LAKE TROUT POPULATION ASSESSMENT

TESLIN LAKE
1997, 2003, 2009

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Summary

Environment Yukon has been conducting assessments of important fish stocks since 1991. Assessments focus on lake trout, which is considered an indicator species of the health of northern aquatic ecosystems. 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.

Teslin Lake has a popular recreational fishery and a current commercial harvest quota (although unused in the last decade) of 125 kg of lake trout. In 1993 Teslin Lake became a High Quality Water (now known as a Conservation Water). Regulations were adopted that reduced catch and possession limits, introduced slot limits (anglers cannot keep lake trout between 65 and 100 cm), and made the use of barbless hooks mandatory. When the Teslin Integrated Fish and Wildlife Management Plan raised concerns, the regulations were changed in 2000. Catch and possession limits were reduced to one lake trout.

For those lakes like Teslin with important fisheries, regular monitoring of the fish population is suitable. Surveys measuring relative abundance of lake trout were done in 1997, 2003, and 2009. The results suggested that lake trout numbers had decreased between 1997 and 2003 but stayed the same between 2003 and 2009. However, high variation in the catch data made detecting differences between years difficult and we cannot be confident that these results represented true changes in the lake trout population size. Our analysis indicates that the methods used in these studies were sensitive enough to measure only large changes in the lake trout population index. We expect that surveys using the same methods will encounter similar limitations. We recommend that future population assessments for Teslin Lake use methods that are better at detecting changes in fish populations.

Key Findings

- The lake trout population in Teslin Lake appears to have declined between 1997 and 2003, but remained relatively stable since then. However, high variation in catch data reduces confidence in these findings.

- Our current methods are coarse. Only large changes in lake trout populations 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 activity level of the commercial, recreational, or aboriginal subsistence fisheries as well as the available fisheries information. Lakes with significant harvest pressure are surveyed on a regular basis. The survey consists of setting non-lethal gill nets 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 typically determines:

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

We surveyed fish on Teslin Lake in 1997, 2003, and 2009. Here we summarize the information from all three study years.

Study Area

Teslin Lake is located in the Southern Lakes region of the territory, straddling the border between Yukon and B.C. The Alaska Highway parallels the lake for approximately 50 km. The lake is approximately 120 km long and covers an area of 354 km^2, with a mean depth of 59 m and a maximum depth of 214 m. It has several major inflows including the Teslin, Jennings, Hayes, Swift, Gladys, Morley, and Nisutlin rivers. The lake is drained by the Teslin River, one of the major headwater tributaries of the Yukon River drainage.

Teslin Lake is in the traditional territory of the Teslin Tlingit First Nation. The community of Teslin sits at the mouth of Nisutlin Bay on the Alaska Highway. Several management issues, including declining lake trout stocks, were identified in the Teslin Integrated Fish and Wildlife Management Plan (2001). 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 1993. Because of concern for lake trout stocks identified in the management planning process, the catch and possession limit for lake trout was reduced to one in 2000.

Methods

We used commonly applied techniques to catch fish in this study (adapted from Lester *et al.* 1991). 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, so few fish are killed or injured using this method. We aimed to reach a density of 0.75 net sets per square kilometre of lake surface area by setting gill nets at between 160 and 276 locations around the lakeshore (Table 1).

Table 1. Sampling information for Teslin Lake surveys.

Year	Dates	Number of sets	Set density (sets/km^2)	Water temperature (°C) Average	Range
2009	June 18 – 24	160	0.45	9.5	4.8 - 16
2003	June 2 – 22	276	0.78	9.5	4 - 15
1997	June 2 – 20	269	0.76	8.9	4.6 – 13.8

Each net set was made up of three panels. Each panel was 22.9 m wide and 2.4 m deep with a mesh size of 3.8, 6.4, or 7.6 cm (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 heavy anchors to make sure 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 prevent 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.

