

While over-fishing likely played a significant role in the current low abundance of CLS, cessation of harvest may not be enough in itself to recover this population. Additional work that may assist with recovery efforts include habitat improvements, hatchery supplementation of the wild population (both captive breeding and traditional hatchery-type enhancement), and predator control.

Recent escapements of CLS are the lowest on record (1925-2005). In the three generation span from 1991 to 2002, the number of effective spawners declined by 92% (Schubert et al. 2002). Simulation work reported by Schubert et al. (2002) show that if high pre-spawn mortality continues, the probability that the population abundance in three out of the four cycle lines would fall below 100 fish is greater than 90%, even in the complete absence of fishing.

CONSERVATION UNIT STRUCTURE

There is a single population of Cultus Lake sockeye (CLS). Cultus Lake is located in the traditional territory of the Soowahlie Band of the Sto:lo First Nation. The lake feeds into the Fraser River system located in southwestern British Columbia, near the town of Chilliwack (Figure 1). This population is exclusively spawn in Cultus Lake and their lengthy migration time and protracted lake residency prior to spawning in late November and December is unique to sockeye. Upon emergence, CLS fry school and move off shore and into the deeper waters of Cultus Lake and typically live for one and a half years in Cultus Lake prior to commencing their seaward migration.

Studies on sockeye population genetics have found that CLS are the most distinct of the Fraser sockeye populations (Withler et al. 2000 as cited by COSEWIC 2003). Attempts to establish non-Cultus origin sockeye in Cultus Lake over the years have been unsuccessful, indicating that Cultus sockeye are highly adapted to the specific environment of Cultus Lake.

DISTRIBUTION

Marine distribution of juvenile CLS extends to both sides of the Pacific Ocean and on the North American coast from Kotezebue Sound in Alaska to the Sacramento River in California (Hallock and Fry 1967, Atkinson et al. 1967, McPhail and Lindsey 1970 all as cited by Groot and Margolis 1991). After an average marine residence time of two years, CLS are assumed to migrate at the same time and area as the other Late Run stocks in general and the Weaver Creek stock specifically. As a result, they are included in the Late Run aggregate for management purposes. Tagging studies conducted in the first half of the 20th century were able to identify CLS on their return migration through Johnstone Strait from mid-July to early September, through Juan de Fuca Strait from mid-July to the end of September, and at Point Roberts from mid-July to mid-October (Foerster 1936 as cited by Schubert et al. 2002).

Freshwater distribution of spawning adults and rearing fry and smolt CLS is exclusive to Cultus Lake (see Figure 1). Within Cultus Lake itself, CLS have been known to spawn only in six distinct lake foreshore areas (COSEWIC 2003, see Figure 2). In recent years, possibly attributed to the low population sizes, spawning has been observed only at Spring Bay (S. Grant, DFO, pers. comm.). Fry immediately migrate to deeper Cultus Lake waters where they remain until outmigration from the lake as smolts.

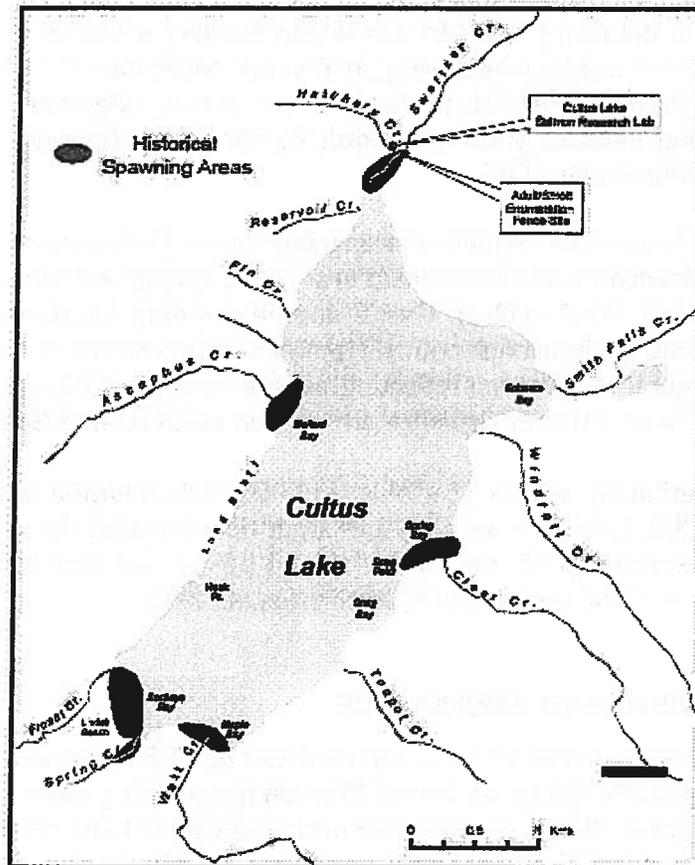


Figure 2. Map of historic spawning areas used by Cultus Lake sockeye (in recent years, spawning has only been observed at Spring Bay (S. Grant, DFO, pers. comm). Figure from COSEWIC (2003).

