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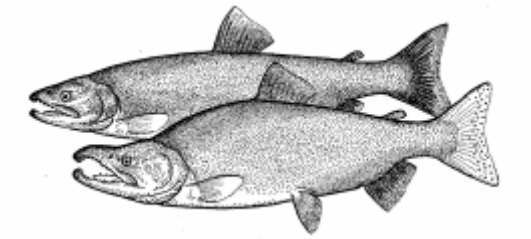
Pacific Region **Stock Status Report 2003/047**



Skeena River Sockeye Salmon (update)

Background

In British Columbia, the Skeena River is the second largest producer of sockeye salmon after the Fraser River. The Skeena River drainage has one very large sockeye nursery lake (Babine Lake) and 28 smaller sockeye nursery lakes. Skeena River sockeye lakes are distributed from the coast to the high interior regions and vary in size and productivity (Fig. 1). Babine Lake comprises 67% of the total sockeye rearing area and accounts for 75-95 % of the total Skeena River sockeye production. Babine Lake was enhanced in the late 1960's and early 1970's with the development of sockeye spawning channels at Pinkut and Fulton Creeks. The channels account for approximately 90% of the fry recruitment to the main basin. Wild (un-enhanced) sockeye also rear in Babine lake, as well as in all 28 non-Babine nursery lakes.

Skeena River sockeye are harvested in mixed-stock marine commercial fisheries in south-southeast Alaska and northern British Columbia, in Skeena River First Nations food, social, and ceremonial fisheries, and in recreational fisheries within the Skeena River drainage. The fisheries primarily target the enhanced Babine Lake component which can withstand higher exploitation rates compared to the un-enhanced wild stocks. Recent analyses of limnological, acoustical fall fry, and spawning ground survey data indicate that, in most cases, wild stock escapements are much too low to fully utilize lake rearing habitat and maximize smolt production.

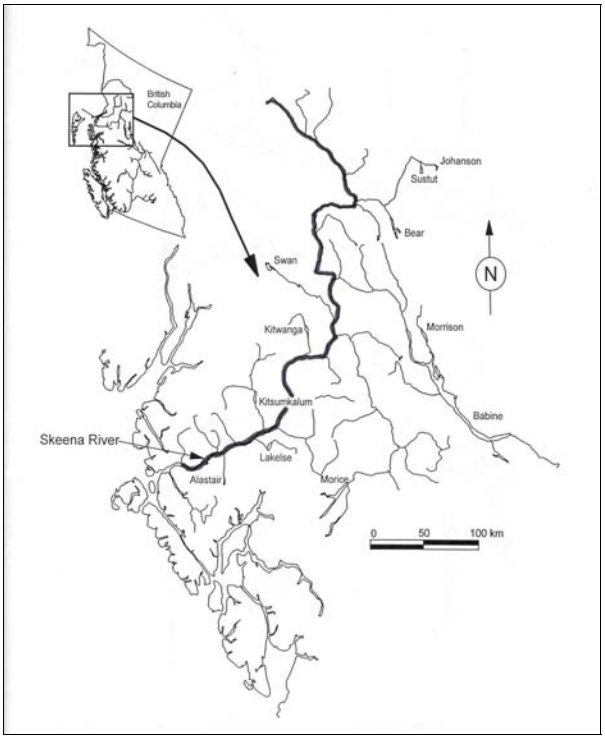


Figure 1: Map of the Skeena River showing principal nursery lakes for sockeye salmon.

Summary

- Exploitation rates on Skeena River sockeye salmon have averaged ~60% since enhancement of Babine Lake began in the late 1960's and early 1970's.
- Enhanced sockeye escapements into Babine Lake have been increasing while non-enhanced sockeye escapements into many non-Babine lakes have been declining or have declined and stabilized at lower levels.
- Lake trophic and juvenile acoustic surveys indicate that the vast majority of non-Babine sockeye nursery lakes are not very productive, are largely fry-recruitment limited (not getting enough spawners), and produce sockeye well below potential production.
- In addition to recruitment limitation, some non-Babine lakes are also being limited by

factors such as low spawning ground capacity or quality, low in-lake growth and/or survival, nutrient limitation, glacial turbidity, and species competition. All of these factors act to reduce sockeye productivity and limit sustainable exploitation rates of wild Skeena River sockeye.

