CRUISE RESULTS
NOAA Ship *Henry B. Bigelow*
Cruise No. HB 23-02
Spring Northeast Ecosystem Monitoring Survey

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CRUISE PERIOD AND AREA

The NOAA research vessel *Henry B. Bigelow* sampled a total of 222 stations on the Spring Ecosystem Monitoring Survey (EcoMon). The vessel sailed from Pier 2 at the Naval Station in Newport RI on 8 June and returned on 28 June 2023, sampling the entire survey area from Cape Hatteras, NC to Georges Bank and the Gulf of Maine. Three factors enabled this cruise to be very successful in its coverage: 1 – adequate time allotted for the survey 2 - excellent weather 3 – lack of any vessel malfunctions or personnel issues. As the survey ended and the ship was returning to Newport from the Gulf of Maine it was able to conduct supplementary sampling of large warm core eddies moving from the northern wall of the Gulf Stream to the shelf waters south of Nantucket Shoals, and after that conduct a series of plankton tows on wind turbine lease areas through a couple of tidal cycles prior to returning to Newport, RI.

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 from the Scientific Flow-through Seawater System using thermosalinograph (TSG), NOAA Scientific Computer System (SCS), a fluorometer, a partial pressure of carbon dioxide (PCO2) system and a Total Alkalinity Sensor.

2. Using an Imaging FLowCytoBot unit, plumbed into the seawater system to photographed phytoplankton from the near-surface waters as the ship sailed.

3. Collect acoustic data using an EK80 and Acoustic Doppler Current Profiler (ADCP).

4. Collect pteropods (planktonic snails), from the plankton samples at various stations throughout the cruise together with simultaneous DIC samples to measure the correlation between ocean acidity and shell thickness.

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

6. Use a hand-deployed submersible radiometer to gather water column light level data during mid-day satellite overpasses.

7. Document the presence of seabirds, marine mammals and sea turtles from sunrise to sunset throughout the cruise by having two dedicated observers recording and photographing any encountered while the vessel is underway between stations.

8. Tow a ring net at a subset of the random plankton satations in the Georges Bank and Gulf of Maine regions to augment sampling by the Canadian Division of Fisheries and Oceans (DFO).

METHODS

The survey originally consisted of 166 stations spread across the Mid-Atlantic Bight, Southern New England, Georges Bank and the Gulf of Maine, 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 excellent weather and ship performance, 222 stations were sampled in the time available (Figures 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 to determine the volume of water filtered by the net. 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. 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 genetics and otolith analysis at the Narragansett NEFSC Lab. 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 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, salinity and oxygen 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. Note that each CMarZ sample was preserved in its own pint jar, while the 20 cm 335 micron mesh bongo samples were combined into a single pint jar.

Prior to preservation, the plankton samples from a number of stations were examined microscopically for the presence of pteropods. Since most of the pteropods encountered on this survey were very small, they were found by gently swirling the sample around so they would collect in the center of the bottom of the sample jar. When found, they were removed from the sample using a pipette, and placed in a glass vial which was put into a drying oven while a DIC sample was taken from the flow-through scientific seawater system or from a Niskin bottle water sample if a water cast had been done at that station. The dried pteropod samples were analyzed by researchers at the NEFSC and collaborators at the Bermuda Institute of Ocean Sciences with the goal of correlating pteropod shell thickness with the acidity of seawater.

A small portion of the plankton samples from a series of stations was frozen for a URI-GSO project to study the carbon and nitrogen isotopes in their tissues.

A 75-cm diameter ring net was deployed at a subset of random plankton stations in the Georges Bank and Gulf of Maine regions. This was in collaboration with the Division of Fisheries and Oceans (DFO) Canada plankton sampling protocol from the Atlantic Zone Monitoring Program (AZMP). The 75-cm diameter ring net was towed vertically from near the bottom, or a maximum depth of 600-m, to the surface while the ship was stationary. The wire retrieval speed is 1 m / second, and the vessel may need to maneuver to keep the wire vertical and off the hull, similar to a CTD cast.

At all fixed stations a Seabird 911+ CTD was deployed on a rosette frame equipped with 12 10-liter Niskin bottles. The package was deployed from the starboard side-sampling station, using the A-frame and aft conducting cable winch. This SBE9/11+ CTD and rosette package was deployed vertically, collecting profiles of water temperature, salinity, chlorophyll-a, and oxygen concentration. Water samples were collected using the Niskin sampling bottles at multiple depths along the upcast to be processed ashore for nutrients and carbonate chemistry. 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. Water samples for chlorophyll-a analysis were drawn from the surface, chlorophyll-max layer and from one depth below the chlorophyll-max layer. Two hundred milliliters of seawater from each depth was filtered through a Whatman GFF glass fiber filter, after which the filters were frozen at -80 C. for shoreside analysis of their chlorophyll content by NASA researchers located in Greenbelt, MD.

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 connected to those sensors. These independent computers also received input from the SCS system onboard. In addition, an ImagingFlowCytobot unit was plumbed into the flow-through seawater system in the CTD lab. This device captured images of diatoms and dinoflagellates on an independent computer provided by the Woods Hole Oceanographic Institution (WHOI).

When weather permitted, a radiometer cast was made between 1000 and 1400 hours EDT to obtain subsurface light levels for ground-truthing sea-surface light measurements conducted during a satellite overpass for determination of sea surface temperatures. This involved hand-lowering a weighted radiometer equipped with two photometers from the stern of the vessel. Each deployment involved five casts to ten meters, followed by a cast where the light level dropped to 1% of what it was at the surface. The light data was observed and recorded in real time as it came from the radiometer to a laptop computer aboard the vessel. A total of 14 casts were made over the course of the 21 day cruise.

RESULTS

A summary of routine survey activities is presented in Table 1. Areal coverage for the cruise is shown in Figures 1. Although the original survey target was 166 stations, the Henry Bigelow sampled at a total of 222 stations due to the fact that the vessel was not hampered by any bad weather or ship problems.

The NOAA Ship *Henry B. Bigelow* sailed from Newport, RI on Thursday, 8 June. After completing acoustic sensor calibrations in Narragansett Bay that day, the acoustic calibration team was returned to shore via small boat transfer. Sampling started just south of Narragansett Bay, and with good weather the vessel worked its way along the offshore stations of the Southern New England and Mid-Atlantic Bight areas, heading towards the southernmost station of the survey. Calanus copepods were abundant at first but dropped off around Norfolk Canyon. Whale and dolphin sightings also dropped off, but seabird numbers increased. Large numbers of very small pteropods were found in the plankton samples, hard to see with the naked eye, but easily concentrated in the bottom of the glass sample jars by gently swirling the samples around. We reached our southernmost station on June 10, then worked our way back north along the inshore stations.

