Application of a New Method for Monitoring Lake Trout Abundance in Yukon: Summer Profundal Index Netting (SPIN)

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Summary

In 2009, we tested a method for assessing lake trout populations, known as Summer Profundal Index Netting (SPIN). It was originally developed by the Ontario Ministry of Natural Resources in 2005.

Based on our testing, this technique offers distinct advantages for the Yukon fisheries management program. Compared to the existing Spring Littoral Index Netting (SLIN), SPIN is better able to track changes between years, has better representation of all lake trout habitats, and is not as time-sensitive. SPIN also provides estimates of lake trout population size, something that SLIN did not do. We can use these data to refine estimates of sustainable harvest and determine appropriate harvest levels.

The disadvantages of SPIN include a higher personnel cost and an inability to compare results with historic data. SPIN also has a higher mortality rate for lake trout (30%, compared with 10% for SLIN) and other species (average of 34% combined for lake and round whitefish and Arctic grayling, based on data from Pine, Lewes, and Fish lakes). We do not expect the increased mortality to cause effects at the population level. We will sample all fish mortalities thoroughly and use the information to better understand the population.

At this point, we need to test different fish communities in a wider range of lake sizes so we can verify the conclusions from our initial assessment. On a small number of lakes, we need an independent population estimate (for example, through mark-recapture) to confirm the SPIN-derived population estimates.

Key Findings

- SPIN is a better tool for assessing populations of lake trout than SLIN.
- Fish captured with SPIN will have higher rates of mortality than with SLIN, but the effects on populations remain low.
- SPIN appears to meet management needs more effectively than SLIN. Further testing is worthwhile.

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Background

Lake trout are the main target of lake fisheries. As a top aquatic predator, they are regarded as an effective indicator of the health of aquatic ecosystems. If lake trout stocks are healthy, stocks of other fish species, populations of other aquatic organisms, and the ecosystem overall are likely healthy. For these reasons, lake trout pose the greatest management challenge as a species and are the main management focus in Yukon's freshwater fisheries (Environment Yukon, 2010). However, the current method for monitoring lake trout in Yukon does not provide data we can use for robust and defensible management recommendations. Here we review this method and look at an alternate one.

Summer Profundal Index Netting (SPIN) is a relatively new method, developed by the Ontario Ministry of Natural Resources in 2005. It is intended to provide a reliable, robust, and efficient means of monitoring lake trout populations. It can be used to estimate the density and population size of "harvestable" lake trout (fork length of 30 cm and greater), and to track changes in the population.

To date, Environment Yukon fisheries management programs have largely relied on a technique that was based on a method called Spring Littoral Index Netting (SLIN, Lester *et al.* 1991). This method uses gill nets set near the lake shore (littoral zone) to track lake trout populations. The average number of fish caught within a standardized time period (one hour) is called catch per unit effort (CPUE). This value is used as an index of the number of fish in the lake – a measure of *relative* abundance. We can compare the SLIN CPUE results between years on one lake to see if there are more or fewer fish since the last survey. Under certain circumstances, comparison of CPUE between lakes can indicate if there are more fish in one lake than another. SLIN data cannot, however, tell us how many fish there are in a lake – the *absolute* abundance.

SLIN was designed as a way of quickly assessing many lakes each year so that each lake could be monitored every few years. However, we found that it is very difficult to use SLIN data to conclusively detect population changes. For example, take a hypothetical scenario where a SLIN survey is done on a small lake and 10 nets are set. In 2000, 15 fish are caught and the average CPUE is 1.5. When the study is done again in 2005, 10 fish are caught and the average CPUE is 1.0. The management question is whether the lake trout population dropped 50% over those five years or whether the difference in the number of fish caught (and in CPUE) was due to factors unrelated to the number of fish in the lake like weather or sampling error. By sampling error, we mean if the study had been done again under similar conditions, would we see the same result? If we are to be certain that a change in CPUE represents a real change in the population, the change in CPUE must be *statistically* different. With SLIN data, we had a difficult time reaching conclusions that were supported by statistics because we often caught very few fish, and we typically set few nets. In our hypothetical example, we would have great difficulty concluding that there was a real change in the fish population based on only 10 net sets.

Recent analyses of the Yukon SLIN data show that, in many cases, we can only draw strong statistical conclusions about very large changes in CPUE: more than +/- 50% change (Jessup 2009, 2011*a, b, c*). In other words, even if we saw a change in CPUE on the order of -30%, we could not be certain that the fish population had actually declined (i.e., there was no statistical difference). If we are only able to confidently detect very large declines, responsive management becomes very difficult.

