92
1968	3,799	155,396	40.90
1969	58,727	412,913	7.03
1970	10,435	384,038	36.80
1971	4,990	155,255	31.11
1972	25,738	342,374	13.30
1973	48,541	355,612	7.33
1974	64,093	276,337	4.31
1975	29,736	145,953	4.91
1976	49,932	304,515	6.10
1977	52,627	234,642	4.46
1978	75,171	1,123,838	14.95
1979	45,026	175,741	3.90
1980	73,830	401,627	5.44
1981	42,002	209,727	4.99
1982	294,083	815,200	2.77
1983	39,341		
1984	59,602		
1985	36,545		

AVG: 35,591 208,335 5.63 (GM)  
 MAX: 294,083 1,123,838 40.90  
 MIN: 1,196 4,623 0.39

## 1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	19,431	131,635	6.77
1952	28,050	11,006	0.39
1956	8,690	21,608	2.49
1960	7,033	4,623	0.66
1964	1,196	25,040	20.94
1968	3,799	155,396	40.90
1972	25,738	342,374	13.30
1976	49,932	304,515	6.10
1980	73,830	401,627	5.44
1984	59,602		
AVG:	27,730	155,314	4.90 (GM)
MAX:	73,830	401,627	40.90
MIN:	1,196	4,623	0.39

## 1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	30,539	184,157	6.03
1954	28,137	235,297	8.36
1958	35,939	31,072	0.86
1962	15,924	47,938	3.01
1966	19,489	76,161	3.91
1970	10,435	384,038	36.80
1974	64,093	276,337	4.31
1978	75,171	1,123,838	14.95
1982	294,083	815,200	2.77
AVG:	63,757	352,671	5.31 (GM)
MAX:	294,083	1,123,838	36.80
MIN:	10,435	31,072	0.86

## 1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	12,725	55,002	4.32
1953	8,789	218,207	24.83
1957	20,237	8,842	0.44
1961	4,246	57,809	13.61
1965	17,924	205,659	11.47
1969	58,727	412,913	7.03
1973	48,541	355,612	7.33
1977	52,627	234,642	4.46
1981	42,002	209,727	4.99
1985	36,545		
AVG:	30,236	195,379	5.88 (GM)
MAX:	58,727	412,913	24.83
MIN:	4,246	8,842	0.44

## 1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	12,856	117,511	9.14
1955	21,636	72,848	3.37
1959	8,363	39,259	4.69
1963	14,469	166,479	11.51
1967	22,581	88,405	3.92
1971	4,990	155,255	31.11
1975	29,736	145,953	4.91
1979	45,026	175,741	3.90
1983	39,341		
AVG:	22,111	120,181	6.66 (GM)
MAX:	45,026	175,741	31.11
MIN:	4,990	39,259	3.37

GATES CREEK SOCKEYE

ALL YEARS

1984 CYCLE YEAR

1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948		30,026	
1949		590	
1950		300	
1951		623	
1952	7,070	38,000	5.37
1953	74	7,885	106.55
1954	45	698	15.51
1955	77	2,505	32.53
1956	7,807	15,990	2.05
1957	891	1,163	1.31
1958	61	441	7.23
1959	582	10,655	18.31
1960	5,413	84,049	15.53
1961	248	14,706	59.30
1962	159	524	3.30
1963	4,113	7,648	1.86
1964	19,396	105,060	5.42
1965	1,642	3,087	1.88
1966	65	936	14.40
1967	1,138	6,661	5.85
1968	10,113	82,525	8.16
1969	777	5,001	6.44
1970	78	580	7.44
1971	426	12,647	29.69
1972	8,323	132,617	15.93
1973	795	12,525	15.75
1974	70	1,992	28.46
1975	1,982	22,413	11.31
1976	17,133	73,413	4.28
1977	2,582	21,804	8.44
1978	258	1,806	7.00
1979	3,828	17,860	4.67
1980	25,088	81,226	3.24
1981	4,670	14,931	3.20
1982	930		
1983	7,784		
1984	28,801		
1985	4,578		

AVG: 4,912 23,908 8.42 (GM)  
 MAX: 28,801 132,617 106.55  
 MIN: 45 300 1.31

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948		30,026	
1952	7,070	38,000	5.37
1956	7,807	15,990	2.05
1960	5,413	84,049	15.53
1964	19,396	105,060	5.42
1968	10,113	82,525	8.16
1972	8,323	132,617	15.93
1976	17,133	73,413	4.28
1980	25,088	81,226	3.24
1984	28,801		

AVG: 14,349 71,434 6.00 (GM)  
 MAX: 28,801 132,617 15.93  
 MIN: 5,413 15,990 2.05

1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950		300	
1954	45	698	15.51
1958	61	441	7.23
1962	159	524	3.30
1966	65	936	14.40
1970	78	580	7.44
1974	70	1,992	28.46
1978	258	1,806	7.00
1982	930		

AVG: 208 910 9.67 (GM)  
 MAX: 930 1,992 28.46  
 MIN: 45 300 3.30

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949		590	
1953	74	7,885	106.55
1957	891	1,163	1.31
1961	248	14,706	59.30
1965	1,642	3,087	1.88
1969	777	5,001	6.44
1973	795	12,525	15.75
1977	2,582	21,804	8.44
1981	4,670	14,931	3.20
1985	4,578		

AVG: 1,806 9,077 8.98 (GM)  
 MAX: 4,670 21,804 106.55  
 MIN: 74 590 1.31

1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951		623	
1955	77	2,505	32.53
1959	582	10,655	18.31
1963	4,113	7,648	1.86
1967	1,138	6,661	5.85
1971	426	12,647	29.69
1975	1,982	22,413	11.31
1979	3,828	17,860	4.67
1983	7,784		

AVG: 2,491 10,127 10.02 (GM)  
 MAX: 7,784 22,413 32.53  
 MIN: 77 623 1.86

PORTAGE CREEK SOCKEYE

ALL YEARS				1984 CYCLE YEAR				1985 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner	Brood Year	Adult Escapement	Total Return	Return Per Spawner	Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948				1948				1949			
1949				1952				1953	50	394	7.88
1950				1956				1957	40	47	1.18
1951	29	244	8.41	1960		624	69.33	1961	23	2,723	118.39
1952				1964	9	1,046	12.16	1965	981	3,463	3.53
1953	50	394	7.88	1968	86	15,283	80.44	1969	963	34,612	35.94
1954	3,369	38,700	11.49	1972	190	8,042	7.72	1973	3,963	68,692	17.33
1955	41	4,392	107.12	1976	1,042	14,340	7.97	1977	7,610	39,710	5.22
1956				1980	1,800			1981	5,755	16,077	2.79
1957	40	47	1.18	1984	1,701			1985	1,703		
1958	4,736	25,645	5.41	AVG:	805	7,867	21.09 (GM)	AVG:	2,343	20,715	8.77 (GM)
1959	572	5,565	9.73	MAX:	1,800	15,283	80.44	MAX:	7,610	68,692	118.39
1960				MIN:	9	624	7.72	MIN:	23	47	1.18
1961	23	2,723	118.39	1986 CYCLE YEAR				1987 CYCLE YEAR			
1962	11,935	72,180	6.05	Brood Year	Adult Escapement	Total Return	Return Per Spawner	Brood Year	Adult Escapement	Total Return	Return Per Spawner
1963	2,011	58,437	29.06	1950				1951	29	244	8.41
1964	9	624	69.33	1954	3,369	38,700	11.49	1955	41	4,392	107.12
1965	981	3,463	3.53	1958	4,736	25,645	5.41	1959	572	5,565	9.73
1966	31,343	31,339	1.00	1962	11,935	72,180	6.05	1963	2,011	58,437	29.06
1967	4,025	4,286	1.06	1966	31,343	31,339	1.00	1967	4,025	4,286	1.06
1968	86	1,046	12.16	1970	3,873	58,068	14.99	1971	281	18,043	64.21
1969	963	34,612	35.94	1974	8,475	41,580	4.91	1975	3,175	13,549	4.27
1970	3,873	58,068	14.99	1978	9,978	81,592	8.18	1979	3,575	65,073	18.20
1971	281	18,043	64.21	1982	23,867			1983	7,747		
1972	190	15,283	80.44	AVG:	12,197	49,872	5.82 (GM)	AVG:	2,384	21,199	13.85 (GM)
1973	3,963	68,692	17.33	MAX:	31,343	81,592	14.99	MAX:	7,747	65,073	107.12
1974	8,475	41,580	4.91	MIN:	3,369	25,645	1.00	MIN:	29	244	1.06
1975	3,175	13,549	4.27								
1976	1,042	8,042	7.72								
1977	7,610	39,710	5.22								
1978	9,978	81,592	8.18								
1979	3,575	65,073	18.20								
1980	1,800	14,340	7.97								
1981	5,755	16,077	2.79								
1982	23,867										
1983	7,747										
1984	1,701										
1985	1,703										
AVG:	4,530	25,848	10.55 (GM)								
MAX:	31,343	81,592	118.39								
MIN:	9	47	1.00								

Note - Includes Seton Creek and Bridge River.



# SEYHOUR RIVER SOCKEYE

## ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	3,889	29,658	7.63
1949	10,772	34,705	3.22
1950	11,049	162,026	14.66
1951	24,320	68,943	2.83
1952	5,963	11,249	1.89
1953	5,692	45,268	7.95
1954	24,774	461,522	18.63
1955	8,971	310,002	34.56
1956	2,490	12,763	5.13
1957	10,870	24,583	2.26
1958	78,371	195,518	2.49
1959	52,310	175,980	3.36
1960	2,902	8,837	3.05
1961	3,622	32,923	9.09
1962	57,836	176,546	3.05
1963	71,654	114,086	1.59
1964	2,745	18,498	6.74
1965	6,089	34,890	5.73
1966	28,698	141,828	4.94
1967	13,361	220,851	16.53
1968	3,838	22,108	5.76
1969	7,176	14,875	2.07
1970	11,971	226,369	18.91
1971	19,028	135,310	7.11
1972	2,802	58,719	20.96
1973	2,704	25,180	9.31
1974	44,588	181,851	4.08
1975	36,828	217,930	5.92
1976	8,306	22,250	2.68
1977	5,709	57,930	10.15
1978	62,808	227,078	3.62
1979	49,306	106,629	2.16
1980	8,309	45,768	5.51
1981	11,359	26,268	2.31
1982	63,271		
1983	29,831		
1984	17,172		
1985	5,620		

AVG: 21,500 107,322 5.41 (GM)  
 MAX: 78,371 461,522 34.56  
 MIN: 2,490 8,837 1.59

## 1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	3,889	29,658	7.63
1952	5,963	11,249	1.89
1956	2,490	12,763	5.13
1960	2,902	8,837	3.05
1964	2,745	18,498	6.74
1968	3,838	22,108	5.76
1972	2,802	58,719	20.96
1976	8,306	22,250	2.68
1980	8,309	45,768	5.51
1984	17,172		
AVG:	5,842	25,539	5.18 (GM)
MAX:	17,172	58,719	20.96
MIN:	2,490	8,837	1.89

## 1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	11,049	162,026	14.66
1954	24,774	461,522	18.63
1958	78,371	195,518	2.49
1962	57,836	176,546	3.05
1966	28,698	141,828	4.94
1970	11,971	226,369	18.91
1974	44,588	181,851	4.08
1978	62,808	227,078	3.62
1982	63,271		
AVG:	42,596	221,592	6.41 (GM)
MAX:	78,371	461,522	18.91
MIN:	11,049	141,828	2.49

## 1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	10,772	34,705	3.22
1953	5,692	45,268	7.95
1957	10,870	24,583	2.26
1961	3,622	32,923	9.09
1965	6,089	34,890	5.73
1969	7,176	14,875	2.07
1973	2,704	25,180	9.31
1977	5,709	57,930	10.15
1981	11,359	26,268	2.31
1985	5,620		
AVG:	6,961	32,958	4.81 (GM)
MAX:	11,359	57,930	10.15
MIN:	2,704	14,875	2.07

## 1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	24,320	68,943	2.83
1955	8,971	310,002	34.56
1959	52,310	175,980	3.36
1963	71,654	114,086	1.59
1967	13,361	220,851	16.53
1971	19,028	135,310	7.11
1975	36,828	217,930	5.92
1979	49,306	106,629	2.16
1983	29,831		
AVG:	33,957	168,716	5.46 (GM)
MAX:	71,654	310,002	34.56
MIN:	8,971	68,943	1.59

SCOTCH CREEK SOCKEYE

ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	10	51	5.10
1949	1,764	6,519	3.70
1950	44		
1951			
1952	12	35	2.92
1953	1,364	9,499	6.96
1954			
1955			
1956	8	952	119.00
1957	2,230	1,220	0.55
1958		23	
1959			
1960	11		
1961	598	8,185	13.69
1962	7	2,717	388.14
1963			
1964		222	
1965	1,910	16,637	8.71
1966	459	2,956	6.44
1967			
1968			
1969	3,395	34,003	10.02
1970	304	2,236	7.36
1971		39	
1972			
1973	6,235	55,304	8.87
1974	447	9,824	21.98
1975			
1976	34	279	8.21
1977	13,586	78,489	5.78
1978	2,056	41,506	20.19
1979			
1980	107	1,283	11.99
1981	18,952	25,422	1.34
1982	4,709		
1983	239		
1984	409		
1985	3,385		

