

CRUISE RESULTS

NOAA Fisheries Research Vessel DELAWARE II
Cruise DE 08-09 (Parts I - III)

Atlantic Herring Acoustic Survey

CRUISE PERIOD AND AREA

Cruise operations were conducted on the continental shelf (depths to 350 m) in the Gulf of Maine and northern Georges Bank regions, including the Canadian Exclusive Economic Zone on eastern Georges Bank. The 2008 Fall Atlantic Herring Acoustic Survey was conducted during three parts between 2 September and 10 October 2008 (Figures 1-3). Part I of the survey (2-12 September) was dedicated to calibrating the scientific echo sounders on the FV Delaware II, collecting acoustic and optical data with the Advanced Fisheries Tow Vehicle (AFTV), and conducting collaborative acoustic research and biological sampling with the RV ENDEAVOR in the Georges Bank region. The annual systematic acoustic and biological survey of Atlantic herring was conducted in the Georges Bank region during Part II (15-26 September) and into Part III. Part III of the cruise (2-13 October) was dedicated to completing the herring survey, a fine-scale acoustic survey and experimental acoustic and optical measurements in the Georges Bank region as well as a systematic survey of Atlantic herring in the Jeffreys Ledge region.

OBJECTIVES

The Northeast Fisheries Science Center (NEFSC) conducts annual Atlantic Herring acoustic surveys each autumn on the historical spawning grounds of Atlantic herring (*Clupea harengus*) in the Georges Bank and Gulf of Maine regions. The main goal of this cruise was to provide timely and accurate fisheries-independent estimates of herring spawning stock biomass using state-of-the-art technologies. Operational objectives were to (1) calibrate the EK500 Scientific Sounder, (2) participate in a collaborative acoustic experiment on Georges Bank, (3) collect acoustic and optic data with the Advanced Fisheries Tow Vehicle, (4) conduct systematic acoustic surveys of selected Atlantic herring spawning stocks, (5) collect *in situ* target strength data with the EK500 and EK60, and (6) collect biological data to verify species-specific acoustic measurements using midwater trawls and underwater video.

METHODS

Calibrations and Ambient Noise Tests of the EK500: Calibrations are required during each survey to ensure data quality and verify echo sounder performance. The EK500 was calibrated by suspending standard calibration spheres of known target strength under

each transducer from three monofilament lines. A calibration sphere was centered in the far field of each transducer and moved throughout the acoustic beam beneath the vessel using remotely controlled downriggers. The 18-, 38-, and 120-kHz split-beam transducers were calibrated in Cape Cod Bay. Noise tests of the EK500 were conducted dockside and while the vessel was underway at 10 knots (survey speed).

Simrad EK500 Scientific Sounder: The Simrad EK500 Scientific Sounder was the primary sampling gear used during the acoustic surveys for providing species-specific abundance estimates. The EK500 operated three hull-mounted transducers (18-, 38-, and 120-kHz split-beam transducers). The EK500 was interfaced via TCP/IP Ethernet to the FRV DELAWARE'S SCS server for data logging using SonarData EchoLog software. RS232 connections were used for navigational (Differential GPS) input. An EchoConfig script file was executed to start EK500 data acquisition to ensure that the same parameter settings were used throughout the cruise. The SCS Event Log was used to record all operational events (e.g., begin and end points of transects, stations, gear deployments, and other events that affect the track cruise and vessel speed) during the cruise.

Advanced Fisheries Towed Vehicle (AFTV): The AFTV is designed to deploy integrated acoustical, optical, and environmental sensors for verifying acoustic backscatter from the water column and seafloor. The AFTV was deployed using a portable fiber optic winch system equipped with 2000 m of 0.322 cable, and has an overall weight of about 5,000 lb. The cable has three single mode fiber optic and three copper conductors, and has an 11,000 lb/ft breaking strength rating. The AFTV towbody weighs about 900 lb and is approximately 7 ft in length. The AFTV also had a 100 lb counter weight arranged about 20 m in front of the towbody to dampen the vessel motion for maintaining the horizontal stability of the towbody. This required a two point deployment approach using the vessel's A-frame and articulating crane on the aft deck. The AFTV was configured with an EK60 38 kHz, CTD, motion sensor, and various underwater cameras and lighting. The AFTV was towed intermittently at relatively slow speeds (1-3 knots) above the seafloor and throughout the water column to collect *in situ* target strength data and verify acoustic backscatter.

