19 December 2006

CRUISE RESULTS
NOAA Exploration Vessel ***OKEANOS EXPLORER***
Cruise No. EX 13-05
Summer Ecosystem Monitoring Survey

CRUISE PERIOD AND AREA

The NOAA exploration vessel *OKEANOS EXPLORER* sampled at a total of 81 stations from 24 August to 5 September 2013. The cruise covered Georges Bank and the Gulf of Maine and had a few stations in the Southern New England area. Normally ecosystem monitoring surveys would also head south to cover the Mid-Atlantic Bight and all of Southern New England waters, but cuts in the vessel schedule only allowed enough time for sampling in the northern portion of the survey area.

OBJECTIVES

The primary objective of this cruise was to assess changing biological and physical properties which influence the sustainable productivity of the living marine resources of the Georges Bank and Gulf of Maine portions of the northeast continental shelf ecosystem.
Key parameters measured for the Ecosystem Monitoring Program included ichthyoplankton and zooplankton composition, abundance and distribution, plus water column temperature, salinity, and chlorophyll-a fluorescence. Secondary objectives of this cruise involved the following:

- Vertical CTD casts to within 5 meters of the bottom in Gulf of Maine deep basin areas and the Northeast Channel to provide hydrographic data detailing the incursion of Labrador Current water into this region.
- Sampling at the site of a proposed liquefied natural gas (LNG) terminal east of Boston Harbor, to collect baseline data.
- Collection of samples for zooplankton genetics (genome) studies.
- Conduct sea-floor mapping in the deeper portions of the study area in cooperation with the NOAA Office of Exploration and Research (OER).
- Testing of two Imaging FlowCytoBot units from the Woods Hole Oceanographic Institute (WHOI) that photograph phyto- and zooplankton from the ship's flow-through seawater system.
- Gathering 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.
- Documenting types of phytoplankton seen at varying depths by use of a fluoroprobe unit mounted on the rosette water sampler array.
- Determine the abundance and distribution of larval and juvenile yellowtail flounder (*Limanda ferruginea*) in the areas surveyed.
- Collect larval and juvenile fish present near puffin nesting areas using a 6 ft wide Isaac Kidd

Midwater trawl.

METHODS

The survey consisted of 81 stations at which the vessel stopped to lower instruments over the starboard side of the vessel from an A-frame and conductive-wire winch. Of these, 10 were in the Southern New England region, 35 were on Georges Bank and the remaining 36 stations were in the Gulf of Maine (Figure 1). All stations sampled were at randomly stratified locations except for 2 in Southern New England, 5 on Georges Bank and 13 stations in the Gulf of Maine which were at fixed locations for hydrography and water chemistry sampling. Five of the fixed stations in the Gulf of Maine were also sampled for plankton. No sampling was planned for the Mid-Atlantic Bight region because there were not enough days in the vessel schedule to sample that far south. Minimal sampling was accomplished in the Southern New England area for the same reason

Plankton and hydrographic sampling was conducted at 66 stations by making double oblique tows using the 61-cm bongo sampler and a Seabird CTD. The tows were made 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. At the randomly designated zoogen stations a 20-cm diameter PVC bongo frame fitted with paired 165-micron nylon mesh nets was put on the towing wire one half meter above the Seabird CTD with a wire stop. A similar PVC bongo frame fitted with two 335 micron mesh nets was used at the remaining plankton stations, along with the large aluminum bongo frame. A 45-kilogram lead weight in the shape of a flat-bottomed pear was attached by a 20-centimeter length of 3/8-inch diameter chain below the aluminum bongo frame to depress the sampler (Figure 2). The flat bottomed configuration of the depressor weight made for safer deployment and retrieval of the sampling gear when the boat was rolling in rough seas. A digital flowmeter was suspended within the mouth of each sampler to determine the amount of water filtered by each net. No flowmeters were used in the 20-cm bongos. The plankton sampling gear was deployed off the starboard side of the vessel using an A-frame and a conducting cable winch. After retrieval the bongo nets were washed down on a table set up near the A-frame to obtain the plankton samples. The 61-centimeter bongo plankton samples were preserved in a 5% solution of formalin in seawater. The zooplankton genetics samples and the Dave Richardson larval fish and egg samples were preserved in 95% ethanol, which was changed once 24 hours after the initial preservation. Tow depth was monitored in real time with a Seabird CTD profiler. The Seabird CTD profiler was hard-wired to the conductive towing cable, providing simultaneous depth, temperature, and salinity for each plankton tow. . A CTD 911/Niskin bottle rosette sampler cast to within 5 meters of the bottom was made in Wilkinson, Jordan, and Georges Basins to provide hydrographic data from below the 200 m limit set for bongo tows. A CTD 911/Niskin bottle rosette sampler cast was also made at all the fixed stations to obtain 96 water samples for nutrient analysis, as well as profiles of water temperatures, salinities, and chlorophyll-a and oxygen levels (Figure 3). A fluoroprobe unit mounted on the array also provided data as to the type of algae present throughout the water column based on the fluorescence observed at different wavelengths.