BIOLOGY

Cultus Lake sockeye are among the latest Fraser River sockeye populations to migrate through the river and are the latest Fraser population to spawn. All CLS die after spawning. They migrate through the approach waters during August and then delay in the Strait of Georgia for up to eight weeks before entering the Fraser River in September to finish the rest of their migration, arriving at Cultus Lake between late September and early December. Spawning occurs in late November and December. This protracted lake arrival time is unique to CLS, being longer in duration than most other Fraser River sockeye populations by 2-6 weeks (Schubert 1998 as cited by COSEWIC 2003).

Since 1995, this typical CLS delay behavior in the Strait of Georgia has not occurred and instead, CLS have migrated earlier, as have the rest of the Late run sockeye group. This early migration has resulted in increased infection rates of CLS by the naturally occurring parasite *Parvicapsula*

minibicornis which, when coupled with the longer than normal freshwater occupancy prior to spawning, has resulted in high pre-spawn mortality rates in CLS.

Upon emergence in the spring, CLS fry move into the deeper waters of Cultus Lake where they remain for usually one and, less frequently, two years. Migration of CLS smolts from the lake to the ocean occurs from late March to June. In the ocean, migration continues north through Johnstone Strait and eventually into the North Pacific where they will reside until maturation, generally in their fourth year of life.

Adult returns to Cultus Lake exhibit a strong four year cyclic pattern, where a dominant year (2003 cycle) is preceded by a sub-dominant year (2002 cycle), and interspersed with two smaller return years (2004 & 2005 cycles). Cyclic dominance only became evident after the 1960s, coinciding with a change in harvest policy. Opinions among scientists differ as to whether cyclic dominance is a natural phenomena reflecting natural biological interactions or were created by harvest policies or some other environmentally related event (Cultus Sockeye Recovery Team, *in press*).

CLS return predominantly as four year olds, with only 6% returning as either three or five year olds (COSEWIC 2003). Adult male CLS are larger than females, the average standard length of a four year old spawner is 55 cm for males and 50 cm for females (Schubert et al. 2002). Average fecundity is 4,200 eggs/female (Schubert et al. 2002).

CU SIZE AND TRENDS IN ABUNDANCE

The life history, habitat, and biological characteristics of CLS have been extensively studied, and a rich data set is available dating back to 1925 when the counting fence on Sweltzer Creek was installed (Schubert et al. 2002). Spawners returning to Cultus Lake, CLS catch, and their exploitation rate each year since the 1950's is presented in Figure 3.

Schubert et al. (2002) estimated the maximum sustainable exploitation rate on CLS was 56%. This exploitation rate was exceeded in all years prior to 1995 (Figure 3). High exploitation rates, low recruitment in the 1990's and high pre-spawn mortality associated with early in-river entry behaviour have all contributed to the current low population abundance of CLS, even in the presence of lowered exploitation rates in recent years (Schubert et al. 2002). In the three generations spanning 1991 to 2002, the effective adult spawning population declined by 92% (Schubert et al. 2002).

Historic spawning populations must be viewed taking into account the large-scale enhancement and predator control experiments of the early half of the 20th century. In five years between 1925 and 1933, all spawners were intercepted at the Sweltzer Creek fence and stripped of eggs which were subsequently either planted in the lake as eyed eggs or released as fry (Foerster 1968 as cited by Schubert et al. 2002). From 1935 to 1938, predator control projects removed close to 39,000 predators from Cultus Lake, of which over 29,000 were pikeminnow (Foerster and Ricker 1953 as cited by Schubert et al. 2002).

Freshwater survival has exhibited compensatory mechanisms in fry/smolt survival. When the adult spawner population is above 7,000, smolt production averages 68 smolts per spawner versus when the adult spawner population is less than 7,000 spawners, smolt production averages

24 smolts per spawner (Schubert et al. 2002). Marine survivals from 1951-1990 average 8.5%, with the 1951 brood year being an obvious outlier at 43.9% (Schubert et al. 2002). In the 1980's, average marine survival increased to 15.3% (Schubert et al. 2002).

