CRUISE RESULTS
NOAA Research Vessel HENRY BIGELOW
Cruise No. HB 18-03
Spring Northeast Ecosystem Monitoring Survey

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CRUISE PERIOD AND AREA

The NOAA research vessel *HENRY BIGELOW* sampled a total of 114 stations from 23 May to 5 June 2018. The vessel left Pier 2 at the Naval Station in Newport RI under sunny skies on Wednesday, 23 May to head south towards Delaware Bay, the southernmost part of the survey area. From there the Bigelow headed back north, sampling in the Middle Atlantic Bight, Southern New England, Georges Bank and Gulf of Maine areas.

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) conduct 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 various depths with a rosette water sampler at predetermined fixed locations

METHODS

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 a return to port for personnel exchange after one day at sea and weather issues near the end of the cruise, only a total of 114 stations were sampled (Figure 1).

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 24 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 bell-shaped 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 flat-bottomed configuration of the bell-shaped depressor weight made for safer deployment and retrieval of the sampling gear when the boat was rolling in rough seas. The plankton sampling gear was deployed off the starboard 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 on a table set up 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 a subset of 18 plankton stations (14 in the Gulf of Maine and 4 on Georges Bank) a vertical tow was made after the bongo net tow using a 70 cm diameter ring net with 200-micron mesh. The tow extended from 5 meters off the bottom to the surface (Figure 3). This effort was led by a Canadian researcher, Andrew Cogswell, to compare plankton catches using Canadian Department of Fisheries and Oceans sampling protocols and nets with samples collected by NEFSC Ecomon bongo protocols.

A Seabird 911+ CTD was deployed on a rosette frame with a carousel water sampling system (SBE32) and 11 10-liter Niskin bottles at all fixed stations (Figure 4). The package was deployed from the starboard side-sampling station, using the A-frame and aft conducting cable winch. This 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. Care was taken to draw a nutrient sample from the same bottle that each Dissolved Inorganic Carbon (DIC) sample had been drawn from, to ensure the best possible correlation between the DIC and nutrient parameters.

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. In addition to the pCO2 system, UNH scientists added a sensor to the flow-through scientific seawater plumbing to measure Total Alkalinity (TA). 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 and TA systems were logged independently on dedicated computers hooked up to those sensors. These dedicated, independent computers for pCO2 and TA did receive correlated data from the SCS system onboard. In addition, an ImagingFlowCytobot unit was plumbed into the flow-through seawater system in the CTD lab**.** The device captured images of diatoms, dinoflagellates and marine ciliates on an independent computer provided by the Woods Hole Oceanographic Institution (WHOI) (Figure 5). This system was monitored daily by Susan Dee, the NOAA Teacher-at-Sea. Susan Dee also deployed a NOAA drifting buoy on the northeast peak of Georges Bank (Figure 6).

Marine mammal and seabird observations and photography were conducted from the bridge and flying bridge of the *HENRY BIGELOW* by seabird and marine mammal observers John Loch and Nick Metheny (Figure 7)

RESULTS

A summary of routine survey activities is presented in Table 1. Areal coverage for the cruise is shown in Figure 1. The NOAA vessel *HENRY BIGELOW* sailed from Newport, RI on Wednesday, 23 May at 1000 hours EDT. Sampling started just south of Narragansett Bay as the vessel headed south and offshore across the Southern New England shelf. An unplanned personnel exchange was made shortly after departure, when the vessel was just 120 nautical miles offshore, necessitating a return to Newport. A new electronics technician was taken onboard. After the personnel exchange the cruise continued sampling towards the south, reaching Delaware Bay before turning north to sample the remainder of the Middle Atlantic Bight, and then Southern New England, Georges Bank and the Gulf of Maine. Excellent weather for most of the survey period allowed the vessel to cover a large part of the planned survey area despite the loss of a day and a half due to the personnel exchange. The vessel, with its newly refurbished electric propulsion motors functioned extremely well, and was easily able to make 12 knots or more on transits between stations, which also contributed to the excellent survey coverage in the truncated time available for this cruise. A large storm system in the Gulf of Maine did hamper coverage of the far northeastern part of this area, but many of the fixed hydrographic Gulf of Maine stations were sampled. Complete coverage was achieved across Georges Bank, (including the Northeast Channel Station), Southern New England and the northern two thirds of the Mid-Atlantic Bight.

The storm system that curtailed operations in the Gulf of Maine forced the *BIGELOW* to return to Newport ahead of schedule on 5 June when safe operations were no longer feasible. Accordingly the *HENRY BIGELOW* returned to Newport, RI via the Cape Cod Canal and docked at the Naval Station Newport on 5 June 2018, marking the end of the HB1803 Spring Ecosystem Monitoring Survey.

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 Maura Thomas at the University of Maine, School of Marine Sciences, 5706 Aubert Hall, Orono, ME. The Total Alkalinity Sensor on the Scientific Seawater system remained in place for the next cruise aboard the Henry Bigelow, but Shawn Shellito took all data collected during the Ecomon cruise to the University of New Hampshire. The ImagingFlowCytoBot 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

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Table 1. Summary of sample activities conducted at 114 stations at which the *HENRY BIGELOW* stopped to lower instruments over the side during Cruise No. HB 1803. Latitude and Longitude are shown in decimal degrees.
Std BON/CTD = 61 cm bongo Standard Protocol, CTD 911 = fixed station, SAL=salinity sample
2B3 D = 333 mesh 20 cm bongo Dave R. samples, 2B1 C = 165 mesh 20 cm bongo CMARZ samples, ,
DIC = Dissolved Inorganic Carbon, NUT = Nutrients, CHL = Chlorophyll

