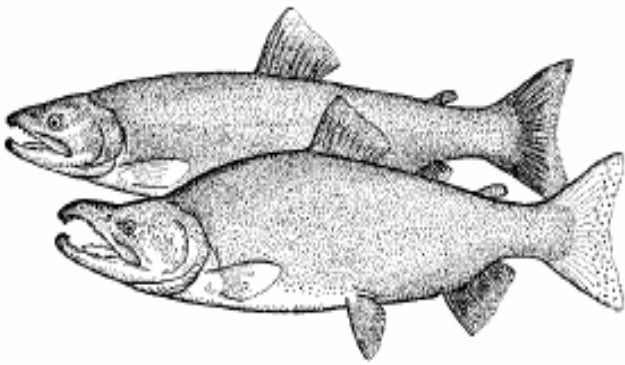




Conservation Strategy for Sockeye Salmon (*Oncorhynchus nerka*), Sakinaw Lake Population



January 2008



CONSERVATION STRATEGY

for the

Sockeye salmon (*Oncorhynchus nerka*),
Sakinaw Lake Population, in British Columbia

2005

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Range jurisdictions

The lead jurisdiction for the protection of Sakinaw Lake sockeye salmon and their habitat is Fisheries and Oceans Canada, under the Canada Fisheries Act. The Province of British Columbia has jurisdiction over the use of the sea floor and aquatic foreshore under the BC Land Act and Upland Forest through the Forest Act. The Canadian Coast Guard has jurisdiction over the river and lake access through the Navigable Waters Protection Act. Finally, the Sunshine Coast Regional District is involved in the protection of lake habitat through the Official Community Plan and similar planning functions.

Disclaimer

The Conservation Strategy for the Sakinaw Lake population of sockeye salmon was prepared by the Sakinaw Sockeye Recovery Team (SSRT) in consultation with experts and observers to identify recovery goals and objectives that are based on sound biological principles, to protect and recover the species. It does not necessarily represent either the official positions of agencies or the views of all individuals involved in the strategy's preparation. The goals, objectives, and approaches identified in the document represent consensus arrived at by the Recovery Team. Implementation of the Conservation Strategy will reflect the priorities and budgetary constraints of participating jurisdictions and organizations.

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- Pacific Salmon Foundation

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- Sliammon First Nation
- Sunshine Coast Regional District
- Area D Salmon Gillnet Association
- Area H Gulf Trollers Association
- Local resident groups
- Sunshine Coast conservation organizations
- Sport Fish Advisory Board

Glossary

Alevin: Young salmon that still has its yolk sac. Alevins are rarely seen in the wild because they continue to develop in the stream or lake gravels.

Anadromous: The life history characteristic of returning from the sea to reproduce in fresh water.

Anthropogenic: Relates to influences by humans.

Artificial selection: Selection by humans.

Biological diversity: The variability among living organisms from all sources – including terrestrial, marine, and other aquatic ecosystems – and the ecological complexes of which they are a part. This includes diversity within species, between species, and of ecosystems.

Broodstock: Mature salmon from which milt and roe are extracted to produce the next generation of cultivated fish.

Captive Breeding: Mating by design using individuals bred and maintained in captivity.

Conservation: The wise use of the salmon resource for the long-term health and productivity of wild populations. See also *preservation* and *protection*.

Diel: Relates to events occurring over the course of a day. In the case of juvenile sockeye their vertical movements change over the course of a day.

Enhancement: The application of biological and technical knowledge and capabilities to increase the productivity of fish stocks. It may be achieved by altering habitat attributes (e.g., habitat restoration) or by using fish culture techniques. In the context of this policy, only fish culture techniques are considered enhancement.

Ecosystem: A community of organisms and their physical environment interacting as an ecological unit.

Escapement: The number of mature salmon that pass through (or escape) the fisheries and return to their rivers of origin to spawn.

Extinction: Loss of a species that does not exist elsewhere in the world.

Fish culture: The use of hatcheries, other incubation facilities, and production spawning channels to protect fish during high-mortality life stages to increase the number of surviving juvenile fish per parent.

Fish habitat: Spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly to carry out their life processes.

Fish habitat stewardship: Acting responsibly to conserve fish habitat for present and future generations.

Genetic diversity: For a species, the sum of the genetic variation within the species, that includes both variability among individuals within a population and differences between populations.

Habitat restoration: The treatment or clean-up of fish habitat that has been altered, disrupted, or degraded for the purpose of increasing its capability to sustain a productive fisheries resource.

Inbreeding: Mating or crossing of individuals more closely related than average pairs in the population.

Life History: The various biological characteristics that portray the individual stock or population (e.g., fecundity, age and size at maturity, sex ratios, and migration timing).

Marine: Pertaining to the sea.

Maximum sustainable yield: The largest catch (yield) that can be continuously taken from a stock under existing environmental conditions.

Meromictic: A stratified lake, usually without oxygen in its deeper portions, due to a density gradient and a lack of turnover.

Migration: The movement of an organism or group from one habitat or location to another.

Parr: Juvenile salmon stage between the fry stage and the smolt stage. Parr are often referred to by their age class as 0+ parr, 1+ parr.

Pelagic: The open sea comprising the water column. Pelagic fish are those that move throughout the open ocean water column.

Phenotype: Observable characteristics of an organism produced by the organism's genotype interacting with the environment.

Piscivorous: Fish eating

Population: A group of interbreeding salmon that is sufficiently isolated from other populations so that there will be persistent adaptations to the local habitat.

Preservation: Refers to actions taken to retard the deterioration of, or to prevent damage to, a natural resource (no consumptive use). See also conservation and protection.

Productive capacity: The maximum natural capability of habitats to produce healthy fish, safe for human consumption, or to support or produce aquatic organisms upon which fish depend.

Productivity: The capacity of an environment/population to produce numbers or biomass of organisms (e.g., fish).

Protection: "Protection" implies the idea of a threat and refers to regulatory measures, resource management and public education programs aimed at ensuring that ecosystems are maintained in a natural state. See also conservation and preservation.

Recruitment: The addition of new fish to the vulnerable population due to growth from smaller size categories.

Redds: Nests built by female salmonids and trout to bury and incubate their eggs. Redds are usually comprised of a depression followed by a mound of clean gravels. The gravel is excavated by the females tail and the eggs are subsequently deposited in the redd.

Remedial measures: Interventions to correct a problem, e.g., fishway in a dam.

Riparian: A term used to describe the vegetative zone found along stream corridors, the vegetation within this zone relies on the stream for nutrients and water.

Risk: The expression of the combination of the chance of different events occurring and their events.

SARA: The Species at Risk Act, officially titled "An Act Respecting the Protection of Wildlife Species at Risk in Canada".

Selective harvest/fishery: A conservation-based management approach that allows for the harvest of surplus target species or stocks while aiming to minimize or avoid the harvest of species or stocks of conservation concern, or to release by-catch unharmed.

Selection: Non-random differential reproductive success of different genotypes in a population.

Smolt: A juvenile salmon during its seaward migration with the physiological capability to survive transition from fresh water to salt water.

Spawning: The process or release of gametes or eggs into the water. In the case of salmon in natural streams, rivers and lakes, spawning includes the deposition of those eggs into nests dug in the substrate.

Species: A taxon of the rank of species; in the hierarchy of biological classification the category below genus; the basic unit of biological classification; the lowest principal category of zoological classification.

Stakeholder: An individual with a vested interest in the resource.

Stock: The part of a fish population that is under consideration for actual or potential utilization. Commonly used in the sense of any group of interbreeding salmon that are reproductively isolated from other such groups, a sense that is equivalent to a local population.

Stock assessment: The use of various statistical and mathematical calculations to make quantitative predictions about the reactions of fish populations to alternative management choices.

Sustainable use: The use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of diversity, thereby maintaining its potential to meet the needs of present and future generations. Sustainable does not imply that abundance is constant.

Terminal harvest/fishery: A fishery in a river or near the mouth of a river where returning salmon pass through or congregate near and where stocks are relatively unmixed prior to spawning.

Viability: The ability to continue to grow or survive.

Wild salmon: In this Recovery Document, salmon are considered wild when they and their parents are offspring of salmon that spawned and grew up in natural surroundings.

Wild salmon population: A population comprising naturally spawning and rearing wild salmon.

Executive Summary

The Sakinaw Lake sockeye is a unique and endangered population endemic to Sakinaw Lake on the Sechelt Peninsula in southwestern British Columbia. Sakinaw Lake is located within the Sechelt First Nation traditional territory and the Pender Harbour community. The small permanent community is augmented by recreational users.

Sakinaw Lake sockeye have a protracted run timing beginning with upstream migration in May and extending into October. Their life history is similar to other Fraser River sockeye populations but they are reproductively isolated. Juveniles leave the lake in May and presumably head north through Johnstone Strait and the North Pacific. Upon return they migrate with Fraser stocks through Johnstone Strait and the Strait of Georgia. Once near Sakinaw Creek they school off the mouth, moving into the Pender Harbour and Jervis Inlet areas.

Adult sockeye enter Sakinaw Lake through a short (<100-m) stream channel and low concrete dam structure. Once in the lake, the adults hold for up to 5 months before moving onto beach areas to spawn. Spawning beaches are critical to the survival of this population and utilization of the beach areas extends 50 m from the shoreline to depths of up to 20 m.

The abundance of all life stages of Sakinaw Lake sockeye has declined significantly in recent decades. Recent estimates are among the lowest recorded for the population, which has ranged from escapements as high as 15,000 adults in the mid-1970s to 24 fish recorded at the dam in 2005. As a result of this alarming decline the Sakinaw Lake sockeye was designated by COSEWIC as Endangered in 2002. The exact cause of the decline is not known. Overexploitation, loss of important habitat and poor marine survival have all been discussed. Regardless of the cause, the decline must be reversed or this population of sockeye risks extirpation in the foreseeable future. It is this urgency that has provided the catalyst for the Conservation Strategy and its implementation.

The Recovery Team has identified potential risks and ranked them by severity. The threats that provide the greatest risk to Sakinaw sockeye include:

- Small population size, thus limiting genetic variation critical to long-term survival;
- Incidental fishing mortality within the sport and mixed stock commercial fisheries;
- Limited available water volume within the lake basin resulting in access problems into and out of the lake during migration periods;

- Elevated water temperatures that approach lethal limits in and around holding areas.

The Recovery Team did not identify marine and freshwater habitat loss with a high-risk severity to recovery. However, it is understood that these habitats are very important to its long-term survival.

The Recovery Team believes that the recovery of the Sakinaw Lake sockeye population is biologically and technically feasible. A conservation strategy that includes an understanding of the life history and anthropogenic and natural factors influencing their ability to survive was developed. Current areas of knowledge gaps include:

- The survival rate of sockeye at each developmental stage during freshwater residency;
- Effects of in-lake and marine predation;
- Ground and surface water dynamics within the main basin and influence on water quantity and quality;
- Impacts from increased recreational use;
- Migration routes and timing for both juveniles and adults.

The Recovery Team attempted to identify habitat it believes is important to the viability of Sakinaw sockeye. The definition and inclusion of this habitat resulted in many discussions as the conservation strategy developed. The result has been the summary of potential important habitat and a short rationale for the inclusion of these potential areas of study. We propose the following as important habitat:

- The outlet of Sakinaw Lake. In order for the population to recover, the outlet needs to be minimally obstructed and disturbed so that the fish pass through it as quickly as possible;
- All lakeshore gravel at depths between 0 and 20 m at the five known spawning beaches (Sharon's, Haskins, Ruby Creek, Kokomo Bay, and Prospector Bay) as well as the watershed contributing to the lake spawning carrying capacity.

