

CRUISE RESULTS  
NOAA Fisheries Research Vessel *Delaware II*  
Cruise No. DE 09-09  
Ecosystems Monitoring Survey and NASA Ground Truth Measurements

CRUISE PERIOD AND AREA

The cruise period was 17 to 29 August 2009. The original cruise plan called for 17 August to 3 September but 4 days were removed for repairs to the ship's heating system. An additional day was lost at the end of the cruise due to Tropical Storm Danny. The NOAA fisheries research vessel *Delaware II* sampled at a total of 105 stations. Of these, 11 were located in the Gulf of Maine (GOM), 30 were located on Georges Bank (GB), 33 were in the Southern New England (SNE) area, and 31 were in the Mid-Atlantic Bight (MAB) region.

OBJECTIVES

This cruise was the first in a series of multiple-objective cruises that are going to be 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 Holly Goyert, and Tim White, graduate students from Staten Island University.
- Collection of sediment samples for DNA analysis by Alison Cleary to coordinate with similar analyses on euphausiid gut contents.

METHODS

The survey consisted of 105 stations at which the vessel stopped to lower instruments over the side (Figure 1). All stations sampled were at randomly stratified locations except for three stations in the GOM, two in the MAB and two in the SNE areas. Three of these non-random stations were at fixed

positions visited on all Ecosystem Monitoring cruises: Wilkinson Basin, Georges Basin, and the Northeast Channel, and four were stops 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 (Figure 2.). The 20 cm bongo sampler was also used to collect samples for scallop larvae at station 11, 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 to a table on a platform over the trawl-way for wash down of the nets to obtain the plankton samples (Figure 3 background). This departure from our usual procedure of washing the nets in the covered work area allowed us to dedicate that space to the Old Dominion researchers' filtering apparatus (Figure 4). 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. 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, and Georges basins and the Northeast Channel to provide hydrographic data from below the 200 m limit set for bongo tows. Two Van Veen bottom grabs were made, one at station 86 on the northeast peak of Georges Bank, and the second at Georges Basin in the Gulf of Maine (Figure 5).

Forty-two casts were made with the CTD 911/Niskin bottle rosette. The rosette was equipped with twelve 10-liter Niskin bottles (Figure 6). These casts were made at sunrise, mid-day and sunset. An additional cast was sometimes made during the morning or afternoon, for a total of 3 to 5 casts per day. 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 deck incubators (Figure 3).

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. Two Winkler titrations were carried out during the cruise to calibrate the dissolved oxygen measurements made during the rosette casts.

Census of Marine Zooplankton (CmarZ) samples 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 and 6 randomly designated stations in the Gulf of Maine.

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 blessed with light winds and calm seas for much of the scheduled time. Hurricane Bill threatened the beginning of the survey, but had no significant effect due to its eastern track. Tropical Storm Danny did hit the Cape and Islands, causing the loss of the last day of operations.

The *Delaware II* sailed at 1600 hours EDT on Monday, 17 August 2009, following a visit from a congressional delegation, and proceeded southwest to sample offshore stations of the Southern New England area. Favorable weather allowed the offshore sampling to continue all the way to Cape Hatteras, which was reached at 0530 on Friday 21 August. During this part of the cruise, at about 20 miles north of Hudson Canyon, a right whale carcass was sighted. The time of sighting was 1430 EDT on Tuesday, 18 August at 40 02.4 N and 72 19.4 W, about 20 miles north of Hudson Canyon. The carcass was being fed upon by large sharks (Figure 7). Hurricane Bill, which was moving northward at this time, tracked far to the east of us, so that work along the inshore track of stations was unaffected by the weather. It was not until the Delaware II turned eastward on Sunday, 23 August and headed offshore to pick up the easternmost Southern New England stations, that swells from the hurricane were felt, slowing the vessel speed a bit and making it more difficult to deploy the rosette. At station 50, off the southern coast of Long Island, it was noticed that the mechanical part of the termination was slipping and that the cable was unraveling. A poured re-termination was done while the vessel was enroute to station 51, where bongo operations were carried out using the vessel's forward winch. Unfortunately this winch failed during the downcast, and was just barely able to retrieve the sampler, so station 51 was left unsampled and the vessel continued on towards station 52, where sampling operations were continued using the aft winch, as the termination was now ready for use. With Hurricane Bill moving further north and east away from our track line, our pace increased as swells diminished. By Wednesday, 26 August the Delaware II reached the northeast peak of Georges Bank. The bird observers Holly Goyert and Tim White sighted large flocks of birds in this area, and a 10 minute neuston tow was done at 1412 EDT on this day at 4147.6 N and 6606.3 W, midway between stations 84 and 85. The aluminum neuston frame used was 0.5 x 1.0 meters, equipped with a 505 micron mesh net and was deployed from the aft A-frame where all the other sampling gear was deployed from (Figure 8). Also on Wednesday, 26 August, NOAA drifter buoy #81929 was launched by David Wehunt, the URI ARMADA Program teacher-at-sea (Figure 9). The time of launch was 1750 EDT at 4155.5 N and 65 42.8 W on station 86 on the northeast peak of Georges Bank. Also on this station, a bongo tow was done after the buoy launch, followed by a Van Veen bottom grab by Alison Cleary. This grab was only partially successful, coming up with a small amount of sand. A second bottom grab taken the next day, on Thursday, 27 August, in Georges Basin (station 91), came back completely filled with mud. Due to the lack of time remaining in the cruise, and the threat of Tropical Storm Danny, the Delaware II was only able to reach 11 stations in the southern

