CRUISE RESULTS
NOAA Fisheries Research Vessel Delaware II
Cruise No. DE 11-05
Ecosystems Monitoring Survey,
NASA Ground Truth Measurements and
Fish Egg and Larvae Survey

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CRUISE PERIOD AND AREA

The cruise period was from 2 to 21 June 2011. The cruise was done all in one leg and covered the entire survey area from Cape Hatteras to Georges Bank and the Gulf of Maine including the Bay of Fundy. Thanks to excellent weather conditions and a lack of any vessel problems the *Delaware II* was able to complete all the designated ecosystem monitoring stations, undertake a full NASA/ODU sampling protocol and go on to sample an additional 65 stations in the western Gulf of Maine and Southern New England areas for fish eggs, larvae and juveniles, within the time allotted.

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. We also 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 as part of their Climate Variability on the East Coast (CliVEC) program. This field data was also used to derive region-independent ocean color algorithms for primary productivity, particulate organic carbon and dissolved organic carbon. Near the end of the cruise additional stations were sampled to look for fish larvae and juveniles and to compare the catching efficiencies of bongo and Isaacs-Kidd plankton nets.

Secondary objectives of this cruise included:

- Deployment of a Laser In-Situ Scattering and Transmissometry (LISST) instrument for measuring the size spectrum of suspended particles (i.e. plankton) in the water column.
- 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 and mammals along the cruise track by observers Marie Martin and Tim White, from the Graduate Center of the City University of New York (CUNY).
- Collection of nutrient samples from the various depths sampled with the Niskin bottle rosette for University of Maine researchers Dave Townsend and Maura Thomas.
- Filtering seawater at selected stations for nitrogen isotope mapping study with researcher Autumn Oczkowski from EPA.
- Collection of *Calanus finmarchicus* copepods for stress analysis by Christopher Taylor at the Narragansett Lab.
- Filtering seawater at selected stations for nitrogen and carbon stable isotope analysis by

researcher Courtney Schmidt from the Graduate School of Oceanography at URI.

METHODS

The first part of the survey consisted of a total of 155 stations (**Figure 1**) at which the vessel stopped to lower instruments over the side. All ecosystem monitoring stations sampled were at randomly stratified locations except for five stations in the GOM that are routinely visited on all Ecosystem Monitoring cruises. These stations were Wilkinson Basin, Georges Basin, Jordan Basin, the Northeast Channel, and the Boston Harbor Liquefied Natural Gas (LNG) terminal. CliVEC sampling was carried out at 53 stations, most, but not all being Ecomon stations, using the CTD 911 rosette array (**Figure 2**).

The second part of the survey consisted of 65 stations, 23 which were in the Gulf of Maine and 42 in the Southern New England areas (**Figure 3**). These stations, laid out as a series of transect lines, were sampled first with a bongo frame equipped with 505 and 335 micron mesh nets. A double oblique tow was done to within 5 meters of the bottom, followed by a double oblique tow done with a 4 foot wide Isaacs-Kidd midwater trawl (**Figure 4**). Unlike the bongo tow which was done from the starboard A-frame, there was no real-time monitoring of the depth of the Isaacs-Kidd net because it was fished off the stern gantry using the starboard trawl winch. Depth of this sampler was ascertained after the tow by downloading data from the Delrin-housed SBE-39 temperature-depth sensor mounted on the spreader bar of the trawl with hose clamps (**Figure 5**).

Plankton and hydrographic sampling on the first part of the survey was conducted 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 6**). A bell-shaped 45-kg lead weight was attached by a 35-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.

A small container (11 ½ ft L x 7 ½ ft W x 7 ½ ft H) was brought on board and 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 fan 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. This freed up space in the Delaware II wet-lab for our NASA and ODU colleagues to set up their filtering gear.

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.

Plankton bongo 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 the thermosalinograph at 10-second intervals. The data records were given a time-date stamp by the GPS unit.

A Niskin bottle rosette equipped with a Seabird 911 CTD unit, fluorometer, oxygen and PAR sensors and ten 10-liter Niskin bottles was brought along to capture hydrographic, chlorophyll, light and oxygen data from the water column., along with nutrient samples from several water column depths. A Laser In-Situ Scattering and Transmissometry (LISST) unit was attached to the rosette (**Figure 7**) for providing suspended particle size spectrum data. Unlike the February ecosystem monitoring cruise where poor weather allowed just one deployment of the rosette sampler, this unit was deployed routinely every day thanks to excellent weather conditions. As a result the LISST unit was deployed as part of the Niskin rosette package, as had been the original intent.

Samples for the Census of Marine Zooplankton (CmarZ) were collected using the 20-cm diameter bongos described above at 5 randomly designated stations in each of three regions sampled: Mid-Atlantic Bight, Southern New England and Georges Bank. Six Census of Marine Zooplankton samples were collected in the Gulf of Maine for a total of 21 CMarZ samples altogether.

An additional fifteen 20-cm bongo tows were made by Chris Taylor to secure quantities of *Calanus finmarchicus* from the Georges Bank and Gulf of Maine areas. Some of these were flash-frozen in liquid nitrogen, while others were preserved in 90% ethanol.

Nitrogen stable isotope ratio samples were collected at 29 stations by filtering 800 ml of seawater from the flow-through seawater system and freezing both the filtered material and the filtrate in the ship's scientific freezer.

On the second part of the cruise the sampling protocol was altered. Starting at station 156 a double oblique bongo tow was made with a 61 cm frame equipped with 335 and 505 micron mesh nets, followed by a tow made using a six foot wide Isaacs Kidd midwater trawl.

RESULTS

A summary of routine survey activities is presented in **Tables 1 and 2**. Areal coverage for the cruise is shown in Figures 1, 2 and 3.

The Delaware II sailed on Thursday afternoon, June 2, and started sampling operations at a station just south of Narragansett Bay before heading offshore and working southward towards Cape Hatteras. Excellent weather permitted the vessel to work its way very quickly along the planned cruise track, despite the intensive sampling operations involving both the CliVEC (Climate Variation East Coast) and Ecosystem Monitoring programs. Calm seas allowed maximum ship speed between

stations and gear deployments took a minimum of time, so that by June 9, all sampling in the Middle Atlantic Bight and Southern New England had been completed and the Delaware II had crossed the Great South Channel and commenced Georges Bank sampling. While on the shoal portion of Georges Bank the first juvenile fish (gadids) were spotted in the bongo net samples (**Figure 8**). By the afternoon of June 12, all Georges Bank sampling was completed and the Delaware II moved on into the Gulf of Maine, via a station in the Northeast Channel. Unlike the shallower Georges Bank stations which had exhibited well mixed water columns, the deeper Gulf of Maine area showed much more stratification, with well-defined thermoclines, and chlorophyll maximum layers usually just above the interface between the lighter warm water and denser cool water masses. Chris Taylor, one of the Narragansett Lab scientists, was able to collect several samples of *Calanus finmarchicus* which he froze in liquid nitrogen to analyze for enzymatic signs of environmental stress ashore (**Figure 9**). Before leaving the Gulf of Maine the crew was able to retrieve a cluster of balloons the ship encountered while steaming between stations (**Figure 10**).