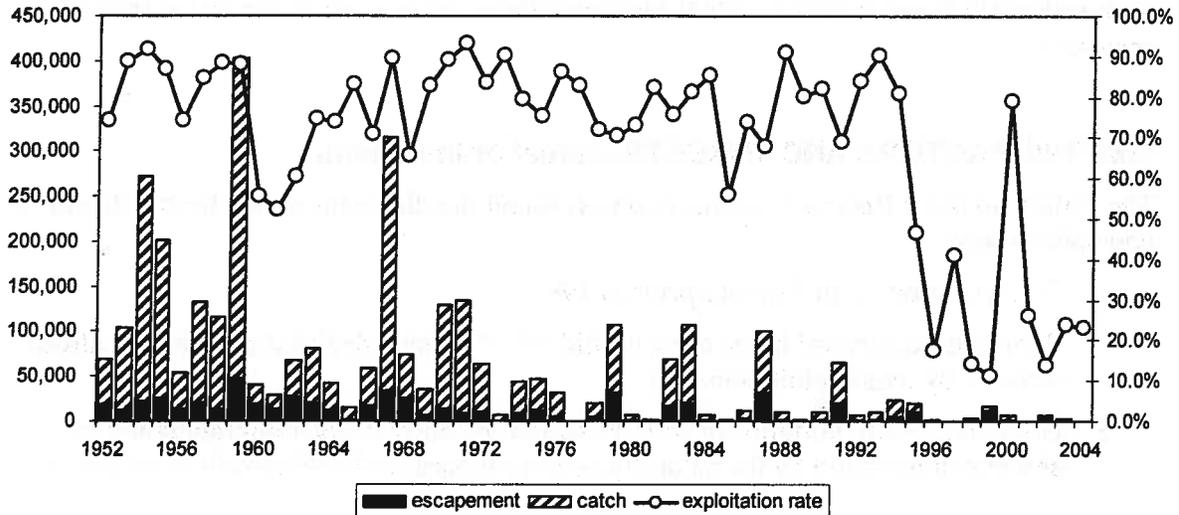


Figure 3. Spawning escapement, catch, and exploitation of Cultus Lake sockeye by year. (data from Pacific Salmon Commission – see Appendix A for raw data).

BENCHMARKS

The three main recovery objectives identified by the Cultus Sockeye Recovery Team (*in press*) were:

Objective 1. *Ensure the genetic integrity of the population by exceeding a four-year arithmetic mean of 1,000 successful adult spawners with no fewer than 500 successful adult spawners on any one cycle. This objective secures genetic variability.*

Objective 2. *Ensure growth of the successful adult spawner population for each generation (that is, across four years relative to the previous four years), and on each cycle (relative to its brood year) for not less than three out of four consecutive years. This objective ensures the population is growing.*

Objective 3. *Recover the population to the level of abundance at which it can be delisted (designated Not at Risk) by COSEWIC.*

The overarching recovery goal was stated as: "...to halt the decline of the Cultus sockeye population and to return it to the status of a viable, self-sustaining and genetically robust wild population that will contribute to its ecosystems and have the potential to support sustainable use."

BIOLOGICAL STATUS

Recent generations' population sizes are well below the long-term average, and are the lowest on record. The 2001-2005 spawner abundances fail to meet Recovery Objective 1. While the four-year arithmetic mean is close to 2,000 spawners, there are two years with fewer than 500 spawners.

LIMITING FACTORS AND THREATS (actual or imminent)

The Cultus Sockeye Recovery Team (*in press*) found that the main causes for the decline in CLS populations were:

1. Overexploitation in fisheries prior to 1995,
2. Poor marine survival in the early to mid-1990's which depleted populations already reduced by overexploitation, and
3. High pre-spawn mortality since 1995 caused by early in-river migration and the associated infection by the naturally occurring parasite *Parvicapsula minibicornis*.

Biological Threats & Limiting Factors

Co-migration

Cultus Lake sockeye co-migrate with several larger Fraser sockeye populations that can be harvested throughout their return migration (e.g., Weaver and Shuswap). Fisheries targeting these more abundant stocks in August, September or October along the migratory route of CLS could also harvest CLS. (Cultus Sockeye Recovery Team, *in press*)

Migration Timing

The current small population size of CLS makes them more vulnerable to environmental changes (e.g., climate change, changes in marine productivity, El Niño events). The early freshwater migration exhibited by CLS since the mid 1990's has resulted in levels of pre-spawn mortality well above the pre-1995 levels. Prior to 1995, the average pre-spawn mortality was 7%. In the years since, pre-spawn mortality increased dramatically from 24% in 1995 to estimates exceeding 90% for 1999 and 2000 (Schubert et al. 2002).

