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ENVIRONMENTAL CONDITIONS IN THE HAMPTON-SEABROOK ESTUARY AND SURROUNDING WATERS DURING REPORTED LOBSTER MORTALITIES IN SEABROOK HARBOR, OCTOBER-NOVEMBER 1977

Prepared for

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ENVIRONMENTAL CONDITIONS IN THE HAMPTON-SEABROOK ESTUARY AND SURROUNDING WATERS DURING REPORTED LOBSTER MORTALITIES IN SEABROOK HARBOR, OCTOBER-NOVEMBER 1977

1.0 INTRODUCTION

High mortalities of the American lobster, *Homarus americanus*, stored in lobster cars in Seabrook Harbor, Seabrook, New Hampshire, were reported to have occurred on October 30 and 31, 1977. Since the cause of these deaths was not apparent, a study was initiated to examine the physical and biological parameters in the water occurring around the period of the reported mortalities. These data were compiled at the request of the Nuclear Regulatory Commission in order that they may establish the environmental conditions existing during that period. Also reported are initial results of a lobster bioassay study which was established at the barge facility under construction by Public Service Company of New Hampshire in Seabrook Harbor. This special study was established to help ascertain if dredging activities at the barge site have an adverse effect on commercially confined lobsters.

2.0 METHODS AND MATERIALS

2.1 HISTORICAL DATA

2.1.1 Hydrographic

Physical, chemical and biological characteristics of the Hampton-Seabrook estuary and the adjacent open ocean have been continuously monitored as part of the Seabrook Station environmental baseline studies carried out by Normandeau Associates, Inc. from 1969 to the present. Data routinely collected which are pertinent to this report are temperature, dissolved oxygen, and salinity. Turbidity data were available from a special study in 1976 (NAI, 1976). Turbidity monitoring is also being conducted, see Section 3.2.1.

Temperatures were continuously monitored at NAI offshore stations (Figure 2.1-1) with NAI *in situ* temperature monitors consisting of Rustrak Model 2133 DC recorders with matched model 1332 thermistor probes. Samples from biweekly plankton and slack-water surveys were used for laboratory determination of dissolved oxygen by azide modification of the Winkler Method (APHA, 1971) and of salinities by standard titratic. methods (Strickland and Parsons, 1972) and with a Guildline "Autosal" precision laboratory salinometer. Estuarine turbidity measurements were made in a special four day study (NAI, 1976) in accordance with the EPA Methods Manual (1974).

Approximate rainfall data of major storms in the New Hampshire coastal area from October through November was examined. This information was extracted from NOAA reports from Boston, Massachusetts and Portland, Maine. NOAA weather maps were used to determine wind velocity and direction. Measurements were made at 0700 EST and wind direction is described as the direction from which the wind was coming.

