

CRUISE RESULTS
NOAA Fisheries Research Vessel DELAWARE II
Cruise No. DE 07-01
Northeast Shelf Ecosystem Monitoring Winter Survey

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CRUISE PERIOD AND AREA

The cruise period was 29 January to 8 February 2007. The NOAA fisheries research vessel DELAWARE II sampled at a total of 36 stations. Of these, 29 were located in the Gulf of Maine and 7 were located on Georges Bank. The Gulf of Maine stations included 3 fixed stations: the Wilkinson and Jordan basins, and the site of a proposed liquefied natural gas (LNG) terminal east of Boston Harbor (Figure 1). Bad weather prevented sampling at 11 more scheduled stations in the Gulf of Maine, and 23 other stations on Georges Bank.

OBJECTIVES

The primary objective of the 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 and salinity. Near-surface along-track chlorophyll-*a* fluorescence, water temperature and salinity were measured while underway with the vessel's flow-through sampling system. Secondary objectives of this cruise included the following:

- Vertical CTD casts to within 5 meters of the bottom in Gulf of Maine deep basin areas to provide hydrographic data detailing the incursion of Labrador Current water into this region.
- 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.
- Collection of *Pseudonitzschia* samples from the ship's flow-through seawater system for mapping the distribution of this red-tide pennate diatom .
- Calibration of flowmeters by towing them over a known distance and recording the revolutions counted.
- Collection of plankton samples for correlation of nitrogen, carbon and oxygen isotopes of zooplankton from the Great South Channel area with isotopes from northern right whale baleen.
- Note presence and volume of *Calanus finmarchicus* in samples upon return of cruise to shore.

METHODS

The survey consisted of 36 stations at which the vessel stopped to lower instruments over the side. Of these, 29 were in the Gulf of Maine and 7 were on Georges Bank. All stations sampled were at randomly stratified locations except for 8 stations in the Gulf of Maine. Three of these non-random stations were at fixed positions visited on all Ecosystem Monitoring cruises: Wilkinson Basin, Jordan Basin and a proposed Liquefied Natural Gas terminal site east of Boston. The other 6 were located at positions between randomly selected stations, and were done to improve areal coverage on long transits.

Plankton and hydrographic sampling was conducted at all 36 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 45-kilogram lead weight in the shape of a flat-bottomed pear was attached by an 80-centimeter length of 3/8-inch diameter chain below the aluminum bongo frame to depress the sampler. The flat bottomed configuration of the depressor weight made for safer deployment and retrieval of the sampling gear when the boat was rolling in rough seas. A digital flowmeter was suspended within the mouth of each sampler to determine the amount of water filtered by each net. No flowmeters were used in the 20-cm bongos. The plankton sampling gear was deployed off the starboard stern quarter of the vessel using an A-frame and a Sea-Mac winch which was placed on board specifically for this operation. After retrieval, the bongo frames were carried into a covered work area on the port side of the aft deck and placed on tables for wash down of the nets to obtain the plankton samples. This work space allowed for much easier removal of the samples, particularly during inclement weather. The 61-centimeter bongo plankton samples were preserved in a 5% solution of formalin in seawater. The zooplankton genetics 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 cast to within 5 meters of the bottom was made in the Wilkinson and Jordan basins to provide hydrographic data from below the 200 m limit set for bongo tows.

Zooplankton genetics (zoogen) samples were collected using the 20-cm diameter bongos described above at 4 randomly designated stations in the Gulf of Maine and 1 on Georges Bank. Five samples had been planned to be collected from each region but this was not possible due to inclement weather.

The 20-cm bongo sampler was also used to collect 1 sample near the Great South Channel for WHOI researcher Nadine Lysiak. This sample was frozen for shore-side analysis of carbon, nitrogen, oxygen and hydrogen stable isotope ratios to correlate with the isotope ratios of these same elements within northern right whale baleen. Four of these samples had been planned for collection, but harsh weather conditions made the addition of the 20 cm bongo to the sampling array too unwieldy for safe deployment most of the time.

