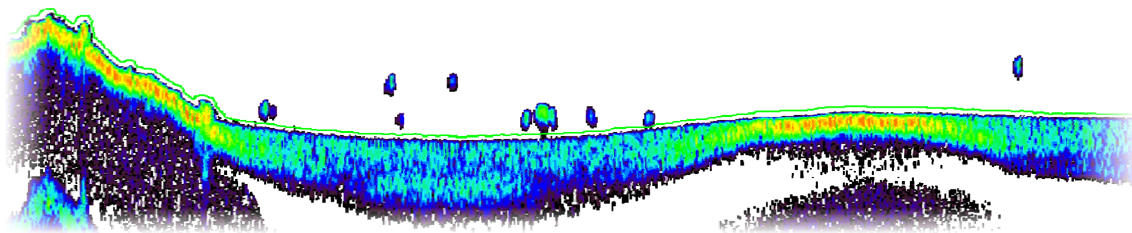
2007 Hood and Myrt Lakes Hydroacoustic Survey Report: Methodology and Summary of Results



Myrt Lake July 27, 2007 10:05

Prepared for:
Wildlife Conservation Society of Canada

Scott W. Milne
February 2008

Milne Technologies

Canada
28 Bradley Blvd, RR1
Hampton, Ontario
L0B1J0
Tel: (416) 848-3945
smilne@milnetechnologies.ca
www.milnetechnologies.ca

Europe
Ivar Aasensgate 1, Suite 3B
Bergen, Norway
N-5007
Tel: +1 416 848 3945

Table of Contents

Index of Figures

Index of Tables

1.0 Introduction

Government of Ontario initiatives such as the Ontario Living Legacy Trust and the Northern Boreal Initiative have been created in response to the increasing interest in evaluating the development potential of broad areas of land and water for mining, forestry, tourism, conservation, and a variety of other land use activities. Key to this process is the identification of important biomes and habitats that will ensure the protection and preserve the ecosystem integrity for future generations. The development of rapid resource assessment methodologies is critical for accurate and timely reporting on the state of the resource. Although much effort has been focused on developing assessment tools for monitoring the flora and fauna of terrestrial environments, application of remote sensing tools within aquatic environments remains underutilized.

The Wildlife Conservation Society of Canada's (WCS) mission is to "save wildlife and wildlands by improving our understanding of and seeking solutions to critical problems that threaten key species and large wild ecosystems throughout Canada". As part of this commitment, WCS has initiated a number of studies focused on gathering key information for identifying and protecting aquatic habitats within the Boreal forests of Ontario that may be at risk.

With the increasing threats to Northern Ontario's wetlands, lakes, and rivers from stresses including climate change, introduction of exotic species, exploitation, and loss of biodiversity, the WCS has published the "Freshwater fish in Ontario's boreal: Status, conservation and potential impacts of development", a document that outlines a number of research priorities and goals aimed at the conservation and protection of aquatic resources (Browne, 2007).

Several coldwater species of fish such as lake herring, whitefish, brook trout, and lake trout have been identified within this document as being at risk. However, explicit information about the local distribution, abundance, life history, genetic diversity, and harvest rates of these populations remain uncertain.

Although the Ontario Ministry of Natural Resources' mandate is "to manage and protect Ontario's natural resources", recent budgetary constraints and cuts to personnel have severely limited the ability of the scientists, managers, and enforcement staff to effectively monitor, protect, and manage the resources at a province-wide scale. In response, the WCS has acted to provide technical assistance and biological expertise to local groups and agencies that lack the resources to respond to specific resource management and conservation issues.

The Hood and Myrt Lake hydroacoustic and netting surveys provide an excellent opportunity for scientific collaboration, information transfer, and for furthering the development of a non-lethal, rapid resource assessment tool for the monitoring and management of freshwater fish populations.