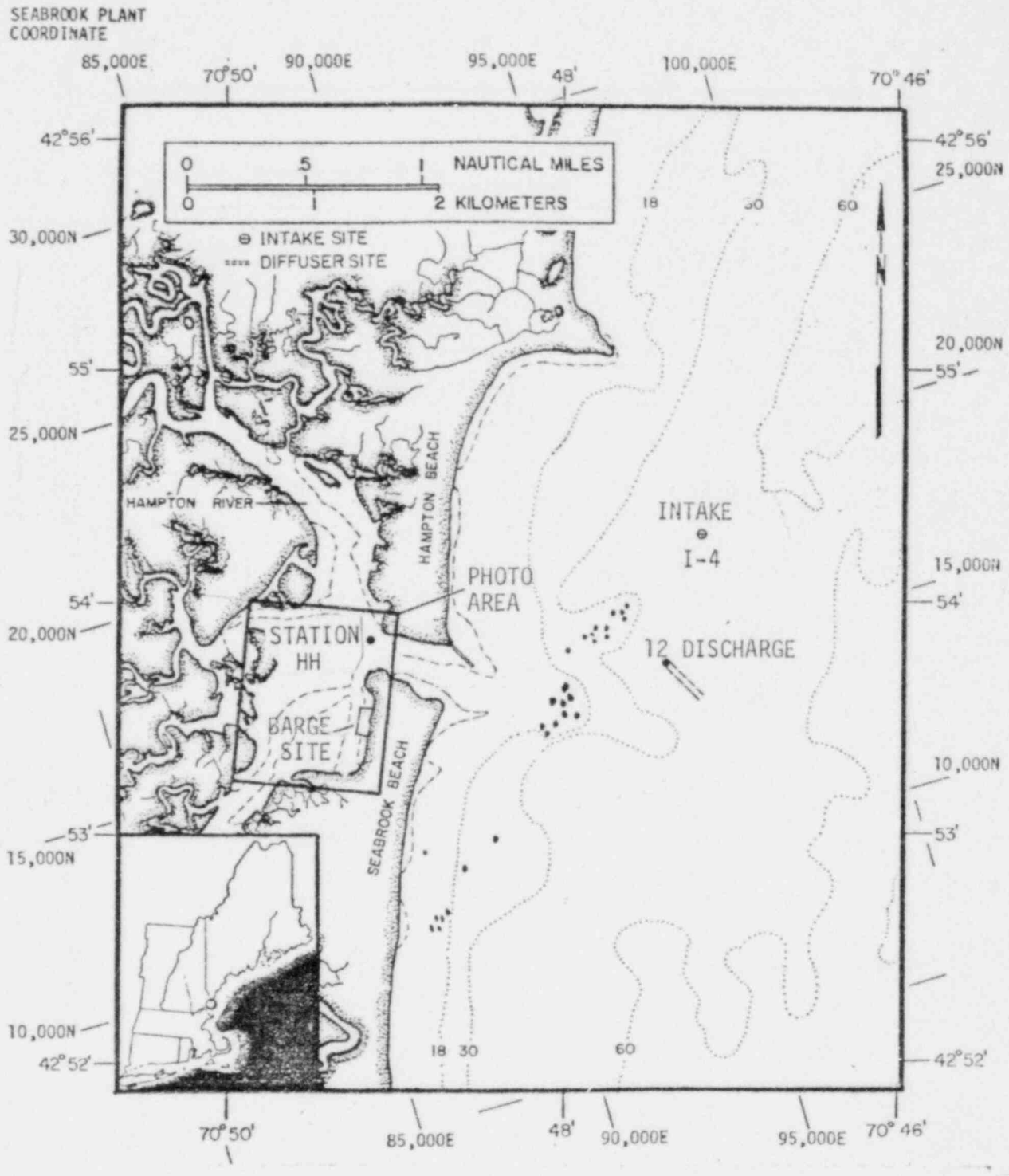


Figure 2.1-1. Location of Public Service Co. of New Hampshire barge site and selected hydrographic monitoring stations. Close-up of enclosed area is shown in Fig. 2.1-2.
Seabrook Environmental Study, 1977.

2.1.2 Coincidental Biological Occurrences

Because very high phytoplankton densities were observed on November 4, a whole water sample was taken for examination. Phytoplankton species composition and density was determined using standard methods for nanoplankton studies. Because of this unusual occurrence, certain samples from biweekly phytoplankton cruises prior to this occurrence were also examined. These included data on temperature, salinity, dissolved oxygen, chlorophyll *a*, phaeophytin and phytoplankton densities.

Large mats of green "scum" were also reported by Seabrook lobstermen to cover mud flat areas in Seabrook Harbor. Although this was not observed directly, it was likely mats of *Enteromorpha* spp. which are common to the Hampton-Seabrook estuary. A large mat of these green macroalgae was visible during this past summer on the clam flats between the Browns and Blackwater Rivers. The occurrence of these algae was reported in the initial environmental studies in the marsh in 1969-1970 (NAI, 1971). In that study *Enteromorpha* spp., along with other green algae, were listed as dominants in the estuarine littoral zone. A survey of "fouling" algae in the Hampton Beach Marina listed *Enteromorpha* spp. as the dominant algae based on biomass.