In order to stop the decline of the Sakinaw Lake sockeye salmon population and re-establish a self-sustaining, naturally spawning population, the Recovery Team identified seven sequential objectives:

- Inform the local community and other stakeholders about the conservation planning process for Sakinaw sockeye and encourage them to become involved in the stewardship of the Sakinaw Lake watershed;
- Achieve continued growth in the generational average by increasing spawner abundance relative to the brood year (4 years prior) for at least 3 out of 4 consecutive years;
- Increase the annual number of spawners (here including those removed for hatchery broodstock) to no fewer than 500 from 2004 to 2007;
- Increase the number of naturally produced spawners to no fewer than 500 annually in 2008 to 2011;
- Ensure that, by 2017, the mean population abundance in any four-year period exceeds 1,000 naturally produced spawners, with no fewer than 500 naturally produced spawners in a year;
- Identify, assess, protect and, where necessary, rehabilitate habitats important to the conservation goal;
- As a longer-term target, identify the level of abundance required to support ecosystem function and sustainable use.

Specific recovery activities include the need to engage the local stakeholders in the process, control of exploitation through conservation-oriented fishing plans, population assessment, a captive breeding project, research on the cause of early migration and high pre-spawn mortality, assessment of littoral habitat, studies on the impact of predation and management strategies for controlling water release at the dam.

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1.0 Background

The Sakinaw Lake sockeye is endemic to Sakinaw Lake located on the Sechelt Peninsula in southwestern British Columbia. This population has declined in recent years from an estimated 16,000 returning spawners to a low of three in 2003 and 24 in 2005. Concern regarding extinction has been voiced since the mid-1990s, and in the early 2000s efforts were undertaken to identify the cause of the decline and to rebuild the population. The Sakinaw Lake Recovery Team was formed in 2002 following review of the population by Fisheries and Oceans Canada and designation by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This document presents the development of the Sakinaw Lake Conservation Strategy developed and provides a framework for government, industry, NGOs, First Nations and public groups to work toward conservation of this diminishing population.

1.1 COSEWIC Species Information¹

Common Name:	Sakinaw Lake Sockeye Salmon
Scientific Name:	<i>Oncorhynchus nerka</i>
Assessment Summary:	May 2003
Status:	Endangered
Reason for designation:	The Sakinaw population has unique genetic and biological characteristics (early river-entry timing, protracted lake residency before spawning, small adult size, low fecundity, large smolts). The lack of success with previous attempts to transplant sockeye to Sakinaw Lake and other lakes suggests that Sakinaw sockeye are irreplaceable. The Sakinaw population has collapsed primarily due to overexploitation, including directed and incidental catches in mixed-stock fisheries at levels above those that can be sustained. In addition, water flow and water level have at times been insufficient to allow adult fish to enter the lake. There are also ecological impacts on the lake habitat from logging, residential development and water usage. Because very few fish remain, the population is

¹ Species information is provided from the original COSEWIC document (COSEWIC 2003). The SSRT notes that threats originally listed by COSEWIC supporting the endangered status may have changed.

at high risk of extinction from even minor impacts from fishing, poaching, and impediments to spawning migration, predation, habitat degradation and water usage.

Occurrence: British Columbia Pacific Ocean

Status history: Designated Endangered in an emergency listing in October 2002. Status re-examined and confirmed in May 2003. Assessment based on new status report.

1.2 General Species Biology

1.2.1 Description

Sockeye salmon, *Oncorhynchus nerka*, is one of five species of Pacific salmon found along the west coast of North America. The sockeye is anatomically unique in having 12 or more anal fin rays, 28 to 40 long, slender, closely spaced gill rakers on the first arch, relatively few (45-115) pyloric caeca, and fine black speckling on its back (Hart 1973, Mecklenburg et al 2002).

At sea, both sexes are metallic dark blue to greenish blue on the head and back, with silver sides and white below providing cryptic protection during this phase of their life history. The adult body becomes red and the head turns olive green in the weeks before spawning. The degree of colour change varies between sexes and populations. Maturing males are usually more brilliantly coloured than the females and they develop an elongated hooked jaw and humped back (Figure 1). In contrast, the female also changes colour but does not develop the hooked nose or humped back observed in males. Adult sockeye can reach a total length of 84 cm and weigh up to 7 kg, but can vary in size with age of maturity and among populations (Foerster 1968).

1.2.2 Life History

Sockeye salmon have an anadromous life history similar to other Pacific salmon, beginning their life in fresh water as eggs and alevins before growing into fry and subsequently parr. Parr undergo dramatic physiological changes that allow them to migrate into the marine environment. Once at sea they continue to feed and grow for 2-3 years before migrating back to their natal freshwater location to spawn as mature adults. In contrast to the anadromous life history is the non-anadromous one, where the entire life cycle takes place in freshwater. These non-anadromous populations are known as kokanee salmon. They typically mature at a smaller size and lack the brilliant colouration of their sea-going counterparts.



Figure 1: Adult male sockeye salmon. Sakinaw Lake sockeye are typically small compared to other southern populations.

Sockeye salmon exhibit the greatest diversity among Pacific salmon in their adaptation to a wide variety of spawning habitats (Burgner 1991). Generally, spawning occurs in streams, although some populations utilize lakeshore beaches. Migration to the spawning grounds may begin as early as February (in Cheewat and Quinalt lakes) with adults schooling in the marine environment for the trip home to their natal streams. These upstream migrations can be anywhere from relatively short distances to hundreds of kilometres.

Spawning begins as early as August and some stocks may spawn into the winter months. Generally, sockeye spawn in stream riffles containing clean gravel where water percolation provides adequate oxygen for embryonic development. Lake spawning populations use areas where there is significant upwelling of groundwater. One or more males fertilize the eggs as the female deposits them in a depression (redd) that she has excavated. She covers the eggs with gravel. Once hatched, the fish still have the egg yolk attached and are called alevins. They emerge from the gravel in early spring when the yolk is mostly depleted.

Now called fry, stream populations migrate downstream (or in some cases upstream) to nursery lakes. A few populations may migrate to other stream habitats or go to sea. Fry are small, measuring between 25 and 35 mm in length (Burgner 1991) and are especially vulnerable to predation. Within days, the juveniles move offshore into deeper waters. Juvenile sockeye usually remain in the lake for one year in southern British Columbia but may stay for two years or more. Typically, they remain at depth during the day and ascend to near the surface at dusk to feed on zooplankton. The rate of growth varies depending on the productive capacity and quality of the available food resources. At the end of

this period the juveniles undergo morphological and physiological changes as they smolt and prepare for life in the marine environment.

Sockeye smolts migrate to sea in the spring at approximately 60 to 150 mm in length. Smolts school, and then migrate from the lake(s), moving downstream through outlet streams. The timing of this outmigration is quite consistent between populations and between years in each population, with the peak movement in May. During this migration they can be subject to intense predation by fish, birds and mammals.

Smolts may pause in the estuary where a freshwater/saltwater transition zone is provided. During this period the physiological mechanisms providing successful transition continue; within days, the fish move away from the estuarine areas.

Most west coast populations of sockeye make a concerted coastal migration northward until they reach the northern Gulf of Alaska in the fall. With the onset of winter they migrate south into the open ocean. They continue to forage and grow in the open ocean, migrating north and south over large areas of the North Pacific. This phase of their life cycle may last up to 3 years. As they near age 4 or 5, the adults make a highly directed spawning migration back to their natal streams where the cycle begins again. It is on this return journey that they are most subject to fishing and predation.

Figure 2 provides a generalized life cycle for the sockeye salmon. It should be noted that each population of sockeye found in the Pacific Northwest exhibits unique biological characteristics.

1.3 Sakinaw Lake Sockeye

Sakinaw Lake sockeye generally follow the life history described above. Adults are small, averaging approximately 2 kg. They enter the lake from May to October, with most entering in July and August. They are known to school off the mouth of Sakinaw Creek and it has been speculated that they may move north toward Jervis Inlet and possibly into Sechelt Inlet.

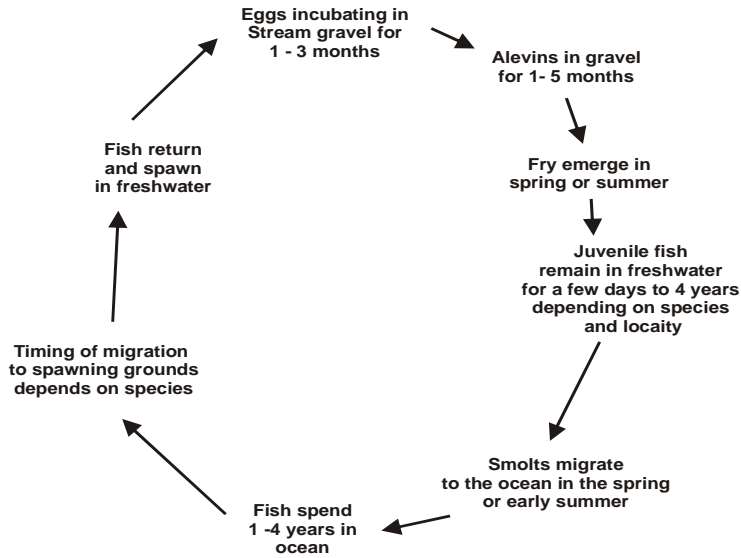


Figure 2: A generalized life cycle for Pacific Salmon. Each phase of the life cycle has specific habitat requirements and associated risks.

Adults rely on suitable tides and water levels to make the short (<100 m) upstream migration through a water control weir and into the lake. Recent data show that the fish move into the lake on high tides during the night (presumably to avoid predators at the mouth). Once in the lake, adults hold without feeding for up to five months before spawning in beach areas. The mature adults seek mates and appear to favour beach areas with significant groundwater seepage. It is assumed that these beaches are critical to the Sakinaw sockeye life history because spawning has never been observed in the stream and lake tributaries to Sakinaw Lake. Redds are excavated within 50 m of shore to depths of 20 m.

As the fry emerge from the beaches they move into deeper waters, feeding in a lake environment that is considered productive relative to other coastal sockeye lakes in BC (Shortreed *et al.* 2003). Information on this phase of the life history is limited. Inferences and comparison regarding the importance of this habitat are drawn from general characteristics of other studied sockeye populations.

The majority of the juvenile sockeye rear in Sakinaw Lake for one year, while a few remain in the lake for a second year. Smolting and migration behavior is similar to other sockeye populations. The juveniles migrate out of the lake from March to June, peaking in May. The most notable difference between Sakinaw Lake sockeye juveniles and other south coast populations is their size. Murray and Wood (2002) noted that Sakinaw smolts are among the biggest recorded in B.C. This may be an indication of low densities in the lake relative to the amount of zooplankton food.

A small estuary at the mouth of Sakinaw Lake Creek (outflow from lake) provides a transition zone for migrating juveniles. The extent of utilization and its importance for this population is unknown. Once at sea the juvenile sockeye are presumed to follow similar migratory patterns to other sockeye populations. Fraser sockeye are known to form schools and move mostly northwest up the east side of the Strait of Georgia toward Alaska (Burgner 1991).