By June 14 a decision was made on the strength of a good forecast, to visit Georges Bank next for sampling. Within five days all of Georges Bank had been sampled, yielding a variety of plankton catches; some having almost no organisms while others were chock-full of Calanus copepods. Many stations in the Southern New England and Georges Bank areas had brownish-colored water, with the Imaging Flow Cytobot showing large numbers of the dinoflagellate *Ceratium* on the laptop monitor. On June 18, sampling was started on the last survey area of the cruise, the Gulf of Maine. Just prior to entering the Gulf of Maine, two drifter buoys were launched, near the southern edge of Georges Bank (Figure 14). The buoys, with ID numbers 5301663 and 5301666, are transmitting their locations and water temperatures daily, and are moving slowly southwest along the outer edge of the continental shelf at the time of this writing (Figure 15). Continued good weather allowed the vessel to sample the entire Gulf of Maine area, which in recent years had not been completely covered due to lack of time and sometimes marginal conditions.

The Henry Bigelow returned to the Newport Naval Station on the morning of Wednesday, 28 June, 2023. All four regions listed in the cruise instructions were sampled, plus supplemental sampling in the Southern New England and southwestern Georges Bank area was done to collect data from Gulf Stream water intrusions on the continental shelf and from tidal cycles in a wind energy lease area. Note that this was the first complete coverage of the entire survey area in several years.

DISPOSITION OF SAMPLES AND DATA

All physical plankton samples were returned to Narragansett, RI for quality control processing and further analysis (except for the CMARZ samples). The CMarZ samples and associated data will be delivered to Anne Bucklin and Peter Wiebe at the Woods Hole Oceanographic Institution. The nutrient samples were delivered to the University of Rhode Island, Graduate School of Oceanography in Narragansett, Rhode Island. The Total Alkalinity Sensor on the Scientific Seawater system was returned to the University of New Hampshire. The ImagingFlowCytoBot unit and the images and data it collected were picked up by Emily Peacock at WHOI. The frozen copepod samples were taken to the URI Graduate School of Oceanography for carbon and nitrogen stable isotope analysis. The dried pteropod samples will be sent to Amy Maas at the Bermuda Institute of Ocean Sciences after preliminary analysis at the NEFSC Narragansett laboratory. 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. Satellite ground-truth radiometry data and equipment was returned to the URI Graduate School of Oceanography.

SCIENTIFIC PERSONNEL

National Marine Fisheries Service, NEFSC, Narragansett, RI

Jerome Prezioso — Chief Scientist
Audy Peoples
Chris Taylor
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University of New England

Mackenzi Kimball

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Morgan Hadley

Pro Tech Marine Mammal and Seabird Observers

Allison Black
Nicholas Methany

Table 1. Summary of deployments and samples collected at 222 stations at which the *Henry B. Bigelow* stopped to lower instruments over the side during Cruise No. HB 23-03, Spring Northeast Ecosystem Monitoring Survey.

CTD Cast	Station	Deployment	DATE	Latitude	Longitude	Depth (m)	Sample Collection
1	1	CTD/Bongo Oblique	9-Jun	4113.7	7114.6	38	6B3, 2B3 D, URI
2	2	CTD/Bongo Oblique	9-Jun	4105.6	7108.8	36	6B3, 2B3 D, URI
3	3	CTD/Bongo Oblique	9-Jun	4056.2	7053.7	54	6B3, 2B3 D, URI
4	4	CTD/Bongo Oblique	9-Jun	4039.2	7029.3	60	6B3, 2B1 C
5	5	CTD/Bongo Oblique	9-Jun	4040.8	7037.4	61	6B3, 2B3 D
1	5	CTD/Water Profile	9-Jun	4040.6	7037.7	61	DIC,O2,UNH,CHL,SAL,NUT
6	6	CTD/Bongo Oblique	9-Jun	4043.1	7112.1	61	6B3, 2B3 D, PTE, URI
7	7	CTD/Bongo Oblique	9-Jun	4028.6	7138.9	77	6B3, 2B3 D, PTE, URI
8	8	CTD/Bongo Oblique	9-Jun	4015.8	7115.3	94	6B3, 2B3 D, URI
9	9	CTD/Bongo Oblique	9-Jun	4010.3	7051.9	134	6B3, 2B1 C, PTE
10	10	CTD/Bongo Oblique	9-Jun	4002.1	7036.6	172	6B3, 2B3 D, PTE, URI
2	10	CTD/Water Profile	9-Jun	4002.3	7035.9	166	DIC,O2,UNH,CHL,SAL,NUT
11	11	CTD/Bongo Oblique	9-Jun	3950.1	7037.3	904	6B3, 2B3 D
3	11	CTD/Water Profile	9-Jun	3949.7	7037.4	956	DIC,O2,UNH,CHL,SAL,NUT
12	12	CTD/Bongo Oblique	10-Jun	4010	7146.9	80	6B3, 2B3D, URI
13	13	CTD/Bongo Oblique	10-Jun	4001.4	7213.2	80	6B3, 2B3D, URI
14	14	CTD/Bongo Oblique	10-Jun	3948.5	7209.1	91	6B3, 2B3D, URI, PTE
15	15	CTD/Bongo Oblique	10-Jun	3927.9	7242.5	77	6B3, 2B1C, PTE
16	16	CTD/Bongo Oblique	10-Jun	3923.3	7248.4	75	6B3, 2B3D, URI
17	17	CTD/Bongo Oblique	10-Jun	3922.7	7232.4	125	6B3, 2B3D, URI, PTE
18	18	CTD/Bongo Oblique	10-Jun	3900.9	7234.6	1004	6B3, 2B3D, PTE
4	18	CTD/Water Profile	10-Jun	3900.7	7235.7	1159	DIC,O2,UNH,CHL,SAL,NUT
19	19	CTD/Bongo Oblique	10-Jun	3902.9	7243.9	511	6B3, 2B3D
5	19	CTD/Water Profile	10-Jun	3902.6	7244.7	278	DIC,O2,UNH,CHL,SAL,NUT
20	20	CTD/Bongo Oblique	10-Jun	3859.7	7250.4	120	6B3, 2B3D
21	21	CTD/Bongo Oblique	10-Jun	3853	7257.8	107	6B3, 2B1C, PTE

