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Fertilizing Adams Lake to Restore Sockeye Rearing Capacity

Background:

The Upper Adams River stock of sockeye salmon was historically reported to be of the same magnitude as the (Lower) Adams River stock (10+ million) and the river has an estimated potential area sufficient for over 2 million spawners. Obstruction to fish passage caused by a logging splash dam located at the outlet of Adams Lake from 1908-1945 caused the extinction of this stock. Restoration efforts were attempted with transplants in the 1940s to the 1970s, and finally a local creek provided enough broodstock for restoration using hatchery techniques from 1980-1996. Since hatchery-aided rebuilding began, the escapement to the Upper Adams River and other tributaries of Adams Lake has increased from 560 in 1980 to approximately 40,000 in 1996.

Because of the lack of returning adults to its tributary rivers, Adams Lake is severely depleted of the nutrients required to support the plankton that young salmon feed on for a year before migrating to the ocean. The decay of millions of spawners in the rivers feeding Adams Lake would have provided an estimated concentration of 20-30 ug/L of phosphate, compared to the 1.2 ug/L phosphate detected by sampling in 1986. This higher level of phosphate would have provided much higher densities of plankton in the lake, giving more food, higher growth rates and higher marine survival for this stock of sockeye salmon. Application of inorganic fertilizer to increase the levels of plankton productivity, and thereby sockeye growth, has been tested on B.C. lakes by DFO for over 20 years, with varying success. Adams Lake was considered a good test case to see if the technique would work on this type of interior lake, while helping with the rebuilding of this potentially very important stock.

Methods:

The usual method of application of fertilizer to lakes is to spray a fine mist over a portion of the lake from low-flying aircraft (fixed wing or helicopter have been used). The fertilizer used is a highly concentrated mixture of soluble nitrogen and phosphorus compounds, that provide a balanced supply of these two most-limiting nutrients. One of the goals of this program was to develop and test a 'low-tech' method of fertilizer application, one that did not require the considerable expense of chartering a specialized aircraft for the growing season and using special handling procedures for mixing the fertilizer. The concentrated liquid fertilizer (already mixed by the manufacturer) was pumped directly into the hold of a large aluminum herring skiff and various methods were tested to distribute behind the boat as it traveled up the lake. The best method was to simply pump the fertilizer into the propeller wash, where it was throroughly mixed both vertically and horizontally into the waters of the lake.

The fertilizer was spread along approximately the middle of the northern half of Adams Lake. Applications occurred 1-2 times per week and varied in amount according to a front-end-loading technique used successfully in other lakes. This technique puts most of the fertilizer into the lake early in the program to stimulate rapid plankton growth. Although historic nutrient levels were probably more than 10 times the present levels, we used the addition of inorganic fertilizer to increase nutrient levels by a modest 2-3 times.

Thorough sampling of the water quality and limnological characteristics of the lake was carried out every month by DFO Habitat Science, under contract, along with two hydroacoustic sampling programs (mid-summer and late fall) to determine the number and size of the fish in the lake. Sockeye smolts were trapped, counted and subsampled in the Adams River as they headed to the ocean in April, 1998, by the Adams Lake Indian Band, under contract. Subsamples were measured for length and weight and the otoliths of the fish were preserved for analysis for strontium marks that were laid down in the hatchery fish.

This study was carried out in conjunction with another restoration effort on this stock, that of releasing hatchery and net-pen reared fry (approximately 1 million) into the lake to supplement the natural production from the spawning grounds. This hatchery program, carried out every four years since 1976, has been responsible for the rebuilding of this stock to date.

Results:

The limnological sampling results were compared to samples taken in 1986, showing an increase in nutrients, primary productivity and zooplankton concentration. Nutrients were well distributed throughout the lake, not surprising considering that 1997 was a particularly windy summer. Of particular interest was that the preferred food of juvenile sockeye salmon,

the zooplankton *Daphnia*, was abundant only in the northern, fertilized, end of the lake. Also, sockeye fry caught in the northern half of the lake had stomachs that were 90% full of almost exclusively *Daphnia*, whereas the fish at the southern end of the lake had stomachs that were only 25% full, with only 60% of the diet being *Daphnia*.

The results of fish surveys in Adams Lake are complicated by the presence of a large population of kokanee, which are difficult to distinguish from sockeye. Samples from both the hydro-acoustic trawl trips and the smolt trapping have been sent to a specialty laboratory at the University of Washington, where patterns of bone growth in their otoliths should help determine whether they are sockeye or kokanee, or whether they are wild or hatchery origin. These tests have not been completed yet.

The smolts exiting Adams Lake in 1992 were only 2.5 g, compared to smolts from other interior lakes (Quesnel, Fraser, Francois) of 7-10 g. Fertilization in 1997 increased the size of the sockeye smolts to approximately 3.5 g, an increase of 40%.

Conclusions:

The fertilization of Adams Lake was successful from three perspectives:

1. Sockeye rearing in the lake clearly benefited from the small amount of added nutrients, helping rebuild this potentially important stock;
2. The plankton and fish in the lake responded positively to fertilization, indicating that other similar interior lakes would show a positive response,
3. The boat application method worked very well and cost a fraction of what aerial application would have cost.

Expenses:

Fertilizer	$73.9K
Operations	$44.2K
Equipment	$16.9K
Biological Monitoring	$45.0K
Total	$180K

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