Continuous monitoring of the seawater salinity, temperature and chlorophyll-*a* level, from a depth of 4.6 meters along the entire cruise track was done by means of a thermosalinograph, and a flow-through fluorometer hooked up to the ship's flow-through seawater system. The Scientific Computer System (SCS) recorded the output from both the thermosalinograph, and the fluorometer at 10-second intervals.

The data records were given a time-date stamp by the GPS unit.

Samples for Seabird CTD salinity data calibration were obtained twice a day using a 1.7 liter Niskin bottle taking a water sample from 25 or more meters depth in an isohaline portion of the water column. Calibration of the CTD salinities and chlorophyll-*a* from the surface flow-through system was undertaken twice daily while the ship was underway. Sample analysis for these calibrations followed the protocol outlined in the Ecosystem Monitoring Program Operations Manual.

Flowmeters were calibrated at sea in Provincetown Harbor. The bongo sampler was towed at normal bongo tow speeds of 1.5 – 2.0 knots, with the cod ends open for a distance of 0.333 nautical miles. After having been towed for that distance, the bongos were removed from the water, flowmeters were read, nets were hosed down to clear the meshes, and the sampler returned to the water, but now towed for the same distance and speed in the opposite direction, to offset the possible effects of any currents on the flowmeters. Two runs were made in each direction with one bongo frame, and then the entire procedure was repeated using two other bongo frames having different flowmeters, thus calibrating 6 flowmeters. The calibration process took about 1 hour for each of the bongo frames.

RESULTS

A summary of routine survey activities is presented in Table 1. Areal coverage for the cruise is shown in Figure 1. Sampling coverage was reduced due to time lost to bad weather on this cruise. As a result the southeastern portion of the Gulf of Maine was not sampled, and most of Georges Bank was not sampled. Extra sampling in the form of 20-cm diameter bongo net tows were also reduced in number, owing to the difficulty of deploying them safely under the conditions encountered during most of the cruise.

The DELAWARE II sailed at 1300 hours on Monday, 29 January 2007, under windy conditions and proceeded east through the Great Round Shoal Channel to a station in the southern Gulf of Maine. Wind and seas were too high upon arrival to permit safe deployment of the plankton nets, so the vessel proceeded north and then west before it was finally able to commence sampling at the third station visited, 26 miles east of Cape Cod. As winds and seas diminished slowly over the next two days, the DELAWARE II worked its way across Wilkinson Basin and up the New England coast until reaching Saco Bay, Maine on 31 January. With a favorable forecast for the next few days, the vessel headed offshore, and east across the central Gulf of Maine, then north towards the Bay of Fundy. After completion of the Bay of Fundy station the DELAWARE II sailed southwest along the Maine coast, then turned south for more offshore sampling until storm force winds forced the vessel to anchor off of Provincetown, MA at 1625 hours on 3 February.

Prior to anchoring in the sheltered waters just outside of Provincetown Harbor, a series of flowmeter calibration runs were made, as specified in the Methods section. Calibration results for the flowmeters are listed in Table 2 and are similar to results obtained in Cape Cod Bay on the DE 06-16 cruise, using the same protocol the previous year. These calibrations are also similar to those obtained in a tow tank, demonstrating that this at-sea technique produces consistent results.

The winds and seas diminished on the morning of 6 February, permitting the DELAWARE II to weigh anchor and head 110 miles to the east to resume sampling. One additional station in the Gulf of Maine was sampled, and then, as conditions improved, sampling was carried out on 6 stations on the northwestern corner of Georges Bank, in hopes of reaching areas that might not be covered by the Winter Bottom Trawl Survey. The unfortunate arrival of another front brought this progress to a halt, and

sampling was ended at 1400 hours on 7 February. The vessel headed west at reduced speed to avoid icing, proceeding towards Martha's Vineyard into steadily increasing winds and seas. A planned stop at an observational tower off the southern coast of Martha's Vineyard at 41° 19.5' N 70° 34.0' W to compare Acoustic Doppler Current Profiler data was dropped when the vessel received word of a crewmember's family medical emergency. High winds and seas made a personnel pick-up by the US Coast Guard unsafe, so the vessel returned to Woods Hole and docked at 2000 hours on 8 February 2007, marking the end of the DE0701 Winter Ecosystem Monitoring Cruise.