Gulf of Maine before returning to Woods Hole.

The Delaware II completed operations at 2345 on Friday 28 August, and returned to Woods Hole via the Great Round Shoal Channel, which was entered at midnight. With a tropical storm approaching Cape Cod, operations were ended 24 hours prior to what had been planned to allow the vessel to dock safely. The Delaware II docked in Woods Hole at 0800 Saturday, 29 August 2009, just hours prior to the storm hitting the Cape and Islands area.

#### 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 researchers, while the ODU incubators and laboratory equipment were stored at the NMFS facility in Woods Hole for use on subsequent cruises.

SCIENTIFIC PERSONNEL

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Table 1. STATION OPERATION REPORT FOR CRUISE DE0909

CAST	STA.	Date(GMT)			TIME(GMT)		LAT	LONG	DEPTH	OPERATION
		mm	dd	yy	hr	min				
1	1	8	17	2009	22	58	4118.6	7056.7	34	B, R1
2	2	8	18	2009	1	22	4123.6	7124.9	32	B
3	3	8	18	2009	2	39	4113.5	7118.4	36	B
4	4	8	18	2009	5	6	4103.7	7050.9	35	B
5	5	8	18	2009	10	8	4038.8	7150.2	52	B
6	6	8	18	2009	12	15	4018.6	7148.5	73	B, R2
7	7	8	18	2009	13	53	4013.7	7136.9	79	B
8	8	8	18	2009	14	58	4006.2	7145	82	B, R3
9	9	8	18	2009	19	35	3958.8	7230.7	67	B, R4
10	10	8	18	2009	20	43	3958.3	7235.4	57	B, C1
11	11	8	18	2009	22	15	4003.5	7250.5	57	B, scallop larvae tow, R5, R6
12	12	8	19	2009	2	36	3948.9	7302.7	69	B
13	13	8	19	2009	5	46	3926.3	7234.8	109	B
14	14	8	19	2009	7	42	3926.2	7254.6	63	B
15	15	8	19	2009	10	43	3906.3	7320.6	61	B, R7
16	16	8	19	2009	13	26	3916.4	7340.5	32	B, C2
17	16	8	19	2009	13	36	3916.2	7340.4	37	W1+2
18	17	8	19	2009	15	24	3901	7348.8	38	B, R8
19	18	8	19	2009	17	13	3848.9	7354.5	37	B, C3
20	19	8	19	2009	20	44	3833.7	7317	124	B
21	20	8	19	2009	21	43	3828.8	7318.3	465	B, R9
22	21	8	20	2009	1	17	3823.6	7342.4	98	B
23	22	8	20	2009	2	33	3818.2	7334.9	430	B
24	22	8	20	2009	3	11	3817.1	7335.1	550	W3+4
25	23	8	20	2009	8	40	3808.5	7434.4	34	B
26	24	8	20	2009	9	33	3801.6	7434.6	40	B
27	25	8	20	2009	10	47	3751.6	7438.4	48	B, R10
28	26	8	20	2009	13	5	3736.2	7432.7	65	B
29	27	8	20	2009	14	29	3734	7446.6	42	B
30	27	8	20	2009	14	39	3733.7	7446.6	42	W5+6
31	28	8	20	2009	15	52	3731.1	7458.6	26	B, R11
32	29	8	20	2009	18	8	3721.3	7514.6	25	B, C4
33	30	8	20	2009	20	34	3701.5	7512.9	36	B
34	31	8	20	2009	21	17	3656.8	7510.9	37	B
35	32	8	21	2009	1	53	3621.4	7500.8	41	B, R12
36	33	8	21	2009	4	14	3603.9	7444.9	500	B
37	33	8	21	2009	4	36	3603.8	7444.5	650	W7+8
38	34	8	21	2009	6	23	3603	7458.2	45	B, C5
39	35	8	21	2009	9	35	3544.3	7523.9	26	B, R13, R14
40	36	8	21	2009	13	10	3608.6	7528.8	28	B, C6, R15

