

CRUISE RESULTS
NOAA Fisheries Research Vessel *Delaware II*
Cruise No. DE 09-02
Northeast Shelf Ecosystem Monitoring Winter Survey

CRUISE PERIOD AND AREA

The cruise period was 26 January to 13 February 2009. The NOAA fisheries research vessel *Delaware II* sampled at a total of 129 stations. Of these, 32 were located in the Gulf of Maine (GOM), 30 were located on Georges Bank (GB), 30 were in the Southern New England (SNE) area, 30 were in the Mid-Atlantic Bight (MAB) and 7 extra stations were sampled off the mouth of the Chesapeake Bay for larval fish.

OBJECTIVES

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. Near-surface along-track chlorophyll-*a* fluorescence, water temperature and salinity were measured while underway with the vessel's flow-through sampling system. 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.
- Sampling at the site of the liquefied natural gas (LNG) terminal east of Boston Harbor, to collect ongoing environmental data.
- Collection of zooplankton for the Census of Marine Zooplankton Project, CMarZ based at University of Connecticut, Avery Point.
- Capture of fish larvae near the entrance to Chesapeake Bay for age analysis from their otoliths.
- Collection of euphausiid samples for analysis of their gut contents by Alison Cleary, a GSO/URI graduate student.
- Special tows for collection of live euphausiids for a feeding study by Alison Cleary.
- Identifications and counts of marine birds along the cruise track by observer Marie Martin, a graduate student from Staten Island University.

METHODS

The survey consisted of 129 stations at which the vessel stopped to lower instruments over the side (Figure 1). All stations sampled were at randomly stratified locations except for five stations in the GOM, and seven in the MAB. Five of the non-random GOM stations were at fixed positions visited on all Ecosystem Monitoring cruises: Wilkinson Basin, Georges Basin, Jordan Basin, the Northeast Channel, and a terminal for off-loading liquefied natural gas located east of Boston harbor. Seven non-random

stations in the Mid-Atlantic Bight, near the mouth of the Chesapeake Bay, were sampled to capture fish larvae for age analysis.

Plankton and hydrographic sampling was conducted at all 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 (Figure 2.). The 20 cm bongo sampler was also used to collect samples for scallop larvae at stations near large scallop beds as determined by the previous year's scallop survey. 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 into a covered work area on the port side of the aft deck and placed on tables for wash down of the nets to obtain the plankton samples. This workspace allowed for much easier removal of the samples, particularly during inclement weather. 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. Fish larvae samples collected near the entrance of the Chesapeake Bay had one bongo net preserved in 95% ethanol, while samples from the other net were preserved in 5% formalin. 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 in the Wilkinson, Jordan and Georges basins and the Northeast Channel to provide hydrographic data from below the 200 m limit set for bongo tows.

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 twice a day using a 1.7 liter Niskin bottle taking a water sample from an isohaline portion of the water column. Calibration of the CTD salinities and chlorophyll-*a* from the surface flow-through system was undertaken twice daily while the ship was underway. Sample analysis for these calibrations followed the protocol outlined in the Ecosystem Monitoring Program Operations Manual.

Census of Marine Zooplankton samples were collected using the 20-cm diameter bongos described above at 5 randomly designated stations in each of three of the regions sampled: Mid-Atlantic Bight, Southern New England, and Georges Bank and 6 randomly designated stations in the Gulf of Maine.

Euphausiids were collected from the ichthyoplankton net side of the 61-cm bongos at 25 stations in the

Gulf of Maine and preserved in 80% ethanol, which was changed once after 24 hours.

Live euphausiids were collected at 2 stations on Georges Bank and 7 stations in the Gulf of Maine by making a separate tow with a 61-cm diameter bongo. These were kept alive on board the vessel by placing them in 2 120-liter coolers equipped with flowing seawater.

Presence and volume of *Calanus finmarchicus* was noted in the samples after completion of the cruise by measuring the settled height of the samples in mm, and then converting it to cc's using the method listed in Prezioso and Kane (in prep).

RESULTS

A summary of routine survey activities is presented in Table 1. Areal coverage for the cruise is shown in Figure 1. The cruise was plagued by strong winds and high seas for much of the scheduled time, and a hydraulics problem on the second day out, but having 19 days allowed almost all of the planned stations to be sampled, with the exception of three stations in the Gulf of Maine. Having temperatures slightly above freezing for much of the cruise period also saved time by preventing the ship from icing up and being further slowed down.