Zooplankton genetics (zoogen) samples were collected at 5 randomly designated stations in the Southern New England region, 8 in the Georges Bank region and 8 in the Gulf of Maine region, yielding a total of 21 samples using the 20-cm diameter bongo samplers as described above for this program.

A 20-cm bongo sampler equipped with 335 micron mesh nets was used to collect 44 ichthyoplankton samples for Dave Richardson from across the entire survey area.

Midwater trawling was conducted at two sites near puffin nesting areas at Grand Manan Island and Matinicus Rock in the Gulf of Maine, using a six foot wide Isaac Kidd midwater trawl (Figure 4).

Continuous monitoring of the seawater salinity, temperature and chlorophyll-*a* level, from a depth of 3.7 meters along the entire cruise track was done by means of a thermosalinograph, and a flow-through fluorometer hooked up to the ship's scientific flow-through seawater system. Two FlowCytoBot Units were also plumbed into this system for recording images of phytoplankton entrained in this flow of near-surface water (Figure 5). The Scientific Computer System (SCS) recorded the output from both the thermosalinograph, and the fluorometer at 10-second intervals. The data records were given a time-date stamp by the GPS unit.

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 *OKEANOS EXPLORER* sailed on Saturday morning, 24 August 2013, from its berth at the Davisville, RI pier and proceeded to an anchorage across from the Newport Naval Station where Mike Jech, Joe Godlewski and Mike Ryan calibrated the acoustic sensors on the vessel after being ferried over from Pier 2 at the Newport Naval Station. Upon completion of the calibration after several hours these three scientists returned to Pier 2 and the *OKEANOS* headed for several stations in Southern New England Georges Bank where bongo net plankton tows were made and 2 CTD 911 rosettes casts were carried out prior to the vessel reaching Georges Bank on Sunday, 25 August. Gammarid amphipods dominated the Southern New England catches, but these dropped off on Georges Bank and were replaced by large numbers of salps on Georges Bank. These salps were so numerous as to obscure everything else in many of the samples, particularly on the southern portion of Georges. Many larval and juvenile fish were seen in the samples taken just east of the Great South Channel. By Thursday, August 29, sampling on Georges Bank was completed and the vessel proceeded into the Gulf of Maine, the numbers of salps dropped off and were replaced by Calanus copepods in most of the catches. Some blocks of time were also set aside for multi-beam acoustic bathymetric mapping of the Jordan Basin, Schoodic Ridge and Wilkinson Basin areas in addition to plankton sampling and CTD 911 rosette casts. In this mapping endeavor the vessel steamed back and forth across these areas several times to provide high resolution three-dimensional views of the sea floor. Startling differences were revealed in the bottom topography of the three areas surveyed. Jordan Basin and Schoodic Ridge had dramatic rocky ridges and valleys, while Wilkinson Basin was revealed to be covered with soft sediment, judging from the weak acoustic returns, and flat and featureless except for numbers of mysterious depressions in the bottom (Figure 6). An additional exercise carried out in the Gulf of Maine was midwater trawling near two puffin nesting areas for juvenile and small fish that they might be feeding on and catching for their chicks. These tows, carried out with great difficulty owing to the large amount of fixed gear in the water and foggy conditions, were not very productive. A twenty minute tow near Grand Manan Island didn't get any fish, and a second tow near Matinicus Rock only caught three fish: two myctophids, each 47 mm, and one sand lance or herring, larva, 27 mm long. These were frozen for analysis ashore.

Another aspect of this cruise involved new technological gear from the Woods Hole Oceanographic Institute (WHOI). Two imaging FlowCytoBot units were plumbed into the scientific flow-through

seawater system prior to sailing. Designed by scientists at WHOI, these instruments obtained clear images of phytoplankton from the near-surface water all along our cruise track (Figure 7).

Despite foggy conditions for part of the cruise, nearly 6000 birds were sighted, predominated by Great Shearwaters and storm-petrels, with less frequent sightings of Manx and Sooty Shearwaters, Pomarine jaegers and both Red-necked and Red Phalaropes. Marine mammal sightings included a Sperm whale, Minke, Fin, Humpback and Pilot whales, as well as Risso's, Bottlenose and Common dolphins.

After completing the Gulf of Maine stations, the *OKEANOS EXPLORER* sailed through the Cape Cod Canal, and completed survey activities in Southern New England waters on Wednesday, 4 September 2013.

The vessel returned to port in Davisville, Rhode Island on the morning of Thursday, 5 September 2014.

DISPOSITION OF SAMPLES AND DATA

All samples and data, except for the zooplankton genetics samples, the University of Maine nutrient samples, and the Seabird CTD data, were delivered to the Ecosystem Monitoring Group of the NEFSC, Narragansett, RI, for quality control processing and further analysis. The zooplankton genetics samples were delivered to Nancy Copley of the Woods Hole Oceanographic Institute. The nutrient samples were sent to Maura Thomas and Dave Townsend at the University of Maine. The CTD data were delivered to the Oceanography Branch of the NEFSC, Woods Hole, MA.

