Results of a Summer Profundal Index Netting Survey Conducted on Livingstone Lake in 2009

File Report

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Livingstone Lake is located in Livingstone Township within the Bracebridge administrative area of the Parry Sound District of the Ministry of Natural Resources. It is approximately 197 hectares surface area, with a maximum depth of 37 meters and mean depth of 13 m. Water clarity is moderate, with a secchi depth reading of about 4 m. Access to the lake is available from an all season maintained municipal road (Livingstone Lake Road).

The primary native sport fish species was brook trout. Lake trout were not native to the lake. Lake trout were introduced in 1968 and stocked regularly until 1995 at which time stocking was discontinued due to the presence of a small proportion of naturally reproduced fish (Table 1). Smallmouth bass became established some time between the 1959 and 1971 surveys, probably through an intentional, but unauthorized introduction. Rainbow smelt were documented for the first time in 1978.

A number of fish community and population and habitat assessments have been conducted on Livingstone Lake including lake trout population assessments in 1978 (Chalk 1978) and 1997 (Thomas 1997), lake trout spawning observations in 1985 and a brook trout stocking assessment in 1992 (Dosser 1996). Temperature and dissolved oxygen profiles have been collected on a regular basis.

The 1992 stocking assessment caught no stocked brook trout, but nine natural brook trout were caught. As a result, stocking of brook trout was discontinued. This assessment also caught 6 lake trout and a large number of rainbow smelt (182).

The 1997 lake trout assessment used the Spring Littoral Index Netting (SLIN) protocol. The catch rate indicated a high abundance of lake trout, but 18 of the 21 lake trout caught were of hatchery origin. It was recommended that stocking could be continued, but the presence of some naturally reproduced fish prompted a decision to manage the lake for natural reproduction. Consistent with that management decision a slot size limit (limit of 2, none between 40-55 cm) was implemented with the Southern Region Natural Trout Strategy at about the same time.

A Summer Profundal Index Netting (SPIN) project was conducted on Livingstone Lake in 2009 to assess the status of the lake trout population 14 years after the cessation of lake trout stocking.

Methods

The SPIN protocol was followed (Sandstrom and Lester 2007). Gear consisted of gill net gangs comprised of 8 panels, each 8 m long. Mesh sizes were 57, 64, 70, 76, 89, 102, 114 and 127 mm stretched measurement (2.25, 2.5, 2.75, 3.0, 3.5, 4.0, 4.5 and 5.0 inch) with a random arrangement of mesh sizes.

Nets were set in the summer when the lake was thermally stratified. Nets were set for 2 hour periods. Effort was allocated, proportional to area, in depth strata of 6-10, 10-20, 20-30 and >30 m.

Captured fish were tallied by the net number and mesh size in which they were caught. Sport fish were sampled for length and weight. Scales and pectoral rays were collected for age determination. All other species were counted and measured for fork length only. All fish were released alive if possible. A fin punch was collected from brook and lake trout for possible genetic analysis.

Temperature-dissolved oxygen profiles were collected to determine the depths at which suitable lake trout habitat occurred.

Finally, lake bathymetry data was collected using a Garmin 430 GPSMap depth sounder.

Results

Netting occurred on July 29 and 30, 2009. At the time the lake was thermally stratified with the thermocline occurring between 6 and 10 m deep (Table 2, Figure 1). Suitable temperatures and dissolved oxygen levels for lake trout occurred from the thermocline to the deepest point of the lake. Weather was fair on both days.

A total of 19, 2-hour sets were completed; four in less than 10 m deep, eight in the 10-20 m stratum, four in 20-30 m and 3 greater than 30 m (Table 3, Figure 2). Some sets overlapped stratum boundaries.

A total of eight fish of three species were caught (Table 4); four lake trout, one brook trout and three white suckers. The lake trout were caught in the main basin in the 6-10 (1), 10-20 (1) and >30 m(2) depth strata. The brook trout was caught in the north basin. Three of the four lake trout were live released; one lake trout and the brook trout were dead in the nets.

Analysis of lake trout abundance was performed using the SPIN Support System (Figure 3). Raw catch data were corrected for net selectivity and weighted by the area of each depth stratum to obtain a mean catch rate of 0.25 fish/net set (S.D.= 0.53). Using the relationship between catch rate and density for populations where cisco are absent (small body conversion, Figure 4), yielded an estimate of 1.4 lake trout/ha (<300 mm FL) or a population estimate of 156 fish (68% CL = 0-383).

The lake trout ranged from 374 to 520 mm FL and 500 to 1450 g round weight (Table 5). Ages were determined to be 5, 6, 7 and 11 years old. All were of natural origin, as indicated by their age and the absence of any fin clips. The brook trout was 310 mm and also of natural origin.

