Lakelse Lake
Hydroacoustic Survey
2013

Prepared for the Department of Fisheries and Oceans Canada (DFO) by:
Janvier Doire

May 2014

Skeena Fisheries Commission
3135 Barnes Crescent
Kispiox, BC V0J 1Y4

ABSTRACT

Skeena Fisheries Commission (SFC) conducted a hydroacoustic survey of Lakelse Lake in August 2013. The main objective of the survey was to enumerate and sample the sockeye fry population in Lakelse Lake. The results of the survey are contained in this report.

Hydroacoustic sampling was conducted using a DT-X echosounder with a downward-pointing split-beam 200 kHz transducer. Fish samples were captured with a mid-water trawl. The trawl sample was used to determine the species composition of the pelagic "small" size fish.

The 2013 hydroacoustic estimate of the juvenile sockeye population at Lakelse Lake appears to be similar to the 2012 hydroacoustic estimate, but significantly higher than hydroacoustic estimates generated in pre-2012 surveys of the same lake. The increases in the juvenile sockeye population at Lakelse Lake in 2012 and 2013 are most likely the result of strong sockeye returns to Lakelse Lake in 2011 and 2012. Even though the juvenile sockeye population appears to have increased at Lakelse Lake, it is still below the lake's rearing capacity.

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INTRODUCTION

The Skeena Fisheries Commission (SFC) has conducted mobile hydroacoustic surveys in small lakes throughout the Skeena Watershed since 2005. Data of fall fry abundance obtained by hydroacoustic techniques for sockeye in their critical rearing habitat can be directly compared to lake productivity potential (Cox-Rogers et. al 2004) to provide an unbiased estimate of the status of the sampled conservation unit.

During early August of 2013, the SFC conducted a hydroacoustic survey of Lakelse Lake (Figure 1). The main objectives of this survey were to estimate the sockeye population size and the relative proportions of juvenile sockeye and competitor limnetic species of Lakelse Lake.

Lakelse Lake is the source of the Lakelse River, a fifth order tributary of the lower Skeena River that drains a watershed area of approximately 589 km^2. The surface area of the lake is approximately 1,360 ha with a volume of 1.15×10^8 m^3 (Table 1). The average depth of the lake is 8.5 m and the maximum depth is approximately 32 m. The southwest basin of the lake is an extensive littoral area that encompasses 42% (571 ha) of the surface area of the lake (Gottesfeld & Rabnett 2008). SFC has conducted annual hydroacoustic surveys of Lakelse Lake since 2006. Lakelse Lake is the warmest lake in the Skeena Watershed and is considered to be a very productive system. Sockeye escapement to Lakelse Lake tributaries has been depressed since the 1990s, but appears to have improved somewhat in the past two years. The estimated sockeye escapement to Lakelse tributaries in 2012 was over 10,700 spawners (Fisheries and Oceans Canada, 2013), which is lower than the 2011 escapement of over 16,000, but higher than the previous decadal (average of 2,265 (Fisheries and Oceans Canada 2012).

The species "*Oncorhynchus nerka*" may include both anadromous (sockeye) and nonanadromous forms (kokanee) in all lakes surveyed. Separation of the two forms was not conducted as part of this study. In this report they will be referred to as "*O. nerka*".

Table 1. Physical characteristics of Lakelse Lake

Lake	Watershed	Elevation (m)	Average Depth (m)	Maximum Depth (m)	Surface Area (ha)	Clarity
Lakelse	Lakelse	77	9	32	1360	Clear