Dual-frequency IDentification SONar (DIDSON). A DIDSON sonar was installed on the AFTV during Part I of the cruise. The DIDSON uses acoustic lens technology to collect very high resolution acoustic data. Using the DIDSON, individual fish and their behavior can be monitored. The DIDSON was located in the forward portion of the AFTV and was focused looking forward.

Acoustic Survey Operations: EK500 data were collected continuously throughout the cruise. During the surveys, a constant ship speed of 10 ± 1 knots was maintained. Vessel speed was reduced to no less than 8 knots during rough seas. EK500 operations were generally suspended when seas exceeded 2 m. Each transect was assigned a sequential number throughout the cruise. A transect was defined as a portion of the cruise track with a constant heading and ship speed. All scientific gear deployments were also assigned a unique, sequential deployment number.

EK500 and EK60 Target Strength Measurements: Target strength measurements with the hull-mounted EK500 split-beam transducers and with the AFTV-mounted 38-kHz EK60 split-beam transducer (ES38-DD) were collected on selected fish aggregations. The vessel was positioned over aggregations, and the towbody was deployed from the vessel's aft A-frame while drifting for 30-60 minutes.

SonarData Echoview Post-processor: SonarData software (v. 4.4) was used for data acquisition and post-processing of EK500 data during the cruise. Echoview was used to conduct preliminary post-processing of EK500 data at sea, which involved removing extraneous bottom echoes and/or water column noise. Echoview was also used to partition acoustic backscatter to Atlantic herring. EK500 data and Echoview files were logged and archived directly to the SCS system via a TCP/IP Ethernet connection. Three computers were set up for the acoustic data. One computer was used for EK500 data acquisition using EchoLog. This computer was located in the SCS room and was part of the SCS system. The other two computers were set up in the dry lab, with one computer used for post-processing and the other used for viewing data in real time.

Irish Herring Midwater Trawl (IHMT): The IMHT midwater trawl was used to collect biological samples and verify species composition of acoustic backscatter. The IMHT was designed to be fished at speeds of about 4 knots. The IMHT was deployed during survey operations, and targeted on acoustic backscatter. The IMHT was towed at about 4 knots, depending on trawl performance and water currents. The duration and depth of the trawls were not standardized, and the Chief Scientist or Watch Chief communicated with the bridge officers as to the haul duration and depths. The Simrad FS903 was deployed with every haul. Officers recorded the time, date, navigational, and station data in FSCS, while the scientists recorded the catch and ITI data for each station deployment. Catch data was recorded using the FSCS on-board entry system.

Simrad FS903 Trawl Monitoring and Third-wire Winch System: The trawl was monitored during fishing operations using the FS903. The Simrad FS903 Trawl Monitoring System was a third-wire device that provided real-time trawl performance information through its sonar images of the trawl opening. The scientific party recorded measurements on hardcopy forms at specified intervals during each deployment.

Scientific Computer System (SCS) and Fisheries Scientific Computer System (FSCS): The SCS system is a PC-based server, which continuously collects and distributes scientific data from various navigational, oceanographic, meteorological, and sampling sensors throughout the cruise. The SCS Event Log program was configured for NEFSC Fisheries Acoustic Survey operations, and was used by the scientists to document all operational events (*e.g.*, begin and end of transects and deployments). Dates and times were synchronized using the vessel's GPS master clock and Dimension IV software. The FSCS system was used for on-board data logging of the biological and catch data.

Conductivity-Temperature-Depth (CTD) Profiler: A Seabird CTD profiler was deployed at the beginning and ending of each transect, and at the beginning of each scientific gear

deployment to define the hydrographic conditions in the study area. Water bottle casts were also deployed twice per day to collect salinity samples.

Vemco Minilog Probes: Temperature-depth probes (set at a 2 sec sampling rate) were attached to the midwater trawl headrope and footrope during trawl hauls.

