

*Oceanography Branch Cruise Report  
Late Autumn Ecosystem Monitoring Survey - DE0616*

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DATE: 19 December 2006

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**CRUISE RESULTS**  
NOAA Fisheries Research Vessel DELAWARE II  
Cruise No. DE 06-16  
Late Autumn Ecosystem Monitoring Survey

**CRUISE PERIOD AND AREA**

The NOAA fisheries research vessel DELAWARE II sampled at a total of 77 stations from 4 to 16 November 2006. The cruise had originally been scheduled to completely cover the Mid-Atlantic Bight and Georges Bank, but cuts in the vessel schedule, plus bad weather prevented more sampling from being done in those areas.

**OBJECTIVES**

The primary objective of the cruise was to assess changing biological and physical properties which influence the sustainable productivity of the living marine resources of the Mid-Atlantic Bight, Southern New England, Georges Bank and Gulf of Maine portions 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, salinity, and chlorophyll-a fluorescence. Secondary objectives of this cruise involved the following:

- Vertical CTD casts to within 5 meters of the bottom in Gulf of Maine deep basin areas and the Northeast Channel to provide hydrographic data detailing the incursion of Labrador Current water into this region.
- Sampling at the site of a proposed liquefied natural gas (LNG) terminal east of Boston Harbor, to collect baseline data.
- Collection of samples for zooplankton genetics (genome) studies.
- Collection of phytoplankton samples from the ship's flow-through seawater system for nitrogen stable isotope ratio analysis.
- Calibration of flowmeters by towing them over a known distance and recording the revolutions counted.
- Testing of a Video Plankton Recorder/MOCNESS array.

**METHODS**

The survey consisted of 77 stations at which the vessel stopped to lower instruments over the side. Of

these, 10 were in the northern area of the Mid-Atlantic Bight region, 27 were in the Southern New England region, 3 were on the northern flank of Georges Bank and the remaining 37 stations were in the Gulf of Maine. All stations sampled were at randomly stratified locations except for 11 stations in the Gulf of Maine and 1 in Southern New England. Four stations in the Gulf of Maine were at fixed locations: 3 deep-basin stations and a proposed Liquefied Natural Gas terminal site, east of Boston. Seven other stations were added in the Gulf of Maine to improve areal coverage on long transits between randomly placed stations. Minimal sampling was planned for the Mid-Atlantic Bight region because a change in the vessel schedule cut the sea days back to 15 from an originally planned 18. Sampling was planned for Georges Bank but severe weather almost completely prevented operations in that region.

Plankton and hydrographic sampling were planned for the northern strata of the Mid-Atlantic Bight region to coincide with data that had been collected in August 2006 from that area using a Rutgers University autonomous underwater glider and a NOAA NEFSC Video Plankton Recorder.

Plankton and hydrographic sampling was conducted at all 77 stations by making double oblique tows using the 61-cm bongo sampler and a Seabird CTD. The tows were made to approximately 5 meters above the bottom, or to a maximum depth of 200 meters. All plankton tows were conducted at a ship speed of 1.5 – 2.0 knots. Plankton sampling gear consisted of a 61-centimeter diameter aluminum bongo frame with two 335-micron nylon mesh nets. At the randomly designated zoogen 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. A 45-kilogram lead weight in the shape of a flat-bottomed pear was attached by an 80-centimeter 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 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 which was placed on board specifically for this operation. 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 work space allowed for much easier removal of the samples, particularly during inclement weather. The 61-centimeter bongo plankton samples were preserved in a 5% solution of formalin in seawater. The zooplankton genetics samples were preserved in 95% ethanol, which was changed once 24 hours after the initial preservation. 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 meters of the bottom was made in Wilkinson, Jordan, and Georges basins to provide hydrographic data from below the 200 m limit set for bongo tows.