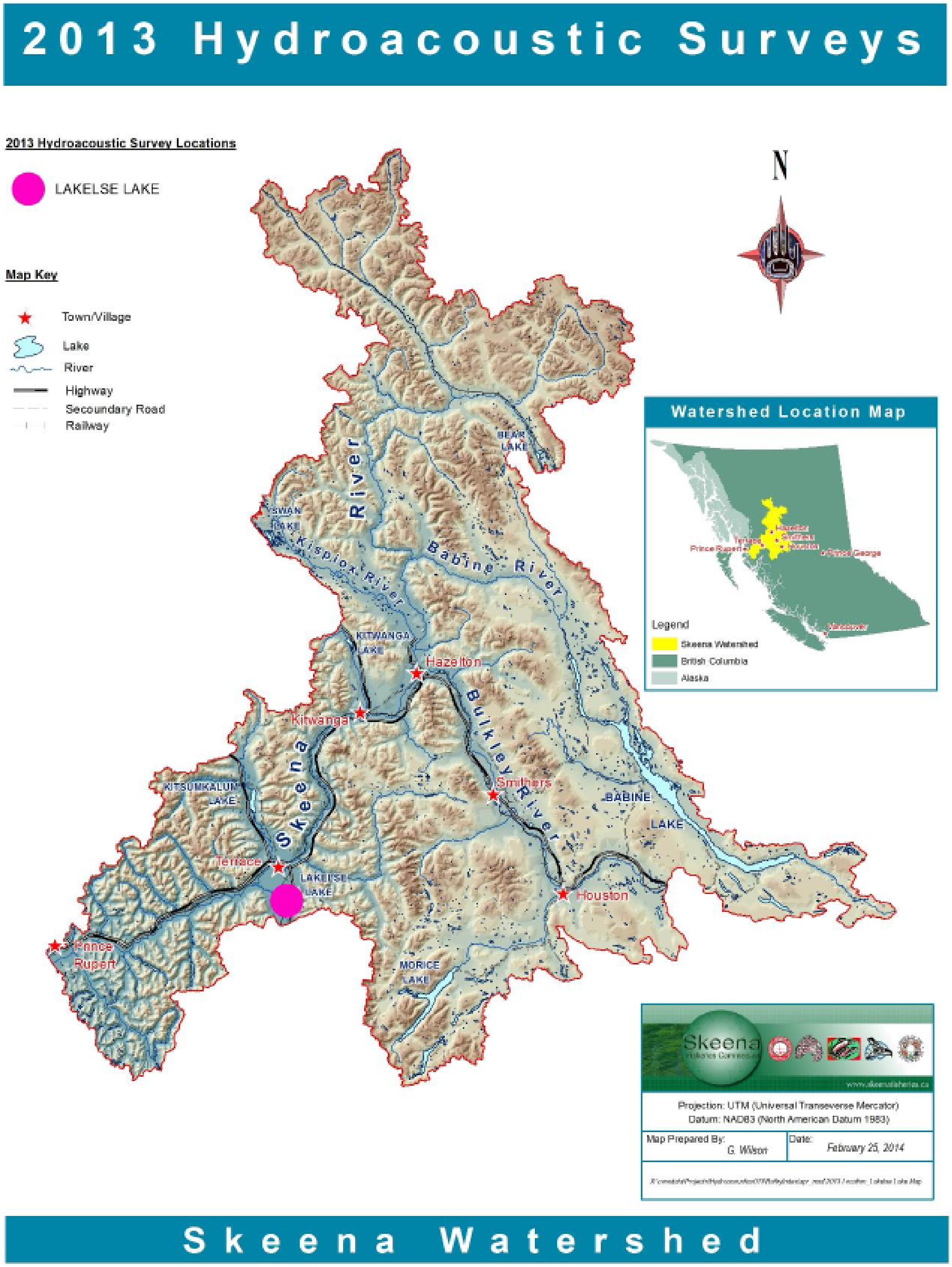

Figure 1. Location of Lakelse Lake in the Skeena watershed

METHODS

Hydroacoustic Survey

The Lakelse Lake hydroacoustic survey was conducted using similar methods and technology as in previous hydroacoustic surveys (Hall 2007, Hall and Carr-Harris 2008, MacLellan and Hume 2010 and Parker-Stetter *et. al.* 2009). Transects were sampled using a Biosonics DT-X echosounder with a 200 kHz split-beam transducer producing a 6 degree beam. The single downward-pointing transducer was pole-mounted to our inflatable vessel, a Bombard Commando C-5 (Figure 2). Hydroacoustic data were collected to an acoustic threshold of -100 dB using Biosonics Visual Acquisition software as the vessel proceeded along transects at a constant speed of 0.7 m/sec.

Figure 2. Photo of the inflatable vessel with the hydroacoustic gear.

