Consensus Report

of the
Technical Review of the
Gulf of Maine Research Institute's

Fishery Independent Herring Acoustic Survey

Convened by the
Northeast Consortium on March 15/16, 2005
At Gulf of Maine Research Institute, Portland, Maine

Submitted by:

Dr. Robert Stephenson, Chair
Dr. David Reid
Mr. Christopher Stevens

May 9, 2005

Introduction

This report is a consensus statement based on an independent peer review of the fisheries independent acoustic survey conducted by the Gulf of Maine Research Institute (GMRI) in partnership with commercial fishermen. Since 1999, this project has monitored spawning herring in the inshore Gulf of Maine. The review served as a formal assessment of the accuracy and precision of the survey to determine the viability of using the data in regional stock assessments. This review was conducted at the Gulf of Maine Research Institute on March 15-16, 2005 and focused on survey design, acoustic system performance, data processing, acoustic parameter calculations, and survey results.

The review has been funded and facilitated by the Northeast Consortium, which has partially funded the herring survey since 2000. The review panel consisted of three scientists, two from Canada and one from Scotland, who are internationally recognized in the fields of acoustics, and herring biology and stock assessment. The review was chaired by one of the panelists. The reviewers agreed to compile this consensus report and to provide comments on the GMRI draft technical report (prior to publication). Some reviewers have submitted additional, more detailed comments in individual reports directly to the Northeast Consortium.

Note: The views expressed in this report are those of the review panelists and do not necessarily reflect those of the Northeast Consortium.

Review Panel

The following information about the review panelists is provided as evidence of the authority and expertise of individuals and to help authenticate the independent nature of the review process. All panelists have signed the Northeast Consortium's "Conflict of Interest and Confidentiality Policies for the Technical Evaluation of Projects" agreement. These individuals served as contractors independent of their employer. Views expressed do not necessarily represent those of their employer or government.

Dr. Robert Stephenson, Chair, St. Andrews, New Brunswick, Canada
Dr. Stephenson is a research scientist at the St. Andrews Biological Station, Department of Fisheries and Oceans, Canada. He has been involved with fisheries assessment and research for over 20 years and is regarded internationally as an authority on the ecology and assessment of herring. Dr. Stephenson is a former member of the ICES Advisory Committee on Fisheries Management and for a number of years has led the section responsible for DFO's Gulf of Maine stock assessment projects.

Dr. David Reid, Aberdeen, Scotland, United Kingdom
Dr. Reid is currently Group Leader the Fishing Technology and Fish Behavior Group at FRS Marine Laboratory, Aberdeen. He has been responsible for the setting up and running of acoustic surveys for herring on the west coast of Scotland since 1992 using

commercial vessels. He has an extensive experience in acoustic, icthyoplankton and bottom trawl surveys.

Mr. Christopher Stevens, St. John's, Newfoundland
Mr. Stevens is head of the Hydroacoustics, Electronics, and Vessel Support Section, Science Branch, Federal Department of Fisheries and Oceans, St. John's, Newfoundland. He has worked in the electronic and underwater acoustic fields for over 30 years. He is regarded as an authority in hydroacoustic instrumentation and calibration of systems used for acoustic surveys and studies.

Other Participants

Other meeting participants include:

Dr. John Annala, meeting host, GMRI Chief Scientific Officer
Mr. Kevin Scheirer, Project Leader, GMRI
Dr. Matthew Cieri, Investigator, Maine Department of Marine Resources
Mr. Shale Rosen, Data Analyst, GMRI
Mr. Allen Clay, Femto Electronics Corporation President
Mrs. Mary Beth Tooley, Industry Advisor, East Coast Pelagic Association Director
Ms. Rachel Gallant, review facilitator, Northeast Consortium Fisheries Specialist

Documentation

In advance of the review, the panel was provided with GMRI's semi-final draft (February 23, 2005 version) technical report entitled, "The Fishery Independent Hydroacoustic Survey of Inshore Gulf of Maine Atlantic Herring: 1999-2004." Additional details on the acoustic system and analyses were provided after the meeting. The panel felt that documentation provided by GMRI staff and associates was certainly adequate for the review.