An updated bathymetric map is shown in Figure 2.

Discussion

The two days of netting effort were sufficient to determine the status of the lake trout population. The standard error of the catch rate estimate was high but many more net sets would have been required to reduce it significantly or to increase the sample size of measured fish substantially.

The distribution of net sets was roughly proportional to the area in each stratum; all lake trout habitat was adequately sampled.

The SPIN protocol was designed specifically to assess lake trout populations but also samples species that use similar habitat. Smallmouth bass were not caught as they occupy the shallow, warmer water not sampled by this method. Rainbow smelt were not caught either. They are a cold water species and occupy the same habitat as lake trout but they are generally only vulnerable to the smallest of mesh sizes. The 1992 assessment, which caught a large number of smelt used mesh sizes of 25 to 64 mm; whereas the smallest mesh used in this survey was 57 mm. Smelt are probably still common in the lake.

Brook trout continue to persist in the lake in small numbers despite the presence of non-native smallmouth bass. It is likely that they originate largely from the major inflow, Livingstone Creek, which supports a resident brook trout population. No brook trout spawning habitat or spawning activity has been documented in the lake itself.

Livingstone Lake supports a modest population of naturally reproduced lake trout. There are probably only between 100 and 300 catchable-sized fish in the lake. Stocked trout, which

dominated the catch in 1978 and 1997 (Table 6) were absent from the catch in 2009, though a small number probably persist. The methods used in 2009 differed from 1997, but the abundance of naturally reproduced fish has not obviously increased in the absence of stocked fish, as was hoped.

The 1978 report found it surprising that the occurrence of natural fish was so low considering that the habitat for lake trout appears to be fairly good; that continues to be the case. The ability of a lake to support a natural lake trout population is largely dependent on the amount and quality of deep water habitat. Juvenile lake trout tend to occupy deeper waters than adults in order to avoid predation. However, if the area of deep water is limited, the level of dissolved oxygen in the deep waters is too low or water clarity is low, juveniles will be forced to live in shallower waters and be subject to predation by adults. In general, the larger the volume and area of water greater than 30 m deep, the higher the levels of dissolved oxygen and the greater the water clarity, the better will be recruitment of natural lake trout.

The size of the hypolimnion and oxygen concentrations for lake trout lakes in Parry Sound District are compared in Figure 5. Livingstone Lake is in about the centre of the range for lakes with natural populations and similar to lakes that have moderately productive populations such as Grass, Long and Camp Lake.

Water clarity in Livingstone Lake averages about 4 m; it is lightly stained from dissolved organic matter which originates from its' relatively large watershed. The clarity is the lowest of eight natural lake trout lakes of similar size and dissolved oxygen levels in Parry Sound District (Figure 6). The lower clarity may be contributing to the lower than expected abundance of natural lake trout.

Livingstone Lake, like many developed lake trout lakes in the area, has populations of non-native smallmouth bass and rainbow smelt. Both species can affect the productivity of lake trout populations through complex interactions between predators and prey (Vander Zanden et al. 2004). Bass divert much of the food produced in the shallow littoral areas from lake trout to themselves. Smelt are themselves food for lake trout, but can prey on young trout or compete with them for zooplankton prey.

The 1978 report suggested that the amount and quality of spawning habitat be investigated. Observations were done in 1985; habitat was described as being good, but no quantitative measurements were made and no fish were seen. In 1993, four lake trout were observed in one evening of observations. Additional night observations of spawning activity and documentation of the quality of habitat should be done. Depending on the results, there may be benefits to improving the habitat.

The small sample of measured lake trout precludes making detailed interpretations about the population structure. In the absence of a large bodied prey species such as cisco, the growth potential of the lake trout is limited, resulting in a typical 'small-bodied' population where fish mature at a relatively small size and seldom grow larger than 55 cm long and more than 1.5 kg in weight.

The fishing regulations that apply to Livingstone Lake are the standard slot size used on many lakes in Fisheries Management Zone 15; no lake trout between 40-55 cm. Only one line may be used when angling through the ice to try to reduce catch and release mortality. The current growth trajectory for Livingstone Lake trout results in most fish growing quickly into the slot but slow growth after maturity result in few growing larger than the slot size. Current angling effort for lake trout has not been quantified, but it is believed to be relatively low, largely due to the restrictive nature of the slot size.

