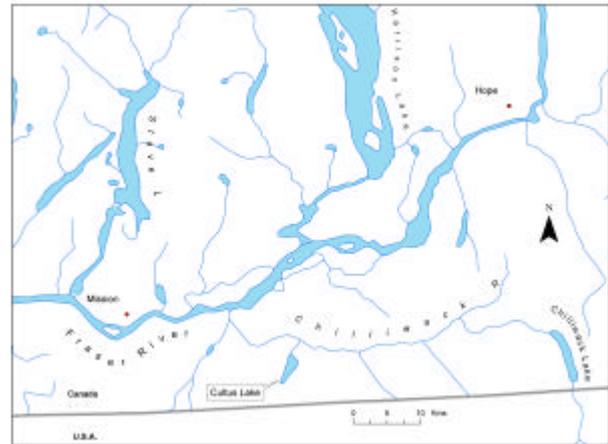


## Cultus Lake Sockeye Salmon

### Background

Sockeye salmon (*Oncorhynchus nerka*) is one of seven species of the genus *Oncorhynchus* native to North America. Populations are distributed through the North Pacific Ocean and its tributary systems in Asia and North America, but are abundant mainly in Alaska and British Columbia. Among the latter, the Fraser River supports the largest number of individual populations and numerically the largest total population. Fraser sockeye are divided into four groups or runs for management purposes based on differences in migratory timing into the Fraser River. The four timing groups are the Early Stuart, Early Summer, Summer, and Late runs. The Late run comprises populations spawning in the Cultus, Widgeon, Harrison, Birkenhead, Weaver, Portage, Adams and Shuswap systems. These populations migrate into the lower Fraser River from September to mid October. Cultus Lake (6.3 km<sup>2</sup> surface area) is located in south-west British Columbia in the eastern Fraser Valley, 112 km upstream from the Strait of Georgia. The lake lies in the traditional territory of the Soowahlie First Nation and is a popular recreational area. Most Cultus Lake sockeye spend one year in freshwater as juveniles before migrating to sea. They typically mature as four-year-olds. Like other late run stocks, the adults migrate from the open ocean to the Strait of Georgia in August where they remain for up to eight weeks before resuming their migration into the Fraser River in September. Since 1995, their migration into the river has been progressively earlier. While the cause of the early migration of the late run is currently unknown, the consequences have been dramatic with abnormally high levels of pre-spawn mortality observed along the migration route and in natal areas. Cultus Lake sockeye were "emergency listed" as endangered in 2002 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).



Location of Cultus Lake in the Lower Fraser Valley, BC.

### Summary

- Cultus sockeye spawning populations were relatively abundant from the 1920s to the late 1960s, averaging 20,000 adults per year. In subsequent years, escapements declined on three cycles and since the early 1990s the abundance on all four cycles declined to very low levels.
- In the last three generations, spawner abundance declined by 51%. The recent escapements of 1,959 (1998), 12,392 (1999), 1,227 (2000) and 515 (2001) are among the lowest ever recorded.
- Since 1995, Cultus and other Late run sockeye adults have migrated into freshwater several weeks earlier than normal. Extremely high levels of pre-spawn mortality have occurred coincident with the early migration. When the elevated pre-spawn mortality is considered, the rate of decline in

effective spawners over the last three generations is 93%.

- Overfishing, recent increases in the level of pre-spawn mortality associated with the early migration, and reductions in marine survival from the *El Niño* events in the 1990s have contributed to the dramatic decline of this population.
- Cultus sockeye were emergency listed as endangered in October 2002 based on information provided to the Emergency Assessment Subcommittee of The Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