22	22	CTD/Bongo Oblique	10-Jun	3844	7313.3	93	6B3, 2B3D, URI
23	23	CTD/Bongo Oblique	10-Jun	3844	7313.3	50	6B3, 2B3D, URI
24	24	CTD/Bongo Oblique	11-Jun	3808.8	7402.7	77	6B3, 2B3D, URI
25	25	CTD/Bongo Oblique	11-Jun	3757.1	7407.9	104	6B3, 2B3D, URI
26	26	CTD/Bongo Oblique	11-Jun	3742.8	7415.3	106	6B3, 2B3D
27	27	CTD/Bongo Oblique	11-Jun	3719.8	7447.1	52	6B3, 2B1C, PTE
28	28	CTD/Bongo Oblique	11-Jun	3635	7445.1	93	6B3, 2B3D
29	29	CTD/Bongo Oblique	11-Jun	3630.6	7458.4	44	6B3, 2B3D, PTE
7	30	CTD/Water Profile	11-Jun	3600.1	7446.8	370	DIC,O2,UNH,CHL,SAL,NUT
30	32	CTD/Bongo Oblique	11-Jun	3549.1	7450.8	605	6B3, 2B3D, URI
31	32	CTD Profile	11-Jun	3548.4	7450.3	674	6B3
32	33	CTD/Bongo Oblique	12-Jun	3535.9	7502	43	6B3, 2B3D, URI
33	34	CTD/Bongo Oblique	12-Jun	3533.6	7507.7	36	6B3, 2B1C
34	35	CTD/Bongo Oblique	12-Jun	3545.7	7522.6	17	6B3, 2B3D, URI
9	36	CTD/Water Profile	12-Jun	3559.6	7510.6	35	DIC,O2,UNH,CHL,SAL,NUT
10	37	CTD/Water Profile	12-Jun	3600	7527.7	27	DIC,O2,UNH,CHL,SAL,NUT
35	38	CTD/Bongo Oblique	12-Jun	3608.2	7534.7	24	6B3, 2B3D, URI, PTE
36	39	CTD/Bongo Oblique	12-Jun	3642.3	7516.7	25	6B3, 2B3D
37	40	CTD/Bongo Oblique	12-Jun	3653	7549.4	14	6B3, 2B1C
38	41	CTD/Bongo Oblique	12-Jun	3656.8	7537.9	21	6B3, 2B3D
39	42	CTD/Bongo Oblique	12-Jun	3727.1	7522	27	6B3, 2B3D, PTE
40	43	CTD/Bongo Oblique	12-Jun	3747.7	7448	38	6B3, 2B3D
41	44	CTD/Bongo Oblique	12-Jun	3750.7	7434.8	54	6B3, 2B3D
11	44	CTD/Water Profile	12-Jun	3750.5	7434.6	55	DIC,O2,UNH,CHL,SAL,NUT
42	45	CTD/Bongo Oblique	13-Jun	3751.9	7512.8	20	6B3, 2B3D
43	46	CTD/Bongo Oblique	13-Jun	3759.9	7457.7	22	6B3, 2B3D
12	46	CTD/Water Profile	13-Jun	3759.8	7457.8	22	DIC,O2,UNH,CHL,SAL,NUT

44	47	CTD/Bongo Oblique	13-Jun	3829.9	7417.6	39	6B3, 2B1C
45	48	CTD/Bongo Oblique	13-Jun	3834.1	7433.6	33	6B3, 2B3D, URI, PTE
46	49	CTD/Bongo Oblique	13-Jun	3834.4	7446.8	29	6B3, 2B3D, URI
47	50	CTD/Bongo Oblique	13-Jun	3901.3	7435.3	15	6B3, 2B3D, URI, PTE
48	51	CTD/Bongo Oblique	13-Jun	3911.7	7425.8	19	6B3, 2B3D, URI
49	52	CTD/Bongo Oblique	13-Jun	3914	7407.9	25	6B3, 2B1C
50	53	CTD/Bongo Oblique	13-Jun	3917.2	7359.1	32	6B3, 2B3D, URI, PTE
51	54	CTD/Bongo Oblique	13-Jun	3930.5	7409.7	18	6B3, 2B3D
52	55	CTD/Bongo Oblique	13-Jun	3942.4	7400	23	6B3, 2B3D
13	55	CTD/Water Profile	13-Jun	3942.2	7400.1	23	DIC,O2,UNH,CHL,SAL,NUT
53	56	CTD/Bongo Oblique	13-Jun	3942.5	7336.3	38	6B3, 2B3D
54	57	CTD/Bongo Oblique	14-Jun	3922.4	7323.1	47	6B3, 2B3D
14	57	CTD/Water Profile	14-Jun	3922.2	7323	48	DIC,O2,UNH,CHL,SAL,NUT
55	58	CTD/Bongo Oblique	14-Jun	3923.6	7314.8	55	6B3, 2B3D
56	59	CTD/Bongo Oblique	14-Jun	4004.1	7258	50	6B3, 2B3D
57	60	CTD/Bongo Oblique	14-Jun	4017.8	7249.7	49	6B3, 2B3D, URI
58	61	CTD/Bongo Oblique	14-Jun	4016.5	7306.8	41	6B3, 2B3D, URI
59	62	CTD/Bongo Oblique	14-Jun	4031.8	7327.6	18	6B3, 2B3D, PTE
60	63	CTD/Bongo Oblique	14-Jun	4034.5	7240.3	39	6B3, 2B1C
61	64	CTD/Bongo Oblique	14-Jun	4030.1	7214.1	57	6B3, 2B3D
62	65	CTD/Bongo Oblique	14-Jun	4053.4	7153.4	36	6B3, 2B3D
63	66	CTD/Bongo Oblique	14-Jun	4101.5	7146.6	27	6B3, 2B3D
64	67	CTD/Bongo Oblique	14-Jun	4100.4	7051.8	49	6B3, 2B3D
65	68	CTD/Bongo Oblique	15-Jun	4105.9	7037.7	45	6B3, 2B3D, PTE
15	68	CTD/Water Profile	15-Jun	4105.8	7037.3	43	DIC,O2,UNH,CHL,SAL,NUT
66	69	CTD/Bongo Oblique	15-Jun	4103.6	7020.9	38	6B3, 2B1C
67	70	CTD/Bongo Oblique	15-Jun	4058.3	7029.9	46	6B3, 2B3D