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CAST	STA.	Date(GMT)		TIME(GMT)		LAT	LONG	DEPTH	OPERATION	
		mm	did	yy	hr					min
41	37	8	21	2009	16	33	3633.4	7542.5	23	B, R16
42	38	8	21	2009	22	35	3725.9	7528.7	23	B, R17
43	39	8	22	2009	2	42	3758.7	7504.7	21	B
44	40	8	22	2009	6	25	3831.2	7448.7	26	B
45	40	8	22	2009	6	34	3831.1	7448.5	27	W9+10
46	41	8	22	2009	8	9	3833.8	7430.9	30	B (STA 42=rosette 18)
47	43	8	22	2009	12	49	3914.2	7430.7	17	B, R19
48	44	8	22	2009	16	16	3931.1	7353	28	B, R20
49	45	8	22	2009	18	10	3943.7	7348.8	22	B
50	45	8	22	2009	18	21	3943.6	7348.5	22	W11+12
51	46	8	22	2009	21	27	4003.5	7323.3	47	B, R21
52	47	8	22	2009	23	44	4018.4	7315.3	37	B
53	48	8	23	2009	3	0	4028.9	7240.8	44	B
54	49	8	23	2009	4	56	4045.7	7238.9	22	B
55	50	8	23	2009	10	30	4020.3	7144	77	B, R22 (No STA 51 Tow aborted)
57	52	8	23	2009	20	1	4020.7	7011.7	85	B, C7 (STA 53=rosette 23)
58	54	8	23	2009	23	37	3959.6	6949.7	143	B, C8
59	55	8	24	2009	1	29	4006.1	6932.9	101	B, CO/809cc
60	56	8	24	2009	4	27	4028.6	6918.8	72	B
61	56	8	24	2009	4	53	4029.2	6919.5	68	W13+14
62	57	8	24	2009	6	27	4038.7	6928.8	55	B
63	58	8	24	2009	7	50	4036.3	6942.3	61	B
64	59	8	24	2009	9	16	4033.9	6950.3	65	B, CO/283cc
65	60	8	24	2009	10	7	4038.4	6954.3	54	B, R24, CO/475cc
66	61	8	24	2009	14	15	4051.4	6926.8	35	W15+16
67	61	8	24	2009	14	25	4051.5	6926.7	42	B, C9
68	62	8	24	2009	16	24	4108.8	6920.5	50	B, R25
69	63	8	24	2009	19	44	4058.7	6849	84	B, C10
70	64	8	24	2009	21	2	4053.6	6837.1	54	B
71	65	8	24	2009	22	42	4036.7	6831.1	68	B, R26, CO/624cc
72	66	8	25	2009	2	30	4015.9	6820.8	163	B
73	67	8	25	2009	6	14	4051.4	6812.7	55	B, C11, CO/698cc
74	68	8	25	2009	7	21	4100.9	6816.6	49	B
75	69	8	25	2009	10	0	4124.4	6813.4	39	B, C12, R27
76	70	8	25	2009	11	33	4125.9	6800.5	38	B
77	71	8	25	2009	13	4	4133.9	6749.4	20	B, R28
78	72	8	25	2009	15	49	4116.6	6749.8	41	B, R29
79	73	8	25	2009	18	17	4058.9	6746.7	57	B, CO/252cc
80	74	8	25	2009	19	30	4056.4	6733.1	72	B, CO/370cc

