5 February 2020

CRUISE RESULTS

NOAA Research Vessel ***GORDON GUNTER***

Cruise No. GU 19-05

Fall Northeast Ecosystem Monitoring Survey

CRUISE PERIOD AND AREA

The NOAA research vessel *GORDON GUNTER* sampled a total of 117 stations on the Fall Ecosystem Monitoring Survey (EcoMon). The vessel sailed from Pier 2 at the Naval Station in Newport RI on 15 October and returned on 1 November 2019, sampling from Cape Hatteras, NC and north, covering the Middle Atlantic Bight, Southern New England and Georges Bank areas completely and a small portion of the southwest Gulf of Maine during the 18 sea days allotted for this trip (Figure 1).

OBJECTIVES

The principal objective of this survey was to assess the pelagic components of the Northeast U.S. Continental Shelf Ecosystem from water currents to plankton, pelagic fishes, marine mammals, sea turtles, and seabirds. The spatial distribution of the following parameters was quantified: water properties, phytoplankton, microzooplankton, mesozooplankton, pelagic fish and invertebrates. Both traditional and novel techniques and instruments were used.

Other operational objectives of this cruise were to:

(1) collect underway data using TSG, SCS, and ADCP.

2) complete CTD and bongo operations at stations throughout area.

(3) collect acoustic data using the EK60.

(4) collect samples for the Census of Marine Zooplankton (CMarZ) genetics studies.

(5) collect samples for aging and genetic analyses of fish larvae and eggs.

(6) collect near-surface underway data and imagery from the entire cruise track using a TSG, fluorometer, SCS, EK-60 Scientific Sounder, ADCP and an Imaging FlowCytoBot unit.

(7) gather data on trends in ocean acidification and nutrient levels by collecting seawater samples at three depths (surface, midwater and bottom) with a rosette water sampler at predetermined fixed locations for the NOAA Ocean Acidification Program.

(8) measure the optical properties of seawater at various depths using optical sensors to better identify sizes and types of phytoplankton using color measurements derived from satellite images.

(9) compare plankton catches taken by a vertical ring net tow protocol from Canada's Department of Fisheries and Oceans Atlantic Zone Monitoring Program with Ecomon bongo tows from the same area. This work is part of an effort to find ways of combining data collected by the US and Canada in the Gulf of Maine and Georges Bank.

(10) Two new initiatives, never before undertaken on our Ecosystem Monitoring Surveys, involved analyzing seawater for the presence of methyl mercury, a toxin that is passed up through the food chain, and environmental DNA, a technique to detect the presence of finfish from fragments of tissue they've left behind from their passage through the water column.

METHODS

Plankton and hydrographic sampling was conducted with double oblique tows using the 61-cm bongo sampler and a Seabird CTD. The tows extended 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 equipped with analog flowmeters that recorded the number of revolutions during the tow. At **20** randomly designated Census of Marine Zooplankton (CMarZ) stations, a 20-cm diameter PVC bongo frame fitted with paired 165-micron nylon mesh nets was added to the towing wire one half meter above the Seabird CTD and towed together with the large aluminum bongo frame (Figure 2). No flowmeters were deployed with the 20-cm bongos. At all other plankton stations, 20 cm 335 micron mesh nets were deployed above the standard CTD/61-cm Bongo sampler in order to collect larval fish and egg samples for NOAA researcher David Richardson. These samples were preserved for genetics and otolith analysis to be carried out at the Narragansett NEFSC Lab. A 45-kilogram lead weight was attached by a 20-centimeter length of 3/8-inch diameter chain below the aluminum bongo frame to depress the sampler. The plankton sampling gear was deployed off the port side of the vessel at the side-sampling station using an A-frame and the forward conducting cable winch. Tow depth was monitored in real time with a Seabird CTD profiler. The Seabird CTD profiler provided simultaneous depth, temperature, and salinity during each plankton tow. A Power Data Interface Module (PDIM) signal booster was used to facilitate data transfer at high baud rates over more than 1600 meters of conducting wire spooled onto the oceanic winch. After retrieval, both the large and small bongo nets were washed down with seawater at a table on the deck of the sampling area to obtain the plankton samples.

The 61-centimeter bongo plankton samples were preserved in a 5% solution of formalin in seawater. The CMarZ genetics samples and the genetics and otolith larval fish and egg samples from the 20-centimeter bongo nets were preserved in 95% ethanol, which was changed once, 24 hours after the initial preservation. At 2 plankton stations on Georges Bank) a vertical tow was made after the bongo net tow using a 75 cm diameter ring net with 200-micron mesh (Figure 3) (Figure 3). The tow extended from 5 meters off the bottom to the surface. This was done to compare plankton catches made by Canada's Atlantic Zone Monitoring Program sampling protocols with samples collected by NEFSC EcoMon protocols in an effort to find ways of combining data collected by each country in the Gulf of Maine and Georges Bank. It had originally been planned to do more of these comparison tows, but due to time lost from bad weather it was decided to drop further ring net sampling to devote maximum time to getting as many stations done as possible in the time remaining on the cruise schedule.

A Seabird 911+ CTD was deployed on a rosette frame with a carousel water sampling system (SBE32) and 12 10-liter Niskin bottles at all fixed stations (Figure 4). The package was deployed from the port side-sampling station, using the A-frame and aft conducting cable winch. This SBE9/11+ CTD and rosette package was deployed on vertical casts, collecting profiles of water temperature, salinity, chlorophyll-a and oxygen levels. Water samples were collected by the Niskin sampling bottles at multiple depths along the upcast to be processed ashore for nutrients and carbonate chemistry. Analysis for chlorophyll-a levels from these water samples was

conducted onboard the vessel in the chemistry lab, using a Turner Designs 10-AU fluorometer and a filtration setup. Water samples for the chlorophyll-a analysis were drawn from the surface, chlorophyll-max layer and from one depth below the chlorophyll-max layer. These were taken as a check for the submersible fluorometer mounted on the rosette. Water was also filtered from 2 to 3 depths for URI GSO researchers to capture phytoplankton from the surface, the chlorophyll max layer and sometimes below the chlorophyll max. This provided them with water column optical data in addition to the surface water optical data they were obtaining from the surface seawater flow through system. Care was taken to draw a nutrient sample from the same bottle that each Dissolved Inorganic Carbon (DIC) sample had been drawn from, (surface, mid-water and bottom) to ensure the best possible correlation between the DIC and nutrient parameters.