There are two main management options, with variations, for the lake trout of Livingstone Lake. The lake could continue to be managed for a self-sustaining population. With this option supplemental stocking should not be done as it could interfere with the recruitment of naturally reproduced fish. The abundance of lake trout may not increase greatly from its present level and only a modest fishery could be supported. The current regulation is very restrictive and could be retained to maximize the abundance of the population or relaxed to achieve more of a balance between protecting the population and allowing harvest. An effort could be made to enhance spawning areas but the amount and quality of deep water nursery area may be more of a limiting factor for the productivity of the population. However, shoal enhancement is a relatively easy, low cost activity and may have benefits.

Alternatively, the lake trout population could be managed on a put-grow-take basis; stocked with no expectation of natural reproduction occurring. This is what was essentially occurring when the lake was being stocked previously. The previous SLIN survey showed that a relatively high abundance of lake trout could be attained and the 1985-1993 voluntary creel survey documented that a considerable amount fishing effort was being supported. In this scenario, the slot size limit would be removed and the zone-wide default season (Jan. 1 – Sep 30) or a year round open season, that is applied to many other stocked lakes, could be regulated. As the population in Livingstone Lake is introduced there is no genetic heritage value to protecting the reproducing population and the productivity of the population and value to society could be improved.

Historically, much lake trout stocking was considered supplemental; stocking to enhance abundance in a lake with a reproducing population. In many lakes though, the practice was essentially put-grow-take stocking as no special effort was being made to protect the native stock such as restricting harvest or stocking compatible genetic strains. Supplemental stocking is now generally discouraged because of its impact on native populations (Olver et al. 1991). A variation of put-grow-take stocking that uses a suitable genetic strain, possibly of local origin, may be a reasonable option for Livingstone Lake.

As a designated lake, the hypolimnetic dissolved oxygen criterion to protect lake trout habitat is applied to Livingstone Lake. If the long term mean volume-weighted hypolimnetic dissolved oxygen (MVWHDO) concentration is less than 7 ppm, or modelling predicts that the development of existing lots will cause it to fall to less than 7 ppm, MNR recommends to the municipality that no new development be permitted on the lake. That is currently the case for Livingstone Lake; although the long term average has been very close to the 7 ppm level. There is currently no distinction between natural and put-grow-take stocked lakes in how the criterion is applied. It is possible that in the future the two lakes types could be treated differently or that continued sampling indicates that additional development could occur.

In summary, Livingstone Lake currently supports a small, introduced, self-sustaining population of lake trout. Stocked lake trout, last planted in 1995, are now almost absent from the population. The deep water habitat for lake trout is fairly good and the lake is capable of supporting a modest self-sustaining population. There may be opportunities to enhance spawning areas for lake trout, though efforts may not translate into adult population improvements because of the limitations of juvenile habitat. Resumption of lake trout stocking would increase the abundance of lake trout and its ability to support a fishery; though possibly at the sacrifice of the natural reproduction that currently occurs. A change from a ‘natural’ to a put-grow-take’ designation does not currently, but potentially has implications for how policies to protect lake trout habitat are applied; specifically shoreline development restrictions to protect hypolimnetic oxygen levels.

References

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Vander Zanden, M.J, K. A. Wilson, J.M. Casselman and N.D. Yan. 2004. Species introductions and their impacts on North American Shield lakes, in *Boreal Shield Watersheds: Lake Trout Ecosystems in a Changing Environment*, Gunn, J.M., Steedman, R.J. and Ryder, R.A. Eds., Lewis Publishers, Boca Raton, FL, Chap. 14.

Table 1 Stocking history of Livingstone Lake, 1968 to present.

Year	Species	Strain	Age	Number	Fin Clip
1983	Brook Trout		Sub-adults	300	NC
1986	Brook Trout			100	NC
1991	Brook Trout	Hills Lake	Yearling	500	RP
1968	Lake Trout		Yearling	4000	AD
1971	Lake Trout		Yearling	5000	RP
1972	Lake Trout		Yearling	5800	
1973	Lake Trout		Yearling	5800	AD
1974	Lake Trout	Lake Manitou	Yearling	5500	LV
1976	Lake Trout	Lake Manitou	Yearling	5800	RV
1979	Lake Trout	Lake Superior	Yearling	5800	LV
1980	Lake Trout	Lake Superior	Yearling	5450	NC
1982	Lake Trout	Lake Manitou	Yearling	4000	RP/RV
1983	Lake Trout	Lake Manitou	Yearling	1800	AD
1984	Lake Trout	Lake Manitou	Yearling	5800	LV
1985	Lake Trout	Killala Lake	Yearling	3800	LP
1989	Lake Trout	Killala Lake	Yearling	3000	LP
1991	Lake Trout	Killala Lake	Yearling	3400	RV
1995	Lake Trout	Killala Lake	Yearling	2000	LP

Table 2 Temperature and dissolved oxygen profile, Livingstone Lake, July 29, 2009.

