UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
166 Water Street
Woods Hole, MA 02543

June 16, 1999

CRUISE RESULTS

NOAA Fisheries Research Vessel DELAWARE II
Cruise number DE 98-10 (Parts I and II)

1998 Fall Herring Acoustic Survey

CRUISE PERIOD AND AREA

The 1998 Fall Herring Acoustic Survey was conducted in two parts; Part I was a broad-scale survey in the Gulf of Maine and northern Georges Bank regions during September 8 - 17 (Fig. 1), and Part II consisted of a series of fine-scale surveys in the Jeffreys Ledge, Fippennies Ledge, Cashes Ledge, and the northern flank of Georges Bank regions during October 2 - 11, 1998 (Fig. 2). Scientific operations were completed with an *in-situ* acoustic experiment on Atlantic herring in the northern Georges Bank region during October 9 - 10, 1998.

OBJECTIVE

The primary cruise objective was to conduct a systematic acoustic survey on selected Atlantic herring stocks in the Gulf of Maine and Georges Bank regions during the fall of 1998. The 1998 Fall Herring Acoustic Survey was the first in a series of annual standardized acoustic surveys to be conducted by the Northeast Fisheries Science Center (NEFSC). The goal was to implement state-of-the-art hydroacoustic technology for deriving improved fisheries-independent abundance estimates on selected Atlantic herring stocks during the fall. An *in-situ* acoustic experiment with underwater video observations were also conducted on Atlantic herring to document the diel variability their acoustical backscatter and individual target strength (TS) measurements in relation to their behavioral patterns.

METHODS

Survey Design:

Scientific operations during Part I involved a broad-scale systematic survey design across the Gulf of Maine comprised of west-east parallel transects and north-south crossover transects (Fig. 1). A systematic zig-zag transect survey was used across the northern flank of Georges Bank which was considered a more effective design to use across slope gradients. Transects during the cruise were sequentially numbered, and a transect was defined as the portion of cruise track between two points where ship speed and heading remained constant. Midwater trawl and underwater video gear were deployed to identify acoustic backscatter. Sequential deployment numbers were assigned for each deployment throughout the cruise.

During Part II, a series of parallel transects were used to conduct fine-scale surveys on Jeffreys Ledge, Fippennies Ledge, and Cashes Ledge, while a zig-zag transect design was used in the northern Georges bank region (Fig. 2). Fine-scale surveys were generally repeated at set times in an effort to obtain day and night abundance estimates from each offshore bank. Survey operations were conducted at a consist ship speed of 10 knots, and was occasionally slowed to 8 knots during rough weather. During the last day of scientific operations, the *in-situ* TS experiment was conducted along a short transect at 5 knots on northern Georges Bank. This transect was repeated during the dusk, night, day, and dawn period to observed the diel variability in herring backscatter and TS.

<u>EK500 Sampling Operations</u>:

The multifrequency Simrad EK500 (v.5.30) Scientific Sounder system sampled acoustical data continuously throughout the cruise track at a rate of one ping per two seconds. EK500 data was collected simultaneously from three downward looking hull-mounted transducers (one single-beam transducer operating at 12 kHz, and two split-beam transducers at 38 and 120 kHz). The 38 and 120 kHz split-beam transducers were calibrated using the standard sphere technique (refer to Cruise Results DE 98-09 for further details). Gain and angle offset parameters were derived using the Simrad Lobe (v.95-01-17) program. The single-beam 12 kHz transducer was not successfully calibrated, therefore 12 kHz calibration settings were used from a 1997 bioacoustic study (refer to Cruise Report DE 97-08). Ambient noise tests were conducted to ensure there were no cross-interference between acoustical instrumentation. The EK500 operations were synchronized with the external trigger of the omni-directional sonar to eliminate acoustic cross-interference during survey operations. The EK500 echo-integrator vertically integrated volume backscatter (S_v in units of m^2/m^3) into 0.5 m depth increments. Volume backscatter was converted to cross-sectional backscatter (S_a in units of m^2/nm^2) as a relative index of abundance along the cruise track. Individual target strength (TS) measurements were also collected by the EK500. The EK500 data were logged to the Simrad BI500 Bergen Integrator (release 1.9.1996) via TCP/IP ETHERNET line. The EK500 received its navigational input from the vessel's Scientific Computer System (SCS) PCODE output. A SUN Sparc-10 workstation operated the BI500 which logged, processed, and archived EK500 data as binary files into the UNIX-based INGRES relational database. The BI500 post-processor was used to filter unwanted noise and partition acoustic backscatter by species composition.

<u>High Speed Midwater Rope Trawl (HSMRT) Sampling Operations</u>:

The High Speed Midwater Rope Trawl (HSMRT) was the main sampling gear used to verify fish backscatter identified by the EK500. The HSMRT is a four seam pelagic trawl design with 53.1 m headrope, footrope, and breastlines. The HSMRT was rigged to 1.8 m^2 double-foiled Suberkrub-type doors with 62.4 m of upper and lower bridles/legs. The optimum tow configuration (2.5 m setback, 227 kg tomweights, intermediate door spread with two shoe weights per door) was implemented for the survey operations (refer to Cruise Results DE 98-09 for further details).

HSMRT deployments were targeted on selected backscatter along the cruise track, and an attempt was made to deploy the HSMRT about four times per day. The HSMRT was towed at an average speed of 4.5 knots typically for 30 minutes in duration. However, duration varied occasionally between 20 to 40 minutes depending on acoustic fish signals observed during the tow. The tow profile of the trawl dropped incrementally through the water column to the desired depth of the scattering layer or about 10 m off the bottom, held at that depth for the duration depending on the fish targets observed by the FS903 trawl monitoring system, and then retrieved back to the surface. The Simrad FS903 Trawl Monitoring System is a third-wire device that provided real-time sonar images of the trawl opening and performance. The Simrad ITI wireless trawl sensors were also used to obtain point measurements of the trawl depth, wing spread, and door spread. Minilog depth-temperature probes were attached to the trawl headrope and footrope to provide continuous depth-temperature profile data for each deployment.