This cruise had additional analyses being done on the water drawn from the sample bottles. Some of the water went to Yuan Liu for her environmental DNA work and some went to Patricia Meyer for her research on the presence of methyl mercury (Figure 5). Since Patricia Meyer's primary interest was finding methyl mercury in surface water, she relied on seawater from the surface flow-through system at each fixed station and only used water from the Niskin sampling bottles at 3 of the fixed position rosette stations for a comparison.

During the daytime rosette casts, the URI researchers made a simultaneous cast from the port stern quarter of the vessel with a hand-deployed submersible radiometer to measure incident light coming down from the surface with an upward-facing sensor and backscatter incident light from a downward-facing sensor (Figure 6). This unit provided valuable optical data to correlate with phytoplankton captured at various depths by the rosette.

Near-surface (~3 meters depth) salinity, temperature and pCO2 levels were monitored continuously along the entire cruise track using a thermosalinograph, and a partial pressure of carbon dioxide (pCO2) system hooked up to the ship's scientific flow-through seawater system. The Scientific Computer System (SCS) recorded the output from the thermosalinograph at 10-second intervals. Records were given a time-date stamp by the GPS unit. Data from the pCO2 system were logged independently on a dedicated computer hooked up to that sensors. The dedicated, independent computer for pCO2 did receive correlated data from the SCS system onboard. In addition, an Imaging FlowCytobot unit was plumbed into the flow-through seawater system in the CTD lab**.** This device captured images of diatoms, dinoflagellates and marine ciliates on an independent computer provided by the Woods Hole Oceanographic Institution (WHOI) (Figure 7). This system was monitored daily by Kyle Turner, a graduate student and researcher from the Graduate School of Oceanography at URI.

Marine mammal and seabird observations and photography were conducted from the bridge and flying bridge of the *GORDON GUNTER* by seabird and marine mammal observers Allison Black and Skye Haas (Figure 8).

RESULTS

A summary of routine survey activities is presented in Table 1. Areal coverage for the cruise is shown in Figure 1. The survey originally consisted of **155** stations at which the vessel planned to stop and lower instruments over the port side of the vessel from an A-frame and two conductive-wire winches. Due to time constraints imposed by the extremely poor weather the vessel was not able to reach most of the Gulf of Maine, the last area to be sampled during this cruise. A total of **117** stations were sampled, from Cape Hatteras, the southernmost point of the survey to stations on the southern and southwestern portions of the Gulf of Maine. The Gordon Gunter returned to Narragansett Bay via the Cape Cod Canal and docked at Pier 2 Naval Station Newport on 1 November 2019, marking the end of a Fall Ecosystem Monitoring Survey that was able to cover the Middle Atlantic Bight, Southern New England and Georges Bank areas in their entirety, with only the Gulf of Maine having almost no survey coverage. Given the marginal weather conditions experienced for most of the cruise this was a remarkable achievement. Future Fall Ecosystem Monitoring Surveys would do well to have more than 18 working days scheduled, given that not being able to reach all the stations in the time allotted is a recurring scenario with the weather conditions typical of late fall.

DISPOSITION OF SAMPLES AND DATA

All samples and data, except for the CMarZ zooplankton genetics samples, the University of Maine nutrient samples, and the Seabird CTD data, were delivered to the NEFSC Ecosystem Monitoring Group in Narragansett, RI for quality control processing and further analysis. The CMarZ samples and associated data were delivered to Nancy Copley at the Woods Hole Oceanographic Institution. The nutrient samples were sent by overnight UPS to Kathleen Thornton at the Darling Marine Center, U. Maine, Orono, ME. The Imaging FlowCytobot unit and the images and data it collected were delivered to Emily Peacock at WHOI. The CTD data were delivered to NEFSC Oceans and Climate Branch staff in Woods Hole, MA. Marine mammal observation data and the seabird observation data went to Tim White at the Bureau of Ocean Energy Management (BOEM) in Reedsville, MD and Beth Josephson, NEFSC Protected Species Branch, Woods Hole, MA.

SCIENTIFIC PERSONNEL

<u>National Marine Fisheries Service, NEFSC, Narragansett, RI</u>

Jerome Prezioso Chief Scientist

Christopher Taylor

National Marine Fisheries Service, NEFSC, Woods Hole, MA

Tamara Holzwarth-Davis

Elisabeth Broughton

National Marine Fisheries Service, NEFSC, Milford, CT

Yuan Liu

University of Rhode Island, Graduate School of Oceanography

Kyle Turner

University of Connecticut

Patricia Meyer

Integrated Statistics Biological Technician

Tucker Taylor

Integrated Statistics Marine Mammal and Seabird Observers

Allison Black

Skye Haas

****

For further information contact:

Paula Fratantoni, Branch Chief, Oceans and Climate Branch

National Marine Fisheries Service, Northeast Fisheries Science Center

Woods Hole, MA 02543

Tel(401) 495-2306;

INTERNET “paula.fratantoni@noaa.gov”.

Table 1. Summary of sample activities conducted at 117 stations at which the *GORDON GUNTER* stopped to lower instruments over the side during Cruise No. GU 1905. Latitude and Longitude are shown in degrees and minutes. BON/CTD = 61 cm bongo Standard Protocol, CTD 911+ = water cast at a fixed station, SAL=salinity sample, 2B3 D = 333 mesh 20 cm bongo Dave R. samples, NUT = Nutrients, CHL = Chlorophyll

2B1 C = 165 mesh 20 cm bongo CMARZ samples, DIC = Dissolved Inorganic Carbon, Net Vertical = Vertical Ring Net Tow, CTD 19/19+ WATER = Seabird 19+ Profiler+water sample, URI = URI water sample