Depth (m)	Temp (^{o}C)	D.O. (ppm)
0	21.3	8.3
1	21.3	8.5
2	21.3	8.5
3	21.2	8.5
4	21.2	8.6
5	20.1	8.7
6	18.1	8.9
7	14.4	8.5
8	12.6	7.9
9	10.6	8.2
10	9.4	8.3
11	8.9	8.4
12	8.1	8.6
13	6.9	9.0
14	6.6	9.1
16	6.1	9.3
18	5.8	9.2
20	5.5	9.2
22	5.3	8.9
24	5.1	8.8
26	5.0	8.5
28	4.9	8.4
29	4.9	8.1

Table 3 Net set summary, Livingstone Lake SPIN, 2009.

Net Set	Date	Depth (min)	Depth (max.)	Set Time	Lift Time	UTM East	UTM North
1	29-Jul-09	11	18	10:25	12:25	678768	5025819
2	29-Jul-09	7	10	11:02	13:01	678320	5025468
3	29-Jul-09	23	23	11:31	13:40	678971	5025173
4	29-Jul-09	31	32	11:58	14:00	678521	5024871
5	29-Jul-09	10	14	12:18	14:20	678761	5024820
6	29-Jul-09	21	16	12:55	14:54	678250	5025039
7	29-Jul-09	8	6	13:34	15:34	679100	5025951
8	29-Jul-09	23	28	13:54	15:33	678566	5025540
9	29-Jul-09	36	36	14:09	16:09	678783	5025252
10	30-Jul-09	8	18	10:12	12:18	678630	5026479
11	30-Jul-09	11	18	10:32	12:45	679097	5025661
12	30-Jul-09	25	32	11:00	13:03	678445	5025031
13	30-Jul-09	7	15	11:28	13:38	679150	5025153
14	30-Jul-09	11	18	11:55	14:00	678450	5025493
15	30-Jul-09	31	35	12:14	14:17	678827	5025456
16	30-Jul-09	11	19	12:45	14:45	678775	5025813
17	30-Jul-09	12	20	13:00	15:00	678811	5024885
18	30-Jul-09	21	23	13:38	15:40	679105	5025333
19	30-Jul-09	9	8	13:55	15:56	678642	5024605

Table 4 Catch summary, Livingstone Lake SPIN, 2009.

Net Set	brook trout	lake trout	white sucker
1		1	
2		1	1
3			
4			
5			
6			
7			
8			
9			
10	1		
11			
12		2	
13			1
14			
15			
16			
17			
18			
19			1
Total	1	4	3

Table 5 Biological characteristics of fish caught in Livingstone Lake SPIN, 2009.

Species	Fish	Fork Length (mm)	Total Length (mm)	Round Weight (g)	Sex	Maturity	Age
brook trout	4	310	320	360	F	unk	
lake trout	1	482	529				6
lake trout	3	508	552	1100	F	mat	11
lake trout	5	520	574	1450			7
lake trout	6	374	415	500			5
white sucker	2	450					
white sucker	7	473					
white sucker	8	425					

Table 6 Biological characteristics of fish caught in Livingstone Lake SLIN, 1997.

Fish	Fork Length (mm)	Total Length (mm)	Round Weight (g)	Clip	Age
20	315	346	340	RV	6
18	335	370	480	LP	8
8	347	379	560	RV	6
19	353	386	590	RV	6
10	364	400	720	RV	6
11	383	424	660	RV	6
12	390	430	730	RV	6
17	392	432	780	RV	6
21	400	439	840	RV	6
15	411	454	980	RV	6
9	420	462	1030	RV	6
5	429	470	1050	RV	6
13	435	475	1000	RV	6
14	441	488	1140	RV	6
1	445	486	1125	RV	6
6	456	502	1390	RV	6
7	458	499	1300	RV	6
16	500	554	1610	none	9
4	510	565	1810	none	9
2	515	570	1460	none	8
3	595	650	2450	LV	9