Biological Sampling:

The catch from each trawl was sorted by species, weighed, and measured (fork length to the nearest cm). Additional subsampling for Atlantic herring included individual weight (to nearest 0.1 g), fork and total lengths (nearest mm), stomach content analyses, and otolith samples for aging.

Furuno CSH-5 Omni-directional Sonar:

The FRV DELAWARE's Furuno CSH-5 Omni-directional Sonar system was used during survey operations for detecting fish schools. The CSH-5 sonar simultaneously scans a full 360^0 with a cone-shaped receiving beam. Its beam can be tilted at various angles from the surface, and the center of its beam was usually angled 7^0 from the surface during calm weather. During rough weather, the beam tilt angle was set at 10^0 to eliminate surface noise. The vertical width of the receiving beam is 15^0 resulting in a horizontal search radius of 800 m when bottom depths were around 200 m. The search radius on the display was set to 400 m during most of the survey operations. In shallow waters of less than 80 m depth, the search radius was lowered to 250 m. The omni-directional sonar operated at 55-64 kHz, which was determined to cause interference with the EK500 operations. This acoustical interference was eliminated by wiring the external trigger of the omni-directional sonar to the EK500 which controlled its ping rate. The omni-directional sonar images were captured by a video capture-board every 30 seconds, and the files were merged with the SCS navigational data and archived.

Static Underwater Stereo Video System:

The Static Underwater Stereo Video System (SUSVS) was designed by the NEFSC Fisheries Acoustics Research Group to directly verify acoustic targets within the EK500 beam. The SUSVS was deployed midship along-side the acoustic beam of the EK500 while the FRV DELAWARE drifted over backscatter aggregations. Matched underwater video cameras (DSP&L MicroSea B&W 1050) were mounted in the array to obtain stereo imagery of targets. The cameras have a low light (0.05 lux) auto adjusting iris with a 77^0 horizontal and 59^0 vertical view field. A pair of DSP&L SeaLasers 100-15 were mounted in parallel (5.4 cm off center) for measuring target size. Two DSP&L SeaLites provided illumination that were dimmed remotely using a 120 v voltage regulator. The real-time depth profile, temperature, compass bearing, and three-dimensional orientation of the camera system were recorded every 10 seconds using the JASCO Attitude Sensor. Real-time dual video and environmental data were recorded from the SUSVS through a 300 m multi-conductor cable to a PC computer and SVHS video recorders. Stereo video was synchronized using a Horita time-code generator.

Scientific Computer System (SCS):

The FRV DELAWARE's Scientific Computer System (SCS) continuously collected navigational, oceanographic, and meteorological data at a rate of every 30 seconds throughout the cruise track. All computers, instrumentation, acoustic data collection, and data recording were synchronized according to the FRV DELAWARE's SCS master clock.

RESULTS

EK500 calibrations and trawl performance tests were conducted successfully during the shakedown of Part I (Fig. 1). The split-beam 38 and 120 kHz transducers were calibrated at sea while drifting with a high degree of precision and accuracy. The TS gain, 3-dB beamwidth, mechanical offset angles, and S_v gain values were similar to calibrations conducted during previous cruises (refer to cruise results DE 97-08 and DE 98-02). The 12 kHz transducer could not be calibrated due to the lack of directionality of the single-beam transducer and the need to have the sphere more than 35 m from the transducer. Therefore, calibration settings from last year's calibration were used for the 12 kHz.

During Part I, broad-scale systematic surveys were completed in the Gulf of Maine and northern Georges Bank regions (Fig. 1). Fine-scale systematic surveys were conducted on Jeffreys Ledge, coastal Maine, Fippennies Ledge, and Cashes Ledge during Part II (Fig. 2). The survey on northern Georges Bank was also repeated during Part II. A total of 20 midwater trawl deployments (HSMRT # 37 - 53, 56, 60) and five underwater video deployments (VIDEO # 54, 55, 57 - 59) were completed during the cruise (Table 1). Acoustical data was collected from approximately 1,455 nautical miles of cruise track (Transect # 120 - 229) during the survey (Table 2).

The broad-scale survey during Part I showed relatively low cross-sectional backscatter (S_a less than 2,000 m^2/nm^2) throughout the Gulf of Maine. The highest concentration of Atlantic herring were observed along the northern flank of Georges Bank, with herring aggregations showing S_a values greater than 10,000 m^2/nm^2. Atlantic herring were confirmed as the predominant fish species along the northern flank of Georges Bank from trawl catches and underwater video observations. Atlantic herring were also most common in the Cashes Ledge region. The acoustical signature of herring during the survey period could easily be identified from other backscatter in terms of individual target strengths and school morphology, while the backscatter from silver hake were most similar to herring. However, few silver hake were captured in the areas that Atlantic herring aggregated. In contrast, silver hake were more common than herring in the inshore surveys areas of Jeffreys Ledge and Fippennies Ledge.

Similar to observations from the 1997 acoustic experiment (refer to Cruise Result DE 97-08), herring backscatter appeared to be greater during the night when they vertically migrated to surface waters to feed. Atlantic herring were typically close to the bottom during the day. Diel variability in the acoustic measurements of Atlantic herring indicated that their acoustic backscatter were greater and individual target strengths were lower during the night.

The HSMRT trawl performed well during survey operations with an average vertical and horizontal net opening of 13 + 3 and 27 + 5 m, respectively. The HSMRT could easily be towed at 4.5 knots by the FRV DELAWARE which targeted the trawl into scattering layers to within 10 m off the bottom using the third-wire FS903 monitoring system. Individual fish targets passing into the trawl were observed from FS903 sonar display which often provided for a shorter tow duration for obtaining the required scientific sample size.