DISPOSITION OF SAMPLES AND DATA

All samples and data, except for the zooplankton genetics samples, the Woods Hole Oceanographic Institute (WHOI) Harmful Algae Bloom (HAB) samples, the WHOI isotope sample 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 and the WHOI HAB samples were taken from the vessel by Nancy Copley and David Kulis of the Woods Hole Oceanographic Institute. Nadine Lysiak from WHOI picked up her frozen isotope sample and the CTD data were delivered to the Oceanography Branch of the NEFSC, Woods Hole, MA. Copies of the CTD logs were retained by the Ecosystems Monitoring Group in Narragansett. Calanus volume information was forwarded to Tim Cole after the cruise report was completed.

SCIENTIFIC PERSONNEL

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Table 1. STATION OPERATION REPORT FOR CRUISE DE0701

CAST	STA.	Date(GMT)		TIME(GMT)		LAT	LONG	DEPTH	OPERATION	
		mm	dd	yy	hr					min
									B=bongo W=water Z=zoogen V=vertical cast (CTD only) m Wiso=WHOI isotope CO=Calanus observed/vol HAB=Harmful Algae Bloom	
1	1	1	30	2007	20	1	4152.2	6920.4	195	B, CO/190cc
2	2	1	30	2007	21	36	4200.5	6923	211	B, CO/252cc, Wiso 1
3	3	1	30	2007	22	13	4200.9	6926.4	205	B, CO/302cc
4	4	1	31	2007	2	34	4229.8	6940	251	W 1
5	4	1	31	2007	2	46	4229.8	6939.9	255	B, CO/283cc
6	5	1	31	2007	4	6	4236.7	6946.9	232	V
7	5	1	31	2007	4	23	4236.6	6946.9	232	B, CO/308cc
8	6	1	31	2007	8	38	4224.9	7036.9	81	B
9	7	1	31	2007	9	41	4222.2	7048.9	31	B
10	8	1	31	2007	12	21	4235.8	7024.8	96	B, CO/97cc
11	9	1	31	2007	13	51	4253.4	7007.8	65	B, Z 1
12	10	1	31	2007	18	26	4326	7018.5	43	W 2
13	10	1	31	2007	18	32	4325.8	7018.6	43	B, HAB 1
14	11	1	31	2007	21	56	4310.2	6938.6	76	B
15	12	2	1	2007	1	1	4257	6904.1	193	W 3
16	12	2	1	2007	1	12	4257	6904	198	B, CO/481cc, HAB 2
17	13	2	1	2007	4	44	4303.2	6822.4	206	B, CO/283cc
18	14	2	1	2007	7	51	4309	6746.2	180	B, CO/252cc
19	15	2	1	2007	11	57	4316.5	6658.8	176	B
20	16	2	1	2007	13	35	4315.8	6715.5	221	W 4
21	16	2	1	2007	13	53	4316	6715.7	217	B, CO/153cc, Z 2, HAB 3
22	17	2	1	2007	16	17	4324	6741.6	245	V
23	17	2	1	2007	16	34	4323.9	6741.4	244	B, CO/159cc, Z 3
24	18	2	1	2007	19	46	4345.3	6717.7	182	B, HAB 4
25	19	2	1	2007	23	0	4407.9	6651.8	170	W 5