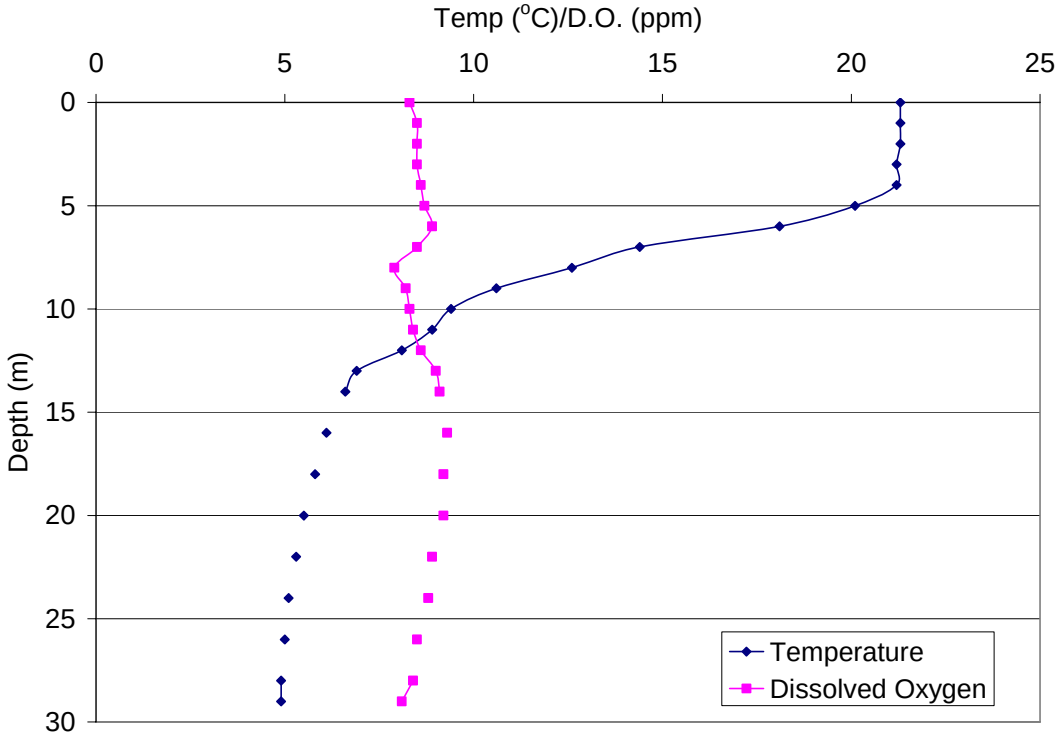


Figure 1 Temperature and dissolved oxygen profile, Livingstone Lake, July 29, 2009.