Biological Sampling: Trawl catches were sorted by species, weighed and measured (to the nearest cm FL) according to standard NEFSC procedures. For Atlantic herring, subsamples were taken for each trawl haul for detailed lengths (FL in mm), individual weights (to nearest 0.1 g), sex/maturity staging, and otolith samples (freeze herring whole). Subsampling protocol was 1 fish per centimeter length class for herring less than 25 cm and 3 fish per centimeter length class for herring 25 cm and longer. The FSCS system was used for on-board entry and auditing of trawl station and biological data. Biological data were transferred to the NEFSC for auditing.

RESULTS

Part I

The first portion of Part I was dedicated to calibrating the hull-mounted EK500, collecting data with the Advanced Fisheries Tow Vehicle (AFTV), and participating in a collaborative acoustic experiment with WHOI and NRL scientists on the RV ENDEAVOR. The AFTV was loaded on the DELEWARE II, and initial testing, trouble shooting, and evaluation was completed on the 2nd and 3rd. The DELAWARE II departed the Fisheries dock on Sept. 4 and headed to Cape Cod Bay to calibrate the EK500.

The 18-, 38-, and 120-kHz EK500 echo sounders were successfully calibrated in Cape Cod Bay. S_v and TS gain setting changes were within tolerance levels ($\pm .25$ dB). A CTD profile was collected at the calibration site. The calibration site was located about five miles southwest of Provincetown, MA. After the calibrations, the vessel steamed to Georges Bank to participate in a collaborative acoustic experiment with the RV ENDEAVOR. The experiment consisted of a small scale systematic survey with parallel transects, oriented north-south with approximately 5 nmi spacing between transects (Fig. 1). Scientists on board the RV ENDEAVOR collected broad-band acoustic data. CTD profiles were collected at the beginning and end of each parallel transect. Trawl locations were chosen on an *ad hoc* basis when fish were present. This experimental survey was conducted from September 5 to 11. During this portion, an impending hurricane forced us to anchor in Provincetown Bay. The storm moved quickly and we were able to get back to Georges Bank within about 24 hours. While anchored in Provincetown, we calibrated the EK60 on the AFTV. At the conclusion of the survey, the DELEWARE II steamed back to Woods Hole and arrived the morning of Sept. 12.

During this portion of the cruise 55 deployments (5 AFTV, 31 CTD, and 19 trawl deployments) and 22 transects were completed.

Part II

The goal of Part II was to conduct the annual systematic acoustic survey of Atlantic herring along the northern edge of Georges Bank and southern Gulf of Maine. Survey operations included EK500 acoustic data acquisition, midwater trawl hauls, and CTD profiles. The vessel departed Woods Hole on Sept. 15 and steamed to the northeast peak of Georges Bank. The vessel arrived on station on Sept. 16 and we commenced the survey (Fig. 2). The survey consisted of parallel transects oriented north-south with 10 nmi spacing. Survey speed was consistently 10 ± 1 knots. CTD profiles were completed at the beginning and end of each transect and immediately prior to each trawl haul. Trawl locations were selected on an *ad hoc* basis to sample the acoustic backscatter.

Due to windy conditions throughout a good portion of Part II, trawling operations were limited to relatively calm periods. The sea state did not prevent acoustic operations, thus it was necessary to collect acoustic data along the transects, mark locations of herring aggregations, and when the weather calmed down, backtrack to trawl on the marked sites. In these cases (there were two occasions during the survey when we needed to backtrack), we steamed 10 nmi north of the trawl mark along that parallel transect, steamed south until we encountered herring and then set the trawl. After the trawl was completed, we steamed 10 nmi north of the next mark and repeated the process until all trawl sites were completed. We then steamed back to where we previously stopped transecting and resumed normal operations. During the AFTV deployment, a communication problem with the AFTV was caused by a broken fiber optic termination. We were able to use a fiber optic cable from the DE II to communicate with the AFTV, but due to rough weather, we were unable to deploy the AFTV. Due to an impending storm, we suspended survey operations on Sept. 24 to steam back to Woods Hole. The survey recommenced during Part III. This portion of the survey was completed on Sept. 24, with a total of 26 trawls, 4 neuston tows, 1 AFTV deployment, 46 CTD profiles and 27 transects (parallel and crossover) completed.