SCIENTIFIC PERSONNEL

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Table 1. Summary of sample activities conducted at 81 stations at which the *OKEANOS EXPLORER* stopped to lower instruments over the side during Cruise No. EX 13-05. Latitude and Longitude are shown in decimal degrees. Std BON = 61 cm bongo Standard Protocol, CTD PROFILE 911 = fixed station, 2B3 = 333 mesh 20 cm bongo 2B1 = 165 mesh 20 cm bongo.

CTD Cast #	SiteID/STA#	Date GMT	Latitude (dd)	Longitude (dd)	Bottom Depth (meters)	Operation
1	1	25-Aug	41.1	-70.62	43	CTD PROFILE 911
2	2	25-Aug	40.745	-70.1633	40	Std BON/CTD, 2B3
3	3	25-Aug	40.6	-69.6617	59	Std BON/CTD, 2B1
4	4	25-Aug	40.835	-69.6717	37	Std BON/CTD, 2B1
5	5	25-Aug	40.9067	-69.8117	32	Std BON/CTD, 2B1
6	6	25-Aug	40.9167	-69.2717	53	Std BON/CTD, 2B1
7	7	25-Aug	41.1483	-69.4	40	Std BON/CTD, 2B1
2	8	25-Aug	40.9	-69.155	65	CTD PROFILE 911
8	9	25-Aug	40.7467	-69.0067	72	Std BON/CTD, 2B3
10	10	25-Aug	40.9117	-68.8317	72	Std BON/CTD, 2B3
11	11	26-Aug	40.745	-68.76	68	Std BON/CTD, 2B3
12	12	26-Aug	40.165	-68.675	160	Std BON/CTD, 2B1
13	13	26-Aug	40.745	-68.5083	55	Std BON/CTD, 2B3
14	14	26-Aug	41.0017	-68.5017	49	Std BON/CTD, 2B3
15	15	26-Aug	41.16	-68.4267	46	Std BON/CTD, 2B3
16	16	26-Aug	41.0833	-68.3317	42	Std BON/CTD, 2B1
17	17	26-Aug	41.16	-67.9283	51	Std BON/CTD, 2B1
3	18	26-Aug	40.9317	-67.705	65	CTD PROFILE 911
18	19	27-Aug	40.8333	-67.8283	66	Std BON/CTD, 2B1
4	20	27-Aug	40.3883	-67.6933	335	CTD PROFILE 911
5	21	27-Aug	40.2533	-67.6867	1200	CTD PROFILE 911
19	22	27-Aug	40.415	-67.495	208	Std BON/CTD, 2B3
21	23	27-Aug	40.8267	-67.3383	90	Std BON/CTD, 2B3
22	24	27-Aug	41.3317	-67.2567	48	Std BON/CTD, 2B3
23	25	27-Aug	41.3283	-66.675	80	Std BON/CTD, 2B3
24	26	27-Aug	41.085	-66.6667	81	Std BON/CTD, 2B3
25	27	28-Aug	41.0733	-66.585	87	Std BON/CTD, 2B3
26	28	28-Aug	41.005	-66.51	115	Std BON/CTD, 2B3
27	29	28-Aug	41.3983	-66.2633	107	Std BON/CTD, 2B1
28	30	28-Aug	41.7483	-66.255	87	Std BON/CTD, 2B1
29	31	28-Aug	41.835	-66.4967	76	Std BON/CTD, 2B3
30	32	28-Aug	41.9983	-66.5017	85	Std BON/CTD, 2B3
31	33	28-Aug	41.9967	-66.0183	98	Std BON/CTD, 2B3
32	34	28-Aug	41.835	-65.8433	130	Std BON/CTD, 2B3
6	35	28-Aug	41.7567	-65.4583	1800	CTD PROFILE 911

Table 1.(continued) Summary of sample activities conducted at 81 stations at which the *OKEANOS EXPLORER* stopped to lower instruments over the side during Cruise No. EX 13-05. Latitude and Longitude are shown in decimal degrees. Std BON = 61 cm bongo Standard Protocol, CTD PROFILE 911 = fixed station, 2B3 = 333 mesh 20 cm bongo 2B1 = 165 mesh 20 cm bongo.