LTER = Long Term Ecological Research Station, E=eDNA, M=Methyl mercury

Cast	STA	Date (GMT)	Lat (deg min)	Long (deg min)	Bot Depth (m)	Operations
1	1	10/15/2019	4119.8	7110.5	30	BON/CTD, 2B3 D
2	2	10/15/2019	4105	7110.2	32	BON/CTD, 2B3 D
3	3	10/15/2019	4100	7114.9	43	BON/CTD, 2B1 C
4	4	10/16/2019	4034.9	7150.2	58	BON/CTD, 2B3 D
5	5	10/16/2019	4039.9	7155	48	BON/CTD, 2B3 D
6	6	10/16/2019	4039.7	7229.7	33	BON/CTD, 2B3 D
7	7	10/16/2019	4039.7	7259.3	14	BON/CTD, 2B1 C
8	8	10/16/2019	4034.8	7255	25	BON/CTD, 2B3 D
9	9	10/16/2019	4020.2	7240.5	49	BON/CTD, 2B3 D
10	10	10/16/2019	4005	7254.9	46	BON/CTD, 2B3 D
11	11	10/16/2019	3959.7	7400.1	18	BON/CTD, 2B3 D
12	12	10/18/2019	3949.2	7344.5	26	BON/CTD, 2B3 D
1	13	10/18/2019	3942.6	7359.6	22	CTD 911+ DIC,URI,E,M,SAL,NUT
13	14	10/18/2019	3920.4	7400.2	29	BON/CTD, 2B1 C
14	15	10/18/2019	3915	7335.4	49	BON/CTD, 2B3 D
2	16	10/18/2019	3921.6	7323.6	48	CTD 911+ DIC,URI, E,SAL,NUT
15	17	10/18/2019	3924.7	7249.9	69	BON/CTD, 2B1 C
3	18	10/19/2019	3900.8	7235.1	960	CTD 911+ DIC,URI,E,M,SAL,NUT
4	19	10/19/2019	3903.1	7244.1	258	CTD 911+ DIC,URI,E,M,SAL,NUT
16	20	10/19/2019	3914.8	7259.9	74	BON/CTD, 2B3 D
17	21	10/19/2019	3900	7309.9	81	BON/CTD, 2B3 D
18	22	10/19/2019	3859.9	7329.9	53	BON/CTD, 2B3 D

Cast	STA	Date (GMT)	Lat (deg min)	Long (deg min)	Bot Depth (m)	Operations
19	23	10/19/2019	3835.1	7315	138	BON/CTD, 2B3 D
5	24	10/19/2019	3742.2	7415.5	106	CTD 911+ DIC,URI,E,M,SAL,NUT
20	25	10/20/2019	3740.1	7424.4	71	BON/CTD, 2B3 D
21	26	10/20/2019	3735	7439.8	60	BON/CTD, 2B3 D
22	27	10/20/2019	3719.9	7509.9	31	BON/CTD, 2B1 C
23	28	10/20/2019	3749.8	7440.2	47	BON/CTD, 2B3 D
24	29	10/20/2019	3809.7	7430.5	45	BON/CTD, 2B3 D
25	30	10/20/2019	3839.9	7455.1	22	BON/CTD, 2B1 C
26	31	10/20/2019	3825	7445.2	31	BON/CTD, 2B3 D
27	32	10/20/2019	3819.8	7454.8	12	BON/CTD, 2B3 D
28	33	10/21/2019	3715	7541.3	12	BON/CTD, 2B3 D
29	34	10/21/2019	3710	7530.1	19	BON/CTD, 2B3 D
30	35	10/21/2019	3640.3	7549.6	18	BON/CTD, 2B1 C
31	36	10/21/2019	3635	7525.2	20	BON/CTD, 2B3 D
32	37	10/21/2019	3630.1	7529.8	29	BON/CTD, 2B3 D
6	38	10/21/2019	3559.8	7528.3	24	CTD 911+ DIC,URI,E,M,SAL,NUT
33	39	10/22/2019	3525.3	7524.5	22	BON/CTD, 2B1 C
34	40	10/22/2019	3534.8	7520.1	32	BON/CTD, 2B3 D
7	41	10/22/2019	3559.7	7510.6	36	CTD 911+ DIC,URI,E,M,SAL,NUT
35	42	10/22/2019	3559.8	7500.1	44	BON/CTD, 2B3 D
8	43	10/22/2019	3600	7446.9	360	CTD 911+ DIC,URI, E,SAL,NUT
9	44	10/22/2019	3559.9	7440.4	1174	CTD 911+ DIC,URI,E,M,SAL,NUT
36	45	10/22/2019	3619.9	7450.2	85	BON/CTD, 2B3 D
37	46	10/22/2019	3645	7515.1	29	BON/CTD, 2B3 D
38	47	10/22/2019	3654.9	7505.1	45	BON/CTD, 2B3 D
10	48	10/23/2019	3750.5	7435.1	53	CTD 911+ DIC,URI, SAL,NUT
11	49	10/23/2019	3759.8	7457	24	CTD 911+ DIC,URI,E,M,SAL,NUT
39	50	10/23/2019	3824.8	7355.6	62	BON/CTD, 2B3 D
40	51	10/23/2019	3844.7	7355.2	45	BON/CTD, 2B3 D
41	52	10/23/2019	3854.8	7405	42	BON/CTD, 2B3 D
42	53	10/24/2019	3944.9	7225.2	86	BON/CTD, 2B3 D
43	54	10/24/2019	4004.5	7224.9	65	BON/CTD, 2B3 D
44	55	10/24/2019	3954.8	7220.1	78	BON/CTD, 2B3 D
45	56	10/24/2019	3945	7200.1	149	BON/CTD, 2B3 D
46	57	10/24/2019	4004.8	7140.2	89	BON/CTD, 2B1 C
47	58	10/24/2019	4030	7125.1	71	BON/CTD, 2B3 D
48	59	10/24/2019	4019.8	7110	91	BON/CTD, 2B3 D
49	60	10/24/2019	4014.9	7055	124	BON/CTD, 2B3 D
50	61	10/25/2019	3950.4	7037.8	822	BON/CTD, 2B3 D
12	61	10/25/2019	3950.1	7037.6	866	CTD 911+ DIC,URI,E,M,SAL,NUT