Part III

The first portion of Part III was dedicated to completing the herring survey in the Great South Channel and near Cape Cod (Fig. 3). The survey was completed on Oct. 2 with an additional 7 trawls, 1 neuston tow, 1 AFTV deployment, 16 CTD profiles, and 9 transects completed. During the AFTV deployment, we developed a problem with powering the system and we determined that a power transformer had gone bad and rendered the AFTV unusable for the rest of the cruise. At the conclusion of the survey, we steamed to Jeffreys Ledge to conduct a systematic survey of Atlantic herring.

We commenced the survey for Atlantic herring on Oct. 2 at the north end of Jeffreys Ledge. The survey consisted of parallel transects, oriented east – west with 4 nmi spacing. CTD profiles were collected at the beginning and end of every 2nd parallel transect and trawl locations were selected on an *ad hoc* basis.

During this survey the ship's crew developed a personnel problem and we needed to take the chief boatswain off the vessel. The DELAWARE steamed from Jeffreys Ledge to the Coast Guard station in Sandwich (the mouth the Cape Cod Canal) to drop off the

boatswain. Without the boatswain, we were unable to conduct 24 hour trawl operations. Therefore the scientific schedule was to conduct acoustic operations 24/7 but trawling operations during one of the deck watches (12 hours). The Jeffreys Ledge survey ended on Oct. 6 and we steamed to Cape Cod Bay to do a final calibration of the EK500. This calibration was done at the same site southwest of Provincetown as during Part I. Upon completion of the successful calibration, all echosounders were within tolerances, we steamed back to Georges Bank to continue acoustic and optic measurements of Atlantic herring.

During Oct. 6 – 10, we conducted day-night comparison transects to examine whether diurnal patterns in Atlantic herring behavior affect abundance estimates. Transects of about 40 nmi, oriented north-south and with 5 nmi spacing, were arranged so that a transect was sampled twice during the day and once during the night. Acoustic data were collected along the transect, and one trawl was completed during the day, and one trawl at night.

This survey was completed on Oct. 10, with a total of 26 trawls, 5 neuston tows, 55 CTD profiles, 1 AFTV deployment, and 46 transects completed during Part III.

DISPOSITION OF DATA

Data and results were archived at the Northeast Fisheries Science Center (NEFSC). Data and results are available on CD-ROM or other media. Cruise reports and results are also available at the NEFSC website:

<http://www.nefsc.noaa.gov/femad/ecosurvey/acoustics/>

SCIENTIFIC PERSONNEL

National Marine Fisheries Service, NEFSC, Woods Hole, MA

Michael Jech (Chief Scientist – Parts I, II)	Research Fishery Biologist	Parts I, II, III
Joseph Godlewski (Chief Scientist – Part III)	Electronics Engineer	Parts I, III
Richard Raynes	Gear Specialist	Part I
Takashi Arbusto	Gear Specialist	Part II
Sarah Pike	Grants & Acquisition	Part III
Robert Alexander	Gear Specialist	Part III

National Marine Fisheries Service, NEFSC, Milford, CT

David Veilleux	Lab Technician	Part III
----------------	----------------	----------

Contractors, NEFSC, Woods Hole, MA

Robert Gamble	Acoustic Scientist	Part II
Francine Stroman	Fisheries Biologist	Parts I, II
Debra Duarte	Fisheries Biologist	Part II
Joshua Cutler	Fisheries Biologist	Part III

City University of New York, New York, NY

Marie-Caroline Martin	Graduate Student	Parts I, II, III
Timothy P. White	Graduate Student	Parts I, II, III

Volunteers

Genevieve Ellison	Dover, NH	Part I
Jaqueline Ostrom	Colorado Springs, CO	Parts I, II
Marilyn Frydrych	Colorado Springs, CO	Part II
Mark Burgess	Dennisport, MA	Part III

Part I: 2 – 12 September 2008

Part II: 15 – 26 September 2008

Part III: 29 September - 10 October 2008

For further information please contact: Michael Jech, National Marine Fisheries Service, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, Massachusetts 02543-1097. Telephone (508) 495-2000.