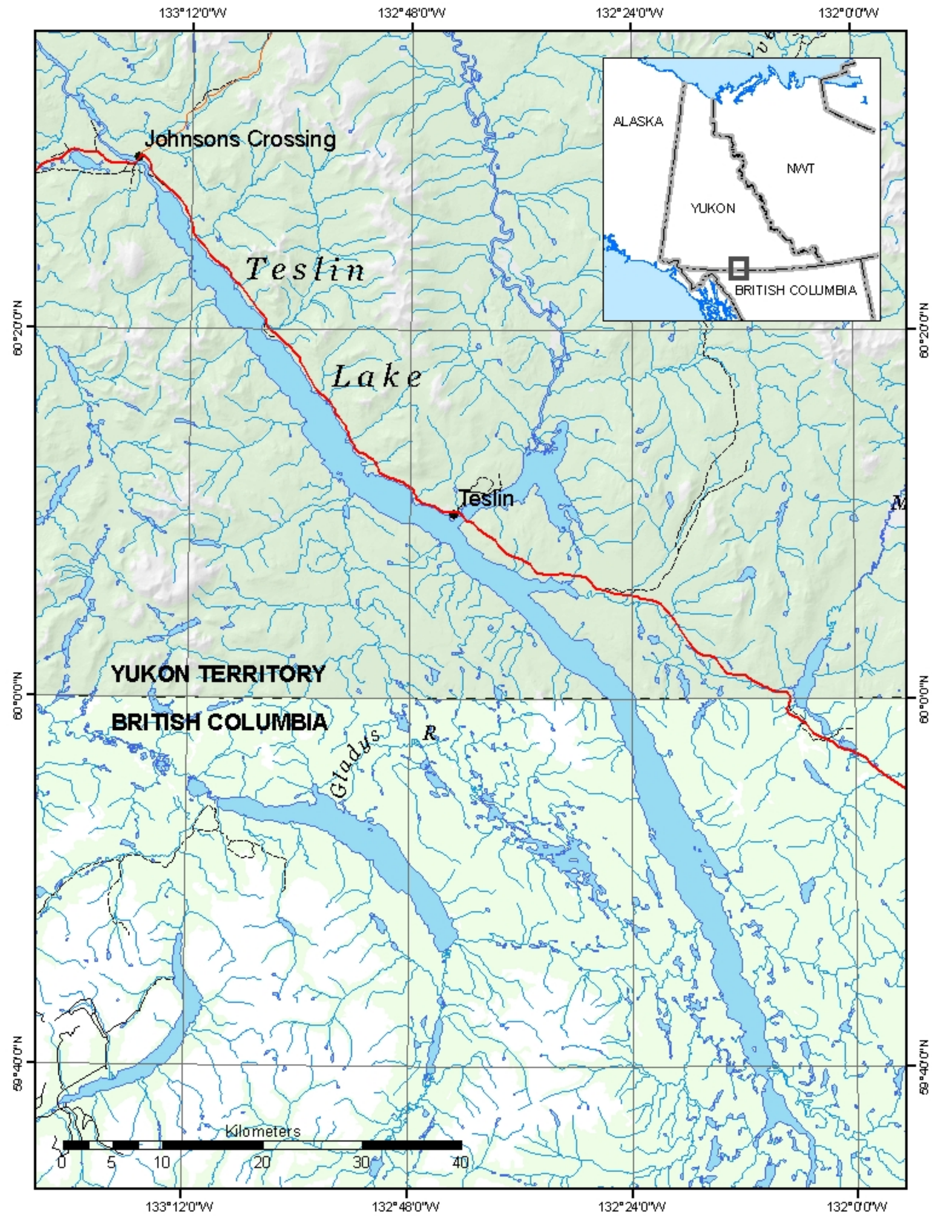

Figure 1. Location of Teslin Lake, Yukon

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 of 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 to compare between years and 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: CPUE = 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 Kruskal-Wallis test to compare CPUE among years. We calculate the power of the Kruskal-Wallis test using a bootstrap method to re-sample with replacement from each of the 3 years and perform the test 1,000 times. We then take the proportion of those 1,000 tests resulting in a significant change as a representation of power. Statistical power is the chance of detecting a change when it exists. For our management purposes, a power of 0.8 (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 data from previous years. We used bootstrap methods to run the simulations 1,000 times and predict power to detect change at various sample sizes. We predicted that we would be able to detect a +80% / -55% change with sufficient (0.8) power. We also predicted that decreasing sample size to 175 sets would likely result in an ability to detect +100% / -60% changes in CPUE. This represented a decrease in detectable effect size (% change in CPUE) of 13% but a decrease in sampling effort of 37%. Sampling effort in 2009 was subsequently reduced to a target of 175 sets, reducing effort by approximately 5 days or 40 person days.

Table 2. Distributions of lake trout catch in net sets in Teslin Lake in 1997, 2003 and 2009. For example, in 2009 152 sets contained 0 lake trout and 8 sets each contained 1 lake trout.

	2009		**2003**		**1997**	
Number of lake trout caught	Number of sets	Percent	Number of sets	Percent	Number of sets	Percent
0	152	95%	263	95%	241	90%
1	8	5%	13	5%	26	10%
2					2	<1%
3						

We used regression analysis to detect trends in CPUE over time. However, because we had only the minimum number of data points (3 years) needed to do this analysis, the results provide limited statistical information. Therefore, little weight is placed on the result of the regression analysis.

