LAKE TROUT POPULATION ASSESSMENT

BENNETT LAKE 2001, 2009

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Summary

Environment Yukon has been conducting assessments of important fish stocks since 1991. Priority lakes are identified for survey based on accessibility, sensitivity, and management concern. Environment Yukon works with user groups, First Nations and RRCs to establish priorities for assessment. Assessments focus on lake trout which is considered an indicator species of the health of northern aquatic ecosystems.

Bennett Lake has a recreational fishery, a subsistence fishery, and currently a commercial harvest quota of 550 kg of lake trout. Regulations were adopted in 2001 that reduced catch and possession limits, introduced slot limits such that no lake trout between 65 and 100 cm could be kept, and made the use of barbless hooks mandatory (High Quality Waters, now Conservation Waters regulations).

For those lakes with important fisheries like Bennett, it is suitable to conduct regular monitoring of the fish population. Surveys were done in 2001 and 2009. Lake trout numbers were stable between surveys as was the length, weight, and condition of trout.

The methods used in these studies were found to be sensitive enough to measure only large changes in the lake trout population. Future surveys using the same methods would encounter the same limitations. We recommend that future population assessments use other methods that are better able to detect changes in the fish populations of Bennett Lake.

Key Findings

- We did not detect a difference in the lake trout population in Bennett Lake between 2001 and 2009 surveys
- Current methods are coarse; only large changes (a 100% increase or 66% decrease) in the lake trout population can be detected.

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Introduction

Since 1991, Environment Yukon has surveyed over 100 Yukon lakes using standardized methods. Lakes are chosen for assessment based on the level of the active commercial, recreational, or aboriginal subsistence fisheries, as well as the level of available fisheries information. Lakes with significant harvest pressure are surveyed on a regular basis. The survey consists of setting gillnets at different locations around the lake and recording biological information about the catch. To allow comparison of results among years the same methods are used each time the survey is done. The survey typically determines:

- the relative abundance of lake trout compared to past surveys; and
- length and weight of individual lake trout and other species.

We conducted fisheries surveys on Bennett Lake in 2001 and 2009; here we report on data from both study years.

Study Area

Bennett Lake is located in the Southern Lakes region of the territory near the community of Carcross (Figure 1). Its southern extreme extends past the B.C. border. The lake is approximately 41 km long and covers an area of 97 km^2. The lake has a mean depth of 62 m and a maximum depth of 123 m. Major inflows include the Lindeman, Homan, Partridge, Wheaton and Watson rivers. The lake is drained by the Nares River, connecting with Tagish Lake and eventually the Yukon River.

Bennett Lake is in the traditional territory of the Carcross/Tagish First Nation and the community of Carcross sits at the mouth of the Nares River on the South Klondike Highway. The lake has been subject to reduced catch and possession limits slot-size limits, and barbless hook regulations (previously High Quality Waters, now Conservation Waters designation) since 2001.

Methods

We used commonly applied techniques (adapted from Lester et al. 1991) to catch fish in this study: we set small-mesh, multi-filament gill nets during the day. In small-mesh nets, lake trout tend to be caught by their teeth and jaws rather than by their gills and few fish are killed or injured using this method. Aiming to reach a net set density of 0.75 sets per km^2 of lake surface area, we set gillnets at 79 and 80 locations around the lakeshore (Table 1).

