



Pacific Fisheries Resource Conservation Council

## Fraser River Sockeye

*Prepared by*  
Richard Routledge and Ken Wilson

June 1999

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Richard Routledge and Ken Wilson

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## TABLE OF CONTENTS

|   |           |
|---|-----------|
| <b>HISTORICAL PERSPECTIVE .....</b>   | <b>1</b>  |
| <b>PRELUDE TO THE 1988 FISHING SEASON .....</b>   | <b>4</b>  |
| <b>THE 1988 FISHING SEASON.....</b>   | <b>6</b>  |
| <b>CONCERNS RAISED DURING THE SEASON.....</b>   | <b>11</b> |
| Were the escapement goals reasonable? .....   | 11        |
| From a conservation perspective, did management respond appropriately to the uncertainties generated by unstable ocean survival and behaviour and warm river water? ..... | 12        |
| What was the explanation for the large discrepancies between Mission and upriver estimates? Can these be reduced? .....   | 13        |
| Was there overescapement? .....   | 14        |
| <b>COMMENTARY.....</b>  | <b>16</b> |

## TABLE OF FIGURES

|  |    |
|--|----|
| Figure 1. Upper Adams Sockeye spawning estimates. ....   | 3  |
| Figure 2. Daily carcass counts at Mission (lagged by six days) vs. upriver passage estimates. ....           | 7  |
| Figure 3. Escapement estimates vs. targets for the four major run timing groups of Fraser sockeye. ....      | 10 |
| Figure 4. Escapement goals vs. recent estimates for the four major run timing groups of Fraser Sockeye. .... | 12 |
| Figure 5. Mission Sockeye total carcass counts. ....   | 14 |

## HISTORICAL PERSPECTIVE

The summer of 1941 was a turning point for Fraser River sockeye. It held the potential for irreparable damage. The narrows at Hells Gate were still blocked by rock debris, despite earlier attempts to clear away the remnants of the 1914 slide. When the water was at the wrong height, fish could not pass through. In 1941, the water was at the wrong height. It was also very warm. To sockeye returning from the much cooler North Pacific, it was hot. In mid-July, the river temperature at Hells Gate reached 21° C. It would not be this warm again for over 50 years.

This was in fact the first year that water temperatures were recorded at Hells Gate. The International Pacific Salmon Fisheries Commission which was created in 1937 and started conducting engineering investigations for the fishways. The most visible step in the program to rebuild Fraser River sockeye had begun.

Many people think that the 1914 slide that blocked fish passage at Hells Gate was the sole cause of the collapse of Fraser sockeye, and that the building of the fishways in the 1940s allowed the sockeye runs to rebuild to the post-slide record levels of the early 1990s. In truth, the slide was only the most dramatic event in a tragedy of errors whose legacy can still be felt.

Most Fraser River sockeye stocks have a four-year abundance cycle. Until early in this century, all the major upriver stocks peaked in the same year, the 1901–05–09–13 cycle. No one really knows how many sockeye returned to the Fraser in the past in these big (so-called dominant) years before Europeans arrived. In 1913, over 30 million fish were caught, and some believe that the runs may once have been over twice as large. Nor can anyone be certain how many Aboriginal people lived along the migration route, building livelihoods based in large part on the abundant resource. Before smallpox and other European diseases decimated the communities, there appear to have been at least 100,000 individuals, possibly many more. By all accounts, Fraser River sockeye were an abundant, valuable resource.

Yet it was also unpredictable. Early Hudson Bay Company records provide evidence of local food shortages from failed runs, and there is evidence of a major catastrophe for both fish and humans 1100 years ago when a slide blocked the Fraser at Texas Creek near Lillooet. The continuing abundance of Fraser River sockeye could never be taken for granted.

By the 1830s, the Hudson Bay Company had developed a small business exporting salted salmon in locally manufactured barrels to the Hawaiian Islands. But the market was limited. Business never flourished as it had for salt cod from Canada's Atlantic coast—not until industrial technology broke through. By the late 1800s, advances in processing and transportation made it possible for Durham coal miners in northern England to lunch on a can of Pacific salmon. A thriving, virtually unregulated canning industry at Steveston began jostling to catch as much salmon as possible to meet an almost limitless European demand.

At first, the resource must have seemed limitless, as did the forests in the surrounding uplands. A cannery's output was limited more by what it could catch, process, and sell than by the size of the resource. There was no organized monitoring of the spawning grounds. Very little was even known about the fishes' homing abilities. The open competition left no incentive to conserve the resource anyway. It couldn't last, and through the early 1900s, the catch in the nondominant years began to dwindle.

Upriver, events of possibly greater significance were unfolding. Gold had been discovered in the Cariboo. Stampeders had churned over prime sockeye spawning beds in the Quesnel watershed in a search that eventually led over the mountains to Barkerville. In their wake, came the Golden

River Quesnel Company. The easy pickings had been taken. A dam across the mainstem of the Quesnel River itself would help in getting more.

They built the dam in 1898. It didn't have a fishway. A truly functional fishway wasn't built until 1903. It was lucky that any of the Quesnel sockeye survived the combined effects of both the dam and the subsequent slide at Hells Gate. Few, in fact, did, and the run was decimated for decades. In 1937, in what should have been a dominant run, only 200 fish were estimated to have returned to spawn, and their offspring had to face the severe conditions at Hells Gate in 1941. From this perilous low, the run has rebuilt. After reaching a plateau in the 1960s, the run recently increased again to surpass the Adams run in the early 1990s. Perhaps now, a full century after its construction in 1898, the only visible legacy of the dam is the few remaining timbers that can still be seen in the riverbed downstream from the bridge at Likely.

The eventual rebuilding of the Quesnel run is a success worth celebrating, as indeed it is in sockeye celebrations organized by the Quesnel River Watershed Alliance and the Secwepmec tribe of the Shuswap Nation. Yet Quesnel sockeye, and indeed all our wild salmon, are still constantly challenged by potentially hazardous conditions, many of them created by humans.

Most of these fish spawn in the Horsefly River. Clearcut logging is continuing at a rapid pace in the Upper Horsefly River, and on some stretches, cattle graze right to the riverbank.

