

CRUISE RESULTS
NOAA Fisheries Research Vessel *Delaware II*
Cruise No. DE 10-01
Ecosystems Monitoring Survey and NASA Ground Truth Measurements

CRUISE PERIOD AND AREA

The cruise period was 2 to 18 February 2010. The original cruise plan called for 1 to 18 February but the departure and arrival times were each pushed back a day, making it 2-19 February, to allow more time for loading the vessel while maintaining the allotted cruise days. Bad weather caused the loss of the last day scheduled. Three additional days were lost on February 5, 6, and 7 due to bad weather that forced the vessel to dock in Norfolk, VA for the weekend and another two and a half days on February 10, 11 and 12. The fisheries research vessel *Delaware II* sampled at a total of 94 stations. Of these, 26 were located in the Gulf of Maine (GOM), 29 were located on Georges Bank (GB), 17 were in the Southern New England (SNE) area, and 22 were in the Mid-Atlantic Bight (MAB) region.

OBJECTIVES

This cruise was the third in a series of multiple-objective cruises that are being done in collaboration with NASA and Old Dominion University. As always, the primary objective of the cruise was to assess changing biological and physical properties that influence the sustainable productivity of the living marine resources of the northeast continental shelf ecosystem. Key parameters measured for the Ecosystem Monitoring Program included ichthyoplankton and zooplankton composition, abundance and distribution, plus water column temperature and salinity. However, we worked with our colleagues from NASA and Old Dominion University to enhance the application of ocean color remote sensing to coastal ecosystems by “ground truthing” SeaWiFS and MODIS-Aqua data with ship-based water column measurements. This field data was also used to derive region-independent ocean color algorithms for primary productivity, particulate organic carbon and dissolved organic carbon.

Secondary objectives of this cruise included:

- Vertical CTD casts to within 5 meters of the bottom in Gulf of Maine deep basin areas to provide hydrographic data detailing the incursion of Labrador Current water into this region.
- Collection of zooplankton for the Census of Marine Zooplankton Project (CMarZ), based at University of Connecticut, Avery Point.
- Identifications and counts of marine birds along the cruise track by observers Marie Martin and Megan Ogberg from Staten Island University.
- Collection of nutrient samples from the various depths sampled with the Niskin bottle rosette for University of Maine researcher Dave Townsend.
- Collection of zooplankton samples for carbon and nitrogen isotope analysis from the four regions surveyed, using the 20-cm bongo sampler for NASA researcher Antonio Mannino.

METHODS

The survey consisted of 94 stations at which the vessel stopped to lower instruments over the side (Figure 1). Most stations sampled were at randomly stratified locations except for several stations in the GOM,

one in Southern New England and one in the Mid-Atlantic Bight. Three of the non-random stations were at fixed positions in the Gulf of Maine, visited on all Ecosystem Monitoring cruises: Wilkinson Basin, the Northeast Channel, and the Boston Harbor Liquefied Natural Gas (LNG) Terminal. There were also several stations in the Gulf of Maine area that were placed to sample for herring larvae on Jeffreys Ledge and Stellwagen Bank. The remaining non-random stops were made for Old Dominion University researchers to collect water samples in coordination with sunrise, sunset or mid-day for primary productivity measurements.

Plankton and hydrographic sampling was conducted at most stations by making double oblique tows using the 61-cm bongo sampler and a Seabird CTD. The tows were made to approximately 5 m above the bottom, or to a maximum depth of 200 m. All plankton tows were conducted at a ship speed of 1.5 – 2.0 knots. Plankton sampling gear consisted of a 61-cm diameter aluminum bongo frame with two 335-micron nylon mesh nets. At the randomly designated CMarZ stations a 20-cm diameter PVC bongo frame