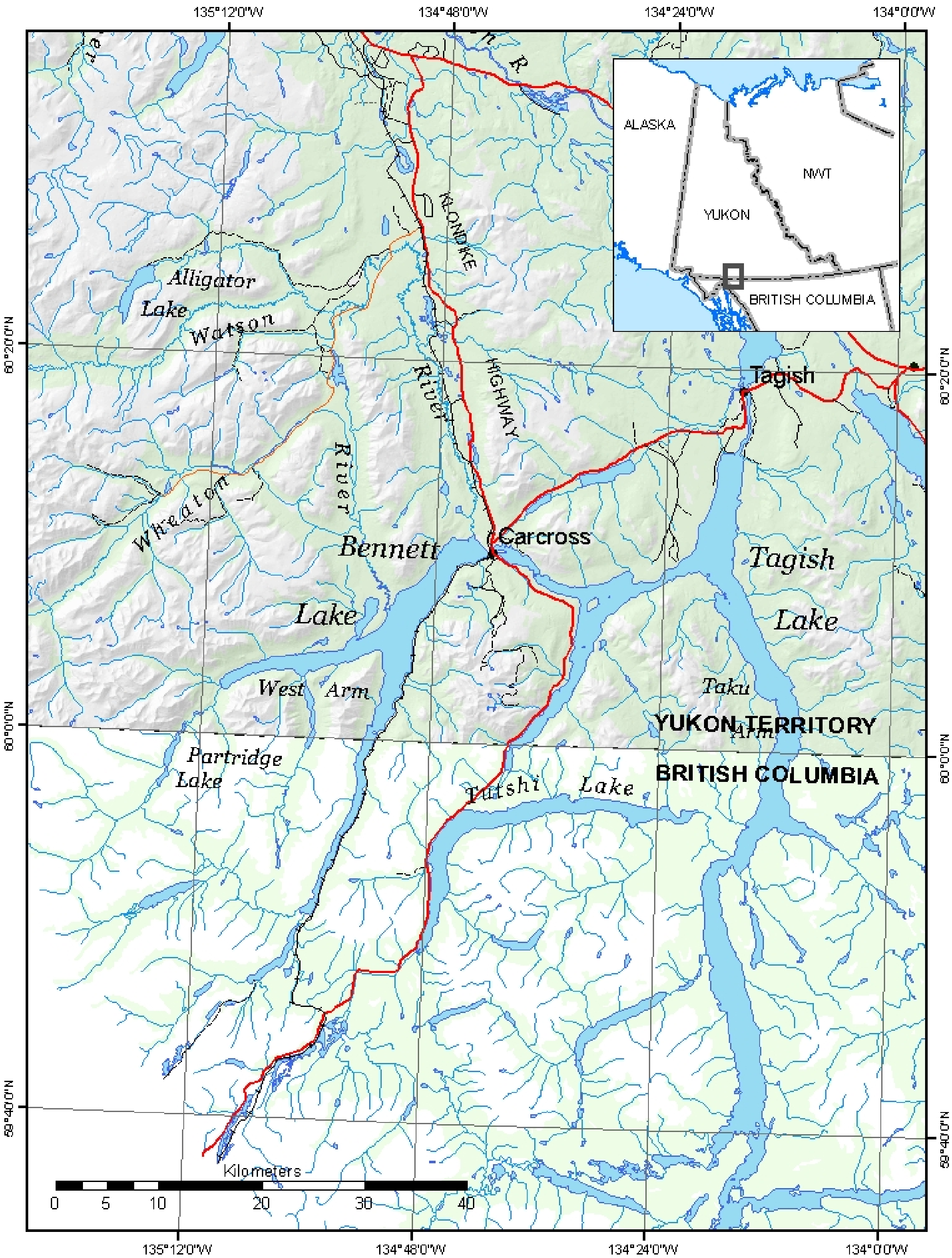

Figure 1. Location of Bennett Lake, Yukon.

Table 1. Sampling information for Bennett Lake surveys.

Year	Dates	Number of Sets	Set Density (sets/km2)	Water Temperature (^{o}C)	
				Average	Range
2009	July 7 - 9	80	0.83	12.5	8 - 16.9
2001	July 16 - 18	79	0.82	10.6	7.6 - 15.4

Each net was 69 m long and 2.4 m deep and was made up of 3 panels of differing mesh sizes. Mesh sizes used were 3.8, 6.4, and 7.6 cm (hung along the net in that order). Nets were set perpendicular to the shoreline with the near-shore end in at least 2.4 m water. The offshore end was sunk with an anchor to ensure the net ran along the bottom of the lake. We alternated between setting the small (3.8 cm) and large (7.6 cm) mesh panels closest to shore to address the issue of net configuration bias (Lester et al. 1991). We checked the nets after one hour. For each net set we recorded location, surface water temperature, and the depth of the offshore anchor.