AVG: 2,491 13,518 9.09 (GM)  
 MAX: 18,952 78,489 388.14  
 MIN: 7 23 0.55

1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	10	51	5.10
1952	12	35	2.92
1956	8	952	119.00
1960	11		
1964		222	
1968			
1972			
1976	34	279	8.21
1980	107	1,283	11.99
1984	409		
AVG:	84	470	11.17 (GM)
MAX:	409	1,283	119.00
MIN:	8	35	2.92

1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	1,764	6,519	3.70
1953	1,364	9,499	6.96
1957	2,230	1,220	0.55
1961	598	8,185	13.69
1965	1,910	16,637	8.71
1969	3,395	34,003	10.02
1973	6,235	55,304	8.87
1977	13,586	78,489	5.78
1981	18,952	25,422	1.34
1985	3,385		
AVG:	5,342	26,142	4.72 (GM)
MAX:	18,952	78,489	13.69
MIN:	598	1,220	0.55

1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	44		
1954			
1958		23	
1962	7	2,717	388.14
1966	459	2,956	6.44
1970	304	2,236	7.36
1974	447	9,824	21.98
1978	2,056	41,506	20.19
1982	4,709		
AVG:	1,147	9,877	24.12 (GM)
MAX:	4,709	41,506	388.14
MIN:	7	23	6.44

1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951			
1955			
1959			
1963			
1967			
1971		39	
1975			
1979			
1983	239		
AVG:	239	39	(GM)
MAX:	239	39	ERR
MIN:	239	39	ERR

LOWER SHUSWAP RIVER SOCKEYE

ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948			
1949	13	13,994	1076.46
1950	12,000	126,844	10.57
1951		203	
1952			
1953		29	
1954	17,462	79,766	4.57
1955	23	1,971	85.70
1956			
1957	2	1,040	520.00
1958	9,367	57,231	6.11
1959	281	3,950	14.06
1960		22	
1961	32	1,956	61.13
1962	31,027	57,484	1.85
1963	2,014	19,344	9.60
1964		5	
1965	292	4,892	16.75
1966	24,415	73,379	3.01
1967	5,951	63,912	10.74
1968		1,154	
1969	999	21,427	21.45
1970	28,799	429,887	14.93
1971	6,117	46,676	7.63
1972	39	379	9.72
1973	2,794	17,604	6.30
1974	85,950	709,941	8.26
1975	11,622	31,579	2.72
1976	30	648	21.60
1977	6,359	36,869	5.80
1978	187,134	1,786,270	9.55
1979	10,048	30,191	3.00
1980	18	631	35.08
1981	4,075	6,039	1.48
1982	513,897		
1983	7,308		
1984	75		
1985	817		

AVG: 32,299 116,946 12.89 (GM)  
 MAX: 513,897 1,786,270 1076.46  
 MIN: 2 5 1.48

1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948			
1952			
1956			
1960		22	
1964		5	
1968		1,154	
1972	39	379	9.72
1976	30	648	21.60
1980	18	631	35.08
1984	75		
AVG:	41	473	19.45 (GM)
MAX:	75	1,154	35.08
MIN:	18	5	9.72

1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	13	13,994	1076.46
1953		29	
1957	2	1,040	520.00
1961	32	1,956	61.13
1965	292	4,892	16.75
1969	999	21,427	21.45
1973	2,794	17,604	6.30
1977	6,359	36,869	5.80
1981	4,075	6,039	1.48
1985	817		
AVG:	1,709	11,539	30.05 (GM)
MAX:	6,359	36,869	1076.46
MIN:	2	29	1.48

1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	12,000	126,844	10.57
1954	17,462	79,766	4.57
1958	9,367	57,231	6.11
1962	31,027	57,484	1.85
1966	24,415	73,379	3.01
1970	28,799	429,887	14.93
1974	85,950	709,941	8.26
1978	187,134	1,786,270	9.55
1982	513,897		
AVG:	101,117	415,100	6.11 (GM)
MAX:	513,897	1,786,270	14.93
MIN:	9,367	57,231	1.85

1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951		203	
1955	23	1,971	85.70
1959	281	3,950	14.06
1963	2,014	19,344	9.60
1967	5,951	63,912	10.74
1971	6,117	46,676	7.63
1975	11,622	31,579	2.72
1979	10,048	30,191	3.00
1983	7,308		
AVG:	5,421	24,728	9.64 (GM)
MAX:	11,622	63,912	85.70
MIN:	23	203	2.72

# ADAMS SOCKEYE

## ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	10,356	22,876	2.21
1949	3,593	34,871	9.71
1950	1,259,381	9,814,596	7.79
1951	143,498	529,379	3.69
1952	7,317	17,932	2.45
1953	3,472	30,998	8.93
1954	2,009,231	15,789,570	7.86
1955	63,836	863,549	13.53
1956	3,321	8,227	2.48
1957	2,807	25,825	9.20
1958	3,287,678	2,132,621	0.65
1959	134,545	378,352	2.81
1960	1,907	2,606	1.37
1961	1,118	6,419	5.74
1962	1,113,088	2,867,521	2.58
1963	156,454	3,112,002	19.89
1964	604	19,478	32.25
1965	1,795	50,849	28.33
1966	1,255,893	3,947,763	3.14
1967	838,945	3,120,311	3.72
1968	3,686	20,773	5.64
1969	4,986	12,652	2.54
1970	1,495,504	5,146,834	3.44
1971	283,791	655,449	2.31
1972	4,153	42,522	10.24
1973	1,014	74,447	73.42
1974	1,061,774	6,394,532	6.02
1975	155,517	994,994	6.40
1976	4,750	13,494	2.84
1977	6,151	56,776	9.23
1978	1,699,329	8,246,094	4.85
1979	288,777	1,473,585	5.10
1980	2,482	34,959	14.08
1981	6,218	3,427	0.55
1982	2,506,038	6,760,897	2.70
1983	204,030		
1984	4,248		
1985	471		

AVG: 474,520 2,077,348 5.20 (GN)  
 MAX: 3,287,678 15,789,570 73.42  
 MIN: 471 2,606 0.55

## 1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	10,356	22,876	2.21
1952	7,317	17,932	2.45
1956	3,321	8,227	2.48
1960	1,907	2,606	1.37
1964	604	19,478	32.25
1968	3,686	20,773	5.64
1972	4,153	42,522	10.24
1976	4,750	13,494	2.84
1980	2,482	34,959	14.08
1984	4,248		
AVG:	4,282	20,319	4.80 (GN)
MAX:	10,356	42,522	32.25
MIN:	604	2,606	1.37

## 1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	3,593	34,871	9.71
1953	3,472	30,998	8.93
1957	2,807	25,825	9.20
1961	1,118	6,419	5.74
1965	1,795	50,849	28.33
1969	4,986	12,652	2.54
1973	1,014	74,447	73.42
1977	6,151	56,776	9.23
1981	6,218	3,427	0.55
1985	471		
AVG:	3,163	32,918	7.92 (GN)
MAX:	6,218	74,447	73.42
MIN:	471	3,427	0.55

## 1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	1,259,381	9,814,596	7.79
1954	2,009,231	15,789,570	7.86
1958	3,287,678	2,132,621	0.65
1962	1,113,088	2,867,521	2.58
1966	1,255,893	3,947,763	3.14
1970	1,495,504	5,146,834	3.44
1974	1,061,774	6,394,532	6.02
1978	1,699,329	8,246,094	4.85
1982	2,506,038	6,760,897	2.70
AVG:	1,743,102	6,788,936	3.54 (GN)
MAX:	3,287,678	15,789,570	7.86
MIN:	1,061,774	2,132,621	0.65

## 1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	143,498	529,379	3.69
1955	63,836	863,549	13.53
1959	134,545	378,352	2.81
1963	156,454	3,112,002	19.89
1967	838,945	3,120,311	3.72
1971	283,791	655,449	2.31
1975	155,517	994,994	6.40
1979	288,777	1,473,585	5.10
1983	204,030		
AVG:	252,155	1,390,953	5.45 (GN)
MAX:	838,945	3,120,311	19.89
MIN:	63,836	378,352	2.31

Includes all late run Shuswap Lake except Lower Shuswap system sockeye

# SHUSVAP LAKE SYSTEM SOCKEYE

## ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	14,255	52,585	3.69
1949	16,142	90,089	5.58
1950	1,282,474	10,103,466	7.88
1951	167,818	598,525	3.57
1952	13,292	29,216	2.20
1953	10,528	85,794	8.15
1954	2,051,467	16,330,858	7.96
1955	72,830	1,175,522	16.14
1956	5,819	21,942	3.77
1957	15,909	52,668	3.31
1958	3,375,416	2,385,393	0.71
1959	187,136	558,282	2.98
1960	4,820	11,465	2.38
1961	5,370	49,483	9.21
1962	1,201,958	3,104,268	2.58
1963	230,122	3,245,432	14.10
1964	3,349	38,203	11.41
1965	10,086	107,268	10.64
1966	1,309,465	4,165,926	3.18
1967	858,257	3,405,074	3.97
1968	7,524	44,035	5.85
1969	16,556	82,957	5.01
1970	1,536,578	5,805,326	3.78
1971	308,936	837,474	2.71
1972	6,994	101,620	14.53
1973	12,747	172,535	13.54
1974	1,192,759	7,296,148	6.12
1975	203,967	1,244,503	6.10
1976	13,120	36,671	2.80
1977	31,805	230,064	7.23
1978	1,951,327	10,300,948	5.28
1979	348,131	1,610,405	4.63
1980	10,916	82,641	7.57
1981	40,604	61,156	1.51
1982	3,087,915	10,204,780	3.30
1983	241,408		
1984	21,904		
1985	10,293		

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AVG:	523,158	2,392,078	4.93 (GM)
MAX:	3,375,416	16,330,858	16.14
MIN:	3,349	11,465	0.71

## 1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	14,255	52,585	3.69
1952	13,292	29,216	2.20
1956	5,819	21,942	3.77
1960	4,820	11,465	2.38
1964	3,349	38,203	11.41
1968	7,524	44,035	5.85
1972	6,994	101,620	14.53
1976	13,120	36,671	2.80
1980	10,916	82,641	7.57
1984	21,904		
=====			
AVG:	10,199	46,486	4.85 (GM)
MAX:	21,904	101,620	14.53
MIN:	3,349	11,465	2.20

## 1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	1,282,474	10,103,466	7.88
1954	2,051,467	16,330,858	7.96
1958	3,375,416	2,385,393	0.71
1962	1,201,958	3,104,268	2.58
1966	1,309,465	4,165,926	3.18
1970	1,536,578	5,805,326	3.78
1974	1,192,759	7,296,148	6.12
1978	1,951,327	10,300,948	5.28
1982	3,087,915	10,204,780	3.30
=====			
AVG:	1,887,707	7,744,124	3.03 (GM)
MAX:	3,375,416	16,330,858	7.96
MIN:	1,192,759	2,385,393	0.71

## 1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	16,142	90,089	5.58
1953	10,528	85,794	8.15
1957	15,909	52,668	3.31
1961	5,370	49,483	9.21
1965	10,086	107,268	10.64
1969	16,556	82,957	5.01
1973	12,747	172,535	13.54
1977	31,805	230,064	7.23
1981	40,604	61,156	1.51
1985	10,293		
=====			
AVG:	17,004	103,557	6.05 (GM)
MAX:	40,604	230,064	13.54
MIN:	5,370	49,483	1.51

## 1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	167,818	598,525	3.57
1955	72,830	1,175,522	16.14
1959	187,136	558,282	2.98
1963	230,122	3,245,432	14.10
1967	858,257	3,405,074	3.97
1971	308,936	837,474	2.71
1975	203,967	1,244,503	6.10
1979	348,131	1,610,405	4.63
1983	241,408		
=====			
AVG:	290,956	1,584,402	4.83 (GM)
MAX:	858,257	3,405,074	16.14
MIN:	72,830	558,282	2.71

Includes Adams, Lower Shuswap, Little River, Shuswap Lake, Scotch, Seymour.