68	71	CTD/Bongo Oblique	15-Jun	4049.5	7018.5	47	6B3, 2B3D
69	72	CTD/Bongo Oblique	15-Jun	4041.9	7003.4	45	6B3, 2B3D
70	73	CTD/Bongo Oblique	15-Jun	4030	6951.1	70	6B3, 2B3D, URI
71	74	CTD/Bongo Oblique	15-Jun	4002.4	6951.6	138	6B3, 2B3D, URI, PTE
72	75	CTD/Bongo Oblique	15-Jun	4010.6	6926.6	85	6B3
73	76	CTD/Water Profile	15-Jun	4010.5	6926.9	85	
74	77	CTD/Bongo Oblique	15-Jun	4014.9	6850.3	109	6B3, 2B3D, URI, PTE
75	78	CTD/Bongo Oblique	15-Jun	4012.9	6845.1	128	6B3
76	79	CTD/Bongo Oblique	15-Jun	4053.6	6832.9	56	6B3, 2B3D
77	80	CTD/Bongo Oblique	15-Jun	4055.2	6826	52	6B3, 2B3D
78	81	CTD/Bongo Oblique	16-Jun	4048.3	6813	54	6B3
79	82	CTD/Bongo Oblique	16-Jun	4044.7	6802.5	76	6B3, 2B3D
80	83	CTD/Bongo Oblique	16-Jun	4018.7	6759.7	206	6B3, 2B1C
16	84	CTD/Water Profile	16-Jun	4014.9	6741.7	964	DIC,O2,UNH,CHL,SAL,NUT
17	85	CTD/Water Profile	16-Jun	4023.1	6741.7	206	
81	86	CTD/Bongo Oblique	16-Jun	4042.9	6728.7	92	6B3, 2B3D, URI
18	87	CTD/Water Profile	16-Jun	4055.7	6741.8	67	
82	88	CTD/Bongo Oblique	16-Jun	4056.8	6753.5	58	6B3, 2B3D, URI
83	89	CTD/Bongo Oblique	16-Jun	4105.5	6801	54	6B3, 2B3D, URI
84	90	CTD/Bongo Oblique	16-Jun	4119.2	6803.2	26	6B3
85	91	CTD/Bongo Oblique	16-Jun	4134.5	6837.2	136	6B3, 2B3D
86	91	CTD/RING NET	16-Jun	4134.1	6836.9	135	7R2
87	92	CTD/Bongo Oblique	16-Jun	4143.1	6824	132	6B3, 2B1C
88	93	CTD/Bongo Oblique	16-Jun	4138.5	6809.3	35	6B3, 2B3D, URI
89	94	CTD/Bongo Oblique	17-Jun	4136.1	6804.9	41	6B3, 2B3D, URI
90	95	CTD/Bongo Oblique	17-Jun	4131.9	6758.6	33	6B3, 2B3D
19	96	CTD/Water Profile	17-Jun	4128.2	6742	40	DIC,O2,UNH,CHL,SAL,NUT

91	97	CTD/Bongo Oblique	17-Jun	4130.4	6735.9	39	6B3, 2B3D, URI
92	98	CTD/Bongo Oblique	17-Jun	4116	6737.4	36	6B3, 2B3D, URI
93	99	CTD/Bongo Oblique	17-Jun	4107.2	6721.1	60	6B3, 2B1C
94	100	CTD/Bongo Oblique	17-Jun	4103.5	6726.2	62	6B3, 2B3D, URI
95	101	CTD/Bongo Oblique	17-Jun	4056.2	6708.2	83	6B3, 2B3D
96	102	CTD/Bongo Oblique	17-Jun	4107.3	6703.8	65	6B3, 2B3D
97	103	CTD/Bongo Oblique	17-Jun	4111	6658.5	69	6B3, 2B3D
98	104	CTD/Bongo Oblique	17-Jun	4114.3	6645.2	77	6B3, 2B3D
99	105	CTD/Bongo Oblique	17-Jun	4121.4	6631.7	93	6B3, 2B1C
100	106	CTD/Bongo Oblique	17-Jun	4131.3	6702.7	65	6B3, 2B3D, URI
101	107	CTD/Bongo Oblique	17-Jun	4140.7	6643	70	6B3, 2B3D, URI
102	108	CTD/Bongo Oblique	17-Jun	4133.7	6557.9	148	6B3, 2B3D, URI
20	109	CTD/Water Profile	17-Jun	4145.1	6526.7	1904	DIC,O2,UNH,CHL,SAL,NUT
103	110	CTD/Bongo Oblique	18-Jun	4146.1	6546.9	139	6B3, 2B3D, URI
104	111	CTD/Bongo Oblique	18-Jun	4157.4	6601.9	95	6B3, 2B3D, URI
105	112	CTD/Bongo Oblique	18-Jun	4213.5	6545.9	227	6B3, 2B3D, PTE
21	112	CTD/Water Profile	18-Jun	4213.2	6545.6	225	DIC,O2,UNH,CHL,SAL,NUT
106	113	CTD/Bongo Oblique	18-Jun	4243.2	6529.6	94	6B3, 2B3D, URI
107	114	CTD/Bongo Oblique	18-Jun	4234	6605.9	160	6B3, 2B3D, URI, PTE
108	115	CTD/Bongo Oblique	18-Jun	4223.5	6619.3	254	6B3, 2B3D, URI
109	115	CTD Profile	18-Jun	4223.2	6619.4	254	
110	116	CTD/Bongo Oblique	18-Jun	4211	6611.8	213	6B3, 2B1
111	117	CTD/Bongo Oblique	18-Jun	4202.4	6636.2	77	6B3, 2B3D, URI
22	118	CTD/Water Profile	19-Jun	4200.8	6740.7	66	DIC,O2,UNH,CHL,SAL,NUT
112	119	CTD/Bongo Oblique	19-Jun	4209.1	6736.5	182	6B3, 2B3D, URI
113	119	CTD/RING NET	19-Jun	4209.6	6737.2	188	7R2
114	120	CTD/Bongo Oblique	19-Jun	4222.7	6703.4	336	6B3, 2B3D
23	120	CTD/Water Profile	19-Jun	4223	6703.1	338	DIC,O2,UNH,CHL,SAL,NUT