Although life history characteristics are similar to other Fraser River sockeye populations, Sakinaw Lake sockeye are reproductively isolated (COSEWIC 2003). Genetic surveys found significant variation in allozyme, microsatellite DNA and mitochondrial DNA (Wood *et al* 1994; Murray and Wood, 2002; Nelson *et al* 2003). This isolation and local adaptation truly separates the Sakinaw sockeye from other sockeye populations in the Pacific Northwest (COSEWIC 2003).

1.4 Distribution

1.4.1 Freshwater

Sakinaw sockeye are endemic to Canada, in that they reproduce only in Sakinaw Lake. Sakinaw Lake is located on the Sechelt Peninsula on the east side of the Strait of Georgia (Figure 3). The lake consists of two basins with a combined area of 6.9 km². The lower basin is meromictic and is the larger of the two with a maximum depth of 112 m. The upper basin has a maximum depth of only 40 m. Distribution of adult sockeye within the lake prior to spawning is unknown.

Access to the lake from the ocean is through a short creek. At the lake outlet is a flow control weir designed to maintain lake levels. The rationale for the original construction dating to the 1950s is unclear although water storage for industry and lake property owners may have been the reason.

Sakinaw Lake is fed by a number of small tributary lakes and streams but there is no indication returning sockeye use them. Sockeye salmon utilize only Sakinaw Lake for spawning and freshwater rearing.

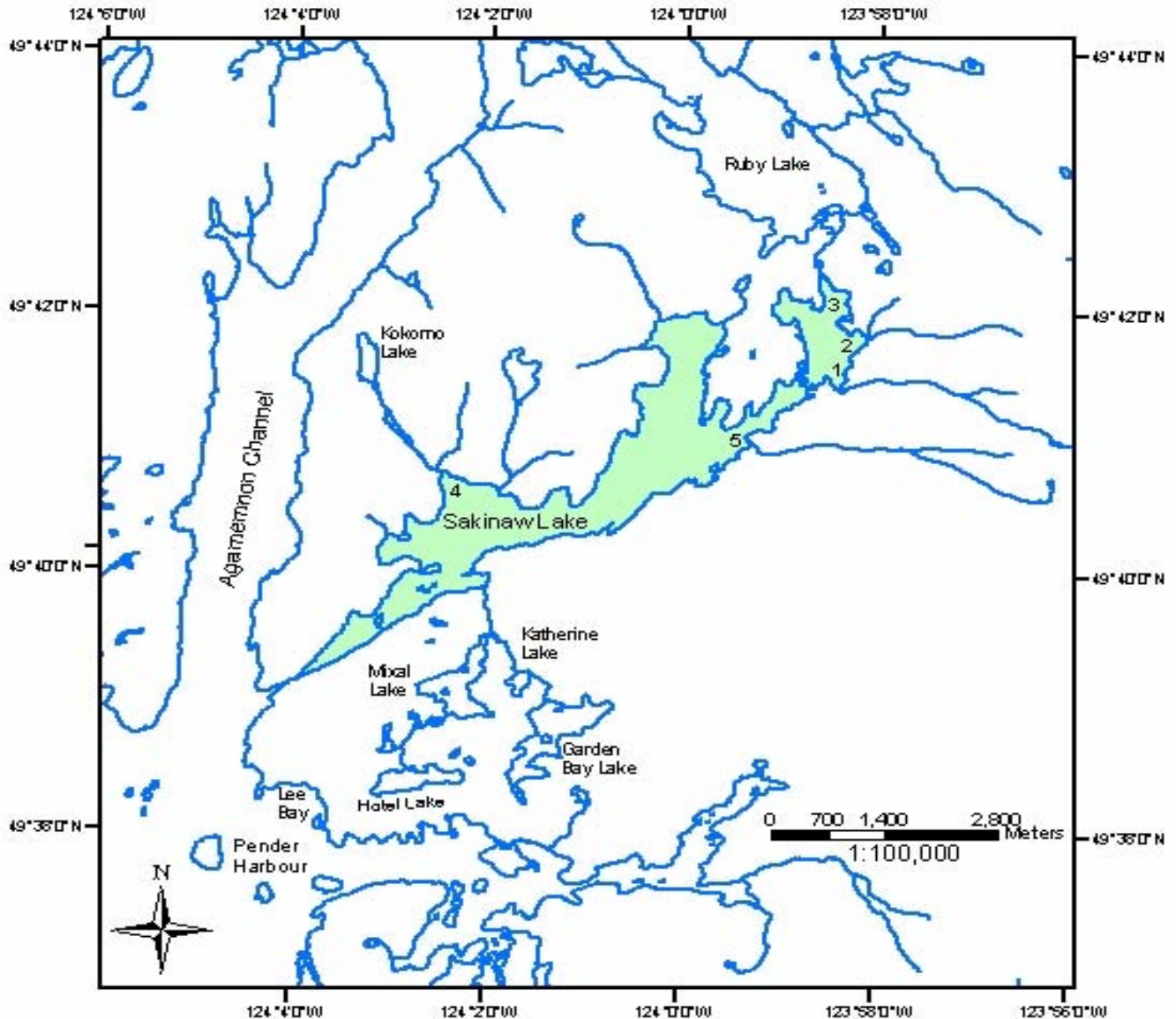


Figure 3: Sakinaw Lake, its tributaries and sockeye spawning beaches: Beach 1 (Sharon's); Beach 2 (Haskins); Beach 3 (Ruby Creek Bay); Beach 4 (Kokomo Creek Bay) and Beach 5 (unnamed - Prospector C).

1.4.2 Ocean

Distribution of Sakinaw sockeye in the ocean is not well known. It is assumed that this population travels routes similar to other central and south-coast sockeye populations. It is most likely that Sakinaw sockeye primarily transit Johnstone Strait, rather than Juan de Fuca Strait, when returning to Sakinaw Lake, although there is very limited historical information from Johnstone Strait to support this assumption. Since there are major 'gauntlet' fisheries in both straits,

uncertainty in ocean distribution and migration timing creates management challenges that must be immediately addressed to protect the population.

Ocean distribution of other known sockeye salmon populations is provided in Figure 4. This illustrates the overall range of spawning and rearing habitat for North American sockeye salmon populations.

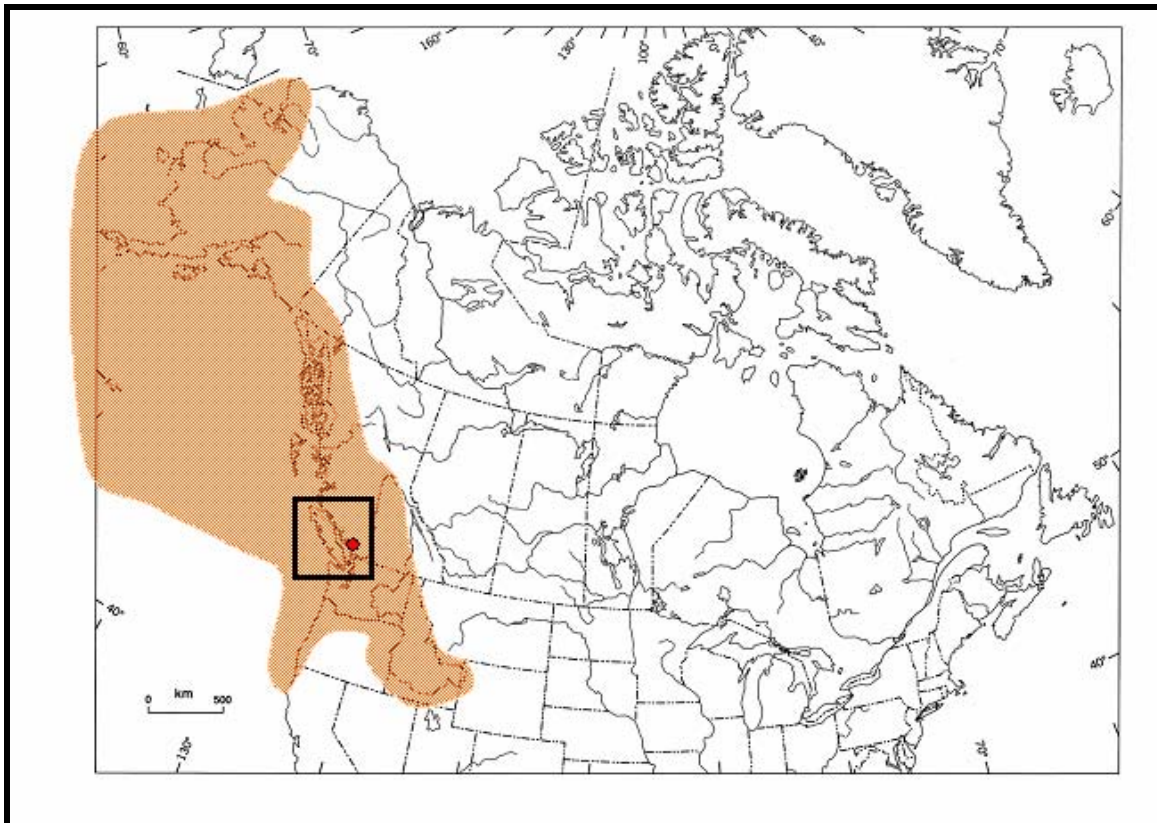


Figure 4: The range of sockeye salmon off the west coast of North America (Wood 1995)

1.5 Population Abundance and Trends

1.5.1 Abundance

The abundance of Sakinaw sockeye has declined dramatically since 1987. From 1947 to 1987, the estimated number of adults entering the lake averaged about 5,000 (range 750 to 16,000) with no significant declining trend. Numbers averaged just over 1,000 per year between 1988 and 1992, less than 200 between 1993 and 1996, and less than 50 between 1997 and 2001. In 2002, sockeye were enumerated by observers at the dam during peak tides; only 78 were counted entering the lake. Additional observer counts on the spawning

beaches in 2002 accounted for only 44 sockeye or 56% of those recorded moving into the lake. In 2003, only three entered the lake (the run was continuously monitored this year). Only one was observed on the spawning beaches (Figure 5). In 2004, 99 spawners entered the lake; in 2005, only 24 were observed.

1.5.2 Trends

A statistically robust estimated rate of decline from regression analysis using one-generation smoothed estimates of mature abundance (based on annual estimates of mature adults between 1988 and 2002, and smoothed to 1990-2001) reveals an annual rate of decline of 33%. This implies a reduction of 99% over 3 generations (Murray and Wood 2002). Using only the endpoints, there has been an 87% or larger reduction in the number of sockeye estimated to enter the lake over the last three generations (from 1991 to 2002 using four years per generation; Murray and Wood 2002; Figure 5). This trend will lead to extinction without immediate intervention and protection of the remnant population.