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CAST	STA.	Date(GMT)		TIME(GMT)		LAT	LONG	DEPTH	OPERATION	
		mm	dd	yy	hr					min
81	74	8	25	2009	19	42	4056.2	6733.2	71	W17+18
82	75	8	25	2009	21	40	4058.9	6712.6	77	B, R30, CO/364cc
83	76	8	25	2009	23	4	4051.3	6707	91	B
84	76	8	25	2009	23	18	4051.4	6706.8	91	W19+20
85	77	8	26	2009	1	10	4043.7	6646.9	275	W21+22
86	77	8	26	2009	1	27	4043.5	6647	280	B
87	78	8	26	2009	3	51	4056.1	6640.9	98	B, C13
88	79	8	26	2009	6	4	4112.2	6701	67	B
89	79	8	26	2009	6	15	4112.2	6701	69	W23+24
90	80	8	26	2009	9	10	4136.1	6720.5	48	B
91	80	8	26	2009	9	20	4135.8	6720.3	40	W25+26
92	81	8	26	2009	10	53	4134.9	6657.6	63	B, R31
93	82	8	26	2009	12	38	4125.3	6644.4	79	B, C14
94	82	8	26	2009	12	45	4125.2	6644.5	79	W27+28
95	83	8	26	2009	14	28	4138.5	6640.9	68	B
96	84	8	26	2009	15	58	4141.5	6626.4	80	B, R32
97	85	8	26	2009	20	1	4153.5	6546.7	168	B
98	86	8	26	2009	21	10	4155.5	6542.8	231	W no sample
99	86	8	26	2009	21	56	4155.5	6541.6	226	B, BG1, drifter buoy launch
100	87	8	27	2009	0	48	4203.9	6544.5	270	B, R33
101	88	8	27	2009	2	35	4213.6	6546	227	B
102	88	8	27	2009	3	9	4212.7	6547.3	228	W29+30
103	89	8	27	2009	6	49	4203.8	6628.4	81	B
104	90	8	27	2009	9	42	4228.4	6638.7	303	B, R34
105	91	8	27	2009	13	33	4225.2	6659.5	364	R35, B, C15, BG2, CO/240cc
106	92	8	27	2009	16	59	4159.2	6647.3	68	B, R36, R37-no sample
107	93	8	27	2009	21	9	4158.8	6720	57	B
108	94	8	27	2009	22	43	4203.4	6736.1	100	B, R38
109	95	8	28	2009	0	26	4153.9	6742.6	39	B
110	96	8	28	2009	3	9	4148.9	6816.5	154	W31+32
111	96	8	28	2009	3	23	4148.9	6816.5	141	B, CO/326cc
112	97	8	28	2009	5	10	4146.2	6834.1	182	B, C16, CO/425cc
113	98	8	28	2009	7	27	4201.3	6854.8	134	B, C17, CO/531cc
114	99	8	28	2009	9	32	4211.1	6916.5	196	B, C18, R39, R40, CO/364cc
115	100	8	28	2009	13	4	4229.8	6940.3	255	B, C19, R41 CO/289cc
116	102	8	28	2009	21	54	4151.6	6909	204	B,C20,CO/302cc,(sta 101=rosette42)
117	103	8	29	2009	0	10	4133.6	6918.8	130	B
118	104	8	29	2009	2	19	4118.9	6932.7	30	B, C21
119	105	8	29	2009	3	31	4128	6935.3	31	B

END OF cruise

TOTALS:	Bongo Casts	= 101
	Bongo 6B3Z Samples	= 100
	Bongo 6B3I Samples	= 101
	CTD 19 Water Samples	= 32
	Vertical CTD 19 Casts	= 0
	CTD 19 Casts	= 119
	CMarZ samples	= 21
	Bottom grab samples	= 2
	Rosette/CTD 911 casts	= 42
	Calanus observations	= 15
	Drifter buoy launch	= 1
	Scallop Larvae Tow	= 1