All ecosystem monitoring operations were completed by June 17. At that point the Delaware II started the second phase of the cruise with a series of comparative tows done between a bongo net plankton sampler and a six foot wide Isaacs-Kidd midwater trawl. Two areas were investigated for the abundance and distribution of larval and juvenile fish using these nets: the western Gulf of Maine, and southern New England waters. Some CliVEC operations continued during this portion of the cruise, although Old Dominion University researchers completed their primary productivity research and drained and removed their deck-mounted incubators (**Figure 11**) from the trawl-way, freeing it up for fishing the Isaacs-Kidd midwater-trawl. The first step in this phase of the cruise was given to determining the scope or wire out for the IKMT when it was towed at a speed of three knots Although we were able to operate the net safely without crashing into the bottom on any of our subsequent tows, it was found to be very difficult to accurately place the net more than halfway down the water column without endangering the gear, particularly in rocky areas with uneven bottom. Many variables affected the performance of the net, such as currents encountered at different depths, the increasing weight of the heavy 1" wire as greater amounts were paid out, and minor variations in ship speed. It would be much better to have real-time control of the net depth, either by means of a third wire or some acoustic system, thus enabling consistent tows to within five to ten meters off the bottom, as is achieved during bongo tows. Another complication in fishing this gear was that the trawl winch did not have a wire-out reader, and so the amount of wire paid out was determined by marks on the wire which were difficult to see at times. Net replacement will be another requirement for a subsequent cruise with the IKMT due to the age of the material, particularly at the cod end.

After ascertaining the scope needed to achieve approximate various depths with the IKMT, twenty three stations arranged in four transects were completed in the western Gulf of Maine area (Figure 3). Some small larval fish were found, but no juveniles. After transiting the Cape Cod Canal early on June 19 two north-south transects were made across the southern New England area. This time juvenile fish, some recognizable as haddock, were found offshore from Martha's Vineyard and Nantucket. The cruise plan called for sampling on Georges Bank next, but it was decided to forgo making the one hundred mile run out there and better use the remaining time for increased sampling in the southern New England area. Accordingly, two more north-south transect lines further to the east were run prior to the vessel returning to Woods Hole.

All sampling operations were completed on June 21, and the Delaware II proceeded to Woods Hole via the Great Round Shoals Channel, where it docked at the NEFSC lab on the morning of June 22, 2011, marking the end of the DE 1105 cruise.

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 nitrogen stable isotope samples and nutrient samples were also taken to Narragansett, RI. 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 samples and data were taken by Mike Novak and Dirk Aurin to Greenbelt, MD. The ODU samples and data were taken by Cory Staryk and Brittany Widner to Norfolk, VA. The Ecosystems Monitoring Laboratory Container was stored in the Woods Hole NEFSC parking lot.

SCIENTIFIC PERSONNEL

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Table 1. STATION OPERATION REPORT FOR CRUISE DE1105 USING CTD 19

CAST	STA.	Date(GMT)			TIME(GMT)		LAT	LONG	DEPTH	OPERATION B=bongo W=water Z=CMarZ A=Antonio sample N=nitrogen T=Taylor sample
		mm	did	yy	hr	min			m	
1	1	6	2	2011	11	25	4123.7	7112.8	27	B, N
2	3	6	3	2011	2	17	4058.7	7030.8	47	B
3	4	6	3	2011	4	44	4046.3	7054.4	59	B, N
4	5	6	3	2011	6	42	4038.7	7114.5	62	B
5	6	6	3	2011	7	35	4036.2	7122.7	65	B
6	8	6	3	2011	11	45	4023.8	7202.9	67	B, N
7	9	6	3	2011	12	29	4018.6	7204.7	63	B
8	10	6	3	2011	15	21	4021.2	7233.2	51	B
9	11	6	3	2011	17	36	4013.7	7248.8	52	B, Z1
10	12	6	3	2011	19	58	4001.3	7228.6	67	B
11	13	6	3	2011	22	22	3941	7218.9	115	B
12	15	6	4	2011	1	36	3944	7252.5	75	B
13	16	6	4	2011	3	30	3956.4	7308.9	78	B, N
14	17	6	4	2011	6	21	3933.9	7316.7	38	B
15	18	6	4	2011	8	17	3923.6	7258.1	62	B, Z2
16	19	6	4	2011	10	12	3913.8	7316.5	60	B
17	20	6	4	2011	13	15	3851.3	7300.8	97	B
18	21	6	4	2011	13	54	3849	7302.8	100	B, N
19	22	6	4	2011	16	52	3829.2	7324.2	110	B, A
23	23	6	4	2011	21	52	3803.3	7351.3	259	W1
24	23	6	4	2011	22	57	3803.8	7350.8	268	B, A, N
25	24	6	5	2011	2	52	3806.5	7424.9	44	B
26	25	6	5	2011	7	23	3733.8	7459.8	31	B, Z3
27	27	6	5	2011	11	39	3703.7	7520.5	32	B, A
28	28	6	5	2011	12	37	3658.7	7512.6	39	B
29	29	6	5	2011	14	58	3658.7	7444.7	82	B
30	30	6	5	2011	16	23	3653.8	7456.6	40	B, Z4
31	31	6	5	2011	18	52	3633.9	7502.4	28	B
33	32	6	5	2011	21	23	3616.2	7450.4	87	W3(no bottle 2)
34	32	6	5	2011	21	32	3616.2	7450.4	87	B, N
35	34	6	6	2011	1	15	3558.3	7517	30	B

Table 1.(continued) STATION OPERATION REPORT FOR CRUISE DE1105 USING CTD 19

CAST sample	STA.	Date(GMT) mm	did	yy	TIME(GMT) hr	min	LAT	LONG	DEPTH m	OPERATION B=bongo W=water Z=CMarZ A=Antonio sample N=nitrogen T=Taylor
36	35	6	6	2011	3	38	3538.7	7524.5	21	B, N
37	36	6	6	2011	6	11	3601.3	7522.6	25	B, Z5
38	37	6	6	2011	8	39	3613.8	7544.7	14	B, Z6
39	39	6	6	2011	12	24	3643.9	7550.7	14	B, N
40	40	6	6	2011	16	19	3718.4	7540.9	11	B, Z7
41	42	6	6	2011	21	15	3756.3	7510.7	15	B
42	44	6	7	2011	1	33	3815.9	7431.2	40	B, N
44	45	6	7	2011	4	42	3828.5	7402.6	55	B
45	46	6	7	2011	6	42	3846.1	7404.7	50	B
46	47	6	7	2011	8	17	3846.3	7346.6	48	B
47	48	6	7	2011	9	17	3853.6	7346.6	45	B
48	50	6	7	2011	12	51	3903.7	7424.8	27	B
49	51	6	7	2011	14	37	3908.7	7404.9	38	B
50	53	6	7	2011	15	53	3916.1	7410.8	29	B, N
51	55	6	7	2011	21	49	4006.1	7400	20	B
52	57	6	8	2011	1	50	4031.4	7330.5	17	B, N
53	58	6	8	2011	4	40	4018.6	7256.8	44	B
54	59	6	8	2011	5	42	4025.7	7253.5	44	B
55	60	6	8	2011	8	27	4044	7228.5	33	B, Z8
56	61	6	8	2011	10	5	4043.8	7208.8	46	B, Z9
57	62	6	8	2011	11	45	4043.7	7152.8	48	B, Z10
58	63	6	8	2011	15	40	4017.5	7117.5	91	W4
59	65	6	8	2011	22	25	4003.8	7002.8	153	B, A
60	67	6	9	2011	1	43	4021.1	6938.7	72	B, A
61	68	6	9	2011	3	13	4013.6	6924.9	86	B, A
62	69	6	9	2011	5	0	4028.6	6924.8	68	B, N
63	69	6	9	2011	5	9	4028.5	6925.2	68	W5
64	70	6	9	2011	6	44	4038.9	6936.6	53	B, A
65	71	6	9	2011	7	36	4046	6936.8	42	B
66	72	6	9	2011	9	19	4059	6930.5	27	B
67	73	6	9	2011	11	1	4103.7	6922.8	44	B, Z11
68	74	6	9	2011	12	53	4048.6	6912.9	67	B
69	75	6	9	2011	14	29	4036.2	6904.9	74	B
70	77	6	9	2011	17	12	4038.6	6841	65	B, Z12