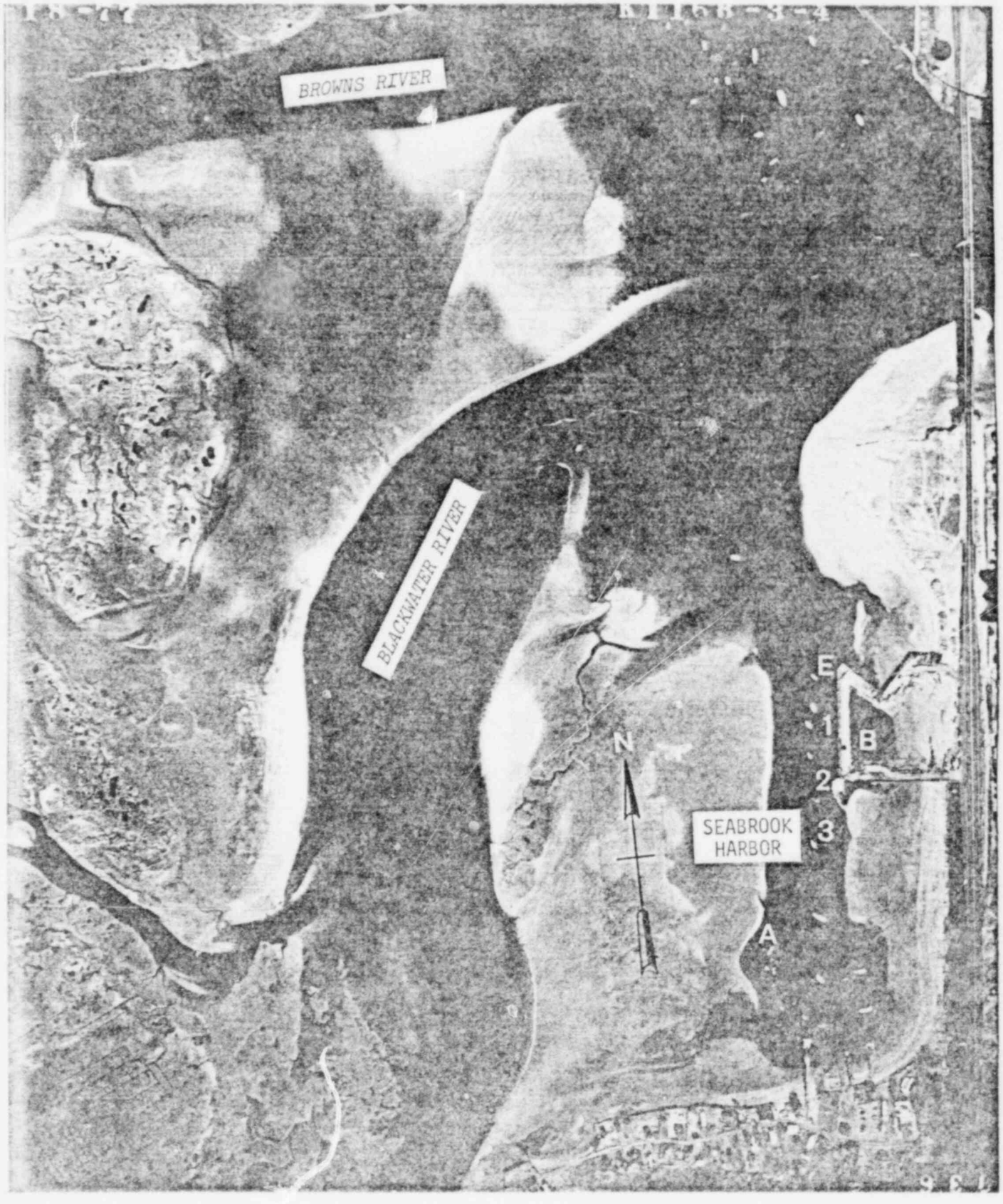
2.1.3 Bioassay Study

In order to monitor the effects of construction activities at the barge site on the viability of confined lobsters, a special study was established. Fifty one-pound lobsters were bought on November 22 from a local lobster pound (Sanders Lobsters, Portsmouth, New Hampshire). They were placed in a water table (4' x 12' x 1' deep) located on the northwest corner of the Public Service Company barge site (Figure 2.1-2). Seawater was pumped from the harbor by three submersible pumps; two off bottom (just below low water) and one floating subsurface next to the barge. On November 26, 1977 a clean lobster car was anchored 50'

Figure 2.1-2. Seabrook Harbor at low tide* with the following areas indicated:

Stations 1, 2, 3 - sites of turbidity samples taken during discharge operations; A - location of Seabrook lobstermen's live cars; B - Barge site; E - location of experimental water tank and live car.

*N.B. - All sandy substrate areas in photograph are inundated during the upper half of tidal prism.


BROWNS RIVER
BLACKWATER RIVER
N
SEABROOK HARBOR
E
1
B
2
3
A

off the northwest corner and supplied with 29 freshly caught lobsters. On November 31, an additional 25 freshly caught lobsters were placed in a lobster crate behind Pierce Island near the mouth of the Piscataqua River (approximately 12 miles north of this barge site) as a control.

Fifty-five of the Hampton Harbor lobsters were banded for identification and tested for Gaffkya on November 29. This bacterium causes the disease known as Gaffkemia or "red-tail" in lobsters and in sufficient concentrations is lethal to lobsters. Fifty lobsters indicating negative presumptive and/or negative gram stains of positive presumptive cultures, were divided (25 lobsters/location) between the water table and barge-site lobster car. The original 25 control lobsters remained in the lobster crate in Portsmouth. The remaining lobsters (24) were stored in a lobster car at the Hampton Beach Marina.

Each station was checked daily for lobster deaths, water quality and food intake. Dead lobsters were: 1) immediately removed; 2) tested for *G. homari*; 3) observed for siltation on the gills and 4) frozen for storage. Tests for the presence of *G. homari* were repeated on all lobsters on December 13 and will continue to be done every two weeks. Water quality measurements were recorded regularly. Temperature, salinity and conductivity were measured by a Beckman Salinometer (Model RS5). Turbidity measurements along the barge site (Figure 2.1-2) were taken during discharge operations, from November 8 to 16. Turbidity measurements were reinitiated when the water tank was set up on November 24. A turbidmeter (Hach Model 2100A) was used to measure turbidity in nephelometric turbidity units (NTU). Dissolved oxygen was measured both by an Orbisphere O_2 meter (Model 2603) and the Winkler Titration Method (Strickland and Parsons, 1962).

Lobsters were tested for *G. homari* as follows: five ml of hemolymph was drawn by sterile syringes from the ventral abdominal region of each lobster. This fluid was injected into 4.5 ml of culture medium as described by Stewart *et al.* (1969). The injected area of each lobster was previously swabbed with alcohol and the mouth of each cul-

ture vial heated to prevent foreign bacterial contamination. An incubation time of 48 hours, at 28°C, was allowed. Those culture tubes showing a change in color, from blue to yellow, within the 48 hours were considered positive in the presumptive test.

Confirmatory tests of all positive presumptive cultures consisted of the following procedures: inoculation of the presumptative test cultures on phenyl ethyl alcohol agar and blood agar; subculture from phenyl ethyl alcohol to blood agar, gram stain of the presumptive test cultures and colonies on phenyl ethyl alcohol agar and blood agar; and the catalase test. Catalase negative, beta-hemolytic, pinpoint colonies of gram positive cocci occurring singly, paired or in tetrads but not in chains or grape-like clusters was taken as positive evidence of infection of the lobster by *G. homari* (Stewart, 1969); all are required for positive evidence. A reference culture of *G. homari* (#6780) obtained from the University of New Hampshire Microbiology Department was used as a positive control for all procedures.

3.0 RESULTS AND DISCUSSION

3.1 HISTORICAL DATA

3.1.1 Hydrographic

3.1.1.1 Water Temperature

Continuous near-surface water temperature measurements at the offshore intake site showed a gradual cooling trend throughout this entire period (Table 3.1-1). From a high of 56.8 F (daily maximum) on October 2, temperatures slowly decreased to a low of 50.0 F (daily maximum) and 48.8 F (daily minimum) on October 24. Then temperatures rose sharply for a few days (up to 54.0 F daily maximum on October 27) at about the time of the lobster deaths. Through the rest of October and into early November, temperatures decreased again. By November 12 temperatures were similar to what they had been on October 24. Through the rest of November they decreased steadily down to 47.8 F (daily maximum) and 44.7 F (daily minimum) on November 29.

Near-surface temperatures in the estuary followed a similar trend but actual data are incomplete because temperatures exceeded the recorder range (30 to 50 F) for a longer time than was anticipated for this time of year. On October 25 the daily minimum was 48.3 F, but then from October 26 to 30 all temperatures exceeded 50.0 F. From October 31 to November 10, the daily minimum temperatures ranged from 48.5 up to 50.0 F. These daily minimum temperatures were generally similar or as much as 2.2 F colder than comparable offshore conditions.