CTD Cast	**Site ID/** STA#	**Date GMT**	**Latitude (dd)**	**Longitude (dd)**	**Bottom Depth(m)**	**Operation**
1	1	May 23, 2018	41.4083	-71.1733	24	BON/CTD, 2B3 D
2	2	May 23, 2018	41.335	-71.0133	28	BON/CTD, 2B3 D
3	3	May 23, 2018	41.1617	-70.665	37	BON/CTD, 2B3 D
4	4	May 23, 2018	41.1583	-70.505	38	BON/CTD, 2B3 D
5	5	May 23, 2018	41.1067	-70.62	44	BON/CTD, 2B3 D
1	5	May 23, 2018	41.1017	-70.6217	44	CTD PROFILE 911+ WATER NUT, DIC
6	6	May 24, 2018	40.6633	-70.625	62	BON/CTD, 2B3 D
2	6	May 24, 2018	40.6567	-70.625	62	CTD PROFILE 911+ WATER, NUT, DIC, CHL

7	7	May 24, 2018	40.4983	-70.8317	78	BON/CTD, 2B3 D
8	8	May 24, 2018	40.4167	-70.9117	87	BON/CTD, 2B1 C
9	9	May 24, 2018	40.1633	-70.41	120	BON/CTD, 2B3 D
10	10	May 24, 2018	40.0333	-70.5917	178	BON/CTD, 2B3 D
3	10	May 24, 2018	40.0317	-70.6083	178	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
4	11	May 24, 2018	39.8317	-70.6117	894	CTD PROFILE 911+ WATER NUT, DIC, CHL,SAL
11	11	May 24, 2018	39.83	-70.615	927	BON/CTD, 2B3 D
12	12	May 25, 2018	40.495	-71.6617	77	BON/CTD, 2B1 C
13	13	May 26, 2018	40.33	-71.6617	82	BON/CTD, 2B3 D
14	14	May 26, 2018	40.1683	-71.4217	89	BON/CTD, 2B1 C
15	15	May 26, 2018	40	-72.1767	83	BON/CTD, 2B1 C
16	16	May 26, 2018	40.085	-72.735	54	BON/CTD, 2B3 D
17	17	May 26, 2018	40.0817	-72.8233	53	BON/CTD, 2B3 D
18	18	May 26, 2018	39.845	-72.835	60	BON/CTD, 2B3 D
19	19	May 26, 2018	39.6683	-72.8317	70	BON/CTD, 2B3 D
20	20	May 26, 2018	39.66	-73.4083	35	BON/CTD, 2B3 D
5	21	May 26, 2018	39.3717	-73.39	47	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
21	22	May 26, 2018	39.2517	-72.8467	84	BON/CTD, 2B1 C
22	23	May 26, 2018	39.3317	-72.5067	135	BON/CTD, 2B3 D
6	24	May 27, 2018	39.0217	-72.5783	925	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
7	25	May 27, 2018	39.0517	-72.735	259	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
23	26	May 27, 2018	38.915	-73.2517	71	BON/CTD, 2B3 D
24	27	May 27, 2018	39.0017	-73.4183	59	BON/CTD, 2B1 C
25	28	May 27, 2018	38.6733	-73.6617	65	BON/CTD, 2B3 D
26	29	May 27, 2018	38.505	-73.9033	56	BON/CTD, 2B3 D
27	30	May 27, 2018	38.3333	-74.4117	40	BON/CTD, 2B3 D
28	31	May 27, 2018	38.7483	-74.9233	41	BON/CTD, 2B3 D
29	32	May 27, 2018	38.825	-74.2583	47	BON/CTD, 2B1 C
30	33	May 27, 2018	39.24	-74.0917	29	BON/CTD, 2B3 D
31	34	May 28, 2018	39.5767	-73.8383	30	BON/CTD, 2B3 D
8	35	May 28, 2018	39.7133	-74.0067	22	CTD PROFILE 911+ WATER NUT, DIC, CHL
32	36	May 28, 2018	39.8267	-73.925	23	BON/CTD, 2B1 C
33	37	May 28, 2018	39.8333	-73.8417	26	BON/CTD, 2B1 C
34	38	May 28, 2018	40.1567	-73.585	39	BON/CTD, 2B3 D
35	39	May 28, 2018	40.3267	-73.35	36	BON/CTD, 2B3 D
36	40	May 28, 2018	40.655	-72.995	19	BON/CTD, 2B3 D
37	41	May 28, 2018	40.7467	-72.1	45	BON/CTD, 2B1 C
38	42	May 28, 2018	40.915	-71.84	39	BON/CTD, 2B1 C
39	43	May 29, 2018	40.8567	-69.76	36	BON/CTD, 2B3 D
40	44	May 29, 2018	40.665	-69.7533	55	BON/CTD, 2B3 D
41	45	May 29, 2018	40.34	-69.6783	73	BON/CTD, 2B3 D