The Static Underwater Stereo Video System (SUSVS) was deployed on fish backscatter and in areas where midwater trawl could not be conducted due to shallow depths or fixed gear. Atlantic herring as well as other organisms (e.g., silver hake, euphausiids, Pandalid shrimp) were observed during some of the SUSVS deployments, however the its lights often caused an avoidance problem. Backscatter was often observed around the SUSVS when lights were off, then the backscatter would quickly disappear when the lights were turned on. There were some deployments when herring could easily be observed schooling and feeding when the lights were on. The SUSVS was considered a useful tool to directly confirm backscatter at times while drifting, however future developments need to be made to the system to minimize avoidance problems.

An event log was hand-entered during the cruise to help manage the various data bases in terms of key reference variables (e.g., date, time, transect and deployment numbers, EK500 log). An improved event logging procedure using a modified SCS Event-Logger program needs to be developed for next year’s cruise to ensure a more accurate and automated time stamp among all data bases.

DISPOSITION OF DATA

All data and results were archived at the Northeast Fisheries Science Center, and will be available through the NEFSC Oracle relational data management system.

SCIENTIFIC PERSONNEL

National Marine Fisheries Service, NEFSC, Woods Hole, MA

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William Overholtz	Research Fisheries Biologist	I
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Jewel Parham	Biological Laboratory Technician	II
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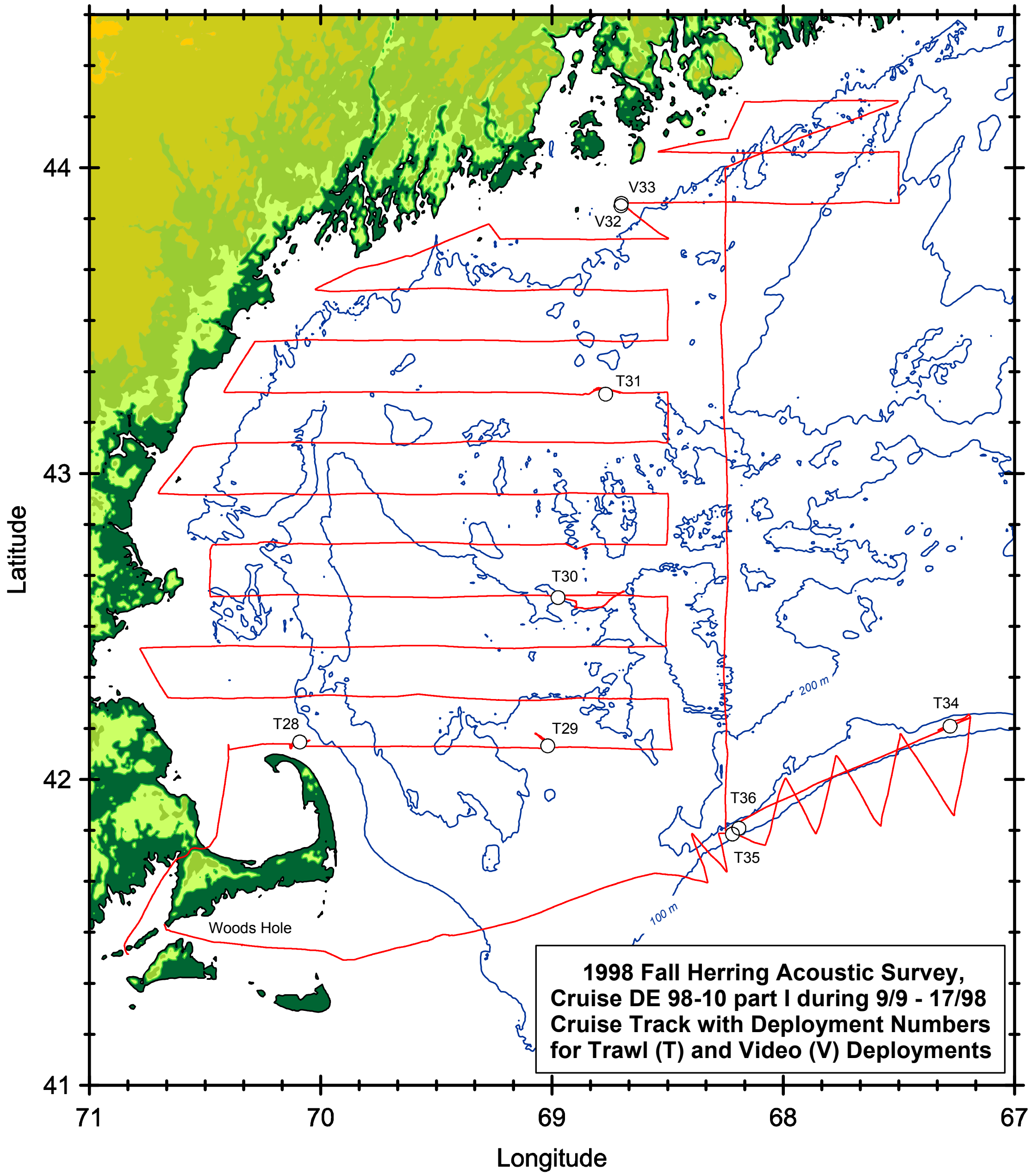

Figure 1. Cruise track and deployment numbers for the 1998 Fall Herring Acoustic Survey DE 98-10 Part I during September 3 - 17, 1998.