- Of 17 Skeena River sockeye nursery lakes surveyed to date, 82% are producing juvenile sockeye at less than 40% of their capacities if no other restraints to sockeye production are operating. Preliminary adjustments to account for other restraints on sockeye production, such as known competitors or limited spawning grounds, suggests that 53% of the lakes are producing sockeye at <40% of their capacity while only 30% are producing sockeye at >60% of their capacity.
- Increasing fry recruitment through increased escapements, combined with lake-specific restorative and/or enhancement techniques, has been suggested for improving sockeye production from non-Babine sockeye nursery lakes.
- Some non-Babine sockeye stocks are at high risk and require re-building. The Pacific Scientific Advice Review Committee (PSARC) recommends that future fishing plans for Skeena River sockeye salmon recognize the depressed status of many non-Babine sockeye stocks and the need to preserve spawners.

Species biology

Skeena River sockeye salmon spawn from late July through October in rivers tributary to the nursery lakes, and along upwelling lakeshore areas within the lakes themselves. Like other sockeye salmon, the adults die soon after spawning. Fry emerge from the gravels in early spring and subsequently school into deeper lake waters soon after. After one to two years of lake rearing, the smolts migrate to sea in late April and move northward from the Skeena River estuary along the coast and offshore into the North Pacific Ocean. Most Skeena River sockeye mature at age 4 or 5, although males ("jacks") also commonly mature at age 3. The maturing fish return from offshore waters of the North Pacific Ocean through Southeast Alaska and northern British Columbia and enter the Skeena terminal fishing areas from mid-June through late-August. The return typically peaks in Canadian waters during the third to fourth week of July. For management purposes, Skeena River sockeye stocks are aggregated into three run-timing timing groups (early, mid, and late) based on past tagging information and recent DNA analyses.

The Fishery

Skeena River sockeye are caught in a complex array of mixed-stock fisheries in southern southeast Alaska, northern British Columbia (Statistical Areas 1 through 5), and in First Nations food, social, and ceremonial fisheries (FSC) and escapement surplus to spawning requirement fisheries (ESSR) within the Skeena River itself. Historical trends in catch and exploitation in each fishery come from revised run-reconstructions for the years 1982-2001 (English et al 2003) and from 1982-83 tagging study results (English et al 1985b) applied to catches from the years 1970-81. Data for 2002 and 2003 are preliminary.

First Nations Fisheries

Four First Nations harvest Skeena River sockeye salmon: the Lake Babine Nation (Babine Lake area), the Gitksan and Wet'suwet'en (middle Skeena River and Bulkley River area), and the Tsimshian (lower Skeena River and adjacent ocean areas). Catches for food, social, and ceremonial purposes (FSC) have averaged 100,000 to 150,000 fish in recent years. Since 1992, new opportunities have also developed for First Nations to selectively harvest sockeye salmon considered as escapement surplus to spawning requirements (ESSR) at Babine Lake. Using fish wheels, beach seines, small lake seines, and existing fish fences, these fisheries have harvested lows of 43,000 fish in 1994 to highs of 785,000 fish in 2000 and

701,000 fish in 2001. First Nations exploitation of Skeena River sockeye has averaged 7% since 1970 (Fig. 2) with decade averages of 5% from 1970-79, 6% from 1980-89, 7% from 1990-99, and 13% from 2000-03.