The *Delaware II* sailed at 1400 hours EST on Monday, 26 January 2009, and proceeded southwest to sample offshore stations of the Southern New England area. After completing 11 stations a hydraulic problem with the aft a-frame forced the vessel to commence steaming to Woods Hole for repairs late the next day, on Tuesday, 27 January. Heavy weather made for a slow trip, and the Delaware docked in Woods Hole on Thursday morning, 29 January at 0700. A hydraulics specialist made repairs to the system and the Delaware was able to sail at 1400 hours and be back at sea and working by 2230 hours that same day, so time lost was minimized. Work continued under a mixture of good and bad weather as the vessel reached the southernmost station in the mid-Atlantic Bight just before noon on Sunday, 1 Feb, then looped back north along the inshore stations, picking up 7 out of 11 Jon Hare ichthyoplankton stations before heading into Norfolk harbor to drop off 2 NOAA Corps officers by small boat for training.

After the drop off at 0730 on 2 February, the Delaware continued north along a trail of inshore mid-Atlantic Bight stations, on into southern New England and then towards Georges Bank, which was reached by Thursday, 5 February. Weather is marginal, with some ice forming on the vessel, then improves slowly as sampling is done along the southern half of Georges, heading eastward, towards the Northeast Channel and Georges Basin, then back onto the shoal area. A storm system halts all work at this point at 2050 on Sunday night. The vessel heaves to until 1130 Monday morning, 9 February. Although seas were rough, temperatures were above freezing, so icing was not a problem. One station was dropped at this time due to unsafe working conditions. As the weather improved and the temperatures remained above freezing, the Delaware made rapid progress in the Gulf of Maine area, although two more stations were dropped because of the inordinate amount of time that would have been spent steaming to and from them.

The Delaware II completed operations at 1900 on Thursday, at a Gulf of Maine station just east of the entrance to the Great Round Shoal Channel. Ironically the weather deteriorated so rapidly at this point that the station was almost dropped, but sampling was completed and the vessel returned to Woods Hole through the Great Round Shoal Channel and docked in Woods Hole at the NMFS pier at 0700, Friday, 13 February.

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 preserved and live euphausiid samples were delivered to the Graduate School of Oceanography at the University of Rhode Island Bay Campus in Narragansett by graduate student Alison Cleary. 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.

SCIENTIFIC PERSONNEL

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Table 1. STATION OPERATION REPORT FOR CRUISE DE0902

CAST	STA.	Date(GMT)		TIME(GMT)		LAT	LONG	DEPTH m	OPERATION	
		mm	did	yy	hr					min
1	1	1	26	2009	22	23	4113.7	7104.9	41	B
2	2	1	27	2009	0	25	4113.8	7130.7	36	B
3	3	1	27	2009	2	4	4058.9	7127	50	B
4	4	1	27	2009	5	35	4038.4	7050.8	68	B
5	5	1	27	2009	7	13	4023.7	7050.8	88	B
6	6	1	27	2009	10	26	4011.3	7017.1	108	B
7	7	1	27	2009	11	29	4008.7	7016.8	118	B
8	8	1	27	2009	14	19	4008.9	7050.7	135	B, C1
10	9	1	27	2009	19	44	3950.7	7151.3	158	W1
11	9	1	27	2009	20	3	3950.5	7151.7	158	B
12	10	1	27	2009	21	1	3955.5	7157.9	96	B
13	11	1	27	2009	22	16	4000.9	7210.2	80	B, C2
14	12	1	30	2009	3	16	4026.2	7136.8	78	B, C3
15	13	1	30	2009	7	7	4031.1	7214.7	54	B
16	13	1	30	2009	7	17	4030.1	7214.8	55	W2
17	14	1	30	2009	10	7	4023.8	7246.7	46	B
18	15	1	30	2009	10	53	4023.8	7254.5	41	B, C4
19	16	1	30	2009	12	41	4011.2	7308.9	43	B
20	17	1	30	2009	15	51	3951.1	7340.6	34	B
21	18	1	30	2009	17	3	3942.8	7348.2	23	W3
22	18	1	30	2009	17	17	3942.7	7348.1	22	B
23	19	1	30	2009	21	20	3936.3	7257	62	B
24	20	1	30	2009	22	24	3929	7304.4	67	B, C5
25	21	1	31	2009	3	19	3858.7	7352.3	41	B
26	22	1	31	2009	4	35	3858.7	7338.6	52	B
27	23	1	31	2009	6	40	3901.2	7316.4	71	B
28	24	1	31	2009	8	42	3846.2	7302.8	181	B
29	25	1	31	2009	9	36	3844.1	7304.6	147	B
30	26	1	31	2009	16	9	3833.6	7406.4	54	B
31	27	1	31	2009	18	56	3806.6	7402.6	83	B
32	28	1	31	2009	20	23	3753.9	7402.7	158	W4
33	28	1	31	2009	20	42	3753.6	7402.5	166	B, C6
34	29	2	1	2009	0	28	3731.4	7434.5	65	B
35	30	2	1	2009	1	3	3731.3	7439.7	57	B
36	31	2	1	2009	1	58	3723.9	7442.7	56	B
37	32	2	1	2009	4	54	3701	7500.7	45	B
38	33	2	1	2009	7	55	3633.6	7506.7	30	B, C7
39	34	2	1	2009	11	58	3559.3	7450.7	97	W5
40	34	2	1	2009	12	4	3559.3	7450.7	97	B