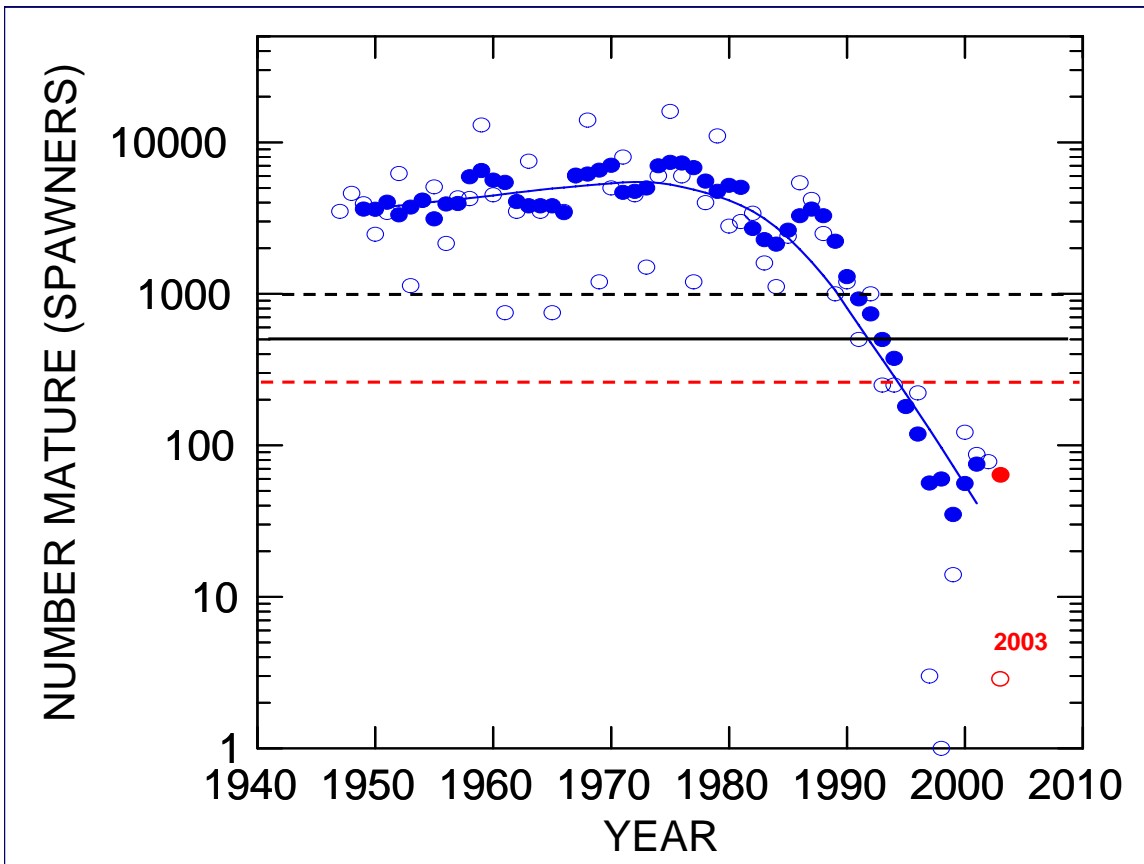


Figure 5: Trends in number of mature individuals in the Sakinaw Lake sockeye salmon population. Open circles are annual estimates of spawning escapement:

filled circles are the corresponding estimates smoothed over one-generation (4 yr.); the line is fitted to smoothed data using LOWESS (Wood and Parken 2004).

1.6 Threats Potentially Limiting Recovery

In order to begin conservation, threats must first be identified, then reduced or removed. The following known and speculative factors are not discussed in order of importance.

Life Stage	Threat	Natural or Human Induced	Threat Class	Likely Severity (Risk)	Identified by COSEWIC Status Report
1 Egg/Alevin	a. Random loss of genetic variation due to low spawning abundance. Small, isolated populations cannot maintain the genetic variation required for long-term viability.	Natural Human	Known	High	Yes
	b. Development and encroachment of lake foreshore resulting in loss of lake spawning habitat. The lakeshore is prime recreational property and continues to be developed.	Human	Presumed	Moderate	Yes
	c. Urban/Industrial Development within the Sakinaw lake watershed influencing surface and groundwater water quality and quantity. Spawning beaches require adequate groundwater for egg incubation. The impact of development within the Sakinaw watershed on the groundwater regime including impacts to aquifer recharging is not known.	Human	Potential	High	Yes
2 Fry/Parr	a. Predation during lake rearing. Cutthroat trout, peamouth chub and lamprey are abundant in Sakinaw Lake, but their impact on the survival of juvenile sockeye is unknown.	Natural	Presumed	Low	Yes
	b. Sport fishing activities. Sport fishing may inadvertently				

		kill large juvenile sockeye prior to migration from the lake.	Human	Potential	Low	No	
	c.	Introduction of exotic aquatic species. The introduction of exotic species such as Eurasian Milfoil or non-salmonid species that will impact habitat quality and increase predation risk.	Human	Potential	Moderate	No	
3	Smolt	a.	Reduced outflow at the dam may influence the smolt out-migration. Smolt migration occurs in the spring when water outflow is typically high. However, outflow is now regulated at the dam to conserve water to facilitate the adult migration into the lake later in the summer. It is possible that reduced outflow during smolt migration can disrupt or influence the timing of smolt migration.	Natural Human	Known	Low	No
		b.	Loss of estuarine habitat due to foreshore development. The estuary area is small and poorly delineated. The importance of this small estuary is not currently known.	Human	Potential	Moderate	No
		c.	Sport fishing activities. Sport fishing may inadvertently kill large juvenile sockeye prior to migration from the lake.	Human	Potential	Low	No
4	Marine Growth	a.	Reduced ocean productivity, including that resulting from climate change. This threat impacts all Pacific salmon populations, but those currently at risk would become more imperiled.	Natural	Potential	Moderate	Yes
		b.	Finfish Aquaculture. The area immediately adjacent to Sakinaw Lake Creek supported numerous salmon farms in the 1980's. How or if these facilities had an impact on the decline in the population is unknown. In addition, aquaculture facilities are located along presumed juvenile and adult marine migration routes. The impacts, if any, of these facilities is unknown at this time.	Human	Potential	Low	No
		c.	Predation in the marine environment. Adult sockeye are especially vulnerable to predators as they approach and ascend the stream into Sakinaw Lake. Predation by	Natural	Presumed	Moderate	Yes

seals and otters has been observed and is of particular concern during years of small run size.

	d.	Incidental fishing mortality. Mixed stock fisheries can un-intentionally kill adult Sakinaw sockeye during their return migration. Little information is available on the migratory route or timing of Sakinaw sockeye so precautionary management of the mixed-stock remains controversial and challenging.	Human	Known	High	Yes
5 Spawner	a.	Difficult access into the lake due to low water conditions and minimal flows in the river and through the dam fishway impairing migrant spawner entry to the lake. Seasonal low flows and periods of unusually low recharging of lake volume can restrict outlet discharge.	Human	Known	High	Yes
	b.	Elevated water temperatures (>23°C) within the river and fishway. These elevated temperatures may be exacerbated by low flows in the late summer. Whether high temperatures impede migration into the lake is unknown.	Natural	Known	High	No
	c.	Predation in freshwater environment by lamprey and river otters. Direct impacts are still unknown.	Natural	Presumed	Moderate	No
	d.	Poaching of adult sockeye holding at the mouth of the river and in the area of the dam. Changes in enforcement presence during the late 1980's and 1990's may have exacerbated this problem.	Human	Known	Moderate	No

1.7 Habitat Identification

1.7.1 General habitat requirements

The habitat requirements of Sakinaw Lake sockeye are geographically and environmentally extensive. In common with most Pacific salmon species, Sakinaw Lake sockeye divide their life cycle between fresh water (for spawning, egg incubation, fry rearing and smolt migration) and the ocean (ocean rearing and return migration to the natal freshwater location). Each of the seven major stages has different habitat requirements.

Marine habitat requirements for Sakinaw sockeye can be taken to be those generic to all Pacific salmon species and include unrestricted ocean corridors and feeding grounds of appropriate temperature and productivity (Foerster 1968; Burgner 1991). Although climate-driven natural variability in ocean productivity will influence the survival of Sakinaw sockeye, management of habitat in marine areas other than the migratory corridor is unlikely to be possible, and we do not discuss these habitats further.

The following sections of the Conservation Strategy relate mainly to freshwater habitat, and describe the habitat requirements for population survival. We use a broad definition of habitat for aquatic species based on the one provided in the Species at Risk Act (SARA), namely that anywhere that the listed population or species lives is considered habitat:

“spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes” (Section 2(1)).

Within that broad definition, we refer to “important” habitat when its loss jeopardizes the survival or recovery of a species or population. Important habitat is therefore the minimum extent and configuration of habitat throughout the life history of Sakinaw sockeye necessary to provide an acceptable probability that Sakinaw sockeye will survive or recover according to specific objectives. It follows that certain amounts of habitat at each life stage may be important.

1.7.2 Requirements for survival and recovery

Migratory (in-stream) routes with appropriate temperature, water flows and refuge

The short (<0.1 km) outlet stream from Sakinaw Lake is used by smolts en route to the sea, and pre-spawning adults when they return to Sakinaw Lake. Access to the lake has been a problem for pre-spawners for years due to limited available lake storage needed to provide minimum fishway flows. Elevated water

temperatures that reach 24°C during the peak of the migration may further affect the entry of adult sockeye.

Long term visual observations by fishery officers and others since 1952 indicate that sockeye migrate into the lake primarily during high tides at night. This may be a behavioral response to predation by otters and seals that move to the base of the dam and fishway in pursuit of adult sockeye and coho. Visual observations in 2003/04 indicate that adult sockeye may take up to one hour to acclimate during transition from seawater to freshwater at high water temperatures. It is possible that low flows in the spring may also make it difficult for the smolts to find the outlet, thereby delaying or preventing emigration.

Temperatures exceed 20°C at times, especially in late May and June. It is a concern that high temperatures and/or low flow may result in a greater proportion of yearlings remaining in the lake. Remaining in the lake for another year may result in lower total survival. This may occur if in-lake mortality of the 'hold-overs' is severe due to predation or some other cause.

The Recovery Team considers the outlet of Sakinaw Lake to be important habitat for Sakinaw Lake sockeye. For the population to recover, the outlet needs to be minimally disturbed so that the fish pass through it as quickly as possible. Possible measures include predator control, creation of refuges, streamlining operation of the enumeration fence, raising public awareness of the reasons for protecting the waterway, and, perhaps most importantly, management of water usage to ensure adequate flow during migratory periods.

The issue of water usage and lack of water volume within the basin continues to increase in importance. Demand for potable water to support area development has directed interest in water extraction from the Sakinaw Lake basin will further exacerbate the problems with minimum access flows at the outlet and potentially impact important habitats. The timely development of a detailed Water Management Plan for the Sakinaw/Pender Harbour area will circumvent further impacts on the Sakinaw Lake sockeye and help direct development of the area.

Spawning and egg incubation habitat

Egg and alevin survival depends on clean spawning gravel and sufficient flow for the delivery of oxygenated water and the removal of metabolic wastes. Sakinaw sockeye spawn exclusively along the lake shoreline. Potential spawning grounds are likely near the mouths of streams where alluvial material and upwelling groundwater exist, or on the lake bottom that is exposed to currents created by strong wave action.

Based on the DFO escapement records - BC16 - (for the period of 1949 to 1986) and Elvidge (1979), there are five beaches that have been used for spawning:

Sharon's (Beach 1), Haskins (Beach 2), Ruby Creek (Beach 3), Kokomo Bay (Beach 4), and Prospector Bay (Beach 5) (Figure 3). Elvidge (1979) indicated that 50% of the sockeye were observed on Sharon's Beach. However these observations were based on visual surface counts and were limited to these five beaches.

It is difficult to predict which of the existing spawning beaches would be most utilized if the population rebuilds, and which should thus be considered most important to conservation. As a precautionary approach, the Recovery Team proposes all lakeshore gravel at depths up to less than 20 m at the five known spawning beaches (Sharon's, Haskins, Ruby Creek, Kokomo Bay, and Prospector Bay) as well as the watershed contributing to the lake spawning carrying capacity as important habitat for Sakinaw sockeye.