Smolts must make the challenging adjustment to salt water in the heavily polluted Fraser Delta. Young adults must then survive in an ocean environment that has recently experienced what some believe to be dramatic declines in nutrients that sustain the base of their food chain.

Mature adults that escape extensive fisheries return to spawn in rivers and streams whose flow patterns are becoming more volatile. Environment Canada scientists have documented reduced summer and fall flows and higher early winter flows in some interior BC streams. These changes are consistent with expected impacts of global climate change.

While the success of stock rebuilding on the Quesnel from a few hundred spawners has been dramatic, the scene to the south on the Upper Adams River, is a stark reminder of how much remains to be accomplished.

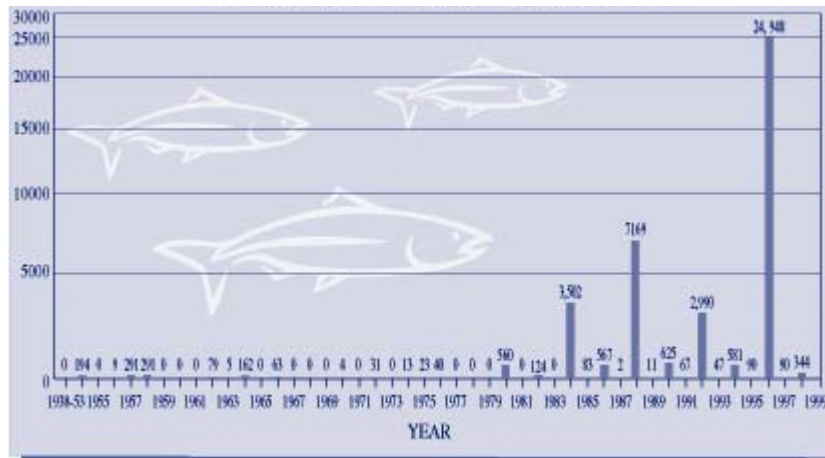
In 1908, a logging company built a dam on the Lower Adams River just below Adams Lake. The country's most important sockeye spawning ground was to be held in servitude to the logging industry. Loggers had learned in the eastern forests how to use the spring break-up to send winter-cut logs on a wild ride to down-river markets. It would become a part of North American folklore. But spring break-up comes only once a year, and is not always reliable. Commerce was at the mercy of a capricious Mother Nature. The dam on the Adams River would solve that problem. Logs could be stored in the lake above the dam, and when enough logs were gathered, "Spring" could be generated by opening the dam. The torrent of water carried logs thrashing down through the prime spawning gravels of the Lower Adams River.

The dam was operational from 1908 to 1921, at times creating spring-like floods on a daily basis. Sockeye somehow survived below the dam, but in small numbers, and their offspring eventually thrived many generations later. The first sockeye to return after the dam ceased operation, in 1922, founded a new dominant cycle that rebuilt to 15 million returning adults in 1958.

But the dam totally blocked access to Adams Lake and beyond. The Upper Adams run, "once so great that every tributary of the lake extending to Tumtum Lake at the head of the watershed was overcrowded with spawning sockeye" (Babcock, 1902-32), was apparently driven to extinction. The dam was removed in 1945 by the International Pacific Salmon Fisheries Commission. Over

40 years of stock replacement work followed. Eggs, fry, and juveniles from other stocks were introduced beginning in 1949. After over half a century of reopened access and stock rebuilding, the Upper Adams run finally showed signs of truly rebounding to its potential in 1996 (Figure 1). This appears to be emerging as a dominant four-year cycle line, with a few hundred spawners in the 1998 line, and fewer than 100 in the other lines. The next solid evidence on the rebuilding of Upper Adams sockeye will come in the year 2000.

**Figure 1. Upper Adams Sockeye spawning estimates.**



These populations, the Quesnel and Upper Adams sockeye, represent two extremes of the rebuilding program that began in earnest in the 1940s with fishway construction and international agreements to limit fishing. The program has been generally successful, but progress has been unsteady. Estimates of both total numbers of adults returning to the coast and numbers of spawners show the same general pattern. Both climbed through to the late 1950s, fell back, and then stagnated for about 20 years. From the late 1970s through to 1991, there was a period of solid gains. Then another period of uncertainty began. In three of the next four years, spawner estimates fell below the levels in the parent generation—in 1994 from a record six million to only three million fish.

How far can the rebuilding process be taken? There is evidence that some lakes may be reaching their capacity to support sockeye in the dominant years, but this evidence is not conclusive. If Fraser sockeye were the product of a chemical engineering process, engineers could probe process capacity through a cleverly designed sequence of substantial adjustments made under carefully controlled conditions. But neither the Fraser River nor the northeastern Pacific Ocean is controllable. Nor is it reasonable to impose wild swings on people's livelihoods. As a result, the information is inconclusive. For example, for the sockeye that rear in Quesnel Lake, there is a long series of generally increasing spawning numbers as the stock rebuilt. Any signs of weakness that might be attributable to increasing population densities could equally be attributed to a trend in environmental quality.

Finally, there is the unknown potential for rebuilding the nondominant-year runs. Scientists remain uncertain about the causes of the dominance cycles. As long as this issue is unresolved, no one can be certain how far we can, or should, go toward rebuilding these smaller runs.

We do know, however, that the rebuilding process has been slow, and that setbacks have occurred. The parent generation for this year's late-run sockeye experienced a substantial setback in the turbulent 1994 fishing season. The Department has no firm policy that dictates a response to such a setback. This was to contribute to friction as the 1998 season began.

## PRELUDE TO THE 1988 FISHING SEASON

Signs of trouble ahead for the 1998 fishing season started developing well before the year even began. In 1997 came signs of continuing environmental instability. In early July of that year, heavy, warm rains fell on the snowpack in the upper watershed. A combination of melted snow and rainwater poured down tributaries and into the Fraser. The Clearwater River knocked out the highway, and tourists were stranded in Wells Grey Park for over a week. While tourists were inconvenienced, fish were dying. The first half of the Early Stuart Run, heading for the far northern reaches of the watershed, met the floodwaters in the Fraser Canyon. They were already low on fat reserves when they entered the river. The run was decimated. Of an estimated 1,259,000 fish passing Mission, only about 313,000 were estimated to have been caught or to have arrived at the spawning grounds. Furthermore, only about a third of these were females, many of which had lost their eggs. About 20 percent died before spawning. The component heading to the Driftwood River, the backbone of that cycle year, was almost wiped out.