115	121	CTD/Bongo Oblique	19-Jun	4221.6	6721.4	332	6B3, 2B3D, URI
116	121	CTD/RING NET	19-Jun	4221.7	6721.8	330	7R2
117	122	CTD/RING NET	19-Jun	4228.2	6729.9	292	7R2
118	122	CTD/Bongo Oblique	19-Jun	4228	6729.8	292	6B3, 2B1C
24	123	CTD/Water Profile	19-Jun	4241.8	6742.1	190	DIC,O2,UNH,CHL,SAL,NUT
119	124	CTD/Bongo Oblique	19-Jun	4252.5	6728.5	246	6B3, 2B3D, URI
120	124	CTD/RING NET	19-Jun	4252.9	6729.3	243	7R2
121	125	CTD/RING NET	19-Jun	4251.9	6711.6	246	7R2
122	125	CTD/Bongo Oblique	19-Jun	4251.5	6711.6	250	6B3, 2B3D, URI
123	126	CTD/Bongo Oblique	19-Jun	4258.2	6659.9	217	6B3, 2B3D
124	126	CTD/RING NET	19-Jun	4258.4	6700.1	210	7R2
25	127	CTD/Water Profile	19-Jun	4302.1	6620.7	132	DIC,O2,UNH,CHL,SAL,NUT
125	128	CTD/RING NET	20-Jun	4258.4	6605.7	151	7R2
126	128	CTD/Bongo Oblique	20-Jun	4258.6	6606.5	114	6B3, 2B3D, URI
127	129	CTD/Bongo Oblique	20-Jun	4326.5	6619.8	63	6B3, 2B1C
128	130	CTD/Bongo Oblique	20-Jun	4337.5	6634.2	132	6B3, 2B3D
129	131	CTD/Bongo Oblique	20-Jun	4339.7	6712.4	162	6B3, 2B3D, URI
130	132	CTD/Bongo Oblique	20-Jun	4338.3	6721.7	217	6B3, 2B3D
131	132	CTD/RING NET	20-Jun	4338.3	6722.7	217	7R2
132	133	CTD/Bongo Oblique	20-Jun	4323.8	6741.3	246	6B3, 2B3D
26	133	CTD/Water Profile	20-Jun	4324.2	6741.6	246	DIC,O2,UNH,CHL,SAL,NUT
133	134	CTD/Bongo Oblique	20-Jun	4352.8	6720.9	221	6B3
134	134	CTD/RING NET	20-Jun	4352.6	6720.7	224	7R2
135	135	CTD/Bongo Oblique	20-Jun	4412.2	6705.6	131	6B3, 2B1C
27	136	CTD/Water Profile	20-Jun	4428.8	6713.3	85	DIC,O2,UNH,CHL,SAL,NUT
28	137	CTD/Water Profile	20-Jun	4412.4	6741.9	132	DIC,O2,UNH,CHL,SAL,NUT
136	138	CTD/Bongo Oblique	21-Jun	4405.7	6752.3	105	6B3, 2B3D
137	139	CTD/Bongo Oblique	21-Jun	4357	6812.1	112	6B3
29	140	CTD/Water Profile	21-Jun	4347	6839.3	115	DIC,O2,UNH,CHL,SAL,NUT
138	141	CTD/Bongo Oblique	21-Jun	4340.9	6822.3	188	6B3, 2B3D, URI

139	141	CTD/RING NET	21-Jun	4340.7	6822.6	192	7R2
140	142	CTD/Bongo Oblique	21-Jun	4330.4	6826.6	173	6B3, URI
141	143	CTD/Bongo Oblique	21-Jun	4319.9	6844.7	124	6B3, URI
142	144	CTD/Bongo Oblique	21-Jun	4312.4	6823.6	169	6B3, URI
143	145	CTD/Bongo Oblique	21-Jun	4303.3	6759.6	198	6B3, URI
144	146	CTD/Bongo Oblique	21-Jun	4248.2	6819.2	201	6B3, URI
145	147	CTD/Bongo Oblique	21-Jun	4221.8	6838	193	6B3
146	148	CTD/Bongo Oblique	21-Jun	4243	6856.9	148	6B3
147	149	CTD/Bongo Oblique	22-Jun	4259.6	6912.2	194	6B3, 2B3D
148	149	CTD/RING NET	22-Jun	4300.1	6912.2	197	7R2
149	150	CTD/Bongo Oblique	22-Jun	4301.1	6933.2	167	6B3, 2B1C
150	151	CTD/Bongo Oblique	22-Jun	4257.3	6943.9	179	6B3, 2B3D
151	151	CTD/RING NET	22-Jun	4257.1	6943.4	181	7R2
152	152	CTD/Bongo Oblique	22-Jun	4314.7	6957.5	137	6B3
153	153	CTD/Bongo Oblique	22-Jun	4335.4	7009.9	23	6B3, 2B3D
154	154	CTD/Bongo Oblique	22-Jun	4318.4	7017.1	57	6B3, PTE
30	155	CTD/Water Profile	22-Jun	4259.9	7024.8	107	DIC,O2,UNH,CHL,SAL,NUT
155	156	CTD/Bongo Oblique	22-Jun	4242.9	7007.8	101	6B3, 2B3D, URI
156	157	CTD/Bongo Oblique	22-Jun	4241.7	7024.4	50	6B3, 2B3D, PTE
157	158	CTD/Bongo Oblique	22-Jun	4234	7020.4	112	6B3, 2B3D
158	159	CTD/Bongo Oblique	22-Jun	4225	7036.4	87	6B3, 2B3D
31	159	CTD/Water Profile	22-Jun	4225.1	7036	87	DIC,O2,UNH,CHL,SAL,NUT
159	160	CTD/Bongo Oblique	22-Jun	4221.8	7028.6	76	6B3, 2B3D
32	160	CTD/Water Profile	22-Jun	4221.9	7028.2	72	DIC,O2,UNH,CHL,SAL,NUT
160	161	CTD/Bongo Oblique	22-Jun	4219.1	7016.7	35	6B3, 2B3D
33	161	CTD/Water Profile	22-Jun	4219.2	7016.5	34	DIC,O2,UNH,CHL,SAL,NUT
161	162	CTD/Bongo Oblique	23-Jun	4229.6	6940.8	261	6B3, 2B3D
34	162	CTD/Water Profile	23-Jun	4229.7	6940.3	257	DIC,O2,UNH,CHL,SAL,NUT