Juvenile Freshwater Rearing Habitat:

Sockeye fry and parr rear in the lake for one and occasionally two years. Juveniles typically occupy much deeper waters during the day than they do at night, with vertical migrations often covering tens of meters. These diel migrations balance optimal feeding at shallower depths (more prey and light to catch them) with the refuge from predators and lower metabolic rates that are optimal at deeper depths, where it is darker and cooler. Metabolic rates are less in cooler water, which allows more food energy to go into growth.

Sakinaw Lake appears to be one of the most productive BC coastal lakes, which as a group are very unproductive. In one survey, the estimated photosynthetic rate was $206 \text{ mg C m}^{-2} \text{ d}^{-1}$ (Shortreed *et al.* 2003) and total phosphorus concentrations ranging from 4 to 6.7 ug/L (Shortreed 2002). *Leptodora spp.*, mysids and *Chaoborus spp.* are also present and feed on *Daphnia*, a major prey item of juvenile sockeye. However, *Leptodora* and *Chaoborus* are favoured prey for larger sockeye fry. Sakinaw sockeye smolts appear to be among the largest in BC (mean size: 13.1 cm. and 23.6 g, based on 1992 to 1995 brood years). The abundance of favoured prey and the strong growth of sockeye suggest that the lake rearing capacity is not a major limitation. This conclusion is supported by data showing very good survival of fry in the lake in 2002. The fact that few smolts left the lake in 2004 may not necessarily indicate poor survival, as they may have failed to leave the lake for other reasons. The majority of information suggests that the pelagic zone is not important habitat at this time.

Lake habitat for adult sockeye

Sakinaw Lake is used by adult sockeye for several months prior to spawning. It is unknown where the sockeye reside in the lake and whether parasitism by lamprey is a significant threat to their survival. At this time, the Recovery Team has not identified any lake habitat as proposed critical habitat for adult sockeye.

1.7.3 Habitat Trends

Human population growth in the Sakinaw Lake watershed has increased significantly in the last three decades, although the specific rate of growth is not available. It is assumed that this growth has had some influence on surface and sub-surface hydrology (increased water use), nutrient loading and habitat alterations. These are the obvious impacts and without detailed examination the extent of the change to area habitat(s) cannot be fully understood.

Forests within the Sakinaw Lake watershed were logged historically and some logging activity continues. Again, there is little information on the effect on Sakinaw Lake sockeye habitat.

Climate change may be one of the most significant factors influencing habitat. For example, climate changes associated with the Pacific Inter-decadal climate oscillation may have resulted in alternating periods of above- and below-average temperatures (1924-1946 and 1977-1998 were “warm” periods as opposed to the cold period of 1947-1976) and may significantly alter the extent of suitable habitat during the period proposed for conservation actions. Relevant, potential impacts of climate change are described for specific sockeye habitats below.

Lake outlet

The lake outlet currently has a concrete dam to regulate water storage. There was a dam from the early 1900s to the mid 1930s, when it was removed. In 1952, lobbying by area residents resulted in the construction by DFO of a more permanent concrete dam to increase water storage. This new structure included a fishway to facilitate salmon migration upstream.

From the mid 1950s to the mid 1980s, DFO maintained the dam and fishway, ensuring access to the lake. Fishery officers patrolled the fishway, counting adult sockeye using a trap mechanism. These officers obtained counts by ensuring the trap operated at the appropriate flood tides and through the night when most migration occurred. In addition to counting adult migrants, the fisheries officers kept poaching and predation under control; both sources of mortality were considered potentially significant given that the dam increased sockeye vulnerability by creating a bottleneck in the migration corridor.

In the early 1990s, staffing was reduced, preventing detailed enumeration of returning sockeye. In the mid 1990s local First Nations attempted periodic trapping at the request of DFO and first identified an alarming reduction in run size. In the mid to late 1990s, problems with diminishing run sizes and predation prompted the permanent removal of the trap and alterations to the approach stream in order to facilitate movement of adult sockeye.

Since 2002, DFO-contracted staff have been present at the dam to facilitate the migration of adult sockeye by controlling the flow and the presence of predators. Additional modifications of the dam and its operation planned for 2004/2005 should improve the safe migration of adult sockeye into the lake.

Extreme water temperatures have also been documented at the lake outlet and dam/fishway complex. In general, adult sockeye migration stops above 21°C (Beschta *et al.* 1987 from Major and Mighell 1966). It is also worth noting that continued exposure to 16°C water was associated with a 12% reduction in the weight of adult sockeye and visible fat reserves were essentially depleted (Bouck *et al.* 1975). The temperature time “series” in Sakinaw lake outlet is available for July and August from 1958 to 1973. Although this is considered a “cold” period, water temperatures above 21°C were often observed. Consequently, thermal stresses and delay in migration may have increased during the recent “warm” period.

Continuous counts of adults entering the fishway in 2004 do not reveal an obvious effect of temperature on migration behaviour. Some people speculate that the population has dealt with elevated water temperatures at the outlet for many generations.

Spawning and egg incubation habitat

Prior to 1979, there may have been habitat degradation on Beaches 2 and 3 due to forestry activities, including a sawmill situated over Haskins Creek at Beach 2. Dive surveys in 2001 and 2002 to enumerate spawners on Beaches 4 and 5 recorded no spawning. Beaches 4 and 5 were covered with a fine layer of natural organic material that may simply reflect the absence of sockeye, who naturally “clean” the beaches when they spawn.

Lake rearing habitat

In general, juvenile sockeye prefer temperatures of 11-15°C while their optimum temperature for growth with unlimited food is 15°C (Beschta *et al.* 1987). Juveniles will migrate to avoid temperatures above 17°C and as a result the amount of lake rearing volume available to juvenile sockeye might be smaller during ‘warm’ periods. At night, sockeye may be forced to remain at greater depths when epilimnion temperatures are high, reducing their capture efficiency due to darker conditions and possibly reducing the amount of available prey. However, recent measurements of smolt size (large) and fry to smolt survival (good) argue against this being a serious detriment.

Marine habitats

Logging activity in the beginning of the 20th century at the mouth of Sakinaw Creek resulted in alterations to the small estuary. The degree of disturbance and

impacts on the early estuarine life history of the Sakinaw Lake sockeye is not known. It is assumed that there has been some habitat loss in this area but the extent cannot be determined.

Loss of marine habitat suitable for sockeye seems plausible, even probable, given the evidence for climate change. Any such changes would be expected to have affected the marine habitat of other south- and central-coast sockeye populations as well. However, without a better understanding of the marine migratory behaviour of Sakinaw sockeye, we can only speculate about trends in the suitability of marine habitat.

1.7.4 Habitat Protection

There is a moderate sized human population residing for at least the summer on the shores of Sakinaw Lake. Portions of the lakeshore have been altered, including the riparian zone. The west side of the lake has seen limited development due to its topography, and riparian forests appear more contiguous and intact.

Development within the watershed continues and presumably will continue to create demands and challenges on water quality and quantity. As a result, a detailed water management plan for this area identifying water usage issues should be developed. This document should be used to aid in resolving the use and conservation needs for the watershed using the Water Act, Fisheries Act and OCP for direction.

The lake's riparian and upland terrestrial habitats are currently protected through two mechanisms: the BC Forest and Range Act on all crown forestlands, and the Land Development Guidelines on lands falling within the Sunshine Coast Regional District (SCRD). This provides limited protection for lake foreshore in the Pender Harbour Area 'A' Official Community Plan.

Finally, the lake itself and its beaches are afforded additional protection, regardless of whether they are Crown or private lands, through the Federal Fisheries Act. It is this act that governs the protection and means of rehabilitating habitat identified as important to the conservation of Sakinaw Lake sockeye.

1.7.5 Studies Required to Identify Critical Habitat

Population modeling

Conservation goals and important habitat should be identified with population viability in mind. Ideally, there is a strong relationship between the conservation objectives and the amount of proposed important habitat.

A population is said to be viable if there is a high probability (e.g. 95%) that it will remain above a threshold for a significant time (e.g. 100 years). The threshold is sometimes defined in terms of the number of individuals necessary to ensure genetic diversity of the population.

Important habitat will be identified using a 5-step process similar to that recommended by Environment Canada (2004). The first two steps deal with the identification of the conservation goals and acceptable level of risk. The following steps aim at determining which habitat(s) or configurations of habitat are essential for viability of the population. This analysis requires a population model (step 3) to project the population into the future. The probability that the projected population will be above the threshold is then estimated (step 4). If the population is below the threshold (i.e. not viable), then additional scenarios specifying improvements to the habitats and/or management actions (supplementation, fishery) are modeled until the population is found to be viable (step-5).

Steps 3 to 5 are referred to as population viability analysis (PVA). The PVA model will be based on a population projection method described by Caswell (2001). It will consist of an age-structured model that divides the population into five age classes (fry, smolts, age 3 adults, age 4 adults, and age 5 adults) and tracks the contribution of individuals in each class at one census to all classes in the following census. It is based on a one-year time interval (Figure 6). Parameters that are needed to build this model are vital rates and include age specific survival, maturity schedule, egg survival, spawning ground area, habitat relationship, etc. This model will project the population into the future. Thousands of projections are usually performed to reflect environmental variability, each projection reflecting a possible realization. Then by comparing the population abundance at time "t" against the threshold, one can estimate the probability that a population will be viable.

Given that a population model is a simulation, results must be interpreted with caution. A model based on measured attributes (parameter values) from the actual population under study will be more realistic than one where these values must be assumed. In the case of Sakinaw sockeye, information is limited and we rely on expert knowledge and information from other similar sockeye populations. Our goal is to re-evaluate the model as new information becomes available from studies and monitoring.