Zooplankton genetics (zoogen) samples were collected at 5 randomly designated stations in the Southern New England region, 1 in the Georges Bank region and 5 in the Gulf of Maine region, yielding a total of 11 samples using the 20-cm diameter bongo samplers as described above.

The 20-cm bongo sampler was also used to collect 2 samples near the Great South Channel for WHOI researcher Nadine Lysiak. These samples were frozen for shore-side analysis of carbon, nitrogen, oxygen and hydrogen stable isotope ratios to correlate with the isotope ratios of these same elements within right whale baleen tissue.

An evaluation was made of a new Video Plankton recorder/MOCNESS sampling array. The 1-meter mouth area MOCNESS was fitted with a Video Plankton Recorder to capture images of planktonic

organisms prior to their capture in the 202 micron mesh net. The frame was fitted with 7 nets. One net provided an integrated water column sample, and each of the other 6 nets was opened every 10 meters, providing depth-discrete samples from 60 meters to the surface. The video camera and ring-strobe system mounted in front of the net opening provided many high quality images of the organisms before they were captured in the nets. The images were stored on a disc drive in a waterproof housing aboard the unit, then downloaded onto a PC after the sampler was retrieved from the water (Figure 2). The 7 MOCNESS samples from this station were preserved in the same manner as the bongo samples, using a 5% solution of formalin in seawater.

Continuous monitoring of the seawater salinity, temperature and chlorophyll-*a* level, from a depth of 4.6 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 25 or more meters depth at 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. Sample analysis for these calibrations followed the protocol outlined in the Ecosystem Monitoring Program Operations Manual.

Nitrogen isotope samples for the US EPA Atlantic Ecology Laboratory were taken at 11 sites along the cruise track. One was from the Mid-Atlantic Bight, 4 were from Southern New England and 6 were from the Gulf of Maine. These samples were collected from the discharge water of the near-surface flow-through system. Samples of 600 to 1000 milliliters of seawater were pre-filtered through a 300 micron mesh nitex gauze to remove most zooplankton, then filtered through a Whatman glass-fiber filter (GFF) and frozen for analysis ashore.

Flowmeters were calibrated at sea in Cape Cod Bay. The bongo sampler was towed at normal bongo tow speeds of 1.5 – 2.0 knots, with the cod ends open for a distance of 0.333 nautical miles. After having been towed for that distance, the bongos were removed from the water, flowmeters were read, nets were hosed down, and the sampler returned to the water, but now towed for the same distance and speed in the opposite direction, to offset the possible effects of any currents on the flowmeters. Two runs were made in each direction with one bongo frame, then the entire procedure was repeated using a second bongo frame having different flowmeters, thus calibrating 4 flowmeters.

## RESULTS

A summary of routine survey activities is presented in Table 1. Areal coverage for the cruise is shown in Figure 1. The DELAWARE II sailed at 0900 hours on Saturday, 4 November 2006, under windy conditions and proceeded southwest to start work off of Montauk Point, New York. The vessel continued in a southwesterly direction, picking up inshore stations until reaching the northern part of the Mid-Atlantic Bight (MAB) on the following day. The DELAWARE II sampled at 10 Mid-Atlantic Bight stations before returning to the Southern New England area on 6 November 2006. Although the MAB stations sampled were too few in number and covered too small a geographic area for adequate representation of this region, they were visited to provide an additional season of data to that obtained from those same strata using a Video Plankton Recorder and an autonomous glider in August of the same year.

Plankton samples from the inshore and midshelf stations of southern New England and the Mid-Atlantic Bight were dominated by large amounts of phytoplankton, and large numbers of medusae, primarily *Pelagia noctiluca*. For this reason testing of the MOCNESS/Video Plankton Recorder was done on a station that was further offshore. The system worked well, and was deployed using 7 nets to capture depth discrete plus an integrated water column sample but was cumbersome to deploy from the DELAWARE II owing to the limited size of the A frame. The offshore Southern New England station was the only station where this system was fished. Increasing wind speeds and growing seas after this initial trial made it more difficult to deploy and retrieve safely due to the very limited clearance between the vertical members of the A-frame.