Cast	STA	Date (GMT)	Lat (deg min)	Long (deg min)	Bot Depth (m)	Operations
51	62	10/25/2019	4002.2	7036.5	168	BON/CTD, 2B3 D
13	62	10/25/2019	4002.3	7036.3	165	CTD 911+ DIC,URI,E,M,SAL,NUT
52	63	10/25/2019	4029.7	7044.9	76	BON/CTD, 2B3 D
53	64	10/25/2019	4039.9	7037.1	61	BON/CTD, 2B3 D
14	64	10/25/2019	4040.2	7037.2	62	CTD 911+ DIC,URI, E,SAL,NUT
54	65	10/25/2019	4105.7	7037.8	44	BON/CTD, 2B3 D
15	65	10/25/2019	4105.9	7038	44	CTD 911+ DIC,URI,E,M,SAL,NUT
55	66	10/25/2019	4059.7	7025.2	42	BON/CTD, 2B1 C
56	67	10/25/2019	4059.7	7006.3	27	BON/CTD, 2B3 D
57	68	10/25/2019	4039.9	6940	52	BON/CTD, 2B3 D
58	69	10/26/2019	4020.4	7000	84	BON/CTD, 2B3 D
59	70	10/26/2019	4019.9	6946	76	BON/CTD, 2B3 D
60	71	10/26/2019	4009.8	6920.3	92	BON/CTD, 2B3 D
61	72	10/26/2019	4004.7	6900.2	171	BON/CTD, 2B3 D
62	73	10/26/2019	4014.7	6825.2	159	BON/CTD, 2B3 D
63	73	10/26/2019	4015.2	6825.4	157	CTD/NET VERTICAL
64	74	10/26/2019	4034.5	6834.9	69	BON/CTD, 2B1 C
65	75	10/26/2019	4029.9	6839.7	76	BON/CTD, 2B3 D
66	75	10/26/2019	4030.3	6839.6	75	CTD/NET VERTICAL
67	76	10/26/2019	4029.9	6905.2	78	BON/CTD, 2B3 D
68	77	10/26/2019	4024.7	6915.3	79	BON/CTD, 2B3 D
69	78	10/26/2019	4044.8	6919.9	34	BON/CTD, 2B3 D
16	79	10/26/2019	4054.2	6909.4	68	CTD 911+ DIC,URI,E,M,SAL,NUT
70	80	10/27/2019	4104.7	6905.1	95	BON/CTD, 2B1 C
71	81	10/27/2019	4124.7	6810.2	44	BON/CTD, 2B3 D
72	82	10/27/2019	4109.7	6820.1	47	BON/CTD, 2B3 D
73	83	10/27/2019	4040.1	6800.4	86	BON/CTD, 2B1 C
17	84	10/27/2019	4015	6741.9	1234	CTD 911+ DIC,URI,E,M,SAL,NUT
18	85	10/27/2019	4023	6741.5	224	CTD 911+ DIC,URI,E,M,SAL,NUT
74	86	10/27/2019	4035.1	6711.2	142	BON/CTD, 2B1 C
75	87	10/27/2019	4044.9	6735.4	84	BON/CTD, 2B3 D
76	88	10/28/2019	4104.9	6730.2	62	BON/CTD, 2B3 D
77	89	10/29/2019	4105.4	6720.7	65	BON/CTD, 2B3 D
78	90	10/29/2019	4114.6	6705.3	64	BON/CTD, 2B3 D
79	91	10/29/2019	4104.8	6705.2	69	BON/CTD, 2B1 C
80	92	10/29/2019	4054.7	6640.9	104	BON/CTD, 2B3 D
81	93	10/29/2019	4109.6	6645.4	71	BON/CTD, 2B3 D
82	94	10/29/2019	4109.8	6620.6	136	BON/CTD, 2B3 D
83	95	10/29/2019	4119.5	6634.6	87	BON/CTD, 2B1
84	96	10/29/2019	4134.8	6635.2	84	BON/CTD, 2B3 D
85	97	10/29/2019	4134.9	6610.5	98	BON/CTD, 2B3 D
86	98	10/30/2019	4154.3	6610.2	93	BON/CTD, 2B3 D

Cast	STA	Date (GMT)	Lat (deg min)	Long (deg min)	Bot Depth (m)	Operations
87	99	10/30/2019	4159.6	6545.8	251	BON/CTD, 2B1 C
88	99	10/30/2019	4159.3	6546	250	CTD 19/19+ WATER
89	100	10/30/2019	4213.6	6546.2	228	BON/CTD, 2B3 D
19	100	10/30/2019	4213.6	6546.2	227	CTD 911+ DIC,URI,E,M,SAL,NUT
90	101	10/30/2019	4209.2	6620.2	186	BON/CTD, 2B3 D
91	102	10/30/2019	4209.6	6630.2	158	BON/CTD, 2B3 D
92	103	10/30/2019	4150.2	6709.8	65	BON/CTD, 2B3 D
93	104	10/30/2019	4145.1	6715	60	BON/CTD, 2B3 D
94	105	10/30/2019	4134.9	6710	54	BON/CTD, 2B3 D
95	106	10/30/2019	4134.8	6715	55	BON/CTD, 2B3 D
20	107	10/30/2019	4127.8	6741.4	35	CTD 911+ DIC,URI,E,M,SAL,NUT
96	108	10/30/2019	4134.9	6735.3	41	BON/CTD, 2B3 D
97	109	10/31/2019	4149.4	6725.6	48	BON/CTD, 2B3 D
21	110	10/31/2019	4200.8	6741.8	73	CTD 911+ DIC,URI, E,SAL,NUT
98	111	10/31/2019	4155.1	6750.3	58	BON/CTD, 2B3 D
99	112	10/31/2019	4225.2	6904.9	192	BON/CTD, 2B1 C
100	113	10/31/2019	4235	6924.3	237	BON/CTD, 2B1 C
101	113	10/31/2019	4235	6925.7	237	CTD 19/19+ WATER
22	114	10/31/2019	4230.2	6939.9	255	CTD 911+ DIC,URI,E,M,SAL,NUT
102	114	10/31/2019	4230.1	6940.5	266	BON/CTD, 2B3 D
103	115	10/31/2019	4225.8	7036.7	88	BON/CTD, 2B3 D
23	115	10/31/2019	4225.5	7037	88	CTD 911+ DIC,URI,E,M,SAL,NUT
24	116	10/31/2019	4221.7	7028.4	78	CTD 911+ DIC,URI,E,M,SAL,NUT
104	117	11/1/2019	4200	7015.1	45	BON/CTD, 2B1 C

TOTALS:	Total Number of Stations Sampled	= 117
	Std BON/CTD Casts	= 95
	2B3 D Bongo Casts	= 80
	2B1 C (CMarZ) Bongo Casts	= 20
	CTD PROFILE 911 Casts	= 23
	Nutrient Casts	= 23
	Chlorophyll Casts	= 23
	Environmental DNA Casts	= 18
	Methyl Mercury Casts	= 23
	Dissolved Inorganic Carbon Casts (DIC)	= 23
	Salinity Sample Casts	= 25
	Vertical Net Casts	= 2