42	46	May 29, 2018	40.4917	-69.175	76	BON/CTD, 2B3 D
43	47	May 29, 2018	40.5883	-69.2517	53	BON/CTD, 2B3 D
44	48	May 29, 2018	40.585	-68.8467	70	BON/CTD, 2B3 D
45	49	May 29, 2018	40.7433	-68.8333	69	BON/CTD, 2B1 C
46	50	May 29, 2018	40.7517	-69.07	87	BON/CTD, 2B3 D
47	50	May 29, 2018	40.7433	-69.0767	75	BON/CTD, 2B3 D
9	51	May 29, 2018	40.8933	-69.1517	70	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
48	52	May 29, 2018	40.995	-68.5083	50	BON/CTD, 2B3 D
49	53	May 30, 2018	40.83	-68.0083	67	BON/CTD, 2B3 D
50	54	May 30, 2018	40.75	-68.0883	73	BON/CTD, 2B1 C
51	55	May 30, 2018	40.415	-68.0917	149	BON/CTD, 2B1 C
52	56	May 30, 2018	40.33	-67.9167	173	BON/CTD, 2B3 D
10	57	May 30, 2018	40.2567	-67.6867	877	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
11	58	May 30, 2018	40.3817	-67.6967	183	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
12	59	May 30, 2018	40.9217	-67.7167	64	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
53	60	May 30, 2018	41.1633	-67.3467	57	BON/CTD
54	61	May 30, 2018	40.8367	-67.0083	94	BON/CTD, 2B3 D
55	62	May 30, 2018	40.99	-66.685	86	BON/CTD, 2B1 C
56	63	May 30, 2018	41.155	-66.67	82	BON/CTD, 2B3 D
57	64	May 30, 2018	41.3217	-66.8317	75	BON/CTD, 2B3 D
58	65	May 30, 2018	41.49	-66.84	71	BON/CTD, 2B3 D
59	66	May 31, 2018	41.5833	-66.59	83	BON/CTD, 2B3 D
60	67	May 31, 2018	41.4167	-66.34	99	BON/CTD, 2B3 D
61	68	May 31, 2018	41.5767	-66.1767	97	CTD/NET VERTICAL
62	68	May 31, 2018	41.5783	-66.1767	97	BON/CTD, 2B3 D
63	69	May 31, 2018	41.5883	-65.925	303	CTD/NET VERTICAL
64	69	May 31, 2018	41.5833	-65.925	267	BON/CTD, 2B3 D
13	70	May 31, 2018	41.755	-65.445	2000	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
65	71	May 31, 2018	41.9067	-65.7483	207	CTD/NET VERTICAL
66	71	May 31, 2018	41.9067	-65.7633	181	BON/CTD, 2B1 C, DRIFT BUOY
14	72	May 31, 2018	42.2283	-65.7617	223	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
67	72	May 31, 2018	42.235	-65.7433	227	CTD/NET VERTICAL
68	72	May 31, 2018	42.2217	-65.7483	229	BON/CTD, 2B3 D
69	73	May 31, 2018	42.1633	-65.83	249	CTD/NET VERTICAL
70	73	May 31, 2018	42.1617	-65.8283	249	BON/CTD, 2B3 D
71	74	May 31, 2018	42.0733	-66.0733	97	CTD/NET VERTICAL
72	74	May 31, 2018	42.0617	-66.0667	96	BON/CTD, 2B3 D
73	75	May 31, 2018	41.9183	-66.0833	96	BON/CTD, 2B3 D
74	76	June 1, 2018	42.01	-66.6817	75	BON/CTD, 2B3 D
75	77	June 1, 2018	41.8317	-67.0867	60	BON/CTD, 2B3 D
76	78	June 1, 2018	41.8383	-67.3333	41	BON/CTD, 2B3 D
77	79	June 1, 2018	41.9267	-67.4183	52	BON/CTD, 2B3 D
78	80	June 1, 2018	41.6683	-67.425	46	BON/CTD, 2B3 D

79	81	June 1, 2018	41.52	-67.4717	51	BON/CTD, 2B3 D
80	82	June 1, 2018	41.425	-67.5817	33	BON/CTD, 2B3 D
15	83	June 1, 2018	41.4617	-67.685	41	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
81	84	June 1, 2018	41.3367	-67.8267	41	BON/CTD, 2B3 D
82	85	June 1, 2018	41.4183	-68.2567	42	BON/CTD, 2B3 D
83	86	June 1, 2018	41.3783	-68.5617	83	BON/CTD, 2B3 D
84	87	June 1, 2018	41.5017	-68.9083	156	CTD/NET VERTICAL
85	87	June 1, 2018	41.4967	-68.9067	154	BON/CTD, 2B1 C
86	88	June 1, 2018	41.58	-68.6683	135	CTD/NET VERTICAL