We used the number of fish caught to estimate catch per unit effort (CPUE). CPUE is defined as the number of fish (of a certain species) caught per unit time. Using this method we cannot estimate the absolute abundance (number) of fish in a lake, but we can use CPUE as an index of abundance and use it to compare between years and to detect changes in the population (i.e., trends in relative abundance).

For each fish caught we noted the size of mesh in which it was caught, species, length, and weight. We released all fish at or near the sampling location. For the few fish that died, we recorded sex and maturity, collected the stomach contents for diet analysis and the otoliths to determine age. Data on diet, age, sex, and maturity are not reported here but can be obtained from Environment Yukon.

Data Analysis

CPUE is calculated as number of fish caught / time (standardized to 1 hour). The frequency distribution of CPUE data is heavily skewed with many data points at zero catch (Table 2). Because of the non-normality of the data, we used the non-parametric Wilcoxon test to compare CPUE between years.

Table 2. Distribution of lake trout catch in nets set in Bennett Lake in 2001 and 2009.

Number caught	2009 Number of sets	2009 Percent	2001 Number of sets	2001 Percent
0	70	88%	62	78%
1	9	11%	17	22%
2	1	1%		
3				
Total	80	100%	79	100%

* For example, in 2001 62 nets contained 0 lake trout and 17 nets contained 1 lake trout.

Statistical power is chance of detecting a change when it exists and for our management purposes a power of 80% is considered reasonable. To estimate statistical power and required sample size *a priori* for the 2009 survey, we simulated possible catch distributions using a Poisson distribution (manipulating the mean to simulate different effect sizes) then compared these distributions to the 2001 data using a Wilcoxon test. We used bootstrap methods to run the simulations 1000 times and calculated power as the proportion of those 1000 simulations which resulted in a significant result. We varied to sample size to predict the effect of increasing our effort on the power of our test. We predicted that we would be able to detect an increase of 114% or a decrease of 64% with sufficient (80%) power. By increasing sample size to 120 sets, the predictions showed that we might detect increases greater than 105% or decreases greater than 60% in CPUE. This represents a reduction in the detectable effect size of 6.5% while increasing sampling effort by 50% so it was not deemed worthwhile to increase sample size in this case.

We used a t-Test to compare the length, weight, and condition factor of lake trout between years. The relationship between a fish's weight and length can be described by its condition factor (K) and is calculated as: K = (weight (g)/length (cm^3)) x 100 (Ricker, 1975). The heavier a fish is at a given length, the better its condition. At the individual level, K can be an indication of fish health. We averaged K over the entire catch and used it this as an indication of overall condition of lake trout within the population.

All statistical comparisons and power calculations were done in R Ver. 2.12.0.

Results and Discussions

Lake Trout Catch and Effort

CPUE in 2009 and 2001 was 0.14 and 0.22 respectively. Using a one-tailed Wilcoxon test, CPUE was not detectably different between 2009 and 2001 (Wilcoxon: W= 2883.5, $P = 0.07$). While we did not detect a difference in CPUE between years, our ability to do so was constrained; based on our *a priori* power analysis, we would likely only have been able to detect large differences (+114% or -64% between 2001 and simulated data). So while CPUE in 2009 was 36% less than in 2001, we cannot conclude that this represents a significant decline in the lake trout population.