With SPIN, in many cases we should be able to detect changes in the population index of 25% or less with 80% power. Power is the percent of the time we will detect a difference when the difference is real, and 80% is a common target for management purposes. Power is inherently related to sample size and effect size (the amount of difference); the more samples you have, the greater the power to detect smaller changes. The smaller the changes we can detect, the more timely and effective our management can be, whether it is education and communication or regulatory amendments.

Below we describe some of the key considerations for the use of SPIN in Yukon. These include the differences between SLIN and SPIN, the impacts of switching methods, and the results from the 2009 preliminary trial. Sandstrom and Lester (2009) give a full description of the SPIN method.

Differences between SLIN and SPIN methods

SLIN uses 69 m nylon gill nets made up of 3 panels of 38, 64, and 76 mm mesh sizes, set for 1 hour. SPIN uses 64 m monofilament gill nets made up of 8 panels of 57, 64, 70, 76, 89, 102, 114, and 127 mm mesh sizes, set for 2 hours. The combination of monofilament mesh, larger mesh sizes, and 2-hour net sets means that more fish are caught in a SPIN survey.

SLIN nets are set around the perimeter of the lake, in the near-shore (littoral) area. Nets are always oriented perpendicular to shore. Surveys must be performed close to ice-out in the spring because in the summer rising water temperatures push lake trout into deeper habitats. A major assumption of SLIN is that the number of lake trout using the shallow near-shore habitat during the survey period represents the population in the rest of the lake. This assumption has not been verified on Yukon lakes.

SPIN avoids this assumption by sampling throughout all depths of the lake. This method uses a random stratified sampling design with effort focused on the larger strata (by area) and on those strata where density of lake trout is highest. Fewer sets are done in strata where density is low. In Ontario, SPIN is normally done during the warmest period of the summer when lake trout are found in more restricted habitats (deeper water). However, since SPIN samples all depths, surveys can be done over a wider time period. Focusing effort on strata where lake trout are more prevalent reduces variation in catch, which in turn reduces variation in CPUE. The SPIN method also improves CPUE estimates by correcting for net selectivity (fish of a certain size are more likely to be caught by the nets than other fish) and weighting by stratum area.

The number of net sets required for SPIN varies by lake from a minimum of 24 to a maximum of 140. SLIN surveys used a target of 0.75 nets per square kilometer of lake surface area. On Yukon lakes this ranged from a minimum of 2 to a maximum of 434 sets. The number of SPIN sets required can be estimated before carrying out the survey. Once a survey is underway, this number can be modified depending on catch variability.

Like SLIN, SPIN produces an index of relative abundance (CPUE), but one which better represents population size and is more statistically robust (as discussed below). SPIN then goes one step further and produces an *absolute* estimate of population size. It converts lake-wide CPUE (i.e., number of fish per net) to lake-wide fish density (i.e., number of fish per hectare), which can then be converted to lake-wide abundance (i.e., number of hectares x fish / hectare = number of fish).

The conversion of CPUE to fish density is based on a relationship between CPUE and density established in Ontario. While this relationship may hold for Yukon lakes as well, we would need to validate it before basing strong conclusions on these results. Any differences in lake trout behaviour or catchability between Yukon and Ontario could alter the relationship, affecting the accuracy of density estimates. To verify the relationship in Yukon, independent estimates of population size, such as those obtained through mark-recapture studies are needed. We would need to carry out such studies on several Yukon lakes and compare the results to the SPIN-derived estimates.

Impacts of Changing Methods

Better population tracking: The main benefit of SPIN is that we can track changes in fish populations between years with greater certainty. Initial testing on Fish Lake in 2009 showed that, by using about 45 net sets, we could detect a change in CPUE of 25%, which is acceptable for management purposes.

Estimates of sustainable yield: The ability to measure population size will have important benefits. We may be able to use the actual numbers of fish to estimate a sustainable harvest level, in addition to relying on productivity estimates of the waterbody. Harvest estimates derived from angler surveys can then be compared directly to the estimated sustainable harvest. This information could be a core component of management decisions.

New baseline: Unfortunately, the status of populations measured with SPIN cannot be directly compared with previous SLIN data. However, the status of populations has always been difficult to track with SLIN because of poor statistical power. Switching to SPIN should not be seen as a loss, but rather as an opportunity to improve the baseline with statistically robust data for management decisions.