87	88	June 1, 2018	41.5783	-68.6633	137	BON/CTD, 2B3 D
88	89	June 2, 2018	41.7217	-67.9617	34	BON/CTD, 2B3 D
89	90	June 2, 2018	41.9133	-68.005	140	BON/CTD, 2B3 D
16	91	June 2, 2018	42.0083	-67.6883	65	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
17	92	June 2, 2018	42.3817	-67.04	338	CTD PROFILE 911+ WATER NUT, DIC, CHL , SAL, VERTICAL
90	92	June 2, 2018	42.375	-67.0317	340	CTD/NET VERTICAL
91	92	June 2, 2018	42.37	-67.0267	338	BON/CTD, 2B3 D
92	93	June 2, 2018	42.5017	-67.0033	335	BON/CTD, 2B1 C
93	93	June 2, 2018	42.4883	-67.0033	337	CTD PROFILE 19/19+
18	94	June 2, 2018	42.7067	-67.6867	191	CTD PROFILE 911+ WATER NUT, DIC, CHL, SAL
94	95	June 2, 2018	42.5	-67.92	224	CTD/NET VERTICAL
95	95	June 2, 2018	42.5	-67.9233	223	BON/CTD, 2B3 D
96	96	June 2, 2018	42.6617	-68.2367	189	BON/CTD, 2B1 C
97	97	June 2, 2018	42.8167	-68.4133	209	CTD/NET VERTICAL
98	97	June 2, 2018	42.8167	-68.415	208	BON/CTD, 2B3 D
99	98	June 2, 2018	43.075	-68.585	186	BON/CTD, 2B3 D
100	99	June 3, 2018	43.4067	-67.6983	250	CTD/NET VERTICAL
101	99	June 3, 2018	43.4117	-67.7017	250	BON/CTD, 2B1 C
19	99	June 3, 2018	43.3983	-67.7017	253	CTD PROFILE 911+ WATER NUT, DIC, CHL
102	100	June 3, 2018	43.7433	-68.0133	169	CTD/NET VERTICAL
103	100	June 3, 2018	43.7467	-68.0267	168	BON/CTD, 2B1 C
20	101	June 3, 2018	43.77	-68.665	113	CTD PROFILE 911+ WATER NUT, DIC, CHL
104	102	June 3, 2018	43.93	-68.825	94	BON/CTD, 2B3 D
105	102	June 3, 2018	43.9333	-68.8233	82	CTD/NET VERTICAL
106	103	June 3, 2018	43.6883	-69.2283	116	BON/CTD, 2B3 D
107	104	June 3, 2018	43.4217	-69.4967	156	CTD/NET VERTICAL
108	104	June 3, 2018	43.4183	-69.495	160	BON/CTD, 2B1 C
109	105	June 3, 2018	43.4933	-69.7533	128	CTD/NET VERTICAL

110	105	June 3, 2018	43.4933	-69.75	138	BON/CTD, 2B3 D
111	105	June 3, 2018	43.4917	-69.7517	135	BON/CTD
112	106	June 4, 2018	42.9967	-69.5883	167	CTD/NET VERTICAL
113	106	June 4, 2018	43	-69.5867	167	BON/CTD
114	107	June 4, 2018	42.505	-69.665	249	CTD/NET VERTICAL
21	107	June 4, 2018	42.51	-69.67	251	CTD PROFILE 911+ WATER NUT, DIC, CHL
115	107	June 4, 2018	42.515	-69.6683	242	BON/CTD, 2B3 D
116	108	June 4, 2018	42.34	-69.2717	243	CTD/NET VERTICAL
117	108	June 4, 2018	42.3433	-69.265	244	BON/CTD, 2B3 D
118	109	June 4, 2018	42.08	-69.9167	92	CTD/NET VERTICAL
119	109	June 4, 2018	42.08	-69.9167	92	BON/CTD, 2B3 D
120	110	June 4, 2018	42.315	-70.28	34	CTD 19/19+ WATER CAST PROFILE
22	110	June 4, 2018	42.3183	-70.2833	35	CTD PROFILE 911+ WATER NUT, DIC, CHL
23	111	June 4, 2018	42.3617	-70.4683	68	CTD PROFILE 911+ WATER WATER NUT, DIC, CHL
121	111	June 4, 2018	42.37	-70.4733	82	CTD 19/19+ WATER CAST PROFILE
122	112	June 4, 2018	42.165	-70.5067	54	BON/CTD, 2B3 D
123	113	June 4, 2018	42.03	-70.4283	52	BON/CTD, 2B3 D
124	114	June 4, 2018	41.92	-70.3583	40	BON/CTD, 2B3 D

TOTALS:	**Std BON/CTD Casts**	**=**	**103**
	2B3 D Bongo Casts	**=**	**71**
	2B1 C (CMarZ) Bongo Casts	**=**	**23**
	CTD PROFILE 911 Casts	**=**	**23**
	Nutrient Casts	**=**	**23**
	Chlorophyll Casts	**=**	**22**
	Dissolved Inorganic Carbon casts (DIC)	**=**	**23**
	Salinity Sample Casts	**=**	**13**
	Vertical Net Casts	**=**	**21**