Table 1.(continued) STATION OPERATION REPORT FOR CRUISE DE1105 USING CTD 19

CAST sample	STA.	Date(GMT) mm	did	TIME(GMT) yy	hr	min	LAT	LONG	DEPTH m	OPERATION B=bongo W=water Z=CMarZ A=Antonio sample N=nitrogen T=Taylor
71	78	6	9	2011	20	2	4016.2	6832.9	136	B
72	79	6	9	2011	22	55	4038.9	6818.6	78	B
73	80	6	10	2011	2	30	4021.2	6744.7	207	B, Z13
74	81	6	10	2011	5	42	4038.9	6720.8	98	B
75	82	6	10	2011	6	37	4043.6	6724.7	95	B
76	83	6	10	2011	8	22	4041.3	6744.7	78	B, Z14
77	84	6	10	2011	10	16	4053.8	6758.4	55	B
78	85	6	10	2011	12	31	4058.7	6816.8	56	B, A
79	86	6	10	2011	13	42	4106.1	6820.7	48	B, Z15
80	87	6	10	2011	14	41	4111.3	6814.7	50	B
81	88	6	10	2011	17	0	4101.3	6755	44	B
82	89	6	10	2011	19	34	4058.9	6732.8	70	B, A
83	90	6	10	2011	22	20	4108.7	6702.8	67	B, Z16
84	92	6	11	2011	1	6	4106.3	6632.7	97	B
85	93	6	11	2011	2	10	4106.4	6622.8	168	B
86	94	6	11	2011	3	9	4111.4	6618.7	140	B, N
87	94	6	11	2011	3	34	4111.7	6618.1	147	W6
88	95	6	11	2011	5	4	4123.6	6620.8	93	B
89	96	6	11	2011	5	37	4126.2	6620.9	98	B
90	97	6	11	2011	7	59	4133.9	6648.9	70	B, A
91	99	6	11	2011	10	9	4133.9	6710.8	54	B
92	100	6	11	2011	13	21	4118.7	6740.6	41	B
93	102	6	11	2011	17	12	4131.3	6816.6	44	B, N
94	103	6	11	2011	19	3	4143.8	6818.4	72	B
95	104	6	11	2011	22	4	4151.3	6752.7	48	B
96	106	6	12	2011	0	4	4156.2	6734.8	49	B
97	107	6	12	2011	3	44	4138.4	6648.3	69	B
98	108	6	12	2011	6	12	4146.1	6624.7	81	B
99	109	6	12	2011	8	9	4151.2	6607	92	B, A
100	111	6	12	2011	10	34	4208.9	6625	178	B
101	112	6	12	2011	13	50	4213.4	6546.1	226	B, N
102	112	6	12	2011	14	15	4213.4	6546	226	no sample
103	112	6	12	2011	14	37	4212.9	6546.4	226	no sample
104	114	6	12	2011	18	44	4241.3	6559.7	80	B
105	115	6	12	2011	21	23	4249.7	6635.5	173	B, Z17

Table 1.(continued) STATION OPERATION REPORT FOR CRUISE DE1105 USING CTD 19

CAST	STA.	Date(GMT) mm	did	yy	TIME(GMT) hr	min	LAT	LONG	DEPTH m	OPERATION B=bongo W=water Z=CMarZ A=Antonio sample N=nitrogen T=Taylor sample
106	116	6	12	2011	23	46	4240.4	6654.7	231	B, A
107	116	6	13	2011	0	11	4240.4	6654.7	218	V1
108	117	6	13	2011	2	12	4224.9	6659.8	367	B
109	117	6	13	2011	2	34	4224.7	6659	367	V2
110	118	6	13	2011	4	1	4231.1	6708.7	334	B
111	118	6	13	2011	4	21	4230.7	6708.1	336	V3
112	119	6	13	2011	6	10	4233.2	6726.6	272	B
113	119	6	13	2011	6	47	4233.6	6726.6	271	V4
114	120	6	13	2011	10	23	4243.6	6754.9	188	B
115	121	6	13	2011	13	39	4306.2	6734.9	203	B, A
117	122	6	13	2011	16	9	4315.7	6730.6	201	B, Z18
118	123	6	13	2011	20	40	4326.2	6649.1	207	B
119	125	6	14	2011	0	20	3454.3	6636	85	B
120	126	6	14	2011	3	22	4411.3	6708.7	129	B, N
121	127	6	14	2011	5	44	4350.9	6718.9	197	B, Z19
122	128	6	14	2011	7	12	4343.7	6730.1	230	B, A
123	128	6	14	2011	7	34	4343.9	6730.6	231	W7
124	130	6	14	2011	10	37	4323.9	6742	252	B, N
125	130	6	14	2011	11	10	4323.9	6741.8	251	W8
126	131	6	14	2011	12	39	4313.8	6744.9	230	B, Z20
127	131	6	14	2011	13	17	4313.8	6744.7	228	W9
128	132	6	14	2011	17	3	4313.1	6822.3	180	B
129	133	6	14	2011	22	25	4356.3	6845.5	86	B, N
130	133	6	14	2011	23	22	4355.3	6844.6	99	B
131	134	6	15	2011	4	58	4336.3	6950.6	84	B
132	135	6	15	2011	6	53	4331.3	6931.2	138	B
133	137	6	15	2011	10	36	4306	6919.6	178	B
134	138	6	15	2011	11	46	4301.2	6924.6	196	B, Z21
135	139	6	15	2011	14	54	4236.3	6916.8	235	B
136	139	6	15	2011	15	22	4236.7	6916.9	227	W10
137	141	6	15	2011	20	40	4236.1	6826.9	215	B
138	141	6	15	2011	21	5	4236.6	6827.5	216	W11
139	143	6	16	2011	1	3	4221.4	6905	225	B
140	143	6	16	2011	1	30	4221.6	6906.2	229	V5