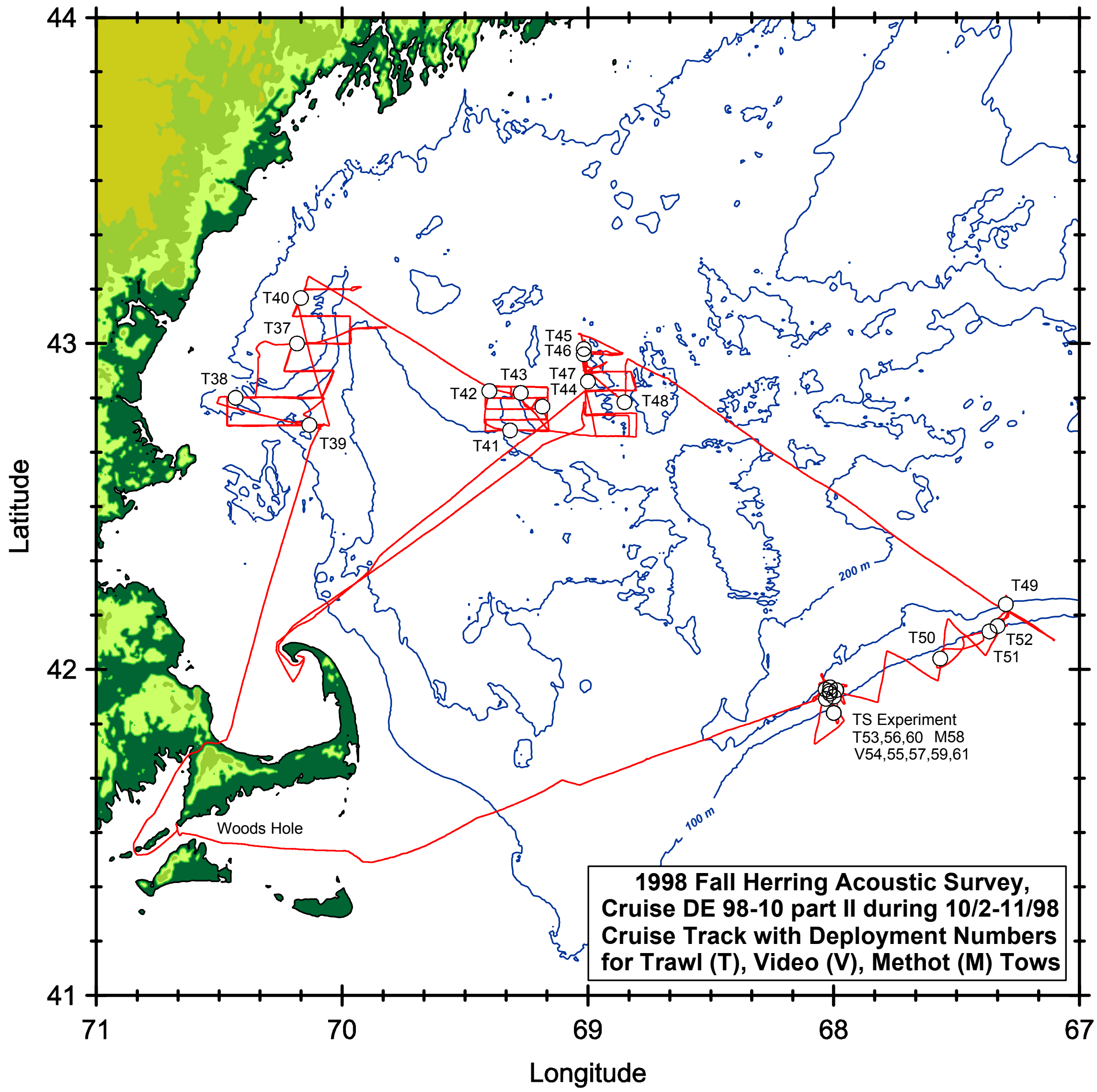

Figure 2. Cruise track and deployment numbers for the 1998 Fall Herring Acoustic Survey DE 98-10 part II during October 2 - 11, 1998.

Table 1. Deployment table for the 1998 Fall Herring Acoustic Survey DE 98-10 parts I and II.