Table 1. (cont.) STATION OPERATION REPORT FOR CRUISE DE0701

CAST	STA.	Date(GMT)		TIME(GMT)		LAT	LONG	DEPTH	OPERATION				
		mm	did	yy	hr	min		m	B=bongo W=water Z=zoogen V=vertical cast (CTD only) Wiso=WHOI isotope CO=Calanus observed/vol HAB=Harmful Algae Bloom				
26		19	2	1	2007	23	9	4408.1	6651.5	165	B		
27		20	2	2	2007	1	37	4426.2	6630.6	198	B, CO/209cc		
28		21	2	2	2007	6	1	4405.4	6714.5	205	B, CO/128cc		
29		22	2	2	2007	7	37	4414.6	6723	215	B, CO/215cc, HAB 5		
30		23	2	2	2007	12	3	4355.9	6811.4	165	B, Z 4		
31		24	2	2	2007	13	41	4358.7	6828.2	61	B		
32		25	2	2	2007	16	20	4338.4	6848.2	119	W 6		
33		25	2	2	2007	16	36	4338.7	6848.8	120	W		
34		25	2	2	2007	16	44	4338.7	6848.9	104	B, HAB 6		
35		26	2	2	2007	19	57	4309.6	6857.8	169	B		
36		27	2	3	2007	0	33	4229.2	6849.3	205	Failed water cast attempt		
37		27	2	3	2007	0	40	4229.2	6849.3	205	W 7		
38		27	2	3	2007	0	50	4229.3	6849.2	205	B, CO/203cc		
39		28	2	3	2007	4	46	4156.6	6849.6	133	B		
	Provincetown	At Anchor	2	3 - 6	2007			4202.4	7010.2	18	Flowmeter calibration, HAB 7, shelter from st		
40		29	2	7	2007	2	53	4217.4	6746.1	226	W 8		
41		29	2	7	2007	3	13	4217.4	6746	228	B		
42		30	2	7	2007	5	55	4209.9	6718.2	166	B		
43		31	2	7	2007	7	43	4208.7	6658.3	78	B		
44		32	2	7	2007	10	56	4149.8	6725.4	51	B		
45		33	2	7	2007	12	54	4133	6711.8	54	B		
46		34	2	7	2007	14	24	4121.6	6708.1	57	B		
47		35	2	7	2007	16	2	4115.1	6720.4	50	W 9		
48		35	2	7	2007	16	9	4115.2	6720.5	50	B, Z 5		
49		36	2	7	2007	18	11	4105.3	6736.6	57	B		
TOTALS:													
											Bongo Casts	=	36
											Bongo 6B3Z Samples	=	36
											Bongo 6B3I Samples	=	36
											Water Samples	=	9
											Vertical Casts	=	1
											CTD Casts	=	49
											Zoogen samples	=	5
											WHOI isotope samples	=	1
											<u>Calanus</u> observations	=	15

Table 2. Results of bidirectional flowmeter calibration runs, Provincetown Harbor, 3 Feb 2007.

FLOWMETER/DIR	START	END	REVS	M/REV	AVG M/REV	FINAL AVG (cal factor)	Flowmeter#
13609 DN	31008	33159	2151	0.286713	0.2671		
13609 UP	33159	35651	2492	0.24748		0.2709	13609
13609 UP	35651	37981	2330	0.264687	0.2746		
13609 DN	37981	40148	2167	0.284596			
02697 DN	26424	28561	2137	0.288591	0.2673		
02697 UP	28561	31067	2506	0.246097		0.2711	2697
02697 UP	31067	33416	2349	0.262546	0.2748		
02697 DN	33416	35564	2148	0.287114			
18685 DN	4009	6195	2186	0.282123	0.2765		
18685 UP	6195	8471	2276	0.270967		0.2795	18685
18685 UP	8471	10625	2154	0.286314	0.2824		
18685 DN	10625	12839	2214	0.278555			
13634 DN	24353	26653	2300	0.268139	0.2626		
13634 UP	26653	29052	2399	0.257074		0.2632	13634
13634 UP	29052	31310	2258	0.273127	0.2638		
13634 UP	31310	33734	2424	0.254422			
B02684 DN	90146	92134	1988	0.310221	0.3141		
B02684 UP	92134	94073	1939	0.318061		0.3038	B02684
B02684 UP	94073	96083	2010	0.306826	0.2934		
B02684 DN	96083	98285	2202	0.280073			
B09629 DN	54216	56479	2263	0.272523	0.2930		
B09629 UP	56479	58446	1967	0.313533		0.3147	B09629
B09629 DN	58446	60437	1991	0.309754	0.3364		
B09629 DN	60437	62136	1699	0.36299			