Although the river subsided before the later runs arrived, they showed evidence of having encountered unfavourable ocean conditions. The runs were unusually late and protracted. The fish were much smaller than normal, and unusual numbers seemed to abandon the effort to migrate to their home spawning areas. This created extra uncertainty for 1998. The reduced fish size and migration anomalies could have been early signs of major problems to come.

Of additional concern for the following year, was the small number of younger, three-year-old males, called jacks, who came back in 1997. Every year, a small proportion of three-year-old Fraser sockeye choose to migrate home a year early. When a lot of jacks come back, it is a sign that perhaps there is a large population of three-year-olds at sea, most of which will come back the next year. Jack returns in 1997 were alarming. Only 8,000 jacks were estimated to have returned to the Fraser system in 1997 vs. 58,000 in the 1993 parent generation. For the Adams stock, the estimates were 400 vs. 20,000. The Department's official forecasts did not incorporate this evidence. To have accepted the evidence at face value would be, in the words of the Pacific Stock Assessment Review Committee Advisory Document of March, 1998, "to assume unprecedented and catastrophic low survival of the 1994 brood." It was clearly reason for concern and caution.

Troubles over the Department's Aboriginal Fisheries Strategy were also brewing. Negotiations over Pilot Sales Agreements had proved difficult. For the first time in seven years, no sales agreements were signed with any groups above the Port Mann Bridge. Annual negotiations with the Stölo First Nation also failed to reach agreement on their participation in fisheries management. This would add to the difficulties in managing the fishery and in estimating the catch. Both the Cheam Band and a large contingent of the commercial fleet also prepared to mount protest fisheries to assert what each perceived as their rights.

Even without these extra difficulties, managing the fishery is a difficult task. Fraser sockeye migration begins in late June and continues through September and early October. It is a complex phenomenon as wave after wave of spawners enter the river on their way to spawning areas scattered throughout the watershed from the Pitt River near Vancouver to the remote Driftwood Valley over 300 kilometers northwest of Prince George. Managers have divided the incoming runs of fish into four groups based on the usual timing of entry into the Fraser: Early Stuart, Early Summer, Summer, and Late. In many instances, stocks within these groups share little more than their approximate entry time into the river. The Early Summer group, for example, contains the remnant of the Upper Adams stock that must swim through the Fraser and Thompson canyons and on up to the approaches to the Columbia Mountains, and the Pitt River stock, some of which

never leave tidal water. Migration conditions and sustainable harvest levels may differ markedly for different stocks in the same run-timing group.

DFO sets annual escapement targets (goals for the numbers of fish that will be allowed to “escape” the fisheries and return to the spawning grounds) for each of these run-timing groups and for some of the larger stocks within these. As the sockeye approach the coast and enter the Fraser River, the Pacific Salmon Commission estimates the size of each major run. These estimates are used to make decisions regarding fishing opportunities. It is a difficult task. Managers have yet to find a way to generate accurate estimates without either catching a substantial fraction of the incoming run of fish or waiting until the fish are well into the river, where fish passage can be estimated by a combination of echo-sounding and test fishing. Even these estimates are tricky to calculate, and may be influenced in unpredictable ways by changes to fishing regulations or shifts in fish behaviour. Estimates of abundance are never precisely accurate, even at the end of the migration when the fish have arrived at their spawning grounds. Most of the smaller stocks are estimated through counts conducted by field staff who survey the spawning beds from one to a dozen or more times in the spawning season. The results will be highly dependent on time at which the surveys are conducted. If the observer catches the peak of the run, the estimate will be higher. No one is certain how best to adjust these incomplete counts for bias.

To further complicate matters, there is considerable overlap in the timing of the four groups. It is not possible in an ocean-based mixed fishery, or even in a river fishery to some extent, to manage these groups entirely separately. In addition, the complex allocation objectives, with separate consultation processes for Aboriginal fisheries, add to the complexity of the process.

Lately another complication has become more worrisome. In the last two years, the Fraser has presented the fish with unusually high flows and then low flows and high temperatures, both setting new records. It is becoming increasingly difficult to predict the number of fish that will arrive at the spawning grounds in sufficiently good condition to be able to spawn. Management of Fraser River sockeye is not only highly complex but also highly uncertain.



## THE 1988 FISHING SEASON

In the second week of June, the first Fraser sockeye approached the northern tip of Vancouver Island. A week later, sockeye were appearing in the test fisheries in Juan de Fuca Strait and the Lower Fraser River, and a few days later, the first sockeye were passing Mission.

By the last week of June several thousand sockeye were estimated to be passing Mission each day and analysis of scale patterns showed that all the sockeye entering the Fraser were headed for the Stuart River system beyond Prince George. This was the Early Stuart Run as expected. Yet most of these sockeye were five, not four, years old. Usually, most Fraser sockeye return at age four. The poor showing of four-year-old fish could indicate weak ocean survival.

There were additional causes for concern. Some Cheam Indian Band members continued fishing for sockeye in the lower Fraser River near Agassiz in protest over the continuing chinook sport fishery. Even more troubling were the record high temperatures that the migrating sockeye were encountering in the Fraser.