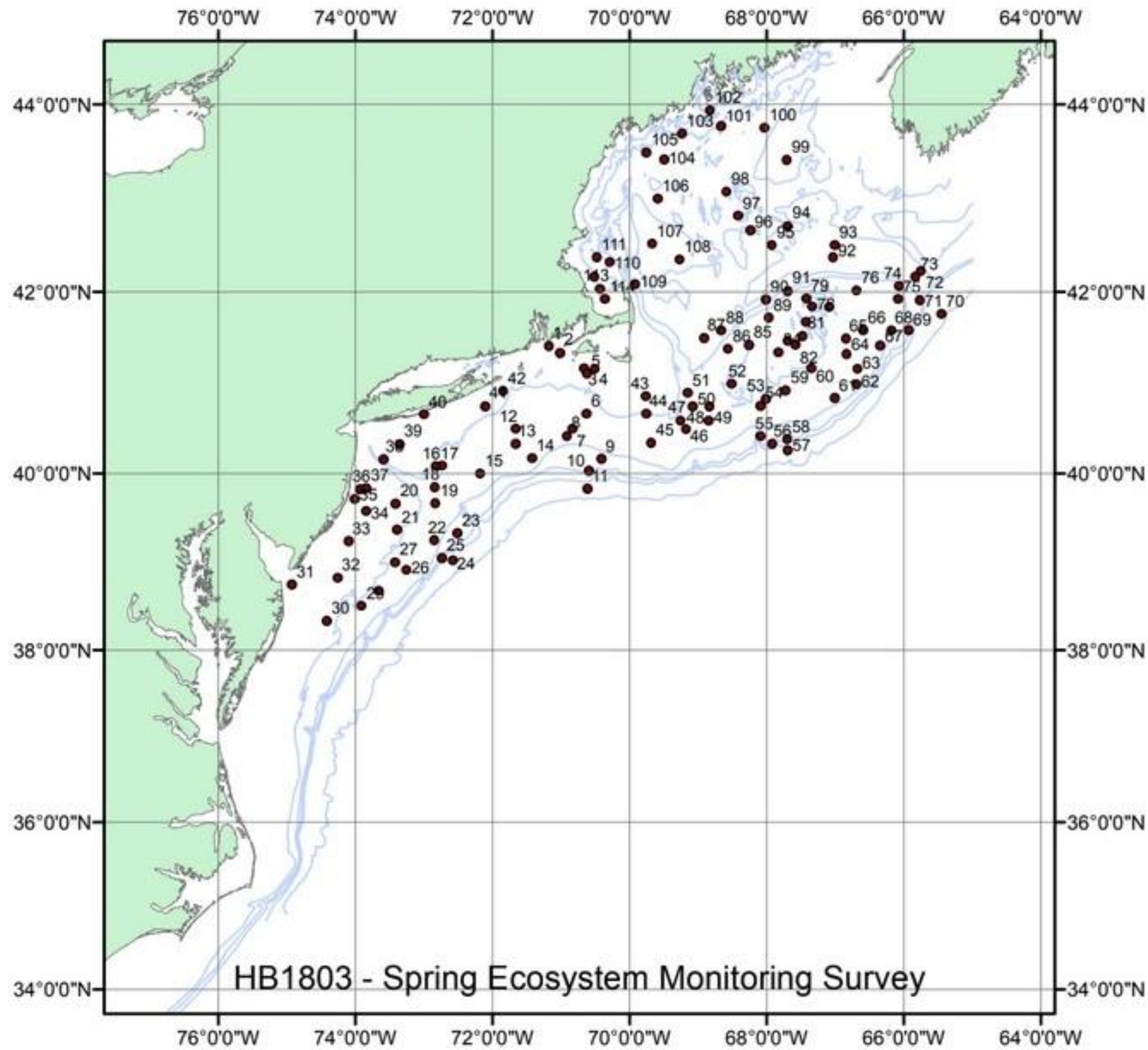

Figure 1. Station locations numbered consecutively for Spring Ecosystem Monitoring Survey HB 1803, 23 May – 5 June 2018.