Table 1.(continued) STATION OPERATION REPORT FOR CRUISE DE1105 USING CTD 19

CAST	STA.	Date(GMT) mm	did	yy	TIME(GMT) hr	min	LAT	LONG	DEPTH m	OPERATION B=bongo W=water Z=CMarZ A=Antonio sample N=nitrogen T=Taylor sample I=IKMT NEB=non ecomon bongo
141	144	6	16	2011	3	56	4208.9	6845.1	186	B
142	145	6	16	2011	7	13	4148.9	6910.5	207	B, N
143	146	6	16	2011	10	21	4146.4	6934.5	163	B, A
144	148	6	16	2011	15	47	4158.9	7014.6	42	B
145	150	6	16	2011	20	6	4224.8	7037.1	84	B, N
146	151	6	16	2011	21	57	4233.7	7020.6	91	B
147	153	6	17	2011	0	22	4228.6	6958.8	157	B
148	154	6	17	2011	2	11	4229.8	6940	257	B
149	154	6	17	2011	2	38	4229.2	6940.2	262	V6
150	156	6	17	2011	14	55	4252.4	7004.5	129	NEB, IKMT
151	157	6	17	2011	17	7	4252.1	7009.8	63	NEB, IKMT
152	158	6	17	2011	18	25	4253.7	7015.5	175	NEB, IKMT
153	159	6	17	2011	19	58	4251.7	7021.9	124	NEB, IKMT
154	160	6	17	2011	21	11	4252.3	7028.6	108	NEB, IKMT
155	161	6	17	2011	23	45	4252.1	7035.7	88	NEB, IKMT
156	162	6	18	2011	1	10	4252.7	7042.6	46	NEB, IKMT
157	163	6	18	2011	4	50	4228.8	7035.2	88	NEB, IKMT
158	164	6	18	2011	6	7	4222.7	7028.8	90	NEB, IKMT
159	165	6	18	2011	7	12	4222.9	7023.9	33	NEB, IKMT
160	166	6	18	2011	8	1	4222.8	7019.9	42	NEB, IKMT
161	167	6	18	2011	8	47	4222.7	7012.8	65	NEB, IKMT
162	168	6	18	2011	9	46	4222.7	7006.1	83	NEB, IKMT
163	169	6	18	2011	11	41	4222.9	6958.4	171	NEB, IKMT
164	170	6	18	2011	13	46	4212	7001.5	136	NEB, IKMT
165	171	6	18	2011	15	14	4212	7008.5	44	NEB, IKMT
166	172	6	18	2011	16	47	4212.4	7014.5	30	NEB, IKMT
167	173	6	18	2011	18	29	4212.3	7020.3	46	NEB, IKMT
168	174	6	18	2011	19	33	4212.2	7026.4	67	NEB, IKMT
169	175	6	18	2011	20	43	4212.2	7032.9	42	NEB, IKMT
170	176	6	19	2011	0	21	4154.1	7014.2	31	NEB, IKMT
171	177	6	19	2011	1	31	4153.4	7021.2	33	NEB, IKMT
172	178	6	19	2011	2	43	4153.6	7027.9	30	NEB, IKMT
173	179	6	19	2011	8	53	4116	7057.7	39	NEB, IKMT
174	180	6	19	2011	9	47	4110.7	7057.6	31	NEB, IKMT
175	181	6	19	2011	10	42	4105.4	7057.8	38	NEB, IKMT

Table 1.(continued) STATION OPERATION REPORT FOR CRUISE DE1105 USING CTD 19

CAST	STA.	Date(GMT)			TIME(GMT)		LAT	LONG	DEPTH	OPERATION B=bongo W=water Z=CmarZ I=IKMT NEB=non ecomon bongo T=Taylor sample
		mm	did	yy	hr	min			m	
171	177	6	19	2011	1	31	4153.4	7021.2	33	NEB, IKMT
172	178	6	19	2011	2	43	4153.6	7027.9	30	NEB, IKMT
173	179	6	19	2011	8	53	4116	7057.7	39	NEB, IKMT
174	180	6	19	2011	9	47	4110.7	7057.6	31	NEB, IKMT
175	181	6	19	2011	10	42	4105.4	7057.8	38	NEB, IKMT
176	182	6	19	2011	12	14	4100.3	7058.2	48	NEB, IKMT
177	183	6	19	2011	13	12	4055.2	7058.2	56	NEB, IKMT
178	184	6	19	2011	14	8	4050.2	7058	58	NEB, IKMT
179	185	6	19	2011	15	6	4045.1	7057.9	62	NEB, IKMT
180	186	6	19	2011	16	42	4040.2	7058.1	68	NEB, IKMT
181	187	6	19	2011	20	52	4008.8	7104.6	145	NEB, IKMT
182	189	6	20	2011	0	16	4014.4	7032.6	116	NEB, IKMT
183	190	6	20	2011	2	21	4028.6	7016.6	70	NEB, IKMT
184	191	6	20	2011	3	57	4034.9	7017	60	NEB, IKMT
185	192	6	20	2011	4	51	4039.7	7017.9	52	NEB, IKMT
186	193	6	20	2011	5	55	4044.9	7016.9	48	NEB, IKMT
187	194	6	20	2011	7	1	4050.2	7017.6	46	NEB, IKMT
188	195	6	20	2011	8	43	4050.2	7004.4	24	NEB, IKMT
189	196	6	20	2011	9	47	4055.7	7006.4	26	NEB, IKMT
190	197	6	20	2011	11	0	4055.9	7017.4	41	NEB, IKMT
191	198	6	20	2011	12	22	4100.7	7018	38	NEB, IKMT
192	199	6	20	2011	13	18	4105.9	7017.9	35	NEB, IKMT
193	200	6	20	2011	14	8	4110.9	7018.7	32	NEB, IKMT
194	203	6	20	2011	19	10	4100.4	6943.9	40	NEB, IKMT
195	204	6	20	2011	20	16	4055.5	6943.7	37	NEB, IKMT
196	205	6	20	2011	21	26	4049.5	6943.5	36	NEB, IKMT
197	206	6	20	2011	22	21	4043.8	6943.4	45	NEB, IKMT
198	207	6	21	2011	0	24	4037.2	6943.3	59	NEB, IKMT
199	208	6	21	2011	1	39	4031.1	6943.1	70	NEB, IKMT
200	209	6	21	2011	2	44	4025.4	6942.8	73	NEB, IKMT
201	210	6	21	2011	3	48	4019.2	6942.8	77	NEB, IKMT
202	211	6	21	2011	7	25	4014.4	6902.4	111	NEB, IKMT
203	212	6	21	2011	9	52	4020.6	6901.6	91	NEB, IKMT
204	213	6	21	2011	11	45	4026.4	6901.3	80	NEB, IKMT
205	214	6	21	2011	12	56	4032.6	6901.6	77	NEB, IKMT