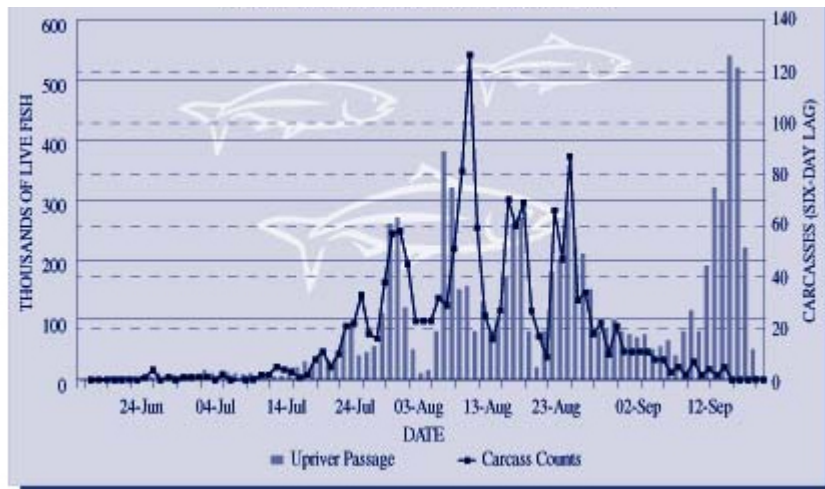
The summer unfolded as one of the hottest and sunniest in most people's memories. The average Vancouver temperature over July, August and September was the warmest in 61 years of records. Vacationers revelled in the seemingly endless sunshine. Yet for sockeye migrating up the Fraser River, it was a potential disaster. By July 1st, the Fraser River water temperature had broken the record for that day set in 1941 at Hells Gate. As the summer progressed, the temperature kept pace with the record, surpassing it on 31 of the 92 days through to September 30th. On August 3rd, it set a new all-time high of 21.2°. At 18°, sockeye typically start to experience difficulties; 24° is essentially lethal. From July 6th to August 26th, the temperature was at or above 18° on all but two days, when it dipped to 17.9°.

By the first week of July the first Early Summer sockeye were also entering the Strait of Georgia. The proportion of five-year-old fish was still very high, and temperatures remained a serious concern.

A week later, the peak of the Early Stuart migration passed Mission mixed with the first of the Early Summer runs. The Early Stuart run appeared to be close to forecast. Although this was encouraging, record high temperatures continued throughout the Fraser, reaching 22° in the Nechako. Early Stuart sockeye would have to swim through this near-lethal water. On July 10th, the Department issued a forecast of 56 percent pre-spawn mortality for Early Stuart sockeye.

Back at Mission, the crew on the echo-sounding boat began recording unprecedented numbers of carcasses drifting downriver. These counts would remain high throughout the summer. Peak carcass counts tracked the peaks in upriver migration with an approximate six-day lag (Figure 2).

**Figure 2. Daily carcass counts at Mission (lagged by six days) vs. upriver passage estimates.**



By mid July, 150,000 Early Stuart sockeye and 11,000 Early Summer sockeye were estimated to have passed Mission. The Early Summer migration appeared to be slightly earlier than usual. The first of the Summer Run of sockeye also began entering the Strait of Georgia. The Cheam Band ended their protest fishery.

Meanwhile, a controversial sockeye agreement between Canada and Washington State was signed on July 2nd. Canada agreed that U.S. fisheries could harvest a maximum of 24.9 percent of the total allowable catch of Fraser sockeye in Panel waters. On the other hand, U.S. fisheries were restricted to operating between July 27th and August 21st. Closing U.S. sockeye fisheries on August 21st (even if their harvest was less than 24.9 percent of the total allowable catch) contributed significantly to conservation of the Adams River component of the Late Run sockeye. Without this agreement, the U.S. would most likely have fished through August and into September in an attempt to harvest what they felt was their share of Fraser sockeye.

During the third week of July, Canada delivered a memo to the U.S. establishing gross escapement targets (170,000 Early Stuart, 484,000 Early Summer, 3,055,000 Summer, and 2,957,000 Late Run sockeye). By July 21st, an estimated 167,000 Early Stuart sockeye had passed Mission, along with 46,000 Early Summer and 3,000 Summer Run sockeye. The number of Summer Run sockeye entering the Strait of Georgia continued to grow, while the last of the Early Stuart Run passed Mission. By the end of this third week, temperatures at Hells Gate had risen above 19° and were continuing to climb rapidly.

By the fourth week of July, the majority of sockeye entering the Strait of Georgia were Summer Run fish. U.S. and Canadian commercial fisheries began late in the fourth week of July. The troll fishery off the northern tip of Vancouver Island and the gillnet fishery in Johnstone Strait were the first Canadian commercial fisheries of the sockeye season. Although they were targeting Summer run sockeye, Early Summer stocks were a significant part of the catch (up to 25 percent). On July 31, catches in the test fisheries and first commercial openings prompted a downgrading of the Early Summer run-size estimate to 400,000 from the pre-season forecast of 642,000. The Summer run-size estimate was also downgraded to four million from a pre-season forecast of 6.6 million. The first of the Late Run sockeye were also showing in the entrances to the Strait of Georgia. On July 29th, the water temperature at Hells Gate reached 21.2°. Two days earlier, it had reached this level in the Horsefly River. Two days later, it peaked in the Nechako at 22.5°.

During the first week of August, commercial fishing continued in the U.S., Canada expanded commercial fishing into the Strait of Georgia, and Fraser River First Nations began fishing sockeye in earnest. Catches in the U.S. fisheries were very poor. Most fish were apparently entering the Strait of Georgia through Johnstone Strait. Improved test fishing catches and catches in the commercial fisheries indicated that the Early Summer sockeye run was not as weak as first thought. On August 3rd, the water temperature at Hells Gate tied the new all-time high at 21.2°.

On August 4th, a decision was made to harvest more Summer Run sockeye from the first part of the run and fewer from the latter part of the run, because the early migrants were encountering lethal temperatures. The water temperature was forecast to decline. Furthermore, the low harvest rate planned for Late Run sockeye would make it impossible to fish heavily the later part of the Summer Run. This decision was viewed with alarm by conservationists. The commercial gillnet fishery in the Lower Fraser was open for 30 hours ending at noon on August 6th. On August 7th, the Early Summer run-size estimate was increased to 450,000. The Summer run-size estimate was also upgraded to 4.5 million but was still two million less than the pre-season forecast. The first indication of Late Run strength suggests a return of three million (slightly below the forecast).

At the same time, very few sockeye were reaching the spawning grounds in the Stuart River system. Concerns for the effects of the record high temperatures, particularly for sockeye returning to the Quesnel watershed, led DFO to unilaterally increase gross escapement targets for summer run stocks to compensate for an expected pre-spawning mortality of 40 percent. The increased escapement target combined with the lower run size meant that there was no harvestable surplus and DFO closed Canadian commercial fishing.