Higher mortality: SPIN surveys have higher mortality rates. Lake trout mortality from the Fish Lake SPIN survey in 2010 was 30%, compared with approximately 10% over 20 years of SLIN monitoring. Mortality of other species averaged a combined 34% for lake/round whitefish and Arctic grayling on Lewes, Fish, and Pine lakes (YG Unpublished data). Mortality of lake whitefish in Ontario has been as high as 75% or more (S. J. Sandstrom, personal communication, May 17, 2010).

The impact of mortality on the population remains small. This is because the number of fish that are captured and die is proportional to the number of fish in the population. If the population is small, very few fish will be caught during the study and even fewer will perish. We expect that increased mortality will not affect species at the population level and will be balanced by the increased value of the data we obtain. For example, on Fish Lake, mortality of trout was 30%, or 22 fish. In terms of sustainability, 22 lake trout represents 21 kg of harvest (average weight of 946 g), or only 2% of the current estimated annual sustainable yield for Fish Lake. When compared to the SPIN-derived population estimate of 55,833 (see below and remember the caveat about using these population estimates), 22 fish represents only 0.04% of the total population. The age and diet information derived from each fish that dies or is killed provides invaluable insight into the biology of the species.

In special circumstances (e.g., the presence of rare or imperiled species), we may be able to modify the method by sampling only in certain strata, or avoiding specific habitats (e.g., creek mouths). Effects may be unavoidable in some circumstances and SPIN may not be appropriate on rare occasions, but this does not detract from the potential benefits of the method as a whole.

Increased effort: For many small lakes, SPIN requires about two to three times the sample effort in person hours compared to SLIN (Table 1). Depending on available crew and resources, fewer lakes might be sampled per season. However, if we use a more focused sampling effort, the benefit of obtaining higher quality information will result in more effective management.

Because SPIN has an upper limit of 140 sets, it requires less effort on very large lakes. However, the performance of SPIN on lakes of this size with this number of sets still needs evaluation.

Table 1. Estimated number of sets and number of person days required for 2-person crews to complete SPIN and SLIN surveys on select Yukon lakes.

Lake	Surface Area (> 10m Deep)	Number of Sets		Number of Person Days	
		SPIN	SLIN	SPIN	SLIN
Teslin	35400 ha	140	276	24	46
Mayo	8547 ha	140	66	24	11
Kathleen	2908 ha	78	26	13	4
Fish	1386 ha	45	10	8	2
Pine	420 ha	32	10	5	2
Tarfu	211 ha	28	10	4	2
Lewes	84 ha	26	10	4	2

Results from Fish Lake, 2009

Testing of the SPIN method in Yukon began on Fish Lake on July 24 and 25, 2009. We set 31 nets in 4 different depth strata, and captured 62 lake trout (Figure 1). The lake-wide CPUE, weighted by lake area and gill net selectivity, was 2.14 (SD = 1.69) fish per set.

Using the CPUE-to-density conversion established in Ontario, the estimated lake-wide density of lake trout greater than 300 mm was 40.3 fish/ha. Expanding this by lake area results in a population estimate of 55,332 with a range of 41,994 to 69,573 (68% confidence interval). It is important to keep in mind that the relationship between CPUE and density has not been verified for Yukon lakes. For future surveys, we estimate we will need 45 sets to detect a 25% change in CPUE relative to the 2009 results.