The DELAWARE II returned to Woods Hole on Wednesday, 8 November 2006 to exchange two of the 4 scientists. The ship docked at 12 noon, at the fisheries dock, then departed at 1230 PM on Thursday, 9 November to continue working in the Gulf of Maine region. The vessel traveled through the Cape Cod Canal to Cape Cod Bay, where flowmeter calibration runs were successfully run. The technique of making the calibration runs over a fixed distance of 0.333 nautical miles, as suggested by Jeff Taylor, the executive officer, and towing in 2 opposite directions to offset the effects of currents, as suggested by the commanding officer, Richard Wingrove, were most effective in producing calibration results similar to that derived from tow tank trials. The results of the calibration runs are summarized in Table 2. This operation took about 2 hours of time, giving the seas some time to come down, since a front had passed over the area while the vessel was in port. The DELAWARE II sampled some inshore stations off Massachusetts, and then headed offshore to sample the Gulf of Maine in a clockwise pattern, zigzagging towards the Bay of Fundy, then south towards the northern flank of Georges Bank. The weather continued to improve daily and made for excellent working conditions until a front reached the region as the DELAWARE II had almost completed the GOM area and was proceeding to the Northeast Channel on Monday, 13 November. Conditions deteriorated steadily throughout the day, and by evening winds were blowing steadily between 30 – 40 knots, from the southeast, the same direction the vessel was traveling towards. As the seas increased in size, the vessel changed course for a more comfortable ride until conditions would permit forward progress to the Northeast Channel station. When conditions had not improved by 1500 hours on the following day, it became apparent that there was not enough time left for adequate coverage of the Georges Bank region. At that point a decision was reached by the chief scientist and captain to start heading back towards Woods Hole and sample at 5 more locations in the Gulf of Maine, where there were big gaps in coverage. At 1542 hours on Tuesday 14 November, the DELAWARE II steamed slowly to the west until conditions improved to where it was safe to start sampling again. Five stations were completed in the central and western portions of the Gulf of Maine. Sampling operations were completed east of Boston late Thursday night. Sampling operations were completed east of Cape Ann, Massachusetts Wednesday afternoon. By the evening of Wednesday, 15 November, the DELAWARE II had reached the Cape Cod Canal, and made an evening transit through it in preparation for docking in Woods Hole the next morning, ahead of another weather front that was approaching the area. The DELAWARE II docked at the Fisheries pier in Woods Hole at 0800 on Thursday, 16 November, marking the end of the Late Autumn Ecosystems Monitoring Survey for 2006, DE 06-16.

#### DISPOSITION OF SAMPLES AND DATA

All samples and data, except for the zooplankton genetics samples, the EPA nitrogen isotope samples, the Woods Hole Oceanographic Institute (WHOI) isotope samples and the Seabird CTD data, were delivered to the Ecosystem Monitoring Group of the NEFSC, Narragansett, RI, for quality

control processing and further analysis. The zooplankton genetics samples and the WHOI isotope samples were taken from the vessel by Nancy Copley of the Woods Hole Oceanographic Institute. The EPA samples were taken to the US Environmental Protection Agency, Atlantic Ecology Division, located in Narragansett, Rhode Island. The CTD data were delivered to the Oceanography Branch of the NEFSC, Woods Hole, MA. Copies of the CTD logs were retained by the Ecosystems Monitoring Group in Narragansett. Calanus volume information was forwarded to Tim Cole after the cruise report was completed.

SCIENTIFIC PERSONNEL

National Marine Fisheries Service, NEFSC, Narragansett, RI

Jerome Prezioso<sup>1,2</sup> Chief Scientist  
Joseph Kane<sup>2</sup>  
Carolyn Griswold<sup>2</sup>

National Marine Fisheries Service, NEFSC, Woods Hole, MA

Maureen Taylor<sup>1</sup>  
Elizabeth Broughton<sup>1</sup>

US Coast Guard, International Ice Patrol Unit, Groton CT

Nicholas Myers<sup>1,2</sup>

<sup>1,2</sup> Legs on which personnel participated.