Data from selected hydrographic stations over this time period show essentially isothermal conditions from near-surface to near-bottom (Table 3.1-2). Surface conditions ranged from 54.5 to 47.3 F offshore and 50.2 to 42.6 F in Hampton Harbor. Near-bottom temperatures ranged from 51.4 to 49.5 F offshore and 50.2 to 42.3 F in the estuary. At the

TABLE 3.1-1. CONTINUOUS SUBSURFACE TEMPERATURE DATA FROM THE OFFSHORE INTAKE SITE. SEABROOK ENVIRONMENTAL STUDY, 1977.

DATE 1977	DAILY MAXIMUM	DAILY MINIMUM	DATE 1977	DAILY MAXIMUM	DAILY MINIMUM
October 1	56.0	54.4	November 1	50.7	50.0
2	56.8	54.3	2	51.0	49.6
3	55.0	54.0	3	51.1	50.0
4	55.0	53.3	4	51.9	50.1
5	55.0	53.0	5	51.5	50.1
6	54.1	53.0	6	51.1	50.3
7	54.9	52.0	7	51.1	50.2
8	53.8	52.0	8	50.9	50.0
9	53.8	52.5	9	50.9	50.0
10	53.0	51.3	10	51.2	50.1
11	53.5	51.0	11	51.0	50.0
12	53.5	52.4	12	50.0	48.2
13	53.0	52.1	13	49.5	48.5
14	52.8	50.9	14	49.0	47.2
15	51.3	50.1	15	48.5	46.0
16	51.4	50.1	16	49.9	47.8
17	51.5	50.6	17	49.9	48.7
18	51.8	50.8	18	49.8	48.9
19	51.7	50.5	19	49.2	48.8
20	51.5	51.0	20	49.1	45.0
21	51.8	50.3	21	48.5	43.9
22	52.0	50.8	22	49.5	47.0
23	51.0	50.0	23	47.1	46.0
24	50.0	48.8	24	46.3	45.5
25	52.2	49.9	25	46.8	45.2
26	51.9	50.5	26	46.6	46.1
27	54.0	50.6	27	47.6	44.1
28	52.7	51.7	28	47.0	44.4
29	52.1	51.2	29	47.8	44.7
30	51.7	50.1			
31	51.0	50.0			

TABLE 3.1-2. SELECTED DATA FROM HYDROGRAPHIC STATIONS ALONG THE SOUTHERN NEW HAMPSHIRE COAST IN OCTOBER AND NOVEMBER 1977. SEABROOK ENVIRONMENTAL STUDY, 1977.

			OCT. 4, 1977	OCT. 19, 1977 LOW WATER	OCT. 19, 1977 HIGH WATER	NOV. 2, 1977	NOV. 16, 1977 LOW WATER	NOV. 16, 1977 HIGH WATER
HAMPTON HARBOR	NEAR BOTTOM	Temp		50.2	50.7		42.6	48.9
		Salinity	NS	21.9	30.8	NS	26.3	31.5
		DO		8.0	---		8.9	8.8
	SURFACE	Temp		50.2	50.5		42.3	48.9
		Salinity	NS	22.2	30.7	NS	26.2	31.5
		DO		8.0	---		8.9	8.8
OFFSHORE INTAKE SITE	NEAR BOTTOM	Temp	53.1	50.9	50.9	49.8	47.3	48.4
		Salinity	31.7	30.9	29.9	30.6	30.9	31.0
		DO	8.4	10.1	---	11.5	9.0	8.9
	SURFACE	Temp	51.4	50.5	50.9	50.2	49.5	49.5
		Salinity	32.2	31.4	31.7	31.7	32.0	31.6
		DO	7.6	8.6	---	8.7	8.3	9.0
OFF MOUTH OF MERRIMACK RIVER	NEAR BOTTOM	Temp	54.5			49.8		
		Salinity	27.7	NS	NS	30.4	NS	NS
		DO	9.0			10.1		
	SURFACE	Temp	51.4			50.2		
		Salinity	32.1	NS	NS	31.6	NS	NS
		DO	7.9			9.1		
OFF RYE HARBOR	NEAR BOTTOM	Temp	54.0			51.1		
		Salinity	31.7	NS	NS	30.9	NS	NS
		DO	9.2			11.0		
	SURFACE	Temp	48.9			49.6		
		Salinity	32.2	NS	NS	32.1	NS	NS
		DO	7.5			6.4		

NS = Not part of the normal sampling scheme on that date; therefore, not sampled.

offshore intake site by November 16, 1977, there was a weak thermal inversion with slightly colder temperatures at the surface than at the bottom.

3.1.1.2 Salinity and Runoff Conditions

Freshwater runoff has the greatest impact on local salinity conditions in view of the "open ocean" nature of the waters of the western Gulf of Maine. Major rainfall for this period is summarized in Table 3.1-3. These data show a major rainy period from October 15 to 18 which resulted in approximately 2.65 inches of rainfall over the New Hampshire coastal region, shortly before the lobster deaths were reported to have occurred.

These runoff conditions resulted in the 21.9 to 22.2 $^{o}/oo$ low-water salinities in Hampton Harbor on October 19 (Table 3.1-2). Offshore salinities were also slightly lower than usual at this time (for example 29.9 $^{o}/oo$ on the surface at the offshore intake site during high water). On November 16 salinities in the estuary were also quite low (26.2 to 26.3 $^{o}/oo$).

3.1.1.3 Dissolved Oxygen

Dissolved oxygen values (Table 3.1-2) were generally comparable with data from previous years. In the estuary, values ranged from 8.0 to 8.9 mg/l. Near-surface values from offshore ranged from 8.4 up to 10.1 mg/l (with the exceptions of high values on November 2 of up to 11.5 mg/l). Near-bottom values were 7.5 to 9.1 mg/l (except for 6.4 mg/l off Rye Harbor on November 2).

