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Final Report

FALL 2002 FINFISH CHARACTERIZATION REPORT

RHODE ISLAND REGION LONG-TERM DREDGED MATERIAL DISPOSAL SITE EVALUATION PROJECT

FINAL

Fall 2002 Finfish Characterization Report

Rhode Island Region
Long-Term Dredged Material Disposal Site Evaluation Project

Contract Number DACW33-01-D-0004
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to

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APPENDICES

Appendix A: Species Catch Data by Trawl
Appendix B: Length Data for Individual Finfish

LIST OF ACRONYMS

ADCP	Acoustic Doppler Current Profiling
˚C	degrees Celcius
cm	centimeters
cm/s	centimeters per second
Corps	U.S. Army Corps of Engineers, New England District
CPUE	Catch Per Unit Effort
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
mg/L	milligrams per liter
mm/s	millimeters per second
ppt	parts per thousand
PRHMDP	Providence River and Harbor Maintenance Dredging Project
RIS	Rhode Island Sound

1.0 INTRODUCTION

1.1 Project Background

The Rhode Island Region Long-Term Dredged Material Disposal Site Evaluation Project includes the collection of environmental baseline data within Rhode Island Sound. Site characterization efforts are designed to fulfill the baseline monitoring requirements defined in the Marine Protection Research and Sanctuaries Act (MPRSA) regulations at Part 228.13. This includes obtaining information from selected locations within Rhode Island Sound that will be used to evaluate secondary impacts from disposal and also to assist in the identification of suitable reference areas for long-term monitoring.

Site characterization goals include documentation of existing physical, chemical, and biological conditions at the sites. Collection of this information provides a basis for comparison of the biological value of the sites (habitat characterizations), helps to assess the suitability of each site for dredged material disposal (bathymetry, sediment type, hydrodynamics), and helps to assess potential short- and long-term impacts from dredged material disposal at each site. Because the Southern New England area supports many ecologically and economically important finfish resources, the local Rhode Island Sound (RIS) finfish populations must be evaluated so that a site may be selected with minimal impacts to this key resource.

During meetings between members of the Rhode Island Fishermen's Association and members of the U.S. Army Corps of Engineers, New England District (Corps) and U.S. Environmental Protection Agency (EPA), fishermen expressed their concern regarding the placement of an open-water dredged material disposal site in Rhode Island Sound (RIS). To address these concerns, the Corps and EPA have conducted three separate finfish surveys to better evaluate this important resource in the RIS. These surveys were conducted in September 2001, June 2002 and November-December 2002. All three surveys were aimed at gaining a better understanding of the finfish use of specific locations within RIS. The November-December 2002 survey was designed to provide data which would allow for a better understanding of the use of the deeper, trench areas identified by local fishermen as key fishing areas within RIS. The results from this survey are presented in this report.

1.2 Study Rationale

The abundance and distribution of many finfish species may be affected by a variety of conditions including temperature, salinity, dissolved oxygen (DO), water circulation patterns, bottom topography/water depth, sediment type, availability of prey species, and various combinations of these parameters. Bottom topography and sediment type, in particular, are key resources to various finfish assemblages. Sediment type often defines the types of prey that are available in a particular location, and thus may influence the species that use that area. Bottom topography and water depth also influence water circulation patterns. Water circulation patterns directly impact physical parameters such as water temperature and DO, which in turn can influence the distribution of many finfish species. Some finfish species may be limited in their distribution to shallow, flat areas with little relief, whereas other species may prefer deeper regions, or areas where bottom topography provides some relief in the form of ledges or

outcroppings. Some species may use both deep and shallow areas during different life history stages or may inhabit different areas seasonally to avoid extremes in physical parameters such as temperature and/or DO.

Bottom topography is one consideration that engineers and environmental managers/planners consider when identifying potential open-water locations for the placement of dredged material. It is believed that by placing dredged material in a deep hole or depression (i.e., a topographic low), erosion of the material from strong currents and storms would be prevented. Additionally impacts to the benthic environment would be localized to a smaller area than if dredged material were placed in a flat, uniform open area (i.e., the same amount of material could be contained in a smaller area if it were a deep hole as opposed to a flat uniform field) because the depression or hole would simply be filled by material to the level of the surrounding areas and minimal impacts would occur to the fishery resources of the area, particularly as the material becomes populated by benthic prey species.