Table 1.(continued) STATION OPERATION REPORT FOR CRUISE DE1105 USING CTD 19

CAST	STA.	Date(GMT)			TIME(GMT)		LAT	LONG	DEPTH	OPERATION B=bongo W=water Z=CmarZ I=IKMT NEB=non ecomon bongo T=Taylor sample
		mm	did	yy	hr	min			m	
206	215	6	21	2011	14	13	4038.3	6901.7	68	NEB, IKMT
207	216	6	21	2011	15	17	4045	6901.6	70	NEB, IKMT
208	217	6	21	2011	16	44	4051.3	6901.4	82	NEB, IKMT
209	218	6	21	2011	18	52	4059	6900.9	85	NEB, IKMT
210	219	6	21	2011	20	24	4105.8	6900.2	97	NEB, IKMT
211	219	6	21	2011	20	58	4104.7	6900.3	94	NEB, IKMT
212	220	6	21	2011	23	28	4112.9	6916.7	60	NEB, IKMT

Table 2. STATION OPERATION REPORT FOR CRUISE DE1105 USING CTD 911

CAST	STA.	Date(GMT)			TIME(GMT)		LAT	LONG	DEPTH	OPERATION N=nitrogen RL=rosette+LISST NUT=nutrients W=water
		mm	did	yy	hr	min			m	
1	2	6	2	2011	23	30	4112.9	7054.8	32	W, RL
2	7	6	3	2011	9	51	4028.5	7147.2	71	W, NUT, RL
3	10	6	3	2011	15	40	4020.9	7233.4	51	W, NUT, RL
4	14	6	3	2011	23	37	3943.6	7229.6	82	W, NUT, RL
5	19	6	4	2011	10	29	7316.7	3913.7	59	W, NUT, RL
6	22	6	4	2011	17	18	3829.4	7324.1	110	W, NUT, RL
7	23	6	4	2011	23	39	3803.7	7350.7	272	W, NUT, RL
8	26	6	5	2011	10	10	3713.5	7514.5	28	W, NUT, RL
9	30	6	5	2011	16	42	3653.8	7456.2	38	W, NUT, RL
10	33	6	5	2011	23	35	3611.2	7508.8	37	W, NUT, RL
11	38	6	6	2011	10	20	3626.7	7547.4	18	W, NUT, RL
12	41	6	6	2011	17	20	3723.7	7534.4	18	W, NUT, RL
13	43	6	6	2011	23	50	3809.1	7443.7	35	W, NUT, RL
14	49	6	7	2011	10	12	3855.3	7353.8	39	W, NUT, RL
15	52	6	7	2011	15	4	3910.4	7406.4	28	W, NUT, RL
16	54	6	7	2011	18	8	3931.4	7407.1	19	W, NUT, RL
17	56	6	7	2011	23	52	4018.5	7344.4	27	W, NUT, RL
18	61	6	8	2011	10	20	4043.7	7208.9	47	W, NUT, RL
19	64	6	8	2011	10	99	4008.7	7104.9	148	W, NUT, RL
20	66	6	8	2011	23	33	4008.9	6955.8	106	W, NUT, RL
21	72	6	9	2011	9	44	4058.7	6930	38	W, NUT, RL
22	76	6	9	2011	16	6	4038.3	6850.6	67	W, RL
23	79	6	9	2011	23	13	4035.5	6818.5	80	W, RL
24	84	6	10	2011	10	33	4053.6	6758.4	56	W, NUT, RL
25	87	6	10	2011	14	56	4111.1	6814.9	45	W, NUT, RL
26	88	6	10	2011	17	20	4101.2	6754.7	46	W, NUT, RL
27	91	6	10	2011	23	35	4107.9	6650	74	W, NUT, RL
28	98	6	11	2011	9	26	4134.3	6705.2	61	W, NUT, RL
29	101	6	11	2011	15	34	4125.1	6802.2	39	W, NUT, RL
30	102	6	11	2011	17	25	4131.4	6818.7	45	W, NUT, RL
31	105	6	11	2011	23	35	4155.7	6736.8	39	W, NUT, RL
32	110	6	12	2011	9	41	4203.2	6618.6	92	W, NUT, RL
33	113	6	12	2011	16	26	4223.7	6551	184	W, NUT, RL
34	120	6	13	2011	9	34	4243.6	6754.6	187	W, NUT, RL

Table 2. STATION OPERATION REPORT FOR CRUISE DE1105 USING CTD 911

CAST	STA.	Date(GMT)			TIME(GMT)		LAT	LONG	DEPTH	OPERATION N=nitrogen RL=rosette+LISST NUT=nutrients W=water
		mm	did	yy	hr	min			m	
35	122	6	13	2011	16	33	4316	6730.8	200	W, NUT, RL
36	124	6	13	2011	23	39	4351.8	6636.5	108	W, NUT, RL
37	129	6	14	2011	9	28	4329.6	6738.9	230	W, NUT, RL
38	132	6	14	2011	16	24	4313.1	6821.9	183	W, NUT, RL
39	133	6	14	2011	23	40	4355.7	6845.2	76	W, NUT, RL
40	136	6	15	2011	9	37	4310.8	6919.2	193	W, NUT, RL
41	140	6	15	2011	17	35	4236.4	6857.2	213	W, NUT, RL
42	142	6	15	2011	23	35	4226.7	6853.2	211	W, NUT, RL
43	146	6	16	2011	9	38	4146.2	6934.6	164	W, NUT, RL
44	147	6	16	2011	15	3	4203.8	7015.9	62	W, NUT, RL
45	149	6	16	2011	18	6	4211.6	7027.4	67	W, NUT, RL
46	152	6	16	2011	23	30	4230	7004.5	113	W, NUT, RL
47	155	6	17	2011	11	5	4252.3	6958.7	188	W, NUT, RL
48	156	6	17	2011	15	19	4252.2	7004.1	134	W, NUT, RL
49	161	6	17	2011	23	1	4252	7033.9	89	W, NUT, RL
50	169	6	18	2011	10	58	4222.8	6958.8	155	W, NUT, RL
51	172	6	18	2011	16	11	4212.2	7014.5	29	W, NUT, RL
52	173	6	18	2011	18	3	4212.2	7020.7	46	W, NUT, RL
53	176	6	18	2011	23	44	4153.6	7014.3	31	W, NUT, RL
54	181	6	19	2011	10	55	4105.4	7058.3	37	W, NUT, RL
55	185	6	19	2011	15	20	4045.3	7058.1	61	W,RL
56	188	6	19	2011	23	3	4012.8	7042.5	125	W, NUT, RL
57	197	6	20	2011	11	39	4055.8	7018	41	W, NUT, RL
58	201	6	20	2011	15	39	4104.3	7011.7	28	W,NUT, RL
59	202	6	20	2011	17	34	4055.6	7000.6	23	W, RL
60	206	6	20	2011	22	58	4044.2	6944.2	51	V
61	206	6	20	2011	23	23	4042.1	6944.1	51	W, NUT,RL
62	213	6	21	2011	11	20	4026.8	6901.3	80	W, NUT, RL
63	216	6	21	2011	15	56	4045.8	6901.9	75	W, NUT, RL
64	218	6	21	2011	18	25	4058.4	6901.1	85	W, NUT, RL
65	220	6	21	2011	22	05	4109.4	6907.9	103	W, NUT, RL