By the end of the first week of August, Canadian commercial fisheries had harvested just over 1.1 million sockeye while the U.S. had harvested just over 300,000. Escapement past Mission was estimated at 169,000 Early Stuart, 297,000 Early Summer and 1.1 million Summer. Late Run sockeye were now entering the Strait of Georgia.

During the week that followed, water temperatures began to decline, but fish physiologists were still anticipating severe migration difficulties. Yet no one could predict with any certainty how many fish would die in the river or be unable to produce viable eggs and sperm on the spawning grounds. Canadian commercial fisheries remained closed while experts debated. After much discussion, the U.S. agreed to an increase in Summer Run escapements corresponding to a 25 percent increase in spawner loss, while Canada insisted on 35 percent.

On August 18th, a second peak of summer run sockeye was evident from test fishing catches, and the run size estimate for summer sockeye was increased to six million sockeye. The run size estimate for Late Run sockeye remained at only three million. With almost 400,000 Late Run sockeye already harvested, and an escapement target of 2.55 million, there was no apparent harvestable surplus. In the approach waters, the Summer and Late runs were intermingled. However, the Late Run appeared to be following their usual pattern of holding off the mouth of the river. Any fishing on Summer Run sockeye would have to take place within the Fraser. A 24-hour pilot sale fishery for Musqueam, Burrard and Tsawassen First Nations beginning on August 19th was accompanied by a protest fishery by commercial gillnet licence holders. This was followed by a gillnet commercial fishery on August 20th-21st.

On August 21st, Pacific Salmon Commission staff reported that Late Run sockeye bound for the Adams and Lower Shuswap rivers were in the lower Fraser as far upstream as Qualark Creek near Yale. With no room to harvest Late Run sockeye and still meet the escapement goal, commercial and First Nations sockeye fisheries were closed for the season during the last week of August.

A small run of Late Run sockeye passed Mission earlier than usual, in late August and the first few days of September. This unusually early appearance of Late Run sockeye in the river was particularly mysterious given the high river-water temperatures. On August 28th, the Late Run size estimate was reduced to 2.8 million.

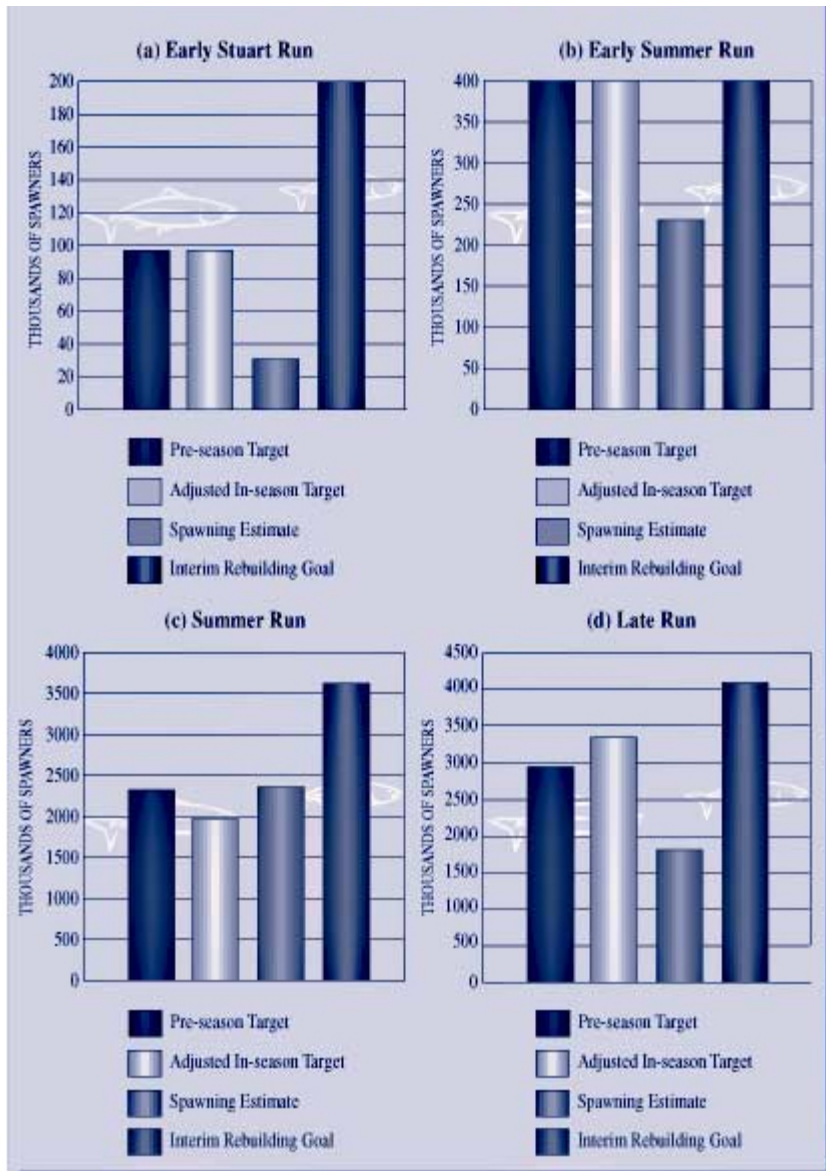
Then in mid-September a large wave of Late Run sockeye swept past Mission. The run peaked sharply at Mission on September 15th and 16th when half a million fish passed Mission in one day. Three days later, the run was abruptly over. The run size estimate was upgraded to 4.3 million.

As spawning ground estimates became available, major discrepancies appeared between the up-river passage estimates at Mission and the combined estimates of up-river catch and numbers of spawners for all run-timing groups. Either around 3.5 million fish died in the river, or some of these estimates contained substantial errors. As a result, spawning escapement targets were not met for any of the runs except the Summer Run, which exceeded the 1998 target but not the longer-term interim rebuilding escapement goal (Figure 3).