The hydroacoustic survey at Lakelse Lake was conducted along transects that were established by the SFC in 2007 (Hall & Carr-Harris 2008) (Figure 3). These include seven transects in the north basin, and one transect in the south basin of the lake, however the data from the south basin transect was not analyzed as Hume and MacLellan (2008) showed *O.nerka* did not use the southern basin. The results of previous studies by Hall (2007), Hall and Carr-Harris (2008), and Carr-Harris (2009, 2011, and 2012) also suggest that *O.nerka* did not occupy the shallow southern basin of Lakelse Lake. Hydroacoustic estimates for the north basin of Lakelse Lake are based on depth layer volumes that were calculated using bathymetric data collected during SFC's 2007 Lakelse Lake hydroacoustic survey (Hall & Carr-Harris 2008).

The hydroacoustic system was calibrated prior to the survey by suspending a standard tungsten carbide sphere (36 mm diameter) in the acoustic beam. The observed target strength was compared to the predicted target strength at that temperature for the standard target. The difference between the observed and predicted target strength produced a calibration offset, which would be applied prior to post-processing of the data.

Hydroacoustic data analysis

Post-processing of hydroacoustic data was performed using Echoview software (v. 5.4.93). Data analysis was conducted using the same methodology as in previous years (Hall & Carr-Harris 2008, Hall 2007). Acoustic targets below -65 decibels were eliminated from analysis using the Parker-Stetter (2009) method of linking the Sv threshold to a TS threshold of -71 decibels, in order to include off-axis sub-threshold targets that would exceed the -65 threshold once compensation for their position is applied by the ST, or single target detection algorithm.

Following the general guidelines of MacLellan and Hume 2010, population estimates were calculated using the integration estimation method for down-looking acoustic data only because the estimated fish densities was above 500 fish/ha. The integration method integrates the average acoustic energy from the Sv output for each depth layer by the average target strength volumetric fish density for the stratum (n/m^3).

Primary analysis outputs from Echoview were processed in Excel (2010) to calculate estimates of total age-0 *O.nerka* for Lakelse Lake. Population estimation procedures were consistent with a stratified systematic transects sampling technique described and used by MacLennan and Hume (2010). The north basin of Lakelse Lake was separated into two distinct sections: one shallow section represented by transects 0.7, 4.2, and 4.8, and one deep section represented by transects 1.4, 2.1, 2.6, and 3.4.

Data from each transects were analyzed in 2m depth layers. The volumetric densities calculated for each transect layer are multiplied by the layer volume of the lake area represented by that transect to produce a transect layer population estimate. Transect estimates are produced from the sum of layer population estimates. Transect densities in a lake section were averaged to provide an estimate of density relative to surface area (n/ha) for the section. The mean density was then multiplied by the surface area of the section to provide a population estimate for the section. The section population estimates were summed to provide a total population estimate for the whole lake. Mean lake density was calculated by dividing the lake population estimate by the surface area of the northern section of Lakelse Lake (631 ha).

The fish estimates were divided into “small” and “large” fish based on the distribution of target strengths from each transect and each layer. "Small" fish were classified as fish with target strengths between –64 and –46 dB. This target strength is approximately equivalent to salmoniform fish <135 mm in length, based on Love (1977) 45^{o} aspect formula. Small fish were apportioned into “*O. nerka*” and “other small fish” based on the relative proportion of species in the trawl and gillnet catch.

Variances for fish densities and population estimates for both sections were calculated independently by using each transects within both sections as a separate sample. The variances for both sections were then weighted by the square of the section area. The sum of the weighted variances was divided by the square of the lake area to provide a variance for the lake population estimate.

Fish Sampling

Pelagic fish were sampled using a 2 x 2 m midwater trawl, which was deployed to a maximum depth of 21 m. The net was towed behind the boat at a constant speed of approximately 1m/s, and retrieved with a portable winch. The depth of each tow varied according to the length of the line that was deployed, which was calibrated and marked prior to sampling. Small fish were sorted by species and stored in 10% formaldehyde, and weighed and measured after at least 30 days of preservation. Scales were removed and inspected under a compound microscope to determine the age of salmonids.