162	163	CTD/Bongo Oblique	23-Jun	4212.8	6914.5	200	6B3, 2B3D,
163	163	CTD/RING NET	23-Jun	4213	6914.2	201	7R2
164	164	CTD/Bongo Oblique	23-Jun	4153.3	6849.9	164	6B3, 2B3D
165	165	CTD/Bongo Oblique	23-Jun	4152.9	6907.6	204	6B3, 2B3D,PTE, URI
166	166	CTD/Bongo Oblique	23-Jun	4138.7	6932.3	89	6B3, 2B3D, PTE
167	167	CTD/Bongo Oblique	23-Jun	4123.2	6935.6	29	6B3, 2B3D, PTE
168	168	CTD/Bongo Oblique	23-Jun	4048.5	6831.3	51	6B3
35	169	CTD/Water Profile	23-Jun	4034.7	6830.9	74	DIC,O2,UNH,CHL,SAL,NUT
169	170	CTD/Bongo Oblique	24-Jun	4018.6	6831	116	6B3
36	171	CTD/Water Profile	24-Jun	4005.9	6830.7	732	DIC,O2,UNH,CHL,SAL,NUT
170	172	CTD/Bongo Oblique	24-Jun	3948.5	6831.2	2454	6B3, PTE
171	173	CTD/Bongo Oblique	24-Jun	3930.7	6831.4	2803	6B3
37	173	CTD/Water Profile	24-Jun	3930.1	6830.9	2822	DIC,O2,UNH,CHL,SAL,NUT
172	174	CTD/Bongo Oblique	24-Jun	3930.2	6858	2580	6B3, PTE
173	175	CTD/Bongo Oblique	24-Jun	3949.1	6858	2025	6B3
38	175	CTD/Water Profile	24-Jun	3948.3	6857.6	2079	DIC,O2,UNH,CHL,SAL,NUT
174	176	CTD/Bongo Oblique	24-Jun	4006.4	6858.6	160	6B3
39	177	CTD/Water Profile	24-Jun	4019.1	6858	95	DIC,O2,UNH,CHL,SAL,NUT
175	178	CTD/Bongo Oblique	24-Jun	4038.9	6858.4	68	6B3, 2B3D
40	179	CTD/Water Profile	24-Jun	4053.2	6909.2	68	DIC,O2,UNH,CHL,SAL,NUT
176	180	CTD/Bongo Oblique	25-Jun	4042	6923.6	56	6B3, 2B3D
177	181	CTD/Bongo Oblique	25-Jun	4050.6	6935	37	6B3
41	182	CTD/Water Profile	25-Jun	4035.2	6925.3	55	DIC,O2,UNH,CHL,SAL,NUT
178	183	CTD/Bongo Oblique	25-Jun	4019.5	6925.4	77	6B3
42	184	CTD/Water Profile	25-Jun	4005.8	6925.3	97	DIC,CHL,NUT
179	185	CTD/Bongo Oblique	25-Jun	3949.3	6925.6	1787	6B3, PTE
180	186	CTD/Bongo Oblique	25-Jun	3931.4	6925.4	2324	6B3, PTE

43	186	CTD/Water Profile	25-Jun	3931.7	6925.8	2320	DIC,O2,UNH,CHL,SAL,NUT
181	187	CTD/Bongo Oblique	25-Jun	3931.5	6951.3	2370	6B3
182	188	CTD/Bongo Oblique	25-Jun	3949	6950.9	1044	6B3
44	188	CTD/Water Profile	25-Jun	3948.9	6950.6	981	DIC,O2,UNH,CHL,SAL,NUT
183	189	CTD/Bongo Oblique	25-Jun	4005.1	6950.5	115	6B3
45	190	CTD/Water Profile	25-Jun	4018.4	6950.6	82	DIC,O2,UNH,CHL,SAL,NUT
184	191	CTD/Bongo Oblique	25-Jun	4035.2	6951.1	62	6B3
46	192	CTD/Water Profile	26-Jun	4047.7	6951	36	DIC,O2,UNH,CHL,SAL,NUT
185	193	CTD/Bongo Oblique	26-Jun	4042.2	7004.4	44	6B3
47	194	CTD/Water Profile	26-Jun	4035.7	7017.1	58	DIC,O2,UNH,CHL,SAL,NUT
186	195	CTD/Bongo Oblique	26-Jun	4020.1	7017.2	88	6B3
48	196	CTD/Water Profile	26-Jun	4005.2	7017.5	151	DIC,O2,UNH,CHL,SAL,NUT
187	197	CTD/Bongo Oblique	26-Jun	3949.3	7018.1	1121	6B3
188	198	CTD/Bongo Oblique	26-Jun	3931.6	7018	2400	6B3
49	198	CTD/Water Profile	26-Jun	3931.1	7017.6	2403	DIC,O2,UNH,CHL,SAL,NUT
189	199	CTD/Bongo Oblique	26-Jun	3930.9	7046.2	2466	6B3
190	200	CTD/Bongo Oblique	26-Jun	3949.6	7046.2	987	6B3
50	200	CTD/Water Profile	26-Jun	3949.2	7045.9	1049	DIC,O2,UNH,CHL,SAL,NUT
191	201	CTD/Bongo Oblique	26-Jun	4004.9	7046	140	6B3
51	202	CTD/Water Profile	26-Jun	4019.3	7046.1	105	DIC,O2,UNH,CHL,SAL,NUT
192	203	CTD/Bongo Oblique	26-Jun	4035	7046.1	69	6B3
52	204	CTD/Water Profile	27-Jun	4048.2	7046.1	59	O2,UNH,CHL,NUT
193	205	CTD/Bongo Oblique	27-Jun	4058.9	7030.6	46	6B3
194	207	CTD/Bongo Oblique	27-Jun	4050	7018.5	47	6B3
195	208	CTD/Bongo Oblique	27-Jun	4042.2	7003.8	44	6B3
196	209	CTD/Bongo Oblique	27-Jun	4042.3	6953.3	49	6B3
197	210	CTD/Bongo Oblique	27-Jun	4052.7	6945.3	31	6B3