FENWELL CREEK SOCKEYE

ALL YEARS

Brood Year Escapement	Adult Escapement	Total Return	Return Per Spawner
1948			
1949			
1950			
1951			
1952			
1953		20	
1954		152	
1955			
1956			
1957			
1958	5	27	5.40
1959	27	1,114	41.26
1960		4,120	
1961			
1962		2,145	
1963	436	6,534	14.99
1964	146	3,637	24.91
1965		259	
1966		411	
1967	916	15,201	16.59
1968	954	15,037	15.76
1969	52	881	16.94
1970	9	740	82.22
1971	1,293	16,707	12.92
1972	1,931	28,899	14.97
1973	205	2,805	13.68
1974	140	299	2.14
1975	4,005	72,617	18.13
1976	4,090	23,900	5.84
1977	355	8,855	24.94
1978	107	4,527	42.31
1979	15,565	11,238	0.72
1980	8,437	17,581	2.08
1981	2,076	4,444	2.14
1982	1,132		
1983	4,977		
1984	11,021		
1985	1,598		
=====			
AVG:	2,586	9,686	11.00 (GM)
MAX:	15,565	72,617	82.22
MIN:	5	20	0.72

1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948			
1952			
1956			
1960		4,120	
1964	146	3,637	24.91
1968	954	15,037	15.76
1972	1,931	28,899	14.97
1976	4,090	23,900	5.84
1980	8,437	17,581	2.08
1984	11,021		
=====			
AVG:	4,430	15,529	9.35 (GM)
MAX:	11,021	28,899	24.91
MIN:	146	3,637	2.08

1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949			
1953			
1957			
1961			
1965		259	
1969	52	881	16.94
1973	205	2,805	13.68
1977	355	8,855	24.94
1981	2,076	4,444	2.14
1985	1,598		
=====			
AVG:	857	3,449	10.55 (GM)
MAX:	2,076	8,855	24.94
MIN:	52	259	2.14

1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950			
1954		20	
1958	5	27	5.40
1962		2,145	
1966		411	
1970	9	740	82.22
1974	140	299	2.14
1978	107	4,527	42.31
1982	1,132		
=====			
AVG:	279	1,167	14.15 (GM)
MAX:	1,132	4,527	82.22
MIN:	5	20	2.14

1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951			
1955		152	
1959	27	1,114	41.26
1963	436	6,534	14.99
1967	916	15,201	16.59
1971	1,293	16,707	12.92
1975	4,005	72,617	18.13
1979	15,565	11,238	0.72
1983	4,977		
=====			
AVG:	3,888	17,652	10.96 (GM)
MAX:	15,565	72,617	41.26
MIN:	27	152	0.72

RAFT RIVER SOCKEYE

ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	10,359	63,337	6.11
1949	6,113	39,626	6.48
1950	6,404	45,556	7.11
1951	8,544	47,653	5.58
1952	15,617	51,182	3.28
1953	7,904	32,124	4.06
1954	9,988	50,488	5.05
1955	5,079	60,522	11.92
1956	9,037	27,140	3.00
1957	6,860	21,015	3.06
1958	10,214	23,143	2.27
1959	10,210	23,614	2.31
1960	5,513	16,948	3.07
1961	7,293	24,325	3.34
1962	7,613	40,549	5.33
1963	8,683	9,817	1.13
1964	5,177	48,724	9.41
1965	6,624	20,626	3.11
1966	6,244	23,539	3.77
1967	1,279	9,658	7.55
1968	8,089	106,397	13.15
1969	5,537	14,370	2.60
1970	4,462	8,860	1.99
1971	801	12,361	15.43
1972	11,048	58,837	5.33
1973	2,714	3,863	1.42
1974	2,383	7,261	3.05
1975	2,609	8,053	3.09
1976	8,665	19,914	2.30
1977	617	6,692	10.85
1978	2,493	16,086	6.45
1979	1,758	2,514	1.43
1980	5,418	52,505	9.69
1981	815	7,443	9.13
1982	2,992		
1983	2,780		
1984	19,086		
1985	3,638		
=====			
AVG:	6,333	29,551	4.34 (GM)
MAX:	19,086	106,397	15.43
MIN:	617	2,514	1.13

1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	10,359	63,337	6.11
1952	15,617	51,182	3.28
1956	9,037	27,140	3.00
1960	5,513	16,948	3.07
1964	5,177	48,724	9.41
1968	8,089	106,397	13.15
1972	11,048	58,837	5.33
1976	8,665	19,914	2.30
1980	5,418	52,505	9.69
1984	19,086		
=====			
AVG:	9,801	49,443	5.19 (GM)
MAX:	19,086	106,397	13.15
MIN:	5,177	16,948	2.30

1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	6,113	39,626	6.48
1953	7,904	32,124	4.06
1957	6,860	21,015	3.06
1961	7,293	24,325	3.34
1965	6,624	20,626	3.11
1969	5,537	14,370	2.60
1973	2,714	3,863	1.42
1977	617	6,692	10.85
1981	815	7,443	9.13
1985	3,638		
=====			
AVG:	4,812	18,898	4.07 (GM)
MAX:	7,904	39,626	10.85
MIN:	617	3,863	1.42

1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	6,404	45,556	7.11
1954	9,988	50,488	5.05
1958	10,214	23,143	2.27
1962	7,613	40,549	5.33
1966	6,244	23,539	3.77
1970	4,462	8,860	1.99
1974	2,383	7,261	3.05
1978	2,493	16,086	6.45
1982	2,992		
=====			
AVG:	5,866	26,935	3.99 (GM)
MAX:	10,214	50,488	7.11
MIN:	2,383	7,261	1.99

1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	8,544	47,653	5.58
1955	5,079	60,522	11.92
1959	10,210	23,614	2.31
1963	8,683	9,817	1.13
1967	1,279	9,658	7.55
1971	801	12,361	15.43
1975	2,609	8,053	3.09
1979	1,758	2,514	1.43
1983	2,780		
=====			
AVG:	4,638	21,774	4.16 (GM)
MAX:	10,210	60,522	15.43
MIN:	801	2,514	1.13

# CHILKO RIVER SOCKEYE

## ALL YEARS

## 1984 CYCLE YEAR

## 1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	670,622	1,947,973	2.90
1949	58,247	623,138	10.70
1950	17,308	205,875	11.89
1951	100,116	752,327	7.51
1952	485,585	1,858,476	3.83
1953	200,691	619,456	3.09
1954	34,296	712,749	20.78
1955	121,167	1,513,275	12.49
1956	646,906	2,435,670	3.77
1957	138,464	138,228	1.00
1958	120,104	433,371	3.61
1959	463,060	2,212,583	4.78
1960	426,546	1,053,335	2.47
1961	39,101	69,453	1.78
1962	77,713	985,562	12.68
1963	998,231	1,206,303	1.21
1964	238,272	2,040,082	8.56
1965	35,335	158,944	4.50
1966	209,619	889,200	4.24
1967	174,715	1,999,484	11.44
1968	413,862	2,461,877	5.95
1969	70,902	402,283	5.67
1970	135,388	688,611	5.09
1971	157,193	602,388	3.83
1972	562,650	1,938,682	3.45
1973	55,675	213,743	3.84
1974	109,563	600,641	5.48
1975	199,739	1,482,366	7.42
1976	361,752	1,616,968	4.47
1977	49,539	192,299	3.88
1978	143,402	1,178,463	8.22
1979	234,924	1,521,877	6.48
1980	467,812	4,283,976	9.16
1981	34,360	180,405	5.25
1982	239,903	1,671,700	6.97
1983	329,220		
1984	452,618		
1985	71,435		

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	670,622	1,947,973	2.90
1952	485,585	1,858,476	3.83
1956	646,906	2,435,670	3.77
1960	426,546	1,053,335	2.47
1964	238,272	2,040,082	8.56
1968	413,862	2,461,877	5.95
1972	562,650	1,938,682	3.45
1976	361,752	1,616,968	4.47
1980	467,812	4,283,976	9.16
1984	452,618		
AVG:	472,663	2,181,893	4.49 (GM)
MAX:	670,622	4,283,976	9.16
MIN:	238,272	1,053,335	2.47

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	58,247	623,138	10.70
1953	200,691	619,456	3.09
1957	138,464	138,228	1.00
1961	39,101	69,453	1.78
1965	35,335	158,944	4.50
1969	70,902	402,283	5.67
1973	55,675	213,743	3.84
1977	49,539	192,299	3.88
1981	34,360	180,405	5.25
1985	71,435		
AVG:	75,375	288,661	3.66 (GM)
MAX:	200,691	623,138	10.70
MIN:	34,360	69,453	1.00

## 1986 CYCLE YEAR

## 1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	17,308	205,875	11.89
1954	34,296	712,749	20.78
1958	120,104	433,371	3.61
1962	77,713	985,562	12.68
1966	209,619	889,200	4.24
1970	135,388	688,611	5.09
1974	109,563	600,641	5.48
1978	143,402	1,178,463	8.22
1982	239,903	1,671,700	6.97
AVG:	120,811	818,464	7.52 (GM)
MAX:	239,903	1,671,700	20.78
MIN:	17,308	205,875	3.61

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	100,116	752,327	7.51
1955	121,167	1,513,275	12.49
1959	463,060	2,212,583	4.78
1963	998,231	1,206,303	1.21
1967	174,715	1,999,484	11.44
1971	157,193	602,388	3.83
1975	199,739	1,482,366	7.42
1979	234,924	1,521,877	6.48
1983	329,220		
AVG:	308,707	1,411,325	5.72 (GM)
MAX:	998,231	2,212,583	12.49
MIN:	100,116	602,388	1.21

AVG:	245,948	1,168,336	5.14 (GM)
MAX:	998,231	4,283,976	20.78
MIN:	17,308	69,453	1.00



# CHILKO LAKE SYSTEM SOCKEYE

## ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	670,622	1,947,973	2.90
1949	58,247	623,138	10.70
1950	17,308	205,875	11.89
1951	100,116	752,327	7.51
1952	485,585	1,858,476	3.83
1953	200,691	619,456	3.09
1954	34,296	712,749	20.78
1955	121,167	1,513,275	12.49
1956	646,906	2,435,670	3.77
1957	138,464	138,228	1.00
1958	120,104	433,371	3.61
1959	463,060	2,212,583	4.78
1960	426,546	1,053,335	2.47
1961	39,101	69,453	1.78
1962	77,713	985,562	12.68
1963	998,231	1,206,303	1.21
1964	238,272	2,040,082	8.56
1965	35,335	158,944	4.50
1966	209,619	889,200	4.24
1967	174,715	1,999,484	11.44
1968	413,862	2,476,069	5.98
1969	70,902	402,283	5.67
1970	135,388	694,456	5.13
1971	168,396	852,842	5.06
1972	564,533	2,033,998	3.60
1973	55,675	220,403	3.96
1974	110,026	620,588	5.64
1975	244,631	1,640,640	6.71
1976	384,390	1,697,694	4.42
1977	51,330	194,068	3.78
1978	146,842	1,227,233	8.36
1979	258,391	1,659,275	6.42
1980	497,759	4,693,216	9.43
1981	34,540	185,253	5.36
1982	249,578		
1983	382,833		
1984	580,178		
1985	71,975		

AVG: 254,667 1,189,809 5.14 (GM)  
 MAX: 998,231 4,693,216 20.78  
 MIN: 17,308 69,453 1.00

## 1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	670,622	1,947,973	2.90
1952	485,585	1,858,476	3.83
1956	646,906	2,435,670	3.77
1960	426,546	1,053,335	2.47
1964	238,272	2,040,082	8.56
1968	413,862	2,476,069	5.98
1972	564,533	2,033,998	3.60
1976	384,390	1,697,694	4.42
1980	497,759	4,693,216	9.43
1984	580,178		
=====			
AVG:	490,865	2,248,501	4.52 (GM)
MAX:	670,622	4,693,216	9.43
MIN:	238,272	1,053,335	2.47

## 1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	17,308	205,875	11.89
1954	34,296	712,749	20.78
1958	120,104	433,371	3.61
1962	77,713	985,562	12.68
1966	209,619	889,200	4.24
1970	135,388	694,456	5.13
1974	110,026	620,588	5.64
1978	146,842	1,227,233	8.36
1982	249,578		
=====			
AVG:	122,319	721,129	7.64 (GM)
MAX:	249,578	1,227,233	20.78
MIN:	17,308	205,875	3.61

## 1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	58,247	623,138	10.70
1953	200,691	619,456	3.09
1957	138,464	138,228	1.00
1961	39,101	69,453	1.78
1965	35,335	158,944	4.50
1969	70,902	402,283	5.67
1973	55,675	220,403	3.96
1977	51,330	194,068	3.78
1981	34,540	185,253	5.36
1985	71,975		
=====			
AVG:	75,626	290,136	3.67 (GM)
MAX:	200,691	623,138	10.70
MIN:	34,540	69,453	1.00

## 1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	100,116	752,327	7.51
1955	121,167	1,513,275	12.49
1959	463,060	2,212,583	4.78
1963	998,231	1,206,303	1.21
1967	174,715	1,999,484	11.44
1971	168,396	852,842	5.06
1975	244,631	1,640,640	6.71
1979	258,391	1,659,275	6.42
1983	382,833		
=====			
AVG:	323,504	1,479,591	5.84 (GM)
MAX:	998,231	2,212,583	12.49
MIN:	100,116	752,327	1.21

includes Chilko River, North End Lake and South End (Early Chilko).