Temperature and Dissolved Oxygen

Temperature and dissolved oxygen data were collected at all lakes using a hand held YSI meter (model 85) with a maximum cable length of 30 m. The YSI meter was calibrated to the nearest 100’ elevation and allowed to stabilize for at least 15 minutes before data were recorded.

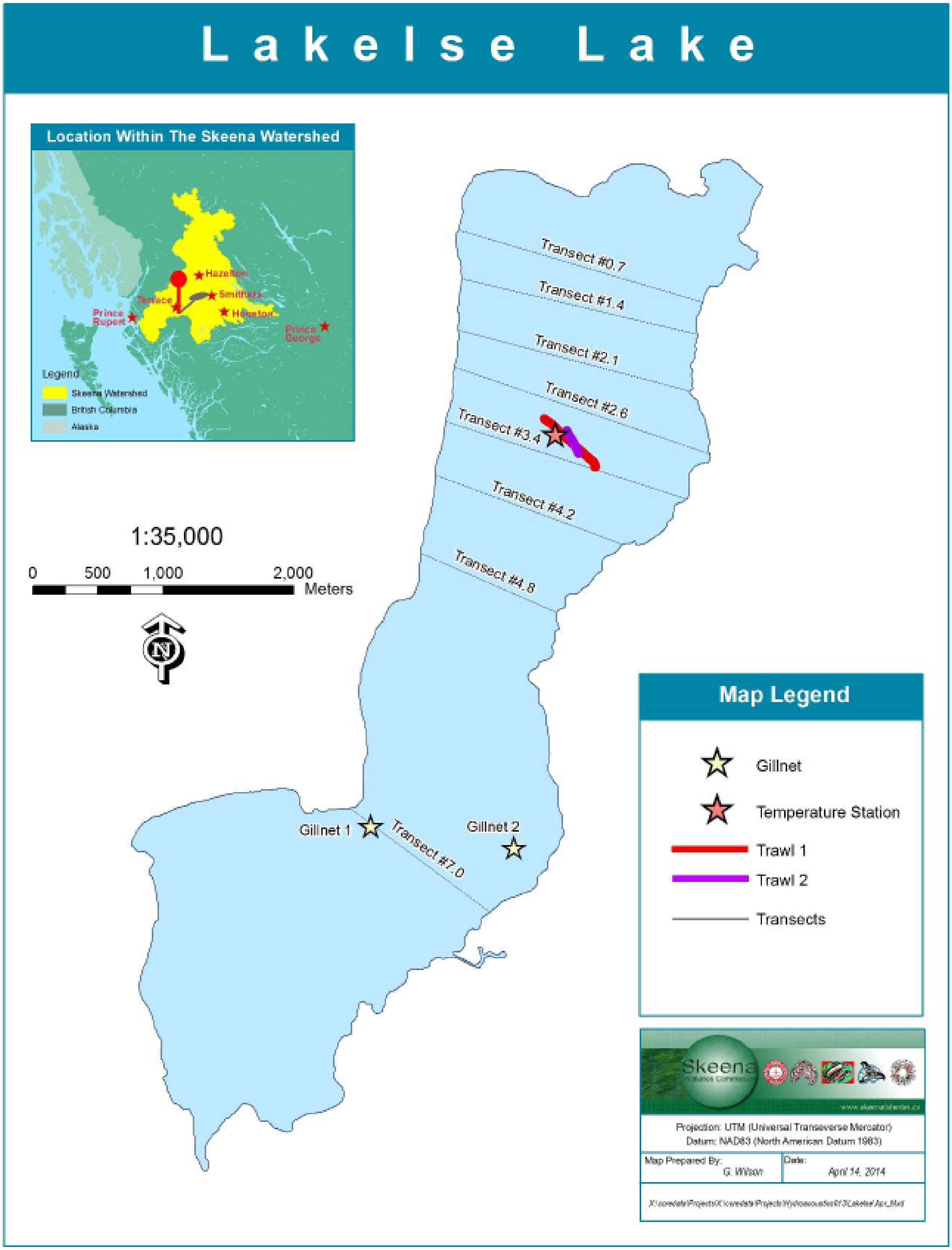

Figure 3. Lakelse Lake survey map

RESULTS AND DISCUSSION

Lakelse Lake was surveyed on the night of August 8, 2013. The surface temperature was 21.4ºC degrees, with a gradual decline to 21.1 ºC at 8 m, and a thermocline between 8 and 18 m with another gradual decline to a hypolimnion of 10.5 ºC below 20 m (Figure 5).