TOTALS:

EcoMon Bongo 6B3Z Samples	= 137
EcoMon Bongo 6B3I Samples	= 138
Non-EcoMon Bongo 6B5I Samples	= 19
Non-EcoMon Bongo 6B3Z Samples	= 19
Bongo 2B1 CMarZ Samples	= 21
Bongo 2B1 Taylor Samples	= 8
Bongo 2B1 Mannino Samples	= 15
IKMT samples	= 58
LISST Casts	= 65
CTD 19 Water Samples	= 10
Vertical CTD 19 Casts	= 6
CTD 19 Casts	= 212
CTD 911 Rosette Casts	= 65
Nutrient Sample Stations	= 31
Nitrogen Isotope Samples	= 29

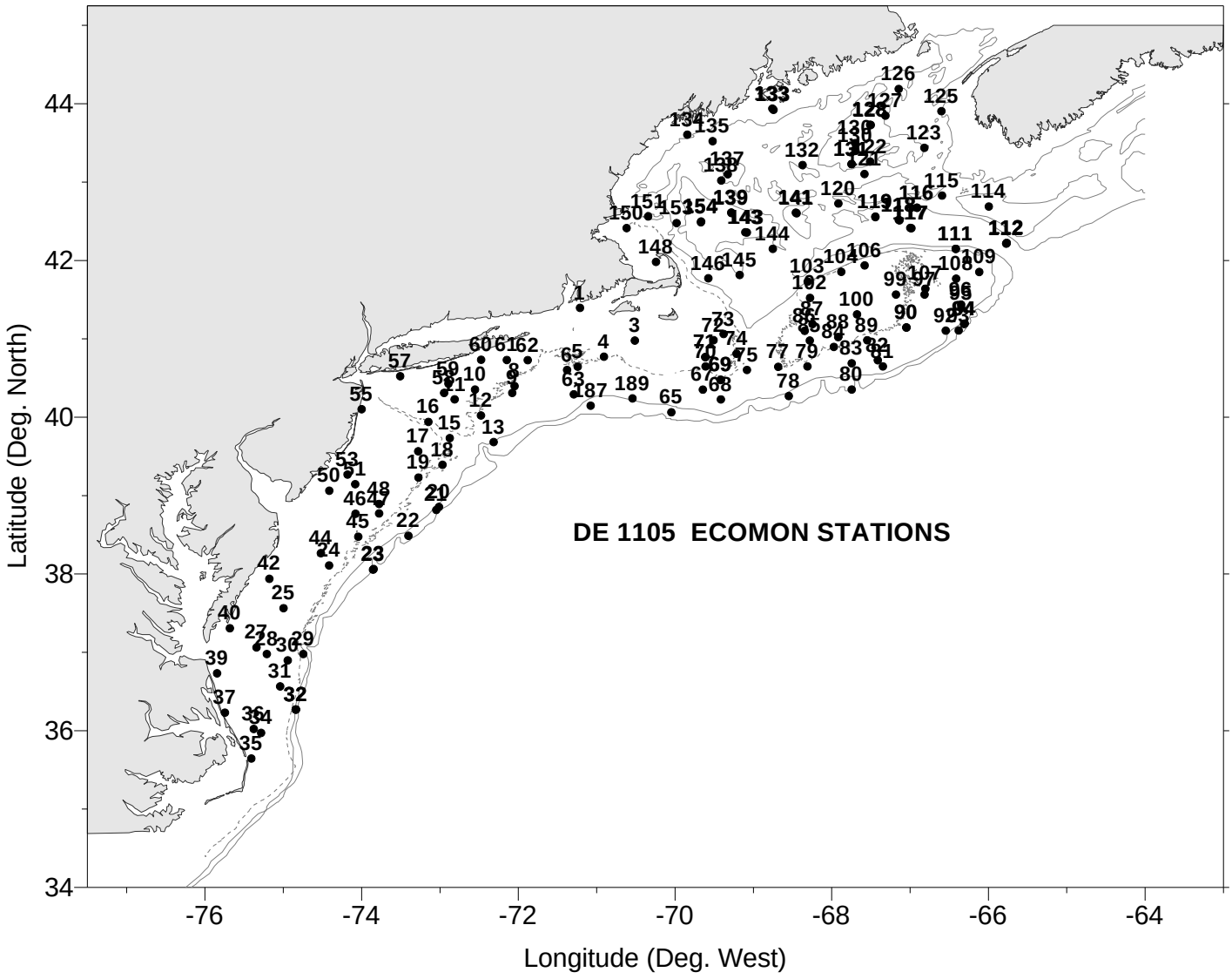

Figure 1. Station locations numbered consecutively for Ecomon stations on Part 1 of Ecosystem Monitoring Survey DE11-05, 2–22 June 2011.