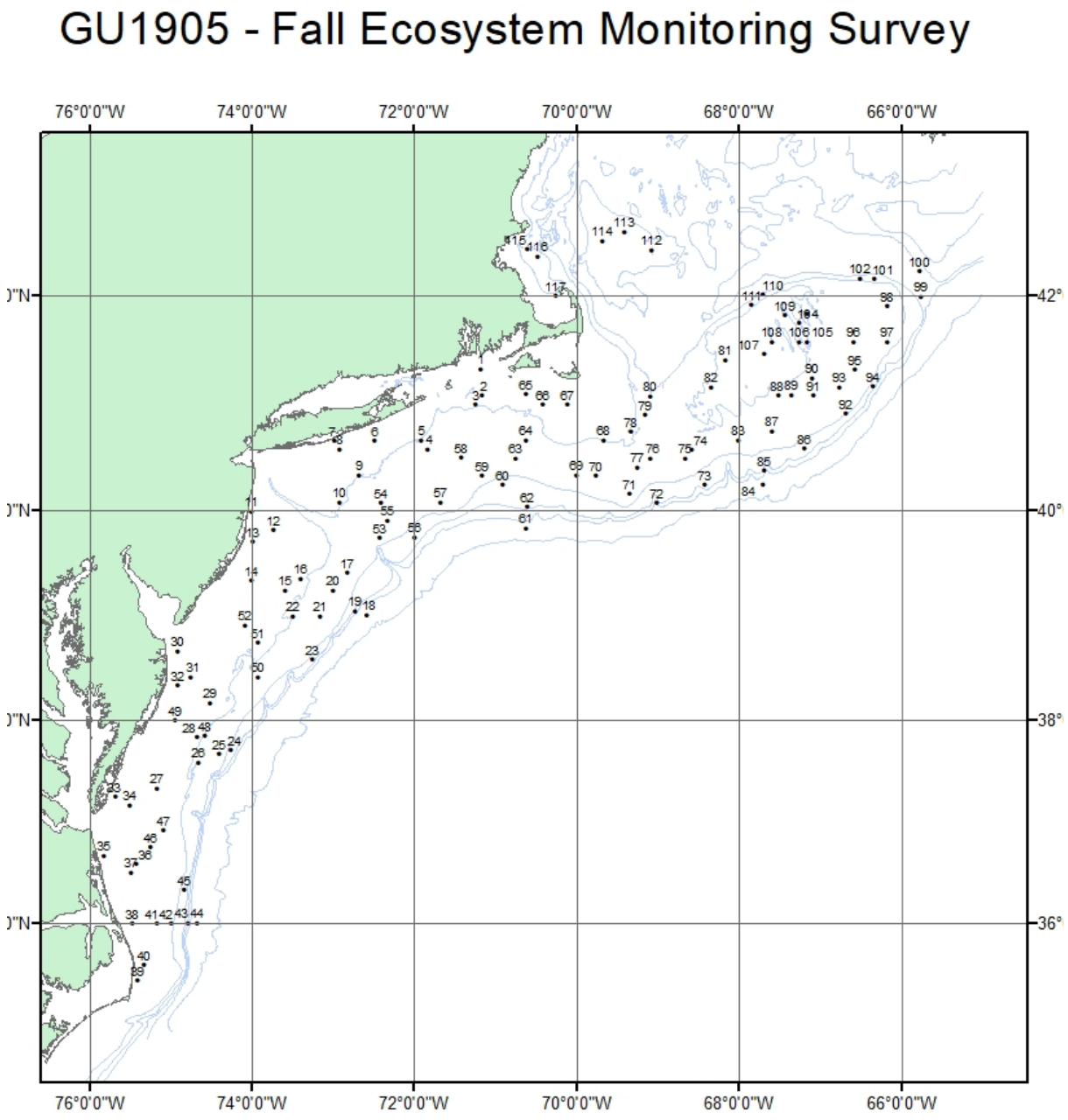


Figure 1. Station locations numbered consecutively for Fall Ecosystem Monitoring Survey GU 1905 15 October – 1 November 2019.

Figure 2. Bongo net array showing 61 and 20 cm bongo nets being deployed from the port side sampling station of the research vessel Gordon Gunter.