We used ANOVA to compare the length and weight 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. The heavier a fish is at a given length, the better its condition. At the individual level, K can be a crude indication of fish health. We averaged K over the entire catch and used this average as an indication of overall condition of lake trout within the population.

Results and Discussion

Lake Trout Catch Effort

Mean CPUE (95% C.I.) in 2009, 2003, and 1997 was 0.05 (0.02 – 0.10), 0.05 (0.03 – 0.08), and 0.11 (0.08 – 0.16) respectively (Figure 2). We found a difference in CPUE among years (Kruskal-Wallis: X2(df = 2) = 8.15, P = 0.02) as well as a significant trend of declining CPUE through time (b (slope) = -0.006, F = 6.69, P = 0.01). Pairwise comparisons (using Bonferroni corrections) found a significant difference in mean CPUE between 1997 and 2003. Mean CPUE in 2009 was not significantly different from that in 1997 or 2003.

Our analysis of these data gathered through 3 surveys, spanning 12 years, suggested that lake trout numbers had declined and then stabilized over that time. However, the small absolute number and the variation in the number of lake trout caught made it difficult to detect differences and therefore to be confident that these results represented true changes in lake trout population size.

Simulations of future catch data predict that, at a current sample size of 175 sets, we would be able to detect an increase of 160% or a decrease of 84% in CPUE from the 2009 results. Any smaller changes in CPUE would go undetected. This result suggests that we only have enough 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. Increasing the sample size to the previous target of 275 is possible, but would require a heavy investment of resources. Additional studies using the same methodology or sample size are not recommended as we will likely be unable to detect all but very large changes in our population index.

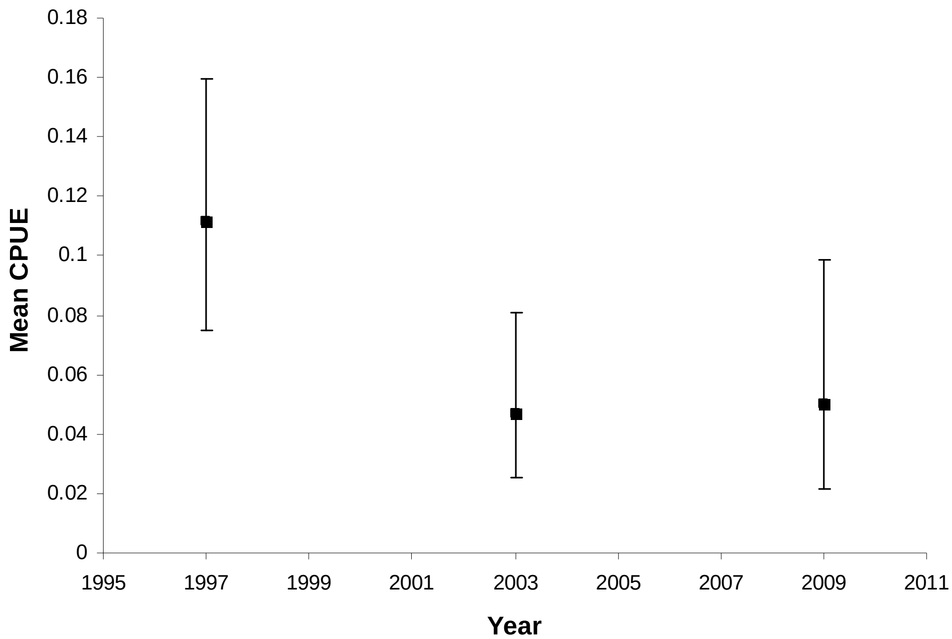

Figure 2. Mean CPUE with 95% confidence intervals for all 3 survey years.

Biological Characteristics of Lake Trout

Lake trout ranged in length from 178 to 909 mm in 1997, 395 to 893 mm in 2003, and 580 to 880 mm in 2009. There was a significant difference in length (ANOVA: $F_{2,48}$= 4.80, P= 0.01) and condition factor (ANOVA: $F_{2,48}$= 4.88, P= 0.01), but not weight (ANOVA: $F_{2,48}$= 1.93, P= 0.16), between years. Further testing (Tukey's HSD) revealed that captured lake trout were longer in 2009 than in 1997, and condition factor was smaller in 2009 than in both 2003 and 1997 (Table 3). The morphology of lake trout did not differ between 1997 and 2003.

Lake trout captured in 2009 were longer and thinner than in previous years. However, since the number of lake trout captured in 2009 was so low, it is difficult to comment on morphological characteristics of the population in general with any certainty. The length and weight data from the 2008 angler harvest survey may help determine if lake trout are indeed in poorer condition than in previous years.

Table 3. Morphological data for lake trout from Teslin Lake.