fitted with paired 165-micron nylon mesh nets was put on the towing wire one half meter above the Seabird CTD with a wire stop. The 20 cm bongo sampler was also used to collect 3 samples for biomass analysis for Antonio Mannino from the different regions surveyed. A bell-shaped 45-kg lead weight was attached by an 80-cm length of 3/8-inch diameter chain below the aluminum bongo frame to depress the sampler. The flat-bottomed configuration of the depressor weight made for safer deployment and retrieval of the sampling gear when the boat was rolling in rough seas. A digital flowmeter was suspended within the mouth of each 61-cm sampler to determine the amount of water filtered by each net. No flowmeters were used in the 20-cm bongos. The plankton sampling gear was deployed off the starboard stern quarter of the vessel using an A-frame and a Sea-Mac winch that was placed on the aft deck specifically for this cruise. After retrieval, the bongo frames were carried to the covered work area for washing the plankton samples into sieves on the port-side table. The starboard table was used for filtering seawater by the ODU researchers (Figure 2). The ODU researchers also used the decked over trawlway to set up two tanks for the incubation of water samples from the depths sampled by the rosette. A small container (11 ½ ft L x 7 ½ ft W x 7 ½ ft H) was brought on board, which was set up as a plankton lab, complete with a fume hood for sample preservation, a sink with running seawater, stainless steel worktables, a small space heater and ventilation fans for the fume hood and the container inside area. This was secured to the port side of the stern deck, just aft of the covered work area. By doing the plankton preservations inside this container, the entire wet lab area was dedicated to the NASA and ODU researchers for setting up their filtering apparatuses. The container lab also provided space for checking the 6B3 Z samples for the presence of sand lance and herring larvae, which were removed and preserved in ethanol for otolith ring versus larval length analysis (Figure 3).

The 61-cm bongo plankton samples were preserved in a 5% solution of formalin in seawater. The CMarZ samples from the 20-cm diameter bongos were preserved in 95% ethanol, which was changed once at 24 hours after the initial preservation. The NASA nitrogen and carbon isotope biomass samples from the 20-cm diameter bongos were frozen. The Dave Townsend U. Maine nutrient samples were also frozen. Tow depth was monitored in real time with a Seabird CTD profiler. The Seabird CTD profiler was hard-wired to the conductive towing cable, providing simultaneous depth, temperature, and salinity for each plankton tow. A CTD cast to within 5 m of the bottom was made on the southern slope of Georges Bank, in the Northeast Channel, and in Wilkinson Basin to provide hydrographic data from below the 200 m limit set for bongo tows. Styrofoam coffee cups were placed in a mesh bag attached to the rosette and compressed at depth at the Georges Bank slope water and Wilkinson Basin stations to demonstrate the effects of water pressure for 7th grade students from the Literacy, Leadership and Technology Academy in Tampa, FL (Figure 4). A 1m x 1m 500 micron mesh net was used to search for herring larvae at four stations in the Gulf of Maine, but problems were encountered in getting it to fish

properly, and modifications to its bridle will need to be made before the next cruise. After the cruise, examination of photos from a previous cruise revealed that the meter net was not rigged the same as it had been on the autumn 2009 EcoMon cruise, where it was fished successfully. On that cruise the bongo depressor weight was rigged with a 2-leg bridle to the bottom of the frame, while the top of the frame was rigged with another 2-leg bridle to the tow cable (Figure 5).

Twenty three casts were made with the CTD 911/Niskin bottle rosette. The rosette was equipped with twelve 10-liter Niskin bottles. These casts were made at sunrise, mid-day and sunset. No rosette casts were made at night. Typically 3 water depths were sampled: near surface, at the chlorophyll-maximum depth, and a sub-chlorophyll-maximum depth. Water samples were filtered by the NASA and ODU researchers to measure particulate and dissolved organic carbon, absorption coefficients of phytoplankton and colored dissolved organic matter to improve the coastal algorithms used to interpret satellite-derived data for estimating these parameters. Field measurements of primary productivity were also made by incubating phytoplankton taken from the different depths in 2 deck incubators as opposed to using 3 deck incubators as had been done on the previous cruise in November. This was because there was less stratification since the water column was so well mixed. It also provided for an increased amount of free deck space on the afterdeck, and less water spillage which minimized the possibility of overflow water freezing on deck. In cases where a greater degree of stratification was encountered, a primary productivity sampling bottle could be placed in an individual shading “sock” prior to going into the incubator tank to mimic the amount of light encountered at a third depth. A total of sixty four nutrient samples were collected for U. Maine researcher Dave Townsend at nineteen of the stations sampled with the rosette.