Explicit models such as PVA are useful because they help focus the discussion by forcing codification of population parameters, their relationships, and underlying assumptions. As such they provide a rational way to identify field studies that are needed (see below)

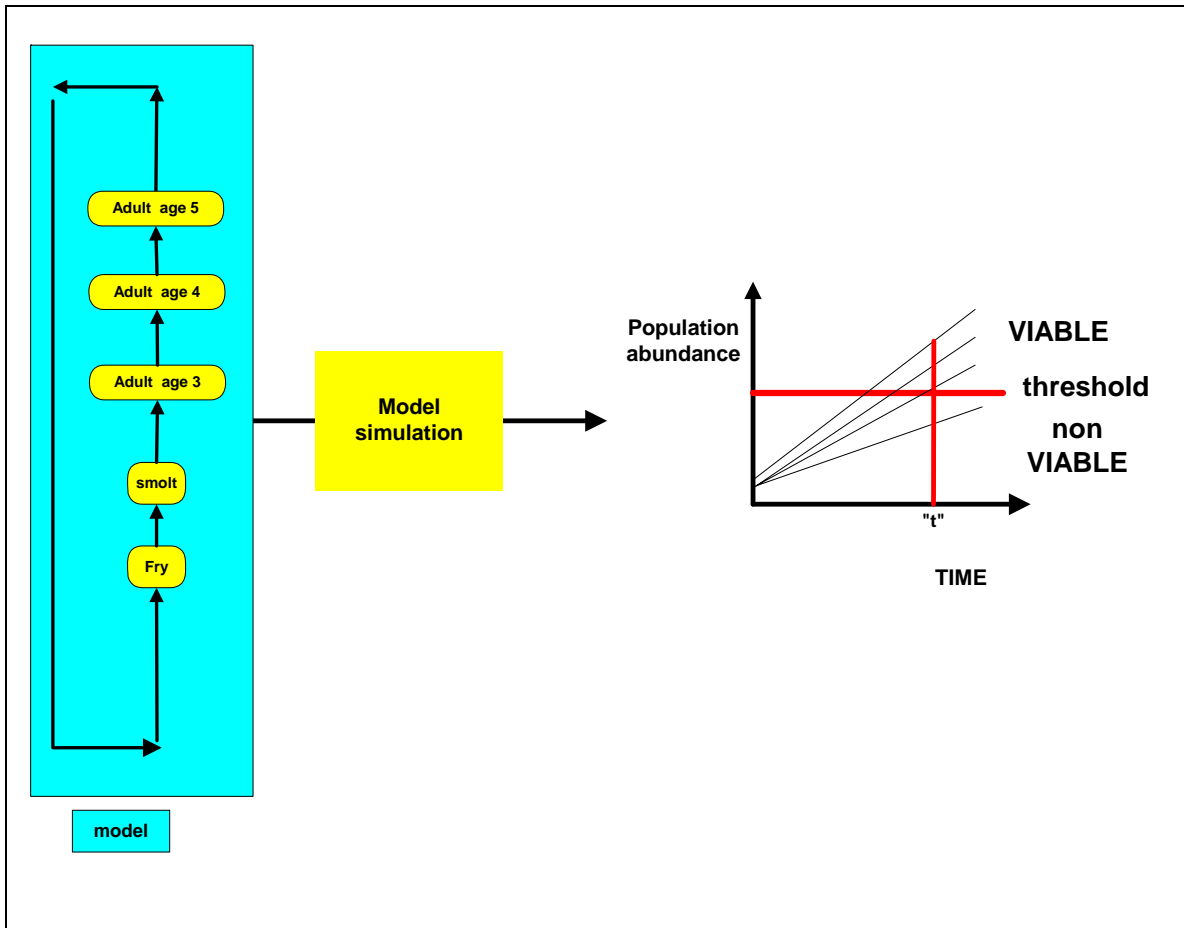


Figure 6: Population viability and assessment for different habitat scenarios. At time 't', the population abundance is 3 out of 4 times above the threshold (red line) and hence has a 75% chance or probability to be viable.

This viability analysis can be used to investigate how different amounts of habitat will influence a population's viability. Output from a viability analysis that models different amounts and configurations of important habitat can be used to rank different options and identify those producing the most favourable population trajectory, or probability of persistence. Based on these types of results, informed advice can be drafted for population objectives and proposed important habitat (step 5).

This approach of identifying the relative importance of threats (either habitat or fisheries) faced by Sakinaw sockeye will be used to answer important questions such as:

- What is the age class that is the most susceptible thus affecting population viability the most?
- What is the minimum habitat, and in what configuration, required to sustain/rebuild the population, given a particular set of assumptions about marine and freshwater survival and exploitation rates?
- What rankings of habitat amounts and configurations produce the most/least favourable population trajectories?
- What are the impacts on population viability and rebuilding of specific changes to the amount or quality of habitat?
- How sensitive is the model's output to changes in amount and configuration of important habitat, parameter variability, and stochasticity?
- What is the relationship between fishery exploitation and population viability?

Spawning Habitat

The definition and inclusion of critical habitat resulted in many discussions as the recovery strategy developed. The result has been the summary of potential critical habitat and short rationale for the inclusion of these potential areas of study.

The amount and quality of spawning habitat appears to have declined since 1979. Given the lack of data, it is difficult to ascertain that the existing spawning habitat may limit recovery without additional work. There is a need to quantify and categorize the suitability of various areas of habitat for spawning:

- Develop habitat suitability criteria and map this information - for use in habitat models to estimate redd capacity;
- Describe the relative quality of spawning substrates with respect to incubation success;
- Document density dependence between numbers of spawning adults and numbers of fry produced.

Migration Corridors

Development of an effective conservation strategy is compromised by a lack of knowledge about the nature of the marine migratory corridor for Sakinaw sockeye. Current efforts to identify where and when Sakinaw sockeye migrate once they leave the lake depend on tracking a limited number of individually coded acoustic tags using a marine acoustic array in 2004 through 2006. Additional information about migratory routing and timing should provide insight about the potential for exposure to threatening factors in the marine environment, and may help to resolve controversy about the vulnerability of Sakinaw Lake sockeye to mixed stock fisheries.

In an attempt to address immediate concerns and declining population size, several research and conservation projects have been implemented. These projects began in 2003. The following table identifies the ongoing projects and the estimated duration and anticipated minimum costs. Each project/study addresses knowledge gaps.

Life Stage	Project Title	Start Date	Proposed End	Estimated Cost
Eggs-Alevins	Study of water quality within intergravel flow found on spawning beaches.	2003	2007	\$60,000
Fry	Utilization of lake resources by juvenile sockeye and the identification of limiting factors.	2004	2006	\$85,000
Smolts	Enumeration of Sockeye smolts from Sakinaw Lake	2003	2013	\$45,000
Marine Juveniles	Identification of the areas within Strait of Georgia, Johnstone Strait, and Queen Charlotte Strait where sub-adult sockeye travel.	2004	Un-determined	\$50,000
Adults	Determination of migratory routes and timing for adult Sakinaw sockeye along coastal BC.	2004	2012	n/a
Pre-spawning Adults	Marine migratory corridor, outlet stream, Sakinaw Lake	2004	2005	n/a
Spawning Adults	Identification and evaluation of known spawning beaches in Sakinaw Lake.	2002	2004	\$60,000
	Potential spawning locations in Sakinaw Lake other than the 5 beaches listed in the plan	2005	Un-determined	\$12,800

1.8 Ecological Role

Anadromous salmonid carcasses provide an important nutrient source in both freshwater and terrestrial ecosystems (Naiman *et al.* 2002). Adult sockeye returning to Sakinaw Lake provide marine-derived nutrients. They all spawn in the lake; presumably, all carcasses and associated nutrients remain to drive the primary producers in the lake. At its peak, Sakinaw sockeye numbered 16,000. Schmidt *et al.* (1998) reported sockeye spawners contain approximately 9 g of phosphorus and 65 g of nitrogen, resulting in a peak loading of 144 kg phosphorous and 1440 kg of nitrogen available for cycling into the lake ecosystem during the peak of the escapement. In recent years, the contribution would be insignificant with the collapse of the population (<100 adult fish). The importance of this contribution also depends on the magnitude of nutrients from other sources, in particular from human sources. The contribution of sockeye salmon to the Sakinaw Lake ecosystem has never been directly studied, although parallels can be made to other nutrient-driven lake ecosystems.

In addition to contributions to the chemical composition of the lake and primary (and secondary) productivity, adult sockeye provide vital food sources for other animals; including salmonids (cutthroat trout, chum and coho salmon), non-salmonid fish (peamouth chub, sculpin, lamprey), crayfish, and birds and mammals (eagle, gull, some waterfowl, Steller's jay, raccoon, mink, and otter). Thus, Sakinaw Lake sockeye play a significant role in the stability of the Sakinaw Lake ecosystem (COSEWIC 2003; Murray and Wood, 2002).

1.9 Importance to People

Sockeye salmon are an economically important species, contributing to commercial, recreational and aboriginal catches along the Pacific coast of North America. The number of extant populations has declined in the southern parts of the species' range (e.g., Nehlsen *et al.* 1991, Slaney *et al.* 1996). As of January 2003, sockeye salmon are considered threatened by extinction in four units, two DUs in southern Canada, (Sakinaw Lake and Cultus Lake, based on October 2002 Emergency Assessments by COSEWIC) and two ESUs in the US Pacific Northwest (Snake River and Ozette Lake, listed under the US Endangered Species Act) (from COSEWIC 2003).

Sakinaw Lake is the largest lake on the Sechelt Peninsula and supports the last remaining anadromous sockeye salmon population in the southern Strait of Georgia (excluding Fraser River populations). Conservation of Sakinaw Lake sockeye is a high priority for the Sechelt Indian Band because Sakinaw Lake lies within their traditional territory and historically provided the Sechelt people with abundant returns of sockeye salmon.

“Since time immemorial the Sechelt First Nation used the

Sakinaw lake sockeye for food, social and ceremonial purposes. This important resource was one of the first salmon species to be harvested in the Sechelt traditional territory each year. Historical U-shaped rock weirs were built on the beach approximately 100 metres from the mouth of the lake to capture the migrating salmon. The sockeye would hold at the mouth waiting to enter at high tide, as the tide would slowly go out all the salmon that couldn't get past the weirs and back to the ocean would be harvested. These weirs are still partially visible but most of them were destroyed by early logging" (J. Johnson, Sechelt First Nation).

In addition to the value of the Sakinaw Lake sockeye to First Nations, it has also played an important role in the development of the Pender Harbour area. The quotation below summarizes the importance of this run to the community; although emphasis may have shifted, it illustrates an important link to the history (Figure 7) and culture of the Pender Harbour area.

"Thought quite a bit last night on what Sakinaw sockeye mean to the local community. To people who have moved here in recent years they may not mean much. To people though whose roots in Pender Harbour go back to some of the first settler's they are a connection to our past. I have one letter here that states that as many as 16 boats would fish Sakinaw sockeye prior to the original logging dam's removal in 1933 so the Sakinaw run was important to the local economy. We have to remember that at this time the Fraser sockeye runs had been devastated by the blockage at Hell's Gate so a local sockeye run was very important economically. The importance to the local people is demonstrated by the years of effort that went in to getting the fisheries department to install the current dam and fishway.

As years went by Sakinaw no longer had the same importance to the main fishing fleet but the Sakinaw fishery remained as a place where kids could get their start fishing and some older fishermen could keep their hand in. Some local women supplemented the family income by gillnetting sockeye. The directed Sakinaw fishery ended in the mid '70's but the interest in this sockeye run remained, as every year fishermen would want to know the escapement and how the run was doing. Sakinaw sockeye are a large part of our community's heritage." (J. Cameron, Commercial Fisherman, Pender Harbour resident).



Figure 7: Photograph of gillnet skiff typically used by local families to harvest sockeye salmon from the area around Sakinaw Lake Creek (J. Cameron).

1.10 Knowledge Gaps

We only partly understand details of the life history of this population and the factors that influence its success. The following broad questions identify areas that are poorly understood. Ways to address each question will be expanded in current and future project planning. All future endeavours should attempt to increase the understanding of the Sakinaw Lake sockeye life history and anthropogenic and natural factors influencing their ability to survive.

- What is the survival rate of juvenile sockeye at each developmental stage in the freshwater part of their life cycle?
- What is the effect of in-lake predation on the survival of juvenile and adult sockeye salmon?
- What are the potential impacts of urban and industrial development on ground and surface water quality and quantity?
- What impacts may occur from increased recreational use of the lake?
- Will water management strategies solve access issues at the dam?
- What is the marine survival of juvenile, pre-adult and adult Sakinaw Lake sockeye, and what are the major factors influencing natural survival?
- What predators have the greatest impact on marine survival of Sakinaw Lake sockeye and can we mitigate them?

- Where are the main migration corridors for both juvenile and adult Sakinaw sockeye and what is the migration timing?
- Can Fishing Management Plans adequately protect this stock during rebuilding?
- Can this stock be harvested at a safe rate in the future?
- What are the socio-economic implications of extinction?