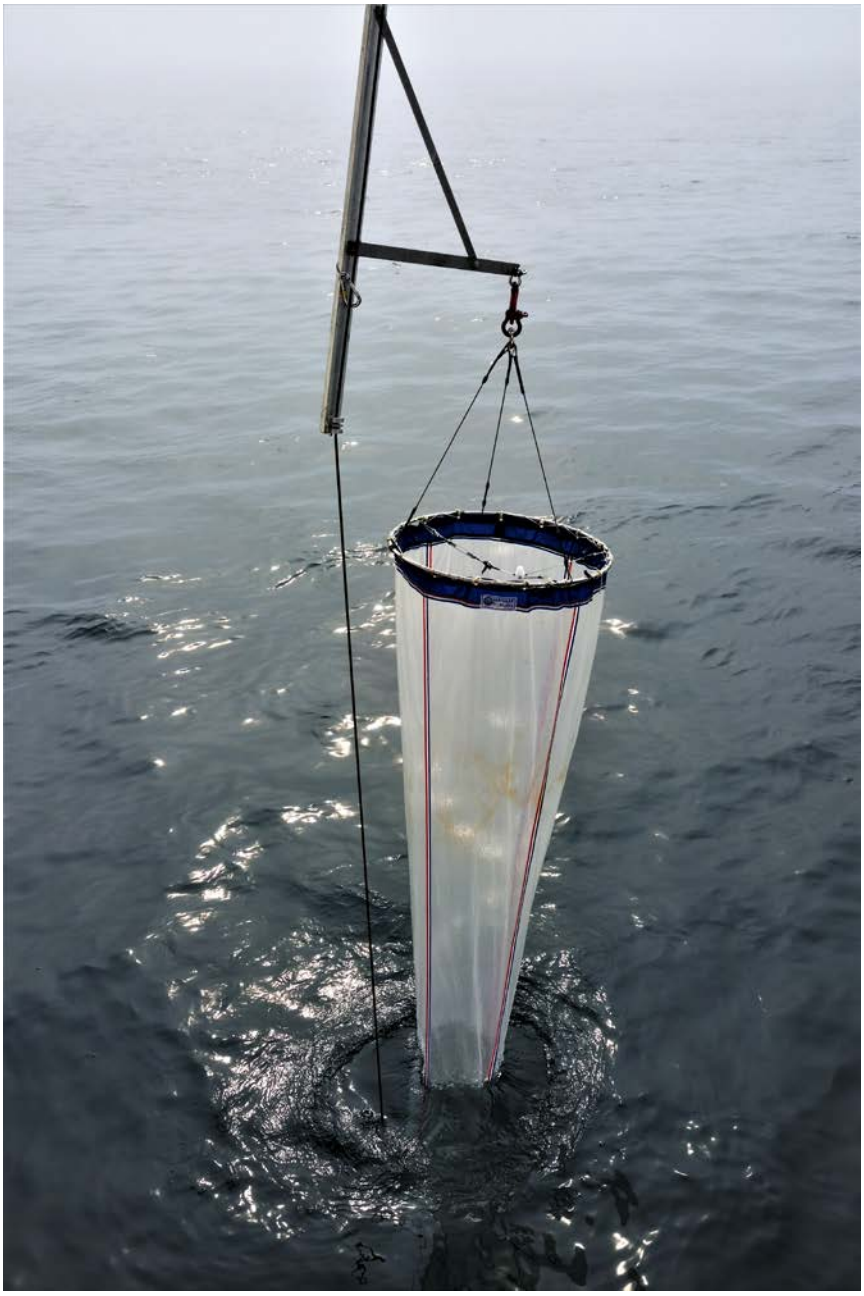


Figure 3. A 75 cm diameter ring net with 200 micron mesh being deployed from the Gordon Gunter.

Figure 4. Niskin bottles and CTD 911 rosette being deployed aboard the FSV Gordon Gunter by the Chief Boatswain, Jerome Taylor.

Figure 5. On top: Yuan Liu preparing to filter seawater for environmental DNA.

On bottom: Patricia Meyer prepares seawater filters to look for presence of methyl mercury.

Figure 6. Kyle Turner deploying radiometer from the port stern quarter of the Gordon Gunter.

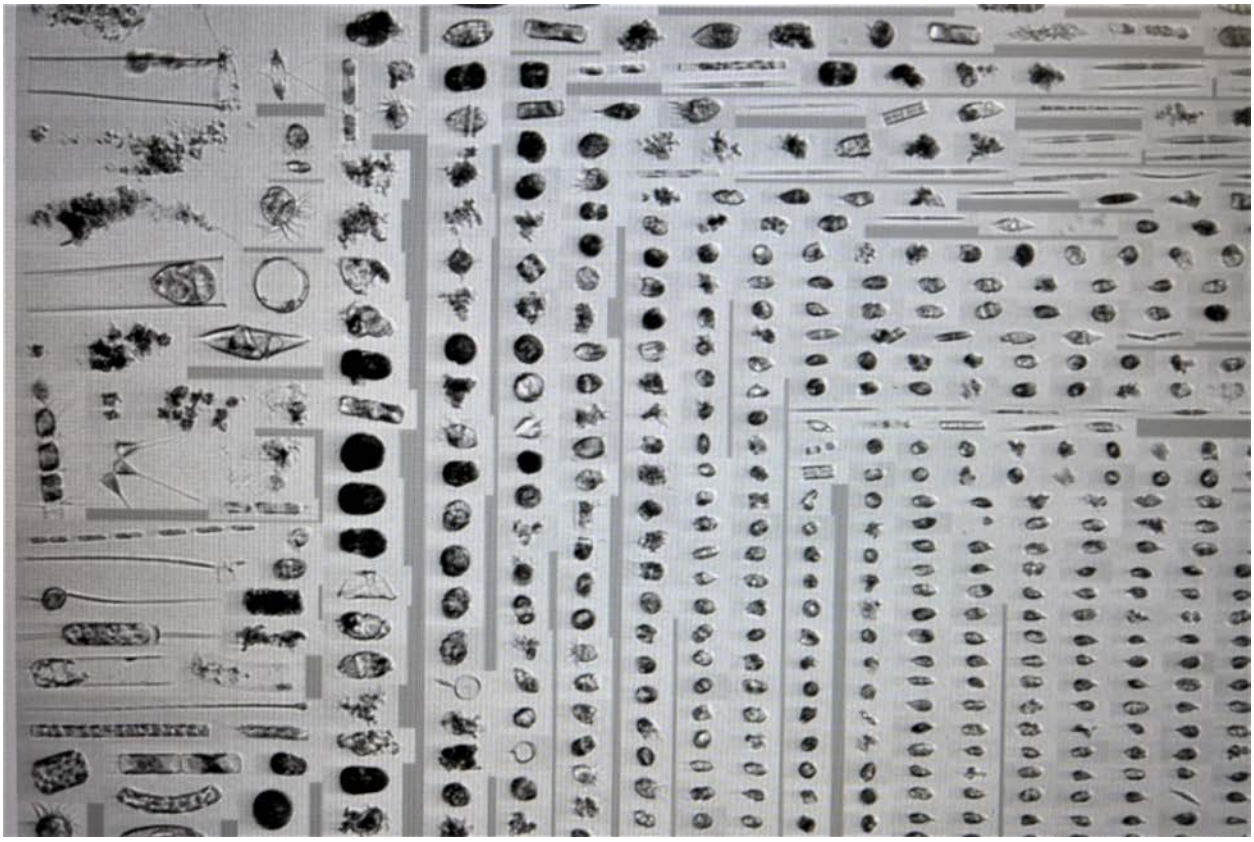


Figure 7. Imagery from the Imaging FlowCytobot unit in the CTD lab aboard the Gordon Gunter.

Figure 8. Seabird and marine mammal observers Allison Black (top) and Skye Haas (bottom) at their observation posts on the flying bridge of the Gordon Gunter.

Appendix A: Seabird and Marine Mammal Survey Report

Seabird Survey Report
15 October-01 November 2019

Marine Species Observer: Allison Black, Christopher (Skye) Haas

Objective:

The primary goal of conducting seabird surveys aboard NOAA Ship *Gordon Gunter* in the fall of 2019 was to gather data on the abundance and distribution of sea birds as a part of longer-term monitoring efforts of the Atlantic Marine Assessment Program for Protected Species (AMAPPS) supported by the National Oceanic and Atmospheric Administration (NOAA), Bureau of Ocean Energy Management (BOEM), US Fish and Wildlife Service (FWS) and the US Navy. The secondary objective in conducting theses surveys was to also collect data, when possible, on the abundance and distribution of other marine megafauna including marine mammals, sea turtles, sharks, and other large pelagic fishes. The sailing opportunity was provided by the Oceans and Climate Branch of the Northeast Fisheries Science Center as part of the Ecosystem Monitoring Program (EcoMon). EcoMon's principal objective is to survey the hydrographic, planktonic and pelagic components of the Northeast U.S. Continental Shelf Ecosystem. Specifically, to quantify the spatial distribution of the following parameters: water currents, water properties, phytoplankton, microzooplankton, mesozooplankton, sea turtles and marine mammals.