When the normal 6-8 week delay in the Strait of Georgia prior to entry into the Fraser River is shortened, CLS spend longer in freshwater prior to spawning, as spawning still occurs in late November and December. Upon freshwater entry, sockeye are exposed to the naturally occurring parasite *Parvicapsula minibicornis*. The increased time spent in freshwater due to early in-river entry behaviour results in a greater percent of CLS dying from *Parvicapsula* infection prior to being able to spawn.

Migration Route

The freshwater migration of CLS sockeye through the Fraser River occurs adjacent to some of the most significant urban, industrial, and agricultural activity in British Columbia. These activities contribute to altering both the hydrology and the water chemistry of the environment these fish must migrate through. In addition, considerable angling (non-sockeye directed) and recreational activity occurs in the Chilliwack River and Sweltzer Creek where these fish must

pass through prior to entering Cultus Lake. All these activities described above may contribute to increasing energy consumption of CLS during their migration and either increasing their pre-spawning mortality or decreasing their spawning success. Delays in migration can increase CLS exposure to high temperatures and also increase their stress and infection by *Parvicapsula*. (Cultus Sockeye Recovery Team, *in press*)

Marine Productivity

Changes in the marine environmental conditions (including changes in ocean climate and productivity) can limit growth and survival of juvenile CLS. Annual or decadal climate cycles (e.g., Pacific Decadal Oscillation and El Niño Southern Oscillation) can effect change in productivity and juvenile salmon survival. Global climate change may also contribute to change in the productivity and associated salmonid survival in the marine environment.

Freshwater Productivity

Similarly, in the freshwater environment, global climate change may influence freshwater productivity. Depensatory survival (i.e., lower survival at lower abundances) has also been observed in the fry/smolts in Cultus Lake. Depensation may result from increased susceptibility to predation at smaller fry population sizes. Preliminary work has been done showing that at the current small returns of CLS, knowing whether depensatory effects are affecting CLS will be of great importance when deciding what recovery actions to take (J. Grout (DFO) and J. Korman (UBC), pers. comm.).

Spawning Behavior

Cultus Lake sockeye are unique in that they spawn exclusively in the lake along the shore. The availability of suitable spawning habitat (e.g., groundwater upwelling, substrate type, temperature) is required for successful egg and alevin incubation. Any change in the quality of habitat due to natural or human causes (e.g., water-use, contaminant input, physical disturbance, etc.) may limit egg to fry survival rates. (Cultus Sockeye Recovery Team, *in press*)

Predation

Predation during the freshwater stage may be another serious factor limiting the recovery of CLS. The main predators of CLS fry in Cultus Lake are coho, trout, sculpins, Dolly Varden char, and northern pikeminnow (Ricker 1941 as cited by COSEWIC 2003). Northern pikeminnow is thought to pose the greatest predation threat to the CLS population because of their high abundance relative to the other species (Foerster and Ricker 1941, Ricker 1933, Ricker 1941, Foerster 1968, and Friesen and Ward 1999 all as cited by Cultus Sockeye Recovery Team, *in press*).

Human-Induced Threats & Limiting Factors

Overexploitation

In recent years, due to concerns for other stocks and species, major mixed-stock Canadian fisheries on Fraser sockeye which would impact CLS have been restricted to Johnstone Strait and the Fraser River. The majority of the sockeye harvested are taken by the commercial and First Nations harvest groups. Mixed-stock fisheries also occur on the US side of the Strait of Juan de Fuca and in the waters around the San Juan Islands. Since 2001, the US fisheries catch has been limited to a maximum of 16.5% of the total available catch of Fraser River sockeye.

While overfishing has been identified as one of the primary causes of the decline of CLS abundance, simulations of population trajectories predict that if the high levels of pre-spawn mortality seen in recent years continues, the population in three out of the four cycles will likely decline to less than 100 spawners even in the complete absence of fishing (Schubert et al. 2002).