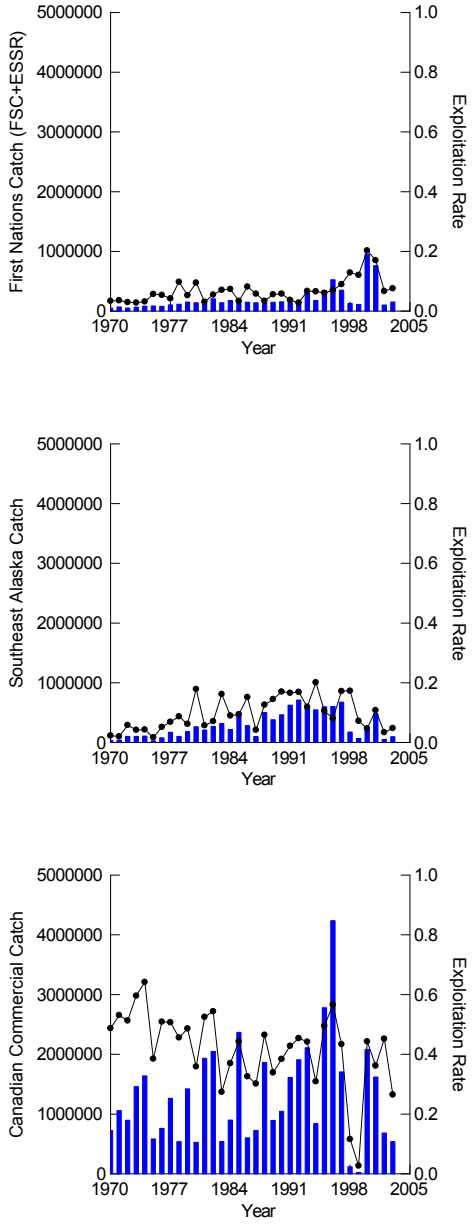


Figure 2: Trends in Skeena River sockeye salmon catch (bars) and exploitation (line) for First Nations (top), Southeast Alaskan (middle), and Canadian commercial fisheries (bottom): 1970-2003.

Alaskan Commercial Fisheries

Skeena sockeye migrate homeward through Southeast Alaska and a proportion of the total run is harvested in Alaska gillnet and seine fisheries. The Pacific salmon Treaty limits catch in some Alaskan fisheries directed at Skeena sockeye salmon, but other interceptions occur as incidental harvests in Alaskan pink and chum fisheries. Alaska commercial exploitation of Skeena River sockeye has averaged 10% since 1970 (Fig. 2) with decade averages of 4% from 1970-79, 11% from 1980-89, 14% from 1990-99, and 5% from 2000-03.

Canadian Commercial Fisheries

The commercial fishery on Skeena River sockeye began with the first cannery operations in 1877. Sockeye salmon were harvested predominantly by gillnets in the Skeena River until the 1930's when powered vessels moved out to ocean fishing areas. A seine fishery was introduced in the 1950's and grew rapidly through the next two decades. In recent years, the number of gillnet and seine vessels fishing Skeena River sockeye has declined through a combination of fleet reduction initiatives and area-based licensing. Since the mid-1990's, selective fishery initiatives have also been introduced to reduce incidental catches of coho and steelhead, as well as earlier non-Babine sockeye.

Management of the commercial fishery has been a compromise between maximizing catch from the enhanced Babine Lake sockeye stock while maintaining production from the diversity of less productive wild sockeye stocks (Wood 1999). The Canadian commercial catch of Skeena River sockeye has generally increased since 1970 and reached a record 4.2 million in 1996. Canadian commercial exploitation of Skeena River sockeye salmon has averaged 42% since 1970 (Fig. 2) with decade averages of 51% from 1970-79, 39% from 1980-89, 36% from 1990-1999, and 38% from 2000-03. Canadian commercial *harvest rates* on Skeena River sockeye have averaged 45% since 1970 (Fig. 3), with decade averages of 53% from 1970-79, 43% from 1980-89, 41% from 1990-99, and 41% from 2000-03.