TABLE 3.1-3. APPROXIMATE RAINFALL OF MAJOR STORMS IN THE NEW HAMPSHIRE COASTAL AREA (BASED ON NOAA DATA FROM BOSTON, MASSACHUSETTS AND PORTLAND, MAINE)*. SEABROOK ENVIRONMENTAL STUDY, 1977.

DATE, 1977	AMOUNT, INCHES
October 2	1.46
3	0.13
10	1.38
15	0.58
16	0.21
17	0.90
18	0.96
November 9	1.55
10	0.68
14	0.10
16	0.52
18	0.32
22	0.09
24	0.08
25	0.10
December 1	0.25
2	1.09
6	
7	0.23
10	0.47

* Excludes days with trace amounts of precipitation (less than 0.05 in).

TABLE 3.1-4. PHYTOPLANKTON DENSITIES, CHLOROPHYLL *a* CONCENTRATIONS AND NUTRIENT CONCENTRATIONS FROM SELECTED DATES BETWEEN SEPTEMBER AND NOVEMBER 1977. SEABROOK ENVIRONMENTAL STUDY, 1977.

	SEPTEMBER 7, 1977		OCTOBER 4, 1977		NOVEMBER 1, 1977	
	STATION 2*	STATION 5	STATION 2	STATION 5	STATION 2	STATION 5
PHYTOPLANKTON						
Chlorophyll a (mg/m^3)	1.19	0.96	2.43	2.46	12.48	14.28
Phaeophyton	0.39	0.39	1.22	1.26	4.38	5.03
NUTRIFNTS (µg at m/l)						
Nitrate	<0.01	<0.01	0.02	0.02	<0.01	<0.01
Nitrite	<0.001	<0.001	0.004	0.003	<0.001	<0.001
Ammonia	0.02	0.06	0.05	0.04	0.03	0.05
Phosphorus	0.024	0.016	0.019	0.019	0.022	0.022
Orthophosphorus	0.016	0.010	0.016	0.020	0.014	0.019

	OCTOBER 4, 1977 STATION 2	NOVEMBER 1, 1977 STATION 2	NOVEMBER 4, 1977 STATION 5
PHYTOPLANKTON DENSITIES (Cells/liter)			
Dominant Species	2.6×10^5 (*Skeletonema costatum*)	5.2×10^6 (*Olisthodiscus luteus*)	5.37×10^7 (*Olisthodiscus luteus*)
Total Cell Count	2.37×10^5	5.5×10^6	5.41×10^7

* Station 2 = Proposed intake location
Station 5 = Proposed discharge location

TABLE 3.1-5. MONTHLY CHLOROPHYLL *a* CONCENTRATION DATA (µg/l) FROM VARIOUS PERIODS OF STUDY IN THE VICINITY OF THE PROPOSED INTAKE SITE FOR SEABROOK STATION. SEABROOK ENVIRONMENTAL STUDIES, 1975-1976.

YEAR	J	F	M	A	M	J	J	A	S	O	N	D
1976	1.1	0.6	7.8	1.5	3.9	0.9						
1975	0.5	1.3	10.6	2.3	4.9	---	1.2	1.2	2.0	3.5	1.8	1.3
1974	1.2	1.2	2.3-5.8	2.3-2.8	2.3	0.4	1.3	5.7	7.0	2.5	7.0	1.4
1973	0.4	---	---	---	---	0.8-1.3	0.7-2.2	1.0-2.8	0.6	4.5	1.4	1.3-2.5

3.1.2 Unusual Biological Occurrences

Whole water samples of phytoplankton collected during this time were found to be dominated by the single-celled microflagellate (35 μ diameters), *Olisthodiscus luteus* (Phylum Chrysophyta). Densities were found to slightly exceed the maximum found in Narragansett Bay (pers. comm., P. E. Hargraves). The density of *O. luteus* and total phytoplankton (Table 3.1-4) on November 4 (5.37×10^7 cells/ml and 5.41×10^7 cells/ml, respectively) was an order of magnitude greater than that found on November 1 (5.2×10^6 cells/ml and 5.5×10^6 cells/ml).

The chlorophyll *a* levels (Table 3.1-4) found on November 1 (12.5 and 14.3 mg/m^3) are the highest levels ever recorded by NAI during the Seabrook studies. The bimodal peaks characteristic of chlorophyll *a* in the open ocean and estuaries is exemplified in Table 3.1-5, indicating that a fall bloom is expected, but not of this magnitude. These high phytoplankton densities probably accou for the "very dirty" appearance of the ocean surface reported by the lobstermen (Clyde Brown, pers. comm.) around the per' d of the reported lobster mortalities.

3.2 BIOASSAY STUDY

3.2.1 Hydrographic Data

Daily surface temperatures at each station showed a steady decline until December 5 (Table 3.2-1). Temperatures took a sudden dip (4.8 C to 1.7 C) on December 6 and steadily declined with the exception of the ebb tide measurements (December 7 and 9). In general, temperatures in the water table were lower than the adjacent lobster car temperatures, likely due to greater air exposure. The control station was consistently higher in temperature.

TABLE 3.2-1. TEMPERATURE, SALINITY AND CONDUCTIVITY DATA AT EXPERIMENTAL SITES OF LOBSTER MONITORING PROGRAM. SEABROOK ENVIRONMENTAL STUDY, 1977.