Methods:

The protocol used for this survey is based on a standardized 300-meter strip transect survey, one that is used by various agencies in North America and Europe (e.g., Anon 2011, Ballance 2011; Tasker 2004).

The survey strip is 300 meters wide, with observers collecting data on all seabirds within that strip, from the bow to 90 degrees to either the port or the starboard side (depending on viewing conditions). Surveys were conducted on the flying bridge of the *Gordon Gunter* whenever possible.

A SeaScribe program (version 1.2.1) was used for data collection. The SeaScribe app draws GPS coordinates, as well as time from a GPS device via bluetooth, so each observation received a Lat/Long, time stamp, and ship's course. The standard data collected for observations included, species, distance, number of individuals, association, behavior, flight direction, flight height, and if possible or applicable, age, sex, and plumage status. While SeaScribe was not specifically designed to collect data on other marine megafauna, other such observations were recorded anytime an animal was seen, both in, and outside of the survey zone.

During surveys, individual observers took two-hour shifts, to prevent observer fatigue. Observers utilized binoculars (10x42) for general scanning purposes within the survey strip, however, if an animal proved elusive a pair of 20x60 Zeiss imaged-stabilized binoculars were used to attain positive identifications. To aide in approximating distance observers used custom made range finders based on height above water and the observers' personal body measurement (Heinemann 1981).

Results:

Over the course of the eighteen-day cruise, the vessel sampled the northeast US shelf from Cape Hatteras, North Carolina, to Georges Bank, and some of the western Gulf of Maine (Figure 1).

Seabird Sightings:

A total of 5861 birds were observed, 2831 in the survey zone (Table 1). Great Shearwater, *Puffinus gravis*, and Northern Gannet, *Morus bassanus*, were the most frequently sited birds.

Table 1. Number of birds observed total and within the survey strip.

Common Name	Scientific Name	Total	Number in Zone
American pipit	*Anthus rubescens*	1	1
Atlantic puffin	*Fratercula arctica*	39	17
Audubon shearwater	*Puffinus lherminieri*	21	18
Belted kingfisher	*Megaceryle alcyon*	1	1
Black Scoter	*Melanitta americana*	62	44
Black-capped petrel	*Pterodroma hasitata*	2	1
Black-legged kittiwake	*Rissa tridactyla*	11	11
Black-throated blue warbler	*Setophaga caerulescens*	1	1
Blackpoll warbler	*Setophaga striata*	3	1
Blue-headed vireo	*Vireo solitarius*	1	1
Brant	*Branta bernicla*	7	7
Brown pelican	*Pelecanus occidentalis*	11	1
Brown-headed cowbird	*Molothrus ater*	2	0
Cory's shearwater	*Calonectris diomedea*	230	168
Dark scoter (black or surf)	*Melanitta sp.*	37	37
Dark-eyed junco	*Junco hyemalis*	1	0
Double-crested cormorant	*Phalacrocorax auritus*	1847	305
Dowitcher	*Limnodromus sp.*	98	10
Dunlin	*Calidris alpina*	9	9
Field sparrow	*Spizella pusilla*	1	0
Golden-crowned kinglet	*Regulus satrapa*	1	1
Gray catbird	*Dumetella carolinensis*	2	2

Great black-backed gull	*Larus marinus*	62	56
Great blue heron	*Ardea herodias*	41	34
Great cormorant	*Phalacrocorax carbo*	1	0
Great shearwater	*Puffinus gravis*	1049	644
Great skua	*Stercorarius skua*	4	0
Hermit thrush	*Catharus guttatus*	1	1
Herring gull	*Larus argentatus*	193	149
Laughing gull	*Larus atricilla*	48	45
Leach's storm-petrel	*Oceanodroma leucorhoa*	3	2
Lesser black-backed gull	*Larus fuscus*	15	14
Lincoln's sparrow	*Melospiza lincolnii*	1	0
Long-tailed jaeger	*Stercorarius longicaudus*	2	0
Manx shearwater	*Puffinus puffinus*	12	10
Marsh wren	*Cistothorus palustris*	1	0
Mourning dove	*Zenaida macroura*	2	2
Northern flicker	*Colaptes auratus*	1	1
Northern fulmar	*Fulmarus glacialis*	175	136
Northern gannet	*Morus bassanus*	867	567
Palm warbler	*Setophaga palmarum*	1	1
Parasitic jaeger	*Stercorarius parasiticus*	5	2
Passerine (Land Bird)		1	1
Peregrine falcon	*Falco peregrinus*	5	4
Pine warbler	*Setophaga pinus*	1	1
Pomarine jaeger	*Stercorarius pomarinus*	152	116

Prothonotary Warbler	*Protonotaria citrea*	1	0
Red phalarope	*Phalaropus fulicaria*	70	66
Red-winged blackbird	*Agelaius phoeniceus*	1	0
Ring-billed gull	*Larus delawarensis*	5	5
Royal tern	*Sterna maxima*	9	8
Ruby-crowned kinglet	*Regulus calendula*	1	1
Shorebird		1	0
Song sparrow	*Melospiza melodia*	6	3
Sooty shearwater	*Puffinus griseus*	1	1
South polar skua	*Stercorarius maccormicki*	1	1
Sulid sp.	*Unidentified Sulid*	1	1
Surf Scoter	*Melanitta perspicillata*	3	3
Swamp sparrow	*Melospiza georgiana*	3	2
Unidentified blackbird		1	0
Unidentified jaeger	*Stercorarius sp.*	6	0
Unidentified large alcid		1	1
Unidentified large gull		1	1
Unidentified skua	*Catharacta sp.*	4	4
Unidentified small shearwater (Audubon's, Manx or Little)	*Puffinus sp.*	1	0
Unidentified small shorebird		1	0
Unidentified sparrow		2	2
Unidentified storm-petrel	*Oceanodroma sp.*	3	3
White-throated sparrow	*Zonotrichia albicollis*	4	2

White-winged Scoter	*Melanitta deglandi*	672	285
Wilson's storm-petrel	*Oceanites oceanicus*	19	13
Winter Wren	*Troglodytes hiemalis*	2	0
Yellow-rumped warbler	*Setophaga coronata*	10	7
TOTAL		**5861**	**2831**