1.2 Background

In collaboration with Milne Technologies and the Ontario Ministry of Natural Resources, the Wildlife Conservation Society of Canada (WCS) has developed a hydroacoustic survey program in an effort to detect potential changes in the population abundance and size distribution of lake trout within Myrt and Hood Lakes (Thunder Bay district). Although both lakes had been previously closed to ice fishing, the Ontario Ministry of Natural Resources has recommended that the lakes be reopened to winter angling in February of 2008. This management change provides a unique opportunity to directly measure the response of the lake trout population to the increased level of fishing effort and harvest.

Hydroacoustic technology is an important tool in fisheries and aquatic resource management. The technology has been proven an effective method for estimating fish abundance in lakes, rivers, and oceans around the world for more than 50 years. With hydroacoustic sampling, large volumes of water can be surveyed within a relatively short amount of time. This technology, when integrated with other fish sampling methods, provides a size and/or species specific estimate of fish abundance with high confidence and precision. In addition to the fisheries information, hydroacoustic surveys simultaneously provide information about fish habitat (bathymetry and quantified thermal habitat mapping), bottom substrate identification (relative hardness and roughness and macrophyte mapping) and trophic linkages (spatial distribution of zooplankton and macro-invertebrates).

The purpose of this report is to provide a detailed description of the hydroacoustic sampling methodology and data analysis and includes a summary of the survey results.

2.0 Data Collection and Analysis Methodology

2.1 Data Collection Methods

2.1.1 Study Lakes

Hood and Myrt Lakes are situated within Northwestern Ontario, approximately 110 km west of Thunder Bay and just east of Quetico Provincial Park (figure 2). Hood Lake is composed of a single elongated basin with a few small shallow bays and a surface area of ~115 hectares. Myrt Lake has almost three times the surface area (~267 ha) and is composed of three distinct basins. The observed maximum depths of Hood and Myrt lakes are 16.8 m and 15.1 m, with mean depths of 7.1 m and 5.2 m, respectively (figure 1).

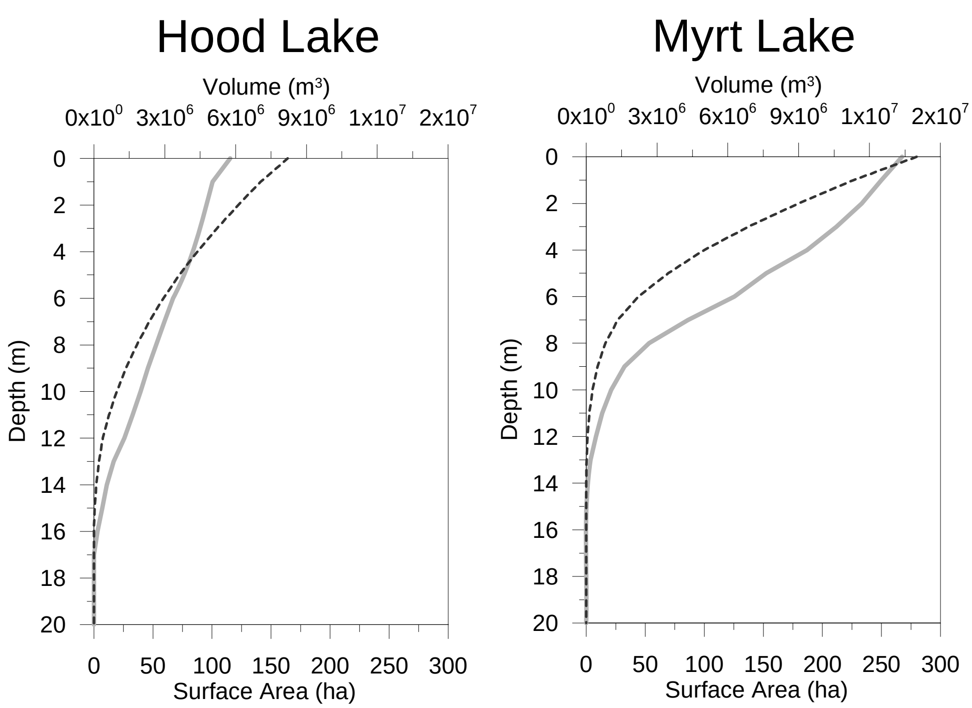


Figure 1. Hypsography of Hood and Myrt Lakes estimated from the 2007 hydroacoustic surveys. Shown are surface area (▬) and lake volume (- - -) by 1 m depth intervals.