	TEMPERATURE (°C)			SALINITY (ppm)			CONDUCTIVITY (Numbers)		
	HAMPTON HARBOR		PORTS.	HAMPTON HARBOR		PORTS.	HAMPTON HARBOR		PORTS.
	WATER TABLE	LOBSTER CAR	CONTROL CRATE	WATER TABLE	LOBSTER CAR	CONTROL CRATE	WATER TABLE	LOBSTER CAR	CONTROL CRATE
Nov 22	7.0			30.5			31.3		
23	7.2			30.0			31.7		
24	7.4	7.1		30.5	32.4		31.7	33.1	
25	8.0			33.0			34.5		
26	7.9			29.3			31.0		
27	4.8			31.6			30.7		
28	5.8	6.5		33.4	33.4		32.8	33.7	
29	5.3			35.0			34.2		
30	5.2			32.8			32.0		
Dec 1	6.5	6.6		32.3	32.5		32.8	32.8	
2	6.1		6.67	27.8		23.0	28.3		24.0
3	6.0			29.4			29.8		
4	5.8		6.13	30.8		22.2	30.3		22.8
5	4.8	4.8	8.54	32.2	30.7	29.0	31.4	29.0	30.5
6	1.7			30.0			26.1		
7	3.4	4.4		32.7	32.1		30.1	30.6	
8	0.7	1.5	5.5	27.1	30.4	26.7	23.6	26.7	26.4
9	3.7	3.8	7.0	34.0	34.0	27.0	31.5	31.6	25.0
10	0.0	3.2		33.8	33.3		25.9	31.2	
11	*								
12	<0.0		4.97	38.4		31.3	28.8		31.3
13	1.8		5.17	35.0		30.3	32.0		30.3
14	<0.0	0.3		33.1	32.0		26.5	28.1	
15		1.6	7.42		30.7	26.8		27.0	26.8

* Lobsters moved from barge site water table to Hampton Beach marine lobster car due to freezing water table equipment.

From November 22 to the present, salinities (Table 3.2-1) have been fairly constant in Hampton Harbor with the exception of December 1 and 2 (27.8 and 29.4 °/oo) following heavy rains (Table 3.1-3), and December 12 and 13 (38.4 and 35.0 °/oo) following extensive ice formation in the estuary. Salinities were generally lower at the control station and susceptible to sharp declines with fresh water runoff (23.0 °/oo and 22.2 °/oo on December 2 and 4).

Dissolved oxygen levels have consistently remained near the saturation point at all stations throughout the experiment.

Turbidity samples taken previous to the lobster experiment at Stations 1-4 (Table 3.2-2) were not unusually high (maximum 2.9 NTU and minimum 0.2 NTU). Water table turbidities were consistently higher (maximum 36.0 NTU and minimum 0.6 NTU). Correlations between wind direction and velocity with turbidity are not evident in Table 3.2-2. However, it can be noted that the high turbidities on December 7 was a result of strong northwest winds causing a chop along the shore where the submersible pumps were located. On that date, lobsters in the tank and adjacent estuary were exposed to very high turbidities of 36 and 108 NTU's, respectively. Examination of data from a study of turbidity levels in the Hampton Harbor estuary (NAI, 1976) shows that the mean turbidity reading for the barge site on September 17, 1975 was 1.43 FTU's.[1] After a northeast storm on October 18 to 21, 1975, the mean turbidity was 3.92 FTU's. The study indicated that turbidity was primarily related inversely to the stage of tide. During high tide, turbidity levels are low, whereas at low tide turbidity levels tend to increase.

3.2.2 Initial Results

Table 3.2-3 summarizes the number of deaths and the results of *G. homari* tests are summarized in Table 3.2-4 (all lobsters not listed

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[1] NTU's are reported comparable to the previously reported FTU (Foramazin Turbidity Units) and JTU's (Jackson Turbidity Units) (U.S.E.P.A., 1974).

TABLE 3.2-2. TURBIDITY DATA FROM SEABROOK HARBOR IN NOVEMBER AND DECEMBER 1977 WITH TIDE STAGE AND WIND CONDITION NOTED. SEABROOK ENVIRONMENTAL STUDY, 1977.

	WIND 0700 EST		TURBIDITY (NTU)					COMMENTS	
DATE	DIR	VEL	STA 1	STA 2	STA 3	STA 4	WATER TABLE	BARGE SITE	TIDE STAGE FOR TURBIDITIES
Nov 8	E	18	1.6	0.8	0.8	1.4			
9	N	10	0.6	0.6	0.7	0.7		Discharging	MLW-Ebb
10	S	10	1.2	1.1	0.5	0.6		Not discharging	MLW-Ebb
11	SSW	10	2.5	2.8	2.9	1.7		Discharging	MLW-Ebb
12	SW	10							
13	NNW	8							
14	NW	15	0.5	0.7	0.4	0.4		Not discharging	MLW-Flood
15	SW	10	0.4	0.6	0.6	0.6		Discharging	MLW-Flood
16	SSW	8	0.7	0.6	0.2	0.6		Not discharging	MLW-Flood
17	SSW	8							
18	SW	10						Discharging	
19	SSW	5						Discontinued	
20	WSW	10						Discontinued	
21	S	10						Discontinued	
22	NW	10						Discontinued	
23	N	10						Discontinued	MLW-Flood
24	N	8					1.4	Discontinued	MLW-Flood
25	NW	8					0.6	Discontinued	MHW-Flood
26	E	20					0.7	Discontinued	MHW-Flood
27	W	18					5.4	Discontinued	MHW-Flood
28	W	5					3.2	Discontinued	MLW-Flood
29	N	8					1.6	Discontinued	MLW-Ebb
30	N	5					1.4	Discontinued	MLW-Ebb
Dec 1	NE	13					1.2	Discontinued	---
2	SW	10					1.3	Discontinued	MLW-Flood
3	SW	10					1.9	Discontinued	MLW-Flood
4	W	10					1.3	Discontinued	MLW-Flood
5							1.5	Discontinued	MLW-Slack
6							2.1	Discontinued	MLW-Flood
7	NW						36.0**	Discontinued	MLW-Ebb
8	NW						4.2	Discontinued	MLW-Ebb
9								Discontinued	MLW-Ebb
10								Discontinued	
11								Discontinued	
12							0.4*	Discontinued	MHW-Flood
13							0.7	Discontinued	MHW-Slack
14							0.7	Discontinued	MHW-Ebb
15							1.5	Discontinued	MLW-Slack

** Unusually high turbidity: the estuary was 108 NTU, the three intake hoses were 54, 150 and 228 NTU

* These measurements are from Hampton Beach Marina.