CTDCast#	SiteID/STA#	Date GMT	Latitude (dd)	Longitude (dd)	Bottom Depth (meters)	Operation
33	36	28-Aug	42.2367	-65.7683	223	Std BON/CTD, 2B3
34	37	28-Aug	42.485	-65.99	180	Std BON/CTD, 2B1
35	38	29-Aug	42.165	-66.9167	113	Std BON/CTD, 2B3
36	39	29-Aug	41.675	-67.3367	41	Std BON/CTD, 2B3
9	40	29-Aug	41.4683	-67.6883	41	CTD PROFILE 911
37	41	29-Aug	41.4967	-67.9833	30	Std BON/CTD, 2B3
38	42	29-Aug	41.5733	-68.0033	32	Std BON/CTD, 2B3
39	43	29-Aug	41.9883	-68.3217	187	Std BON/CTD, 2B1
40	44	29-Aug	41.835	-67.9283	51	Std BON/CTD, 2B1
10	45	29-Aug	42.015	-67.7017	76	CTD PROFILE 911
42	46	30-Aug	42.25	-67.765	233	Std BON/CTD, 2B3
43	47	30-Aug	42.8233	-67.835	186	Std BON/CTD, 2B3
11	48	30-Aug	42.71	-67.7133	192	CTD PROFILE 911
44	49	30-Aug	42.33	-67.425	314	Std BON/CTD, 2B3
45	50	30-Aug	42.3833	-67.0583	345	Std BON/CTD, 2B3
12	50	30-Aug	42.378	-67.0467	337	CTD PROFILE 911
46	51	30-Aug	42.825	-66.7617	218	Std BON/CTD, 2B1
47	52	30-Aug	42.8317	-66.425	143	Std BON/CTD, 2B1
13	53	30-Aug	43.0267	-66.3433	140	CTD PROFILE 911
48	54	30-Aug	42.995	-66.5017	121	Std BON/CTD, 2B3
49	55	1-Sep	43.075	-66.8317	168	Std BON/CTD, 2B3
50	56	1-Sep	43.3967	-67.7	249	Std BON/CTD, 2B3
51	57	1-Sep	43.7433	-67.7483	234	Std BON/CTD, 2B1
53	58	1-Sep	43.5783	-67.4317	221	Std BON/CTD, 2B3
54	59	1-Sep	43.815	-66.4083	65	Std BON/CTD, 2B1
55	60	1-Sep	43.99	-66.8267	119	Std BON/CTD, 2B3
56	61	1-Sep	44.25	-67.175	159	Std BON/CTD, 2B3
15	62	1-Sep	44.4883	-67.2217	61	CTD PROFILE 911
57	62	1-Sep	44.44	-67.2317	120	CTD/IKMT
16	63	1-Sep	44.2017	-67.6983	144	CTD PROFILE 911
58	64	2-Sep	44.0667	-67.8167	119	Std BON/CTD, 2B1
17	65	2-Sep	43.7733	-68.6667	113	CTD PROFILE 911
60	66	2-Sep	43.685	-68.8083	99	CTD/IKMT
61	67	2-Sep	43.6033	-69.5433	121	Std BON/CTD, 2B3
62	68	2-Sep	43.4117	-69.335	173	2B3
63	68	2-Sep	43.4017	-69.3033	159	Std BON/CTD

Table 1.(continued) Summary of sample activities conducted at 81 stations at which the *OKEANOS EXPLORER* stopped to lower instruments over the side during Cruise No. EX 13-05. Latitude and Longitude are shown in decimal degrees. Std BON = 61 cm bongo Standard Protocol, CTD PROFILE 911 = fixed station, 2B3 = 333 mesh 20 cm bongo 2B1 = 165 mesh 20 cm bongo.

CTDCast#	SiteID/STA#	Date GMT	Latitude (dd)	Longitude (dd)	Bottom Depth (meters)	Operation
64	69	2-Sep	43.335	-69.0983	155	Std BON/CTD, 2B1
65	70	2-Sep	42.755	-68.8333	155	Std BON/CTD, 2B1
66	71	2-Sep	42.25	-69.0000	188	Std BON/CTD, 2B3
67	72	3-Sep	41.995	-69.415	212	Std BON/CTD, 2B3
68	73	3-Sep	42.5067	-69.665	250	Std BON/CTD, 2B3
69	73	3-Sep	42.5033	-69.665	247	Vertical CTD 19 Profile Only
70	74	4-Sep	42.6567	-69.7467	245	Std BON/CTD, 2B3
71	74	4-Sep	42.6417	-69.735	246	-----
18	75	4-Sep	42.9917	-70.43	102	CTD PROFILE 911
72	76	4-Sep	42.7633	-70.4333	93	Std BON/CTD, 2B3
73	77	4-Sep	42.6267	-70.325	83	Std BON/CTD, 2B3
74	78	4-Sep	42.42	-70.6033	87	Std BON/CTD, 2B3
19	78	4-Sep	42.1833	-70.6117	86	CTD PROFILE 911
75	79	5-Sep	41.33	-71.005	28	Std BON/CTD, 2B3
76	80	5-Sep	41.0817	-71.245	36	Std BON/CTD, 2B1
77	81	5-Sep	41.2433	-71.4967	38	Std BON/CTD, 2B3