# MITCHELL RIVER SOCKEYE

ALL YEARS			
Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948			
1949	664	9,794	14.75
1950		121	
1951			
1952			
1953	2,344	7,252	3.09
1954	18	380	21.11
1955			
1956			
1957	2,677	21,598	8.07
1958	65	16	0.25
1959			
1960			
1961	6,601	17,864	2.71
1962	5	587	117.40
1963			
1964			
1965	5,335	52,955	9.93
1966	142	120	0.85
1967			
1968	4	13	3.25
1969	8,939	144,443	16.16
1970	23		
1971			
1972	3		
1973	24,673	177,596	7.20
1974		2,886	
1975			
1976	7		
1977	42,396	320,878	7.57
1978	1,237	513	0.41
1979		117	
1980		9	
1981	66,106	1,448,788	21.92
1982	3,829		
1983	119		
1984	20		
1985	204,579		

AVG: 16,808 116,102 5.51 (GM)  
 MAX: 204,579 1,448,788 117.40  
 MIN: 3 9 0.25

1984 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948			
1952			
1956			
1960			
1964			
1968	4	13	3.25
1972	3		
1976	7		
1980		9	
1984	20		
AVG:	9	11	3.25 (GM)
MAX:	20	13	3.25
MIN:	3	9	3.25

1986 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950		121	
1954	18	380	21.11
1958	65	16	0.25
1962	5	587	117.40
1966	142	120	0.85
1970	23		
1974		2,886	
1978	1,237	513	0.41
1982	3,829		
AVG:	760	660	2.92 (GM)
MAX:	3,829	2,886	117.40
MIN:	5	16	0.25

1985 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	664	9,794	14.75
1953	2,344	7,252	3.09
1957	2,677	21,598	8.07
1961	6,601	17,864	2.71
1965	5,335	52,955	9.93
1969	8,939	144,443	16.16
1973	24,673	177,596	7.20
1977	42,396	320,878	7.57
1981	66,106	1,448,788	21.92
1985	204,579		
AVG:	36,431	244,574	8.32 (GM)
MAX:	204,579	1,448,788	21.92
MIN:	664	7,252	2.71

1987 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951			
1955			
1959			
1963			
1967			
1971			
1975			
1979		117	
1983	119		
AVG:	119	117	(GM)
MAX:	119	117	ERR
MIN:	119	117	ERR

HORSEFLY RIVER SOCKEYE

ALL YEARS				1984 CYCLE YEAR				1985 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner	Brood Year	Adult Escapement	Total Return	Return Per Spawner	Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	100	1,132	11.32	1948	100	1,132	11.32	1949	30,000	476,070	15.87
1949	30,000	476,070	15.87	1952	184	562	3.05	1953	108,573	602,993	5.55
1950	398	1,927	4.84	1956	81	2,553	31.52	1957	220,990	976,515	4.42
1951	49	413	8.43	1960	292	1,475	5.05	1961	295,964	1,223,026	4.13
1952	184	562	3.05	1964	254	2,797	11.01	1965	359,371	1,614,217	4.49
1953	108,573	602,993	5.55	1968	695	484	0.70	1969	270,022	1,496,320	5.54
1954	281	10,312	36.70	1972	108	1,392	12.89	1973	253,388	1,983,829	7.83
1955	63	180	2.86	1976	298	1,233	4.14	1977	473,803	3,547,060	7.49
1956	81	2,553	31.52	1980	274	886	3.23	1981	682,515	8,125,619	11.91
1957	220,990	976,515	4.42	1984	895			1985	1,113,172		
1958	1,798	3,396	1.89								
1959	65	165	2.54	AVG:	318	1,390	5.79 (GM)	AVG:	380,780	2,227,294	6.72 (GM)
1960	292	1,475	5.05	MAX:	895	2,797	31.52	MAX:	1,113,172	8,125,619	15.87
1961	295,964	1,223,026	4.13	MIN:	81	484	0.70	MIN:	30,000	476,070	4.13
1962	1,073	6,700	6.24								
1963	83	956	11.52	1986 CYCLE YEAR				1987 CYCLE YEAR			
1964	254	2,797	11.01								
1965	359,371	1,614,217	4.49								
1966	1,607	7,342	4.57								
1967	119	1,761	14.80								
1968	695	484	0.70								
1969	270,022	1,496,320	5.54								
1970	1,345	20,339	15.12								
1971	171	747	4.37								
1972	108	1,392	12.89								
1973	253,388	1,983,829	7.83								
1974	4,459	18,336	4.11								
1975	193	1,713	8.88								
1976	298	1,233	4.14								
1977	473,803	3,547,060	7.49								
1978	7,377	172,439	23.38								
1979	511	4,828	9.45								
1980	274	886	3.23								
1981	682,515	8,125,619	11.91								
1982	36,012	514,400	14.28								
1983	2,036										
1984	895										
1985	1,113,172										
AVG:	101,806	594,975	6.82 (GM)	AVG:	6,039	83,910	8.36 (GM)	AVG:	366	1,345	6.65 (GM)
MAX:	1,113,172	8,125,619	36.70	MAX:	36,012	514,400	36.70	MAX:	2,036	4,828	14.80
MIN:	49	165	0.70	MIN:	281	1,927	1.89	MIN:	49	165	2.54

# EARLY STUART SOCKEYE

ALL YEARS			
Brood Year	Adult Spawner	Total Return	Return Per Spawner
1948	19,979	198,153	9.92
1949	582,228	1,036,968	1.78
1950	59,104	241,666	4.09
1951	60,423	173,654	2.87
1952	30,212	88,600	2.93
1953	154,036	540,891	3.51
1954	35,050	155,823	4.45
1955	2,159	27,467	12.72
1956	25,020	110,394	4.41
1957	234,850	1,222,936	5.21
1958	38,807	103,107	2.66
1959	2,670	20,835	7.80
1960	14,447	74,149	5.13
1961	198,921	255,842	1.29
1962	26,716	75,785	2.84
1963	4,607	92,554	20.09
1964	2,390	42,887	17.94
1965	23,045	417,211	18.10
1966	10,830	84,786	7.83
1967	21,044	339,693	16.14
1968	1,522	10,423	6.85
1969	109,655	1,375,594	12.54
1970	32,578	182,136	5.59
1971	95,940	431,210	4.49
1972	4,657	32,232	6.92
1973	299,892	1,341,984	4.47
1974	39,518	140,516	3.56
1975	65,754	224,052	3.41
1976	11,761	31,854	2.71
1977	117,445	757,997	6.45
1978	50,004	56,170	1.12
1979	92,746	108,699	1.17
1980	16,939	64,115	3.79
1981	129,457	331,330	2.56
1982	4,557	25,800	5.66
1983	23,867		
1984	45,201		
1985	234,519		
=====			
AVG:	76,909	297,643	4.84 (GM)
MAX:	582,228	1,375,594	20.09
MIN:	1,522	10,423	1.12

1984 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	19,979	198,153	9.92
1952	30,212	88,600	2.93
1956	25,020	110,394	4.41
1960	14,447	74,149	5.13
1964	2,390	42,887	17.94
1968	1,522	10,423	6.85
1972	4,657	32,232	6.92
1976	11,761	31,854	2.71
1980	16,939	64,115	3.79
1984	45,201		
=====			
AVG:	17,213	72,534	5.64 (GM)
MAX:	45,201	198,153	17.94
MIN:	1,522	10,423	2.71

1985 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	582,228	1,036,968	1.78
1953	154,036	540,891	3.51
1957	234,850	1,222,936	5.21
1961	198,921	255,842	1.29
1965	23,045	417,211	18.10
1969	109,655	1,375,594	12.54
1973	299,892	1,341,984	4.47
1977	117,445	757,997	6.45
1981	129,457	331,330	2.56
1985	234,519		
=====			
AVG:	208,405	808,973	4.46 (GM)
MAX:	582,228	1,375,594	18.10
MIN:	23,045	255,842	1.29

1986 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	59,104	241,666	4.09
1954	35,050	155,823	4.45
1958	38,807	103,107	2.66
1962	26,716	75,785	2.84
1966	10,830	84,786	7.83
1970	32,578	182,136	5.59
1974	39,518	140,516	3.56
1978	50,004	56,170	1.12
1982	4,557	25,800	5.66
=====			
AVG:	33,018	118,421	3.72 (GM)
MAX:	59,104	241,666	7.83
MIN:	4,557	25,800	1.12

1987 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	60,423	173,654	2.87
1955	2,159	27,467	12.72
1959	2,670	20,835	7.80
1963	4,607	92,554	20.09
1967	21,044	339,693	16.14
1971	95,940	431,210	4.49
1975	65,754	224,052	3.41
1979	92,746	108,699	1.17
1983	23,867		
=====			
AVG:	41,023	177,271	5.99 (GM)
MAX:	95,940	431,210	20.09
MIN:	2,159	20,835	1.17

# LATE STUART SOCKEYE

## ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948		327	
1949	107,752	1,530,202	14.20
1950	5,843	39,681	6.79
1951	4,364	63,810	14.62
1952	35	3,973	113.51
1953	368,634	1,552,239	4.21
1954	5,470	137,965	25.22
1955	7,582	51,345	6.77
1956	913	46,102	50.50
1957	531,108	1,329,884	2.50
1958	23,619	54,677	2.31
1959	8,225	7,392	0.90
1960	2,396	9,617	4.01
1961	410,887	778,478	1.89
1962	18,643	45,069	2.42
1963	3,222	12,049	3.74
1964	1,816	3,101	1.71
1965	214,943	1,124,519	5.23
1966	9,027	74,079	8.21
1967	1,629	16,556	10.16
1968	389	31,299	80.46
1969	207,014	1,625,590	7.85
1970	14,978	70,838	4.73
1971	1,535	66,770	43.50
1972	7,341	17,266	2.35
1973	214,230	606,161	2.83
1974	14,190	43,407	3.06
1975	14,229	196,849	13.83
1976	2,898	3,339	1.15
1977	146,459	1,349,483	9.21
1978	12,738	62,421	4.90
1979	31,918	9,750	0.31
1980	946	9,811	10.37
1981	249,494	1,978,010	7.93
1982	16,758	54,300	3.24
1983	2,246		
1984	1,228		
1985	274,620		

AVG: 79,441 371,610 5.97 (GM)  
 MAX: 531,108 1,978,010 113.51  
 MIN: 35 327 0.31

## 1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948		327	
1952	35	3,973	113.51
1956	913	46,102	50.50
1960	2,396	9,617	4.01
1964	1,816	3,101	1.71
1968	389	31,299	80.46
1972	7,341	17,266	2.35
1976	2,898	3,339	1.15
1980	946	9,811	10.37
1984	1,228		
=====			
AVG:	1,996	13,871	9.85 (GM)
MAX:	7,341	46,102	113.51
MIN:	35	327	1.15

## 1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	5,843	39,681	6.79
1954	5,470	137,965	25.22
1958	23,619	54,677	2.31
1962	18,643	45,069	2.42
1966	9,027	74,079	8.21
1970	14,978	70,838	4.73
1974	14,190	43,407	3.06
1978	12,738	62,421	4.90
1982	16,758	54,300	3.24
=====			
AVG:	13,474	64,715	4.96 (GM)
MAX:	23,619	137,965	25.22
MIN:	5,470	39,681	2.31

## 1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	107,752	1,530,202	14.20
1953	368,634	1,552,239	4.21
1957	531,108	1,329,884	2.50
1961	410,887	778,478	1.89
1965	214,943	1,124,519	5.23
1969	207,014	1,625,590	7.85
1973	214,230	606,161	2.83
1977	146,459	1,349,483	9.21
1981	249,494	1,978,010	7.93
1985	274,620		
=====			
AVG:	272,514	1,319,396	5.12 (GM)
MAX:	531,108	1,978,010	14.20
MIN:	107,752	606,161	1.89

## 1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	4,364	63,810	14.62
1955	7,582	51,345	6.77
1959	8,225	7,392	0.90
1963	3,222	12,049	3.74
1967	1,629	16,556	10.16
1971	1,535	66,770	43.50
1975	14,229	196,849	13.83
1979	31,918	9,750	0.31
1983	2,246		
=====			
AVG:	8,328	53,065	5.30 (GM)
MAX:	31,918	196,849	43.50
MIN:	1,535	7,392	0.31