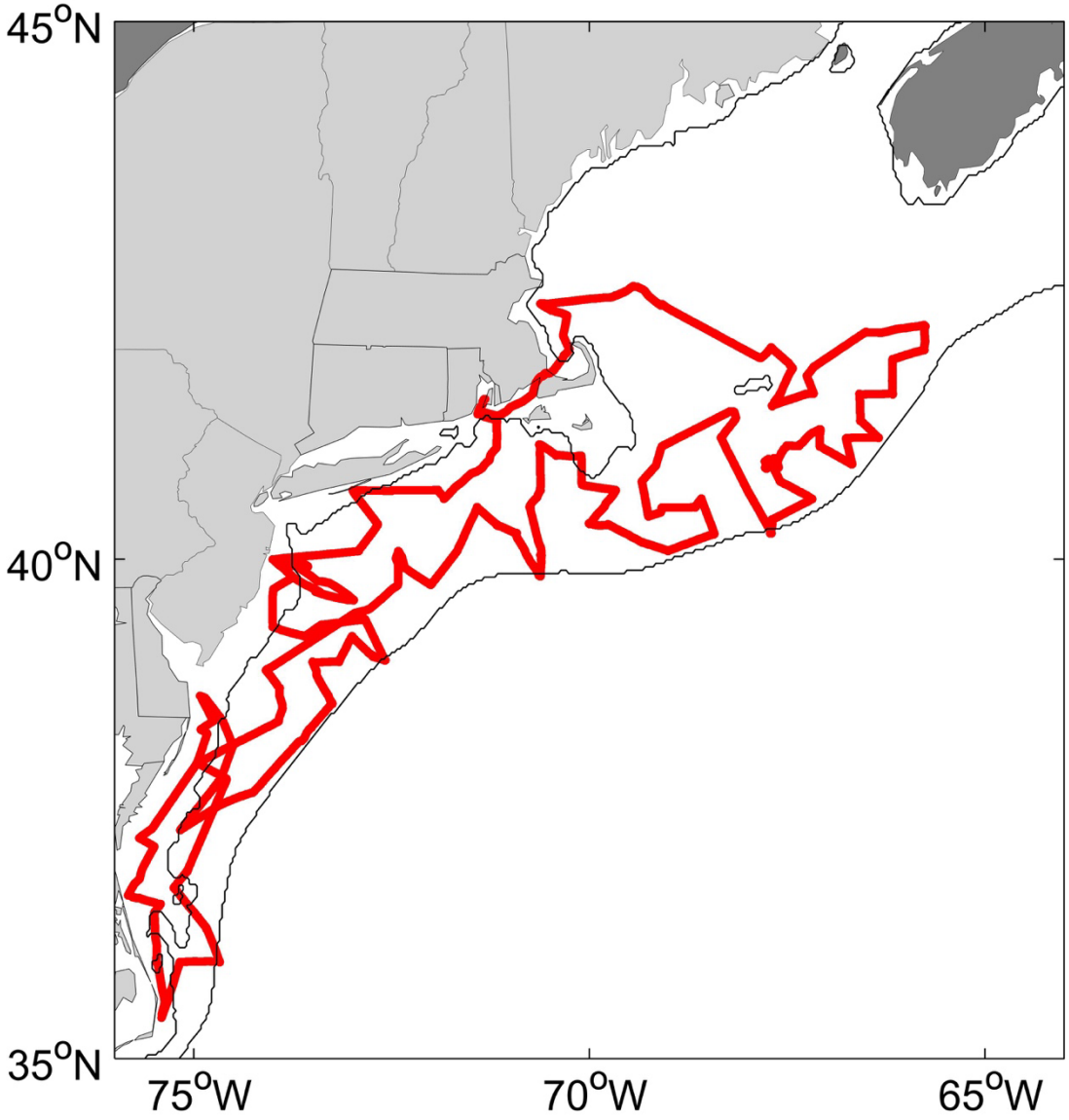
Marine Mammal, Sea Turtle, and Large Fishes Sightings

A total of 736 other megafauna were observed, 593 in the survey zone (Table 2). The Common Dolphin, *Delphinus delphis,* was the most frequently sighted marine mammal. Short-finned Pilot Whale, *Globicephala macrorhynchus*, was the most frequently whale. Ten turtles were sighted, 9 Loggerhead and 1 Leatherback. Ocean Sunfish, *Mola mola*, were the most frequently sited fish.

Table 2. Number of non-birds observed total and within the survey strip.

Common Name	Scientific Name	Total	Number in Zone
Butterfly, Monarch	*Danaus plexippus*	1	1
Dolphin, Atlantic Spotted	*Stenella frontalis*	30	30
Dolphin, Bottlenose	*Tursiops truncatus*	125	117
Dolphin, Common	*Delphinus delphis*	515	427
Fish, Ocean Sunfish (Mola Mola)	*Mola mola*	5	5
Ray, Manta	*Manta sp.*	1	
Seal, Gray	*Halichoerus grypus*	2	1
Turtle, Leatherback	*Dermochelys coriacea*	2	1
Turtle, Loggerhead	*Caretta caretta*	9	9
Turtle, Unidentified	*Cheloniidae*	1	
Whale, Fin	*Balaenoptera physalus*	1	1
Whale, Humpback	*Megaptera novaeangliae*	11	
Whale, Pilot (Short-finned)	*Globicephala macrorhynchus*	26	
Whale, Sei	*Balaenoptera borealis*	1	1
Whale, Unid.		1	
Whale, Unid. Large		2	
Whale, Unid. Ziphiid		3	
TOTAL		736	593

Figure 1. Cruise track of GU1905.



Literature Cited

Anonymous. 2011 Seabird Survey Instruction Protocol. Seabird distribution and abundance, Summer 2011. NOAA RV Henry B. Bigelow. Northeast Fisheries Science Center.

Ballance, Lisa T. 2011. Seabird Survey Instruction Manual, PICEAS 2011. Ecosystems Studies Program Southwest Fisheries Science Center, La Jolla, California.

Heinemann, D. 1981. A range finder for pelagic bird censusing. Journal of Wildlife Management 45: 489-493.

Tasker, M.L., Hope Jones, P., Dixon, T. and Blake, B.F. 1984. Counting seabirds at sea from ships; a review of methods employed and a suggestion for a standardized approach. Auk 101: 567 – 577.