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Table 1. STATION OPERATION REPORT FOR CRUISE DE0616

CAST	STA.	Date(GMT)		TIME(GMT)		LAT	LONG	DEPTH	OPERATION
		mm	dd	yy	hr				
									B=bongo W=water Z=zoogen V=vertical cast (CTD only) Wiso=WHOI isotope CO=Calanus observed/vol MOC=mocness N=nitrogen isotope
1	1	11	4	2006	20 16	4101.2	7152.8	21	B
2	2	11	4	2006	21 19	4054.2	7148.6	43	W1
3	2	11	4	2006	21 27	4054.1	7148.6	43	B
4	3	11	4	2006	23 13	4043.7	7132.3	63	B
5	4	11	5	2006	0 51	4048.7	7150.5	42	B
6	5	11	5	2006	2 29	4051.2	7210.5	34	B
7	6	11	5	2006	6 29	4023.8	7246.8	44	B
8	6	11	5	2006	6 40	4023.7	7246.1	44	W2
9	7	11	5	2006	11 28	4031.2	7350.5	15	B, Z1, N1
10	8	11	5	2006	17 8	3933.8	7352.6	26	B
11	9	11	5	2006	19 25	3921.3	7331	47	W3
12	9	11	5	2006	19 33	3921.4	7331.1	48	B
13	10	11	5	2006	21 38	3914	7356.9	32	B
14	11	11	6	2006	0 11	3913.9	7428.9	18	B
15	12	11	6	2006	0 50	3908.9	7426.7	22	B
16	13	11	6	2006	3 21	3903.8	7355.2	34	B
17	14	11	6	2006	5 15	3853.8	7337	45	B
18	14	11	6	2006	5 24	3853.6	7336.7	45	W4
19	15	11	6	2006	8 16	3841.2	7304.8	222	B, N2
20	15	11	6	2006	8 49	3841.1	7304.9	241	V
21	16	11	6	2006	11 32	3903.5	7249	119	B
22	17	11	6	2006	12 40	3908.4	7258.3	85	B, Z2
23	18	11	6	2006	15 47	3921.2	7224.7	142	B
24	19	11	6	2006	17 47	3923.7	7246.6	76	W5
25	19	11	6	2006	17 53	3923.7	7246.6	76	B, Z3
26	20	11	6	2006	19 0	3926.3	7256.7	62	B
27	21	11	6	2006	20 32	3936.2	7246.7	66	B
28	22	11	6	2006	22 22	3933.8	7308.5	41	B
29	23	11	6	2006	23 32	3941.1	7318.3	40	B
30	24	11	7	2006	0 45	3945.8	7306.9	47	B
31	25	11	7	2006	6 37	4011.1	7200.9	66	B
32	25	11	7	2006	6 45	4011.2	7200.6	65	W6
32	25	11	7	2006	7 48	4008.8	7148.9	75	B
33	26	11	7	2006	7 48	4008.8	7148.9	75	B, N3, MOC1
34	27	11	7	2006	12 3	4028.8	7135.1	76	B
35	28	11	7	2006	13 16	4018.8	7129.9	82	B, Z4
36	29	11	7	2006	17 19	4001.4	7046.6	222	B
37	30	11	7	2006	20 37	4008.8	7011	114	W7
38	30	11	7	2006	20 43	4008.8	7011	114	B, Z5, N4
39	31	11	7	2006	21 32	4013.6	7007	96	B
40	32	11	8	2006	1 10	4021.3	6925.1	73	B