LATE NADINA SOCKEYE

ALL YEARS				1984 CYCLE YEAR				1985 CYCLE YEAR			
Brood Year	Adult Escapement	Total Return	Return Per Spawner	Brood Year	Adult Escapement	Total Return	Return Per Spawner	Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948		43		1948		43		1949		105,947	
1949		105,947		1952	9	91	10.11	1953	13,617	162,560	11.94
1950	774	5,097	6.59	1956	18	4,108	228.22	1957	27,549	116,806	4.24
1951	175	981	5.61	1960	29	1,178	40.62	1961	17,542	94,420	5.38
1952	9	91	10.11	1964	209	7,735	37.01	1965	11,293	95,017	8.41
1953	13,617	162,560	11.94	1968	1,249	43,963	35.20	1969	27,895	106,259	3.81
1954	770	4,725	6.14	1972	2,554	10,728	4.20	1973	16,720	79,728	4.77
1955	106	3,953	37.29	1976	1,625	7,257	4.47	1977	16,858	129,205	7.66
1956	18	4,108	228.22	1980	3,017	18,774	6.22	1981	18,912	73,315	3.88
1957	27,549	116,806	4.24	1984	7,070			1985	13,807		
1958	635	5,083	8.00	=====				=====			
1959	1,013	17,000	16.78	AVG:	1,753	10,431	18.59 (GM)	AVG:	18,244	107,029	5.77 (GM)
1960	29	1,178	40.62	MAX:	7,070	43,963	228.22	MAX:	27,895	162,560	11.94
1961	17,542	94,420	5.38	MIN:	9	43	4.20	MIN:	11,293	73,315	3.81
1962	1,683	12,045	7.16	=====				=====			
1963	7,304	59,653	8.17	1986 CYCLE YEAR				1987 CYCLE YEAR			
1964	209	7,735	37.01	=====				=====			
1965	11,293	95,017	8.41	Brood Year	Adult Escapement	Total Return	Return Per Spawner	Brood Year	Adult Escapement	Total Return	Return Per Spawner
1966	1,724	34,010	19.73	1950	774	5,097	6.59	1951	175	981	5.61
1967	7,790	153,066	19.65	1954	770	4,725	6.14	1955	106	3,953	37.29
1968	1,249	43,963	35.20	1958	635	5,083	8.00	1959	1,013	17,000	16.78
1969	27,895	106,259	3.81	1962	1,683	12,045	7.16	1963	7,304	59,653	8.17
1970	3,929	29,884	7.61	1966	1,724	34,010	19.73	1967	7,790	153,066	19.65
1971	14,481	75,454	5.21	1970	3,929	29,884	7.61	1971	14,481	75,454	5.21
1972	2,554	10,728	4.20	1974	3,730	12,482	3.35	1975	15,309	307,348	20.08
1973	16,720	79,728	4.77	1978	2,584	17,832	6.90	1979	55,681	92,270	1.66
1974	3,730	12,482	3.35	1982	2,349			1983	26,876		
1975	15,309	307,348	20.08	=====				=====			
1976	1,625	7,257	4.47	AVG:	2,020	15,145	7.30 (GM)	AVG:	14,304	88,716	9.97 (GM)
1977	16,858	129,205	7.66	MAX:	3,929	34,010	19.73	MAX:	55,681	307,348	37.29
1978	2,584	17,832	6.90	MIN:	635	4,725	3.35	MIN:	106	981	1.66
1979	55,681	92,270	1.66	=====				=====			
1980	3,017	18,774	6.22	=====				=====			
1981	18,912	73,315	3.88	=====				=====			
1982	2,349			=====				=====			
1983	26,876			=====				=====			
1984	7,070			=====				=====			
1985	13,807			=====				=====			
=====				=====				=====			
AVG:	9,080	55,530	9.40 (GM)	=====				=====			
MAX:	55,681	307,348	228.22	=====				=====			
MIN:	9	43	1.66	=====				=====			

Note - Includes Early Nadina, Nithi & Endako.

STELLAKO RIVER SOCKEYE

ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	15,763	207,177	13.14
1949	104,720	179,876	1.72
1950	145,021	939,117	6.48
1951	96,076	455,367	4.74
1952	40,384	110,701	2.74
1953	42,134	174,245	4.14
1954	141,859	1,211,299	8.54
1955	51,739	629,796	12.17
1956	38,438	246,735	6.42
1957	38,522	151,843	3.94
1958	112,251	340,460	3.03
1959	79,305	541,420	6.83
1960	38,880	164,514	4.23
1961	46,863	147,402	3.15
1962	124,485	589,505	4.74
1963	138,794	727,926	5.24
1964	30,890	177,837	5.76
1965	39,385	243,651	6.19
1966	101,529	359,906	3.54
1967	91,480	550,524	6.02
1968	30,368	129,822	4.27
1969	49,211	253,245	5.15
1970	45,797	234,108	5.11
1971	39,691	509,267	12.83
1972	36,700	758,244	20.66
1973	30,404	77,458	2.55
1974	41,275	262,761	6.37
1975	175,941	1,750,824	9.95
1976	150,734	244,377	1.62
1977	23,047	264,679	11.48
1978	58,898	416,677	7.07
1979	290,042	577,843	1.99
1980	72,050	424,166	5.89
1981	21,826	234,242	10.73
1982	69,420	377,500	5.44
1983	121,692		
1984	60,957		
1985	42,099		
=====			
AVG:	75,754	418,986	5.41 (GM)
MAX:	290,042	1,750,824	20.66
MIN:	15,763	77,458	1.62

1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	15,763	207,177	13.14
1952	40,384	110,701	2.74
1956	38,438	246,735	6.42
1960	38,880	164,514	4.23
1964	30,890	177,837	5.76
1968	30,368	129,822	4.27
1972	36,700	758,244	20.66
1976	150,734	244,377	1.62
1980	72,050	424,166	5.89
1984	60,957		
=====			
AVG:	51,516	273,730	5.52 (GM)
MAX:	150,734	758,244	20.66
MIN:	15,763	110,701	1.62

1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	104,720	179,876	1.72
1953	42,134	174,245	4.14
1957	38,522	151,843	3.94
1961	46,863	147,402	3.15
1965	39,385	243,651	6.19
1969	49,211	253,245	5.15
1973	30,404	77,458	2.55
1977	23,047	264,679	11.48
1981	21,826	234,242	10.73
1985	42,099		
=====			
AVG:	43,821	191,849	4.58 (GM)
MAX:	104,720	264,679	11.48
MIN:	21,826	77,458	1.72

1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	145,021	939,117	6.48
1954	141,859	1,211,299	8.54
1958	112,251	340,460	3.03
1962	124,485	589,505	4.74
1966	101,529	359,906	3.54
1970	45,797	234,108	5.11
1974	41,275	262,761	6.37
1978	58,898	416,677	7.07
1982	69,420	377,500	5.44
=====			
AVG:	93,393	525,704	5.34 (GM)
MAX:	145,021	1,211,299	8.54
MIN:	41,275	234,108	3.03

1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	96,076	455,367	4.74
1955	51,739	629,796	12.17
1959	79,305	541,420	6.83
1963	138,794	727,926	5.24
1967	91,480	550,524	6.02
1971	39,691	509,267	12.83
1975	175,941	1,750,824	9.95
1979	290,042	577,843	1.99
1983	121,692		
=====			
AVG:	120,529	717,871	6.49 (GM)
MAX:	290,042	1,750,824	12.83
MIN:	39,691	455,367	1.99

BOWRON RIVER SOCKEYE

ALL YEARS

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	25,205	80,266	3.18
1949	22,283	62,791	2.82
1950	16,146	75,548	4.68
1951	21,731	103,821	4.78
1952	18,645	43,304	2.32
1953	13,277	75,579	5.69
1954	10,515	66,916	6.36
1955	9,350	96,955	10.37
1956	6,964	38,484	5.53
1957	12,011	41,966	3.49
1958	14,843	18,155	1.22
1959	29,247	61,865	2.12
1960	7,620	17,733	2.33
1961	7,449	28,148	3.78
1962	6,286	21,327	3.39
1963	25,141	214,316	8.52
1964	1,500	27,507	18.34
1965	2,659	17,849	6.71
1966	2,470	22,249	9.01
1967	31,695	206,494	6.52
1968	3,611	44,642	12.36
1969	3,872	17,211	4.44
1970	1,305	16,197	12.41
1971	25,497	124,507	4.88
1972	4,138	20,361	4.92
1973	4,558	8,564	1.88
1974	1,850	12,396	6.70
1975	29,700	170,357	5.74
1976	2,250	7,112	3.16
1977	2,500	8,609	3.44
1978	3,141	20,314	6.47
1979	35,000	21,542	0.62
1980	2,894	22,407	7.74
1981	1,170	14,724	12.58
1982	1,647		
1983	6,451		
1984	10,461		
1985	6,395		

AVG: 11,355 53,830 4.72 (GM)  
 MAX: 35,000 214,316 18.34  
 MIN: 1,170 7,112 0.62

Note - Includes Indianpoint Creek.

1984 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1948	25,205	80,266	3.18
1952	18,645	43,304	2.32
1956	6,964	38,484	5.53
1960	7,620	17,733	2.33
1964	1,500	27,507	18.34
1968	3,611	44,642	12.36
1972	4,138	20,361	4.92
1976	2,250	7,112	3.16
1980	2,894	22,407	7.74
1984	10,461		
AVG:	8,329	33,535	5.16 (GM)
MAX:	25,205	80,266	18.34
MIN:	1,500	7,112	2.32

1985 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1949	22,283	62,791	2.82
1953	13,277	75,579	5.69
1957	12,011	41,966	3.49
1961	7,449	28,148	3.78
1965	2,659	17,849	6.71
1969	3,872	17,211	4.44
1973	4,558	8,564	1.88
1977	2,500	8,609	3.44
1981	1,170	14,724	12.58
1985	6,395		
AVG:	7,617	30,605	4.31 (GM)
MAX:	22,283	75,579	12.58
MIN:	1,170	8,564	1.88

1986 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1950	16,146	75,548	4.68
1954	10,515	66,916	6.36
1958	14,843	18,155	1.22
1962	6,286	21,327	3.39
1966	2,470	22,249	9.01
1970	1,305	16,197	12.41
1974	1,850	12,396	6.70
1978	3,141	20,314	6.47
1982	1,647		
AVG:	6,467	31,638	5.27 (GM)
MAX:	16,146	75,548	12.41
MIN:	1,305	12,396	1.22

1987 CYCLE YEAR

Brood Year	Adult Escapement	Total Return	Return Per Spawner
1951	21,731	103,821	4.78
1955	9,350	96,955	10.37
1959	29,247	61,865	2.12
1963	25,141	214,316	8.52
1967	31,695	206,494	6.52
1971	25,497	124,507	4.88
1975	29,700	170,357	5.74
1979	35,000	21,542	0.62
1983	6,451		
AVG:	23,757	124,982	4.22 (GM)
MAX:	35,000	214,316	10.37
MIN:	6,451	21,542	0.62



Appendix 3. Estimated capacity of Fraser River spawning grounds for sockeye salmon.

Rearing lake/ stock	Usable area (m <sup>2</sup> )	Capacity (Total spawners)	Last dominant year escapement	Unutilized capacity
<u>Pitt Lake</u>				
Upper Pitt R	84,000	68,900	37,800 (88)	31,100
Widgeon Sl.	800	1,400	2,000 (88)	(-200)
sub total	84,800	70,300	-	-
<u>Cultus Lake</u>				
Cultus Lake	28,000	56,300	32,300 (87)	-
<u>Harrison Lake</u>				
Big Silver Cr.	25,000	21,100	2,600 (86)	18,500
Birkenhead R.	167,000	278,300	348,300 (86)	(-70,000)
Harrison R.	207,000	81,000	7,300 (86)	73,700
Weaver Cr.	48,000	47,600	66,500 (86)	(-18,900)
sub total	447,000	428,000	-	-
<u>Seton/Anderson Lakes</u>				
Gates Cr.	12,000	20,900	19,300 (88)	1,600
Portage Cr.	4,000	7,800	14,400 (86)	(-6,600)
sub total	16,000	28,700	-	-
<u>Nahatlatch Lake</u>				
Nahatlatch R.	150,000	281,200	16,600 (88)	264,600
<u>Adams Lake</u>				
Upper Adams R.	635,000	1,552,000	7,200 (88)	1,545,000
Momich-Cayenne R.	2,000	4,800	5,900 (88)	(-1,100)
sub total	637,000	1,556,800	-	-
<u>Kamloops Lake</u>				
Raft R.	7,000	12,800	19,900 (88)	(-7,100)
Barriere R.	117,000	224,700	300 (88)	224,400
sub total	124,000	237,500	-	-
<u>North Barriere Lake</u>				
Fennell Cr.	8,000	14,500	26,500 (88)	(-12,000)
<u>Shuswap Lake</u>				
Adams R.	422,000	1,429,800	1,334,600 (86)	95,200
Eagle R.	21,000	50,600	25,700 (86)	24,900
Little R.	334,000	629,200	227,900 (86)	401,300
Lower Shuswap R.	281,000	713,200	600,500 (86)	112,700
Lake & S. Thompson R.	64,000	159,100	70,400 (86)	88,700
Scotch Cr.	13,000	33,100	30,900 (86)	2,200
Seymour R.	47,000	116,800	129,600 (86)	(-12,800)
sub total	1,182,000	3,131,800	-	-

Appendix 3. Estimated capacity of Fraser River spawning grounds for sockeye salmon. cont'd