Site	Transect	Deploy	Gear	B_Date	B_Time	B_Lat	B_Lon	B_Vlog	E_Date	E_Time	E_Lat	E_Lon	E_Vlog
Jeffreys_L	152	37	HSMRT	10/4/98	18:53:00	43 00.04	70 11.64	2090.7	10/4/98	19:23:00	42 59.82	70 14.48	2092.9
Jeffreys_L	153	38	HSMRT	10/4/98	23:02:00	42 50.16	70 26.27	2111.5	10/4/98	23:35:00	42 50.21	70 29.14	2113.5
Jeffreys_L	154	39	HSMRT	10/5/98	1:55:00	42 44.91	70 07.88	---	10/5/98	2:25:00	42 44.97	70 05.04	---
Jeffreys_L	155	40	HSMRT	10/5/98	5:14:00	43 08.14	70 10.19	---	10/5/98	5:44:00	43 10.14	70 09.08	---
Fippen_L	166	41	HSMRT	10/5/98	16:39:00	42 44.06	69 18.58	---	10/5/98	17:09:00	42 44.22	69 21.22	---
Fippen_L	168	42	HSMRT	10/5/98	18:38:00	42 51.88	69 24.09	2283.7	10/5/98	19:31:00	42 52.11	69 19.40	---
Fippen_L	179	43	HSMRT	10/6/98	5:52:00	42 50.66	69 16.47	---	10/6/98	6:22:00	42 48.78	69 15.56	---
Fippen_L	180	44	HSMRT	10/6/98	7:29:00	42 48.68	69 11.20	2376.5	10/6/98	8:03:00	42 46.47	69 10.23	---
Cashes_L	193	45	HSMRT	10/7/98	15:00:00	42 58.84	69 00.52	---	10/7/98	15:30:00	42 56.77	69 00.30	---
Cashes_L	193	46	HSMRT	10/7/98	21:05:00	42 57.70	69 01.12	---	10/7/98	21:35:00	42 59.75	69 01.29	---
Cashes_L	204	47	HSMRT	10/8/98	5:48:00	42 53.83	69 00.77	---	10/8/98	6:18:00	42 55.89	69 00.79	---
Cashes_L	206	48	HSMRT	10/8/98	9:20:00	42 51.39	68 50.84	---	10/8/98	9:50:00	42 53.42	68 50.75	---
Georges_B	208	49	HSMRT	10/8/98	21:20:00	42 11.78	67 17.80	---	10/8/98	21:50:00	42 09.97	67 17.30	---
Georges_B	211	50	HSMRT	10/9/98	1:33:00	42 03.11	67 33.92	---	10/9/98	1:58:00	42 01.75	67 34.78	---
Georges_B	211	51	HSMRT	10/9/98	3:29:00	42 06.44	67 25.98	---	10/9/98	3:59:00	42 06.94	67 23.07	---
Georges_B	211	52	HSMRT	10/9/98	5:01:00	42 07.73	67 18.79	---	10/9/98	5:41:00	42 07.22	67 22.08	---
Georges_B	214	53	HSMRT	10/9/98	11:09:00	41 56.51	68 02.04	2956.8	10/9/98	11:48:00	41 56.15	67 58.97	---
Georges_B	223	54	VIDEO	10/9/98	20:00:00	41 52.82	68 00.28	3021.4	10/9/98	20:05:00	41 52.82	68 00.30	3021.4
Georges_B	223	55	VIDEO	10/9/98	20:08:00	41 52.82	68 00.32	3021.4	10/9/98	20:35:00	41 52.86	68 00.54	3021.4
Georges_B	223	56	HSMRT	10/9/98	21:00:00	41 53.03	68 00.76	---	10/9/98	22:12:00	41 57.67	68 02.16	---
Georges_B	225	57	VIDEO	10/10/98	1:32:00	41 56.22	67 59.41	---	10/10/98	1:40:00	41 56.30	67 59.41	3044.4
Georges_B	227	59	VIDEO	10/10/98	6:34:00	41 55.55	68 00.94	---	10/10/98	7:18:00	41 55.39	68 00.76	---
Georges_B	227	60	HSMRT	10/10/98	7:59:00	41 55.10	68 00.17	---	10/10/98	8:29:00	41 55.53	68 02.68	---
Georges_B	228	61	VIDEO	10/10/98	12:48:00	41 54.65	68 01.02	---	10/10/98	13:00:00	41 54.84	68 01.16	---

Table 2. Transect table for the 1998 Fall Herring Acoustic Survey, cruise DE 98-10 parts I and II.