Eurasian watermilfoil

Eurasian watermilfoil is an invasive, non-native plant first observed in Cultus Lake in the 1970's. Watermilfoil now covers nearly all of the available near-shore habitat, providing shelter and rearing habitat for juvenile pikeminnow. Dive surveys have also shown that spawning areas heavily infested by watermilfoil were no longer used by CLS. However, the effect of watermilfoil on CLS (especially at current population abundances) is not fully understood. (Cultus Sockeye Recovery Team, *in press*)

Recreation

Cultus Lake is a popular recreation destination and receives millions of visitors each year. Water-related recreational activities such as swimming and angling have been observed to delay spawner migration. The use of boats increases the amount of pollution, construction of piers, and contributes to the spread of watermilfoil. (Cultus Sockeye Recovery Team, *in press*)

Table 1. Summary of potential threats to CLS population by life stage. (from Cultus Sockeye Recovery Team, *in press*)

Life Stage	Threat	Natural or Human Induced	Threat Class	Possible Severity	Identified by COSEWIC Status Report?
1. Egg and alevin	a. Habitat alteration	Human	Potential	Unknown	Yes
	b. Predation (suckers, sculpins)	Natural	Known	Unknown	No
	c. Early migration (egg viability)	Natural	Potential	Unknown	No
	d. Pollution	Human	Potential	Unknown	Yes
2. Fry	a. Predation (pikeminnow, salmonids, sculpins)	Natural	Known	High	Yes
	b. Exotic species (Eurasian watermilfoil; incremental pikeminnow recruitment)	Human	Known	Medium	Yes
	c. Diseases and parasites (<i>Salmincola</i>)	Natural	Known	Unknown	Yes
	d. Habitat alteration	Human	Potential	Unknown	Yes
	e. Pollution	Human	Potential	Unknown	Yes
3. Smolt	a. Habitat alteration	Human	Potential	Low	No
	b. Pollution	Human	Potential	Low	No
	c. Predation	Natural	Known	Low	No
	d. Diseases and parasites (<i>Parvicapsula</i>)	Natural	Known	Unknown	No
	e. Diseases and parasites (<i>Salmincola</i>)	Natural	Known	Unknown	No
4. Marine juvenile and adult	a. Global warming	Human	Potential	High	No
	b. Environmental change	Natural	Known	High	Yes
	c. Diseases and parasites (aquaculture)	Human	Potential	Low	Yes
	d. Pollution	Human	Potential	Low	Yes
5. Pre-spawning adult	a. Over exploitation in fisheries	Human	Known	High	Yes
	b. Early migration (prespawn mortality)	Natural	Known	High	Yes
	c. High water temperatures	Natural	Known	Medium	Yes
	d. Recreational activities	Human	Known	Medium	Yes
	e. Habitat alteration	Human	Potential	Low	Yes
	f. Illegal harvest	Human	Known	Unknown	No
	g. Predation (seals, sea lions)	Natural	Potential	Unknown	No
6. Spawner	a. Exotic species (spawning habitat encroachment)	Human	Known	High	Yes
	b. Habitat alteration	Human	Potential	Unknown	Yes
7. All	a. Environmental variability	Natural	Potential	High	Yes

MANAGEMENT ACTIONS

Beginning in 2001, the Fraser River Panel, which is the international management body responsible for Fraser River sockeye, has limited fisheries on Late run sockeye in an effort to reduce the exploitation rate on Fraser Late run sockeye to 15-17%. Further, Fisheries & Oceans Canada have limited domestic fisheries to try to keep exploitation rates on CLS to between 10-12% in 2004 and 2005. Actual exploitation rates, however, have in general exceeded the target, with the exception of 2005.

RECOVERY EFFORTS & STUDIES

In 2000, a captive breeding and supplementation program was initiated as a CLS recovery action to preserve genetic diversity of this population and also to supplement the wild population with hatchery-produced fry and smolts. This method involves removing a proportion of returning wild adults from the population, spawning these fish in the hatchery, and rearing the resultant fry in captivity to maturation. The progeny of these hatchery-reared adults are then released back to Cultus Lake to supplement the wild fry and smolt production.

Another project conducted in Cultus Lake was focused on improving the freshwater habitat for both spawning adults and smolts. Eurasian watermilfoil was removed from selected areas of Cultus Lake in March 2006. In Cultus Lake, milfoil was removed from the outlet of Sweltzer Creek where smolt outmigration occurs and also Spring Bay where spawning occurs.

A pikeminnow predator control program and population assessment was also conducted in 2004 and 2005. Earlier research in the 1930's and 1940's provided evidence for increased salmon abundance associated with pikeminnow removal. In 2004 and 2005, a total of 6,000 pikeminnow were removed from Cultus Lake using a combination of trapping and angling methods. The estimated population size for this predator, based on the mark-recapture study, was 60,000 to 70,000 fish.

Other recent work in Cultus Lake has been conducted to assess CLS egg incubation and fry rearing habitat quality. Some of the recent studies in Cultus Lake have included: a) mapping milfoil distribution in Cultus Lake, b) assessment of spawning substrate quality in Cultus Lake, and c) mapping groundwater near human development and groundwater upwelling at spawning sites.