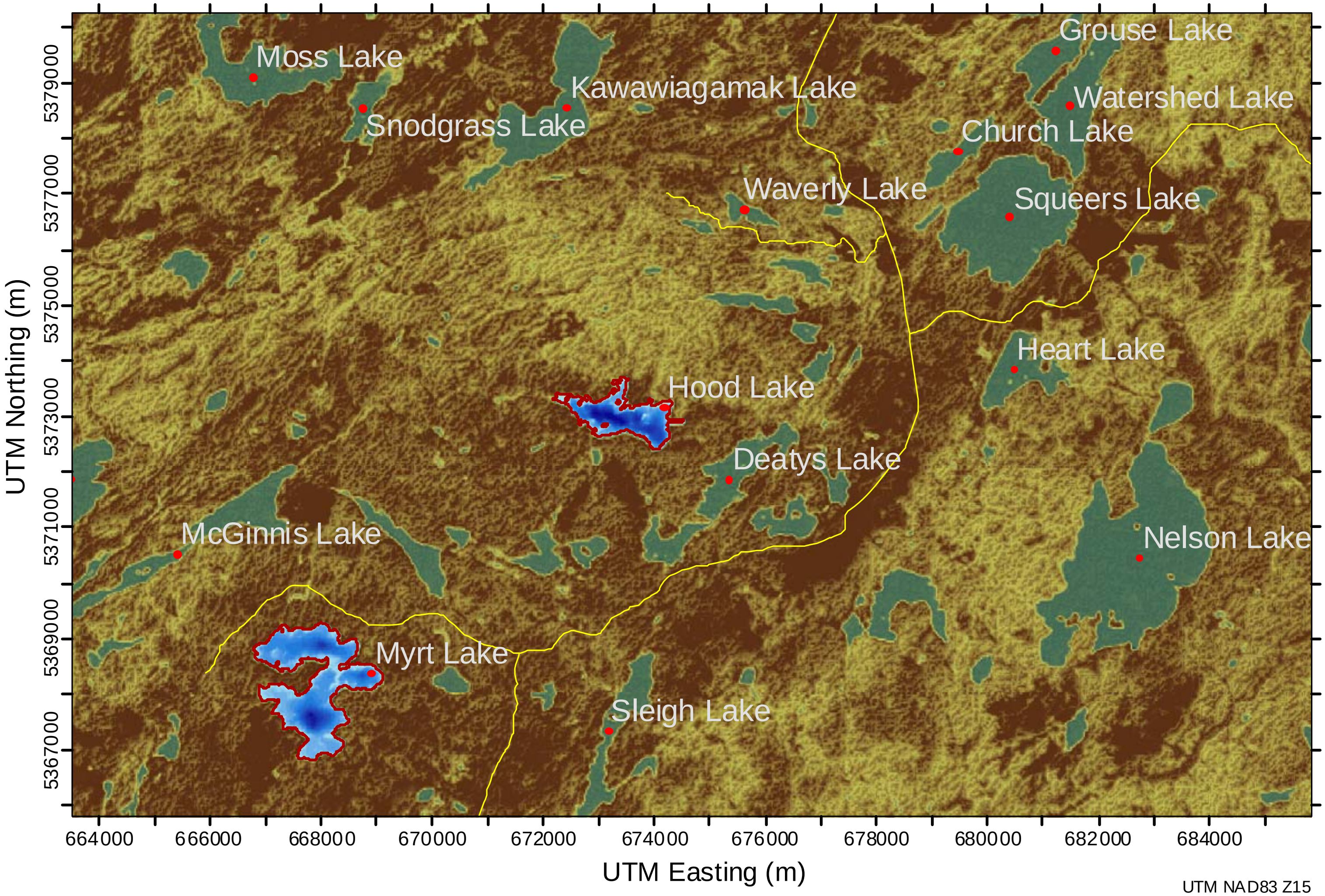


Figure 2. Orthographic image of Hood and Myrt Lakes with surrounding area. LandSat-7 Image from www.geobase.ca