Table 1. (cont.) STATION OPERATION REPORT FOR CRUISE DE0616

CAST	STA.	Date(GMT)		TIME(GMT)		LAT	LONG	DEPTH	OPERATION	
		mm	did	yy	hr	min		m		
									B=bongo W=water Z=zoogen V=vertical cast (CTD only) m Wiso=WHOI isotope CO=Calan159us observed/vol MOC=mocness N=nitrogen isotope	
41	33	11	8	2006	4	29	4048.3	6952.1	33	B
42	34	11	8	2006	6	3	4044.7	7007.5	38	B
43	34	11	8	2006	6	11	4044.9	7007.3	38	W8
44	35	11	8	2006	7	11	4053.6	7008.7	27	B
45	36	11	8	2006	9	52	4103.7	7040.7	46	B
46	37	11	8	2006	10	43	4108.8	7046.9	35	B, N5
47	38	11	10	2006	3	41	4216.2	7036.5	46	W9
48	38	11	10	2006	3	50	4216	7036.6	45	B
49	39	11	10	2006	4	57	4224.9	7036.9	83	B, N6
50	40	11	10	2006	6	40	4217.9	7018.3	33	B, CO/54cc
51	41	11	10	2006	8	46	4211.1	6952.9	125	B, CO/97cc
52	42	11	10	2006	13	59	4216.3	6843.9	202	B, Wiso1, CO/203cc
53	43	11	10	2006	14	58	4221.1	6845.1	199	B, Wiso2, CO/128cc
54	44	11	10	2006	19	19	4229.9	6939.9	251	W10
55	44	11	10	2006	19	33	4229.8	6940	256	B, N7, CO/271cc
56	45	11	10	2006	21	22	4238.6	6926.7	234	V
57	45	11	10	2006	21	35	4238.5	6926.6	234	B, CO/265cc
58	46	11	11	2006	0	8	4248.8	6900.6	175	B, CO/803cc
59	47	11	11	2006	1	14	4250.7	6845.9	202	B
60	48	11	11	2006	5	11	4317	6910.9	158	B, CO/178cc
61	49	11	11	2006	8	17	4341.5	6934.8	88	W11
62	49	11	11	2006	8	27	4341.2	6935	93	B, N8
62	49	11	11	2006	8	27	4341.2	6935	71	B
63	50	11	11	2006	12	35	4343.8	6838.4	116	B, Z6, CO/234cc
64	51	11	11	2006	15	28	4329.1	6806.9	194	B, Z7, CO/382cc
65	52	11	11	2006	17	41	4324.1	6742.1	247	W12
66	52	11	11	2006	17	46	4324.1	6742.1	247	B, N9, CO/345cc
67	53	11	11	2006	19	57	4336.1	6756.6	223	V
68	53	11	11	2006	20	8	4336.3	6756.5	226	B, CO/685cc
69	54	11	11	2006	22	19	4348.9	6810.8	184	B, CO/271cc
70	55	11	12	2006	2	44	4422	6741.3	60	B
71	56	11	12	2006	5	57	4424.3	6658.3	111	B, CO/97cc
72	57	11	12	2006	9	15	4433.8	6612.7	129	B
73	58	11	12	2006	12	8	4411.1	6631.8	89	W13
74	58	11	12	2006	12	17	4411	6631.7	90	B, Z8
75	59	11	12	2006	16	40	4336.4	6704.7	193	W14
76	59	11	12	2006	16	46	4336.5	6704.6	189	B, Z9, N10, CO/116cc
77	60	11	12	2006	19	12	4326.4	6640.8	138	B
78	61	11	12	2006	22	52	4256.6	6658.9	192	B, CO/221cc
79	62	11	13	2006	2	31	4251.7	6742.5	219	B, CO/271cc
80	63	11	13	2006	5	1	4233.9	6753	225	W15