Year	Total catch	Average length (mm)	Average weight (g)	Average condition factor (K)	% of catch by weight
2009	8	718	4150	1.05	10.91
2003	13	676	4650	1.30	14.35
1997	30	554	2966	1.27	12.57

Other Fish Species

On average, round whitefish made up the largest proportion of total catch, followed by least cisco, lake whitefish, broad whitefish, and northern pike. Lake trout, Arctic grayling, longnose sucker, inconnu, and burbot, on average, combine to make up 5% of the total catch in all years (Table 4). In 2009, the catch of least cisco was particularly low. However, because we do not know the bias of these surveys in capturing species other than lake trout, we cannot statistically support any conclusions about the abundance (number) of other species. Nonetheless, a decline in this important prey species could be biologically significant to lake trout stocks, and could potentially explain poorer condition of lake trout. Unfortunately, concrete conclusions are not possible with current information. Although cisco catches appeared low, the catch of round whitefish, another important prey species, was particularly high in 2009.

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

Species	Year	Total number of sets	Total catch	Average length (mm)	Average weight (g)	CPUE (# fish caught per hour net set)	Proportion of total catch
Lake Trout	2009	160	8	718	4150	0.05	0.02
	2003	276	13	676	4650	0.05	0.02
	1997	269	30	554	2966	0.11	0.02
	Average	235	17	650	3922	0.07	0.02
Arctic Grayling	2009	160	11	281	305	0.07	0.02
	2003	276	6	367	542	0.02	0.01
	1997	269	15	307	348	0.06	0.01
	Average	235	11	318	398	0.05	0.01
Broad Whitefish	2009	160	60	367	801	0.38	0.12
	2003	276	91	374	851	0.33	0.13
	1997	269	152	372	785	0.57	0.11
	Average	235	101	371	812	0.43	0.12
Burbot	2009	160	0	n/a	n/a	0.00	0.00
	2003	276	1	584	1500	0.00	0.00
	1997	269	7	514	1111	0.03	0.01
	Average	235	4	549	1305	0.01	0.00
Inconnu	2009	160	0	n/a	n/a	0.00	0.00
	2003	276	4	701	3425	0.01	0.01
	1997	269	2	484	1500	0.01	0.00
	Average	235	3	592	2463	0.01	0.00
Lake Whitefish	2009	160	116	343	620	0.73	0.24
	2003	276	108	362	725	0.39	0.15
	1997	269	252	331	547	0.94	0.19
	Average	235	159	345	631	0.69	0.19
Least Cisco	2009	160	36	188	58	0.23	0.07
	2003	276	238	211	85	0.93	0.34
	1997	269	377	197	105	1.40	0.28
	Average	235	217	199	83	0.85	0.23
Longnose Sucker	2009	160	4	282	470	0.03	0.01
	2003	276	10	337	679	0.04	0.01
	1997	269	51	353	655	0.19	0.04
	Average	235	22	324	601	0.09	0.02
Northern	2009	160	20	660	2148	0.13	0.04

Pike	2003	276	49	635	1755	0.18	0.07
	1997	269	81	581	1512	0.30	0.06
	Average	235	50	625	1805	0.20	0.06
	2009	160	226	347	446	1.42	0.47
	2003	276	188	337	436	0.68	0.27
Round	1997	269	372	330	403	1.38	0.28
Whitefish	Average	235	262	338	428	1.16	0.34

Factors Affecting Results

Catch can vary within a lake when netting is done under different environmental conditions. To be comparable, all surveys must be done when fish are equally susceptible to being caught. One of the main environmental conditions, water temperature, was similar between all survey years (Table 1).

Netting results cannot be extrapolated to the entire lake (i.e., to those areas of the lake that we did not sample), 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 must be done cautiously as conditions can vary greatly among lakes.

Recommendations

Further monitoring of Teslin Lake using the methods and sample sizes of these studies is not recommended. Increasing the sample size to the 2003 target objective of 275 sets may marginally increase the effectiveness of the survey, but would substantially increase the effort required.

Future sampling for Teslin Lakes should be conducted using a method that can detect true variations in lake trout abundance, using sample sizes that are realistically feasible. We are doubtful whether the current methods would detect changes in the lake trout population unless those changes were very large and our sampling effort was increased.

Literature

LESTER, N., M. PETZOLD, W. DUNLOP, B. MONROE, S. ORSATTI, T. SCHANER, AND D. WOOD. 1991. Sampling Ontario lake trout stocks: issues and standards. Lake trout synthesis sampling issues and methodology working group, Ontario Ministry of Natural Resources. http://www.mnr.gov.on.ca/226944.pdf. Accessed 2009 March 23.