2.1.2 Hydroacoustic System Hardware

Hydroacoustic data were collected using a BioSonics Inc. DTX 7.5^o 120 kHz split-beam system on loan from the Ontario Ministry of Natural Resources, Lake Ontario Management Unit. The digital transducer was fixed to an aluminum pole and mounted port-side on the gunwale of the survey vessel (figure 3). A spirit level was affixed to the top of the pole mount to ensure the transducer face remained parallel to the lake surface. A short length of aircraft cable attached to the foot of the transducer pole was extended to a crossbeam mounted at the bow to stabilize and reduce transducer movement when under survey.

Real-time GPS data strings were provided to the acoustic systems from an internal WAAS GPS system installed on the field computer. We also used Fugawi moving map software to display vessel position and boat speed.

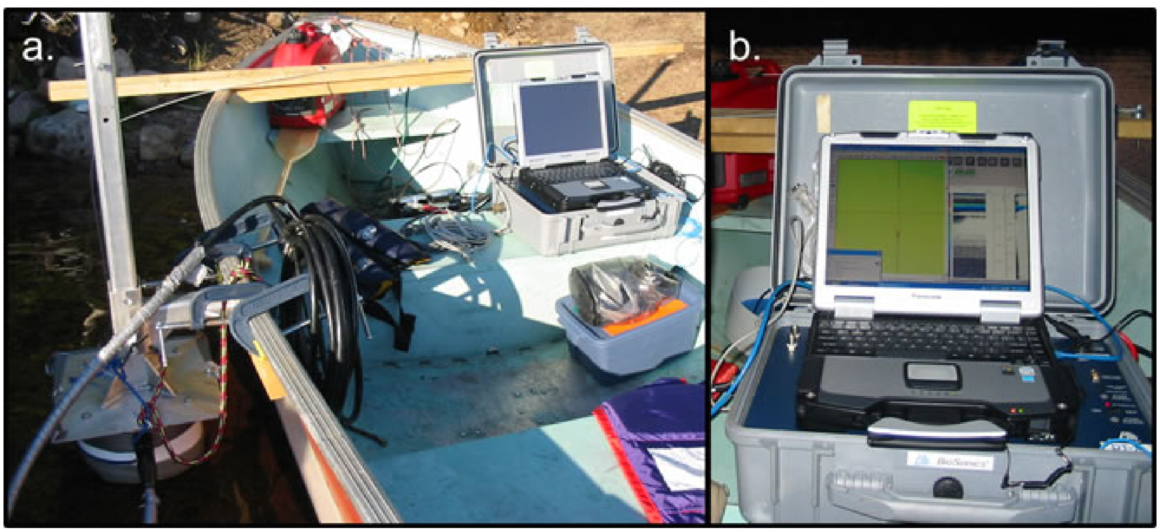


Figure 3. The digital transducer (partially submerged) was deployed from an aluminum pole that could be lowered from the gunwale mount (figure 3a). A short length of aircraft cable attached to the foot of the pole was extended to a cross beam mounted near the bow to reduce transducer movement while under survey. Also shown is the BioSonics DTX processor (pelican case) and field computer (figure 3b). The field computer was used to run the BioSonics Visual Acquisition software, record data, and display the real-time navigation.