Continuous monitoring of the seawater salinity, temperature and chlorophyll-*a* level, from a depth of 3.7 meters along the entire cruise track was done by means of a thermosalinograph, and a flow-through fluorometer hooked up to the ship’s flow-through seawater system.. The Scientific Computer System (SCS) recorded the output from both the thermosalinograph, and the fluorometer at 10-second intervals. The data records were given a time-date stamp by the GPS unit.

Samples for Seabird CTD salinity data calibration were obtained at intervals using a 1.7 liter Niskin bottle taking a water sample from an isohaline portion of the water column. Winkler titrations were carried out during the cruise by U. Seattle student Evan Howard to calibrate the dissolved oxygen measurements made during the rosette casts. He used the rear of the dry lab area adjacent to the fume hood to set up his apparatus (Figure 6).

Nineteen Census of Marine Zooplankton (CMarZ) samples were collected using the 20-cm diameter bongos described above at 5 randomly designated stations in each of the four regions sampled: Mid-Atlantic Bight, Southern New England, Gulf of Maine and Georges Bank (where only 4 samples were collected due to bad weather).

RESULTS

A summary of routine survey activities is presented in Table 1. Areal coverage for the cruise is shown in Figure 1. Bad weather caused the loss of three days at the dock in Norfolk, VA and a day and a half at anchor off of Provincetown, off of Cape Cod. Large seas made sampling slow and difficult on Georges Bank, and the total amount of time lost caused most of the Gulf of Maine to not be sampled.

The *Delaware II* sailed punctually at 1400 hours EST on Tuesday, 2 February 2010 after a busy day of

loading on Monday 1 February. The vessel worked its way to the offshore Southern New England area and then headed south, picking up a total of 14 stations, most of them along the outer edge of the shelf, in calm but snowy weather, until a squall caused operations to stop and two offshore mid-Atlantic Bight stations to be missed early on Thursday 4 February 2010. Interestingly, a 15 cm lamprey was caught in the bongo sampler at station 14, just prior to the suspension of operations (Figure 7). The vessel jogged further to the south but remained offshore until later that day, when work was able to resume in the afternoon. With the forecast of a large coastal storm rapidly approaching, the Delaware II worked its way towards Norfolk, VA, completing a total of 24 stations before docking at the Atlantic Marine Center on Friday morning 5 February at 0930, where it remained until Monday morning, 8 February. Sailing was at 0900, and the decision was made to drop all stations south of the Chesapeake Bay due to the loss of time incurred and to proceed north along the coast, picking up the inshore stations of the Mid-Atlantic Bight. On the afternoon of Tuesday, 9 February the cruise track was altered and a station near New York harbor was dropped to permit the vessel to pick up the remaining inshore stations in the Southern New England area before the arrival of another large storm. Work stopped after station 39, just south of Montauk Point, Long Island, on Wednesday morning, 10 February as the vessel headed through the Cape Cod Canal and anchored off of Provincetown that evening. Two days later on 12 February the vessel weighed anchor and resumed working, heading out to Georges Bank, and bypassing stations that were in the southeastern portion of the Southern New England area, due to lack of time. The Georges Bank area was completely sampled except for one station, despite the large seas and high winds encountered in this region. Due to the slow progress made, and all the time lost to weather earlier in the cruise, only the southwest portion of the Gulf of Maine was sampled, including Jeffreys Ledge and Stellwagen Bank. Four meter net tows in addition to bongo tows were made in this area, but the meter net did not fish properly.