See Table 2 for additional recovery efforts both underway and proposed.

Table 2. Summary of approaches to the recovery of the Cultus Lake Sockeye population. Threat categories correspond to those found in Table 1, Objective numbers correspond to objectives listed under section on *Benchmarks*. (from Cultus Sockeye Recovery Team, *in press*)

Recovery Objective #	Approach	Threat	Anticipated Effect	Status
1	a. Captive brood stock program for 2000-2007 brood years.	Multiple	Increased successful spawners, reduced threat of extinction.	Underway
	b. Control harvest to achieve 1,000/500 objective.	5a	Increased successful spawners, reduced threat of extinction and of detrimental genetic effects.	Proposed
	c. Improve freshwater survival of 2004 and 2005 broods by removing watermilfoil.	2b, 6a	Reduced pikeminnow recruitment, decreased predation, increased number of sockeye smolts, increased spawning habitat.	Underway
	d. Improve freshwater survival of 2004 and 2005 broods by removing predators.	2a, 3c	Reduced predator populations, increased number of sockeye smolts.	Underway
	e. Identify the causes of the early migration phenomenon.	1c, 5b	Increased number of successful spawners.	Underway
	f. Focused enforcement where the population is most at risk.	5f	Increased number of successful spawners.	Proposed
	g. Identify imminent risks from habitat destruction, pollution affecting each life stage.	Multiple	Improved survival at all life stages.	Proposed
	h. Maintain assessments of fry, smolt and adult populations.	Multiple	Maintain ability to assess threats and recovery progress.	Underway
	i. Eliminate activities that cause migratory delay in Sweltzer Cr.	5c, 5d	Increased successful spawners.	Proposed
	j. Identify and eliminate risk from marine mammal predation.	5g	Increased number of adults through Sweltzer fence.	Proposed
2	a. Lake stocking using fry, smolts surplus to the captive brood stock program during the period 2003 to 2009.	Multiple	Increased number of smolts, increased successful spawner populations, reduced genetic risk.	Underway
	b. Control fishery harvest to levels that permit generational growth.	5a	Increasing successful spawner populations.	Underway
	c. Develop an integrated water-milfoil, predator control project.	5b, 6a, 2a, 3c	Maintain larger fry, smolt populations established by 1c and 1d.	Proposed
	d. Focused enforcement to reduce the threat of poaching.	5f	Increased number of successful spawners.	Proposed
	e. Mitigate effects on habitat.	Multiple	Improved survival at all life stages.	Proposed
	f. Determine the effects of <i>Salmincola</i> on marine survival.	2c, 3e	Increase marine survival, increased number of successful spawners.	Proposed
3	a. Develop sustainable harvest rules and escapement policies that are consistent with Team goals and objectives and explicitly address uncertainties	5a	Maintain a viable, self-sustaining and genetically robust population over the long term.	Underway
	b. Evaluate freshwater productivity during recovery.	1a, 1d 2d, 2e	Improved understanding of threat to recovery posed by depensatory mortality, predator pit and habitat alteration.	Underway

OTHER CUs WITH COMMON THREATS

Other Fraser Late run sockeye CUs have similarly experienced pre-spawn mortality associated with early in-river migration timing and infection with the *Parvicapsula* parasite.

CU OUTLOOK

Recent returns of CLS have been the lowest on record since 1925 when record keeping began. The future of the CU appears to be highly dependent on future pre-spawn mortality (Schubert et al. 2002) and marine survival rates. Total exploitation rates have been reduced from 70-90% prior to 1995 to less than 30% since 2001.

The outlook for Cultus Lake sockeye is highly uncertain and depends on the magnitude of negative impacts due to fishing, habitat perturbations, and especially future levels of pre-spawn mortality.

SOURCES OF INFORMATION

Atkinson, C.E., J.H. Rose, and T.O. Duncan. 1967. Pacific salmon in the United States, p. 43-223. *In: Salmon of the North Pacific Ocean. Part IV. Spawning populations of North Pacific salmon.* Int. North Pac. Fish. Comm. Bull. 23.

COSEWIC 2003. COSEWIC assessment and status report on the sockeye salmon *Oncorhynchus nerka* (Cultus population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 57pp.

Cultus Sockeye Recovery Team. *In press.* National recovery strategy for sockeye salmon (*Oncorhynchus nerka*), Cultus Lake population, in British Columbia. National Recovery Strategy No. XXX. Recovery of Nationally Endangered Wildlife (RENEW). Ottawa, Ontario, 48pp.