Commercial fishermen in Rhode Island stated that bottom topography is critical to their fishing areas, and believe that the filling of these topographic lows (i.e., deep depressions) would have serious implications for the fishery resources in the area. They mentioned that many key commercial species use the low lying depression areas in RIS during seasonal migrations into and out of Narragansett Bay and inshore reaches of the Sound. There have also been suggestions that many species will use these topographic lows as thermal refuges during extremes in temperature because the deeper areas will stay at a more constant temperature than the shallower regions. Because temperatures remain more constant in these regions, it is also believed that dissolved oxygen and other physical parameters will also remain relatively constant.

During meetings with the U.S. Army Corps of Engineers (Corps) New England District and the Environmental Protection Agency (EPA), members of the Rhode Island Fishermen's Association pointed out their key fishing locations, many of which coincided with the topographic low areas in the region. The fishermen stated that these topographic low areas surrounded by relatively flat shallower regions are the regions where they harvest the most fish. Other than this anecdotal evidence provided by the fishermen, very little information on fish use of these topographic low areas has been documented in the scientific literature. Therefore, to better evaluate whether fish use of these topographic low areas, the Corps proposed sampling in November and December 2002 to estimate the use of these deeper low lying areas and surrounding flat areas by various finfish species. The timing of the sampling was proposed to coincide with seasonal movements of several key finfish species (particularly winter flounder and scup) into and out of the region.

2.0 METHODS

To characterize finfish abundance and distribution in the topographic low areas and surrounding shallower flat areas, otter trawl tows were conducted at five areas within RIS in both November and December 2002. Figure 1 shows the location of the tows within RIS, and Table 1 presents the specific information associated with each tow including the date, duration and length of the