### ***Species biology***

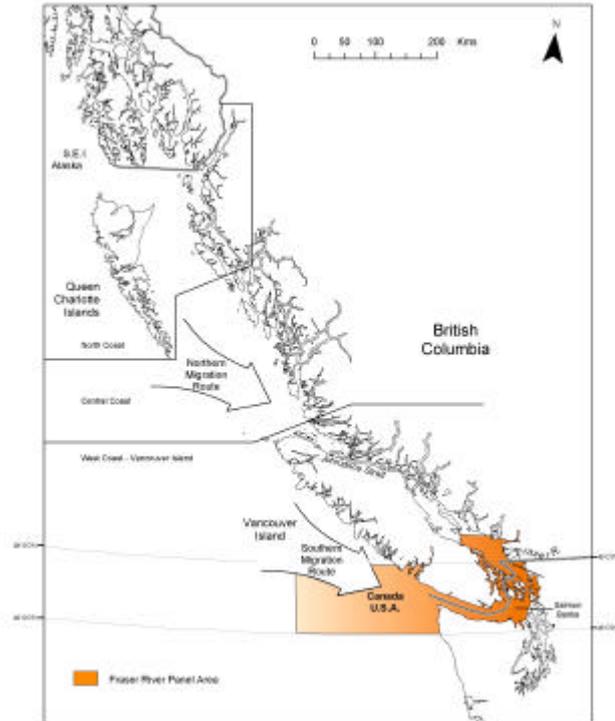
Cultus sockeye mature predominantly in their fourth year after two years in freshwater and two years in the ocean. They exhibit a four-year abundance pattern typified by a strong dominant cycle (2003), a moderate sub-dominant cycle (2002) and two numerically weak cycles (1999 and 2000). Maturing adults migrate from the open ocean to the Strait of Georgia in August where they remain for up to eight weeks. Normally, they resume their migration into the Fraser River and Cultus Lake in September and continue migrating into the lake until December. The protracted migration of about ten weeks is considerably longer than most other Fraser River sockeye populations. Recently, the onset of the migration into the Fraser River has been earlier and has resulted in elevated pre-spawn mortality levels. Pre-spawn mortality has been linked to heavy infestations of *Parvicapsula minibicornis*, a parasite that attacks the kidneys and gills. Although the parasite occurs in most Fraser River sockeye populations, it has caused significant mortality only among early migrating late run populations.

Cultus sockeye spawn from late November through December and are the latest population to spawn in the Fraser watershed. Cultus sockeye spawn exclusively in the lake. They are one of a few populations that spawn in lakes rather than in streams or rivers. Like other sockeye, they die soon after spawning. The fry emerge from the gravel in the spring and immediately school and move into deeper water. They are resident in the lake for one and sometimes two years. They are distributed throughout the limnetic zone and are exposed to dense predator populations that include northern pikeminnow, coho salmon, trout, Dolly Varden char and sculpins. They emigrate from the lake as smolts from late March to June. After leaving the Fraser River they migrate northward through Johnstone Strait and northwest along the coast until late fall or winter when they move offshore into the Gulf of Alaska. They rear in the Gulf of Alaska for about two years.

### ***The Fishery***

Fraser River sockeye are managed under auspices of the Canada-U.S. Pacific Salmon Treaty. In the Fraser River Panel area, they are managed bilaterally by the Pacific Salmon Commission's (PSC) Fraser Panel. In other areas, they are managed domestically by Canada or the United States. Historically, annual fishing plans were established for each of the four run-timing groups based on run forecasts and escapement objectives for the dominant populations in each group. The late run was managed to the objectives for Adams and Weaver sockeye. Cultus sockeye have not been managed as a discrete stock. Marine area fisheries directed at the Summer run also incidentally harvest Cultus sockeye. The cumulative impacts of the directed harvest

of the numerically dominant Summer and Late run stocks have determined the harvest patterns of Cultus Lake sockeye.



Migration routes and fishery locations in coastal B.C. waters and U.S. waters.

Cultus sockeye can be harvested along the full extent of their migration pathway, from the point of landfall along the B.C. coast until their entry into Cultus Lake. Most are taken in large mixed-stock ocean fisheries, although a significant proportion can be taken in the Fraser River fisheries. Total catch is available since 1952, and estimates for individual fisheries are available since 1973. The 1974-2001 total catch averaged 19,400 sockeye (range 102 to 88,000).