Email: Michael.Jech@noaa.gov

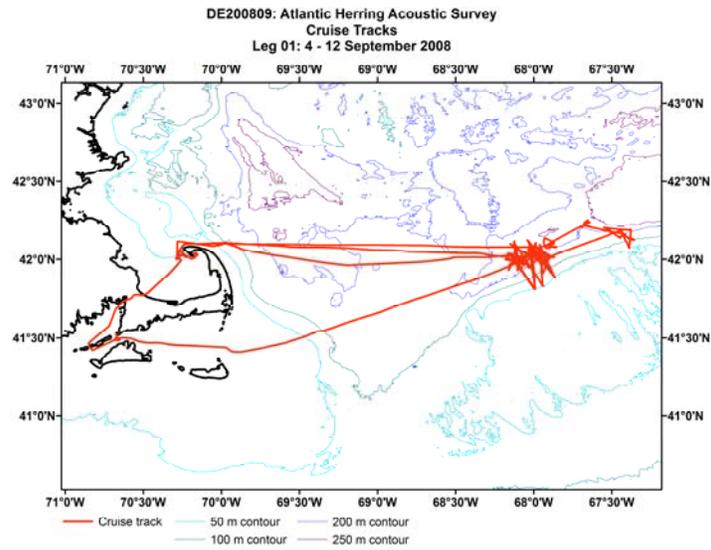


Figure 1. Part I (September 2-12, 2008) area of operations and cruise track for DE200809, Atlantic herring acoustic survey.

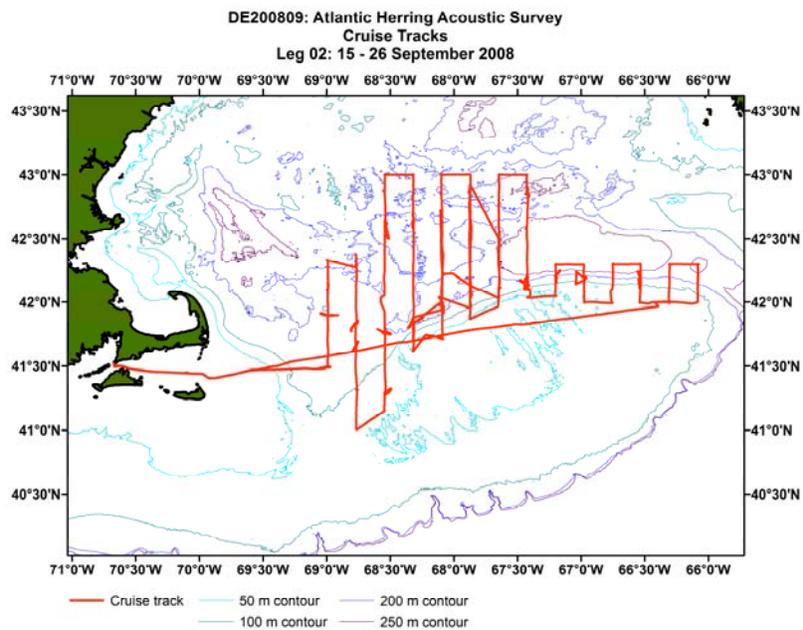


Figure 2. Part II (September 15-26, 2008) area of operations and cruise track for DE200809, Atlantic herring acoustic survey.

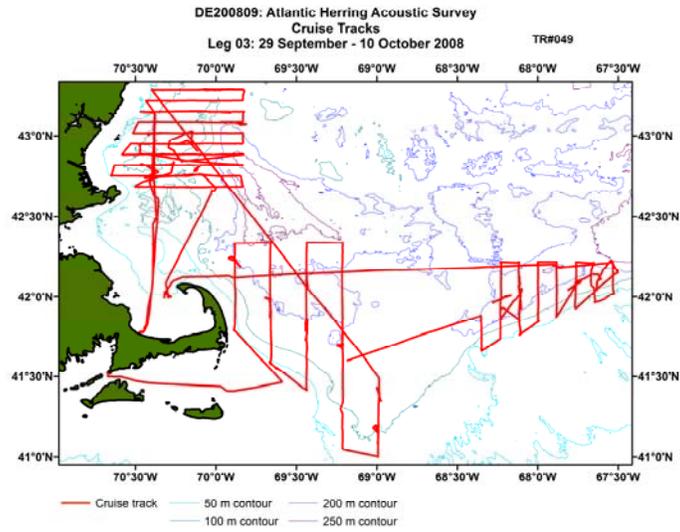


Figure 3. Part III (September 29 - October 10, 2008) area of operations and cruise track for DE200809, Atlantic herring acoustic survey.