Rearing lake/ stock	Usable area (m <sup>2</sup> )	Capacity (Total spawners)	Last dominant year escapement	Unutilized capacity
<u>Mable Lake</u> Middle Shuswap R.	209,000	545,600	80,500 (86)	465,100
<u>Chilko Lake</u> Chilko R.	204,000	369,000	453,000 (84)	(-84,000)
Chilko L.	130,000	224,200	188,800 (87)	35,400
sub total	334,000	593,200	-	-
<u>Taseko Lake</u> Taseko Lake	17,000	31,000	11,100 (88)	19,900
<u>Quesnel Lake</u> Cameron R.	2,000	4,500	2,200 (85)	2,300
Horsefly R. (Upper)	185,000	498,600	730,700 (85)	(-232,100)
Horsefly R. (Lower)	547,000	1,477,400	258,000 (85)	1,219,400
Horsefly R. (above falls)	60,000	162,600	31,500 (85)	131,100
Little Horsefly R.	8,000	23,900	17,000 (85)	6,900
McKinley R.	52,000	142,500	97,600 (85)	44,900
Mitchell R.	32,000	82,500	204,600 (85)	(-122,100)
Penfold Cr.	300	800	200 (85)	600
Quesnel Lake	3,000	6,300	5,700 (85)	600
Summit Cr.	2,000	4,500	1,200 (85)	3,300
Wasko Cr.	800	1,800	500 (85)	1,300
sub total	892,000	2,405,400	-	-
<u>Francois Lake</u> Lower Nadina R.	91,000	?	900 (87)	?
Upper Nadina R.	8,000	15,100	7,900 (87)	7,200
Nithi R.	2,000	4,100	1,000 (83)?	3,100
Uncha Cr.	800	1,600	?	?
sub total	101,800	20,800	-	-
<u>Fraser Lake</u> Endako R.	2,000	3,300	1,000 (87)	2,300
Ormonde Cr.	800	1,600	?	?
Stellako R.	232,000	429,200	367,700 (88)	61,500
sub total	234,800	434,100		
<u>Stuart Lake</u> Kuzkwa Cr.	32,000	62,000	4,000 (86)	58,000
Tachie R.	220,000	401,500	155,700 (85)	245,800
Pinchi Cr.	800	1,600	800 (87)	800
sub total	252,800	465,100	-	-

Appendix 3. Estimated capacity of Fraser River spawning grounds for sockeye salmon. cont'd

Rearing lake/ stock	Usable area (m <sup>2</sup> )	Capacity (Total spawners)	Last dominant year escapement	Unutilized capacity
<u>Trembleur Lake</u>				
Kazchek Cr.	19,000	37,400	2,000 (85)	35,400
Middle R.	440,000	804,100	114,100 (85)	690,000
Felix Cr.	9,000	19,000	20,600 (85)	(-1,600)
Fleming Cr.	5,000	9,500	5,400 (88)	4,100
Paula Cr.	6,000	13,300	8,300 (88)	5,000
Rossette Cr.	6,000	12,600	18,900 (88)	(-6,300)
Forfar Cr.	10,000	18,300	24,600 (88)	(-6,300)
Kynock Cr.	23,000	47,600	53,400 (88)	(-5,800)
sub total	518,000	961,800	-	-
<u>Takla Lake</u>				
Ankwill Cr.	14,000	28,600	12,000 (85)	16,600
Biyuac Cr.	3,000	5,700	4,300 (88)	1,400
Blanchette Cr.	500	1,000	200 (87)	800
Crow Cr.	3,000	6,300	1,800 (85)	4,500
Driftwood R.	165,000	345,700	94,000 (85)	251,700
Dust Cr.	14,000	29,500	5,500 (85)	24,000
Forsythe Cr.	5,000	9,500	3,300 (85)	6,200
French Cr.	500	1,000	700 (85)	300
Frypan Cr.	9,000	19,000	3,000 (85)	16,000
Gluske Cr.	11,000	24,100	20,000 (87)	4,100
Hooker Cr.	200	400	500 (88)	(-100)
Hudson Bay Cr.	100	200	44 (85)	260
Leo Cr.	2,000	4,800	29 (85)	4,770
McDougall Cr.	500	1,000	30 (85)	970
Narrows Cr.	13,600	28,600	11,300 (87)	17,300
Point Cr.	1,000	1,900	2,000 (85)	(-100)
Sandpoint Cr.	9,000	19,000	5,100 (88)	13,900
Shale Cr.	2,000	4,800	2,700 (87)	2,100
5 Mile Cr.	100	200	600 (85)	(-400)
15 Mile Cr.	200	400	400 (85)	0
25 Mile Cr.	900	1,900	1,500 (87)	400
Sakenichie R.	5,000	10,000	300 (85)	9,700
sub total	259,600	543,600	-	-
<u>Bowron Lake</u>				
Bowron R.	18,000	45,400	12,800 (88)	32,600
Total Fraser	5,513,800	12,013,700	-	-

Appendix 4. Current and interim escapement levels for Fraser River sockeye.

Timing/ Stock Group	Escapement Level	Cycle:			
		1985	1986	1987	1988
<b>EARLY RUNS</b>					
Early Stuart	Current	234,000	29,000	148,000	110,000
	Target	500,000	150,000	280,000	150,000
<b>SUMMER RUNS</b>					
Early Misc.	Current	44,000	240,000	382,000	255,000
	Target	350,000	350,000	350,000	350,000
Chilko	Current	86,000	282,000	240,000	375,000
	Target	100,000	300,000	600,000	600,000
Late Stuart	Current	275,000	29,000	6,500	4,000
	Target	500,000	50,000	200,000	50,000
Stellako	Current	42,000	77,000	211,000	80,000
	Target	100,000	300,000	300,000	100,000
Horsefly	Current	1,349,000	181,000	18,000	1,000
	Target	2,200,000	2,200,000	250,000	250,000
Upper Adams	Current	100	600	0	10,000
	Target	200,000	200,000	100,000	500,000
TOTAL	Current	1,834,100	1,145,600	1,023,500	805,000
	Target	3,750,000	3,700,000	2,100,000	2,150,000
<b>LATE RUNS</b>					
Adams	Current	12,000	1,664,000	606,000	6,000
	Target	100,000	2,330,000	2,330,000	100,000
Shuswap	Current	1,000	681,000	11,000	700
	Target	50,000	1,200,000	1,200,000	50,000
Late Misc.	Current	9,000	27,000	46,000	8,000
	Target	100,000	100,000	100,000	100,000
Birkenhead	Current	38,000	336,000	166,000	80,000
	Target	300,000	300,000	300,000	300,000
Weaver	Current	37,000	111,000	60,000	70,000
	Target	80,000	80,000	80,000	80,000
TOTAL	Current	59,000	2,483,000	723,000	84,700
	Target	330,000	3,710,000	3,710,000	330,000
<b>ALL TIMINGS</b>					
	Current	2,127,100	3,657,600	1,894,500	999,700
	Target	4,580,000	7,560,000	6,090,000	2,630,000

Current Escapement: actual escapement in 1985, 1986, and 1987 and pre-season expectations for 1988

Target Escapement: interim target set for rebuilding program by Task Force

## Appendix 5. Evaluation of options for rebuilding.

### Option development

Once the goals for rebuilding were established, it was necessary to analyze options for achieving this potential. How quickly do we want to rebuild stocks? On which stocks do we target our management?

Rebuilding speed is the number of years taken to rebuild target stock escapement from current to interim escapement goals. To rebuild in one cycle requires escapement to increase to the escapement goal in one cycle. Options of rebuilding within one, three and six cycles were considered.

Since there are several co-migrating stocks in each of the main timing windows, (early middle and late stock groups), and the difference between current and interim goals varies among stocks (Appendix 4), we cannot expect to achieve the rebuilding goals on all of them simultaneously. Therefore the management strategy focuses on a target stock within each group. Options include managing to the goals of the dominant (largest run), sub-dominant (next largest run) or weak (smaller run) stocks in all run timing groups and cycles.

Numerous combinations of rebuilding speed and target stocks exist for each cycle and run timing. Only six broad strategies and the recommendation are described in this evaluation (Table A). The recommendation was developed after an analysis of the broad options. The best of the broad options was refined to provide an improved recommended option.

Table A. Rebuilding strategies.

Strategy name	Target stock/rebuilding speed
1. Dominant (1)	Dominant stock/1 cycle
2. Dominant (3)	Dominant stock/3 cycles
3. Dominant (6)	Dominant stock/6 cycles
4. Secondary (3)	Sub-Dominant stock/3 cycles
5. Secondary (6)	Sub-Dominant stock/6 cycles
6. Weak (6)	Weak stock/6 cycles

e.g. For Dominant (1) in the 1988 cycle, the Early Stuart, Chilko and Weaver stocks would be managed to their interim goals in the first cycle rebuilding. For Dominant (3), escapement goals would be increased from current levels in equal amounts such that they achieve their interim goals in 3 cycles.

### Summary of Results

#### 1985 Cycle

Table B shows the evaluation of the options for the 1985 cycle. The most striking result in the 1985 option is the small return resulting from rebuilding,

shown by the low NPV for sockeye for all options. This result suggests that little benefit exists from rebuilding the 1985 sockeye stocks beyond the current strategy, yet there are significant costs in terms of foregone catch. These poor returns from rebuilding can be explained in that the major stock, the Horsefly, is already rebuilding in the base scenario.

Although there is not much difference in the options, in terms of benefits from sockeye rebuilding, they have significant effects on the benefits related to pink salmon. Strategies that focused on dominant sockeye stocks provided positive benefits to pink salmon while secondary or weak stocks options resulted in negative NPVs for pink salmon. The Dominant (6) option has the highest overall NPV and is followed closely by the Dominant (3) option. However, in the Dominant (6) option, both the late sockeye and pink stocks do not rebuild as well as in the Dominant (3) option (i.e. their escapements are well below their target levels).

The recommended option is a modified version of the Dominant (3) strategy. The overall NPV is relatively high and all stocks are rebuilding.

#### 1986 Cycle

The evaluation of the options is shown in Table C. The Dominant (3) option results in the highest economic benefits, but also requires a considerable foregone catch. The Dominant (6) option also results in relatively high NPV and involves a much smaller upfront cost. However, the stocks do not rebuild as quickly and would be 19% short of the target in 20 years.

The recommended option is a modification of combining the Dominant (3) and (6) options. It provides a NPV similar to Dominant(6), with higher foregone catch in the first year but allows rebuilding to within 9% of the target.

#### 1987 Cycle

The 1987 cycle has the greatest rebuilding potential. The largest difference between current and target escapements exist for this cycle, particularly for the late run stocks (Appendix 4). All the options result in high benefits from sockeye rebuilding (Table D). The increased value of the NPV from the worst option (Secondary (3): \$53.2 million) is higher than the NPV of the best option in any other cycle. However, to initiate the rebuilding to achieve these benefits requires substantial costs in the first year with most options requiring a catch reduction of more than 1 million pieces.

The Weak (6) option has the highest NPV for sockeye one of the lowest catch reductions. However, as discussed for the 1985 cycle, the sockeye management actions have a significant effect on the pink stocks and benefits that they generate. Only the Dominant options result in positive benefits for pink salmon. The Dominant (3) option results in the highest combined NPV and it has relatively low catch reductions for both sockeye and pink.

The recommended option is a modified version of Dominant (3). It results in a slightly lower NPV and reduces the foregone catch of both sockeye and pink. It provides similar rebuilding of sockeye and pink stocks.

Table B. Evaluation of options for the 1985 cycle year.

Model option	Option Description			Difference in sockeye NPV from base	Difference in pink NPV from base	Difference in sockeye & pink NPV from base	Difference in 1st year sockeye catch from base	Difference in 1st year pink catch from base
	Early	Summer	Late	(thousand \$)	(thousand \$)	(thousand \$)	(thousand )	(thousand )
Base								
Dominant (1)	E1	H1	W1	(3,422)	30,303	26,881	(1,469)	(868)
Dominant (3)	E3	H3	W3	(33)	45,795	45,762	(471)	274
Dominant (6)	E6	H6	W6	1,415	44,623	46,038	(235)	831
Secondary (3)	E3	LS3	B3	(3,790)	(139,829)	(143,619)	(643)	(5,459)
Secondary (6)	E6	LS6	B6	5,483	(108,542)	(103,059)	(507)	(4,464)
Weak (6)	E3	EM6	A6	(5,750)	(55,041)	(60,791)	(1,088)	(6,461)
Recommended	E3	H3	W2 (120)	1,629	38,828	40,457	(531)	(798)

#### Biological Criteria

Model option	Sockeye escapement (4th cycle)	% of goal	Pink escapement		% of goal	Early runs % of goal (4th cycle)	Summer runs % of goal (4th cycle)	Late runs % of goal (4th cycle)
			2nd cycle (thousands)	of goal				
Base	2,282,000		3,111	0.52	48.0	50.8	45.9	
Dominant (1)	4,036,000	0.88	3,548	0.59	100.0	92.1	56.8	
Dominant (3)	4,026,000	0.88	4,792	0.80	100.0	91.7	57.6	
Dominant (6)	3,456,000	0.75	4,028	0.67	82.2	79.0	50.8	
Secondary (3)	4,356,000	0.95	12,022	2.00	100.0	93.5	100.0	
Secondary (6)	3,601,000	0.79	9,123	1.52	82.2	77.6	81.4	
Weak (6)	3,976,000	0.87	12,925	2.15	100.0	83.7	93.2	
Pink (3)	4,311,000	0.94	5,075	0.85	100.0	93.5	92.9	
Recommended	4,162,000	0.91	5,558	0.93	100.0	92.0	76.0	

Pink values include both 1985 and 1987 options because the management strategy in the brood year affects the returns in both odd year cycles.