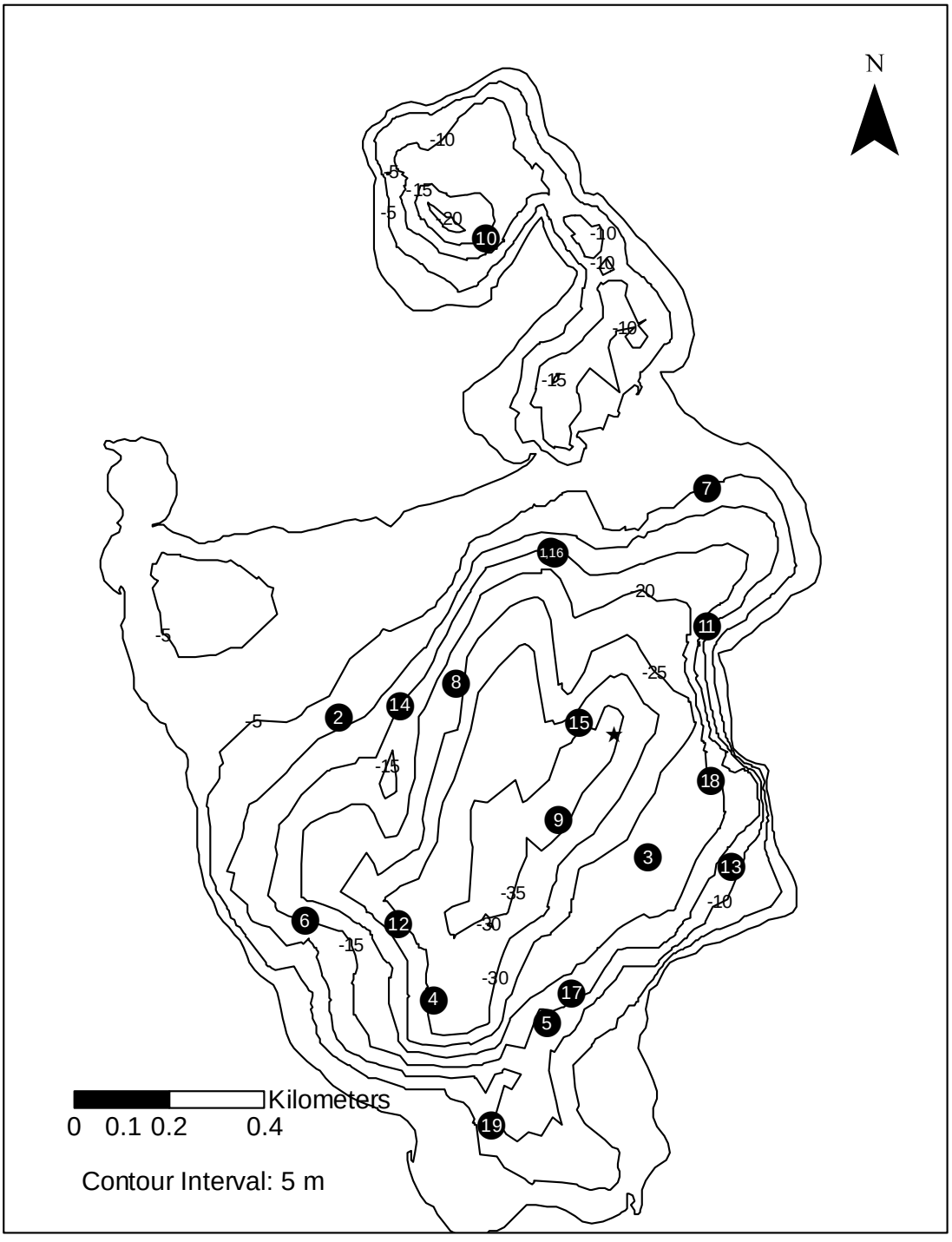


Figure 2 Map of Livingstone Lake showing SPIN net set (circles) and water chemistry station (star), 2009. Contour interval: 5 m.

SUMMER PROFUNDAL INDEX NETTING REPORT

Lake: Livingstone | Office: Bracebridge | Target Sp: Lake Trout | SPIN

Date: 2009 (Year) 7 (Month) | Total Area: | Sampled Area: 113 | TDS:

Using Large Body Conversion

Area Wt. Selectivity Adj Values	Total Catch	Arith CUE	Arith Stdev	Arth RSE
Lake Trout >=300 and <=1500mm	4	0.25	0.53	0.49

Density (ha)	Pop Est	Low Est	Upper Est	Pred. Level
1.4	156	0	383	68%

Sel. Corr. Length Summary (mm)

	Mean	Std
Total Catch	452	64
For LT >300	452	64

Stratum Info	Sites #	Total # Nets	% Sites	% Samp Area	Tot Catch #	Tot Catch %	Mean CUE	Std	RSE
Stratum 1 (8-10m)	3	3	16%	12%	1	24%	0.34	0.59	1.00
Stratum 2 (10-20m)	9	9	47%	40%	1	24%	0.11	0.34	1.00
Stratum 3 (20-30m)	4	4	21%	29%	2	52%	0.55	1.11	1.00
Stratum 4 (30-40m)	3	3	16%	19%	0		0.00	0.00	
Stratum 5 (40-60m)	0	0			0				
Stratum 6 (60-80m)	0	0			0				
Stratum 7 (80+m)	0	0			0				
Total	19	19	100%	100%	4	100%			
				actual	4				

No. of Sets Next Day	
Stratum 1	1
Stratum 2	2
Stratum 3	6
Stratum 4	1
Stratum 5	
Stratum 6	
Stratum 7	

Total Biomass >300mm: 1.4 kg/ha opt

Target Annual Harvest Rate: 0.28 kg/ha opt

Acceptable Harvest No.: < 0 LT >300mm

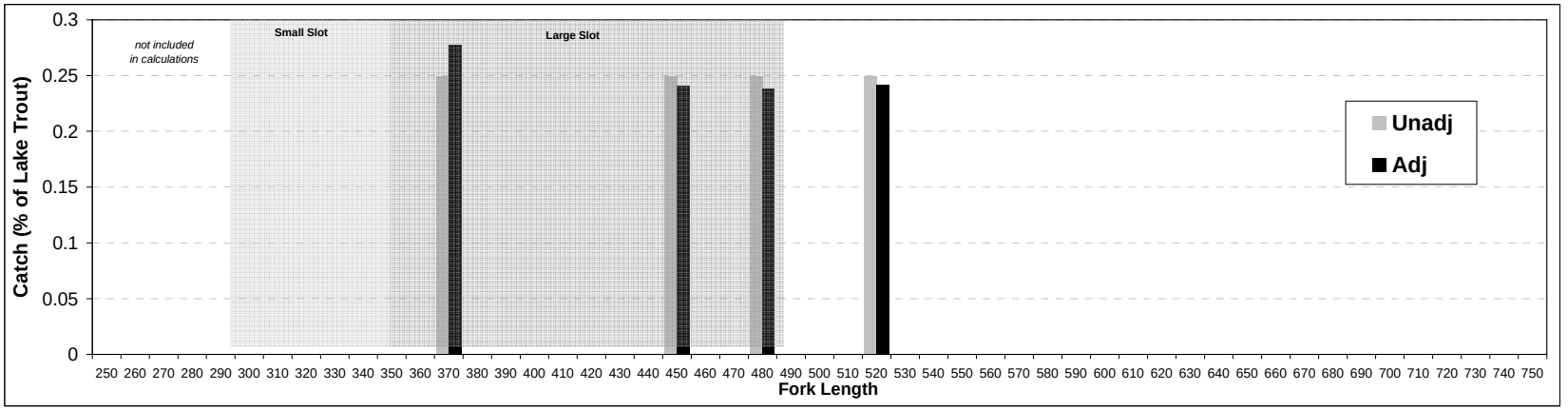
Previous Arith Mean:
Previous Arith Stdev:
Previous n=:

p-Value:
Previous Mean,Stdev, n= not specified

Power Observed:

Power Desired: 80%
Change Detectable: 20%
Sets Required (n=): 515

Thermocline(top): n/a m
Thermocline(bottom): 0 m



% zero S1	67%
% zero S2	89%
% zero S3	75%
% zero S4	100%
% zero S5	
% zero S6	
% zero S7	
Area Wt % zero	84%

Report generated with SPIN SUPPORT SYSTEMS (ver 8.7build)

Print Date 10/03/2010

Figure 3 Summer Profundal Index Netting report (S. Sandstrom, Muskoka Lakes FAU).

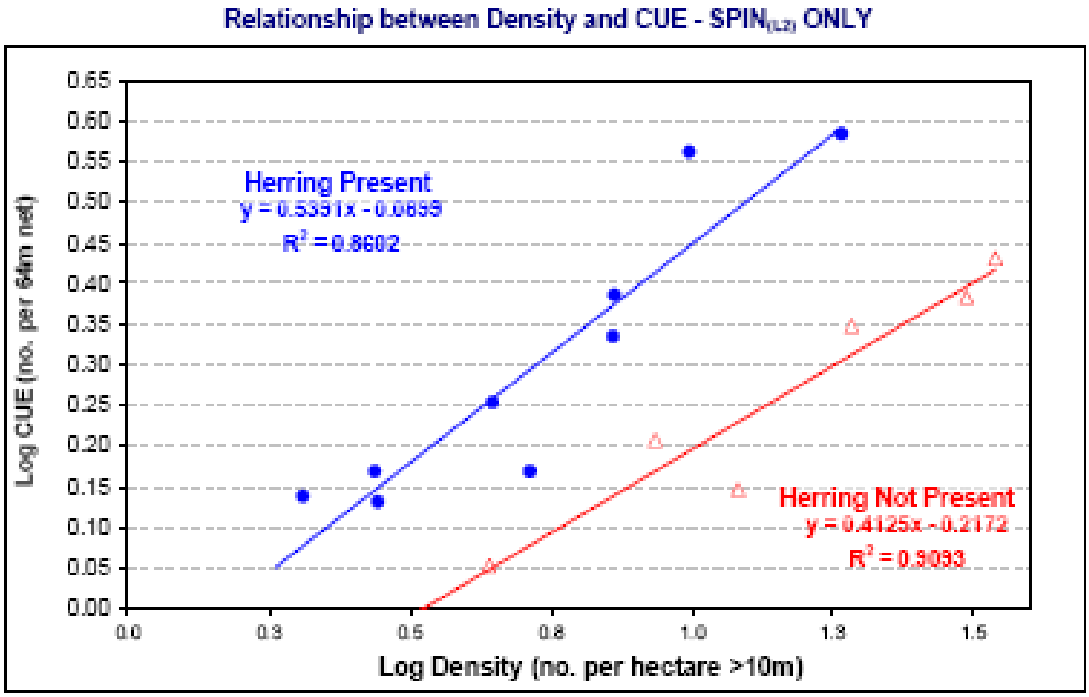


Figure 4 Relationship between SPIN catch rate and estimated lake trout density (Sandstrom and Lester 2007).