Agenda/Logistics

The review was conducted at GMRI, in Portland, Maine on March 15-16, 2005. Presentations by project participants were followed by discussion between participants and reviewers. The agenda and list of presentations are appended (Appendix A and B).

Observations and Comments of the Panel

The review was guided by the Terms of Reference and Evaluation Criteria, which are appended (Appendix C). The meeting participants interpreted the Terms of Reference as asking three primary questions, which served as a means to focus discussion:

1) Does the GMRI herring acoustic survey information provide the basis for valid input into a stock assessment at present?
2) Can the data collected to date provide useful information if analyzed differently?
3) What would be required to provide more useful information in future?

The following observations and comments of the panel are ordered in terms of the sequence which material was presented at the meeting.

Survey Objectives

The panel observed that the objectives of the acoustic program have changed through time. Objectives (primarily from statements in annual reports) have included:

- Test the concept of collecting reliable acoustic data on commercial vessels;
- Involve members of industry in designing the surveys and collecting data;
- Estimate abundance of the coastal spawning stock;
- Establish a regular monitoring (census) effort and incorporate the results into the stock assessment;
- Develop and execute a reliable survey of the inshore component that will compliment surveys of the Georges Bank component;
- Understand the spawning behavior of the inshore component;
- Produce an index (relative or absolute) of spawning stock biomass for the inshore component; and
- Monitor the major spawning grounds on an annual or biannual basis as a proxy for stock health.

The diversity of objectives made it difficult to determine how successful the program has been. The objective(s) of the survey need to be reconsidered in relation to the assessment need (see later sections). Perhaps the key objectives should be to obtain a relative index of abundance for the coastal stock and to monitor the changes in use of key spawning grounds by the stock.

The project and surveys to date have involved diverse personnel and vessels. There has been significant turnover of scientific staff and there has been great inconsistency in survey platforms, acoustic systems, survey design and in sampling methods. Inconsistency is a major theme throughout the review, and complicates the usefulness of data collected to date. Development of a valid survey time series requires more consistency in methods, personnel, and approaches.

Survey Design

The survey originally intended to determine the absolute biomass of spawning herring in management Area 1A. More recently, there has also been an attempt to define spawning index areas (post stratification into three units of spawning areas). Although the survey

has intended to target spawning herring, biological samples have clearly indicated that much of the surveyed biomass have been juveniles.

GMRI recognized a number of shortcomings in survey design, including:

- Lack of set strata;
- Variable spatial and temporal extent;
- Variable transect design; and
- Lack of integration of biological sampling as part of the survey design.

The panel felt that there has been insufficient consideration of the survey approach (e.g. census vs. index) and design (e.g. arrangement of transects within a stratified random design) in relation to the life history stage and behavior of herring.

Herring stock assessment needs in Area 1A suggest two major objectives for acoustic surveys:

1) monitor changes in the persistence/viability of major spawning aggregations within Area 1A; and
2) provide input into the assessment model to assist in partitioning biomass among components of the stock complex – essentially, a comparable biomass index for the inshore and offshore components of the stock.

These two objectives suggest the need for different survey approaches:

A] monitoring of key (sentinel) spawning grounds including Jeffries Ledge with a small-scale specific survey approach aimed at the spawning fish; and

B] broader scale systematic surveys of herring when they are more widely distributed (off the spawning grounds).

The broader systematic surveys could, perhaps, make use of the three areas designated in previous surveys, but with more careful attention to transect design, coverage, and sampling. There appear to be two time periods that the broad-scale survey would be most useful– July and autumn (September-October).

The September-October period seems preferable in that it matches the survey timing of the offshore herring acoustic survey conducted by the National Marine Fisheries Service. It would build on the surveys conducted to date and provide the context for any sentinel spawning bed surveys. In July, there may be less conflict with lobster gear, herring would be expected to be spread out, and the fleet is active. However, it would represent a new survey, would be expected to be confounded by the presence of Georges Bank fish in the area, and would have less survey time due to long hours of daylight.

Biological Sampling

GMRI staff pointed out numerous major sampling challenges, including:

- widespread and dense fixed gear that prevent trawling;
- large areas of shallow water that are difficult to sample; and
- different survey vessels with different sampling capabilities.