Foerster, R.E. 1936. The return from the sea of sockeye salmon (*Oncorhynchus nerka*) with special reference to percentage survival, sex proportions and progress of migration. *J. Biol. Bd. Can.* 3(1): 26-42.

Foerster, R.E. 1968. The sockeye salmon, *Oncorhynchus nerka*. *Fish. Res. Board Can. Bull.* 162. Ottawa.

Foerster, R.E. and W.E. Ricker. 1941. The effect of reduction of predaceous fish on survival of young sockeye salmon at Cultus Lake. *J. Fish. Res. Bd. Can.* 5(4): 315-336.

Foerster, R.E. and W.E. Ricker. 1953. Predator control and sockeye salmon production. Fisheries Research Board of Canada, Confidential Manuscript, 18p.

Friesen, T.A., and D.L. Ward. 1999. Management of northern pikeminnow and implications for juvenile salmonid survival in the lower Columbia and Snake rivers. *N. Am. J. Fish. Manage.* 19: 406-420.

Hallock, R.J. and D.H. Fry, Jr. 1967. Five species of salmon, *Oncorhynchus*, in the Sacramento River, California. Calif. Fish Game 53:5-22.

IUCN. 2001. IUCN Red List categories and criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. 30 p.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Bull. Fish. Res. Board Can. p.173:381

Ricker, W.E. 1933. Destruction of sockeye salmon by predatory fishes. Biol. Bd. Canada, Pacific Prog. Rept. No. 18, 3-4.

Ricker, W.E. 1941. The consumption of young sockeye salmon by predaceous fish. J. Fish. Res. Bd. Can. 5(3): 293-313.

Schubert, N.D. 1998. The 1994 Fraser River sockeye salmon (*Oncorhynchus nerka*) escapement. Can. Tech. Rep. Fish. Aquat. Sci. 2201: 62p.

Schubert, N.D., T.D. Beacham, A.J. Cass, T.E. Cone, B.P. Fanos, M. Foy, J.H. Gable, J.A. Grout, J.M.B. Hume, K.F. Morton, K.S. Shortreed, M.J. Staley, and R.E. Withler. 2002. Status of Cultus Lake Sockeye Salmon (*Oncorhynchus nerka*). Canadian Science Advisory Secretariat.

Withler, R.E., K.D. Le, R.J. Nelson, K.M. Miller, and T.D. Beacham. 2000. Intact genetic structure and high levels of genetic diversity in bottlenecked sockeye salmon (*Oncorhynchus nerka*) populations of the Fraser River, British Columbia, Canada. Can. J. Fish. Aquat. Sci. 57(10): 1985-1998.

NAME(S) OF INDIVIDUALS WHO COMPLETE/ UPDATE TEMPLATE, COMPLETE MAILING ADDRESSES AND DATES

Ann-Marie Huang; Resource Management, Operations Branch, Fisheries and Oceans Canada, Lower Fraser Area, 3-100 Annacis Parkway, Delta, BC V3M 6A2.

Phone: 604-666-6033

Email: huanga@pac.dfo-mpo.gc.ca

Date: March 2006

CONSERVATION UNIT TEMPLATE

APPENDIX A. Cultus Lake Catch, Escapement, & Exploitation Information By Cycle Year.
(data from Pacific Salmon Commission)

CULTUS LAKE SOCKEYE - Adults Only

2000 CYCLE YEAR

YEAR	MARINE * CATCH	EXPLOIT. RATE	NATIVE CATCH	EXPLOIT. RATE	TOTAL CATCH	EXPLOIT. RATE	SPAWN. ESCAPE.	TOTAL RUN
1952	51215	74.1%	56	0.1%	51271	74.2%	17833	69104
1956	38928	73.3%	467	0.9%	39395	74.2%	13718	53113
1960	21746	54.8%	295	0.7%	22041	55.5%	17640	39681
1964	30771	72.5%	584	1.4%	31355	73.9%	11067	42422
1968	47943	64.8%	760	1.0%	48703	65.8%	25314	74017
1972	52830	83.5%	72	0.1%	52902	83.6%	10366	63268
1976	27412	85.7%	130	0.4%	27542	86.1%	4435	31977
1980	4547	71.3%	106	1.7%	4653	73.0%	1657	6376
1984	5791	84.2%	92	1.3%	5883	85.5%	994	6877
1988	8904	91.0%	20	0.2%	8924	91.2%	861	9785
1992	6298	84.0%	0	0.0%	6298	84.0%	1203	7501
1996	391	15.9%	39	1.6%	430	17.5%	2022	2452
2000	2768	47.0%	1892	32.1%	4660	79.2%	1227	5887
2004	25	21.4%	2	1.7%	27	23.1%	90	117
AVG:	21397.79	72.6%	322.5	1.1%	21720.29	73.7%	7744.786	28469.79