The 1998 season showed once more how difficult it is to manage the fishery in the presence of so much uncertainty. The uncertainties are not likely to diminish in the immediate future. This winter's incessant storms have deposited an unusually large snowpack in southern British Columbia, especially in the coastal mountains—by mid-March, over nine meters were recorded, even on the mountains on the North Shore of Burrard Inlet. Long-term monitoring stations also set new records in such widely dispersed sites as Horsefly Mountain east of Quesnel and Lac Le Jeune south of Kamloops. The British Columbia Ministry of the Environment predicts that if this snow melts rapidly, there could be widespread flooding, and that even a gradual melt would probably result in high flows. It appears likely that returning fish in 1999 will once again have to battle unusually high flows.

**Figure 3. Escapement estimates vs. targets for the four major run timing groups of Fraser sockeye.**

*Adjusted inseason targets do not include any buffers for anticipated mortality.*



## CONCERNS RAISED DURING THE SEASON

### Were the escapement goals reasonable?

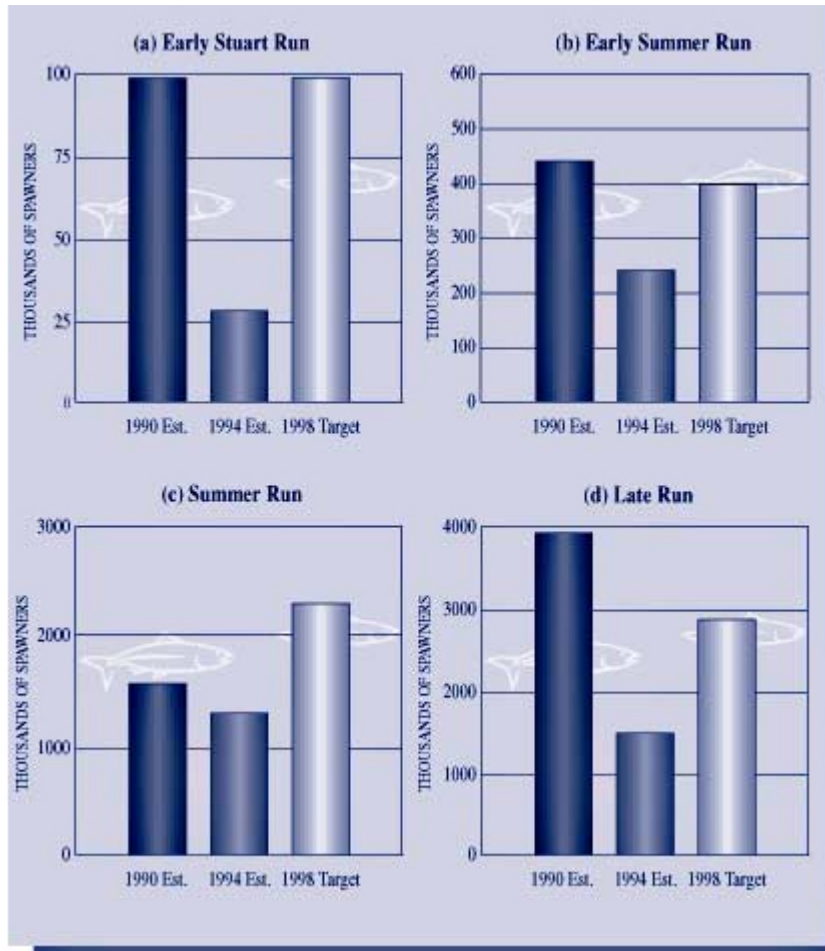
Escapement goals have always been controversial. The greatest difficulty is that the capacity of the system remains unknown. The situation is very much like that of a mountaineering party searching for a summit in the fog. Even with an efficient search plan, they will make wrong turns, encounter unexpected gullies, and arrive at what might be false summits. They can never even be certain that they have reached the top, and scientists are divided as to whether or not we have achieved the summit for some stocks, especially in their dominant year. The mountaineers may also commit themselves too hard to a single push, and deplete their resources. Many in the commercial fishing sector felt that the high escapement goals of last summer had denied them access to income at a time when many of them desperately needed it to survive—that they were unprepared victims of an ill-timed push for the summit. Others have argued that the rebuilding program has been delayed through overly aggressive fishing for far too long. Furthermore, in a year when coho by-catch concerns were destined to limit fishing opportunities anyway, it seemed to some observers to be appropriate to increase the escapement targets.

Here are the facts as the Council perceives them.

- There is no formally adopted escapement policy that dictates annual escapement targets, particularly after a setback such as occurred in 1994, or with low forecasts for returns such as existed this year.
- Some components have clearly not yet rebuilt to their potential—most notably the Upper Adams in the Early Summer run-timing group.
- For each of the four overlapping run-timing groups, the escapement targets for 1998 exceeded the 1994 escapements substantially. But 1994 was a troubled year in which escapements fell way below those in the parent generation of 1990. The escapement targets were set, on average, to rebuild the stocks to 1990 levels (Figure 4). There was a higher Summer Run escapement target and a reduced Late Run escapement target. The higher Summer Run escapement is in keeping with long-term objectives to probe the ability of lakes like Quesnel Lake to support greater numbers of sockeye fry in non-dominant years of the four-year cycle.
- There is evidence suggesting that, from a sockeye production perspective, Shuswap Lake may be fully stocked by fewer fish than spawned in 1990. However, for reasons already stated, the evidence is not conclusive.
- The Late Run was predicted to be small. At 3.75 million, it was barely larger than the 3.72 million estimated to have spawned in the record year of 1990. The escapement target was set at 2.33 million (consistent with 1994 recommendations from the Pacific Stock Assessment Review Committee). This would allow 22 percent of the run to be caught.
- This low harvest rate would severely restrict fishing options on the overlapping Summer Run. Had historical migration patterns held, Summer Run sockeye would have entered the river well ahead of the Late Run, and a larger Summer Run harvest rate could have been taken through in-river fisheries. Nonetheless, as the 1998 season was to amply demonstrate, historical patterns cannot be relied upon. Without this option, for the Late Run target to be met, the Summer Run harvest rate would have to be small, and the Summer Run escapement target, high. At 2.33 million spawners, this was well above the record escapement of 1.31 million on this cycle.

- Spawning ground estimates show that, with the exception of the Summer Run, escapements were remarkably close to 1994 levels; i.e., low.