Biological sampling has been low, and in some cases simply insufficient to provide the biological characteristics required for evaluation of acoustic targets. There were some areas and times within each annual survey where herring were observed acoustically and no associated biological samples were taken. In other cases, distant samples (in time or space) or samples from commercial fishermen have been used as surrogates. It is recommended that the use of these 'distant' samples be studied more closely, e.g. by comparison of known tows with adjacent (in time and space) commercial samples.

Use of surrogate samples should be the exception, rather than the rule. The required sampling intensity depends upon the variability among samples. Sampling should be intense when there is uncertainty about size or species composition, and less as variability is demonstrated to be low. It is recommended that initially intensive biological sampling be carried out to determine the pattern of spatial variability in length frequency. Once this has been established, less intensive sampling may be possible. This can be studied by random elimination of increasing numbers of samples and examining the effect on the calculated biomass and its age/length structure.

The biological data have not been used for partitioning the echo integrals by species; it may be that the biological data is insufficient to do this at present. While there are only a few other species taken, and apparently in small numbers, it is suggested that there be further exploration and documentation on the sensitivity of the results to major bycatch species (e.g. dogfish). This has been done for mackerel and should be extended to any other major bycatch species.

The meeting discussed the possible use of additional gear-types, such as deployed fish traps, research gillnets, or small ring seines for deployment in areas where fishing would otherwise be impossible due the dense pot fisheries.

Although, much of the sampling has been by midwater trawl, a wide variety of sampling gears has been used in the past. It is recommended that the main sampling should be restricted to midwater trawl from now on. If possible, this should be with a uniform net. The current tow speed (3.5 knots) may be too slow, such that herring might evade the gear. In addition, there should be inter-calibration between this net and the method chosen for working in the inaccessible areas.

Femto Acoustic System

The frequency used for almost all of these surveys (75 kHz) is higher than that used most often for herring surveys elsewhere (38 kHz), but seems a good choice for herring at the shallow depths encountered in this survey. The only caveat is that there are no published TS figures available at this frequency, and this required the calculation of a theoretical TS based on that at 38 kHz. This precludes any comparisons of in-situ target strengths should these become available.

Target strength has been calculated based on published theoretical equations. Another approach would be to use the type of Kirchhoff Ray-Mode models developed by Mike Jech of the National Marine Fisheries Service who is an advisor to the project.

The reliability, integrity and functionality of the Femto system seem adequate. Meeting participants examined two cases where the Femto system had been used along with another system in the field (on the F/V Creed and F/V Western Wave). Further documentation of the performance of the Femto system under controlled conditions would be beneficial, including:

- experience of other established acoustic workers with the system;
- further documentation of measured performance (e.g. in comparison to theoretical beam patterns and in tracking of year to year system calibrations); and
- documentation of 'ageing rate' and performance change of the ceramic components of the transceivers.

There was considerable discussion about the use of DGPS derived navigation data. While there is a process to remove obviously bad fixes, there was the suggestion that smoothing of the navigation track be used. Currently the acoustic data are binned over an interval of 20 good navigational fixes. This is a short interval and prone to variation in the presence of "bad fixes." The integration and presentation of the data would be more comparable with others if binned on distance (elementary distance sampling units - EDSU) rather than on (good) fix aggregation rate. The size of the EDSU could be determined by a study of the auto-correlations in the data.

Regarding data acquisition thresholds, it was suggested that each system be operated in a passive mode to acquire a sample of inbound data for that vessel under normal survey operating conditions. This data can provide a baseline dataset for the influence of vessel and other sources of noise.

The protocol used for calibration should be documented more explicitly in the GMRI report[1]. Sound speed should be measured and the resultant value should be used to determine both the TS value for the standard target and the range between transducer face and sphere. Calibration should be done at more than one range if possible. Calibration methods and results should be documented and tracked over time.

[1] GMRI has included more calibration details as an appendix to the final draft of the 2000-2004 report.

Data Treatment and Storage

Documentation was generally sufficient to evaluate data treatment. There are some data from part of one year that are currently unavailable due to data storage format problems. Constant evolution of this project and high turnover of staff pose challenges for data archiving and storage and for the corporate memory that should accompany a data series.