Simulations for future surveys predict that at current sample size of 80 sets, we would be able to detect an increase of 130% or a decrease of 80% in CPUE from the 2009 results. Any changes in the population that were smaller than this would go undetected. This suggests that we only have sufficient power to detect very large changes in the population. For management purposes, it is desirable to be able to detect changes of 25% or less with good power. Based on the *a priori* analysis, increasing the sample size would result in a modest increase in power but would require a heavy investment of resources. In this context, additional studies using the same methodology are not recommended as we will likely be able to detect only very large changes in our population index.

Biological Characteristics of Lake Trout

Lake trout ranged in length from 165 to 870 mm in 2001 and 203 to 628 mm in 2009. There was no significant difference in length (t-Test: $t_{df=26} = 0.46$, $P = 0.65$) weight (t-Test: $t_{df=26} = 0.44$, $P = 0.66$), or condition factor (t-Test: $t_{df=26} = -0.53$, $P = 0.60$) between 2001 and 2009.

Table 3. Length and weight data for lake trout from Bennett Lake.

Year	Total Catch	Average length (mm)	Average weight (g)	Average Condition Factor (K)
2009	11	437	1464	1.17
2001	17	468	1793	1.12

Other Fish Species

On average, round whitefish constituted the largest proportion of total catch followed by Arctic grayling, lake trout, lake whitefish, and longnose sucker (Table 4). Burbot and least cisco were also captured.

Table 4. Summary of catch data for Bennett Lake in 2009.

Species	Years	Total Number of Sets	Total Catch	Average length (mm)	Average weight (g)	CPUE (# fish caught /hour net set)	Proportion of Total Catch (No.)	Proportion of Total Catch (Weight)
Lake Trout	2009	80	11	437	1464	0.14	0.04	0.06
	2001	79	17	468	1793	0.22	0.07	0.11
	Average	-	14	453	1629	0.18	0.05	0.09
Arctic Grayling	2009	80	68	327	399	0.85	0.22	0.10
	2001	79	60	315	397	0.76	0.24	0.09
	Average	-	64	321	398	0.81	0.23	0.09
Burbot	2009	80	-	-	-	-	0.00	0.00
	2001	79	1	750	2750	0.01	0.00	0.01
	Average	-	-	-	-	-	0.00	0.01
Lake Whitefish	2009	80	5	351	777	0.06	0.02	0.01
	2001	79	18	349	623	0.23	0.07	0.04
	Average	-	12	350	700	0.15	0.04	0.03
Least Cisco	2009	80	-	-	-	-	0.00	0.00
	2001	79	2	202	113	0.03	0.01	0.00
	Average	-	-	-	-	-	0.00	0.00
Longnose Sucker	2009	80	14	377	643	0.18	0.04	0.03
	2001	79	8	353	631	0.10	0.03	0.02
	Average	-	11	365	637	0.14	0.04	0.03
Round Whitefish	2009	80	216	329	382	2.70	0.69	0.31
	2001	79	149	321	363	1.89	0.58	0.20
	Average	-	183	325	373	2.30	0.64	0.26

Factors Affecting Results

Catch can vary within a lake when netting is done under different environmental conditions. To be comparable, it is important that all surveys are done when fish are equally susceptible to being caught. Timing was slightly different between years and water temperatures were slightly higher in 2009 than in 2001 (Table 1). Higher temperatures can negatively affect catches, but the real impact on the surveys is unknown.

Netting results cannot be extrapolated to the entire lake (i.e., to those areas of the lake that we did not sample) and so we are not able to produce a lake-wide density estimate or an estimate of fish abundance. However, because our methods are identical from year to year we can compare results through time on a single lake and detect potential changes in the population. Comparisons of results among lakes must be done cautiously as conditions can vary greatly among lakes.

Recommendations

Further monitoring of Bennett Lake using the methods and sample sizes used in these studies is not recommended. We found that with the current methods, the level of change we can detect in the lake trout population is not sufficient for management purposes. Future monitoring of Bennett Lake should be conducted using a method that can detect true changes in lake trout abundance with more certainty.

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