TABLE 3.2-3. SUMMARY OF INITIAL RESULTS OF LOBSTER MORTALITIES IN EXPERIMENTAL TANKS. SEABROOK ENVIRONMENTAL STUDIES, 1977.

SAMPLE PERIOD/SITE	# LOBSTERS IN TANK	TOTAL # DEATHS	DATE OF DEATHS	TESTS FOR GAFFKEMIA NO. + PRESUMPTIVE OF NO. DEAD	NO. + PRESUMPTIVE OF NO. ALIVE	NO. + CONFIRMATORY OF NO. DEAD	NO. + CONFIRMATORY OF NO. ALIVE	GILL CONDITION
11-22 to 12-9*								
Barge Site:								
Water Table	50	5	11/22,2,24(2),29	2	9	0	1	Generally clean; a few pieces of detritus, at base of gill filaments
Live Car	0							
Ports. Live Car	0							
HBM Live Car	0							
12-6 to 12-10								
Barge Site:								
Water Table	25	0						
Live Car	25	5	12/8(2),9(3)	4	0	1	0	4 very clean; 1 with moderate amounts of detritus
Ports. Live Car	25	0						
HBM Live Car	12	0						
12-11 to 12-15*								
Barge Site:								
Water Table	0	0						
Live Car	25	4	12/4(2),15(2)	4	4	***N.C.	N.C.	All with small amounts detritus
Ports. Live Car	25	0						
HBM Live Car	32**	12	12/13(10),14(1)	2	2	N.C.	N.C.	11 with small amounts detritus 1 with heavy silt/detritus and filaments with red discoloration

* All lobsters test for *G. homari* on 11-29 and 12-13-77

** Lobsters moved from water table to HBM car

*** N.C. = Not Completed to date

TABLE 3.2-4. BACTERIOLOGICAL STUDY OF IMPOUNDED LOBSTERS: PRESUMPTIVE AND CONFIRMATORY TESTS FOR GAFFKEMIA. SEABROOK ENVIRONMENTAL STUDY, 1977.

LOBSTER (CONDITION DATE TESTED, 1977)	PRESUMPTIVE TEST CULTURE		PHENYLETHYL ALCOHOL SUBCULTURE OF P.T.C.		BLOOD AGAR SUBCULTURE OF P.T.C.		CONFIRMATORY	
	COLOR	GRAM STAIN	COLONY	GRAM STAIN	COLONY	GRAM STAIN	HEMOLYSIS	CATALASE
Pegged 29XI77 (dead, 11-29)	yellow	Gram positive: small rods; diplobacilli and chains	Small greyish-white after 6 days much larger than 6870	Pleomorphic; gram positive rods (some in chains); a few gram positive cocci in tetrads	Small greyish translucent	Small gram positive rods	+	not done
38 29XI77 (alive, 11-29)[3]	yellow	Gram positive cocci in tetrads	Small, greyish translucent	Gram positive cocci in tetrads	Small greyish translucent	Gram positive cocci in tetrads	+	-
46 (alive, 11-29)	yellow	Small gram positive rods: diplobacilli and chains	Medium greyish translucent	Gram positive small short rods; many diplobacilli	Heavy growth, small	Small gram positive rods	Some	Not done
34 (alive, 11-29)	pale yellow	A few gram positive rods	Medium to large, opaque, white Small to tiny, greyish translucent	Gram positive cocci in grapelike clusters and tetrads Same as above	Grey, large, moist Small, cream	Gram negative rods Gram positive cocci in grapelike clusters	- -	Not done Not done
14 (alive, [illegible])	pale purple	Gram negative bacilli and cocci	Not done	Not done	Large, grey, flat surface small, cream	Gram negative rods Gram positive cocci in grapelike clusters	-	Not done
44 (alive, 11-29)	pale purple	large gram positive irregular "ovals"	Not done	Not done	Not done	Not done		Not done
20 (alive, 11-29)	pale darkish purple	debris, gram negative "ovals"	Not done	Not done	Not done	Not done		Not done
10 (alive, 11-29)	pale purple	debris and gram positive rods	Not done	Not done	Not done	Not done		Not done
41 (alive, 11-29)	pale yellow with darkish tinge	a few gram positive cocci; gram negative rods, gram positive rods, some in chains, gram negative "ovals"	Small, cream, convex	Gram positive cocci in grapelike cluster	Large, grey, moist, convex	Pleomorphic; gram negative rods	-	Not done

(Continued)

TABLE 3.2-4. (CONTINUED)

LOBSTER (CONDITION DATE TESTED, 1977)	PRESUMPTIVE TEST CULTURE		PHENYLETHYL ALCOHOL SUBCULTURE OF P.T.C.[1]		BLOOD AGAR SUBCULTURE OF P.T.C.[1]		CONFIRMATORY	
	COLOR	GRAM STAIN	COLONY	GRAM STAIN	COLONY	GRAM STAIN	HEMOLYSIS	CATALASE
39 (died, 12-8)	yellow with darkish tinge	Gram negative "ovals"	No growth after 48 hours		No growth after 48 hours		Not applicable	
44 (dead, 12-9)	yellow	Gram positive cocci mostly in pairs large gram positive rods	Small translucent center raised with flat edge after 48 hours	Gram positive tetrads	Small, greyish, translucent, convex	Gram positive cocci in pairs tetrads	+	-
					large, cream, convex	Gram positive rods, short, medium, long	-	+[2]
40 (dead, 12-9)	yellow	A mixture of gram negative and gram positive rods	Medium convex	Pleomorphic, gram negative rods	small, greyish, translucent, convex	small, short gram positive rods	+	Not done
			Small, convex	Gram positive rods	Medium, flat, white	Short gram negative rods in short chains and pairs	-	Not done
52 (dead, 12-9)	yellow	fat, short, gram negative rods	Medium, convex, white	Gram positive oval, irregular cocci	Small, translucent, convex, white	Gram negative rods	-	Not done