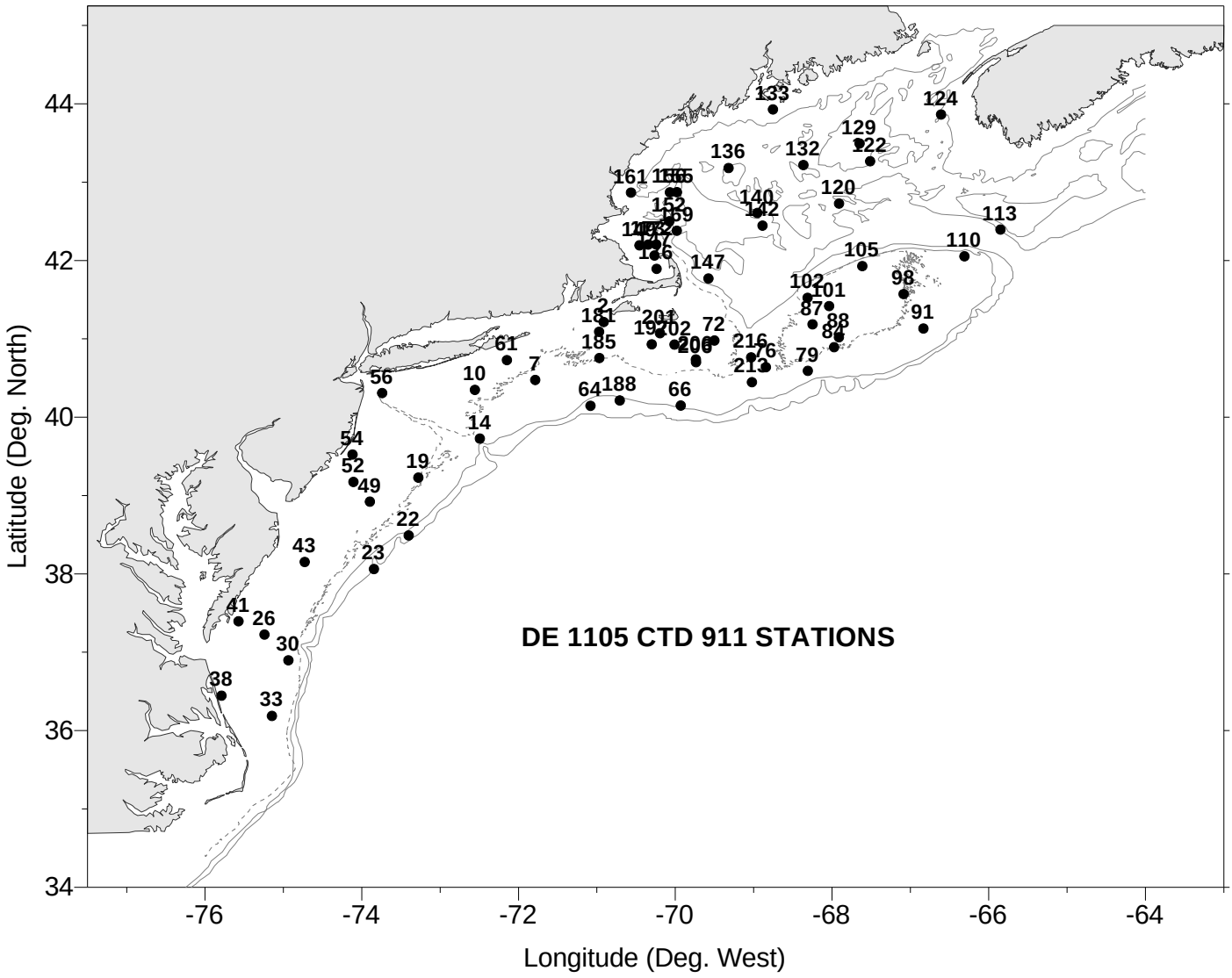

Figure 2. Station locations numbered consecutively for CTD 911 Casts on Part 1 of Ecosystem Monitoring Survey DE 11-05, 2 – 22 June 2011.

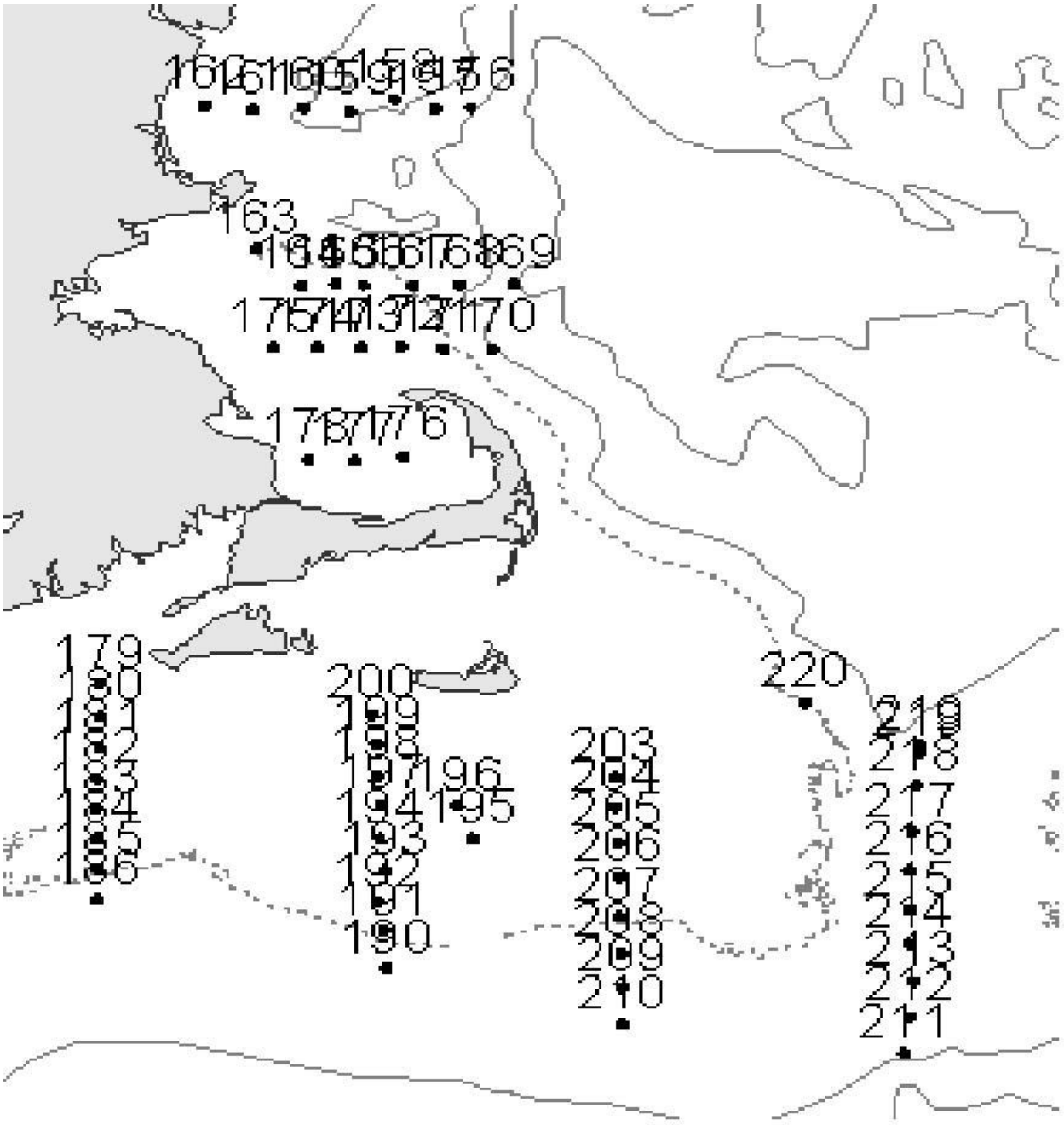

Figure 3. Station locations numbered consecutively for Non-Ecomon stations on Part 2 of Ecosystem Monitoring Survey DE11-05, 2–22 June 2011.

Figure 4. Isaacs-Kidd Midwater Trawl being hauled up the trawlway of the Delaware II during Part II of the DE 11-05 cruise.

Figure 5. Tamara Holzwarth-Davis securing SBE-39 in plastic housing to spreader bar of Isaacs-Kidd midwater trawl.

