GREAT LAKES FISHERY COMMISSION

2003 Project Completion Report[1]

A new signal processing system for inter-agency fisheries acoustic surveys in Lake Erie

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Abstract

The Great Lakes Fishery Commission (GLFC) Coordination Activities Program supported the purchase of a modern acoustic signal processing and data management system for ongoing, inter-agency fisheries acoustic surveys on Lake Erie. The new signal processing system, **ECHOVIEW**, is a product of the company **SonarData**. This project also supported **ECHOVIEW** training from the software developer for Messer's Einhouse and Witzel. We subsequently convened a workshop for members of the Lake Erie Forage Task Group to introduce **ECHOVIEW** software and its application to ongoing Lake Erie acoustic surveys.

Introduction

In 1993 Lake Erie fisheries agencies implemented an eastern basin acoustic survey program as a component of the ongoing, annual fish stock assessment efforts coordinated through the GLFC's Lake Erie Committee. In 1997 the Lake Erie Committee member agencies together with the Great Lakes Fishery Commission collaborated in the purchase of a modern fisheries acoustic system, provided training, and expanded pilot surveys into the central and western basins of Lake Erie. This collaborative approach for purchasing expensive survey equipment and conducting basin-wide, inter-agency acoustic surveys recognizes that these acoustic fish assessments are expensive endeavors and usually beyond the means of any one fisheries assessment office on Lake Erie. The ongoing eastern basin, Lake Erie acoustic survey entered it's 11th year in 2003 and has become a basinwide standard for assessment of pelagic forage fish populations in Lake Erie (Johnson et al. 2001). Since

it's inception in 1993, development of this eastern basin Lake Erie survey has benefited from two GLFC workshops, and three published studies that advanced of knowledge of survey design (Connors 1999), comparability of acoustic systems (Rudstam et al. 1999), and acoustic target strength determination (Rudstam et al. 2003).

A remaining limiting factor for our ongoing surveys has been that our signal processing system had become antiquated relative to new products designed to manage larger volumes of data and achieve compatibility in **Windows** operating system. The high cost of acoustic signal processing systems, and the accompanying shared responsibility for implementing Lake Erie surveys precluded any single Lake Erie agency from unilaterally purchasing a modern signal processing system and training the appropriate Lake Erie agency personnel. Furthermore, in recent years it has become clear that the signal processing software **ECHOVIEW** has emerged as a new standard to process acoustic data for Great Lakes surveys. Acquiring **ECHOVIEW** for Lake Erie is a step towards standardizing our approach to acoustic surveys on the Great Lakes, building broad network of expertise among the Great Lakes research community, sharing, and ensuring uniformity of results. The purchase of the **ECHOVIEW** signal processing system and accompanying training was supported by the GLFC's Coordination Activities Program and addressed the need to achieve standardization, and a modern signal processing system for Lake Erie surveys.

Project Objectives

This project addressed two objectives for ongoing Lake Erie acoustic surveys. First, we acquired new software that has recently emerged as a broad standard for

storing, sharing, managing and processing fisheries acoustic survey data. We completed the purchase of **ECHOVIEW** software on December 12, 2002. We accompanied purchase of the software with an extended upgrade and support agreement that will be underway through December 12, 2005.

Our second objective was to receive training for this software. Mr. Einhouse and Mr. Witzel received three days of ECHOVIEW training at a workshop sponsored by the software developer, **SonarData**. Subsequently, Messer's Einhouse and Witzel, led a workshop for Lake Erie's Forage Task Group that introduced this software to other biologists connected with fisheries acoustic surveys on Lake Erie (Appendix I and II).