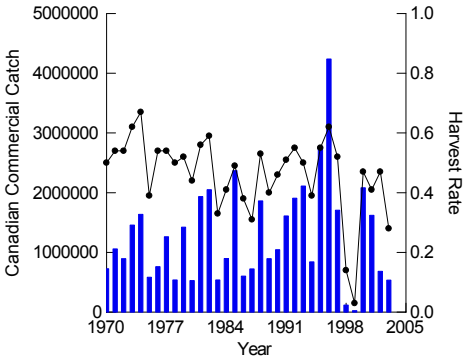


Figure 3: Trends in Canadian commercial catch (bars) and harvest rate (line) of Skeena River sockeye salmon: 1970-2003.

Resource Status

The aggregate escapement goal for Skeena River sockeye is 900,000 plus 150,000 for native food, social, and ceremonial purposes. The escapement goal represents the number of sockeye required to produce maximum sustained yield (MSY) for the aggregate stock. Currently, there are not specific escapement goals for individual sockeye rearing lakes, although minimum and target escapements do exist for the Pinkut and Fulton Creek spawning channels. A daily management model is used to develop fishing plans for the Canadian commercial fishery. Sockeye escapements into the Skeena River are estimated in-season by a gillnet test fishery located at Tyee near the escapement boundary. Monitoring programs in the various fisheries provide in-season estimates of catch and effort. Monitoring programs throughout the Skeena River drainage provide post-season escapement estimates.

Aggregate Stock Abundance and Exploitation

Skeena River sockeye returns and escapements have increased markedly since enhancement of Babine Lake began in the early 1970's (Fig. 4). Total returns have averaged 2.9 million since 1970, with decade averages of 2.0 million from 1970-79, 3.0 million from 1980-89, 3.8 million from 1990-99, and 3.2 million from 2000-03. Exploitation rates have averaged just under 60% since enhancement began (Fig. 5.).

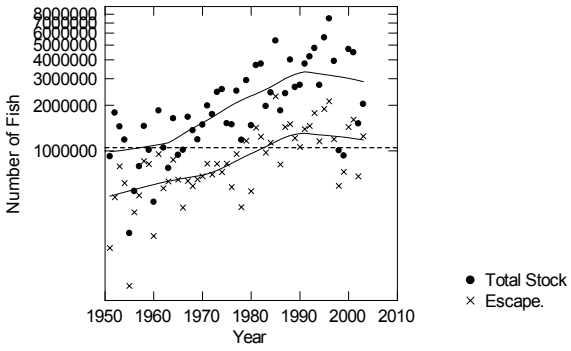


Figure 4: Trends in total abundance and escapement of Skeena River sockeye salmon: 1951-2003. The dashed line is the escapement target of 1.05 million. Note the y-axis is plotted on a logarithmic scale.

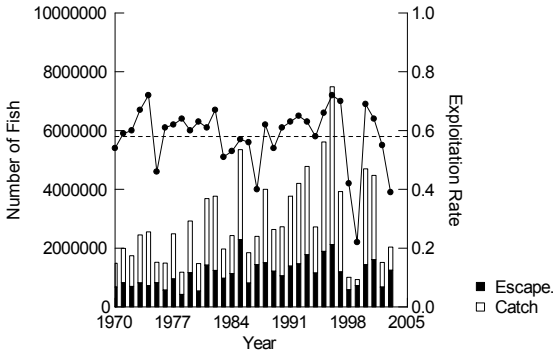


Figure 5: Trends in escapement (solid bar), total catch (open bar) and total exploitation (line) for Skeena River sockeye salmon: 1970-2003. The dashed line is the mean exploitation rate.

Wild Stock Abundance and Exploitation

Annual catch and escapement data for each wild Skeena River sockeye stock are not available and so exploitation rates cannot be directly calculated. Instead, exploitation rates are modeled using weekly sockeye harvest rates in Canadian fisheries, run-timing curves for the wild stocks, and add-on exploitation for U.S. and in-river First Nations fisheries (Cox-Rogers et al 2003). Table 1 summarizes estimated exploitation rates for wild Skeena River sockeye stocks peaking in Canadian commercial fisheries in different weeks.