[1] Presumptive test culture

[2] ...sed as a positive control, *Streptococcus pyogenes* used as a negative control

[3] Sacrificed for gill samples

showed a negative presumptive test). Two lobsters out of the 50 originally tested for *G. homari* were confirmed to have been infected by the bacteria. Eight other cultures indicated positive presumptive tests without positive confirmatory tests. Four of the first 50 lobsters bought from Sanders Lobster Pound died within two days of being placed in the water table. One other death, the last in the water table, occurred after seven days.

The lobsters were removed from the water table to a lobster car in the Hampton Beach Marina on December 11 as a result of excessive ice formation within the table and water pumps. Nine of these lobsters died immediately following the second testing of *G. homari* on December 14. Several lobsters autotomized their chelipeds during the air exposure time of the testing.

A total of six lobsters have died in the lobster car. Five deaths occurred within two days of the excessive turbidity levels shown in Table 3.2-2. The sixth death occurred shortly after the second assay for *G. homari*. The presence of *G. homari* was not confirmed in any of these individuals. Samples of gills appeared to be relatively heavily silt-laden compared to all others examined.

There have been no deaths in the control station at the mouth of the Piscataqua River.

The recorded deaths of the "water table lobsters" are clumped in two time periods (Table 3.2-3). It is noted that the first group of deaths occurred following their placement in the water table. It is suggested that these lobsters were weakened by the period of air exposure (5-6 hours) during transport from the lobster pound and the set-up of the culture system and became susceptible to cannibalism. The second group of deaths took place in the Hampton Beach Marina lobster car immediately after being tested for *G. homari* on December 13. Exposure to subfreezing air temperatures (-15 C) during transport (20-25 minutes)

is believed to have caused crystalization of lobster body fluids and ultimately their death. The extremely high turbidity levels on December 7 (Table 3.2-2) did not result in any deaths in the water table. Five of the total six deaths occurring in the lobster car did, however, transpire within two days following December 7. Confirmation of *G. homari* in these animals has not been completed to date, however, only one individual showed relatively high amounts of sedimentation in its gills.

The confirmation of *G. homari* present in two lobsters out of the 55 originally tested is not greater than the percentages found in the wild by various studies. Ninety-six lobsters out of a population of 2035 lobsters (almost 5%) captured in five areas off the Canadian coast were infected with *G. homari* in a study done by Stewart *et al.* (1969). Their work strongly suggests that the bacterium is resident in all lobster populations, although at varying percentages (a range of 1.7-39.9%). Apparently, *G. homari* can exist as a free living organism, Goggins and Hurst (1960) were able to isolate *Gaffkyia*-like bacteria readily from mud samples from tidal ponds. Scrapings of mud and slime taken on December 2 from the area of the reported deaths were placed in presumptive test medium. The test procedure proved negative to the presence of *G. homari*. More thorough studies of this nature will be carried out.

It is emphasized that this is only an interim report on the lobster bioassay. The design of such a study is limited in that simulation of the same environmental factors present at the time of the reported deaths is impossible using the techniques described above. The present studies are continuing at the barge site in an attempt to ascertain immediately any adverse effects of the barge landing construction on confined lobsters. These studies will include monitoring of critical environmental parameters, condition of confined lobsters, and further tests for *Gaffkyia homari*.

4.0 SUMMARY

1. Unusually high lobster mortalities were reported in live cars in Seabrook Harbor by lobstermen on October 30-31, 1977.

2. Maximum surface water temperatures in the area showed a rise to 54 F just prior to the lobster mortalities; maximum temperatures during the week previous were around 51 F.

3. A major rainfall (2.65 inches) occurred between 15 and 18 October, resulting in salinities (at low water) as low as 21.9 °/oo in Hampton Harbor.

4. Dissolved oxygen levels were normal except for unusually high values (11.5 mg/l) offshore at the intake site on November 2 and unusually low values (6.4 mg/l) off Rye Harbor also on November 2.

5. A phytoplankton bloom consisting of *Olisthodiscus luteus* was detected during the first week of November and was likely present during the reported lobster mortalities. Cell densities as high as 54 million cells/liter were recorded, giving surface waters a very low transparency.

6. Confined lobsters have been set up adjacent to the barge site to monitor construction effects on these organisms. The organisms are being monitored with particular emphasis on the presence of Gaffkemia and sediment deposits in the gills.

7. During set up of the experiment, some lobsters have died. During the first week, five of the original 50 in the barge site water tank died; all five had generally clean gills. The presence of *Gaffkya homari* in one live individual was confirmed.

   During the second period of the experiment set-up, five of 25 died in the barge site live car; four had very clean gills, one had moderate amounts of silt in its gills and one was confirmed to have *G. homari*.

   During the third period of the experimental set-up, four individuals (of 25) died in the barge site live car; all had clean gills. Twelve individuals (of 32) died in the Hampton Beach marine live car; 11 had clean gills; one had heavy silt/detritus deposits in the gills which were discolored red. The confirmatory tests for *G. homari* have not been completed on these individuals.

   The majority of the deaths reported above have been attributed to handling difficulties.

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