**Figure 4. Escapement goals vs. recent estimates for the four major run timing groups of Fraser Sockeye.**



**From a conservation perspective, did management respond appropriately to the uncertainties generated by unstable ocean survival and behaviour and warm river water?**

Managers were called upon to make extremely difficult decisions. No one really knew what fate awaited the sockeye as they headed upriver past Mission. The riskiest decision of the season was the lengthy gillnet opening in early August as the water temperatures at Hells Gate peaked. This opening targeted Summer Run sockeye, and escapements for this group were the only ones to meet the goals. Hence, it is tempting to conclude that it was an acceptable risk. Yet it was based on an uncertain forecast that water temperatures would decline, and that the later portion of the run would face an easier journey. The managers took a calculated risk and won. The decision was made under extreme pressure as managers tried to meet a complex suite of allocation goals under considerable uncertainty surrounding run size and forthcoming river temperatures.

The real question is, “What was at stake?” The stakes were potentially high. There was no way of knowing how many fish were to die before spawning. The rebuilding program on the Horsefly

could have been dealt a massive setback by the warm water, and every fish could have been extremely valuable as a potential progenitor of thousands of offspring in a seriously depleted run. With this one exception though, the management system performed remarkably well in light of the extraordinarily difficult conditions. The managers deserve to be commended for a job well done under much duress.

### **What was the explanation for the large discrepancies between Mission and upriver estimates? Can these be reduced?**

The cause(s) of these discrepancies remain uncertain. Here are the facts as the Council perceives them.

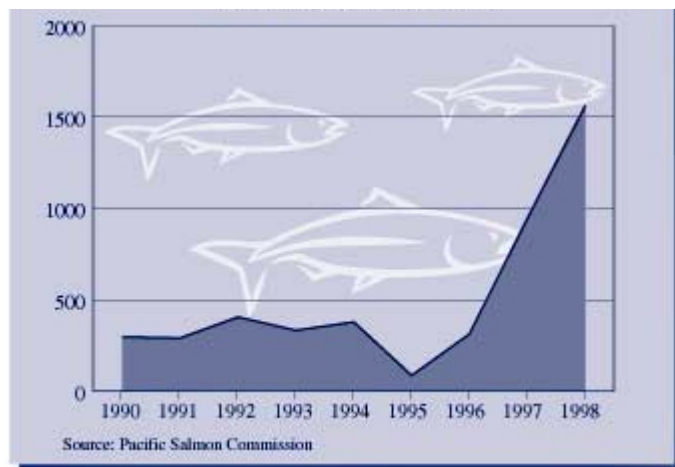
- The discrepancies were substantial for all run timing groups and most major stocks. The echosounding estimates from Qualark Creek in the Fraser Canyon below Yale were consistent with those from Mission until about mid-August. At that time, technical difficulties associated with unusual sockeye swimming behaviour, and extraordinarily low water levels began to affect the quality of the estimates from Qualark Creek.
- Water temperatures were high enough to create substantial stress for returning sockeye. The major stocks that faced the least stress were those entering the Harrison system. Sockeye headed for the relatively cool waters of the Chilko River would also likely have faced less stress than other runs heading further up the Fraser or up the Thompson. In-season estimates showed no apparent discrepancy for Chilko, but a large difference for the Weaver Creek component to the Harrison. These fish have only a short, approximately 30 kilometers, journey from Mission.
- Sockeye densities were very high as the peak of the Late Run passed Mission. Extremely high fish densities can make it difficult to distinguish individual fish in a hydroacoustic record.
- Harrison-bound fish migrate into the river along with the more abundant late run of fish to the Shuswap area. Harrison fish may be swimming more slowly up the river than Shuswap-bound fish. This would lead to their overrepresentation in test fishing samples, and hence to an overestimate of the numbers of Harrison-bound sockeye passing Mission. The possible extent of this bias is yet to be determined.
- More carcasses were seen at Mission than in any year since 1990, when observations were first formally recorded. These numbers, relative to the number of fish estimated to be passing Mission, remained high until the Late Run arrived. Unfortunately, there is no comparable information related to the peak migration in the Late Run. For the earlier runs, the peak carcass counts appeared to lag behind the peak up-river passage estimates by about six days. The Late Run peaked sharply on September 15th and 16th, and was essentially over three days later. The echosounding program, including the carcass counting, was terminated on September 20th. Before 1997, carcass counts hovered around 300. In 1997, the total was about tripled. In 1998, it increased to over five times the pre-1997 average (Figure 5). Two potentially contributing factors for this increase have been put forth. One is that many more fish than normal died of natural causes in the Fraser Canyon; the other is that some poor-quality fish were encountered in Aboriginal fisheries above Mission and discarded.
- If 50 percent of the Horsefly fish died and none of the Chilko fish did, then one must assume that mortality occurred when the stocks were separated or else the Horsefly run is highly vulnerable to temperature stress while the Chilko is not. A six-day lag (which includes the



time required to swim up and float back down) is consistent with death in the canyon, but both of these Summer-Run stocks had to migrate through the canyon.

- The early run of sockeye to the Stuart River watershed arrived in poor condition. An estimated 44 percent of them died before spawning. These fish also face the most arduous journey.
- Prespawning mortality was under ten percent for each of the later run timing groups.
- The Fraser River Environmental Watch Program tested samples of eggs and sperm for fertilization ability in both the Early Stuart and Quesnel groups. The study was also conducted in 1997 for the Early Stuart Run. In 1997, fertilization rates generally exceeded 90 percent. In 1998, for the Early Stuart Run, it dropped to around 70 percent. Early spawners in the Horsefly River also had low fertilization rates. Their fertilization success was estimated at just over 50 percent; for samples taken later in the run, the estimate jumped to over 90 percent.
- Catch estimation for Aboriginal fisheries in the Lower Fraser was conducted under more difficult conditions than in recent years, but errors in these estimates could not account for more than a very small portion of the overall discrepancies.