We captured 173 *O. nerka* during two trawl tows with a combined length of about 0.75 km (Figures 3, 4 and Table 2). The average length of *O. nerka* fry captured by trawl was 55.4 mm, with an average weight of 1.8 grams (Table 3). All of the *O. nerka* fry were age-0, or young of the year fry, and were all of wild origin (adipose fin present).

Most fish targets were found below 14 m depth in the water column, with peak densities occurring at 18 to 24m depth (Figures 6 and 7). The highest densities of fish targets were found in the deepest section of the lake, along Transects 3.4, 2.6, and 2.1. The total age-0 *O.nerka* population for Lakelse Lake in 2013 is estimated at approximately 1.15 x 10^6 ± 26.9%, calculated using the integration method (Table **4**). The high fish density prevented data analyses using the single target (ST) and tracked target (TT) methods. The total age-0 *O.nerka* biomass was estimated at 2,066 kg (Table 5).

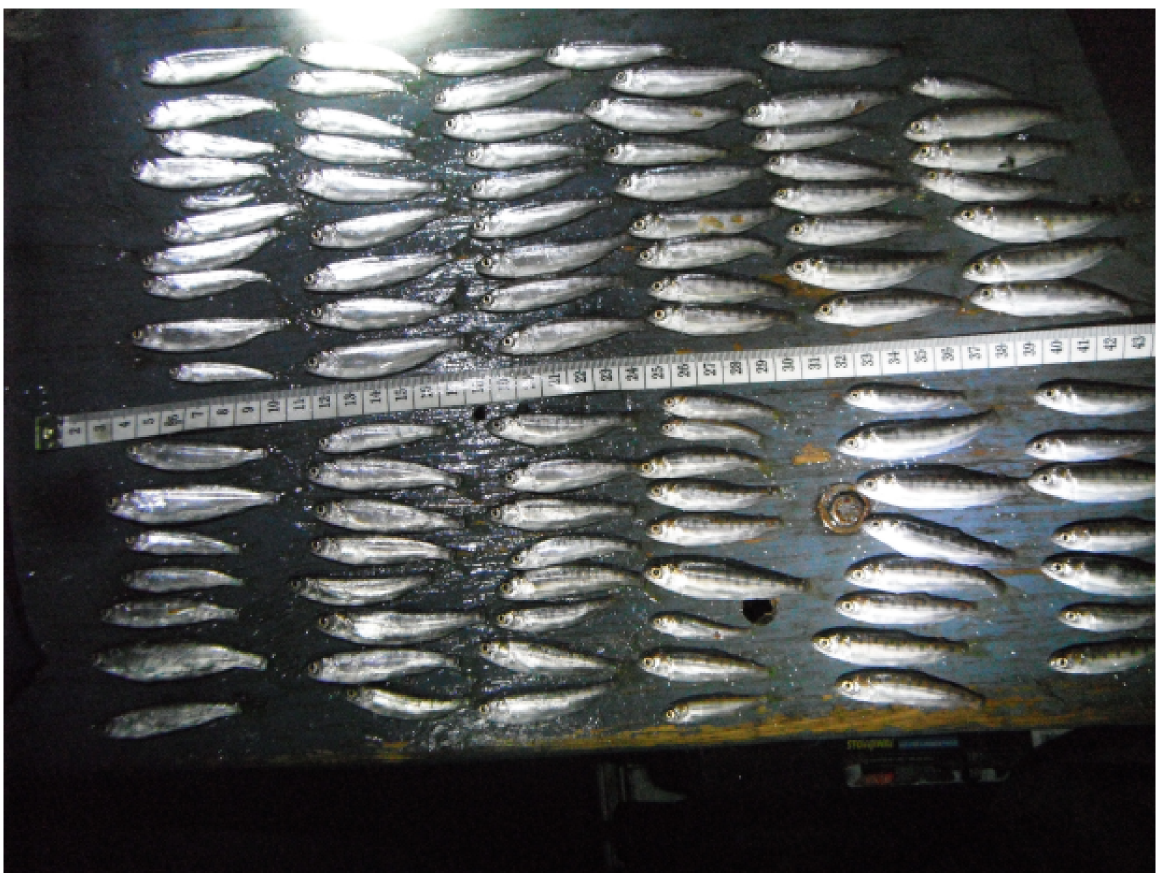

Figure 4. Photo of juvenile sockeye caught in the second trawl tow at Lakelse Lake. August 9, 2013.