2.1.3 Hydroacoustic Survey Design

The Hood and Myrt Lakes hydroacoustic surveys implemented a systematic zig-zag or parallel transect design to maximize the coverage of the lake. As recommended by Simmonds and MacLennan (2005), this systematic survey design is the most appropriate survey type for sampling a system where:

1. There is no previous knowledge about the current spatial distribution of fish.
2. Sampling is confined to a single diurnal period (i.e., nighttime or daytime).
3. The survey area is large and the available survey time (i.e., hours of daylight and crew availability) is limited.
4. An unbiased estimate of abundance of multiple age or size classes is required in addition to a map of the spatial distribution.
5. Other information is required (i.e., bathymetric, substrate, and macrophyte spatial information).

For both lakes we completed an initial bathymetry and habitat mapping survey using a systematic parallel survey design to maximize coverage of the lake at sufficient resolution for spatial modeling and habitat quantification. The bathymetry and habitat mapping survey was completed on both lakes with a transect resolution of 50 to 75 m (figure 4 and 5). Preliminary bathymetry maps of the lakes were produced to delineate potential lake trout habitat for planning the lake trout survey transects.

For the Hood Lake lake trout surveys, we chose a systematic triangular grid design where the turning points along the nearshore boundaries were ~200 m apart providing an average transect spacing of ~100 m (figure 6). The zig-zag design is the most appropriate sampling design where survey area is long and narrow in shape (Simmonds and MacLennan 2005). The longest fetch (>5 m depth) across Hood Lake (southeast to northwest) is 1.8 km and is approximately 4 times greater than the lake's average width (north to south) and thus is best suited to the zig-zag design. In contrast, Myrt Lake is composed of three distinct basins that are generally round or oval in shape. For these areas the systematic parallel design was deemed most suitable (figure 7).

In both lakes the survey area was defined as the surface area of the lake where the depth was greater than 5.0 m. The depth criteria reduced the surface area of Hood Lake from a total surface area of 115 ha to an effective surface area of ~76 ha (66% of the total surface area) where the bottom depth was greater than 5 m. Myrt Lake, with a total surface area of 268 ha, had an effective surface area of 152 ha (56% of the total area). Within this reduced area, defined as the survey area, we used a GIS to plot the survey transects using either the systematic parallel or zig-zag design described above.

For Myrt Lake, the parallel transects were separated by 125 m spacing and the Hood Lake zig-zag transects were separated, on average, by 100 m spacing. The transect spacing was chosen to maximize survey coverage while minimizing the influence of autocorrelation on the estimate from transects that were spaced too close together.

The total length (*D*) of the survey transects (omitting turning points and nearshore corners) were ~5.1 km for Hood Lake and 11.0 km for Myrt Lake (table 1). The expected degree of coverage indices ($\Lambda = D/\sqrt{A}$, where *A* is the sample area in km^2) for Hood and Myrt Lakes were calculated as 5.8 and 8.91, respectively, with an expected coefficient of variation of <0.25. The proportion of the total lake volume sampled within the acoustic beam was observed to be greater than 0.3 % for both lakes.

Table 1. Summary of the total transect length, effective survey surface area, expected coefficient of variation (CV) and acoustic sample volume from the 2007 Hood and Myrt Lakes surveys. The expected degree of coverage index is calculated as $\Lambda = D/\sqrt{A}$ (where *A* is the sample area in km^2).

	Hood Lake	**Myrt Lake**
Transect Length, km (analysis transects only)	5.1	11.0
Effective Survey Area, ha (>5 m Depth)	76.3	152.3
Exp. Degree of Coverage Index (Λ)	5.82	8.91
Exp. CV (*b* =0.5)	0.21	0.17
Beam Wedge Volume (m^3) x 10^4	4.10	4.20
Lake Volume (m^3) x 10^4	821.33	1399.52
Prop'' Sample Volume (%)	0.499	0.300