Table C. Evaluation of options for the 1986 cycle year.

Model option	Option Description			Difference in NPV from base (thousand \$)	Difference in 1st year catch from base (thousand )	Escapement (4th cycle)	% of goal
	Early	Summer	Late				
Base						4,125,000	
Dominant (1)	E1	H1	A1	39,922	(2,251)	7,323,000	0.97
Dominant (3)	E3	H3	A3	55,102	(1,182)	7,321,000	0.97
Dominant (6)	E6	H6	A6	50,344	(306)	6,099,000	0.81
Secondary (3)	E3	S3	SH3	16,551	(771)	7,508,000	1.00
Secondary (6)	E6	S6	SH6	29,118	(217)	6,888,000	0.91
Weak (6)	E3	H3	LM6	42,837	(1,679)	7,231,000	0.96
Recommended	E2	H5	A3	50,429	(650)	6,817,000	0.91

Biological Criteria

Model option	Biological Criteria		
	Early runs % of goal (4th cycle)	Summer runs % of goal (4th cycle)	Late runs % of goal (4th cycle)
Base	83.3	23.5	80.5
Dominant (1)	100.0	93.9	100.0
Dominant (3)	100.0	93.9	100.0
Dominant (6)	73.3	68.0	92.4
Secondary (3)	100.0	99.4	100.0
Secondary (6)	73.3	95.7	88.5
Weak (6)	100.0	91.9	99.4
Recommended	100.0	79.0	100.0



Table D. Evaluation of options for the 1987 cycle year.

Model option	Option Description			Difference in sockeye NPV from base	Difference in pink NPV from base	Difference in sockeye & pink NPV from base	Difference in 1st year sockeye catch from base	Difference in 1st year pink catch from base
				(thousand \$)	(thousand \$)	(thousand \$)	(thousand \$)	(thousand \$)
Base								
Dominant (1)	E1	C1	A1	111,061	30,303	141,364	(3,761)	(6,307)
Dominant (3)	E3	C3	A3	108,705	45,795	154,500	(1,481)	(2,344)
Dominant (6)	E6	C6	A6	98,416	44,623	143,039	(896)	(1,984)
Secondary (3)	E3	S3	B3	53,245	(139,829)	(86,584)	(2,158)	(5,849)
Secondary (6)	E6	S6	B6	64,284	(108,542)	(44,258)	(1,963)	(5,638)
Weak (6)	E3	H3	LM3	113,526	(55,041)	58,485	(1,378)	(3,769)
Recommended	E2	C3	A4	104,902	46,594	151,496	(1,316)	(1,777)

#### Biological Criteria

Model option	Sockeye escapement (4th cycle)	% of goal	Pink escapement		Early runs % of goal (4th cycle)	Summer runs % of goal (4th cycle)	Late runs % of goal (4th cycle)
			2nd cycle (thousands)	% of goal			
Bas	1,467,000	0.24	2,325	0.39	39.3	23.7	23.4
Dominant (1)	5,481,000	0.90	5,305	0.88	100.0	91.5	89.3
Dominant (3)	5,249,000	0.87	5,914	0.99	100.0	89.6	84.3
Dominant (6)	4,108,000	0.68	4,572	0.76	84.3	74.4	63.6
Secondary (3)	5,923,000	0.98	9,400	1.57	100.0	92.4	100.0
Secondary (6)	5,767,000	0.95	10,315	1.72	84.3	88.7	98.9
Weak (6)	4,824,000	0.80	6,707	1.12	100.0	52.5	90.4
Recommended	5,155,000	0.85	5,743	0.96	100.0	89.4	82.0

Pink values include both 1985 and 1987 options because the management strategy in the brood year affects the returns in both odd year cycles.

## 1988 Cycle

The evaluation of the options for the 1988 cycle are shown in Table E. The Dominant (1) option which involves achieving the interim escapement goals of the dominant stocks in one cycle would provide the highest NPV but would require the greatest catch reduction in the first year of rebuilding. This can be interpreted to mean that in the long term, the harvests from faster rebuilding offset the initial costs. The Secondary (6) option has the lowest catch reductions. Although this option has relatively high economic benefits (NPV), it only enables stocks to rebuild to 69% of their interim target within 20 years.

The recommended option is a combination of the Dominant (1) and (3) options. The objective is to build the Early Stuart and Weaver stock to interim targets in one cycle, and the Chilko stock to its target in 3 cycles.

## Summary of Evaluation

When there is a small difference between current escapement and the interim target, as in the 1984 cycle, the best option is usually to rebuild quickly (Dominant (1)). Stocks with low current escapement and high targets, such as the Horsefly in 1986 or the Adams in 1987, also have higher benefits if rebuilt quickly. Catch increases in future cycles outweigh the large harvest cutbacks required initially for quicker rebuilding. However the quick rebuilding for these stocks puts significant financial hardship on fishermen because of the large foregone catch in the early years. Therefore, the recommendation attempts to reduce these reductions.

Secondary and weak stock rebuilding provide good benefits and relatively low short term costs when conducted slowly, over a 6 cycle period. However these options do not provide the opportunity to achieve the interim targets within a reasonable timeframe (20 years). In the odd years, when pink salmon are present, these strategies result in overall lower benefits than the dominant strategies. Therefore the dominant stock rebuilding strategy was recommended.

The sensitivity of long-term sockeye and pink NPV to the economic assumptions on discount rates and prices was analyzed. The conclusion was that the rankings of the options do not change substantially with lower discount rates. The order of the dominant rebuilding strategies changes, but the NPVs are fairly close. Similarly, when constant prices are used rather than the projected increasing prices, the option ranking does not change substantially.

## Management Options to Address Cyclic Dominance

The previous analysis was based on a conservative estimate of the potential, the interim escapement goals. However the controversy regarding cyclic dominance is unresolved. The optimum escapement in the Adams run was estimated at 2.3 million spawners in the dominant and subdominant cycles whereas the interim target in the off-cycles is 100,000 spawners. The question is whether the system can produce maximum production in all 4 cycles. The proposed schedule for rebuilding will not address this question within the next 20 years.

Table E. Evaluation of options for the 1988 cycle year.

Model option	Option Description			Difference in NPV from base (thousand \$)	Difference in 1st year catch from base (thousand )	Escapement (4th cycle)	% of goal
	Early	Summer	Late				
Base						1,025,000	
Dominant (1)	E1	C1	W1	22,835	(596)	2,163,000	0.82
Dominant (3)	E3	C3	W3	20,838	(281)	2,092,000	0.80
Dominant (6)	E6	C6	W6	19,181	(200)	1,863,000	0.71
Secondary (3)	E3	EM3	B3	19,721	(224)	2,098,000	0.80
Secondary (6)	E6	EM6	B6	20,439	(73)	1,821,000	0.69
Weak (6)	E3	UA6	A6	6,160	(115)	2,259,000	0.86
Recommended	E1	C3	W1 (80)	21,045	(330)	2,093,000	0.80

Biological Criteria

Model option	Biological Criteria		
	Early runs % of goal (4th cycle)	Summer runs % of goal (4th cycle)	Late runs % of goal (4th cycle)
Base	54.7	28.4	66.2
Dominant (1)	100.0	81.1	81.4
Dominant (3)	100.0	77.6	80.5
Dominant (6)	91.3	66.6	78.3
Secondary (3)	100.0	71.2	100.0
Secondary (6)	91.3	60.9	88.4
Weak (6)	100.0	85.6	83.3
Recommended	100.0	77.9	79.7

## Summary of Evaluation

When there is a small difference between current escapement and the interim target, as in the 1984 cycle, the best option is usually to rebuild quickly (Dominant (1)). Stocks with low current escapement and high targets, such as the Horsefly in 1986 or the Adams in 1987, also have higher benefits if rebuilt quickly. Catch increases in future cycles outweigh the large harvest cutbacks required initially for quicker rebuilding. However the quick rebuilding for these stocks puts significant financial hardship on fishermen because of the large foregone catch in the early years. Therefore, the recommendation attempts to reduce these reductions.

Secondary and weak stock rebuilding provide good benefits and relatively low short term costs when conducted slowly, over a 6 cycle period. However these options do not provide the opportunity to achieve the interim targets within a reasonable timeframe (20 years). In the odd years, when pink salmon are present, these strategies result in overall lower benefits than the dominant strategies. Therefore the dominant stock rebuilding strategy was recommended.

The sensitivity of long-term sockeye and pink NPV to the economic assumptions on discount rates and prices was analyzed. The conclusion was that the rankings of the options do not change substantially with lower discount rates. The order of the dominant rebuilding strategies changes, but the NPVs are fairly close. Similarly, when constant prices are used rather than the projected increasing prices, the option ranking does not change substantially.

## Management Options to Address Cyclic Dominance

The previous analysis was based on a conservative estimate of the potential, the interim escapement goals. However the controversy regarding cyclic dominance is unresolved. The optimum escapement in the Adams run was estimated at 2.3 million spawners in the dominant and subdominant cycles whereas the interim target in the off-cycles is 100,000 spawners. The question is whether the system can produce maximum production in all 4 cycles. The proposed schedule for rebuilding will not address this question within the next 20 years.

Obviously the benefits of increased catch would be substantial if it were possible to increase off-cycles to the level of dominant cycles. A separate analysis was conducted to address this question of unknown potential.

This analysis examined each of the twelve discrete management units, the three timing windows in each of the cycles to identify which would be most suitable for further harvest reductions. This suitability was based on where greatest benefits and knowledge could accrue with the least disruption to the fisheries. Alternative harvest proposals were simulated based on differing assumptions (i.e. cyclic dominance or no cyclic dominance).

The results of this analysis indicate that the greatest potential for addressing the cyclic dominance controversy would be to reduce harvest rates to 50% for in the mid-timing 1987 cycle and the late-timing 1988 cycle. The potential costs and benefits of this proposal is shown in Table 9. The late-timing 1988 cycle is the best option because it presents the opportunity for the greatest possible gain if it works while the costs of failure are minor

compared to the potential benefits. The mid-timing 1987 cycle has the potential for modest gains in the long term with essentially no long term cost.

### Recommended Approach

The recommended option is based on managing to the dominant stocks in each run timing group. It involves a schedule of increasing escapements to interim goals based on average run sizes. Rebuilding is based on decreasing harvest rates, from 75-85% in the base to about 65-70% in most timing groups. The projected escapements, Canadian catch and harvest rates are shown in Fig's 7, 8 and 9.

If all stocks were at optimum, the best average harvest rate would be 66%. As few stocks are presently at optimum, the fastest way to get there is to drop harvest rates below 66%. However, this would cause undo hardship on the industry. Therefore, we are recommending a gradual change toward the 66% harvest rate on the larger stocks. On stocks with the greatest potential (e.g. Horsefly 1986 cycle), we recommend more severe harvest rate reductions to achieve this potential sooner.

The difference in catch from the base indicates that most of the sockeye catch foregone in the first 4 years is repayed in the second 4 years (Figure 10). The major exception is the 1985 cycle where the change in sockeye harvest is minor in the long term. However, the increase in pink salmon catch is substantial in the long term.

The plan also includes the opportunity to explore the ultimate potential of the system. It includes a more radical reduction in harvest rate to 50% in two timing windows, the mid-timing 1987 and late-timing 1988 cycles. This approach provides opportunities for substantial benefits and will enable the off-cycle runs to respond to reduced harvest pressure and help to resolve the questions of cyclic dominance.

## Appendix 6. Potential enhancement projects for Fraser River sockeye.

### Stuart River Watershed

The Early Stuart Sockeye run is comprised of 25-30 separate populations that spawn in tributaries of the Middle River and Takla and Trembleur Lakes (Fig A). Dominance for the run as a whole is on the 1989 cycle with the Driftwood River accounting for one third of the total spawners in 1985. Some tributaries are dominant on the 1987 or 1988 cycles. Enhancement of several of the tributaries is recommended to either increase rebuilding rates on off cycle years or to provide fry to rear in specific areas of Takla and Trembleur Lakes now assumed to be greatly underutilized. Possible stocks for enhancement include Dust Creek, on the west arm of Takla Lake, Paula Creek, on the west end of Trembleur Lake, and Gluske and Leo creeks which are tributaries of the Middle River. Leo Creek supports very few sockeye but could benefit from habitat improvement and a transplant from Gluske Creek. It is also a potential community involvement project as it is near an Indian community. One possible approach would be to install a central incubation facility with the capacity to simultaneously handle eggs from several stocks. The stocks to be enhanced could change annually depending upon requirements. This approach needs further investigation to determine its feasibility.