198	211	CTD/Bongo Oblique	27-Jun	4041.9	6953.4	50	6B3
199	212	CTD/Bongo Oblique	27-Jun	4041.9	7003.5	45	6B3
200	213	CTD/Bongo Oblique	27-Jun	4049.7	7018.3	47	6B3
201	214	CTD/Bongo Oblique	27-Jun	4041.9	7003.7	45	6B3
202	215	CTD/Bongo Oblique	27-Jun	4041.9	6952.9	50	6B3
203	216	CTD/Bongo Oblique	27-Jun	4052.4	6945	33	6B3
204	217	CTD/Bongo Oblique	27-Jun	4042.1	6952.6	49	6B3
205	218	CTD/Bongo Oblique	27-Jun	4042.6	7003.4	44	6B3
206	219	CTD/Bongo Oblique	27-Jun	4049.8	7018.3	47	6B3
207	220	CTD/Bongo Oblique	27-Jun	4058.4	7030.4	46	6B3
208	221	CTD/Bongo Oblique	27-Jun	4056.1	7052.5	54	6B3
209	222	CTD/Bongo Oblique	28-Jun	4106.1	7109.2	36	6B3

Table 2. Summary of number of stations with deployment and sample collection types for plankton, hydrography, and water sampling at which the NOAA Ship Henry B. Bigelow stopped to lower instruments over the side during Cruise No. HB 23-02. 6B3 = 60-cm bongo with 333 mesh, 2B3 = 20-cm bongo with 333 mesh, 2B1 = 20-cm bongo with 165 mesh, 7B2 = 70-cm ring net with 200 mesh

Deployment	Sample Collection	Number of stations
CTD/Bongo Oblique	Plankton – 6B3	192
	Plankton – 2B3	117
	Plankton – 2B1	18
CTD/Ring Net	Plankton – 7B2	15
CTD Profile/Water	Hydrography and Water Samples	47
	Nutrients	47
	O2	47
	Chlorophyll	46
	Dissolved Inorganic Carbon (DIC)	46
	Salinity	46
	Pteropods	30
	URI Isotope	56

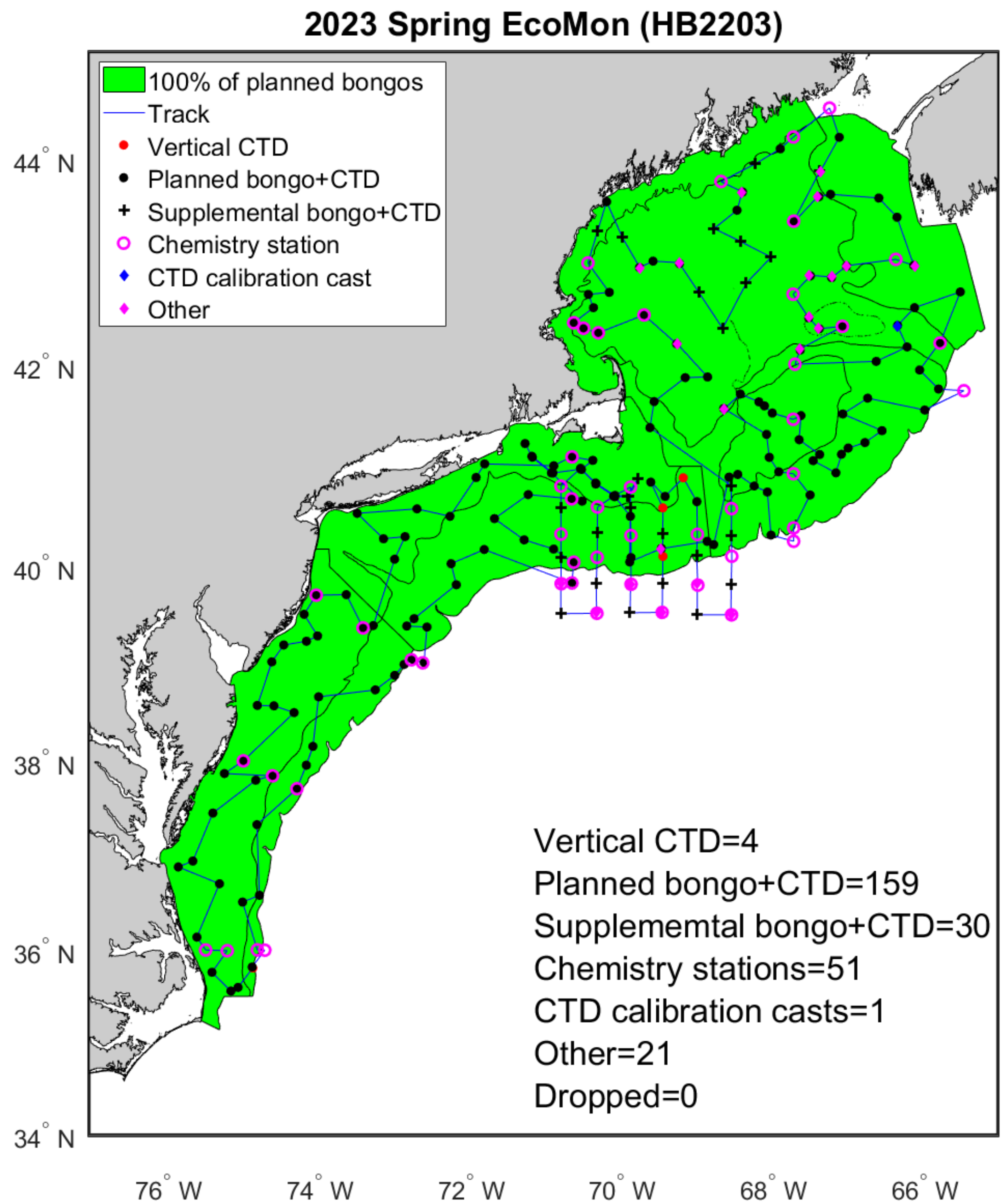

Figure 1. Station locations and percent coverage of bongo samples during Spring Northeast Ecosystem Monitoring Survey, HB 23-02, 8 – 28 June 2023.