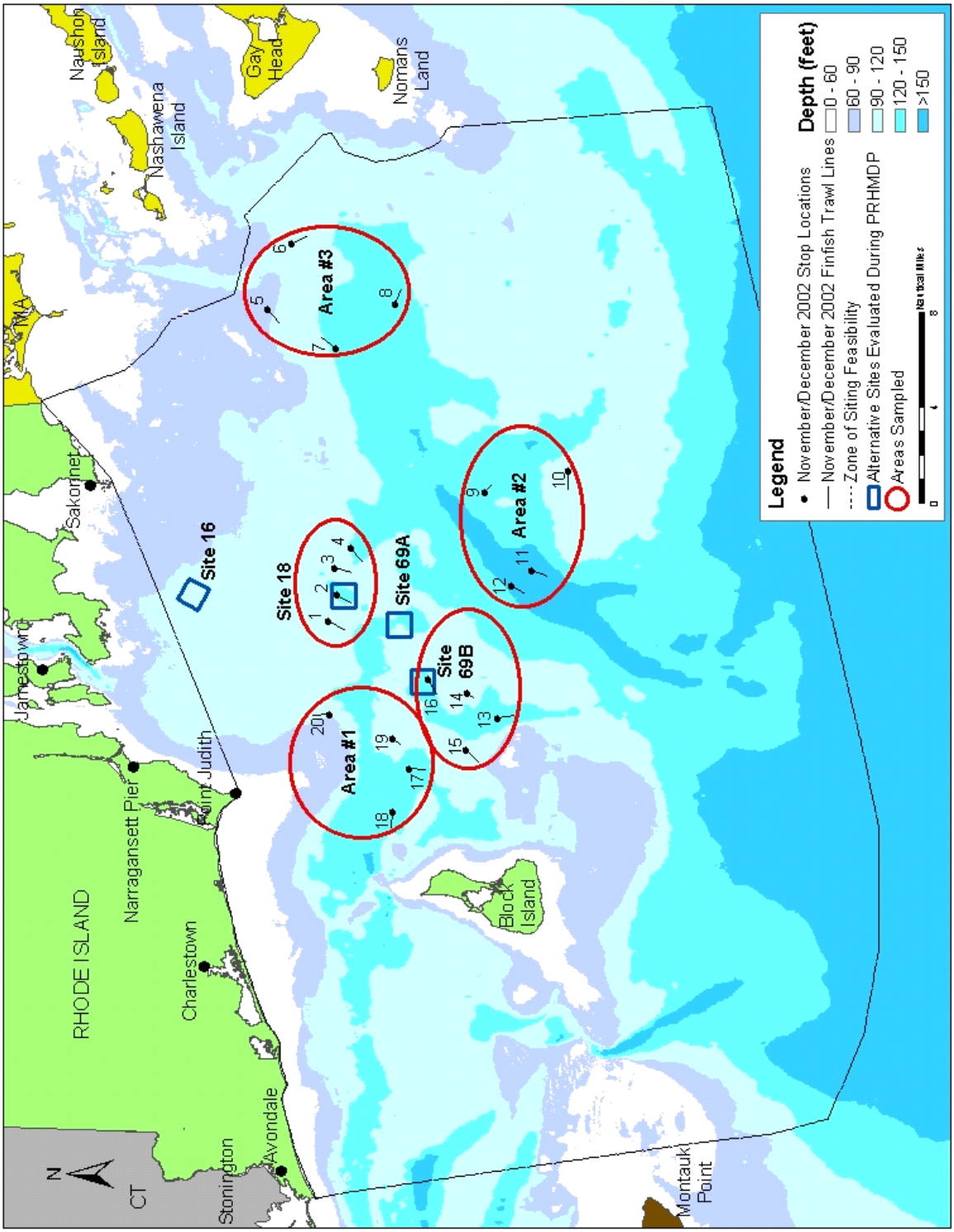

Figure 1. Areas Sampled and Locations of Trawls Conducted During the November and December 2002 Finfish Surveys

Table 1. Date, Sampling Location, Tow Length, Average Depth and Time of Trawls Conducted Within 5 General Areas in RIS.

Date	Area	Tow No.	Tow Length (nm)	Average Depth during length of tow (m)	Tow Time (min)
Nov 20, 2002	Site 18 Area	1	0.87	34.2	15
		2	0.71	38	15
		3	0.74	35.6	15
		4	0.77	37.4	15
Nov 20, 2002	Site 69B Area	16	0.72	37	15
		14	0.45	33.8	9
		13	0.74	40.5	15
		15	0.75	31.3	15
Nov 21, 2002	Area #1	20	0.69	32.1	15
		18	0.70	42	15
		17	0.66	37.6	15
		19	0.53	35.5	11
Nov 21, 2002	Area #2	12	0.75	48	15
		11	0.72	55.2	15
		10	0.70	31	15
		9	0.44	39.1	8
Nov 25, 2002	Area #3	8	0.73	39.9	15
		7	0.73	36.7	15
		6	0.76	31.4	15
		5	0.71	27.1	15
Dec 18, 2002	Area #2	9	0.74	44	15
		10	0.78	35.7	15
		11	0.69	59.3	15
Dec 18, 2002	Site 69B Area	13	0.73	44.4	15
		14	0.60	36.5	11
		15	0.73	35.1	15
		16	0.77	41.8	15
Dec 18, 2002	Area #1	19	0.78	34.4	15
Dec 19, 2002	Area #1	17	0.72	41.8	15
		18	0.78	46.4	15
		20	0.81	34.6	16
Dec 19, 2002	Site 18 Area	1	0.75	35.9	15
		2	0.69	36.5	15
		3	0.78	33.7	15
		4	0.90	36.9	17
Dec 20, 2002	Area #3	8	0.73	41.2	15
		6	0.71	32.6	15
		5	0.74	27.6	15
		7	0.68	Not reported	15

tow, and average depth of the tow. As mentioned above, the general areas selected for sampling were identified as key fishing locations by commercial fishermen and consisted of deep trough regions surrounded by shallower flat areas. Two of the areas selected surrounded locations that were considered as alternative disposal locations during the Providence River and Harbor Maintenance Dredging Project (PRHMDP). For these surveys, the region around these previously evaluated locations were identified by the site names assigned during the PRHMDP and will be referred to throughout the report as Site 18 and Site 69B. A location referred to as "Area #1" was west of the Site 18 Area and northwest of the Site 69B Area. The location

referred to as "Area #2" is southeast of the Site 69B Area and "Area #3" is east of the Site 18 region (Figure 1).

Twenty tows were conducted during each survey. Within each of the five general areas, four tows were assigned such that two tows were considered "deep" and two tows were considered "shallow" relative to each other. Using a bathymetric map, each area was reviewed to determine the maximum depth. Two tows were assigned to the deeper depths within the area, and two tows were assigned to the shallow depths of that area. In most areas, the deep tows were conducted in waters of 120 feet (36.6 meters) deep or greater, and the shallow tows were conducted in waters less than 120 feet deep (36.6 meters). However, in some cases, the average depth is slightly more or less because of the tidal range and timing of the tow. A summary of deep and shallow tows is shown in Table 2 and presented graphically for each individual area in Figures 2 thru 6.