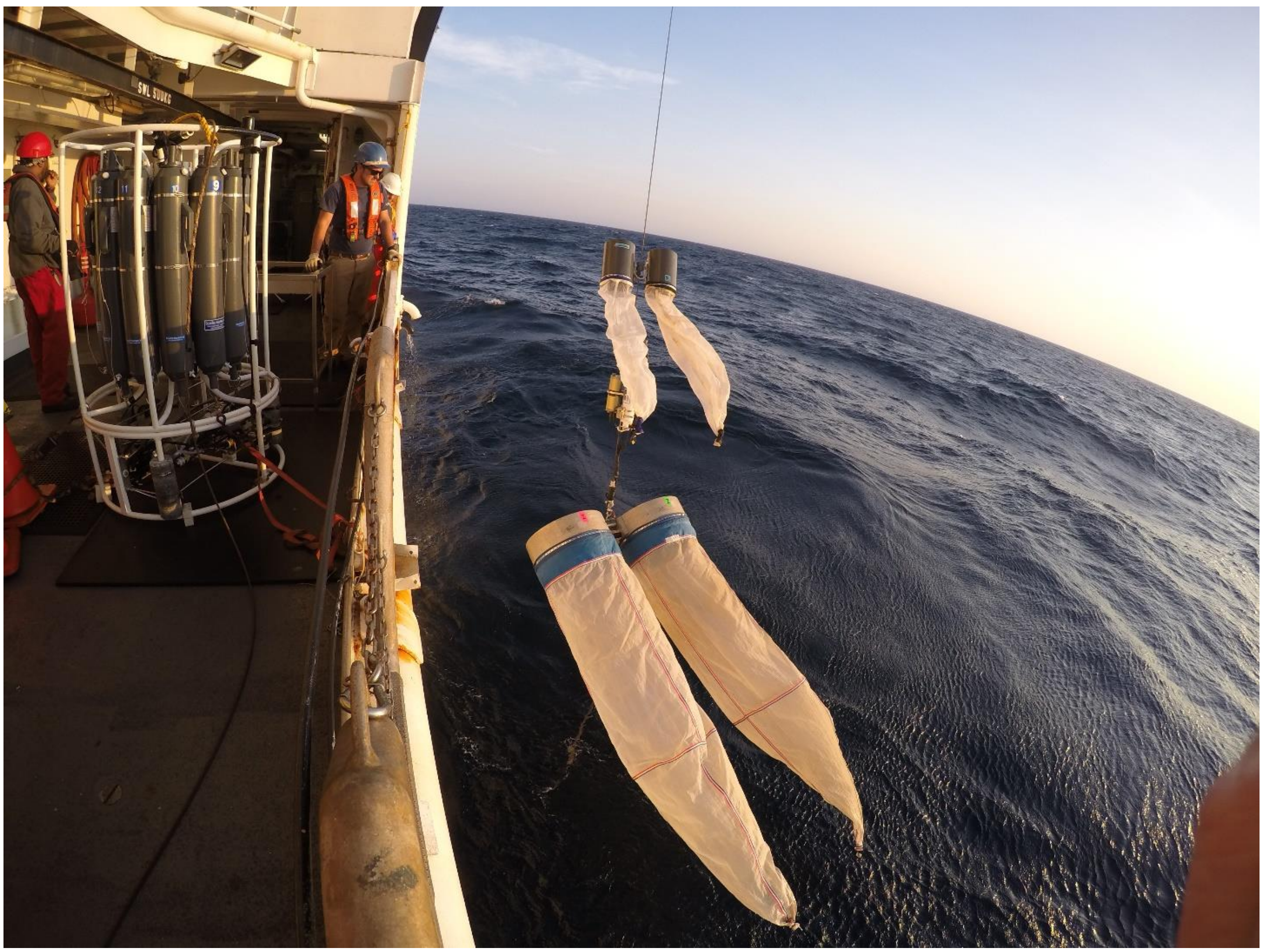

Figure 2. Bongo net array showing 61 and 20 cm bongo nets being deployed from the side sampling station on the Henry Bigelow.

Figure 3. A 70 cm diameter ring net with 200 micron mesh being deployed from the Side-sampling station on the Henry Bigelow.

Figure 4. Niskin bottle and CTD 911 rosette being deployed aboard the FSV *Henry Bigelow.*

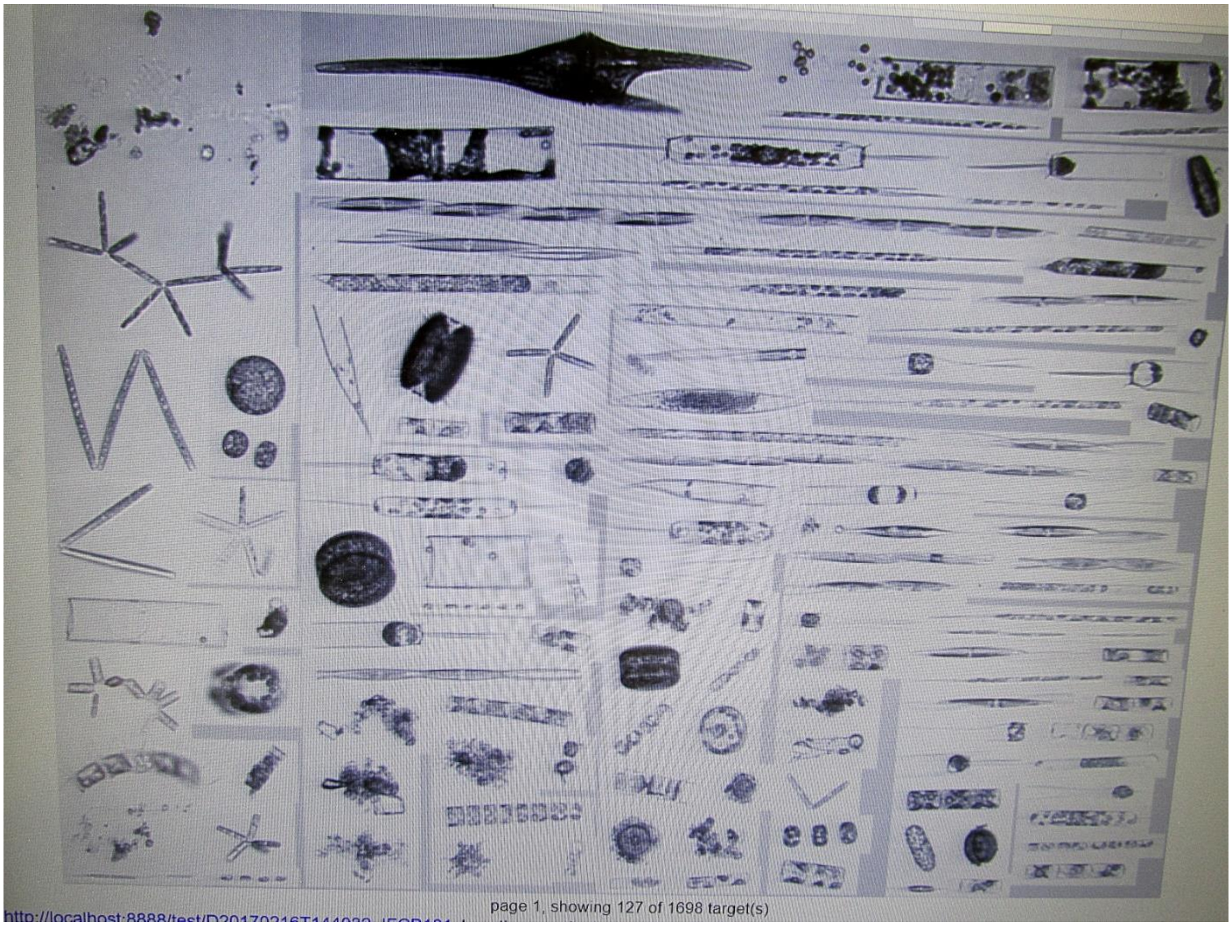

Figure 5. Images of diatoms & dinoflagellates from the imaging FlowCytobot Unit.