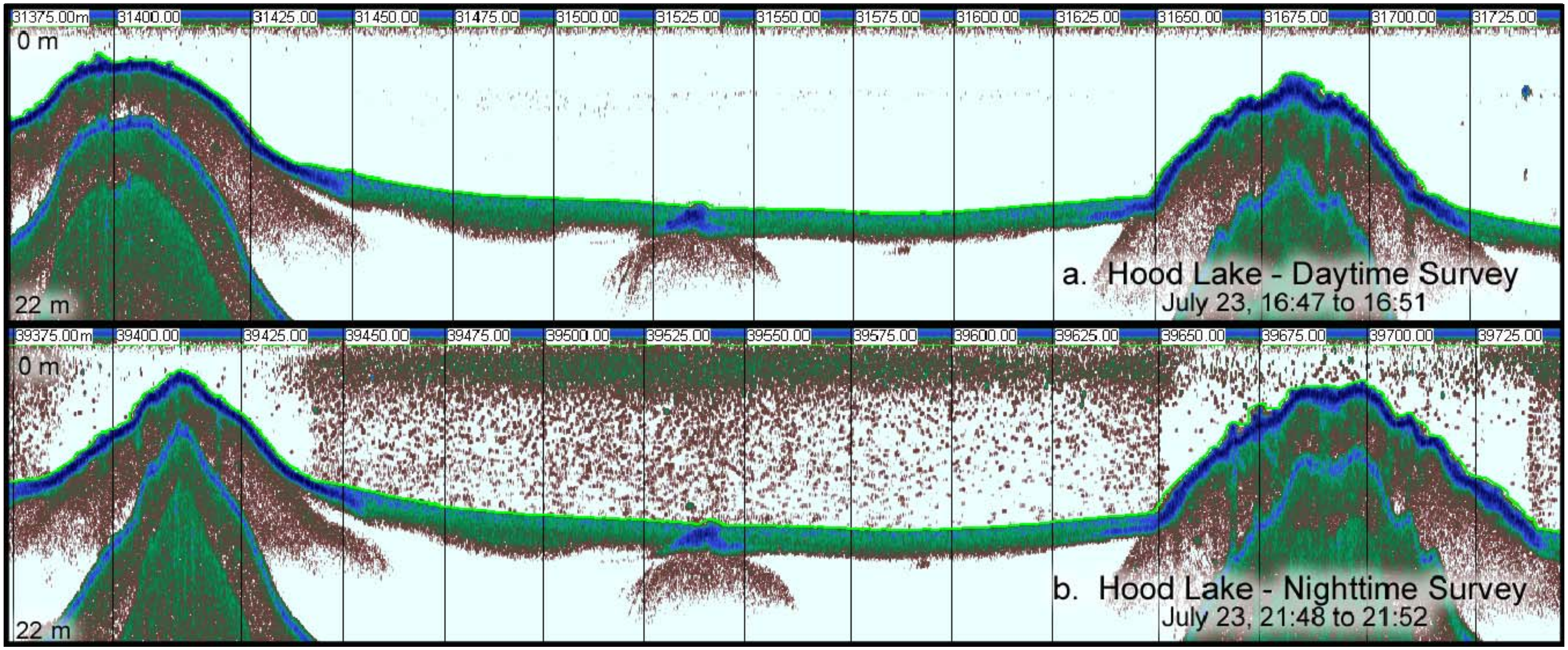


Figure 19. The recorded volumetric backscatter (Sv) echograms from the 2007 Hood Lake hydroacoustic surveys for a segment of transects that bisects the main basin just west of the field camp island. The top panel (a.) is an echogram from the daytime surveys (a. July 23, 16:47 – 16:51) and the lower panel is from the nighttime survey (b. July 23, 21:48 – 21:52) from the same transect segment. A minimum Sv threshold of -70 dB was applied to both echograms. The lake bottom is shown as the solid green and blue band through the echogram where dark blues (and 2nd echo) indicate hard or rocky substrates and the lighter green areas indicate a relatively softer substrate type. Although few targets were observed within this segment during the daytime surveys, the nighttime survey revealed a high density of small biological scatters, likely large zooplankton and macro-invertebrates (chaoborus etc.) within the mid water column. This layer was most dense at depths < 6.0 m and appeared to be most concentrated within the offshore areas over softer substrates.