The PR capacity model (Cox-Rogers et. al 2004) provides a benchmark that can be used to compare an observed sockeye fry biomass with the rearing capacity of a given lake. According to the PR capacity model, the biomass of *O. nerka* fry observed during the 2013 hydroacoustic survey represents 17% of the adjusted rearing capacity, or R_{max}, calculated by Shortreed *et al.* (2007) at Lakelse Lake (Table 5).

The 2013 Lakelse Lake sockeye fry population estimate is comparable to the hydroacoustic estimate calculated in 2012, though the 2013 age 0 *O.*nerka biomass estimate is somewhat smaller than the 2012 age-0 *O.nerka* biomass estimate (2,066 kg vs 2,578 kg). With the exception of the 2012 survey, the 2013 Lakelse Lake sockeye fry population estimate is significantly higher than the estimates from other hydroacoustic surveys undertaken since 2003 at Lakelse Lake (Table 6). This significant increase in the abundance of age-0 *O. nerka* in 2012 and 2013 is most likely the result of the strong sockeye returns to Lakelse Lake in 2011, and 2012.

DFO released approximately 291,350 hatchery sockeye fry in Lakelse Lake in the spring of 2013. No age-0 *O.nerka* from hatchery origin were caught during the 2013 survey even though 173 age-0 *O.nerka* were caught and examined for the presence of adipose fin. During the 2012 survey, 65 age-0 *O.nerka* were also caught and examined for adipose fin. No hatchery origin *O.nerka* were found during the 2012 hydroacoustic survey at Lakelse Lake (Doire, 2013) following the release of 303,400 hatchery sockeye fry into the lake in the spring of 2012. It is possible that hatchery origin *O.nerka* in Lakelse Lake are significantly bigger and faster than the wild origin *O.nerka,* and may be more effective at avoiding the trawl net.

CONCLUSION

Hydroacoustic surveys allow us to gauge trends in juvenile sockeye populations in lakes that represent ongoing or potential conservation concerns. Regular hydroacoustic surveys provide a baseline that we can use to compare estimates across years. Where escapement is known, hydroacoustic data provides an indicator of freshwater survival.

The 2013 juvenile sockeye population estimate at Lakelse Lake appears to be comparable to the 2012 results, and significantly higher than other hydroacoustic estimates generated in surveys of the same lake undertaken since 2003 (Table 6). The increases observed are likely the result of the strong sockeye return observed in 2011, and 2012. Even though the juvenile sockeye population appears to have increased at Lakelse Lake, it is still well below the rearing capacity. The portion of the rearing capacity used in 2013 for Lakelse Lake was 17%.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Department of Fisheries and Oceans Canada (DFO), and the Regional District of Kitimat-Stikine. The field work was carried out by Gordon Ridley, and Janvier Doire. Thanks to Steve MacLellan and Fisheries and Oceans Canada's Cultus Lake Group for sharing their data and transect designs in addition to assisting with our training in data analysis. Allen Gottesfeld and Charmaine Carr-Harris provided invaluable advice and technical support throughout the field season and during analysis. Analysis of the data and report preparation were by the author, with mapping by Gordon Wilson, and editing by Charmaine Carr-Harris.