Operations were completed on Wednesday, 17 February 2010. Continuing bad weather and a lack of sufficient time to reach distant offshore stations prompted the decision to have the vessel return to port a day earlier than scheduled. The vessel returned to port in Woods Hole via the Cape Cod Canal on 18 February 2010, docking at the NMFS pier at 0700.

DISPOSITION OF SAMPLES AND DATA

The plankton samples and data were delivered to the Ecosystem Monitoring Group of the NEFSC, Narragansett, RI for quality control processing and further analysis. The Census of Marine Zooplankton samples were retrieved from the vessel by Woods Hole Oceanographic Institute researcher Nancy Copley. The Fisheries Oceanography Investigation of the NEFSC, Woods Hole, retained the CTD data and original log sheets. The NASA and ODU researchers retained their samples, data and logs. The NASA laboratory equipment was returned to Greenbelt, MD by the NASA_researchers, while the ODU incubators and laboratory equipment were stored at the NMFS facility in Woods Hole for use on subsequent cruises. Samples, data and equipment used by the University of Seattle researcher Evan Howard were returned to that institution. The Ecosystems Monitoring Laboratory Container was stored next to the Woods Hole NEFSC storage building.

SCIENTIFIC PERSONNEL

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Table 1. STATION OPERATION REPORT FOR CRUISE DE1001

CAST	STA.	Date(GMT)			TIME(GMT)		LAT	LONG	DEPTH	OPERATION
		mm	dd	yy	hr	min				
1	1	2	2	2010	22	6	4118.7	7050.8	27	B, R1
2	2	2	2	2010	23	38	4121.1	7104.3	19	B
3	3	2	3	2010	2	48	4056.1	7126.8	58	B
4	4	2	3	2010	5	58	4026.6	7138.6	79	B
5	5	2	3	2010	7	15	4016.9	7142.2	82	B
6	6	2	3	2010	10	20	3951.6	7202.6	99	B
7	7	2	3	2010	11	32	3944	7203.2	132	B, R2, N
8	8	2	3	2010	14	20	3948.8	7219	84	B, C1
9	9	2	3	2010	17	6	3926.9	7238.2	92	B, R3, N
10	10	2	3	2010	21	44	3953.7	7312.8	56	B, C2
11	11	2	3	2010	23	23	3939	7308.8	42	B, R4
12	12	2	4	2010	1	28	3943.7	7328.7	41	B, C3
13	13	2	4	2010	4	21	3916.4	7330.8	47	B
14	14	2	4	2010	8	5	3846.2	7302.9	175	B
15	15	2	4	2010	17	50	3816.1	7411.9	61	B, R5, N
16	16	2	4	2010	19	50	3808.8	7401.5	72	B, C4
17	17	2	4	2010	23	20	3736.4	7416.7	156	B, R6, N, A
18	18	2	5	2010	1	25	3733.8	7434.7	65	B, C5
19	19	2	5	2010	2	31	3736.2	7446.6	46	B
20	20	2	5	2010	4	27	3721.4	7500.8	39	B
21	21	2	5	2010	5	46	3714	7512.2	22	B
22	22	2	5	2010	7	28	3701.7	7524.4	28	B
23	23	2	5	2010	8	0	3703.5	7528.4	28	B
24	24	2	5	2010	9	47	3658.3	7546.8	16	B
25	25	2	8	2010	18	16	3705.2	7540.3	15	B, R7
26	26	2	8	2010	23	27	3746.2	7512.8	20	B, R8, N
27	27	2	9	2010	4	17	3826.2	7443.1	31	B
28	28	2	9	2010	6	35	3846.1	7454.6	15	B, C6
29	29	2	9	2010	8	16	3838.9	7438.9	29	W1
30	29	2	9	2010	8	25	3838.9	7438.9	29	B
31	30	2	9	2010	12	4	3903.6	7406.9	37	B, R9, C7, N
32	31	2	9	2010	15	46	3933.7	7402.9	21	B, R10, N
33	32	2	9	2010	17	50	3936.3	7346.6	22	B
34	33	2	9	2010	19	57	3955.8	7352.9	28	B
35	34	2	9	2010	23	56	4011	7311.9	44	B, R11, N
36	35	2	10	2010	3	14	4023.6	7236.9	48	B, C8
37	36	2	10	2010	4	36	4018.9	7223	56	B
38	37	2	10	2010	6	39	4030.3	7204.6	60	B
39	38	2	10	2010	8	8	4043.4	7210.7	47	B, C9
40	39	2	10	2010	10	14	4053.8	7149.1	45	B, R12, C10