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TOTALS:  Std/BON/CTD Casts        =  66
         2B3 Bongo Casts          =  44
         2B1 Bongo Casts          =  21
         CTD PROFILE 911 Casts    =  17
         Vertical CTD 19 Profile  =   1
         CTD/IKMT Tows            =   2
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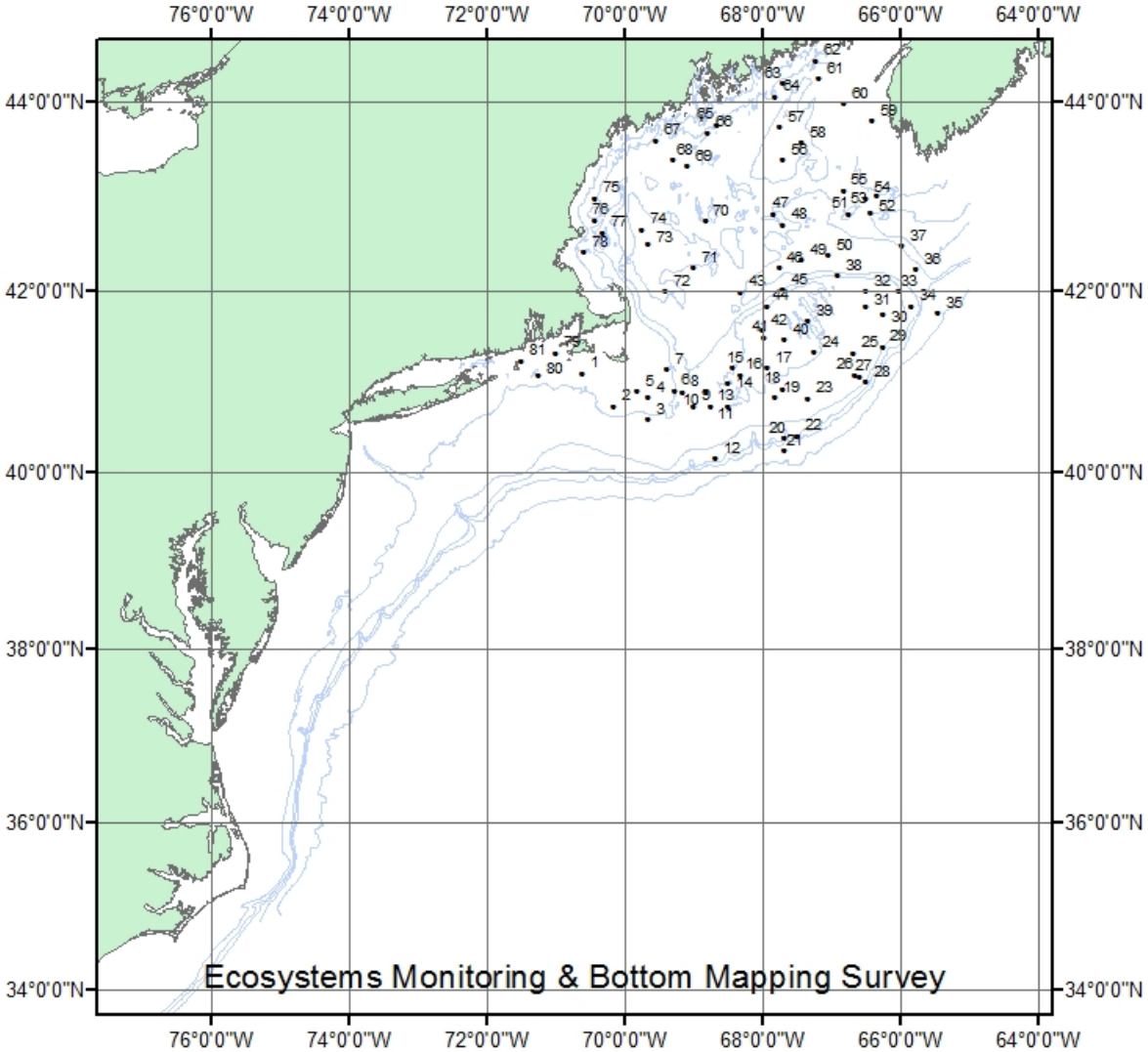

Figure 1. Station locations numbered consecutively for Summer Ecosystem Monitoring & Bottom Mapping Cruise EX1305, 24 August to 5 September, 2013.

Figure 2. Launching of bongo net array from the Okeanos Explorer, showing 61 and 20 cm bongo nets, CTD unit and depressor weight.