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Table 2. 2013 Lakelse Lake hydroacoustic survey trawl summary

Lake	Date	Trawl #	Time Start	Time End	Easting Start	Northing Start	Easting End	Northing End	Depth (m)	ON
Lakelse	09-Aug-13	1	0407	0417	529303	6027767	529691	6027398	19	74
Lakelse	09-Aug-13	2	0439	0442	529566	6027500	529479	6027667	21	99

ON: *O. nerka*

Table 3. 2013 Fish sample summary

Lake	Gear	Species	n	Mean Length (mm)	Max. Length (mm)	Min. Length (mm)	Std. Dev Length (mm)	Mean Weight (g)	Max. Weight (g)	Min. Weight (g)	Std. Dev Weight (g)
Lakelse	Trawl	*O. nerka*	173	55.4	70	32	7.2	1.8	3.7	0.3	0.7

Table 4. 2013 Lakelse Lake hydroacoustic integration estimate

Lake	Estimate Method	Size Class	Density		Population	
			n/ha	95% C.I.	n	95% C.I.
Lakelse	Integration	Age-0 *O. nerka*	1,818	26.9%	1,148,012	26.9%
		Other Small	n/a	n/a	n/a	n/a
		Large	134	59.2%	84,811	59.2%

Table 5. PR Capacity comparison chart

Lake	Adjusted Rmax	Acoustic survey date	Estimation Method	Observed O. nerka fall fry	Avg. Weight	Observed biomass (kg)	% Rmax (adjusted)
Lakelse	12,104*	8-Aug-13	Integration	1,148,012	1.8	2,066	17%

* - From Shortreed *et al.* 2007

Table 6. Past hydroacoustic estimates for Lakelse Lake

Lake	Year	Date	Age-0 sockeye		Method	Source
			n/ha	n		
Lakelse (North basin only)	2003	13-Jul	469	295,846	Tracked Targets	Hume and MacLellan 2008
	2003	30-Sept	195	123,036	Tracked Targets	Hume and MacLellan 2008
	2004	25-Sept	378	238,429	Tracked Targets	Hume and MacLellan 2008
	2005	05-Sept	620	391,401	Integration	Hume and MacLellan 2008
	2006	10-Oct	113	71,086*	Tracked Targets	Hall 2007
	2007	26-Sept	321	202,474*	Integration	Hall and Carr-Harris 2008
	2008	29-Aug	474	299,149	Integration	Carr-Harris 2009
	2009	25-Aug	719	453,798	Integration	Unpublished data
	2010	30 Sept	385	242,900*	Integration	Car-Harris 2011
	2011	03-Sept	433	273,145	Integration	Carr-Harris 2012
	2012	21-22-Aug	1,633	1,031,223	Integration	Doire 2012
	2013	08-Aug	1,818	1,148,012	Integration	This report

*- Total small fish population. Not apportioned for age-0 *O.nerka*

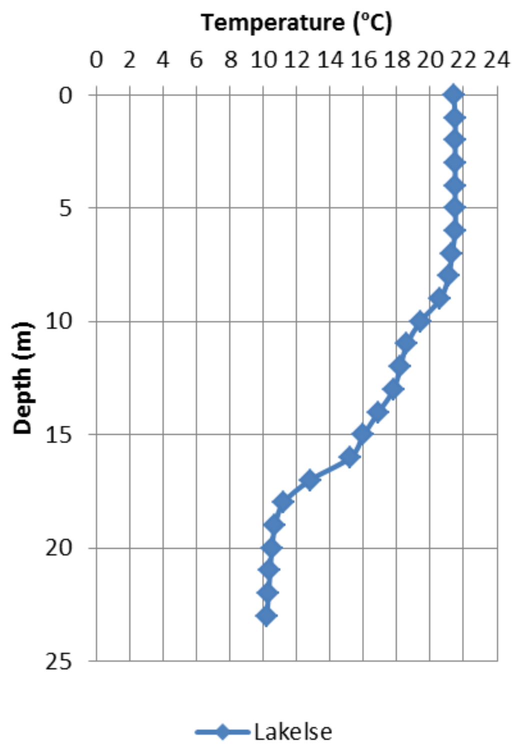

Figure 5. Temperature profiles for Lakelse Lake in early August 2013.