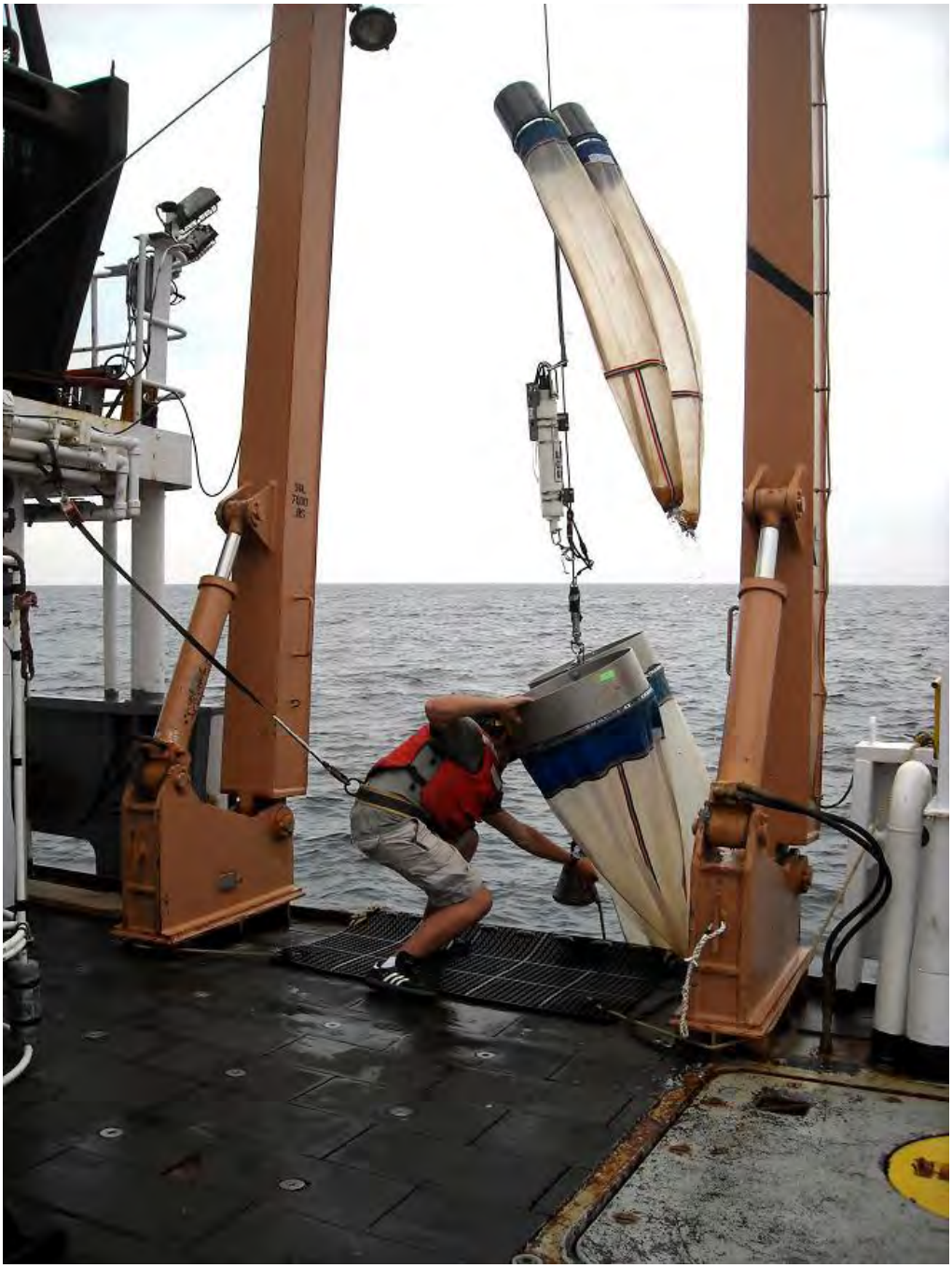

Figure 6. 61 and 20 cm diameter Bongo nets being retrieved. Note plankton visible in cod ends of 20 cm nets.

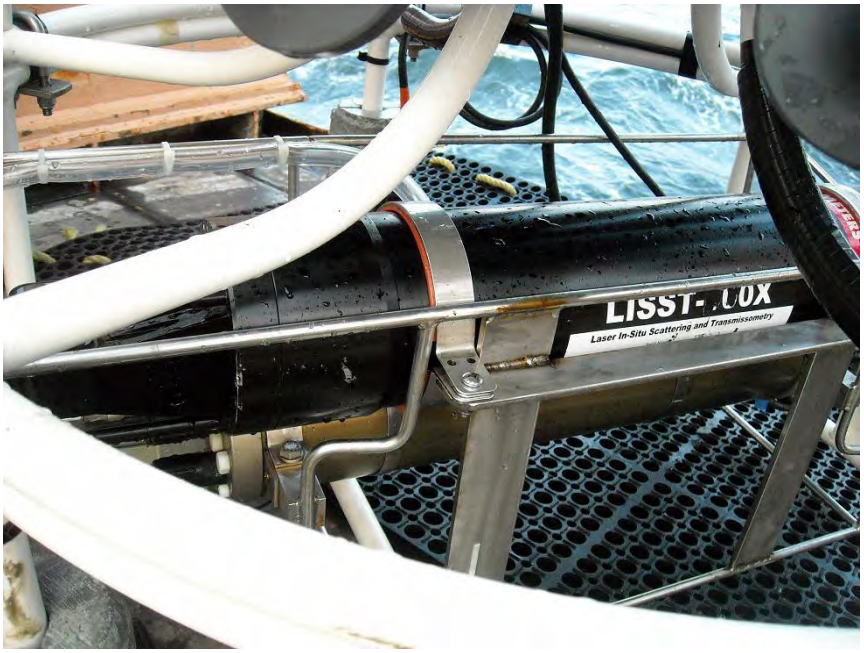

Figure 7. LISST unit mounted horizontally on lower part of rosette frame, just below Niskin bottles.

Figure 8. Juvenile gadid captured on shoal portion of Georges Bank.

Figure 9. Chris Taylor picking *Calanus finmarchicus* from 20 cm bongo samples.

Figure 10. Ensign Shannon Hefferan steers the Delaware II towards a balloon cluster for the crew to retrieve.

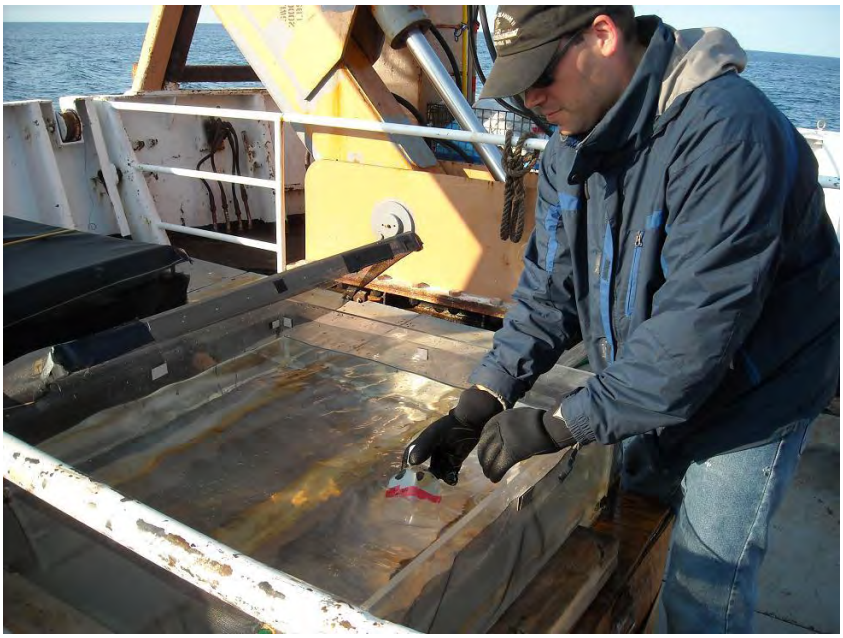

Figure 11. ODU researcher Cory Staryk removes primary productivity bottle from seawater-filled deck mounted incubator.