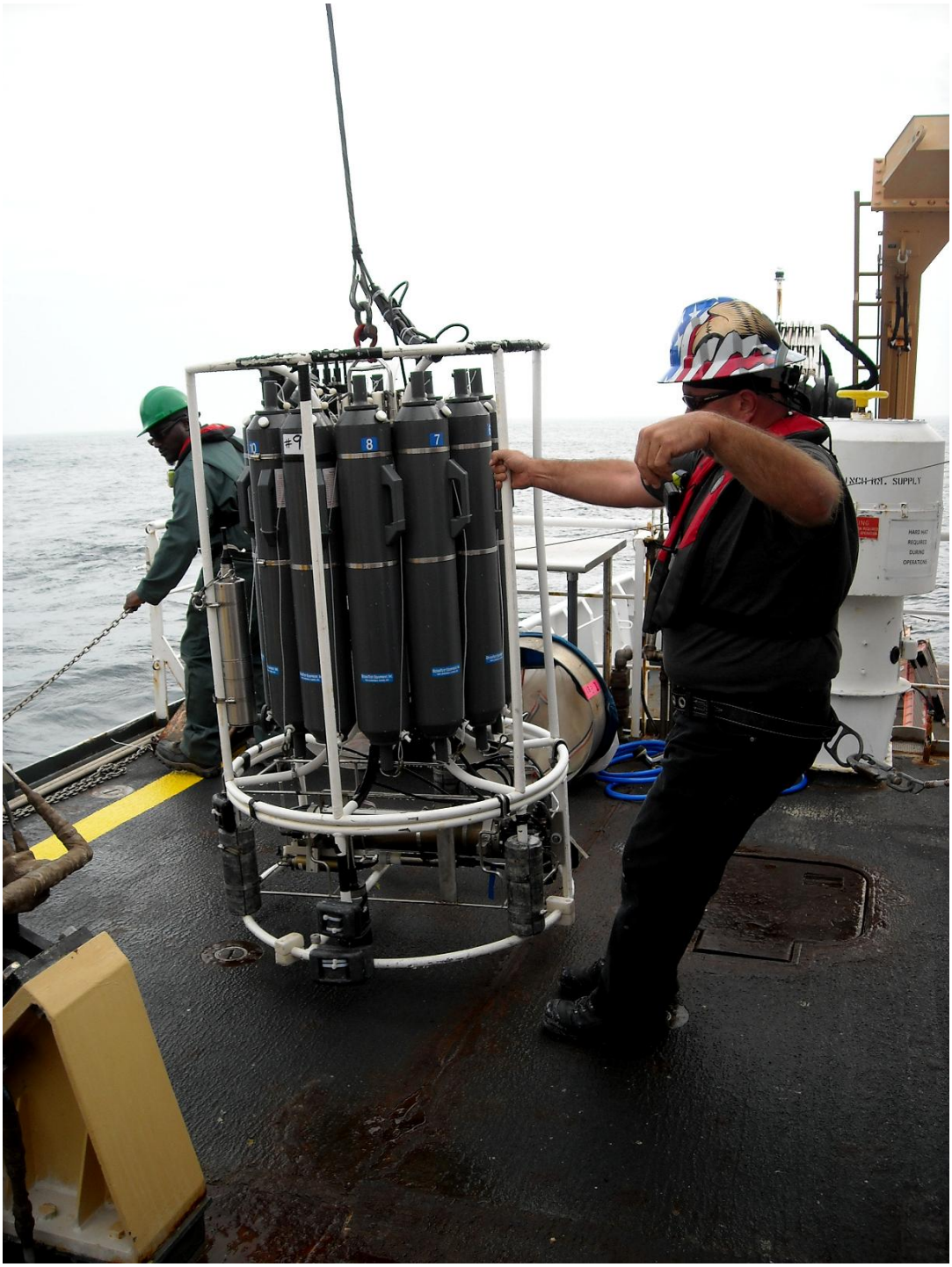

Figure 3. Niskin bottle and CTD array being retrieved onto Okeanos Explorer.

Figure 4. Six foot wide Isaacs Kidd midwater trawl being fished near puffin nesting areas in the Gulf of Maine.