Mean exploitation has been >50% for those stocks co-migrating with the enhanced Babine Lake component (mid-late July) and may actually have been higher for specific stocks where in-river exploitation rates are likely under-estimated. Preliminary analyses suggest that exploitation has probably been higher than sustainable exploitation at MSY for most wild Skeena River sockeye stocks (Cox-Rogers et al 2003).

Week	Peaking Jn 25-1	Peaking Jl 1-7	Peaking Jl 8-14	Peaking Jl 15-21	Peaking Jl 22-28	Peaking Jl 29-04	Peaking Au 5-11
1970-79	0.262	0.361	0.446	0.502	0.530	0.531	0.506
1980-89	0.245	0.321	0.412	0.486	0.520	0.514	0.481
1990-99	0.338	0.426	0.498	0.534	0.531	0.499	0.452
2000-09	0.279	0.405	0.510	0.560	0.548	0.486	0.391

Table 1: Estimated decadal mean exploitation (marine+FSC) for wild Skeena River sockeye salmon stocks peaking during specific weeks in Canadian marine fisheries. Data for 2000-09 are only for the years 2000-02 inclusive.

Spawning Escapements

Escapements to enhanced sites within Babine Lake continue to exceed spawning requirements in most years because enhanced Pinkut and Fulton returns cannot be harvested fully in mixed-stock fisheries without over-harvesting the less productive wild populations. On average, more than a third of the sockeye migrating past the Babine Lake counting fence are surplus fish produced by the spawning channels (Wood 1999). Although these fish are surplus to spawning requirements the nutrients from their decomposing carcasses increases the capacity of Babine Lake to rear sockeye fry (Shortreed and Morton 2000). Trends in escapement to Babine Lake are shown in Figure 6. Since enhancement activities began, the mid-timed wild Morrison River run into Babine Lake has remained below escapement objectives and pre-enhancement levels. Escapements to other wild runs within Babine Lake whose run-timing is either earlier or later than the enhanced Pinkut and Fulton runs have not been statistically different than pre-enhancement levels (Wood 1999). In recent years, however, escapements to some wild late-run Babine Lake stocks (e.g. Babine River) appear to be increasing, likely because of reduced harvesting in August aimed at protecting co-migrating steelhead and coho salmon.

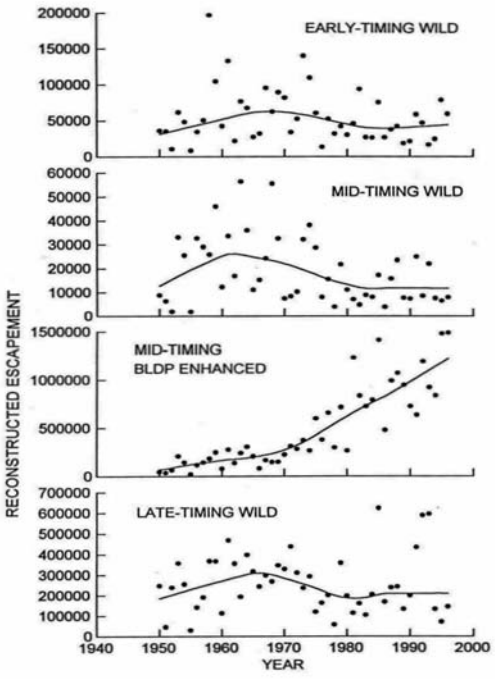


Figure 6: Trends in sockeye salmon escapement to Babine Lake by run-timing group: 1950-1996 (source Wood et al 1998).