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									B=bongo W=water C=CMarZ V=vertical cast (CTD only) IA=ichthyo aging CO=Calanus observed / vol EP=euphausiid sample preserved EL=euphausiid sample live	
41	35	2	1	2009	13	22	3556.3	7502.1	42	B
42	36	2	1	2009	16	24	3535.3	7524.4	17	B, C8
43	37	2	1	2009	18	13	3551.6	7530.8	21	W6
44	37	2	1	2009	18	26	3551.7	7530.6	20	B
45	38	2	1	2009	20	51	3613.5	7516.9	30	B, C9
46	39	2	2	2009	0	39	3643.7	7540.6	20	B
47	40	2	2	2009	1	13	3646.4	7538	18	B, IA
48	41	2	2	2009	2	0	3646.4	7545.2	20	B, IA
49	42	2	2	2009	2	47	3646.4	7552.6	13	B, IA
50	43	2	2	2009	3	45	3653.6	7548.3	16	B, IA
51	44	2	2	2009	4	48	3700.5	7552.3	11	B, IA
52	45	2	2	2009	5	37	3700.8	7544.1	15	B, IA
53	46	2	2	2009	6	21	3700.8	7536.9	24	B, IA
54	47	2	2	2009	7	22	3708.8	7538.7	15	B
55	48	2	2	2009	20	23	3728.8	7514.8	31	B, C10
56	49	2	3	2009	0	8	3748.6	7437	52	B
57	50	2	3	2009	2	2	3803.7	7428.9	43	W7
58	50	2	3	2009	2	9	3803.6	7429	43	B, CO/246cc
59	51	2	3	2009	5	5	3811.2	7502.9	21	B
60	52	2	3	2009	9	17	3843.4	7445	16	B
61	53	2	3	2009	12	45	3904	7424.8	29	B, CO/370cc
62	54	2	3	2009	16	32	3926.1	7411.4	17	B
63	55	2	3	2009	20	41	3953.7	7354.9	25	B, CO/326cc
64	56	2	4	2009	1	25	4018.7	7320.9	33	B, CO/227cc
65	57	2	4	2009	4	16	4033.5	7258.6	30	B
66	58	2	4	2009	8	8	4036.3	7212.7	51	W8
67	58	2	4	2009	8	14	4036.2	7212.7	50	B
68	59	2	4	2009	11	57	4021.2	7131	82	B
69	60	2	4	2009	17	49	4046.2	7028.8	54	W9
70	60	2	4	2009	18	3	4046.1	7029	54	B
71	61	2	4	2009	19	47	4101.3	7024.7	42	B
72	62	2	5	2009	0	2	4056.1	6933.2	40	B
73	63	2	5	2009	2	18	4036.2	6945	60	B
74	64	2	5	2009	4	59	4011.1	6938.7	89	W10
75	64	2	5	2009	5	6	4011	6938.7	90	B
76	65	2	5	2009	6	26	4013.9	6928.8	80	B
77	66	2	5	2009	8	10	4023.3	6928.1	70	B
78	67	2	5	2009	10	52	4041.1	6916.6	57	B
79	68	2	5	2009	14	32	4018.2	6843.4	99	B
80	69	2	5	2009	17	7	4013.5	6822.4	169	B
81	70	2	5	2009	19	42	4026.3	6824.9	100	B
82	71	2	5	2009	22	34	4046.1	6834.9	62	B
83	72	2	5	2009	23	52	4053.6	6827.2	52	B
84	73	2	6	2009	3	7	4105.9	6843.4	58	B
85	74	2	6	2009	6	24	4103.8	6810.5	45	B