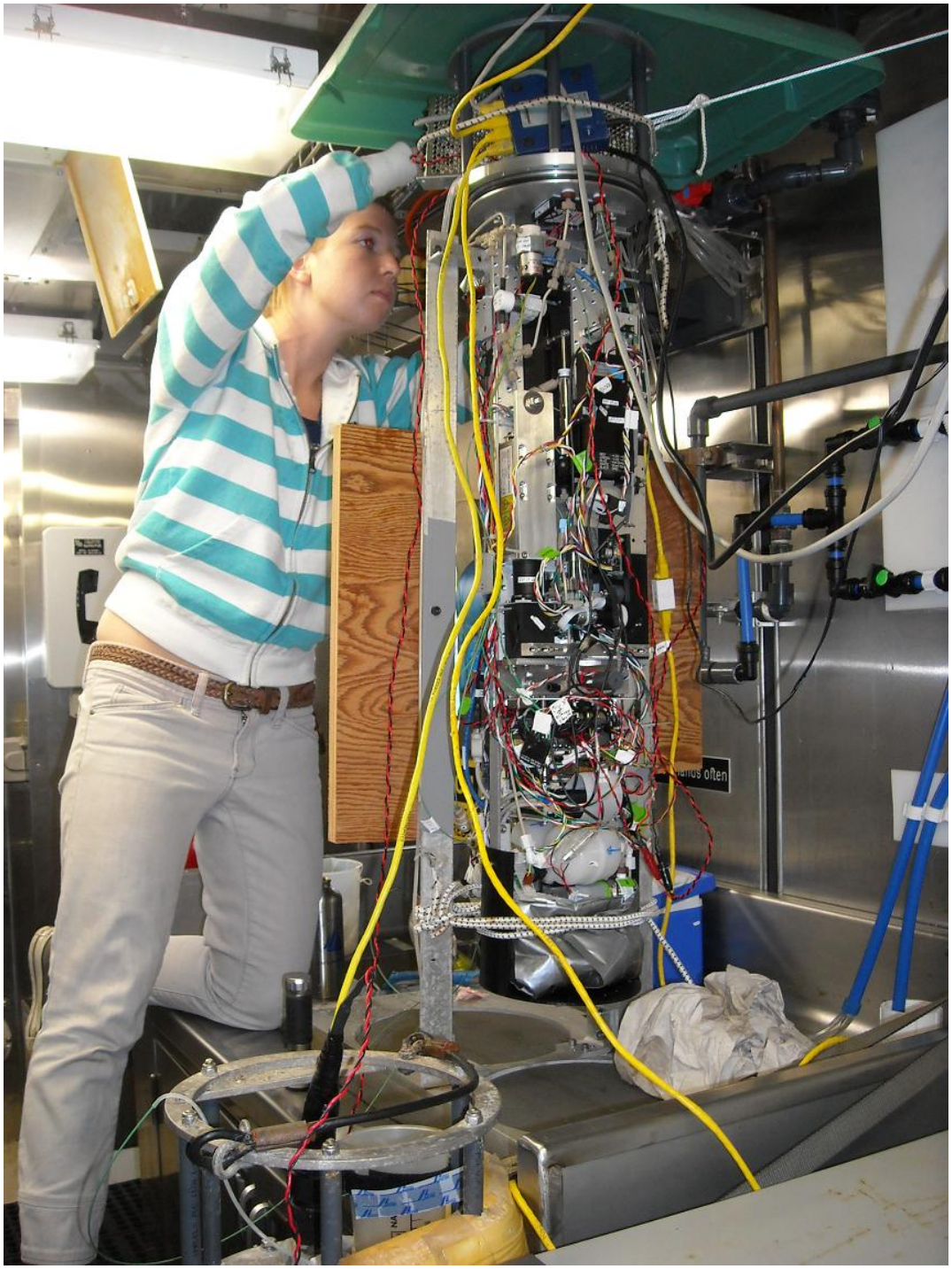

Figure 5. Emily Brownlee of WHOI tends to one of the two FlowCytoBot units mounted in the wet lab of the *OKEANOS EXPLORER.*

