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Lakelse Lake Limnology and Juvenile Fish Ecology: 2003 Update

by Ken Shortreed

FISH STAFF → FILE

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In 2003, Fisheries and Oceans Canada personnel carried out a study of the limnology and fish ecology of Lakelse Lake. A similar study was also carried out in 1994. The focus of the study was on juvenile sockeye rearing habitat, which is the offshore portion of the lake (the limnetic zone).

In the limnological part of the study, we sampled the lake once monthly from May to October. On each sampling date, we collected a variety of physical, chemical, and biological data from two sites in the lake. One site was located in the deepest part of the lake (mid-lake opposite Furlong Bay) and the other was in shallower water (mid-lake opposite Mailbox Point). Physical variables sampled included vertical profiles of temperature and light transmission. Chemical analyses on collected water included conductivity, pH, dissolved oxygen, total dissolved solids, alkalinity, silicate, phosphorus (total, dissolved, soluble reactive, and particulate), and nitrogen (nitrate, ammonia, and particulate). Biological variables included bacteria numbers, phytoplankton biomass and species composition, photosynthetic rates, zooplankton biomass and species composition, and the mysid *Neomysis mercedis*. *N. mercedis* is a small (it grows up to 1.4 cm long) freshwater shrimp which is abundant in Lakelse Lake and can compete with juvenile sockeye for their preferred food. An additional component of the study was to carry out stable isotope (carbon-13 and nitrogen-15) analyses on zooplankton, juvenile sockeye, snails, and mysids. These analyses provide insight into the lake's foodweb and help determine the extent to which sockeye and mysids compete for the same food.

In the fish ecology portion of the study, we sampled the lake twice (mid-July and the end of September). In this work, we used an echo-sounder (hydroacoustics) and a mid-water trawl to estimate the abundance, and species of the fish in the offshore portion of the lake. By doing a series of transects with the echosounder we obtained a hydroacoustic estimate of the abundance and distribution of the midwater fish in the lake. With trawl samples, determined species, length, weight, condition, age, and diet of these fish.

Surface temperatures in Lakelse Lake were 14.1ºC on our first sampling date (May 10) and increased to a seasonal high of 19.4ºC on August 14. The lake was thermally stratified from June to September, and thermocline depths were unusually

deep (usually greater than 20 m) for a relatively small lake. This is no doubt due to the frequent winds. The lake is relatively clear, with an average euphotic zone depth (the depth to which plants can grow) of 8.2 m.

Lakelse Lake water had a near-neutral pH averaging 7.1, a relatively low average conductivity of 54 μS/cm, and a total alkalinity of 22.5 mg $CaCO_3$/L. These values are near the middle of the range seen for a number of other lakes in the Skeena River system. Dissolved oxygen concentrations were relatively high (8-11 mg/L) except in the deep waters (25-30 m) in August, when they declined to 4.1 mg/L.

A number of the variables measured help determine a lake's trophic status, or level of productivity. Total phosphorus concentrations averaged 5.4 μg/L. Spring nitrate concentrations were approximately 50 μg N/L and although epilimnetic nitrate did not become completely depleted, it was <6 μg N/L from June to September. Bacteria numbers averaged 1.5 million/mL and average chlorophyll concentrations were 1.4 μg/L. Photosynthetic rates averaged 144 mg $C \cdot m^{-2} \cdot d^{-1}$. **These data all indicate that Lakelse is a relatively unproductive lake and is in the middle of the oligotrophic range.** Some Skeena system lakes are substantially more productive (Kitwanga, Bear) and others such as Morice and Motase are much less productive. The data indicate that for much of the growing season, lake productivity is limited by the availability of both nitrogen and phosphorus. In other words, an increased supply of both nitrogen and phosphorus would stimulate lake productivity.

Lakelse has a somewhat unusual zooplankton community in that the preferred food item (*Daphnia*) of juvenile sockeye is abundant only in July. The rapid decline of *Daphnia* numbers from July to August is likely due to the high numbers of the mysid shrimp *N. mercedis*, which was most abundant (360/m^2) in August. Stable isotope analyses indicate that mysids and juvenile sockeye both feed primarily on *Daphnia*. Despite the relatively low *Daphnia* numbers after July, it remains the primary food source of sockeye for most of the growing season.

Most of the fish captured in the midwater trawls were juvenile sockeye, but we also captured river and Pacific lamprey, threespine stickleback, larval sculpins, northern pikeminnow, and redside shiner. Juvenile sockeye in Lakelse Lake grow rapidly and are >6 g by fall. This is larger than average for juvenile sockeye in Skeena lakes, and is attributable to the productive *Daphnia* population and to the low numbers of sockeye which were present in the lake in 2003. In the fall of 1994 we estimated there were 450,000 sockeye juveniles in the lake but our fall estimate in 2003 found only 100,000 sockeye fry. It would require approximately 750 sockeye spawners in the previous year to produce this number of fry in the fall of 2003.

Every sockeye nursery lake has a rearing capacity for juvenile sockeye that is controlled by a number of factors, some of which are surface area, nutrient loading, productivity, and presence of competitors. We estimate that the large mysid population in Lakelse Lake reduces its sockeye rearing capacity by 40%. **Taking this into account, Lakelse has the capacity to effectively rear the sockeye fry from 29,000**

spawning adults. Data collected in 2003 suggest that <5% of the lake's sockeye rearing capacity was being utilized.

Summary Conclusions:

The low juvenile densities observed in Lakelse Lake in 2003 correspond with suspected low sockeye escapements in 2002. In recent years, available escapement records suggest a marked and concerning decline in sockeye escapements to this system. Given the favourable rearing conditions in the lake and estimated low fisheries exploitation rates for this stock, poor sockeye recruitment into Lakelse lake could be due to a) reduced spawning habitat/spawner access in the tributary creeks relative to historic levels or b) higher predation on juvenile sockeye somehow due to reported increases in macrophyte loading relative to historic levels (e.g. predator refuges). Of these two possibilities, I suspect that spawning habitat issues might be more relevant given the recent and documented changes to flow regimes in several Lakelse Lake spawning tributaries.

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Subject: Lakelse Lake Trophic Status Update: 2003

The enclosed summary has been taken from a technical document (currently being finalized) outlining 2003 lake survey results for Lakelse Lake. Ken Shortreed has written the text for a non-technical audience. I have added the last paragraph after talking with Ken and Jeremy Hume about the likely causes of poor sockeye production in Lakelse Lake. The study looked at trophic status and juvenile sockeye production from May-Sept 2003. Please call if you have any questions or comments. The final technical report should be available in May.

<<Lakelse summary.doc>>

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<Q> Why are there mysids in Lakelse Lake?