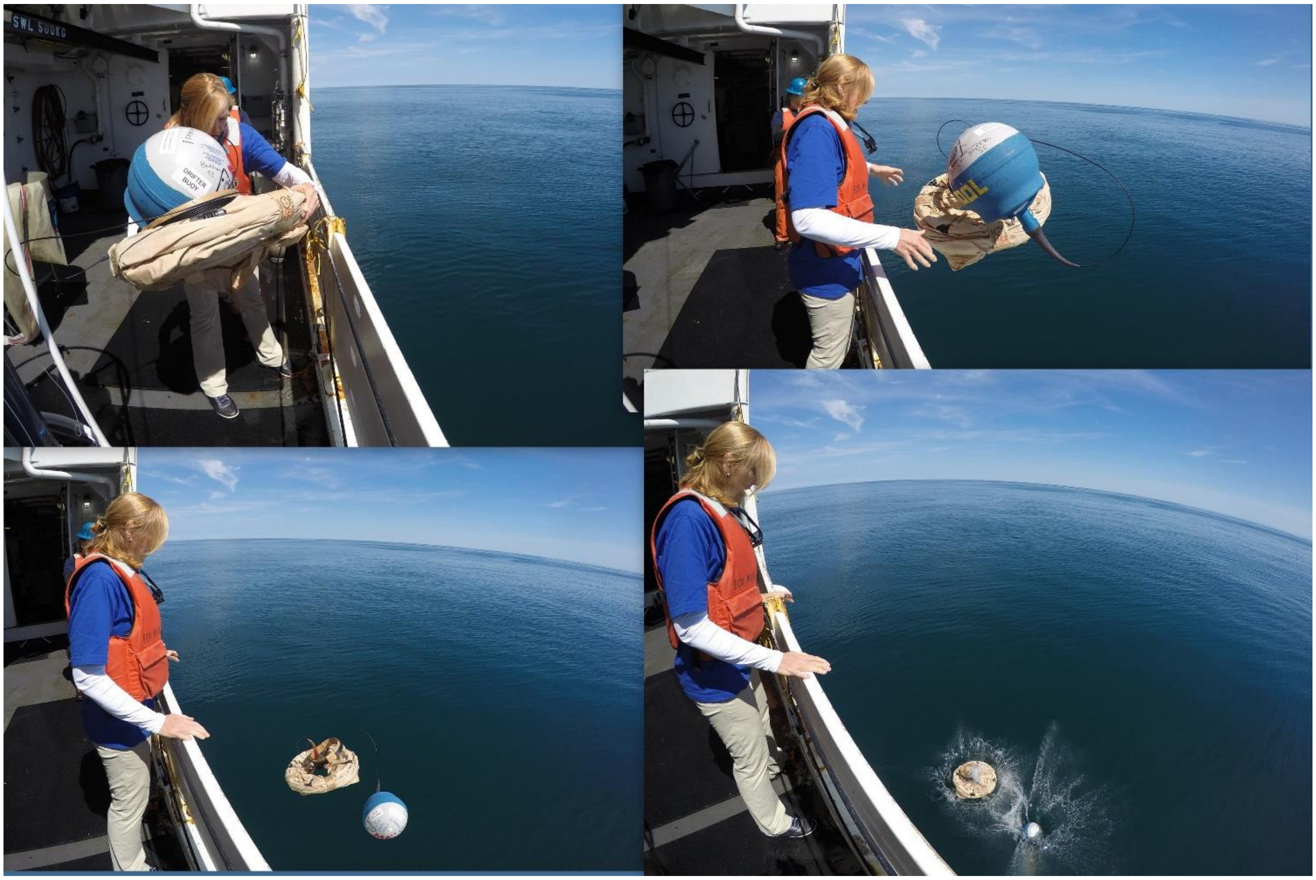

Figure 6. Photo-sequence showing Susan Dee, NOAA Teacher-at-Sea, launching a Drifter Buoy on the northeast peak of Georges Bank.

Figure 7. Marine mammal and seabird observer, John Loch, at his observation post on the flying bridge Of the Henry Bigelow.

Appendix A

Seabird Survey Report

Northeast Fisheries Science Center Contractor

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Marine Species Observers: Nicholas Metheny and John Loch

Objective:

The primary goal of conducting seabird surveys aboard the Henry Bigelow in May/June 2018 was to gather data on the abundance and distribution of seabirds as a part of longer term monitoring efforts for these far-ranging apex predators. Our 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.

Collecting this data in conjunction with other biological data and abiotic factors will help better complete our "picture" of possible changes occurring in the marine ecosystem in the Northwest Atlantic from the Outer Banks to the Bay of Fundy.

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). Observations can be made in seas up to a Beaufort 7, in light rain, fog, and ship speeds between 8-12 knots (below 8 knots, the data becomes questionable to use for abundance estimates).

Surveys were conducted on the flying bridge (15 m) of the Henry Bigelow.

The software used to collect survey data was, SeeBird version 4.3.7. This program draws GPS coordinates, as well as time from the ship's navigation through a NMEA data feed, so each observation received a Lat/Long, time stamp, and ship's course. Due to some initial issues with the Ship Computer System (SCS), a GPS puck was used to replace the ship's navigation feed on the first day of surveys, until the SCS issue was fixed and a reliable feed was established on the flying bridge. 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. Flocks of seabirds that were once recorded in a SeaBird sub-module, have been incorporated into the regular sighting data module with species counted within a given flock being given a special notation in the comment section, marking them as part of a flock, along with an estimated distance to that flock from the transect line. On another note, while SeeBird 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 or 8x42) 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:

Seabird Sightings

Over the course of the cruise approximately 1,300 nautical miles were surveyed, from the mouth of the Delaware Bay to surveying Georges Banks and around the Gulf of Maine. A total of 2,893 birds were observed in the survey zone, within an additional 1,951 birds observed outside the zone (on and off effort). As is usual at this time of year Wilson’s Storm Petrels, *Oceanites oceanicus*, out numbered all other seabirds totaling 992 individuals seen in the survey; this being followed by Sooty Shearwaters, *Ardenna grisea,* at 580 individuals seen in the survey zone. A fair number of alcid species were observed this year (compared to years past), with survey lines going very close to two breeding colonies in the Gulf of Maine, accounting for a fraction of the Atlantic Puffin, *Fratercula arctica*, Razorbill, *Alca torda,* and Black Guillemot, *Cepphus grylle*, sightinged. Of special, note was the sighting of a wayward Franklin’s Gull, *Leucophaeus pipixcan*, that was a good deal East of its normal migration route. Furthermore, there were frequent sightings of South Polar Skua, *Stercorarius maccormicki*, this trip, sometimes several times in a given day depending on the area the ship was traversing.