2002 CYCLE YEAR

YEAR	MARINE * CATCH	EXPLOIT. RATE	NATIVE CATCH	EXPLOIT. RATE	TOTAL CATCH	EXPLOIT. RATE	SPAWN. ESCAPE.	TOTAL RUN
1954	249657	91.9%	25	0.0%	249682	91.9%	22036	271718
1958	102275	88.4%	48	0.0%	102323	88.5%	13324	115647
1962	40750	60.0%	192	0.3%	40942	60.3%	26997	67939
1966	40931	70.4%	255	0.4%	41186	70.9%	16919	58105
1970	113429	88.2%	1249	1.0%	114678	89.2%	13941	128619
1974	33765	77.6%	737	1.7%	34502	79.3%	8984	43486
1978	14668	71.6%	100	0.5%	14768	72.1%	5705	20473
1982	51979	75.2%	409	0.6%	52388	75.8%	16725	69113
1986	9034	72.7%	129	1.0%	9163	73.8%	3256	12419
1990	8537	82.1%	3	0.0%	8540	82.1%	1860	10400
1994	18771	80.8%	72	0.3%	18843	81.1%	4399	23242
1998	1427	13.9%	46	0.4%	1473	14.4%	1959	10264
2002	783	13.1%	33	0.6%	816	13.7%	5149	5965
AVG:	52769.69	81.9%	253.6923	0.4%	53023.38	82.3%	10865.69	64414.62

2001 CYCLE YEAR

YEAR	MARINE * CATCH	EXPLOIT. RATE	NATIVE CATCH	EXPLOIT. RATE	TOTAL CATCH	EXPLOIT. RATE	SPAWN. ESCAPE.	TOTAL RUN
1953	92544	88.9%	20	0.0%	92564	88.9%	11543	104107
1957	112019	84.6%	81	0.1%	112100	84.6%	20375	132475
1961	14285	50.8%	416	1.5%	14701	52.3%	13396	28097
1965	12164	82.6%	110	0.7%	12274	83.3%	2455	14729
1969	28860	82.6%	117	0.3%	28977	83.0%	5942	34919
1973	5858	89.9%	18	0.3%	5876	90.2%	641	6517
1977	384	79.7%	16	3.3%	400	83.0%	82	482
1981	1201	82.4%	0	0.0%	1201	82.4%	256	1457
1985	541	56.1%	0	0.0%	541	56.1%	424	965
1989	1679	80.1%	0	0.0%	1679	80.1%	418	2097
1993	9805	90.2%	3	0.0%	9808	90.2%	1063	10871
1997	51	34.2%	10	6.7%	61	40.9%	88	149
2001	106	15.2%	77	11.0%	183	26.2%	515	698
AVG:	21499.77	82.8%	66.76923	0.3%	21566.54	83.1%	4399.846	25966.38

2003 CYCLE YEAR

YEAR	MARINE * CATCH	EXPLOIT. RATE	NATIVE CATCH	EXPLOIT. RATE	TOTAL CATCH	EXPLOIT. RATE	SPAWN. ESCAPE.	TOTAL RUN
1955	174732	87.0%	122	0.1%	174854	87.1%	25922	200776
1959	354492	88.0%	525	0.1%	355017	88.1%	47779	402796
1963	59041	73.8%	694	0.9%	59735	74.6%	20303	80038
1967	262763	89.4%	462	0.1%	263225	89.5%	33198	316423
1971	125312	93.2%	0	0.0%	125312	93.2%	9128	134440
1975	34263	74.1%	624	1.3%	34887	75.5%	11349	46236
1979	73904	68.3%	2242	2.1%	76146	70.4%	32031	108177
1983	87566	81.2%	388	0.4%	87954	81.5%	19944	107898
1987	68538	68.0%	0	0.0%	68538	68.0%	32184	100722
1991	43602	67.2%	1161	1.8%	44763	69.0%	20157	64920
1995	7803	40.3%	1222	6.3%	9025	46.7%	10341	19341
1999	4349	10.8%	126	0.3%	4475	11.1%	12403	40266
2003	603	21.1%	77	2.7%	680	23.7%	2184	2864
AVG:	101305.2	81.0%	587.9231	0.5%	101893.2	81.5%	21299.85	124992.1