2.0 Biological and Technical Feasibility of Recovery

The Sakinaw sockeye population is at the brink of extinction. Nevertheless, conservation actions to ensure a viable population appear to be both biologically and technically feasible. Given the population's current low abundance, the need to increase escapement numbers is urgent. Action is required immediately to address threats to the population and to raise awareness of the biological, socials and cultural issues. Conservation actions must involve sectors, including research, habitat, enhancement, and fisheries management branches of the federal government, provincial and local governments, First Nations, harvesters, non-governmental organizations (NGOs) and the public.

2.1 Biological Feasibility

Biological feasibility depends on the intrinsic viability of the population once human threats are controlled. Marine survival has not yet been determined, so assessment of biological feasibility is difficult. Adult returns of 24 fish in 2005 provided an indication of the low marine survival of the 14,792 smolts that were enumerated in 2003.

2.2 Technical Feasibility

Technical feasibility should reflect the availability of tools that respond to the needs of the species and the willingness of organizations and jurisdictions to use them. Government or stakeholder actions can mitigate threats if the groups are committed to the conservation process. For example, marine survival could be improved by reducing incidental fishing mortality through modifications to harvest gear, time/area closures, selective harvest techniques and other creative restrictions. In fresh water, recreational activities that affect adults or juveniles can also be modified, perhaps through gear restrictions and area closures.

As stated above, while some natural impacts, such as years of poor marine survival due to climatic variations, cannot be mitigated directly, technical tools do exist to reduce some of the natural threats. Technically feasible conservation

actions include improving freshwater survival by controlling predators. Hatchery technologies that include captive breeding and juvenile stocking provide an immediate response to the decline in population.

2.3 *Recommended Scale for Recovery*

The approach recommended for the conservation of Sakinaw sockeye is a single species or population strategy. The decision to follow a single population approach is based on the unique set of physical, biological and social circumstances surrounding Sakinaw sockeye. While there is currently one other sockeye population listed by COSEWIC as endangered (Cultus Lake sockeye), the issues surrounding the two populations are sufficiently different to warrant dedicated conservation strategies for each.

Conservation of an endangered species or population depends to a great extent on the contributions of various sectors of society, and the involvement of multiple sectors has a synergistic effect. Fortunately, the scale of actions on Sakinaw sockeye can be broadened through cooperation with other organizations and jurisdictions.

Involvement of the community by way of stewardship activities that contribute to the protection of the population will provide some sense of ownership in the process. The importance of the salmon to First Nations promises close cooperation with the Sechelt and Sliammon First Nations on all activities. Finally, management plans developed and implemented by Fisheries and Oceans Canada represent the formal reflection of conservation actions related to harvest.

3.0 Conservation

3.1 *Conservation Goal*

The goal is to stop the decline of the Sakinaw Lake sockeye salmon population and re-establish a self-sustaining, naturally spawning population, ensuring the preservation of its unique biological characteristics.

3.2 *Conservation Objectives*

Objective 1.

Inform the local community and other stakeholders about the conservation planning process for Sakinaw sockeye and encourage them to become involved in the stewardship of the Sakinaw Lake watershed.

This conservation strategy is intended to promote the health of the Sakinaw Lake watershed both as an end in itself and to maintain long-term viability of Sakinaw

sockeye. Community and stakeholder initiatives and support for stewardship activities will be critical to the success of the process.

Objective 2.

Achieve continued growth in the generational average by increasing spawner abundance relative to the brood year (4 years prior) for at least 3 out of 4 consecutive years.

A positive overall population trajectory is required to demonstrate population viability and to meet criteria for delisting by COSEWIC. Fishery management planning must attempt to achieve positive sockeye population growth in all years. More stringent measures must be considered to ensure positive growth in the current year whenever one or more of the three preceding years has shown a decline relative to its brood year, four years earlier. Extreme management efforts are required in 2004 and 2005, because annual spawner abundance has declined continuously since 2000 and because 2005 (when 24 adult fish returned) may be the last opportunity to take advantage of significant adult returns expected from previous fry supplementation efforts.

Objective 3.

Increase the annual number of spawners (including those removed for hatchery broodstock) to no fewer than 500 from 2004 to 2007.

The recovery team emphasizes the urgent need to safeguard genetic diversity by increasing adult sockeye escapements, but also recognizes limits to the biological feasibility of attaining adequate spawning abundance in the immediate future. Accordingly, the team has identified two interim objectives (3 and 4) that appear biologically feasible. The first interim objective is to attempt to rebuild the population to a minimum of 500 adults in a fast and effective manner, by relying heavily on intensive fish culture initiated in 2001 including the establishment of a captive brood program. The first interim target will include all adults that survive to reach the spawning beaches in spawning condition, including those brood removed for artificial propagation for fry supplementation and the captive brood program. Efforts to maximize genetic diversity and to minimize inbreeding are in place.

Achieving this objective will also depend on minimizing mortality wherever possible, e.g. fishing mortality and juvenile and adult predation.

Objective 4.

Increase the number of naturally produced spawners to no fewer than 500 annually in 2008 to 2011.

The second interim objective is intended to maintain focus on a self-sustaining population that is “wild” by nature. This interim target of 500 by 2008 will include only naturally produced adults that spawn naturally within the lake. It is expected that brood collection and subsequent fish culture activities will stop and all returning adults will remain within Sakinaw Lake to spawn on their own. This objective will be achieved through earlier efforts to rebuild using intensive fish culture, rehabilitation of important habitats, management strategies implemented to reduce interception and community and stakeholder stewardship activities.

Objective 5.

Ensure that, by 2017, the mean population abundance in any four year period exceeds 1,000 naturally produced spawners, with no fewer than 500 naturally produced spawners in a year.

This level has been judged the minimum viable population (MVP) size required to prevent the random loss of genetic diversity, and consequent loss of viability and evolutionary potential.

Objective 6.

Identify, assess, protect and where necessary, rehabilitate important habitats.

Salmon population declines in many areas of the Pacific Northwest are attributed to habitat degradation. In Sakinaw Lake, with the exception of the outlet stream, little information exists on the important habitats required by the sockeye population. Habitat degradation and loss has probably caused a decline in the productivity of the Sakinaw sockeye population. In order to sustain any future recovered population, sufficient suitable habitat must be available to the population. Research, governance and stewardship methods will be necessary to achieve this.

Objective 7.

Identify the level of abundance required to support ecosystem function and sustainable use, as a longer-term target for recovery.

This objective is intended to address long-term goals and sustainable use. Biological benchmarks or milestones will be determined based on an understanding of the population dynamics of Sakinaw sockeye and the productive capacity of the Sakinaw Lake ecosystem. The following candidate benchmarks have been suggested for Cultus sockeye and are considered equally relevant to Sakinaw sockeye:

- The number of spawners (yet to be determined) that would provide maximum sustainable yield (S_{MSY});
- The number of spawners required to “seed” the lake above some minimum proportion of its productive capacity;
- The average number of spawners observed historically before the run collapsed. The average escapement between 1957 and 1987 was approximately 5,000 spawners;
- The number of spawners considered sufficient to maintain ecosystem function (not yet defined).

3.3 Approaches to Meeting Conservation Objectives

Objective	Expected Approach and/or Strategy	Anticipated Effect	Status
1	Engage and consult stakeholders using the appropriate consultative and media process.	Increased awareness within the community of stakeholders of the value and vulnerability of the Sakinaw Lake ecosystem and in particular, Sakinaw sockeye.	On-going
1	Develop and implement watershed stewardship initiatives.	Short- and long-term community support for conservation and protection of Sakinaw sockeye.	Proposed
2 to 6	Collection of hydrometric data on the main watershed lake basins and tributaries focusing on surface water volumes.	Development of a Water Management Plan.	On-going
		Development of water release protocol at Sakinaw Creek to reduce impacts of migration bottlenecks.	On-going
		Understanding of runoff dynamics needed for the conservation of stored water.	On-going
2	Reduce natural and fishing mortality on Sakinaw sockeye.	Increased spawning escapement.	

Objective	Expected Approach and/or Strategy	Anticipated Effect	Status
2 to 4	A captive brood and fry stocking program with marking of hatchery fry.	Increased juvenile abundance within Sakinaw Lake.	On-going Since 2002
2 and 3	Enumerate and collect biological information on smolts migrating out of the Sakinaw Lake.	Information about the extent and potential sources of mortality in the lake.	On-going
		Improved knowledge about survival and growth of both hatchery and wild juveniles in the freshwater and marine phases will allow evaluation of threats.	
		Identification of freshwater mortality agents.	
		Evaluation of remedial measures.	
		Forecast future returns.	
2 to 5	Tag Sakinaw smolts to estimate routes and timing of juveniles and adults.	Better management of mixed stock fisheries (i.e., reduced	On-going

Objective	Expected Approach and/or Strategy	Anticipated Effect	Status
		fishing mortality on Sakinaw sockeye) will increase spawning escapements.	
2 to 5	Develop and implement selective fishing strategies that would reduce commercial and food fishing impact on Sakinaw sockeye.	Reduced mortality of Sakinaw sockeye in sport, commercial and food fisheries.	Implemented in 2004
2 to 5	Monitor adult sockeye when they enter the lake and when they spawn (abundance, size, age and other biological characters)	Freshwater and marine survival; timing of lake entry; population parameters; identify and delineate spawning locations.	On-going
		Identification of freshwater mortality agents.	
		Evaluation of remedial measures.	
		Forecast future returns.	
2 to 6	Rehabilitation of spawning, rearing and migration habitat in the lake and outlet stream.	Improved survival from utilization of rehabilitated habitat.	On-going
6	Identify important habitat for each life stage by modeling impacts of	Important habitat can be	On-going

Objective	Expected Approach and/or Strategy	Anticipated Effect	Status
6	<p>habitat loss/improvement along with other management actions on population viability.</p> <p>Potential spawning locations in Sakinaw Lake other than the 5 beaches listed in the conservation strategy.</p>	<p>identified, protected and rehabilitated if necessary.</p> <p>Identify up to 10 lakeshore locations that may have spawning potential.</p>	Proposed
7	<p>Estimate the abundance of non-anadromous <i>O. nerka</i> in Sakinaw Lake and determine whether they are kokanee (genetically distinct “wildlife species”) or residual sockeye (same species).</p>	<p>Reconnaissance survey of the top 10 potential spawning locations. Test if the locations identified in 1 and 2 are potential spawning sites.</p> <p>Determination of lake productivity.</p> <p>Reassessment of status may be warranted if the non-anadromous fish are residual sockeye and abundant.</p>	Ongoing

3.4 Actions Already Completed or Underway

	Objective(s)
Time and area closures of mixed-stock fisheries were more restrictive in 2004 and will continue in 2005 in order to reduce fishing mortality on Sakinaw sockeye.	2
Captive brood program: Eggs and milt were collected at Sakinaw Lake in the fall of 2002 and 2004, and then transported to Rosewall Creek hatchery on Vancouver Island. They will be reared to adults at this facility and their progeny will be released into Sakinaw Lake as fry starting in 2004.	2 and 3
Hatchery supplementation through fed fry releases into the lake. Fry are progeny of captured wild parents from the 2000, 2001 and 2002 brood years and are released in the late spring into the lake. Release groups are marked so they can be identified as smolts at the outlet.	2 and 3
Continued collection and analysis of surface hydrometric data within the main lake basin. Data is used to determine the water storage schedule for Sakinaw Lake in order to aid migration through the Sakinaw Creek dam.	2 to 6
Modification to the Sakinaw Lake outlet dam including addition of mechanized control gates on spillway. Modifications will assist in effective and efficient water storage.	2 to 6
Video enumeration of sockeye entering the lake through the fishway provides size, sex and escapement data.	2 to 5
Fisheries and Oceans Canada personnel and contractors maintain a daily visual watch on migrating sockeye to prevent otter and seal predation and to observe sockeye migration behaviour during periods of low flow and high temperature.	2 to 5
Sampling and complete enumeration of sockeye smolts leaving the lake each spring. The smolt program was started in 2003 following earlier, less intense smolt trapping from 1994 to 1996. The smolt-trapping program continued in 2005. Data include total numbers, number of marked	2 to 5

smolts from fry releases, ages, sizes and predation wound incidence. The number of marked smolts will provide accurate estimates of freshwater survival from the time of release.