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CAST	STA.	Date (GMT)		TIME (GMT)		LAT	LONG	DEPTH	OPERATION	
		mm	did	yy	hr					min
86	75	2	6	2009	8	29	4051.2	6756.7	65	B
87	76	2	6	2009	10	18	4046.2	6743	70	B
88	77	2	6	2009	11	32	4043.8	6731.2	89	W11
89	77	2	6	2009	11	39	4043.7	6731.2	88	B
90	78	2	6	2009	13	55	4056.2	6738.5	69	B, C11
91	79	2	6	2009	15	31	4106.1	6738.7	54	B
92	80	2	6	2009	17	4	4116.1	6735	43	W12
93	80	2	6	2009	17	14	4115.9	6735	43	B
94	81	2	6	2009	18	52	4116.3	6720.8	47	B, C12
95	82	2	6	2009	23	27	4041.3	6652.9	195	BAD TOW – NO SAMPLE
96	82	2	7	2009	0	3	4041.2	6652.7	208	B, EP1
97	82	2	7	2009	0	34	4040.1	6653.1	237	B, EL1
98	83	2	7	2009	3	5	4053.4	6634.9	226	V1
99	83	2	7	2009	3	26	4053.2	6635.1	225	B, C13, EP2
100	84	2	7	2009	7	8	4119.2	6618.5	102	B
101	85	2	7	2009	11	12	4146.1	6547.3	138	B, EL2
102	85	2	7	2009	11	32	4146.2	6547	138	B, EP3
103	86	2	7	2009	13	31	4141.2	6608.7	94	W13
104	86	2	7	2009	13	40	4141.2	6608.7	93	B, C14
105	87	2	7	2009	16	17	4126.2	6630.6	93	B
106	88	2	7	2009	18	5	4116	6646.9	75	W14
107	88	2	7	2009	18	17	4115.8	6646.7	74	B
108	89	2	7	2009	20	29	4133.9	6646.9	75	B, C15
109	90	2	7	2009	22	6	4136.2	6708.5	58	B
110	91	2	8	2009	0	54	4153.8	6638.9	76	B
111	92	2	8	2009	1	49	4201.3	6638.7	78	B
112	93	2	8	2009	2	42	4201.2	6628.8	83	B
113	94	2	8	2009	5	56	4213.2	6545.6	224	W15
114	94	2	8	2009	7	2	4213.7	6544.6	228	B, EP4
115	94	2	8	2009	7	25	4213	6545	228	B, EL3
116	95	2	8	2009	8	51	4216.4	6558.9	239	W16
117	95	2	8	2009	9	15	4216.6	6558.9	240	B, C16, EP5
118	96	2	8	2009	15	1	4224.8	6700.2	363	V2
119	96	2	8	2009	15	27	4225	6659.7	363	B, EP6
120	97	2	8	2009	17	3	4228.8	6710.8	345	W17
121	97	2	8	2009	17	29	4228.8	6710.2	344	B
122	98	2	8	2009	22	32	4158.8	6736.7	44	B
123	99	2	8	2009	23	26	4153.9	6742.7	38	B
124	99	2	8	2009	23	55	4154.5	6743.3	39	B
125	100	2	9	2009	16	35	4151	6758.3	63	W18
126	100	2	9	2009	16	41	4150.9	6758.4	63	B, CO/215cc
127	101	2	9	2009	18	43	4201.2	6748.9	173	B, CO/147cc
128	102	2	9	2009	20	49	4206.2	6802.6	225	W
129	102	2	9	2009	21	9	4206	6802.4	218	B, EP7, CO/326cc
130	103	2	9	2009	22	57	4206.2	6814.7	192	B, EP8, CO/178cc
131	104	2	10	2009	0	3	4206.2	6822	179	B, EP9, CO/153cc
132	104	2	10	2009	0	31	4206.4	6823.4	183	B, EL4