Summary of Panel Recommendations - Primary Questions

Does the GMRI herring acoustic survey information provide the basis for valid input into a stock assessment at present?

The diversity of platforms, locations and degree of coverage, sampling levels and general evolution of the methods compromise the use of existing data as a series. Current data are best treated as six years of exploration.

Can the data collected to date provide useful information if analyzed differently?

By applying a test of consistency (one vessel, one sampling gear, similarity in transect approach, adequate sampling), it may be that the data from some areas in 2003 and 2004 are comparable. The 03/04 data should be explored (combined with critical thinking about objectives and sampling plan) as the basis for development of consistent methods and survey design for future surveys.

The historical data from the acoustic surveys could be used, in combination with literature records and other knowledge of herring spawning to define the precise areas and times of relevance for a 'sentinel' approach to monitoring spawning ground performance.

What would be required to provide more useful information in future?

A large fraction of the herring landed in New England comes from Area 1A. This provides ample rationale for the existence of some sort of survey of Area 1A to provide input required for assessment and management. Acoustic surveys are generally considered to be the survey of choice for herring, and the panel recommends that this technique be continued in this case. There appear to be two survey objectives of potential relevance to assessment: an estimation of biomass in the Area 1A, and an assessment of the ongoing viability of the spawning stocks in Area 1A. These require different survey strategies - a broad systematic survey, and a more focused sentinel approach, respectively.

Development of a systematic survey should include consideration of the following:

- Survey herring while they are more widely distributed prior to spawning.
- Use historical evidence of herring distribution (fishery and previous surveys– perhaps making use of the three key areas of interest to date).
- Timing would ideally be after the Georges Bank fraction has departed the area (September - October).
- Jeffery's Ledge and Schoodic Ridge seem to be of particular interest, and there could be more intense effort in those areas.
- There must be adequate biological sampling (sufficient to determine species and size composition of targets) and intense sampling at first until it is clear where to economize.
- Transect spacing should be examined using a geostatistical approach to determine the minimum spacing. Transect direction should be across the path of any known migration.
- Consideration should be given to making multiple and more widely spaced surveys of the area.
- If possible the survey should include the entire distribution area of the stock of interest.

Development of a sentinel spawning area monitoring survey should consider:

- Target the most important spawning areas in Area 1A (Jeffery's Ledge, Schoodic Ridge, Portland Lightship, Cutler); Jeffery's and Schoodic seem to be key targets for a research program.
- Published information or questionnaire surveys regarding evidence of spawning to help define specific times and locations. There may be sampling approaches other than acoustics that could be used in this survey to overcome limitations by fixed gear, shallow depths, and differences between survey vessels (e.g. egg samplers?).
- Biological sampling must be adequate to determine species composition, spawning stage (in this case looking for ripe and running herring), and size composition (if acoustics is used).

Appendix A

Agenda

Tuesday, March 15

8:00 - 8:15 Arrival, coffee and pastries

8:15 - 8:30 Welcome and introduction

8:30 - 9:00 Project background

9:00 - 12:00 Survey design

12:00 - 1:00 Lunch at GMRI

1:00 - 2:30 Herring management

2:30 -5:00 Biological sampling

Wednesday, March 16

8:00 - 8:10 Arrival, coffee and pastries

8:10 - 8:40 Review of yesterday's discussion

8:40 - 10:30 Femto system data collection and processing

10:30 - 12:00 Survey operations and data editing

12:00 - 1:00 Lunch at GMRI

1:00 - 2:00 Femto system calibration

2:00 - 3:30 Length/weight target strength calculations

3:30 - 5:00 Biomass estimation

Appendix B

Meeting Presentations

Tuesday, March 15

8:30 Project Background: General description of survey beginnings and rationale, vessel selection, and staff and partners. (Kevin Scheirer)

9:00 Survey Design: 20 minute presentation on areas of interest, spatial extent, timing, and transect design – open discussion including design issues and remediation. (Kevin Scheirer)

1:00 Herring management data: Presentation of commercial sampling data statistics, stock component interactions, inshore model, and potential use of SSB index – open discussion. (Matt Cieri)

2:30 Biological Sampling: Presentation of gear types, sampling operations, sampling locations and restrictions, and sample data recording methods – open discussion including sample revisions and oceanographic sampling from the document. (Shale Rosen)