Changes in freshwater exploitation rates for both Kokanee and juvenile sockeye salmon based on in lake sampling during the late fall.

7

Hydroacoustic and limnological sampling of Sakinaw Lake basin to review productivity estimates for the lake. In 2004, we found that young sockeye can live in the lake for extended periods. *Nerka* fry are concentrated in, and appear to be limited to, the upper basin of Sakinaw Lake. Older immature *nerka* are distributed throughout both basins. Kokanee and sockeye spawn near and spawn in similar locations and presumably compete. Juvenile kokanee outnumber sockeye. Significant lamprey predation occurs on young *nerka* in the lake. Outstanding questions: are Sakinaw sockeye limited by freshwater factors? Why sockeye remain in freshwater. Number of sockeye and kokanee in the lake?

7

Identification of habitats. In 2004, we initiated and evaluated a procedure needed to identify important habitat. Simulation results indicated that with exploitations <15% resulting in probabilities of quasi-extinction <10%, the status of the stock is improved by beach restoration (improving egg to fry survival), predator control and flow management at the lake outlet (reducing pre-spawner mortalities), and by increasing the carrying capacity for female spawners. In 2005, we plan to further investigate the model, test alternative assumptions and management actions, and perform a retrospective analysis.

Rehabilitation of known and potential spawning beaches by removal of materials that are degrading spawning habitat quality. This rehabilitation has involved the removal of accumulated woody debris and fine sediments blanketing the spawning substrates. The rehabilitation of these areas has been evaluated using qualitative methods and collection of water temperature and dissolved oxygen data within the area.

6

Collection, analysis and interpretation of scale data from marine fisheries that occurs in migration corridors during the migration period.	2 to 5
Tagging, collection and interpretation of migration data in juveniles using Pacific Offshore Shelf Tracking (POST) technology. Acoustic tagging provided information on the travel time of Sakinaw sockeye smolt to various locations along the 120km of coast, mortality within the first month of migration as well as on the effect of size on travel time and survival.	2 to 5
Forecast of stock status for 2004 (Wood and Parken 2004) based on estimates for freshwater survival and number of age-3 sockeye in the complete count of escapement in 2003. This forecast, together with the returns observed to date, provide the first empirical evidence that Sakinaw sockeye are threatened by poor marine survival. Fisheries managers were advised to expect smaller returns than had been expected previously.	2 to 5
Changes in management strategies within the Strait of Georgia and Johnstone Strait for both the sport and commercial fisheries have reduced the exploitation rate on Sakinaw sockeye.	2 to 5
Public consultation process that has included public meetings and media information on the current status of the stock and initial plans to protect and rebuild this stock of salmon.	1

3.5 Next Steps

Sakinaw Lake sockeye are designated as endangered by COSEWIC. The Department of Fisheries and Oceans is committed to ensuring the survival and recovery of Sakinaw Lake sockeye and suggests that one or more program plans should be completed. One or more program planning groups may be needed to further refine and act upon the approaches developed in this conservation strategy.

3.6 Evaluation

Objective	Assessment of Progress
1	<p>Inclusion of the public through stewardship initiatives that help to protect important habitats and restore impacted habitats.</p> <p>Community awareness using the appropriate media and developed in consultation with the local community groups.</p> <p>Partnerships with public and industry to develop stewardship initiatives.</p>
2 to 5, 7	<p>Spawner abundance will be estimated on the spawning grounds to determine trends and abundance relative to the objectives. Combined efforts to reduce adult mortality and to increase juvenile abundance by artificial propagation will have been successful if population abundance increases to 500 naturally-produced spawners by 2012.</p> <p>Smolt enumeration will indicate survival of juveniles released from intensive fish culture program.</p>
2 to 5	<p>Determination of juvenile and adult migration timing and routes.</p> <p>Known rate of interception in aboriginal food and commercial fisheries.</p> <p>Development and implementation of a selective fishing strategy that protects Sakinaw sockeye.</p>

6 Identify and quantify, where possible, freshwater and marine habitats required for the protection and recovery of the Sakinaw sockeye.

Working with local government, ensure important habitats are protected during development of area.

Development of mitigation measures for habitat impacts.

3 to 7 Eliminate biological and physical bottlenecks to production starting with the development of a mitigation plan for low water flows at the dam.

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5.0 Annexes

5.1 Record of Cooperation and Consultation

Sakinaw Lake sockeye is an aquatic species under federal jurisdiction, managed by Fisheries and Oceans Canada: 200 – 401 Burrard Street, Vancouver, BC, V6C 3S4.

In November 2003, Fisheries and Oceans Canada (DFO) engaged a Sakinaw Lake Recovery Team to work cooperatively in the development of this strategy. The Recovery Team membership is provided on page ii of the strategy. Representatives from the Sechelt First Nations and the Sechelt Indian Band sit on the team to ensure there is information exchange on Sakinaw Lake sockeye planning and activities with their respective communities. The Sakinaw Lake team membership also includes participants from the Province, academia, industry, local government as well as local stewardship groups. Each team member has brought important technical expertise or knowledge of Sakinaw sockeye that has contributed to the development of the strategy.

Integral to the planning process is involving participants at every step along the way. The Recovery Team has worked hard to develop a comprehensive strategy that provides advice on protection and conservation measures for the Sakinaw Lake sockeye population. As the strategy is turned into program plans, the contribution and participation of communities and individuals will play a key role in helping to rebuild this population.

On April 29th, 2004 DFO held a Technical Workshop by invitation to engage a broader group of experts and participants in the strategy development process to review early drafts of the strategies for the Cultus Lake sockeye, Sakinaw Lake sockeye and Interior Fraser coho populations. The intent of the workshop was to:

1. Share knowledge and information on Cultus Lake sockeye, Sakinaw Lake sockeye and Interior Fraser coho with the communities, groups and individuals likely to play a key role in the recovery of these populations or may be impacted by recovery actions.
2. Receive technical advice on the draft goals and objectives in the draft strategies from workshop participants.

3. Receive technical advice on possible approaches for the conservation of Cultus Lake sockeye, Sakinaw Lake sockeye and Interior Fraser coho. This advice will be summarized in a report that will be considered by the recovery teams in completing the draft strategies, and subsequently by program planning groups for the development of program plans.
4. Engage participants in the process.

A summary report of the workshop was prepared and provided to the teams for integration into the development of their strategies.

In October and November 2004, the Department of Fisheries and Oceans Canada (DFO) conducted a series of information sessions (7) throughout BC on the draft strategy for Sakinaw Lake Sockeye. DFO took a variety of steps to inform First Nations, stakeholders and the public of the sessions. In summary, DFO announced the consultation process in early October 2004, with a press release to media throughout BC. Invitation letters and agendas were mailed to 197 First Nations, as well as First Nations organizations, tribal councils and fisheries commissions, and to more than 5,000 stakeholders, including all commercially licensed fishermen, recreational fishing and conservation organizations, local governments and stewardship groups. Display advertisements, with information about the stakeholder sessions and open houses, were placed in all local newspapers that serve the communities in which the sessions were held. In addition, a number of follow-up telephone calls, emails, and personal communications were made by DFO to encourage participation.

The intent of the consultation sessions was to gather First Nations and stakeholders' including environmental groups, industry and local communities' comments, information and feedback on the draft strategy. In particular, at the sessions, team members solicited comments on the four key themes mentioned above. Many participants viewed the draft strategy as well thought out and comprehensive, in part because Sakinaw Lake sockeye is a historically small population with a short migration route to and from the lake. However, a number of participants commented that the recovery team needed to further explore several unknowns including the potential impacts of development and recreation, lake habitat, and ocean conditions. More specifically, a number of participants noted the importance of protecting the short channel that connects Sakinaw Lake to the ocean because it is the only migration route.

The recovery team responded to several of the points raised in the final version of the document. Additional modifications of the dam and its operation have been planned for 2004/2005, which should improve the safe migration of adult sockeye into the lake. Furthermore, the team has identified the outlet of the lake as proposed important habitat that will require further studies and research to be done to clearly understand its role and how to protect it. Although changes in water temperature at the outlet of the lake have been identified as a potential

threat, continuous counts of adults entering the fishway in 2004 do not reveal an obvious effect of warm temperatures on migration behaviour. Although purely speculative at this time, some believe this population has dealt with elevated water temperatures at the outlet for many generations. The concern related to urban development in and around the lake with respect to water quality and quantity issues has also been a concern of the recovery team. The team has responded to this concern by identifying research projects that need to be undertaken to determine the effects of water quality within inter-gravel flow found on spawning beaches as well as utilization of lake resources by juvenile sockeye and the identification of limiting factors.

A summary report was compiled that includes the input and feedback received at each of the sessions. The report and the individual meeting notes are available on the DFO Pacific Region website:

www-comm.pac.dfo-mpo.gc.ca/pages/consultations/consultation2004

The Sakinaw Lake Recovery Team also engaged the local community and other interested stakeholders in additional consultations over the past year to provide an opportunity for information exchange during the development of the strategy. These meetings included the following:

Date: February 4, 2003
Group: Sechelt First Nation
Location: Sechelt, BC

Date: April 8, 2003
Group: Sliammon First Nation
Location: Sliammon, BC

Date: May 7, 2003
Group: Commercial fishing representatives regarding Sakinaw Lake sockeye adult marine migration timing.
Location: Sechelt, BC

Date: November 12, 2003
Group: Public Information Session
Location: Sechelt Public Library, Sechelt, BC

Date: November 19, 2003
Group: Public Information Workshop
Location: Driftwood Inn, Sechelt, BC

Date: October 7, 2004
Group: Community/Stakeholders Dialogue Session
Location: Prince Rupert

Date: October 19, 2004
Group: Community/Stakeholders Dialogue Session
Location: Victoria

Date: October 22, 2004
Group: Community/Stakeholders Dialogue Session
Location: Nanaimo

Date: October 26, 2004
Group: Community/Stakeholders Dialogue Session
Location: Port Hardy

Date: October 29, 2004
Group: Community/Stakeholders Dialogue Session
Location: Campbell River

Date: November 2, 2004
Group: Community/Stakeholders Dialogue Session
Location: Vancouver

Date: November 8, 2004
Group: Sliammon First Nation
Location: Sliammon

Date: November 8, 2004
Group: Sechelt First Nation
Location: Sechelt

Date: November 9, 2004
Group: Community/Stakeholders Dialogue Session
Location: Pender Harbour