Table 2. Designation of "Deep" and "Shallow" Tows in the Five Areas Sampled During the November and December Otter Trawls in RIS.

	Deep Tows	Shallow Tows
Area	**Tow #**	**Tow #**
Site 18 Area	2 4	1 3
Site 69B Area	13 16	14 15
Area #1	17 18	19 20
Area #2	9 11 12	10
Area #3	7 8	5 6

In all areas except Area #2, two "deep" tows and two "shallow" tows were conducted. In Area #2, two of the deep tows (i.e., tow #11 and Tow #12) were conducted in a very deep trench that was greater than 150 feet in depth (Figure 3). The shallow areas surrounding this trench were generally 120 feet in depth or at depths that were considered "deep" in the other areas. For this reason, one of the two shallow tows at Area #2 (i.e., Tow #9; Figure 3) was actually conducted in waters that are considered "deep" when compared to the other areas and for that reason will be considered deep for the purposes of analysis.

All tows used a commercial, ¾ whiting net with a 51-foot sweep, 39-foot headrope and 10 fathom legs. The net contained 6-inch mesh in the wings and square and 2-inch mesh in the belly. The cod end contained a 0.25-inch mesh liner to capture smaller fish and juveniles. Each tow was conducted at a speed of 3 knots for a target duration of 15 minutes. Following completion of each tow, the contents of the net were sorted, identified, counted, and measured (Appendix A; Appendix B). Catch Per Unit Effort (CPUE) was calculated as the total number of fish collected in a 15 minute tow. Tows that were slightly less or more than 15 minutes were normalized to the 15-minute tow.

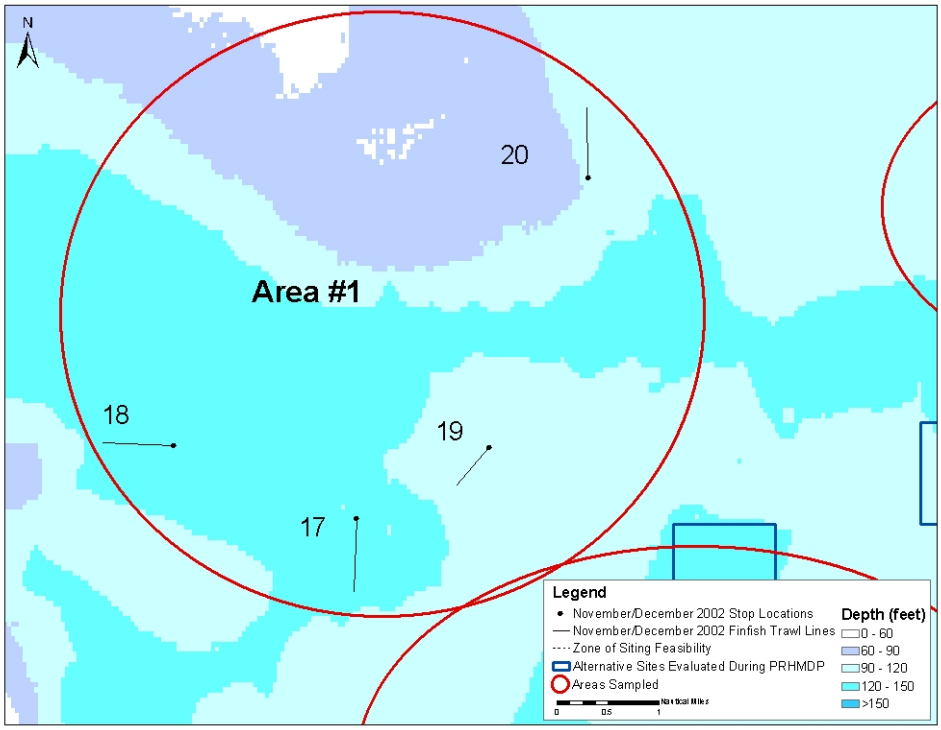

Figure 2. Location of "Deep" and "Shallow" Otter trawls within Sampling Area #1.