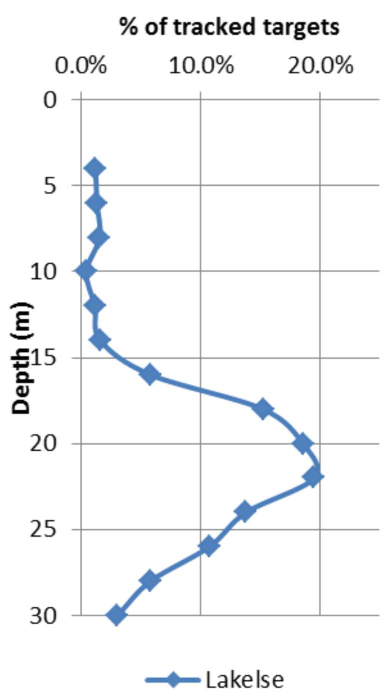

Figure 6. Vertical distribution of target density for Lakelse Lake early August 2013.

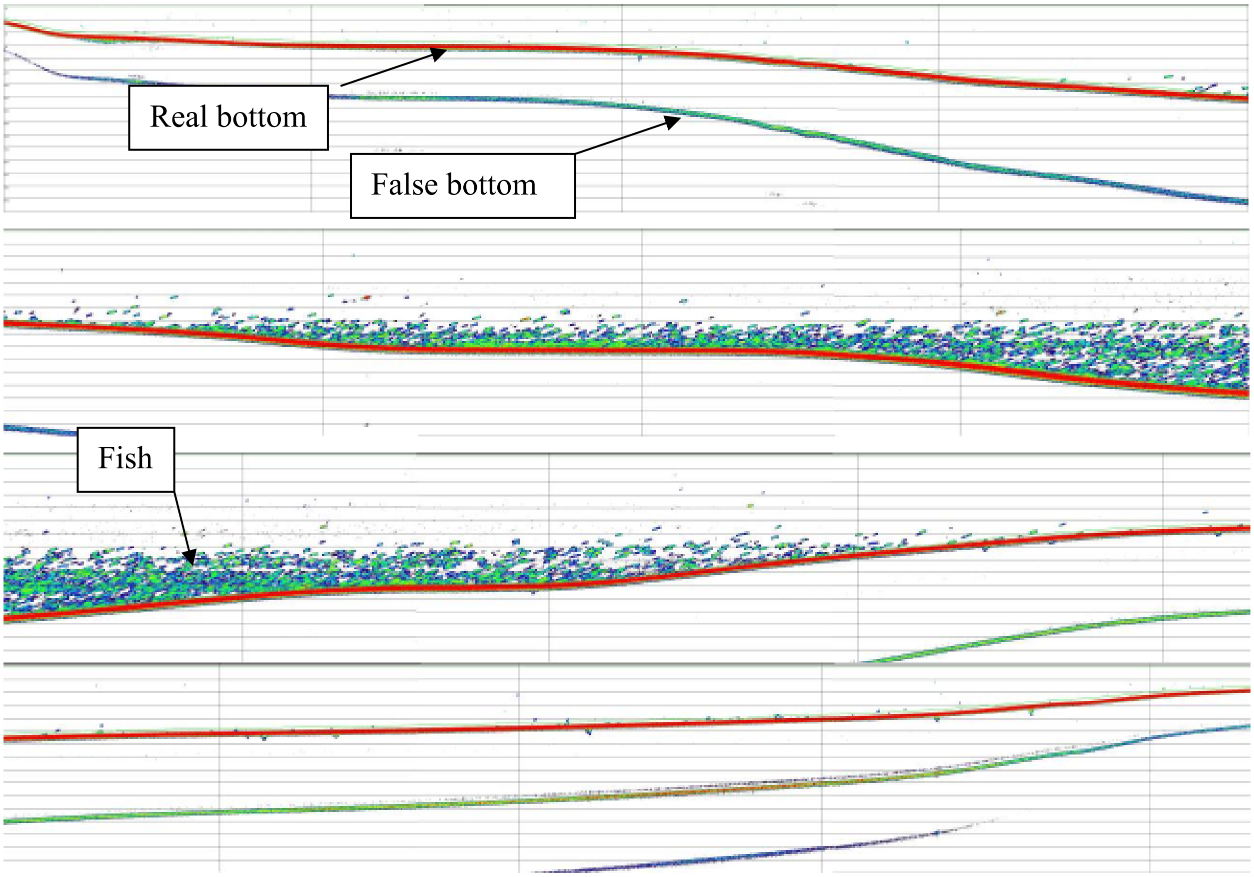

Figure 7. Lakelse Lake transect 3.4 echogram