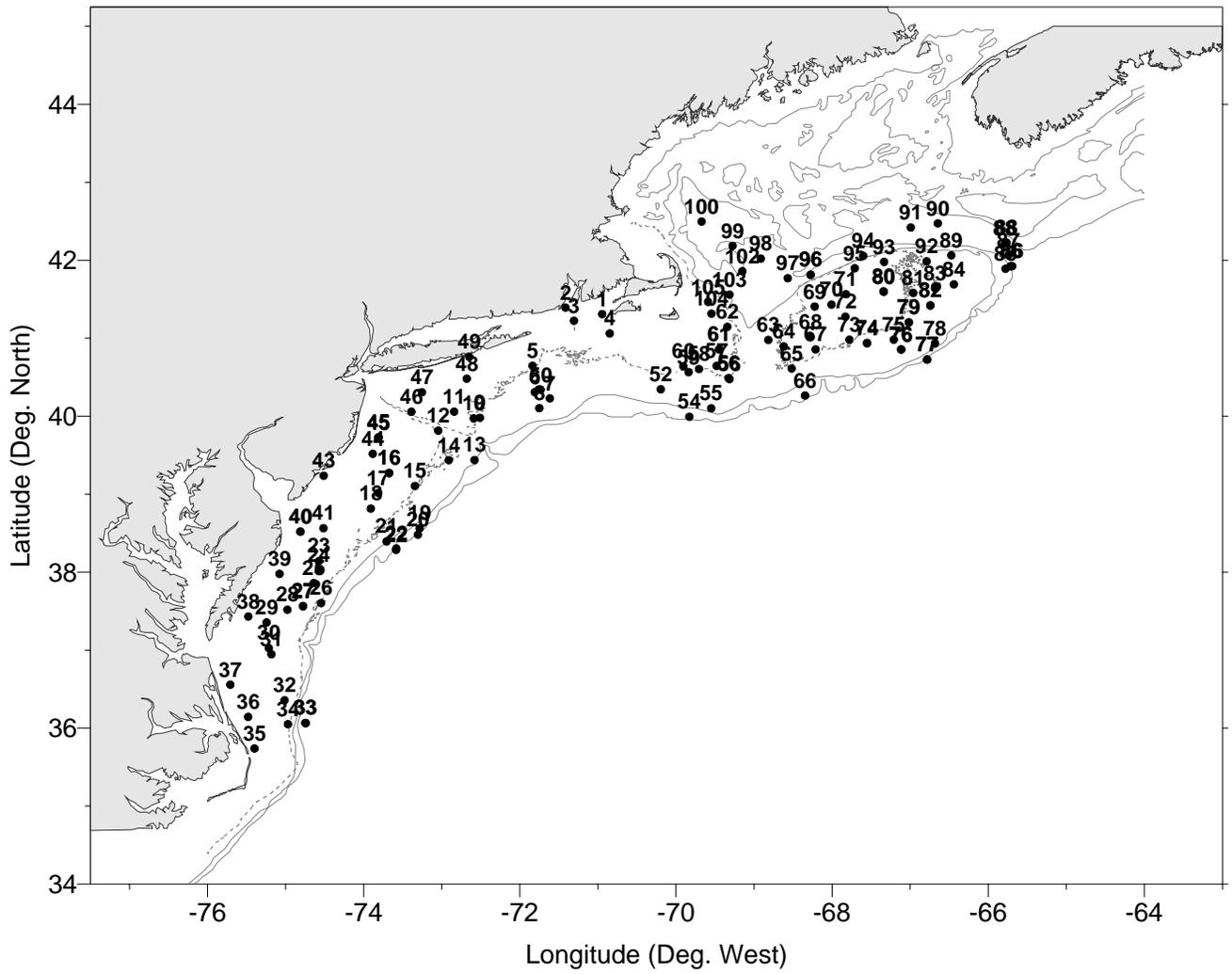


Figure 1. Station locations numbered consecutively for Ecosystems Monitoring Survey and NASA Ground Truth Measurements Cruise DE 09-09, 17 - 29 August 2009.