Table 1. Total Number of Birds Observed

Common Bird Name	Scientific Name	Number Observed in Zone	Total Observed
Atlantic Puffin	*Fratercula arctica*	10	22
Black Guillemote	*Cepphus grylle*	4	5
Dovekie	*Alle alle*	6	10
Common Murre	*Uria aalge*	1	1
Razorbill	*Alca torda*	1	3
Razorbill/Murre		0	1
Common Loon	*Gavia immer*	33	80
Red-throated Loon	*Gavia stellata*	0	1
Cory's Shearwater	*Calonectris borealis*	22	32
Great Shearwater	*Puffinus gravis*	249	379
Sooty Shearwater	*Ardenna grisea*	580	1242
Manx Shearwater	*Puffinus puffinus*	13	23
Unidentified Shearwater		0	1
Wilson's Storm Petrel	*Oceanites oceanicus*	992	1430
Leach's Storm Petrel	*Oceanodroma leucorhoa*	185	148
Unidentified Storm Petrel		0	40
Unidentified Petrel		0	1
Northern Fulmar	*Fulmarus glacialis*	155	249
Arctic Tern	*Sterna paradisaea*	64	67
Common Tern	*Sterna hirundo*	123	192
Unidentified Tern		38	74
Great Black-backed Gull	*Larus marinus*	102	262
Herring Gull	*Larus argentatus*	160	362
Bonaparte's Gull	*Chroicocephalus philadelphia*	1	1
Laughing Gull	*Leucophaeus atricilla*	29	30
Franklin's Gull	*Leucophaeus pipixcan*	1	1
White-Winged Scoter	*Melanitta fusca*	5	9
Parasitic Jaeger	*Stercorarius parasiticus*	2	5
Long-tailed Jaeger	*Stercorarius longicaudus*	1	3
Unidentified Jaeger		0	1
South Polar Skua	*Stercorarius maccormicki*	23	43
Double Cresred Cormorant	*Phalacrocorax auritus*	0	20
Northern Gannet	*Morus bassanus*	36	45
Red Phalarope	*Phalaropus fulicarius*	1	1
Red-necked Phalarope	*Phalaropus lobatus*	27	28
Unidentified Phalarope		7	7
Magnolia Warbeler	*Setophaga magnolia*	2	2
Barn Swallow	*Hirundo rustica*	2	3
Cedar Waxwing	*Bombycilla cedrorum*	1	1
Red-bellied Woodpecker	*Melanerpes carolinus*	1	1
Gray Catbird	*Dumetella carolinensis*	1	1
American Goldfinch	*Spinus tristis*	1	1
American Redstart	*Setophaga ruticilla*	1	1
Cuckcoo sp	*Coccyzus sp*	1	1
Passerine		10	10
Peregrine Falcon	*Falco peregrinus*	0	1
Osprey	*Pandion haliaetus*	2	3
Total		2893	4844

Marine Mammal, Sea Turtle, and Large Fishes Sightings

The most commonly seen marine mammal, was of course, the Common Dolphin, *Delphinus delphis,* accounting for approximately 75% of all mammal sightings, followed by Pilot Whales, *Globicephala melas*, at around 9%. Of the large whales seen, Humpback Whales, *Meaptera novaengliae*, made up a majority of individuals. Of special note were a small pod of Atlantic White-sided Dolphins, *Lagenorynchu acutus*, as well as Sperm Whales, *Physeter macrocephalus*, and a group of unidientified Beaked Whale, *Mesoplodon sp;* these species are not often seen on regular survey.

Only one Loggerhead sea turtle, *Caretta caretta,* was sighted and was sighted this trip, probably mostly due to the limited time spent in warmer waters down South or in the Gulf Stream. Of special note a large number of Sunfish, *Mola mola,* and Basking Shark, *Cetorhinus maximus*, were seen off of New England. Specifically concerning the sightings of Basking Sharks, several different individuals were seen breaching clear out of the water.

Table 2. Other Sighted Marine Megafauna

Common Name	Scienctific Name	Number Observed
Fin Whale	*Balaenoptera physalus*	2
Humpback Whale	*Megaptera novaeangliae*	22
Minke Whale	*Balaenoptera acutorostrata*	2
Unidentified Whale		4
Unidentified Small Whale		1
Unidentified Large Whale		5
Sperm Whale	*Physeter macrocephalus*	2
Pilot Whale	*Globicephala melas*	43
Risso's Dolphin	*Grampus griseus*	6
Common Dolphin	*Delphinus delphis*	336
Bottlenose Dolphin	*Tursiops truncatus*	15
Atantic White-sided Dolphin	*Lagenorhynchus acutus*	5
Unidentified Dolphin		1
Mesoplodon sp		2
Loggerhead Sea Turtle	*Caretta caretta*	1
Ocean Sunfish	*Mola mola*	41
Basking Shark	*Cetorhinus maximus*	29
Blue Shark	*Prionace glauca*	1
School of Tuna (larger/small)		6
School of Fish		3

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