Signal Processing Exercise

A major element of the Lake Erie acoustic workshop demonstrated standard data processing steps of the ongoing, eastern basin, Lake Erie survey using **ECHOVIEW** software. This demonstration replicated steps performed using our previous signal processing software, **EP500,** a product that accompanied the purchase of our inter-agency Lake Erie echosounder in 1996. A major component of this standard signal processing method for eastern Lake Erie is defining the vertical stratification for each sampling transect to separate regions of small young-of-the-year (YOY), and larger yearling-and-older (YAO), cohorts of pelagic forage fish. In the past, this stratification task has been the most time consuming element of the required data processing steps to produce survey results. This procedure has now been automated by electronically exporting a fine scale summary of the two-dimensional (depth layer by distance interval) spatial distributions of fish acoustic size distributions from **ECHOVIEW** software. A

depth-variable line fitted through this matrix of acoustic fish sizes (target strengths - TS) according to a user defined TS-based selection criterion delineates a stratum boundary between an epilimnion layer dominated by YOY fishes, and a colder, metalimnion layer dominated by the YAO rainbow smelt. This line that defines the epilimnion-metalimnion boundary is then electronically imported into **ECHOVIEW** and becomes the primary delineating factor for achieving discrete density estimates for YOY and YAO cohorts of rainbow smelt. In summary, a key data management step has now become largely automated for our ongoing Lake Erie acoustic survey and represents a major breakthrough to efficiently process acoustic data. This project has provided us new tools that will facilitate efficient re-visiting of our current database, and more rapid processing of new survey data.

Validation of Results

An additional element of our project compared acoustic survey density estimates achieved by our previous standard, **EP500**, with our new signal processing system, **ECHOVIEW**. Table 1 shows results of this validation exercise for a representative transect sampled during the July 2003 eastern basin, Lake Erie acoustic survey. Results produced through two signal processing products for estimating fish densities were nearly identical in the epilimnion and metalimnion thermal regions. However, mean density estimates differed by 15 percent in the hypolimnion thermal stratum. Each software processed an identical data file collected by a Simrad split beam echosounder and used accompanying *in situ* target strength measures to apportion overall echo integration measures to fish densities. We believe observed differences in

fish density estimates are likely attributable to differences in scale and range for ascribing the frequency distribution of single target detections between EP500 and ECHOVIEW signal processing systems. ECHOVIEW provides a broader dynamic range and allows for finer scale binning of single target detections than the EP500 signal processing system. As such, mean acoustic fish size estimates from these two signal processing systems are likely to be slightly different, but improved accuracy should accompany density estimates produced through ECHOVIEW because this system utilizes a broader range for binning single fish targets that can be used to apportion total densities among all *in situ* single fish detections encountered during the survey.

Table 1. Comparison of mean fish density estimates derived from output of two hydroacoustic data signal processing softwares – Simrad's EP500 and SonarData's Echoview, using 2003 eastern basin, Lake Erie acoustic data collected on transect 58837 with a Simrad EY500 120khz split beam echosounder.

Thermal Strata	**Number per ha EP500**	**Number per ha ECHOVIEW**	**Percent Difference**
Epilimnion	25,480.3	25,356.8	0.5%
Metalimnion	313.0	307.2	1.9%
Hypolimnion	226.8	196.6	15.4%

Future Plans

This project addressed our two primary objectives of: 1) acquiring a modern acoustic signal processing system for Lake Erie and, 2) providing ECHOVIEW training for Lake Erie personnel. However, there are some remaining fisheries acoustic program requirements that require ongoing attention. Most prominently, our previous acoustic survey data series needs to be calibrated with our current approach, and stored in a standard format using ECHOVIEW data files. Our entire time series of results need to be re-examined with new standards in place that reflect our current knowledge of scientifically sound survey methodology, better understanding of the acoustic size range of rainbow smelt age groups, and the incorporation of N_v testing to discern when use of *in situ* TS analysis may be inappropriate (Rudstam et al. 2003). Finally, acoustic applications are expanding further as a fisheries assessment tool in Lake Erie. As such, expanded support will be required to efficiently administer these surveys. Lake Erie's Forage Task Group currently shares one acoustic system and one signal processing site license among five Lake Erie jurisdictions. This inter-agency acoustic monitoring program will require a dedicated ongoing effort for maintenance, upgrades, expansion of site licenses, and periodic training of personnel to remain as a functional fish stock assessment tool for Lake Erie.