**Figure 5. Mission Sockeye total carcass counts.**



From these observations, it seems likely that much of the Early Stuart Run died from the effects of warm water between Mission and their remote spawning grounds. The absence of high pre-spawning mortality on the later runs is mysterious. What is known about sockeye physiology led biologists to expect other runs to experience considerable stress. In particular, they expected high pre-spawning mortality on the spawning grounds and reduced egg viability. These were not consistently observed. Nor were there any reports of high carcass counts above the Fraser canyon.

The evidence remains incomplete and inconsistent. Yet it is important that this issue be resolved if at all possible. As this report is being prepared, the Pacific Salmon Commission and Department of Fisheries and Oceans are conducting a joint assessment.

### **Was there overescapement?**

Scientists are divided on the issue of overescapement. What may constitute overescapement from a short-term production perspective may be valuable in terms of maintaining nutrient balances or in other subtle ways. Even without considering such subtleties, the Council sees no evidence of

## Concerns Raised During the Season

overescapement in 1998. The numbers of spawners appear to be at about the 1994 level for most stocks, considerably below the larger 1990 levels. There is evidence suggesting, but not proving, that Late Run escapement to the Shuswap area was too high in 1990, when it reached an estimated 3.7 million. This year's level was well below that high. Summer Run escapements, though high, were well below the interim rebuilding targets. These targets were set, in part, to probe the rearing lakes' ability to support more fry in non-dominant years. The achieved escapement levels, therefore, were consistent with reasonable objectives.

## COMMENTARY

Recent years have brought unusually frequent and intense El Niño events, major shifts in Fraser sockeye migration patterns, and record-breaking temperatures at Hells Gate. Some or all of these may be simply a part of the usual vagaries of Nature. Yet major trends in global climates have been clearly documented, with discernible local components. Environment Canada scientists have documented evidence that coastal watersheds are highly sensitive to changes in temperature and precipitation. They have also found, in south-central BC streams, evidence of lower late-summer and early-fall flows and higher early-winter flows. Hydrologists expect such changes to accompany global warming. The possibilities that these trends will either continue or worsen, and that they will have a debilitating effect on Canada's Pacific salmon, must not be taken lightly.

All Canadians must be constantly vigilant for major changes to the viability of our fish populations and their habitat and ecosystems, and be ready to make necessary adjustments, no matter how disruptive they may be. Conservation of the resource must remain the top priority. This includes not only the sorts of adjustments that fishers were required to accept last summer. Canada has signed international agreements to reduce greenhouse gas emissions, and all citizens share a responsibility in meeting them.

The events of last summer were also yet another reminder of the conflict over Aboriginal fishing rights. The Pilot Sales Agreements remain a flash point in the dispute, but this is only one of many troublesome aspects to this complex issue. Although a basic Aboriginal right to fish has been affirmed in the courts, the extent of this right remains uncertain. Nor is there a clear vision of the management arrangements through which these rights could be exercised.

The Conservation Council is apprehensive over the impact of these unresolved issues on fish conservation. The present uncertainty is straining the management system. People's livelihoods and deeply valued traditions are under threat. There is a festering sense of mistrust on all sides, and with it, the ever-present danger that people who feel alienated will lose the incentive to cooperate in conserving the resource.

Existing management arrangements are under constant attack, including frequent court challenges. This conflict takes a heavy financial and emotional toll. Valuable resources and personal energies are constantly being drained from already depleted reserves. Furthermore, management arrangements are in a constant state of flux. As the conflicting expectations and rights of different groups change, management agencies face a constant struggle to maintain the ability to monitor and control fishing effort.

The current unstable situation is not conducive to conservation. As long as the conflict remains unresolved, the Council shall maintain a watching brief to ensure that the ability of the management system to fulfil its conservation mandate is preserved and enhanced. From the conservation perspective, it is critical that any arrangements guarantee the capacity to protect the resource. Specifically vulnerable are both:

- the ability to monitor and control fishing efforts, and
- management flexibility in the face of increasing demands for more detailed and complex allocation obligations.

To many people in the commercial sector in particular, the escapement goals for last summer came as a shock. This is a serious matter when people's livelihoods are at risk. The Council believes that it can and should be avoided. The present arrangement is too vaguely defined. The

Canadian Caucus of the Fraser Panel has formally raised this concern with the Department. The Department has stated, in a memo from T. Tebb to the Canadian Caucus, its intention to “involve the Canadian Caucus in the process of establishing escapement goals and the strategy to realize the goals”, and recognizes that other “groups and interested parties will wish to be involved.”

Clearly, a consistent long-term rebuilding policy is required to protect against the depletion of genetic diversity, promote the rebuilding of depressed stocks, and continue to provide opportunities to probe the capacity of the Fraser system to produce fish. There should be a clear pre-season process for any changes to the rebuilding policy.

As a part of the rebuilding policy, there should be formal procedures for determining and adjusting annual escapement goals. The procedural guidelines must also lead to clear, unequivocal directions for in-season fisheries management, including the authority of the government regulators to increase escapement targets in response to adverse migration conditions. Where possible, management actions should flow automatically from these procedural guidelines as the season unfolds. However, it is not possible for procedural guidelines to anticipate all contingencies. To this end, general, risk-averse principles for dealing with uncertainties should be clearly stated.

The processes for changing the rebuilding policy and adjusting annual escapement goals should require widespread pre-season consultation with Aboriginal, commercial, and recreational fishing interests and other interest groups. However, in implementing the guidelines and principles to achieve conservation goals, managers must neither be encumbered during the fishing season by overly inflexible allocation commitments nor be vulnerable to pressure from vested interest groups. No interest group must feel it has a right of veto. In the end, the Minister has the obligation and authority to act on behalf of all Canadians to conserve the fish and to provide abundant fish for traditional Aboriginal fisheries.

The events of last summer also underscored the need for reliable, timely information. Staff at both the Pacific Salmon Commission and DFO have been working to improve techniques for both in-season run-size estimation and prediction of in-river migration difficulties. Managers should continuously look for cost-effective ways to minimize the uncertainties in management information. For Fraser River sockeye, three major areas of concern are the capability to:

- improve methods for estimating run size in light of altered fishing regulations and fish migration patterns;
- anticipate and assess significant sources of in-season natural mortality; and
- monitor the abundance and diversity of Fraser River sockeye through an annual spawning ground estimation program.

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