Table 1. (cont.) STATION OPERATION REPORT FOR CRUISE DE0616

CAST	STA.	Date(GMT)		TIME(GMT)		LAT	LONG	DEPTH	OPERATION	
		mm	did	yy	hr	min		m	B=bongo W=water Z=zoogen V=vertical cast (CTD only) Wiso=WHOI isotope CO=Calanus observed/vol MOC=mocness N=nitrogen isotope	
81	63	11	13	2006	5	17	4234	6753.1	227	B, CO/252cc
82	64	11	13	2006	8	21	4208.8	6738.7	179	B, Z10
83	65	11	13	2006	9	21	4213.7	6730.9	254	V
84	65	11	13	2006	9	38	4213.9	6731.2	259	B
85	66	11	13	2006	11	16	4203.9	6720.6	50	B
86	67	11	13	2006	12	25	4206.1	6707	54	B
87	68	11	13	2006	14	37	4225.1	6659.6	358	V
88	68	11	13	2006	15	8	4224.5	6700.6	359	B, Z11, N11
89	69	11	13	2006	17	25	4213.8	6642.9	233	V
90	69	11	13	2006	17	41	4213.9	6643	237	B
91	70	11	13	2006	19	18	4221.2	6633	300	V
92	70	11	13	2006	19	35	4221.3	6633.5	304	B
93	71	11	13	2006	22	50	4241.3	6618.5	78	B
94	72	11	14	2006	1	15	4243.5	6557.7	81	B
95	73	11	15	2006	5	3	4241.4	6807	195	B, CO/265cc
96	74	11	15	2006	7	34	4239.2	6836.4	196	B, CO/252cc
97	75	11	15	2006	14	9	4252.9	7002.9	137	W16
98	75	11	15	2006	14	15	4252.9	7002.7	138	B, CO/159cc
99	76	11	15	2006	17	36	4254.9	7040	55	B
100	77	11	15	2006	19	52	4239.2	7020.2	74	B

TOTALS: Bongo Casts = 77  
 Bongo 6B3Z Samples = 77  
 Bongo 6B3I Samples = 77  
 Water Samples = 16  
 Vertical Casts = 7  
 CTD Casts = 100  
 Zoogen samples = 11  
 WHOI isotope samples = 2  
 Nitrogen isotope samples = 11  
 Calanus observations = 21  
 MOCNESS/VPR Casts = 1  
 MOCNESS/VPR Samples = 7

Table 2. Results of bidirectional flowmeter calibration runs in Cape Cod Bay on 9 November 2006.

<b>FLOWMETER</b>	<b>START</b>	<b>END</b>	<b>REVS</b>	<b>M/REV</b>	<b>AVG M/REV</b>	<b>FINAL AVG (cal factor)</b>	<b>Flowmeter #</b>
13609 UP	83992	85795	1803	0.342052	0.2883		
13609 DN	85795	88425	2630	0.234494		0.2858	13609
13609 DN	88425	90994	2569	0.240062	0.2834		
13609 UP	90994	92882	1888	0.326653			
02697 UP	80282	82072	1790	0.344536	0.2895		
02697 DN	82072	84702	2630	0.234494		0.2874	2697
02697 DN	84702	87248	2546	0.242231	0.2852		
02697 UP	87248	89127	1879	0.328217			
18685 UP	95067	96991	1924	0.320541	0.2899		
18685 DN	96991	99369	2378	0.259344		0.2785	18685
18685 DN	99369	101842	2473	0.249381	0.2671		
18685 UP	1842	4007	2165	0.284859			
13634 UP	14948	16989	2041	0.302166	0.2743		
13634 DN	16989	19491	2502	0.246491		0.2645	13634
13634 DN	19491	22081	2590	0.238116	0.2547		
13634 UP	22081	24354	2273	0.271324			