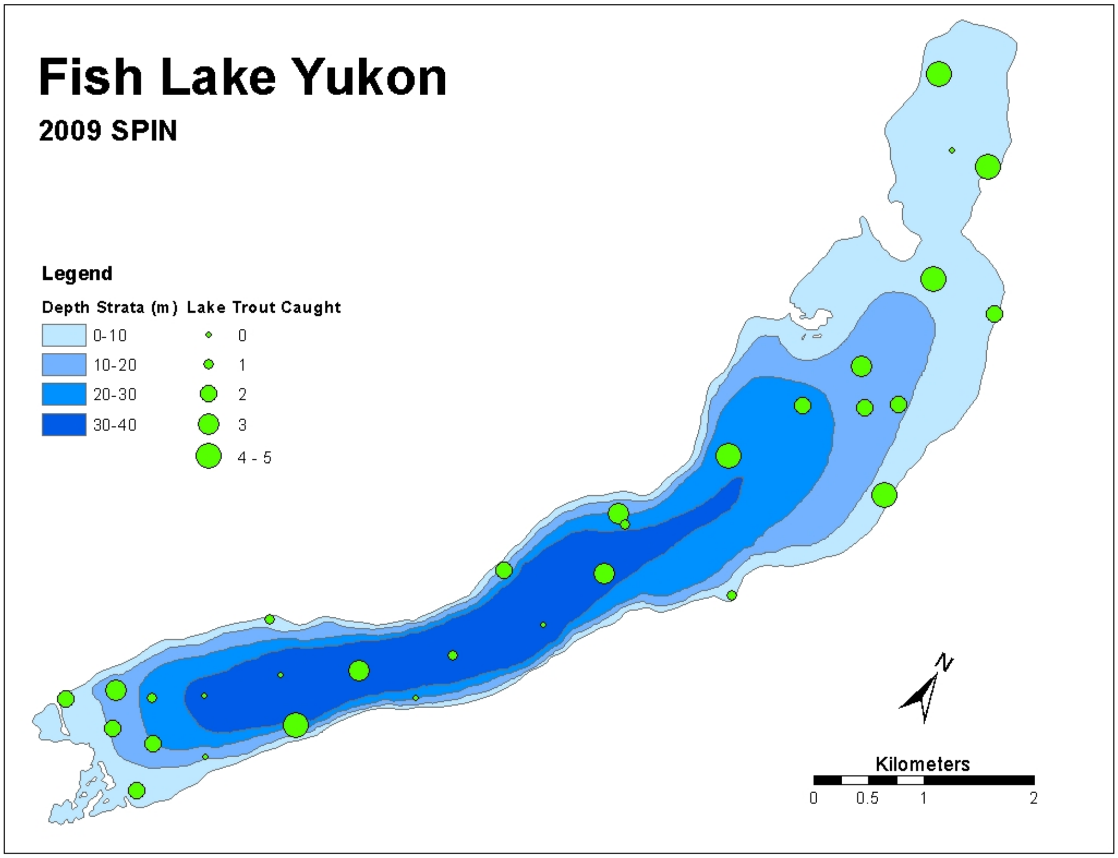

Figure 1. Bathymetric map of Fish Lake showing the number of lake trout caught at each set location.

Conclusions

SPIN is a more statistically robust method of tracking population changes than SLIN. Once the validation of the Ontario relationship between CPUE and density is complete, it will also provide an estimate of the number of lake trout in a lake (population size). This validation would be an ongoing part of adopting SPIN, but is not crucial to the success of the program. The main benefit of SPIN is the increased ability to detect changes between years. The ability to measure population size is an added future benefit which will eventually allow us to estimate sustainable harvest more accurately by comparing harvest estimates to the number of fish in the lake. Although SPIN is more time-intensive on smaller lakes, the increased value of the data is worth the effort. The broader available sampling period over the summer (June through August) also allows us to be more flexible in planning and completing surveys.

Advantages of SPIN:

- Tracks changes in lake trout populations with greater certainty (i.e., more statistically robust conclusions).
- Provides information on fish use in all habitats (i.e., not just the littoral zone).
- Is less time-sensitive; we can survey from June through August.
- Provides estimates of lake trout population size that could be used to estimate sustainable harvest.
- Results in improved information for making management decisions.

Disadvantages of SPIN:

- Requires more person hours (effort) for small lakes than SLIN.
- Does not allow us to compare data from SPIN to past data from SLIN.
- Increases mortality of fish caught, but because catch and mortality always scale with population size, the impacts to small populations will also be small.

Recommendations

1. Data from a SPIN surveys enable us to better meet fisheries management needs in Yukon compared to SLIN. We should test the method further on other Yukon lakes.
2. We should assess the effectiveness of SPIN across a range of lake sizes, including large lakes at the upper range of required sets.
3. We should adapt surveys when possible to offset the increased mortality of non-target species such as lake whitefish or Arctic grayling (for example, by avoiding creek mouths or shallow waters). We cannot avoid good lake trout habitat because it will bias and invalidate the results.
4. We should record and track mortality for all species. We will always obtain age structures, sex, maturity, and stomach contents from such mortalities. We should report the magnitude of the study's impact on the population. Where SPIN is expected to have a significant impact on the population, we should consider alternative methods.
5. We should use Yukon data to validate the relationship established in Ontario between CPUE and density. We are now carrying out a mark-recapture study on Fish Lake to obtain one data point in Yukon. We recommend mark-recapture studies on other Yukon lakes. It may take several years to get accurate mark-recapture

estimates on any given lake, depending on the size of populations and amount of captures possible. If we perform mark-recapture on small lakes, we should be able to minimize the amount of time and effort required. Even without density and absolute population size estimates, the use of SPIN improves our ability to detect changes in populations.

6. If the method continues to prove useful and appropriate, we recommend using SPIN as the Department's lake trout monitoring tool.

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