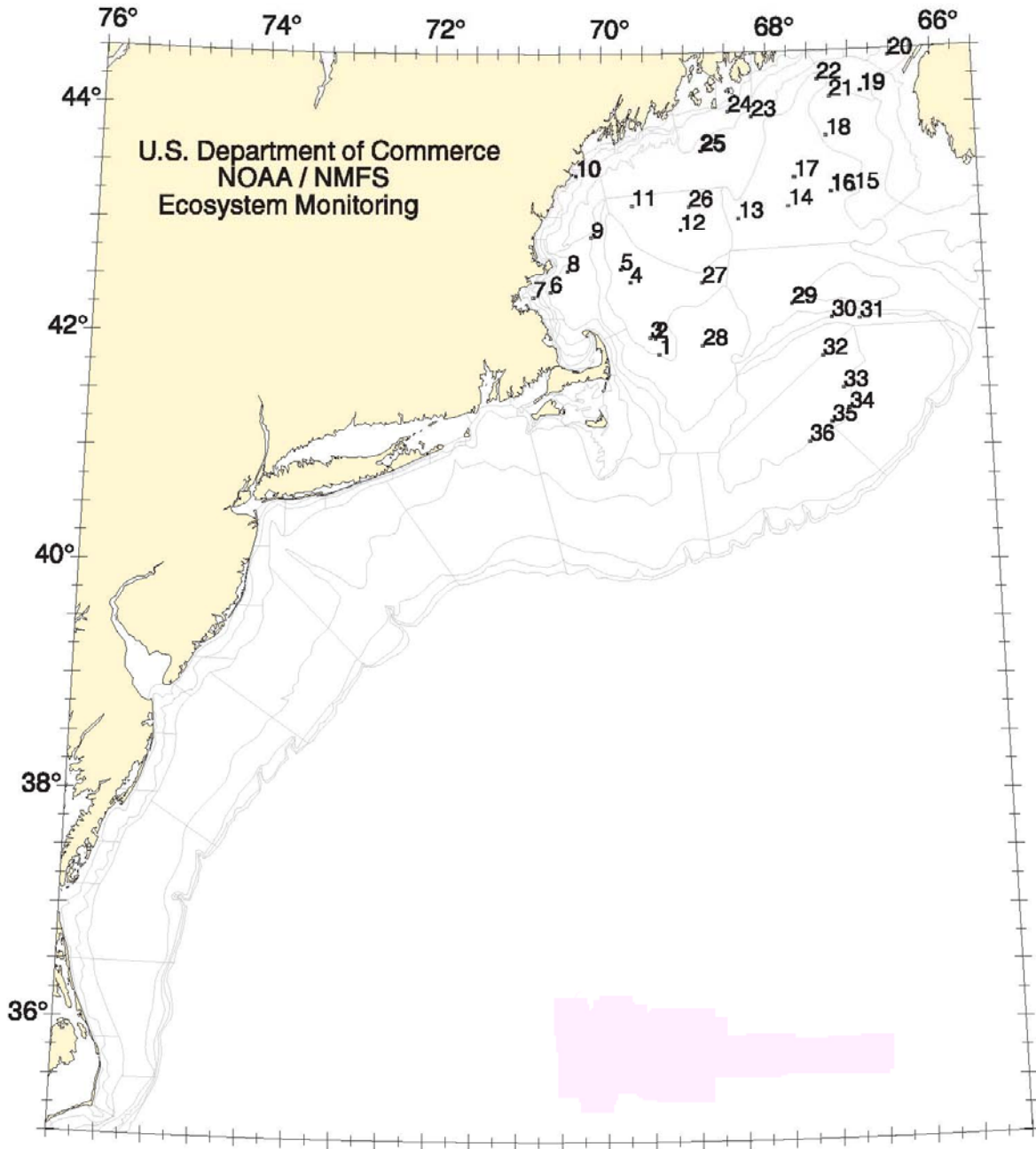


Figure 1. Station locations numbered consecutively for Winter Ecosystem Monitoring Cruise DE 07-01, 29 January - 8 February 2007.