B=bongo W=water C=CMarZ
V=vertical cast(CTD only) R=rosette cast
N = nutrient sample A = Antonio sample

Table 1. (cont.) STATION OPERATION REPORT FOR CRUISE DE1001

CAST	STA.	Date(GMT)		TIME(GMT)		LAT	LONG	DEPTH	OPERATION	
		mm	did	yy	hr					min
41	40	2	12	2010	17	22	4138.9	6936.9	81	B, R13, N
42	41	2	12	2010	18	55	4128.8	6926.9	46	B, C11
43	42	2	12	2010	20	27	4136	6913	169	B
44	43	2	12	2010	21	48	4128.9	6905.3	142	B, R14, N
45	44	2	13	2010	3	14	4054	6829.3	51	B
46	44	2	13	2010	3	24	4054	6829.3	51	W2
47	45	2	13	2010	5	44	4034.2	6838.5	69	B
48	46	2	13	2010	6	56	4026.3	6846.5	82	B
49	47	2	13	2010	9	26	4021	6819.3	131	B
50	48	2	13	2010	11	38	4033.7	6809	98	B, R15, N
51	49	2	13	2010	14	50	4023.8	6740.9	307	W3
52	49	2	13	2010	15	11	4023.7	6741.1	305	B
53	50	2	13	2010	16	52	4036	6744.9	87	B, R16, C12, N
54	51	2	13	2010	19	29	4051.1	6729.2	81	B, C13
55	52	2	13	2010	21	41	4053.7	6705	88	B
56	53	2	13	2010	23	9	4101.2	6655	76	B, R17, N
57	54	2	14	2010	1	20	4118.7	6706.6	61	B
58	55	2	14	2010	3	8	4136.1	6710.6	47	B
59	56	2	14	2010	4	46	4141.2	6651.1	66	B
60	56	2	14	2010	5	1	4141	6651.5	65	W4
61	57	2	14	2010	7	27	4116.3	6650.6	73	B, C14
62	58	2	14	2010	9	51	4103.6	6624.9	400	B, R18, CC, N
63	59	2	14	2010	14	39	4123.7	6623	96	B, C15
64	60	2	14	2010	17	44	4148.5	6608.9	89	B
65	61	2	14	2010	19	51	4203.4	6600.7	134	B
66	62	2	14	2010	21	48	4213.2	6546.6	224	B
67	63	2	15	2010	2	3	4201.5	6628.7	85	B
68	64	2	15	2010	5	6	4210.9	6652.6	180	B
69	65	2	15	2010	7	58	4208.3	6706.1	68	B
70	66	2	15	2010	8	57	4203.5	6658.8	59	B
71	67	2	15	2010	12	4	4201.5	6719.9	54	B
72	68	2	15	2010	19	0	4141.2	6736.6	36	B
73	69	2	15	2010	21	55	4123.7	6738.8	37	B
74	70	2	16	2010	0	7	4114	6754.6	39	B
75	71	2	16	2010	1	35	4118.7	6805.1	34	B
76	72	2	16	2010	3	6	4113.9	6816.6	44	B
77	73	2	16	2010	4	44	4128.6	6811	49	B
78	74	2	16	2010	8	9	4154.9	6825.7	188	B
79	74	2	16	2010	9	2	4155	6825.9	196	B
	75	2	16	2010	12	08	4209.5	6852.2	169	R19 (Rosette Only Sta), N
80	76	2	16	2010	14	52	4225	6920.4	260	W5