Literature cited

Connors, M. L., 1999. Use of Adaptive Cluster Sampling Designs for Hydroacoustic Fish Surveys. MS Thesis, Cornell University, Ithaca, New York, August, 1999.

Johnson, T., M. Bur, J. Deller, D. Einhouse, R. Haas, C. Murray, L. Rudstam, M. Thomas, E. Trometer, J. Tyson, L. Witzel. 2001. Report of the Lake Erie Forage Task Group to the Standing Technical Committee, Lake Erie Committee and Great Lakes Fishery Commission. 2001 Annual Meeting of the Lake Erie Committee.

Rudstam, L. G., S. Hansson, T. Lindem and D. W. Einhouse. 1999. Comparison of target strength distributions and fish densities obtained with split and single beam echo sounders. Fisheries Research 42(1999) 207-214

Rudstam, S. L., S. L. Parker, D. W. Einhouse, L. D. Witzel, D. M. Warner, J. L. Stritzel, D. L. Parrish, and P. J. Sullivan. 2003. Application of in situ target –strength estimations in lakes: examples from rainbow-selt surveys in Lakes Erie and Champlain. ICES Journal of Marine Science, 60: 500-507.

APPENDIX I. Lake Erie Acoustic Survey Workshop

Location: OMNR Lake Erie Office, Port Dover, Ontario, Canada
Dates/Time: 1:00 PM 12/3/2003 to Noon 12/4/2003

Objectives:

1) Describe and document the design, signal processing and analysis procedures for the Lake Erie acoustic assessments of rainbow smelt.

2) Perform a replicate signal processing effort for a representative transect in both EP500 and Echoview software to validate results of past efforts.

3) Commence analysis of 2003 acoustic data for the eastern and central basin of Lake Erie using standard methods.

Participants:

- Biologists that have participated in Lake Erie in acoustic surveys.
- Others are welcome to attend, but max attendance < 10 preferred

Agenda: Day 1 – presentations - 1 PM to 5 PM

1) An overview: Development of inter-agency acoustic efforts for rainbow smelt in eastern Lake Erie - Einhouse

2) Cluster sampling survey design and analysis methods applied to eastern Lake Erie's ongoing Acoustic Survey - Einhouse

3) Application of in-situ TS for abundance estimation, implications for Lake Erie acoustic assessments - Rudstam, Parker, Warner or Einhouse?

4) Echoview overview, Lake Erie site license requirements, hardware lock, modules, available technical support, etc. - Witzel

5) Echoview software signal processing example applied for standard Lake Erie data management procedures. – Witzel

Day 2 – discussion and exercises - 8:30 AM to Noon

1) *Exercise* - Density estimation for a Lake Erie transect with EP500 and Echoview processing software. Do estimates agree? - All

2) *Discussion* – Analyzing our Lake Erie time series, standard procedures, timetable, product, and assignments. – All

3) *Exercise* – Begin signal processing as per assignments developed from item # 2, and to be completed as homework after the workshop. - All

APPENDIX II. Lake Erie Acoustic Survey Workshop Attendance

OMNR Lake Erie Office, Port Dover, Ontario, Canada
1:00 PM 12/3/2003 to Noon 12/4/2003

Participant	Affiliation
Michael Bur	USGS, Sandusky Field Station
John Deller	Ohio DNR, Fairport office
Donald Einhouse *	NYS DEC, Dunkirk Fisheries Station
Robert Haas	Michigan DNR, Mt. Clemens office
Timothy Johnson	OMNR, Wheatley office
James Markham	NYS DEC, Dunkirk Fisheries Station
Martin Stapanian	USGS, Sandusky Field Station
Lars Rudstam **	Cornell University
Jeff Tyson	Ohio DNR, Sandusky office
David Warner **	USGS, Great Lakes Science Center, Ann Arbor
Larry Witzel *	OMNR, Wheatley office
Jeffrey Zhu	University of Windsor

* - Workshop organizer/presenter

** - Workshop invited presenter