The Driftwood River is a possible candidate for a spawning channel. Being situated at the north end of Takla Lake, the fry would have the opportunity to disperse along the length of the lake. Significant numbers of spawners are available only during the 1989 cycle at present. A transplant from Middle River streams during the off cycles may provide a means for building up the low years. Further bioreconnaissance is recommended.

Lake Stuart sockeye spawn primarily in Middle and Tachie rivers with smaller populations in Kuskwa and Kazchek creeks. Dominance is on the 1989 cycle. The Tachie River was proposed by the IPSFC as a site for a major spawning channel. The proposal has been examined by DFO engineers and found to be feasible. The Task Force supports the concept of spawning channel in the Tachie River but recommends a phased approach to its implementation. The gravel quality of the Middle River spawning grounds is considered to be poor. To improve egg-to-fry survival, gravel addition is recommended, particularly near the confluence with Kazchek Creek.

### Nechako River Watershed (excluding Stuart)

A sockeye population that spawns in the Lower Nadina River (Early Nadina sockeye) at one time numbered in excess of 30,000 but has since dwindled to less than a thousand fish on the 1987 and 1988 cycles and virtually none on the other two cycles. It appears headed for extinction unless remedial action is taken soon. An incubation facility associated with the Nadina spawning channel may be feasible and should be explored.

The late Nadina stock, which spawns further up the river, is enhanced by a spawning channel, although the productivity of the stock is less than desired. The natural spawning grounds are of poor quality and both salmon and trout would benefit from the addition of good graded gravel. The project is technically feasible and has the support of the local provincial government fisheries managers.

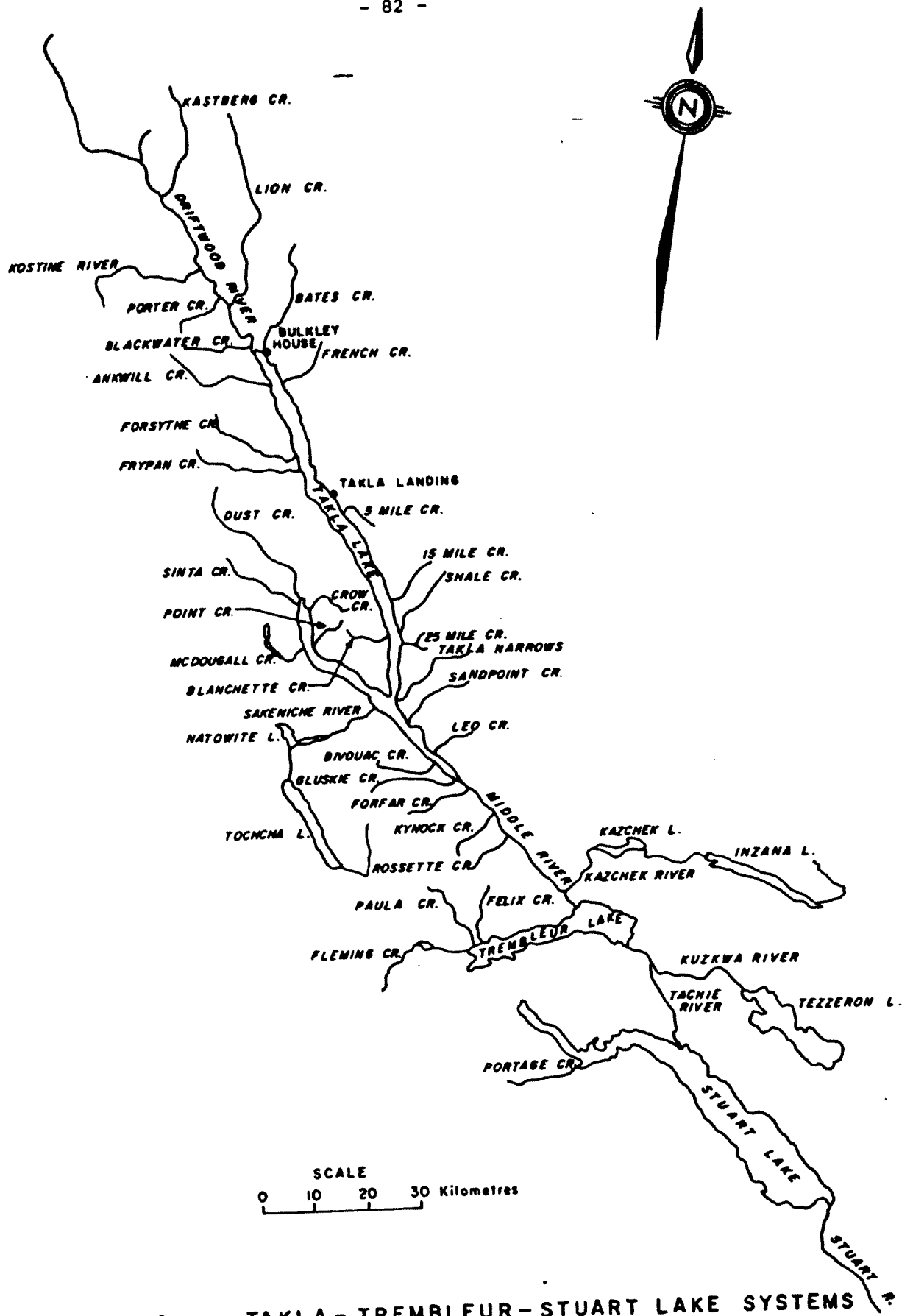


FIGURE A. TAKLA - TREMBLEUR - STUART LAKE SYSTEMS  
SALMON SPAWNING STREAMS.

Even if the Nadina spawning channel was operated to full capacity and the natural spawning populations of Early and Late Nadina sockeye were restored to historical levels, there would still be substantial unutilized rearing capacity in Francois Lake. To take advantage of this potential, one suggestion is to build a spawning channel adjacent to the Stellako River and transport the fry back to Francois Lake for rearing. This proposal requires considerably more discussion and investigation.

#### **Quesnel Lake Watershed**

The Horsefly River sockeye population has been increasing rapidly in recent dominant cycle years (1989 cycle). While historically, the majority of spawning occurred in the Lower Horsefly River, most of the recent spawning has been in the upper river, which was at capacity in 1985, although about 260,000 spawned in the lower area that year. To assist in the rebuilding of the lower Horsefly run on both the dominant and subdominant years and to take advantage of the vast rearing potential of Quesnel Lake, a moderate sized spawning channel (to produce 500,000 adults) is recommended for construction on the Lower Horsefly River. The channel should be constructed in time for the 1989 run.

It is also recommended that the airlift of sockeye above the falls undertaken in 1985 be repeated in 1989 and subsequent dominant years. The number of fish transferred will be dependent on surpluses available but could be up to 100,000. In the long term, installation of a fishway should be considered, if the benefit-cost warrants it.

On the Mitchell River, the possibility of installing a flow control structure to improve egg-to-fry survival should be pursued. The concept of a spawning channel for the Mitchell River needs further consideration as the capacity of the spawning grounds may already be exceeded on the dominant cycle. Returns from a channel would exacerbate this situation.

Enrichment of Quesnel Lake is recommended by the Task Force as it would benefit all stocks in the lake and generate larger catches.

#### **Bowron River**

This is a small stock (up to 12,000 spawners recently), which is strongest on the 1987 and 1988 cycles. Massive clear cutting in the watershed may reduce productivity so some form of enhancement to stabilize production is recommended.

#### **Middle Fraser**

A spawning channel on the Chilko River commenced operation in 1988 to increase the number of fry entering this large lake. Enrichment of the lake also started in the fall of 1988 to improve growth and survival of the juveniles. No further enhancement is recommended at this time other than continuation of enrichment and supporting evaluation studies.

Portage Creek, situated between Seton and Anderson lakes, would benefit by work to improve channel stability around the mouth of the stream to increase egg-to-fry survival. This is a potential community involvement project.



## Thompson River Watershed

Fennell Creek in the North Thompson watershed is a possible candidate for enhancement but would require development of a surplus fish utilization policy, otherwise escapement will grossly exceed capacity as it is starting to do now on some years. The local Indian band could potentially benefit from the returns if a satisfactory arrangement could be worked out for harvesting the surplus.

In the lower Adams River the addition of gravel and a flow control structure on the "display area" channel would improve egg-to-fry survival. While fish now spawn in this area, when water levels decline in the winter, the eggs are lost.

Continuation of the hatchery operation in the upper Adams River to restore this once large run is strongly urged.

Possible spawning channels for sockeye in Seymour River and Scotch Creek should be considered. Seymour River is quite flashy so a channel would help to stabilize production and also have the benefit of adding fry into the Seymour Arm of Shuswap Lake which is underutilized.

Production of the Middle Shuswap River stock, which rears in Mabel Lake, is limited by the poor quality of the gravel (siltation from flushing of the nearby hydroelectric dam contributes to the problem). An enhancement facility to augment production and to take advantage of rearing capacity in Mabel Lake is recommended.

## Lower Fraser

Escapements of several late-timed stocks in the lower Fraser Valley have been reduced by the high harvest rates (up to 90%) applied to the co-migrating Weaver Creek run which is enhanced by a spawning channel. The Cultus Lake stock is relatively strong on the 1987 cycle (32,000 spawners in 1987) but weak on the other cycles, particularly on the 1988 and 1989 cycles. Some form of incubation to increase fry production is recommended. Also, predator control has been previously investigated for this stock and found to benefit production. Further assessment of the potential for predator control (especially squawfish) should be undertaken.

Widgeon Slough, which supports a small late-timed run, has poor quality silt-laden gravel which probably affects egg-to-fry survival. It is recommended that gravel be added to improve survival. This is a potential community involvement project.

The Harrison River sockeye stock is also low in abundance. The feasibility of developing enhancement techniques for this stock is recommended. These fish are unique in the Fraser in that they apparently rear in side sloughs or in the river for a period of time (rather than in a lake) before migrating to the estuary.

Big Silver Creek, which empties into Harrison Lake, has spawning escapements which are well down from historical levels. Natural alterations in the channel configuration in the vicinity of the spawning grounds are considered to have affected production. The feasibility of returning water flows to the lower right channel, where most spawning previously occurred, should be examined.

Production of Upper Pitt River Sockeye has been supported by an incubation channel for many years. The facility needs replacing and consideration is being given to re-establishing it on a different tributary. Expansion of the facility and possible construction of a spawning channel to further augment production has been discussed. As there is navigable access from the Fraser River to Pitt Lake, the possibility of directed fisheries for sockeye in Pitt Lake should be considered. This may, however, have an impact on the small early-timed chinook run into Pitt Lake which is now being enhanced.

## Appendix 7. Options for implementation.

### A. Strict Escapement Goals

Under this approach, the users bear all the costs and gain all the benefits associated with the variability in return rates. In poor years, they will give up catch to ensure that the escapement target is met. In the good years, all sockeye surplus to the goal are caught.

This approach would result in varying harvest rates, ranging from 0% if the run comes back equal to or less than the escapement goal, to over 90% if the run comes back substantially higher than expected. Very low harvest rates would be difficult for the users to accommodate while high harvest rates could have adverse effects on other co-migrating species.

If the dominant stock has a higher return rate than the other co-migrating sockeye stocks, the resulting high harvest rate could limit the rebuilding potential of the other stocks. This effect will be most exaggerated if the approach is directed at achieving the dominant stock escapement. If the approach is directed at achieving the aggregate escapement for the timing group, the effect on the other stocks would be moderated and there would be some surplus escapement to the dominant stock.

If the other stocks have a higher return rate than the dominant stock, this approach could result in surplus escapements to these other stocks (e.g. Stellako in 1988).

The strict escapement approach would provide a very high likelihood of following the recommended rebuilding schedule for the dominant stocks. However, because of the variability in the other stocks, they could be ahead or behind schedule. The current assumption is that the average productivity is the same for all the Fraser sockeye stocks. However, if this assumption is false, the disparity between the dominant and co-migrating stock escapements would increase from cycle to cycle.

### B. Flexible Escapement Goals

With this approach, the users and the resource share the costs and benefits associated with variability. In years of poor returns, the escapement goal is lowered and catch is reduced. In good years, the escapement goal is increased to some predetermined maximum and the users receive higher catches. Since harvest rates must be maintained at levels consistent with the productivity of co-migrating stocks, this approach also enables other sockeye stocks and other species to benefit.

Escapement surplus to the interm goals can occur with this approach. If the dominant stock returns at a much higher rate than average, the escapement goal would be limited to its interm goal, until the point where harvest rates became unacceptable for the rebuilding of the other stocks. In this case the escapement of the dominant stock would exceed the interm goal. If the dominant stock returns at a lower than average rate, and the other stocks return at a higher rate, the escapements of some stocks may exceed their interm goals.

This approach enables rebuilding to proceed at either a faster rate than in the recommended schedule or more slowly in response to the variability in return rates. This is a positive aspect of this approach since it allows the rebuilding plan to take into account the long term cycles in salmon productivity.