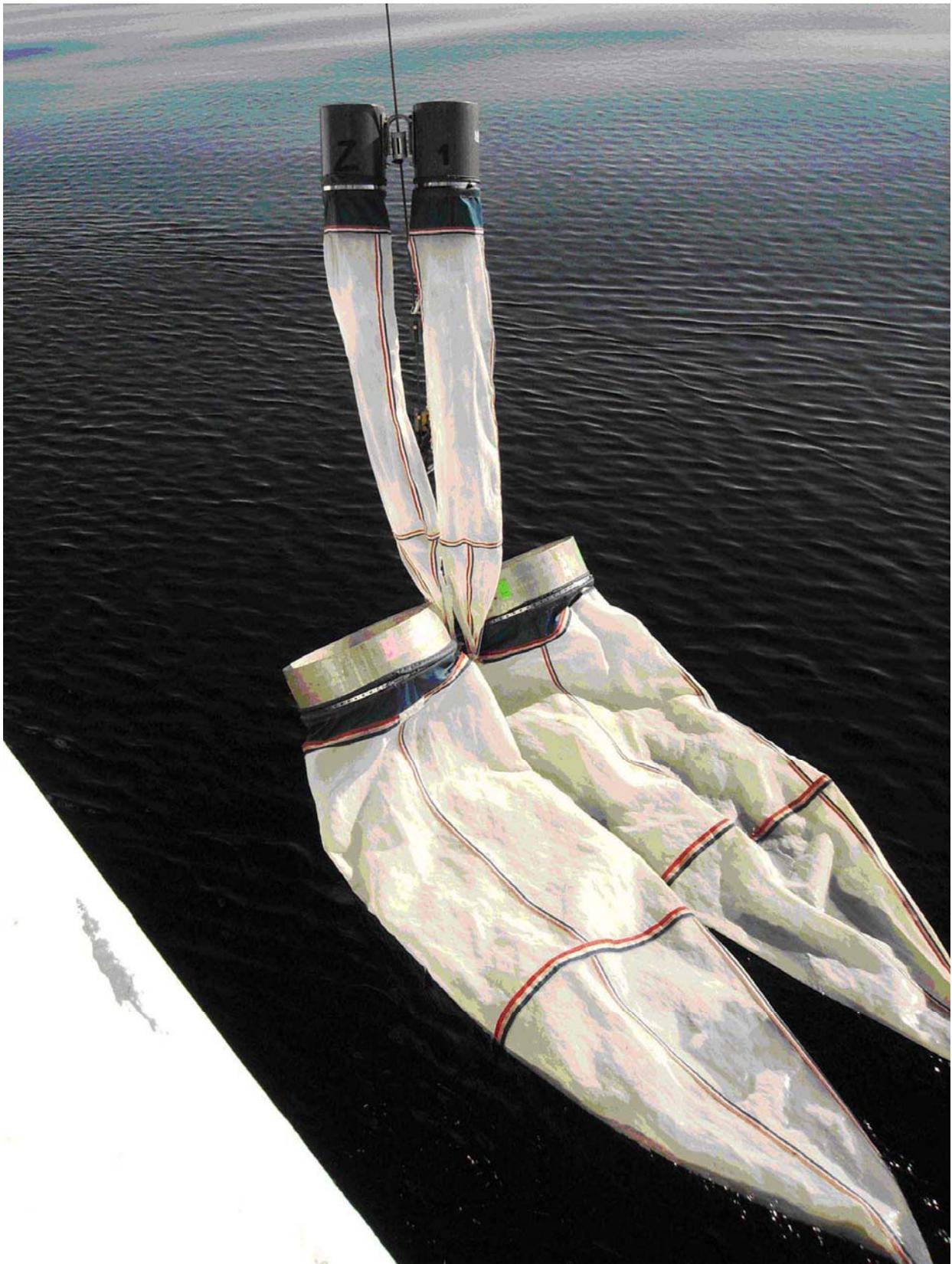


Figure 2. 20 cm + 61 cm bongo sampling array used for collecting CMarZ samples simultaneously with Ecosystem Monitoring samples.



Figure 3. ODU researcher Margie Mulholland placing a primary productivity sample into one of four deck-mounted incubators. Note bongo frames in background, marking the plankton net wash-down area at the stern, over trawlway.



Figure 4. ODU researchers Margie Mulholland and Chris Burbage in covered work area of Delaware II on DE0909 cruise.



Figure 5. Alison Cleary, a URI Graduate School of Oceanography student, prepares to launch a Van Veen Bottom Grab from the Delaware II aft A-frame, to sample sediment from Georges Basin.