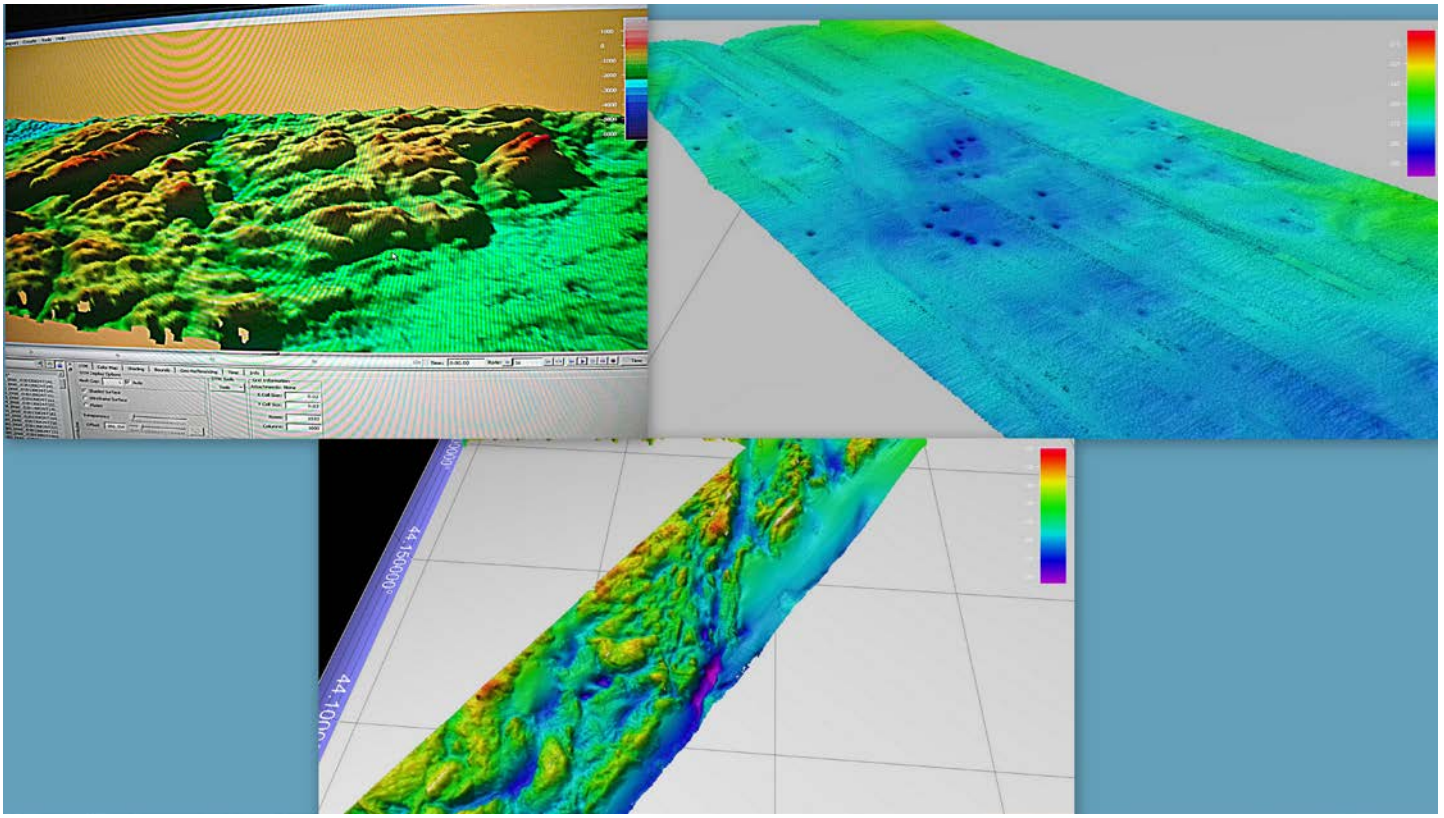

Figure 6. Three-dimensional views of Jordan Basin (upper left), Wilkinson Basin (upper right) and Schoodic Ridge (bottom center) seafloor topography produced with the multi-beam acoustic array aboard the *OKEANOS EXPLORER*.

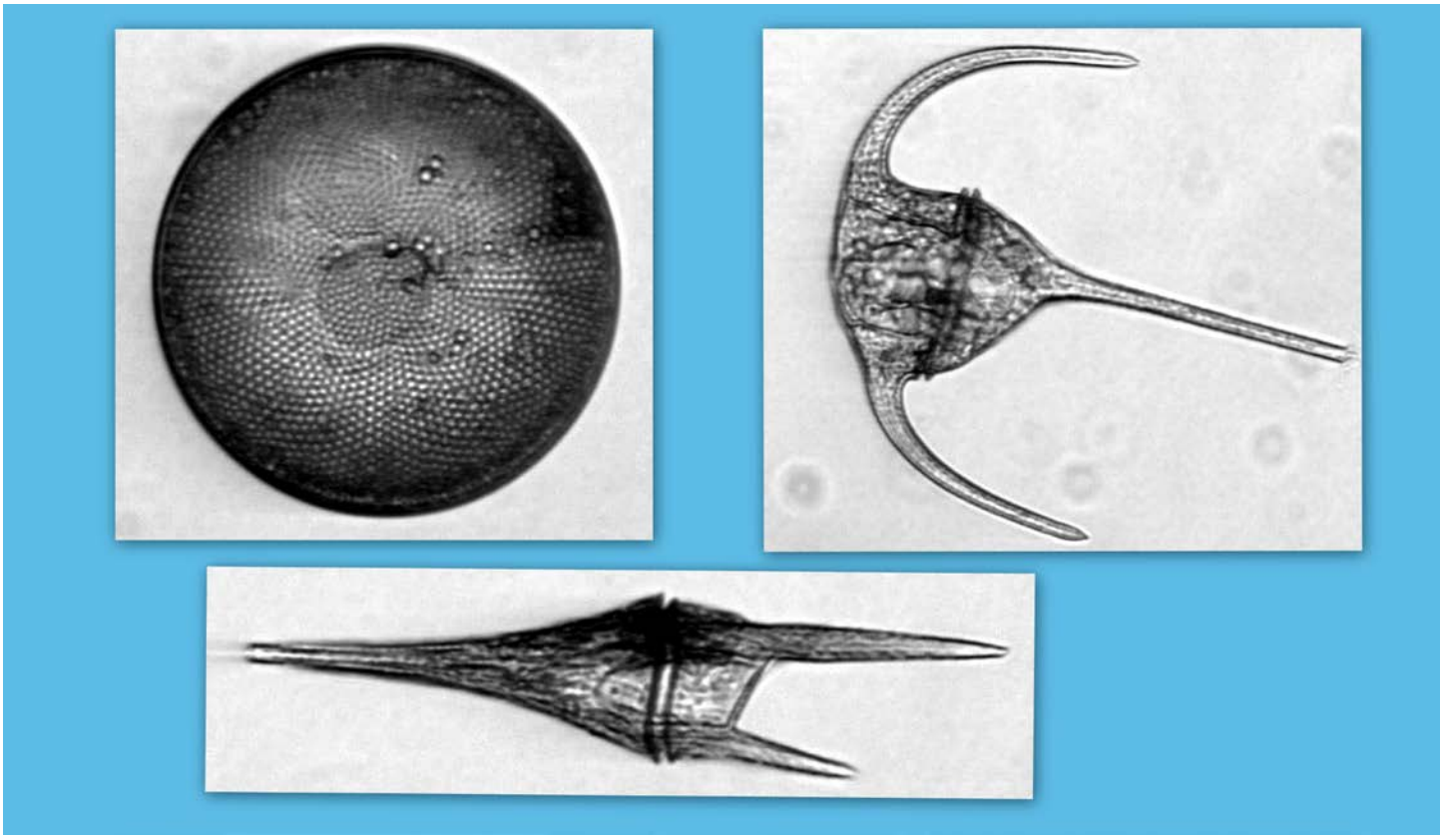

Figure 7. Diatom (upper left corner) and two dinoflagellates photographed with the FlowCytoBot unit from the flow-through seawater system on the *OKEANOS EXPLORER.*