Escapement trends for wild Skeena River sockeye have been more difficult to assess because the counts represent visual estimates of unknown accuracy, variable methodology, and decreasing coverage over time. Still, the available escapement data (B.C. 16's) are useful for establishing general trends. The records suggest that wild Skeena River sockeye escapements have generally declined and stabilized to lower levels over time (Fig. 7). There is also evidence for increased escapements in the mid-1990's despite the sustained high harvest rates on the Skeena run as whole. Wood et al (1998) presumed this to be a direct result of continuing efforts to harvest the mid-timing Babine sockeye as selectively as possible. However, Wood (2001) pointed to evidence that Babine smolt-to-adult (presumably marine) survival had in fact increased until 1995, then stabilized, whereas exploitation rate on the Skeena aggregate continued to

increase. He argued that this exploitation became excessive and may have become even more intense on the early run Skeena populations, contributing to the decline in their escapements through 2001.

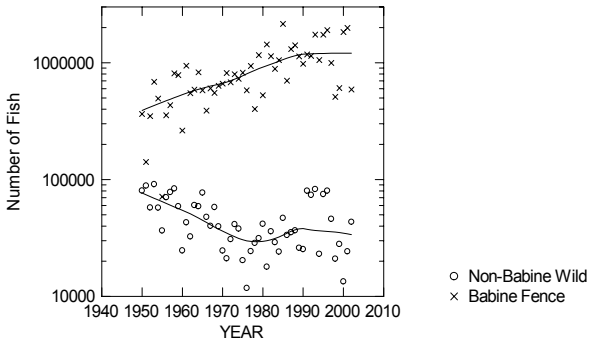


Figure 7: Trends in sockeye salmon escapement into Babine Lake (fence counts) and non-Babine lakes (B.C. 16 visual estimates): 1950-2003. Note the y-axis is plotted on a logarithmic scale.

Several wild Skeena River sockeye stocks are now being monitored with escapement counting fences. Escapements to these lakes have either been low or have shown declining trends in recent years (Fig. 8) although returns in 2003 were very good and likely the result of favorable brood year production coupled with reduced exploitation in both marine and in-river FSC fisheries.

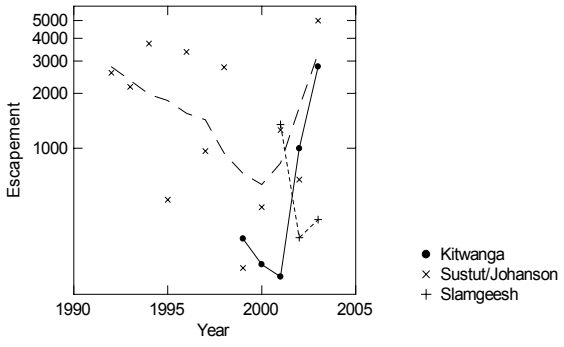


Figure 8: Trends in sockeye salmon escapements for Kitwanga Lake, Sustut/Johanson, and Slamgeesh Lake: 1992-2003. Note the y-axis is plotted on a logarithmic scale.

Limnological and juvenile surveys

Ongoing analyses of limnological and juvenile acoustic data for Skeena sockeye nursery lakes indicates that, in most cases, spawning escapements are much too low to fully utilize lake rearing habitat and maximize smolt production (Shortreed et al 1998, 2001). In addition to recruitment limitation, some lakes are also being limited by factors such as low spawning ground capacity or quality, low in-lake growth and/or survival, nutrient limitation, glacial turbidity, and species competition. All of these factors act to reduce sockeye productivity and limit sustainable exploitation rates.