Table 1. (cont.) STATION OPERATION REPORT FOR CRUISE DE1001

CAST	STA.	Date(GMT)		TIME(GMT)		LAT	LONG	DEPTH m	OPERATION B=bongo W=water C=CMarZ M=meter net A=Antonio sample V=vertical cast(CTD only) R=rosette cast N = nutrient sample CC=cup compression
		mm	dd	yy	hr min				
81	76	2	16	2010	15 8	4225.2	6920.7	267	B, C16
82	77	2	16	2010	16 58	4229.8	6939.9	255	B, R20, CC, N
83	78	2	16	2010	19 28	4236.4	7000	125	B, C17
84	78	2	16	2010	19 44	4236.6	6959.9	120	M (lost sample)
85	78	2	16	2010	20 2	4236.9	6959.7	126	M
86	79	2	16	2010	20 56	4241.4	7005.2	107	B
87	79	2	16	2010	21 12	4241.8	7005	109	M
88	80	2	16	2010	22 9	4249.4	7004.8	127	B
89	80	2	16	2010	22 30	4249.4	7004.8	125	M (lost sample)
90	81	2	17	2010	0 41	4306.4	7005.1	133	B
91	82	2	17	2010	2 17	4313.7	6957.1	136	B
92	82	2	17	2010	2 39	4314.1	6957.7	127	W6
93	83	2	17	2010	4 46	4303.9	7022.8	105	B, C18
94	84	2	17	2010	5 47	4256.7	7020.1	140	B, A
95	85	2	17	2010	6 37	4251.7	7020.1	60	B
96	85	2	17	2010	6 47	4251.6	7020.3	59	W7
97	86	2	17	2010	7 25	4246.5	7020.1	56	B
98	87	2	17	2010	8 22	4240.6	7025.9	45	B, C19
99	88	2	17	2010	10 19	4225.1	7037.8	82	B
100	89	2	17	2010	12 5	4225.9	7026.7	63	B, R21, N
101	90	2	17	2010	13 58	4230.7	7015.9	85	B, A
102	91	2	17	2010	14 42	4226.3	7012.7	77	W8
103	91	2	17	2010	14 52	4226.2	7012.8	77	B
104	92	2	17	2010	15 56	4221.9	7004.9	88	W9
105	92	2	17	2010	16 7	4221.9	7005	85	B
106	93	2	17	2010	17 28	4210.7	7006	55	B, R22, N
107	94	2	17	2010	19 46	4203.8	7027	54	B, R23, N
108	94	2	17	2010	19 56	4203.9	7027.3	53	W10

TOTALS: Bongo Casts = 93
 Bongo 6B3Z Samples = 93
 Bongo 6B3I Samples = 93
 CTD 19 Water Samples = 10
 Vertical CTD 19 Casts = 0
 CTD 19 Casts = 108
 CMarZ samples = 19
 U Maine Nutrient Samples = 64
 Rosette/CTD 911 casts = 23
 Meter Net Tows = 4