Site	B_Date	B_Time	B_Lat	B_Lon	B_Vlog	Transect	TransType	E_Date	E_Time	E_Lat	E_Long	E_Vlog
Jeffreys_L	10/3/98	0:12:00	42 43.04	70 06.38	1736.2	120	parallel	10/3/98	2:03:00	42 45.03	70 28.09	1754.7
Jeffreys_L	10/3/98	2:03:00	42 45.03	70 28.09	1754.7	121	crossover	10/3/98	2:31:00	42 50.02	70 27.71	1760.0
Jeffreys_L	10/3/98	2:31:00	42 50.02	70 27.71	1760.0	122	parallel	10/3/98	3:59:00	42 49.89	70 04.41	1777.0
Jeffreys_L	10/3/98	3:59:00	42 49.89	70 04.41	1777.0	123	steaming	10/3/98	4:27:00	42 46.96	70 09.41	1781.5
Jeffreys_L	10/3/98	7:20:00	42 44.98	70 04.81	1795.4	124	parallel	10/3/98	9:16:00	42 44.94	70 27.87	1813.0
Jeffreys_L	10/3/98	9:16:00	42 44.94	70 27.87	1813.0	125	crossover	10/3/98	9:53:00	42 50.10	70 27.85	1817.7
Jeffreys_L	10/3/98	9:53:00	42 50.10	70 27.85	1817.7	126	parallel	10/3/98	11:42:00	42 50.02	70 05.02	1834.4
Jeffreys_L	10/3/98	11:42:00	42 50.02	70 05.02	1834.4	127	crossover	10/3/98	12:25:00	42 55.02	70 03.00	1840.7
Jeffreys_L	10/3/98	12:25:00	42 55.02	70 03.00	1840.7	128	parallel	10/3/98	13:18:00	42 54.92	70 13.98	1848.8
Jeffreys_L	10/3/98	13:18:00	42 54.92	70 13.98	1848.8	129	crossover	10/3/98	13:57:00	43 00.08	70 11.37	1854.6
Jeffreys_L	10/3/98	13:57:00	43 00.08	70 11.37	1854.6	130	parallel	10/3/98	14:59:00	42 60.00	69 58.36	1864.2
Jeffreys_L	10/3/98	14:59:00	42 60.00	69 58.36	1864.2	131	crossover	10/3/98	15:33:00	43 05.01	69 58.18	1869.4
Jeffreys_L	10/3/98	15:33:00	43 05.01	69 58.18	1869.4	132	parallel	10/3/98	16:38:00	43 04.98	70 11.88	1879.3
Jeffreys_L	10/3/98	16:38:00	43 04.98	70 11.88	1879.3	133	crossover	10/3/98	17:12:00	43 09.85	70 08.92	1885.0
Jeffreys_L	10/3/98	17:12:00	43 09.85	70 08.92	1885.0	134	parallel	10/3/98	18:04:00	43 10.06	69 57.77	1893.1
Jeffreys_L	10/3/98	20:07:00	43 09.94	69 58.02	1897.1	135	parallel	10/3/98	20:54:00	43 10.02	70 08.97	1905.0
Jeffreys_L	10/3/98	20:54:00	43 10.02	70 08.97	1905.0	136	crossover	10/3/98	21:24:00	43 05.07	70 11.98	1910.4
Jeffreys_L	10/3/98	21:24:00	43 05.07	70 11.98	1910.4	137	parallel	10/3/98	22:16:00	43 05.06	69 58.52	1920.4
Jeffreys_L	10/3/98	22:16:00	43 05.06	69 58.52	1920.4	138	crossover	10/3/98	22:48:00	42 59.90	69 58.78	1926.1
Jeffreys_L	10/3/98	22:48:00	42 59.90	69 58.78	1926.1	139	parallel	10/3/98	23:44:00	42 59.97	70 11.74	1935.9
Jeffreys_L	10/3/98	23:44:00	42 59.97	70 11.74	1935.9	140	crossover	10/4/98	0:16:00	42 54.80	70 13.51	1942.1
Jeffreys_L	10/4/98	0:16:00	42 54.80	70 13.51	1942.1	141	parallel	10/4/98	1:02:00	42 54.60	70 02.12	1950.6
Jeffreys_L	10/4/98	1:02:00	42 54.60	70 02.12	1950.6	142	crossover	10/4/98	1:30:00	42 50.04	70 05.50	1956.2
Jeffreys_L	10/4/98	1:30:00	42 50.04	70 05.50	1956.2	143	parallel	10/4/98	3:07:00	42 49.80	70 28.10	1972.9
Jeffreys_L	10/4/98	3:07:00	42 49.80	70 28.10	1972.9	144	crossover	10/4/98	3:34:00	42 44.81	70 27.72	1977.8
Jeffreys_L	10/4/98	3:34:00	42 44.81	70 27.72	1977.8	145	parallel	10/4/98	5:09:00	42 45.09	70 04.77	1994.7
Jeffreys_L	10/4/98	6:57:00	42 44.90	70 05.16	1995.9	146	parallel	10/4/98	8:29:00	42 44.89	70 27.78	2013.1
Jeffreys_L	10/4/98	8:29:00	42 44.89	70 27.78	2013.1	147	crossover	10/4/98	8:56:00	42 49.70	70 28.00	2018.2
Jeffreys_L	10/4/98	9:05:00	42 50.07	70 26.26	2019.4	148	parallel	10/4/98	11:09:00	42 50.08	70 05.09	2035.4
Jeffreys_L	10/4/98	11:09:00	42 50.08	70 05.09	2035.4	149	crossover	10/4/98	11:37:00	42 54.98	70 02.10	2040.6
Jeffreys_L	10/4/98	11:37:00	42 54.98	70 02.10	2040.6	150	parallel	10/4/98	12:28:00	42 54.98	70 14.14	2049.8
Jeffreys_L	10/4/98	12:28:00	42 54.98	70 14.14	2049.8	151	crossover	10/4/98	12:59:00	42 59.83	70 11.04	2055.3
Jeffreys_L	10/4/98	12:59:00	42 59.83	70 11.04	2055.3	152	parallel	10/4/98	13:48:00	42 59.99	69 58.06	2064.8
Jeffreys_L	10/4/98	21:30:00	42 57.33	70 20.51	2100.0	153	steaming	10/4/98	22:09:00	42 50.31	70 21.08	2107.4
Jeffreys_L	10/5/98	0:06:00	42 49.07	70 30.48	2115.2	154	steaming	10/5/98	1:26:00	42 45.28	70 11.21	2130.0
Jeffreys_L	10/5/98	2:51:00	42 44.98	70 03.14	2136.1	155	steaming	10/5/98	4:54:00	43 06.64	70 10.62	2158.3
enroute_FL	10/5/98	6:24:00	43 12.34	70 08.06	2164.5	156	steaming	10/5/98	9:56:00	42 52.18	69 24.94	2201.9

Table 2. Cont.