The majority (98%) of the Cultus harvest occurs in commercial troll, gillnet and seine fisheries off the north coast and the west coast of Vancouver Island, in Johnstone, Juan de Fuca and Georgia

straits, the Fraser River, and Puget Sound. The 1974-2001 average annual catch was 5,200 sockeye (27% of the total annual catch) in U.S. Panel waters; 137 (1%) in U.S. non-Panel waters; 4,800 (25%) in Canadian Panel waters; and 8,900 (46%) in Canadian non-Panel waters.

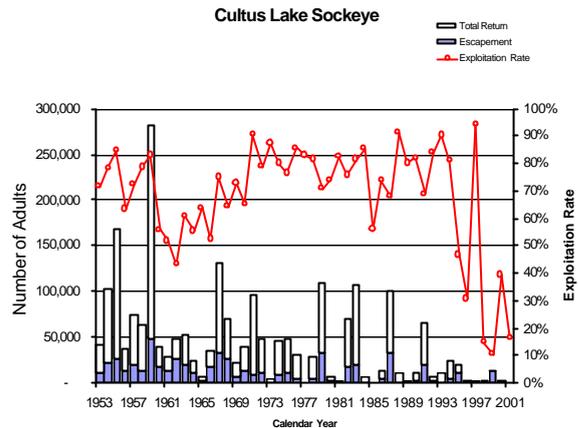
First Nation fisheries have harvested Cultus sockeye for thousands of years. The majority of the catch occurs in set and drifted gill net fisheries in the lower Fraser River. The average annual First Nation catch was 355 sockeye (2% of the total annual catch). Smaller catches are taken in seine and gillnet fisheries conducted under special licence in Canadian marine waters, and in U.S. Treaty gillnet fisheries in Puget Sound and Juan de Fuca Strait.

Recreational fisheries in the southern Strait of Georgia, Juan de Fuca and Johnstone straits and the lower Fraser River harvest small numbers of Cultus sockeye. The lower Fraser recreational fishery is typically a sockeye non-retention fishery except for short periods in the summer when Cultus encounter rates are low.

### **Resource Status**

The Cultus sockeye population is among the most intensively studied salmon stocks in the world. Studies of spawner abundance, lake characteristics and juvenile production began with the work of the Pacific Biological Station in the 1920s and have continued until the present. As a result, there is a wealth of data on lake limnology and fish community structure as well as accurate abundance information for the sockeye fry, smolt and adult life stages.

Spawner abundance was strong but variable from the 1920s to the late 1960s (average 20,000), when spawner numbers collapsed on two cycles and began a sustained decline on a third cycle. Since the early 1990s, abundance has declined dramatically on all four cycles; the most recent populations on all cycles (average 4,000) have been among the lowest ever observed. In the last three generations, the adult spawner population declined by 51%, a rate of 6.5% per year across all cycles. When recent increases in prespawn mortality are considered, the rate of decline in effective spawners over the last three generations is 93%. Current population levels are a small fraction (7%) of the most conservative estimate of the productive capacity of the population, which is estimated to lie in the range of 56,000 to 115,300 effective spawners. Similar declines have been recorded in assessments of the fry and smolt populations and the total adult return.



Total return, catch, escapement and exploitation rate for Cultus sockeye salmon, 1952 to 2001.

Estimates of fishery exploitation rates averaged 68% (1952-2001) and ranged from 10.4% (1999) to 94.5% (1997). Exploitation rates have frequently exceeded 80% and sometimes 90%, especially on the off-cycles where fisheries are managed to harvest enhanced Weaver sockeye. In recent years, fisheries have been adjusted in response to concerns regarding the early migration of the late run; consequently, Cultus exploitation rates have been reduced to target levels less than 20%. The mean exploitation rate at Maximum Sustainable Yield for Cultus sockeye is estimated at 56%. Because fisheries are managed based on objectives for the more productive co-migrating stocks, exploitation rates have far exceeded this level in most years and on all cycles.