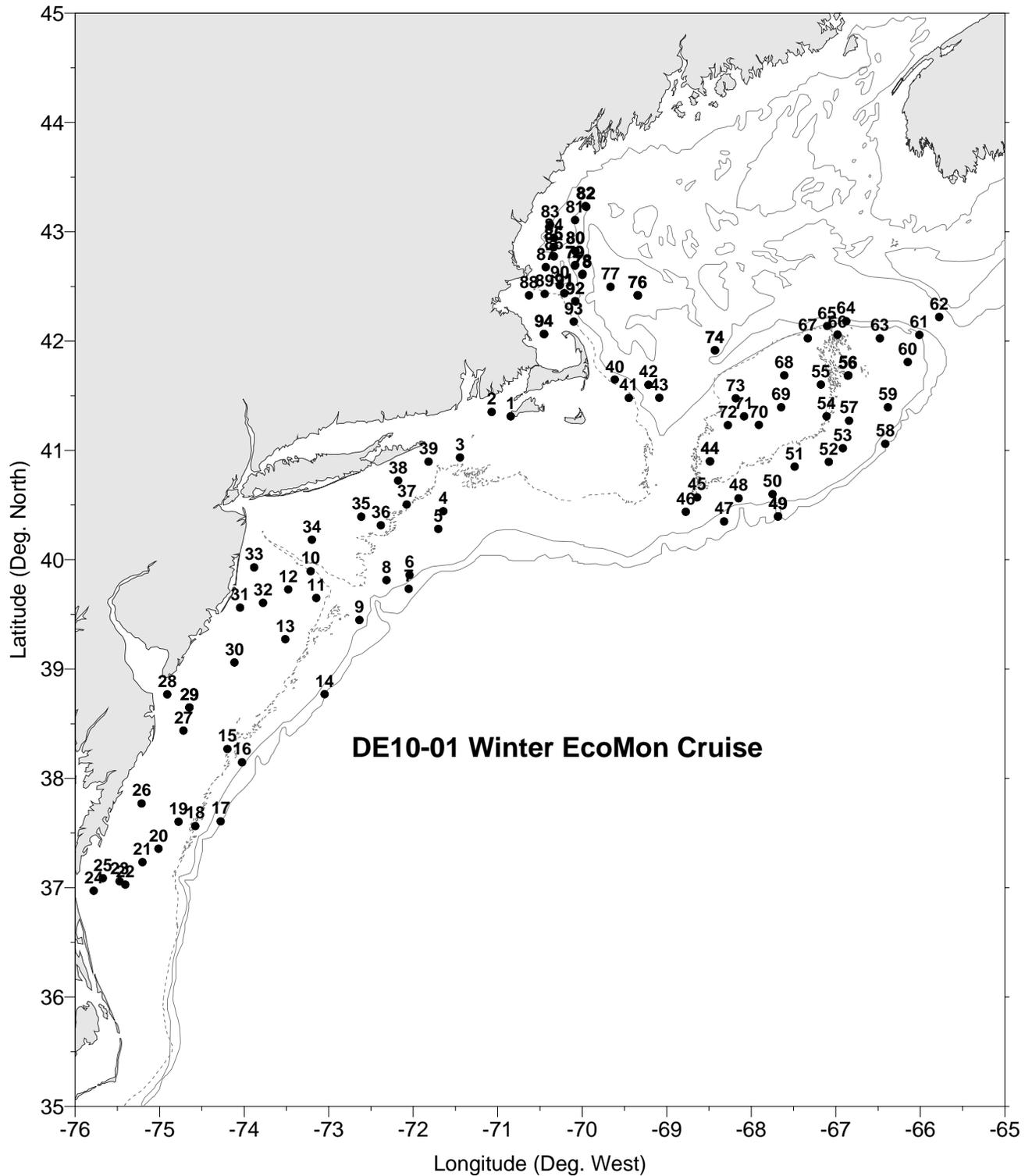


Figure 1. Station locations numbered consecutively for Ecosystems Monitoring Survey and NASA Ground Truth Measurements Cruise DE 10-01, 2-18 February 2010.



Figure 2. Covered work area, showing port and starboard work tables.



Jon Hare searching for herring and sand lance larvae in 6B3 Z sample.



Figure 4. Decorated styrofoam cups from 7th grade students at the Literacy, Leadership and Technology Academy in Tampa, FL being placed on rosette by Chief Boatswain Adrian Martyn-Fisher for depth compression demonstration.



Figure 5. Meter net, properly rigged on DE0911 Fall EcoMon Cruise. Note that depressor is attached to lower part of frame and tow cable is attached to upper part of frame.



Figure 6. University of Seattle researcher Evan Howard running a Winkler titration for oxygen determination of water samples in the dry lab area of the Delaware II.



Figure 7. A 15 cm lamprey caught in the bongo net in the Mid-Atlantic Bight region.