Wednesday, March 16

8:40 Femto DE9320 System: Presentation of echosounder structure, transducer specs, system calibration, and data collection – open discussion. (Allen Clay)

9:30 HDPS Data Processing: Presentation of the processing of data from edited transects to biomass estimates – open discussion. (Allen Clay)

10:30 Survey Operations and HDPS Data Editing: Presentation and open discussion. (Shale Rosen)

1:00 Femto DE9320 System: Calibration. (Allen Clay)

2:00 Length/Weight and Target Strength Calculations: Presentation of the equations and the Excel file used for sample data entry and target strength calculation – open discussion. (Kevin Scheirer)

3:30 Biomass estimation: Presentation of strata selection and composition, sample and strata revisions, and revised biomass estimates for SSB index – open discussion. (Kevin Scheirer)

Appendix C

Terms of Reference and Evaluation Criteria

Terms of Reference

The review panel was asked by GMRI to address the following:

1. Review the various survey designs used, including their strengths, weaknesses, and potential biases. Recommend any changes to current survey design and timing given the results of the review.
2. Review the survey operations conducted in each year and comment on the credibility and consistency of the methods used. Provide recommendations on improvements to these methods.
3. Evaluate the integrity, functionality, and reliability of the Femto DE9320 system hardware and software. Evaluate the use of 75 kHz to conduct acoustic surveys for herring, and the reliability of a single frequency for species discrimination.
4. Review the data recording, archiving, and editing methods. Provide advice on best practices for acoustic data editing and the use of HDPS features, as well as improvements to general data management.
5. Compare the estimation of length-weight regression and target strength values with standard methods and provide recommendations on the best methods.
6. Review the acoustic data integration and processing methods. Suggest improvements to methods of transect selection, survey area estimation, biomass estimation, and partitioning by size/age class and by species.
7. Review the biological sampling aspects of the surveys. Recommend modifications if necessary.
8. Provide recommendations on the utility of the acoustic spawning stock biomass trend as a stock assessment model index in current and future assessments and management. Recommend any improvements.

Evaluation Criteria

The review panel was asked by the Northeast Consortium to addresses the criteria listed below, noting specific strengths and weaknesses of the project. Panelists were asked to consider all criteria, but focus their evaluation on the second, using the Terms of Reference as the basis of their analysis. The criteria have been developed for the review of Northeast Consortium-funded projects that are complete. Since the herring survey is an ongoing project, some of the criteria may not apply. For example, the public posting of data usually occurs upon project completion.

1. Project success: Did the project accomplish its stated goals and objectives?

2. Certification of results: Is there adequate description of the approaches to experimental design, methods, and data analysis? Were these approaches

appropriate? Are there other approaches that the participants should have considered or used? Are the data accurate, precise, and believable? Are the results and conclusions well supported by the data and statistically valid? Can the results and conclusions contribute to a sound basis for management decisions and policies?

3. Data accessibility and dissemination of results: Are the data available through the Northeast Consortium Fisheries and Ocean Data Management System? Are the data being served via another internet-accessible database? If so, are the data formatted suitably for data integration by the Northeast Consortium database? Is the final report complete, sufficient, of high quality, and understandable to end-users?

4. Project partnerships: Consider the degree to which the project was of mutual interest to participants and whether partners were key participants throughout the course of the project, including project design, data collection and analysis, and application of the results or products. What were the most and least successful aspects of the partnership? Were all parties equally interested and engaged in the project?

5. Project impacts: What impacts has the project had or could it have? What are the potential effects on fishing practices; socio-economics; and fisheries, coastal, and ocean management?

6. End-Users: Being as specific as possible, who could benefit from knowing about the research? How can a fishing sector incorporate any new information from the project? Which fishery management organization, working group, or plan development team could use the data?

7. Overall rating. Rate the overall project as excellent, very good, good, fair, or poor. Explain the reasoning behind the rating.

8. Future research. Is additional research needed to answer the original questions posed by the project? Are there obvious avenues of further research that should or must be pursued? Should this future research be a high priority for the Northeast Consortium?

9. Additional comments and guidance. Provide any additional comments that will assist the Northeast Consortium in evaluating this project.