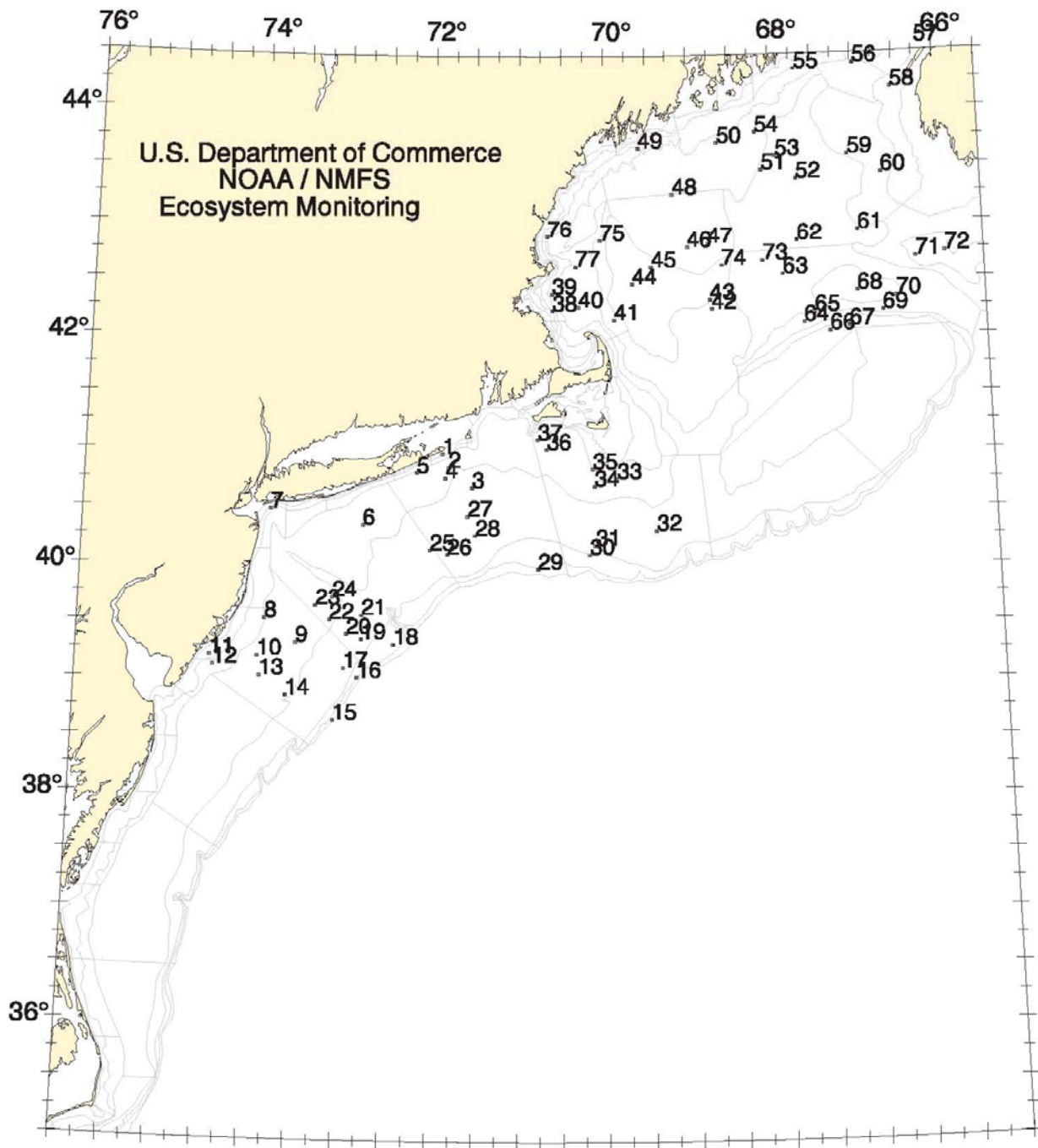


Figure 1. Station locations numbered consecutively for Late Autumn Ecosystem Monitoring Cruise DE 06-16, 4 - 16 November 2006.



Figure 2. Scientist Elizabeth Broughton downloading images onto a PC in DELAWARE II dry lab from MOCNESS/VPR hard drive after deployment at Station 26 in Southern New England.