An index of freshwater survival shows no obvious long term trend, except a sharp recent decline in the production of smolts per spawner that is associated with elevated levels of prespawn mortality. The total survival index, which incorporates freshwater and marine life history stages, is highly variable but dropped below the replacement line during a series of *El Niño* events in the 1990s.

2002 Subdominant Cycle		2003 Dominant Cycle		2000 Off Cycle		2001 Off Cycle	
Year	Escapement	Year	Escapement	Year	Escapement	Year	Escapement
1926	2,622	1927	82,426	1928	14,661	1929	5,423
1930	7,946	1931	37,473	1932	2,231	1933	2,864
1934	22,940	1935	15,339	1936	8,322	1937	1,227
1938	9,434	1939	70,789	1940	73,536	1941	13,950
1942	36,959	1943	11,822	1944	14,002	1945	5,030
1946	33,068	1947	8,699	1948	12,746	1949	9,055
1950	29,928	1951	12,677	1952	17,833	1953	11,543
1954	22,036	1955	25,922	1956	13,718	1957	20,375
1958	13,324	1959	47,779	1960	17,640	1961	13,396
1962	26,997	1963	20,303	1964	11,067	1965	2,455
1966	16,919	1967	33,198	1968	25,314	1969	5,942
1970	13,941	1971	9,128	1972	10,366	1973	641
1974	8,984	1975	11,349	1976	4,435	1977	82
1978	5,076	1979	32,031	1980	1,657	1981	256
1982	16,725	1983	19,944	1984	994	1985	424
1986	3,256	1987	32,184	1988	861	1989	418
1990	1,860	1991	20,157	1992	1,203	1993	1,063
1994	4,399	1995	10,316	1996	2,022	1997	88
1998	1,959	1999	12,392	2000	1,227	2001	515
Average		Average		Average		Average	
1926-1938	10,736	1927-1939	51,507	1928-1936	8,405	1925-1937	3,650
1942-1966	25,604	1943-1967	22,914	1940-1968	23,232	1941-1969	10,218
1970-1986	9,596	1971-1987	20,927	1972-1988	3,663	1973-1989	364
1990-1998	2,739	1991-1999	14,288	1992-2000	1,484	1993-2001	555
All years	14,651	All years	27,049	All years	12,307	All years	4,992

Total adult escapement by cycle year for Cultus Lake sockeye, 1925 to 2001.

## Outlook

Cultus sockeye are genetically unique from all other sockeye populations, including those in the upper Fraser that originated from different glacial refugia, and those in the lower Fraser with whom they share a common ancestry. They exhibit a number of adaptations for survival in their local lake environment that further distinguish them from other sockeye in the Fraser River and in other parts of their range. Attempts to introduce non-native populations of sockeye into Cultus Lake have not been successful. Due to their geographic isolation and their genetic and adaptive divergence from other sockeye populations, they are a distinct unit (a Nationally Significant Population) as defined by Canada's Species At Risk Act and COSEWIC.

Overfishing, recent increases in the level of pre-spawn mortality associated with the early migration, and reductions in marine survival from the *El Niño* events in the 1990s have contributed to the collapse of this population and its subsequent emergency listing as endangered by COSEWIC.

The outlook for Cultus sockeye largely depends on whether the early migration phenomenon continues and on the magnitude of ongoing impacts from fishing, habitat degradation and climate changes. At current low abundances, the population is particularly vulnerable to environmental changes that reduce its productivity and increase the probability of extinction. At current pre-spawn mortality levels, simulation studies show that the population has a high probability of extinction (24% in three generations) even in the complete absence of fishing. The probability of losing complete year classes

or cycles is much higher (77% on three cycles). Consequently, if the early migration continues, mitigation measures such as the captive broodstock program currently in place could be required to maintain a viable population. If pre-spawn mortality drops below 80%, the probability of extinction is significantly reduced but recovery is expected to require decades.

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