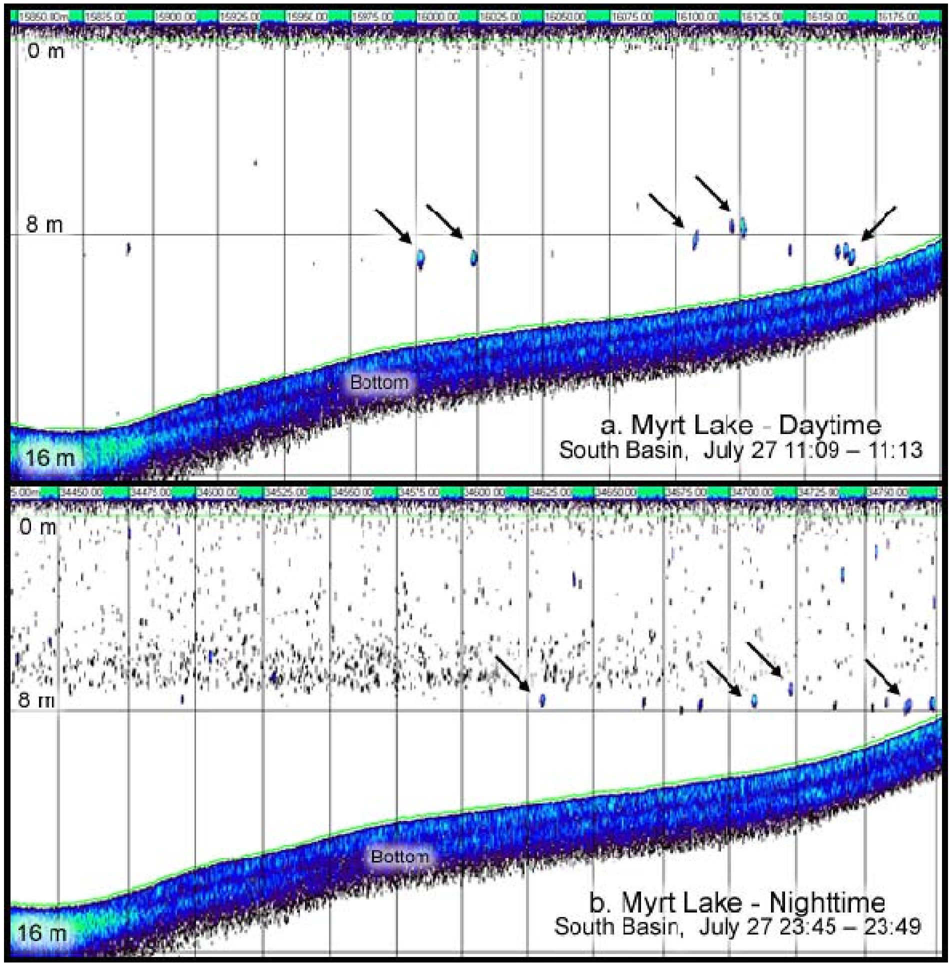


Figure 45. The recorded volumetric backscatter (Sv) echograms from the 2007 Myrt Lake hydroacoustic surveys for the segment of transects indicated within figures 44 and 45. (a.) is an echogram from the daytime surveys (July 27, 11:09 – 11:13) and (b.) is from the nighttime survey (July 27, 23:45 – 23:49) from the same transect segment. The horizontal line through the images delineates the 8.0 m depth layer. Backscatter from large fish targets are indicated with arrows. Note the change in the vertical distribution of the large targets between day and night. Small dark speckling apparent within the nighttime echogram at depths <8.0 m are likely backscattering from large zooplankton. Virtually no biological backscatter is observed within the nighttime echogram within the >8.0 m depth layer.

Milne Technologies
Environmental and Aquatic Resource Consulting
www.milnetechnologies.ca
28 Bradley Blvd. RR1 Hampton Ontario Canada L0B 1J0
Tel: (416) 848-3948 info@milnetechnologies.ca

Please contact Milne Technologies for the complete report.