Site	B_Date	B_Time	B_Lat	B_Lon	B_Vlog	Transect	TransType	E_Date	E_Time	E_Lat	E_Long	E_Vlog
Fippenn_L	10/5/98	9:56:00	42 52.18	69 24.94	2201.9	157	parallel	10/5/98	10:52:00	42 51.88	69 09.97	2212.8
Fippenn_L	10/5/98	10:52:00	42 51.88	69 09.97	2212.8	158	crossover	10/5/98	11:02:00	42 50.06	69 09.95	2214.8
Fippenn_L	10/5/98	11:02:00	42 50.06	69 09.95	2214.8	159	parallel	10/5/98	12:07:00	42 49.98	69 24.92	2226.0
Fippenn_L	10/5/98	12:07:00	42 49.98	69 24.92	2226.0	160	crossover	10/5/98	12:19:00	42 47.95	69 24.56	2228.1
Fippenn_L	10/5/98	12:19:00	42 47.95	69 24.56	2228.1	161	parallel	10/5/98	13:17:00	42 47.89	69 09.93	2238.9
Fippenn_L	10/5/98	13:17:00	42 47.89	69 09.93	2238.9	162	crossover	10/5/98	13:28:00	42 45.97	69 10.14	2241.0
Fippenn_L	10/5/98	13:28:00	42 45.97	69 10.14	2241.0	163	parallel	10/5/98	14:31:00	42 45.92	69 25.07	2252.1
Fippenn_L	10/5/98	14:31:00	42 45.92	69 25.07	2252.1	164	crossover	10/5/98	14:42:00	42 43.86	69 24.85	2254.1
Fippenn_L	10/5/98	14:42:00	42 43.86	69 24.85	2254.1	165	parallel	10/5/98	15:41:00	42 43.89	69 09.49	2265.6
Fippenn_L	10/5/98	15:42:00	42 43.83	69 09.66	2265.8	166	parallel	10/5/98	16:14:00	42 44.01	69 16.72	2270.7
Fippenn_L	10/5/98	17:17:00	42 44.30	69 21.66	2274.5	167	steaming	10/5/98	17:59:00	42 45.51	69 25.29	2277.5
Fippenn_L	10/5/98	17:59:00	42 45.51	69 25.29	2277.5	168	steaming	10/5/98	18:38:00	42 51.88	69 24.09	2283.7
Fippenn_L	10/5/98	20:22:00	42 50.68	69 18.36	2290.4	169	steaming	10/5/98	20:50:00	42 52.10	69 24.86	2295.4
Fippenn_L	10/5/98	20:50:00	42 52.10	69 24.86	2295.4	170	parallel	10/5/98	21:52:00	42 52.00	69 10.16	2306.4
Fippenn_L	10/5/98	21:52:00	42 52.00	69 10.16	2306.4	171	crossover	10/5/98	22:22:00	42 49.18	69 09.80	2309.3
Fippenn_L	10/5/98	22:31:00	42 50.03	69 10.92	2310.8	172	parallel	10/5/98	23:29:00	42 50.00	69 24.92	2321.5
Fippenn_L	10/5/98	23:29:00	42 50.00	69 24.92	2321.5	173	crossover	10/5/98	23:40:00	42 47.96	69 24.92	2323.5
Fippenn_L	10/5/98	23:40:00	42 47.96	69 24.92	2323.5	174	parallel	10/6/98	1:04:00	42 47.95	69 09.99	2334.3
Fippenn_L	10/6/98	1:04:00	42 47.95	69 09.99	2334.3	175	crossover	10/6/98	1:17:00	42 46.11	69 10.02	2336.2
Fippenn_L	10/6/98	1:17:00	42 46.11	69 10.02	2336.2	176	parallel	10/6/98	2:41:00	42 45.92	69 24.90	2347.2
Fippenn_L	10/6/98	2:41:00	42 45.92	69 24.90	2347.2	177	crossover	10/6/98	2:56:00	42 43.87	69 24.76	2349.5
Fippenn_L	10/6/98	2:56:00	42 43.87	69 24.76	2349.5	178	parallel	10/6/98	4:12:00	42 44.03	69 09.91	2360.2
Fippenn_L	10/6/98	4:12:00	42 44.03	69 09.91	2360.2	179	steaming	10/6/98	5:04:00	42 49.23	69 15.89	2367.1
Fippenn_L	10/6/98	6:52:00	42 48.20	69 13.68	2373.0	180	steaming	10/6/98	7:06:00	42 49.90	69 12.31	2374.9
enroute_CL	10/6/98	8:50:00	42 43.84	69 08.67	2382.0	181	steaming	10/6/98	9:36:00	42 42.96	68 58.17	2389.8
Cashes_L	10/6/98	9:36:00	42 42.96	68 58.17	2389.8	182	parallel	10/6/98	10:22:00	42 43.28	68 48.26	2397.5
Cashes_L	10/6/98	10:22:00	42 43.28	68 48.26	2397.5	183	crossover	10/6/98	10:47:00	42 47.16	68 48.42	2401.4
Cashes_L	10/6/98	10:47:00	42 47.16	68 48.42	2401.4	184	parallel	10/6/98	11:40:00	42 47.12	69 00.89	2410.8
enroute_Pt	10/6/98	15:36:00	42 44.53	69 01.24	2417.4	185	steaming	10/6/98	22:50:00	42 04.72	70 15.30	2485.2
enroute_CL	10/7/98	3:32:00	42 05.37	70 15.25	2509.5	186	steaming	10/7/98	9:59:00	42 51.26	69 00.56	2581.4
Cashes_L	10/7/98	9:59:00	42 51.26	69 00.56	2581.4	187	parallel	10/7/98	10:53:00	42 51.39	68 48.22	2590.6
Cashes_L	10/7/98	10:53:00	42 51.39	68 48.22	2590.6	188	crossover	10/7/98	11:12:00	42 54.81	68 49.68	2594.2
Cashes_L	10/7/98	11:12:00	42 54.81	68 49.68	2594.2	189	parallel	10/7/98	11:56:00	42 55.07	69 00.71	2602.5
Cashes_L	10/7/98	11:56:00	42 55.07	69 00.71	2602.5	190	crossover	10/7/98	12:26:00	42 58.45	69 00.00	2608.0
Cashes_L	10/7/98	12:26:00	42 58.45	69 00.00	2608.0	191	parallel	10/7/98	13:31:00	42 58.25	68 52.03	2613.8
Cashes_L	10/7/98	13:31:00	42 58.25	68 52.03	2613.8	192	parallel	10/7/98	14:07:00	42 58.08	69 00.74	2620.2
Cashes_L	10/7/98	14:07:00	42 58.08	69 00.74	2620.2	193	crossover	10/7/98	14:22:00	43 00.63	69 00.86	2622.8
Cashes_L	10/7/98	22:15:00	43 01.75	69 02.27	2647.3	194	steaming	10/7/98	23:06:00	42 58.08	68 51.77	2655.5
Cashes_L	10/7/98	23:06:00	42 58.08	68 51.77	2655.5	195	parallel	10/7/98	23:46:00	42 58.09	69 00.72	2662.5
Cashes_L	10/7/98	23:46:00	42 58.09	69 00.72	2662.5	196	crossover	10/8/98	0:08:00	42 54.61	69 00.44	2665.7

Table 2. Cont.