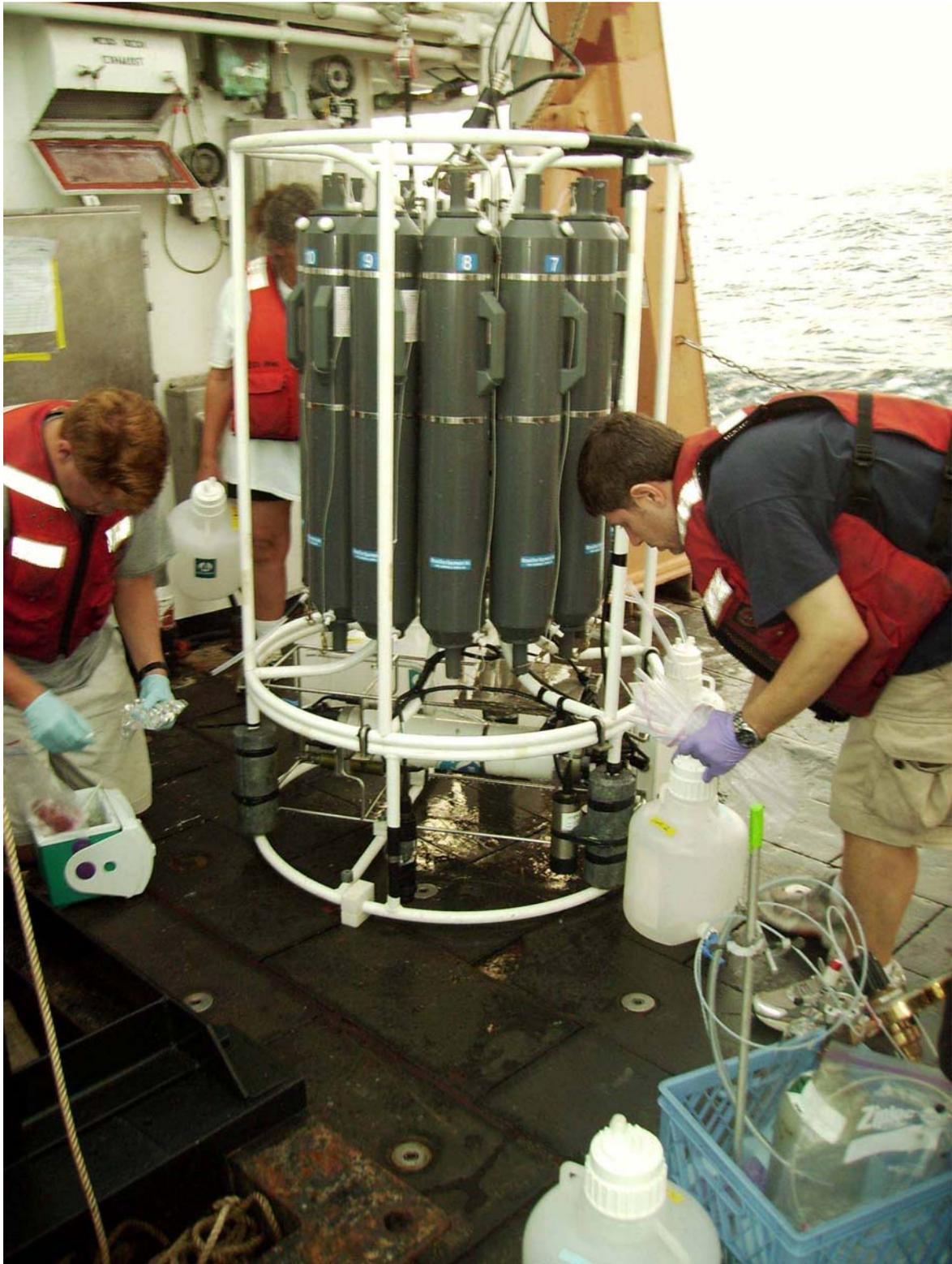


Figure 6. ODU researcher Chris Burbage and NASA researcher Antonio Mannino collecting water from rosette sampler on DE 0909 cruise.



Figure 7. A large shark feeding on a right whale carcass sighted 20 miles north of Hudson Canyon during DE 0909 cruise.



Figure 8. The neuston sampler used for surface plankton sampling in the vicinity of a large flock of birds midway between stations 84 and 85 on DE 0909 cruise.



Figure 9. David Wehunt, URI ARMADA Program Teacher-at-Sea, prepares to launch a NOAA drifter buoy on station 86 of the DE 0909 cruise.