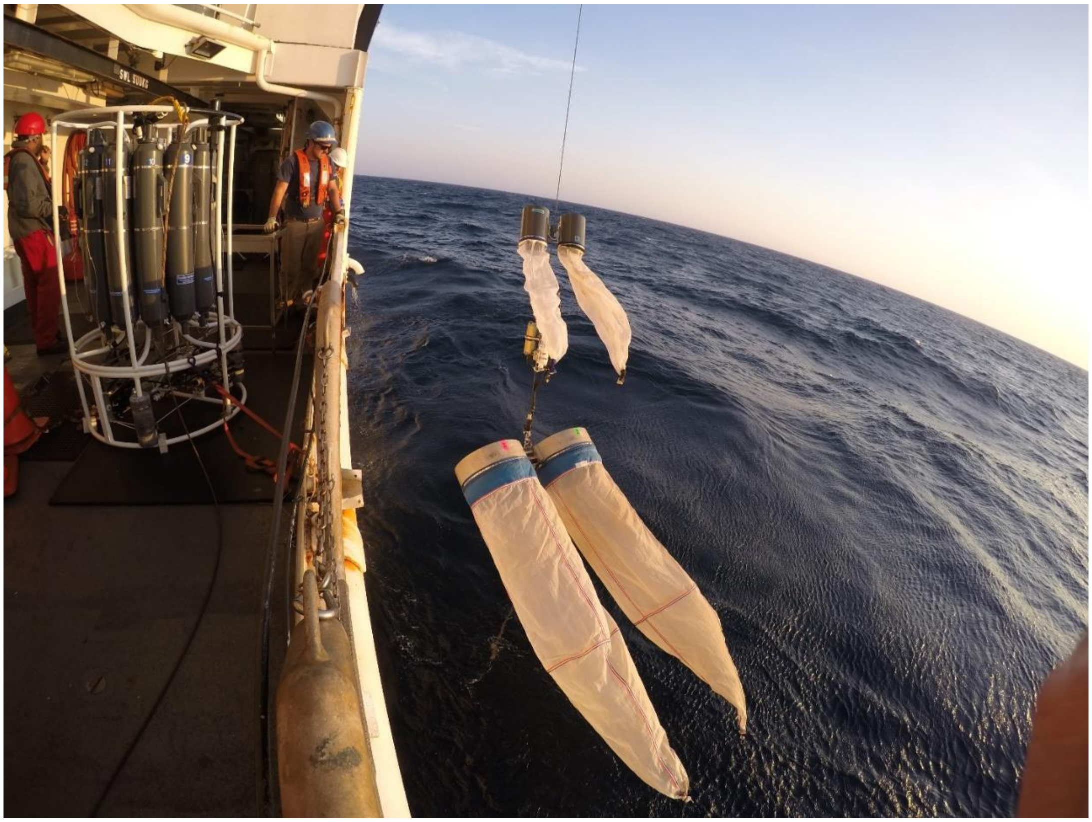

Figure 2. Deployment of 60-cm (bottom) and 20-cm bongo being deployed from the side sample station of the NOAA Ship *Henry B. Bigelow.*

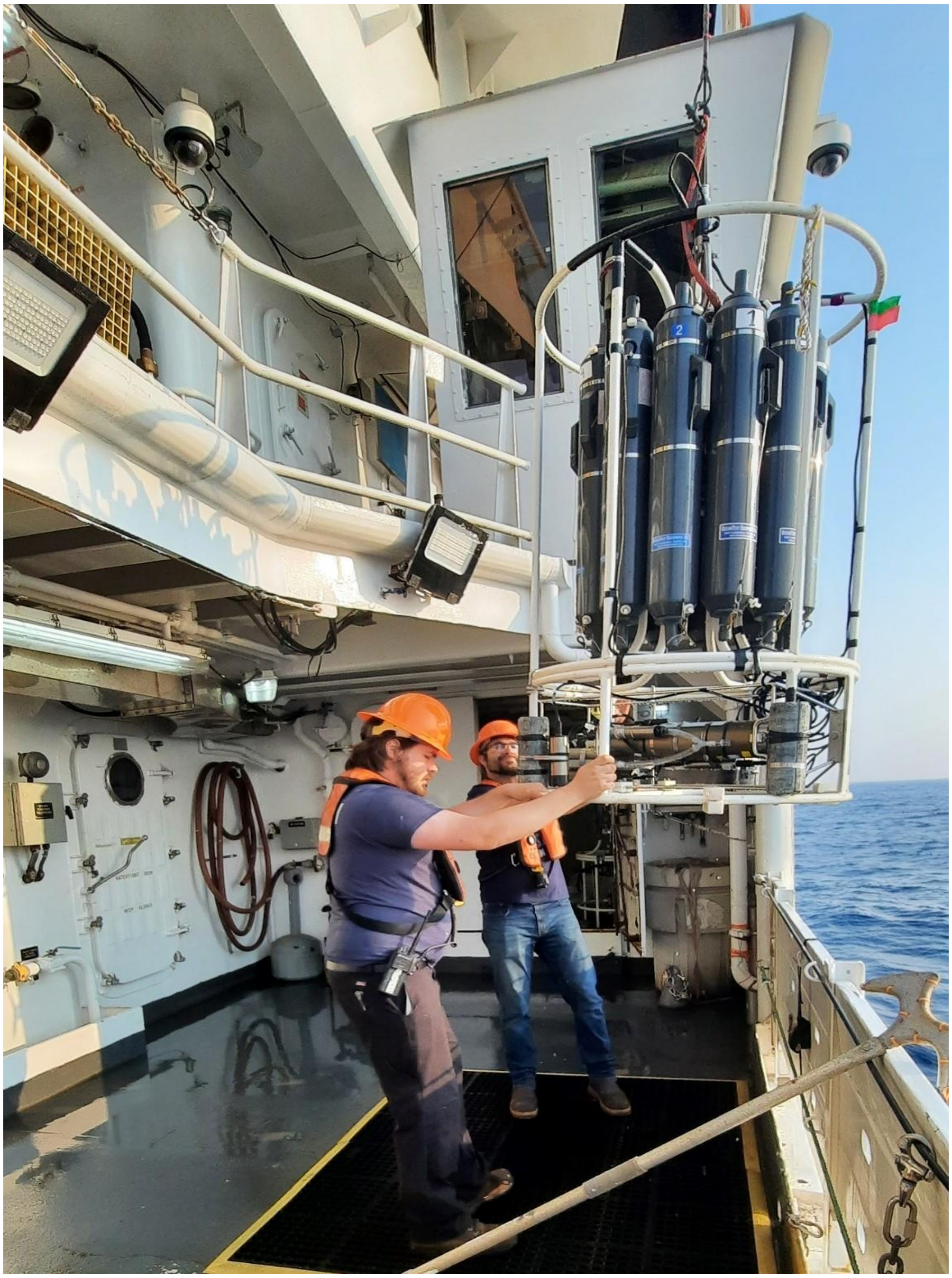

Figure 3. Deployment of water sampling rosette with Conductivity, Temperature and Depth (CTD) from the side sample of the NOAA Ship *Henry B. Bigelow.*

Figure 4. Deployment of 70-cm ring net from the side sample station of the NOAA Ship *Henry B. Bigelow.*