Site	B_Date	B_Time	B_Lat	B_Lon	B_Vlog	Transect	TransType	E_Date	E_Time	E_Lat	E_Long	E_Vlog
Cashes_L	10/8/98	0:08:00	42 54.61	69 00.44	2665.7	197	parallel	10/8/98	0:52:00	42 54.82	68 49.66	2673.8
Cashes_L	10/8/98	0:52:00	42 54.82	68 49.66	2673.8	198	crossover	10/8/98	1:13:00	42 51.40	68 48.34	2677.6
Cashes_L	10/8/98	1:13:00	42 51.40	68 48.34	2677.6	199	parallel	10/8/98	2:10:00	42 51.11	69 00.51	2686.6
Cashes_L	10/8/98	2:10:00	42 51.11	69 00.51	2686.6	200	crossover	10/8/98	2:35:00	42 46.81	69 00.54	2691.1
Cashes_L	10/8/98	2:35:00	42 46.81	69 00.54	2691.1	201	parallel	10/8/98	3:19:00	42 46.38	68 50.02	2698.9
Cashes_L	10/8/98	3:19:00	42 46.38	68 50.02	2698.9	202	crossover	10/8/98	3:39:00	42 43.05	68 50.00	2702.0
Cashes_L	10/8/98	3:39:00	42 43.05	68 50.00	2702.0	203	parallel	10/8/98	4:26:00	42 43.00	68 58.07	2708.2
Cashes_L	10/8/98	4:26:00	42 43.00	68 58.07	2708.2	204	steaming	10/8/98	5:18:00	42 51.84	69 00.68	2717.4
Cashes_L	10/8/98	7:02:00	42 58.43	69 01.55	2724.1	205	steaming	10/8/98	7:39:00	42 55.42	69 01.02	2727.1
Cashes_L	10/8/98	7:39:00	42 55.42	69 01.02	2727.1	206	steaming	10/8/98	8:53:00	42 49.25	68 51.09	2736.6
enroute_GB	10/8/98	11:00:00	42 57.15	68 50.20	2744.8	207	steaming	10/8/98	19:26:00	42 05.47	67 06.20	2837.6
Georges_B	10/8/98	19:26:00	42 05.47	67 06.20	2837.6	208	zigzag	10/8/98	20:28:00	42 11.26	67 17.35	2847.8
Georges_B	10/8/98	22:00:00	42 09.54	67 17.65	2854.6	209	zigzag	10/8/98	23:47:00	42 02.72	67 22.77	2869.0
Georges_B	10/8/98	23:47:00	42 02.72	67 22.77	2869.0	210	zigzag	10/9/98	0:36:00	42 09.26	67 31.95	2878.9
Georges_B	10/9/98	0:36:00	42 09.26	67 31.95	2878.9	211	zigzag	10/9/98	1:06:00	42 04.26	67 33.14	2883.8
Georges_B	10/9/98	7:07:00	42 03.75	67 33.16	2918.5	211	zigzag	10/9/98	7:41:00	41 57.99	67 34.92	2924.5
Georges_B	10/9/98	7:41:00	41 57.99	67 34.92	2924.5	212	zigzag	10/9/98	8:42:00	42 03.36	67 46.90	2935.2
Georges_B	10/9/98	8:42:00	42 03.36	67 46.90	2935.2	213	zigzag	10/9/98	9:40:00	41 54.00	67 49.36	2944.7
Georges_B	10/9/98	9:40:00	41 54.00	67 49.36	2944.7	214	zigzag	10/9/98	10:36:00	41 56.64	68 02.86	2955.2
Georges_B	10/9/98	12:21:00	41 57.09	67 56.93	2961.2	215	zigzag	10/9/98	13:46:00	41 46.39	68 04.71	2975.1
Georges_B	10/9/98	13:46:00	41 46.39	68 04.71	2975.1	216	crossover	10/9/98	14:22:00	41 50.60	67 57.50	2982.1
Georges_B	10/9/98	14:22:00	41 50.60	67 57.50	2982.1	217	crossover	10/9/98	15:11:00	41 57.43	68 03.26	2990.6
Georges_B	10/9/98	15:11:00	41 57.43	68 03.26	2990.6	218	crossover	10/9/98	15:17:00	41 57.92	68 02.01	2991.7
Georges_B	10/9/98	15:17:00	41 57.92	68 02.01	2991.7	219	parallel	10/9/98	15:49:00	41 53.93	67 57.34	2997.6
Georges_B	10/9/98	15:49:00	41 53.93	67 57.34	2997.6	220	parallel	10/9/98	16:00:00	41 55.65	67 58.24	2999.7
Georges_B	10/9/98	16:00:00	41 55.65	67 58.24	2999.7	221	parallel	10/9/98	16:49:00	41 55.36	68 01.08	3006.9
Georges_B	10/9/98	16:49:00	41 55.36	68 01.08	3006.9	222	parallel	10/9/98	17:29:00	41 57.22	68 01.75	3009.6
Georges_B	10/9/98	17:29:00	41 57.22	68 01.75	3009.6	223	steaming	10/9/98	20:00:00	41 52.82	68 00.28	3021.4
Georges_B	10/9/98	22:12:00	41 57.67	68 02.16	3026.7	224	steaming	10/9/98	23:10:00	41 57.05	68 01.69	3030.8
Georges_B	10/9/98	23:10:00	41 57.05	68 01.69	3030.8	225	steaming	10/10/98	1:32:00	41 56.22	67 59.41	3044.3
Georges_B	10/10/98	5:02:00	41 51.59	67 59.75	3052.9	226	steaming	10/10/98	6:07:00	41 57.13	68 01.82	3058.8
Georges_B	10/10/98	6:07:00	41 57.13	68 01.82	3058.8	227	steaming	10/10/98	6:30:00	41 55.55	68 00.99	3060.8
Georges_B	10/10/98	8:29:00	41 55.53	68 02.68	3066.7	227	steaming	10/10/98	11:11:00	41 56.92	68 01.88	3075.9
Georges_B	10/10/98	11:11:00	41 56.92	68 01.88	3075.9	228	steaming	10/10/98	12:48:00	41 54.65	68 01.02	3084.5
enroute_WH	10/10/98	13:08:00	41 55.17	68 01.51	3085.7	229	steaming	10/11/98	5:20:00	41 29.75	70 37.98	3209.8