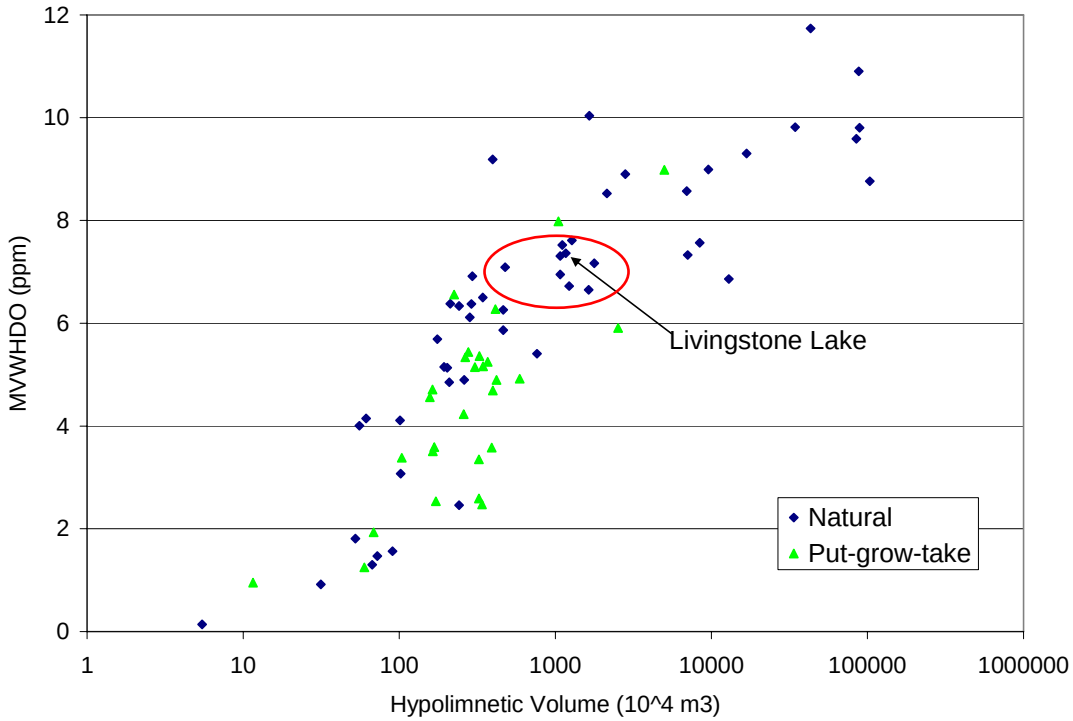


Figure 5 Relationship between hypolimnetic volume and mean volume-weighted hyplimnetic dissolved oxygen (MVWHDO) levels in lake trout lakes in Parry Sound District. 'Natural' lakes are managed for natural reproduction. "Put-grow-take' lakes are stocked with no expectation of natural reproduction.

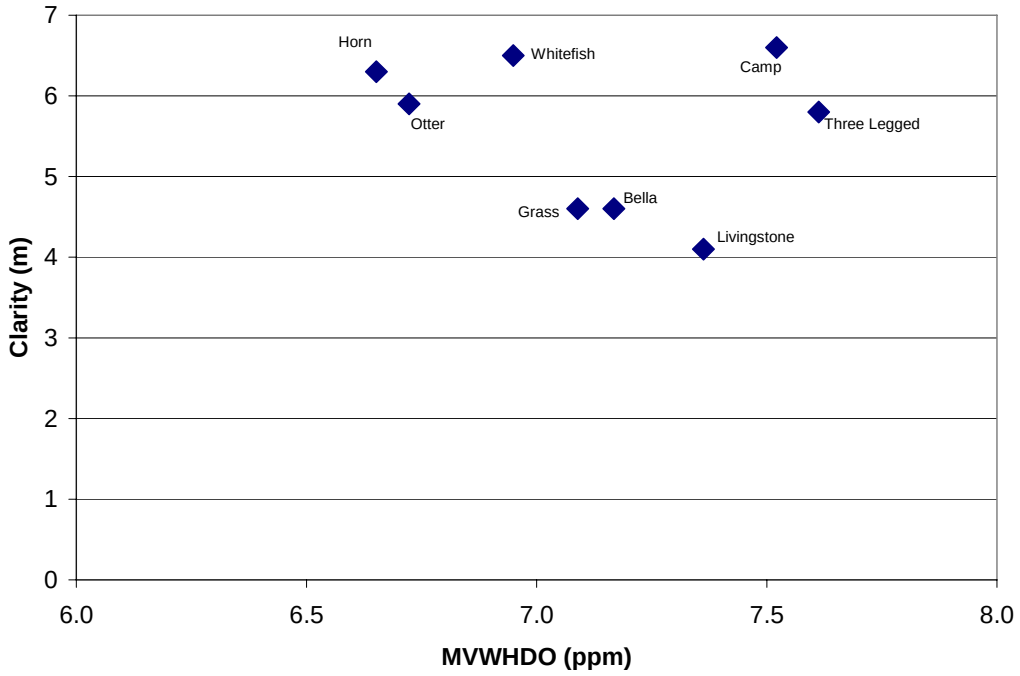


Figure 6 Comparison of hypolimnetic dissolved oxygen and water clarity for lakes circled in Figure 5. Source of water clarity data is District Municipality of Muskoka and MOE Lake Partner Program.