A general measure of current stock status for Skeena sockeye nursery lakes can be obtained by comparing current juvenile densities to the maximum number each lake can support. Juvenile densities are also correlated with the number of spawners in a given lake. Of the Skeena River sockeye nursery lakes surveyed to date, 82% are estimated to be producing juvenile sockeye at less than 40% of their capacities if no other restraints to sockeye production are operating (Fig. 9) Preliminary adjustments to account for other restraints on sockeye production, such as known competitors or limited spawning grounds, suggests that *53% of surveyed Skeena sockeye nursery lakes are producing sockeye at <40% of their capacity while only 30% are producing sockeye at >60% of their capacity* (Fig. 10). Low juvenile densities are a concern for Kitwanga Lake, Sustut Lake, Johanson Lake, Kalum Lake, and Club Lake, as well as for many lakes where quantitative data are absent or preliminary (Motase Lake, Atna Lake, Kluatantan Lake, Kluayaz Lake, Asitka Lake, Spawning Lake, Bulkley Lake, and Maxan Lake).

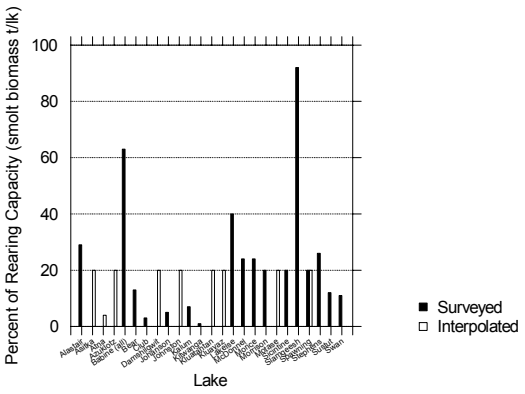


Figure 9: Percentage of juvenile rearing capacity being achieved for Skeena sockeye nursery lakes if no other restraints to sockeye production are operating other than lake rearing capacity (see text). Data for interpolated lakes are based on production parameters for surveyed lakes of similar size and similar geographic location.

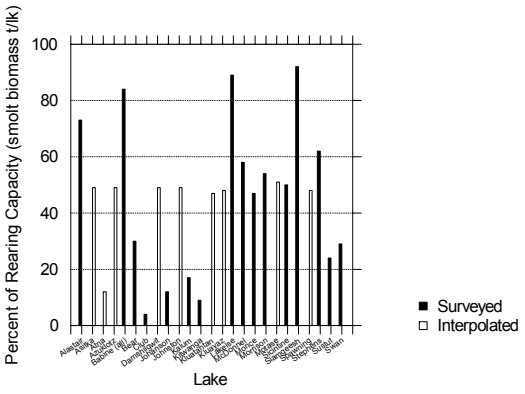


Figure 10: Percentage of juvenile rearing capacity being achieved for Skeena sockeye nursery lakes accounting for restraints on sockeye production beyond just lake rearing capacity (see text). Data for interpolated lakes are based on production parameters for surveyed lakes of similar size and similar geographic location

Outlook

Skeena sockeye abundance is driven by the Babine Lake stock and by the enhanced component of the Babine Lake stock in particular. Given its high level of productivity and substantial rearing capacity, future production from Babine Lake is expected to remain strong. For non-Babine sockeye nursery lakes, and for some wild stocks rearing within Babine Lake itself, the outlook is less certain. Although many lakes still require evaluation and productivity estimates are still under review, ongoing assessments re-enforce previous studies (Shortreed et al 1998, 2001) concluding that the majority of non-Babine sockeye nursery lakes in the Skeena River drainage are not very productive, appear to be largely fry-recruitment limited (not getting enough spawners) and produce sockeye well below potential production. Simulation studies have shown that some non-Babine sockeye stocks are at high risk under continued patterns of high fisheries exploitation and require re-building (Cox-Rogers et al 2003). Increased fry recruitment through increased escapements, combined with lake-specific restorative and/or enhancement techniques, has been suggested for improving sockeye production from non-Babine nursery lakes (Shortreed et al 1998, 2001).

In May 2003, the Pacific Scientific Advice Review Committee (PSARC) recommended that fishing plans recognize the depressed status of many Skeena River sockeye stocks and the need to preserve spawners (Tanasichuk 2003). Major improvements in stock status for many Skeena River sockeye stocks will likely require more careful matching of future fisheries exploitation to lake-specific productivity.

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