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									B=bongo W=water C=CMarZ V=vertical cast (CTD only) IA=ichthyo aging CO=Calanus observed / vol EP=euphausiid sample preserved EL=euphausiid sample live	
133	105	2	10	2009	2	35	4218.8	6808.8	194	B, EP10, CO/159cc
134	106	2	10	2009	6	49	4246.3	6812.9	184	B, EP11, CO/97cc
135	107	2	10	2009	9	19	4241.3	6838.1	187	B, EP12, CO/97cc
136	107	2	10	2009	9	45	4241.3	6839.3	180	B, EL5
137	108	2	10	2009	11	45	4246.1	6904.1	171	B, C17, EP13, CO/140cc
138	109	2	10	2009	13	49	4253.8	6845.1	196	W19
139	109	2	10	2009	13	55	4253.8	6845.2	184	B, EP14, CO/128cc
140	110	2	10	2009	18	58	4318.7	6752.8	230	W20
141	110	2	10	2009	19	15	4318.4	6752.9	228	B, CO/277cc
142	111	2	10	2009	20	47	4323.7	6742	247	V3
143	111	2	10	2009	21	2	4323.6	6741.9	246	B, EP15, CO/159cc
144	112	2	10	2009	21	58	4321.3	6735	220	V4
145	112	2	10	2009	22	13	4321.2	6734.7	219	B, C18, EP16, CO/246cc
146	113	2	11	2009	0	13	4336	6723	218	B, EP17, CO/159cc
147	113	2	11	2009	0	37	4336.2	6721.5	219	B, EL6
148	114	2	11	2009	2	45	4356.6	6728.7	198	B, EP18
149	115	2	11	2009	5	43	4421.6	6742.9	63	B, C19, EP19
150	116	2	11	2009	9	40	4341.7	6756.5	205	B, EP20, CO/221cc
151	116	2	11	2009	10	6	4340.8	6756.3	211	B, EL7
152	117	2	11	2009	12	34	4346.1	6826.2	172	W21
153	117	2	11	2009	12	44	4345.9	6826.4	160	B, C20, EP21
154	118	2	11	2009	17	50	4313.7	6916.9	173	B, C21
155	119	2	11	2009	20	57	4331.2	6946.8	127	W22
156	119	2	11	2009	21	7	4331.2	6946.7	112	B, CO/141cc
157	120	2	12	2009	0	37	4301.3	7006.7	130	B, EP22, CO/246cc
158	121	2	12	2009	2	28	4305.8	7025.9	77	B
159	122	2	12	2009	4	8	4251.5	7019.1	59	B
160	123	2	12	2009	7	49	4231.7	6936	260	B, EL8
161	123	2	12	2009	8	6	4231.4	6935.5	260	W23
162	123	2	12	2009	8	25	4231.4	6935.5	260	B, EP23, CO/122cc
163	124	2	12	2009	9	11	4230.1	6939.8	250	W24
164	124	2	12	2009	9	31	4230.1	6939.6	248	B, EP24, CO/159cc
165	125	2	12	2009	14	16	4225.5	7036.8	87	B
166	126	2	12	2009	15	55	4211.4	7033	44	B
167	127	2	12	2009	20	21	4153.8	6936.8	200	B, EP25, CO/159cc
168	127	2	12	2009	20	50	4152.7	6936.9	184	B, EL9
169	128	2	12	2009	21	46	4146.3	6936.5	155	W25
170	128	2	12	2009	21	55	4146.3	6936.4	153	B, CO/184cc
171	129	2	12	2009	23	58	4129.2	6936.7	31	B (LAST STA)

TOTALS:	Bongo Casts	= 129
	Bongo 6B3Z Samples	= 122
	Bongo 6B3I Samples	= 121
	Ichthyoplankton aging samples	= 7
	Water Samples	= 25
	Vertical Casts	= 4
	CTD Casts	= 171
	CMarZ samples	= 21
	Euphausiid samples (live)	= 9
	Euphausiid samples (preserved)	= 25
	Calanus observations	= 25

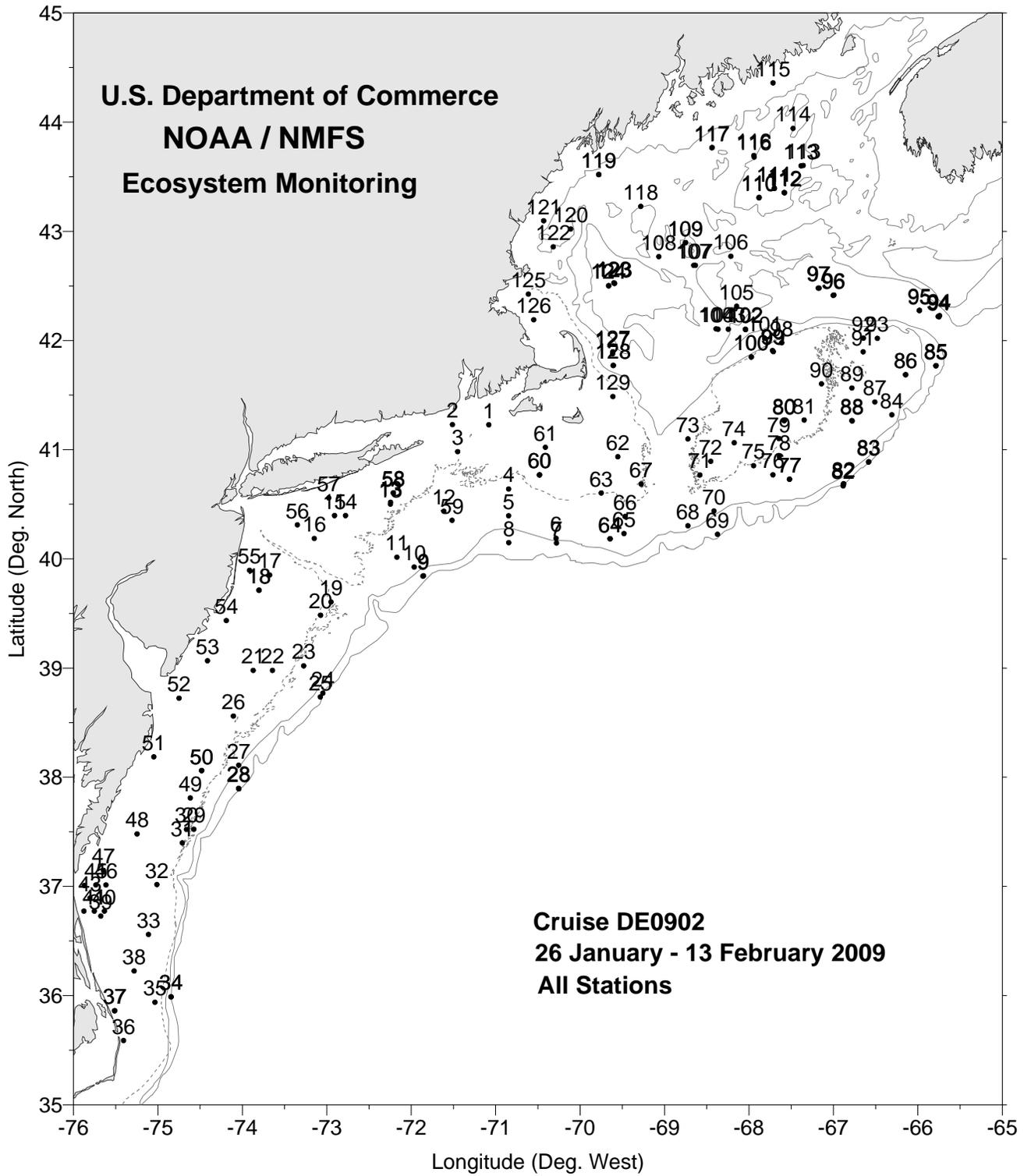


Figure 1. Station locations numbered consecutively for Winter Ecosystem Monitoring Cruise DE 09-02, 26 January - 13 February 2009.