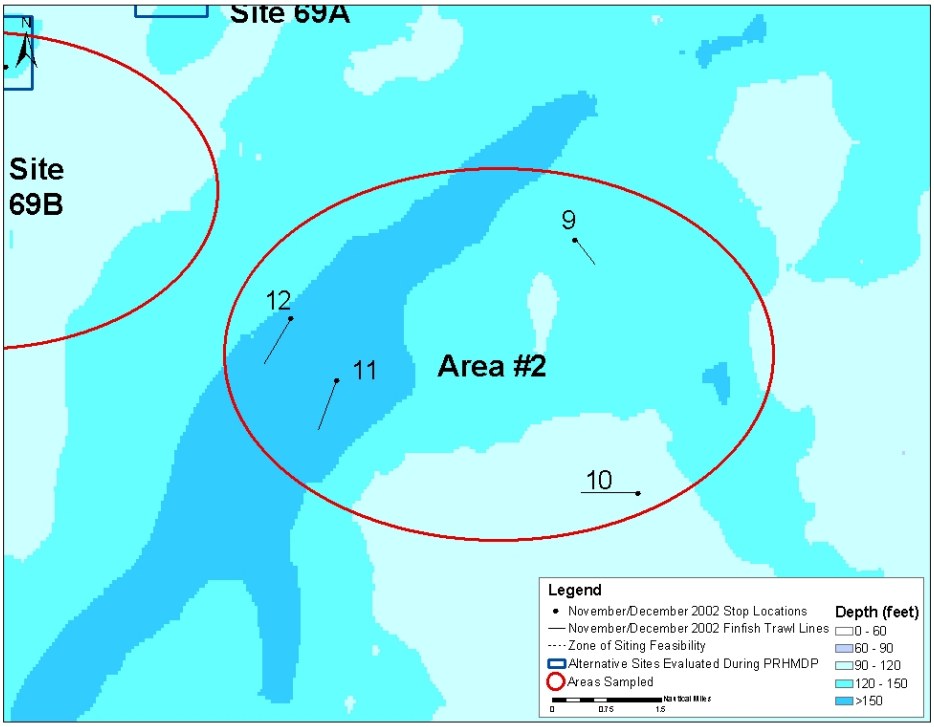

Figure 3. Location of "Deep" and "Shallow" Otter Trawls within Sampling Area #2.

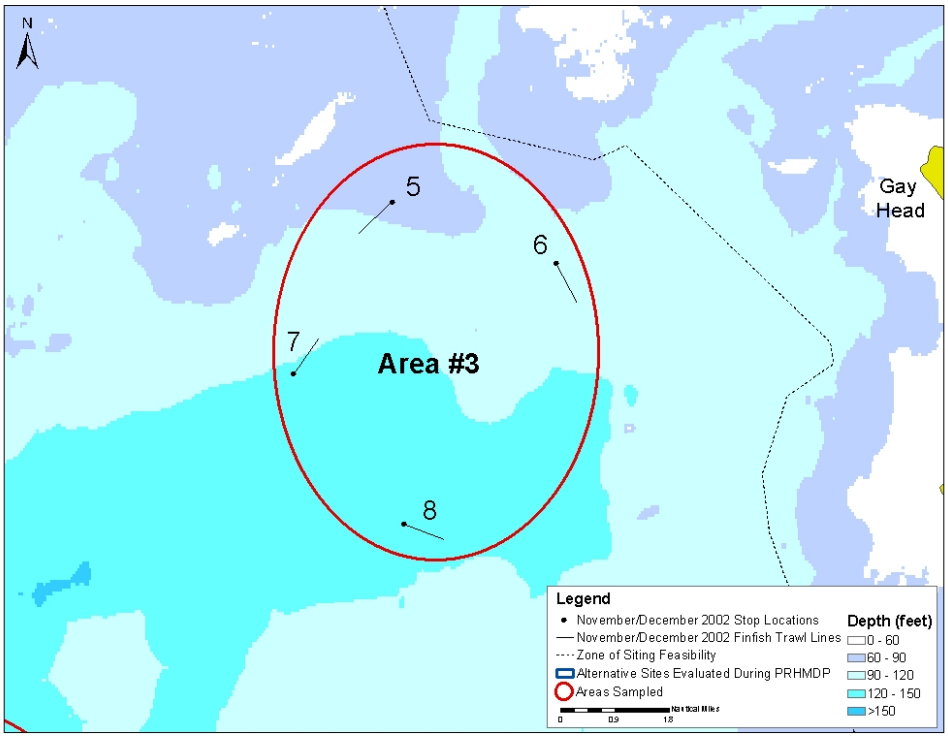

Figure 4. Location of "Deep" and "Shallow" Otter Trawls within Sampling Area #3.

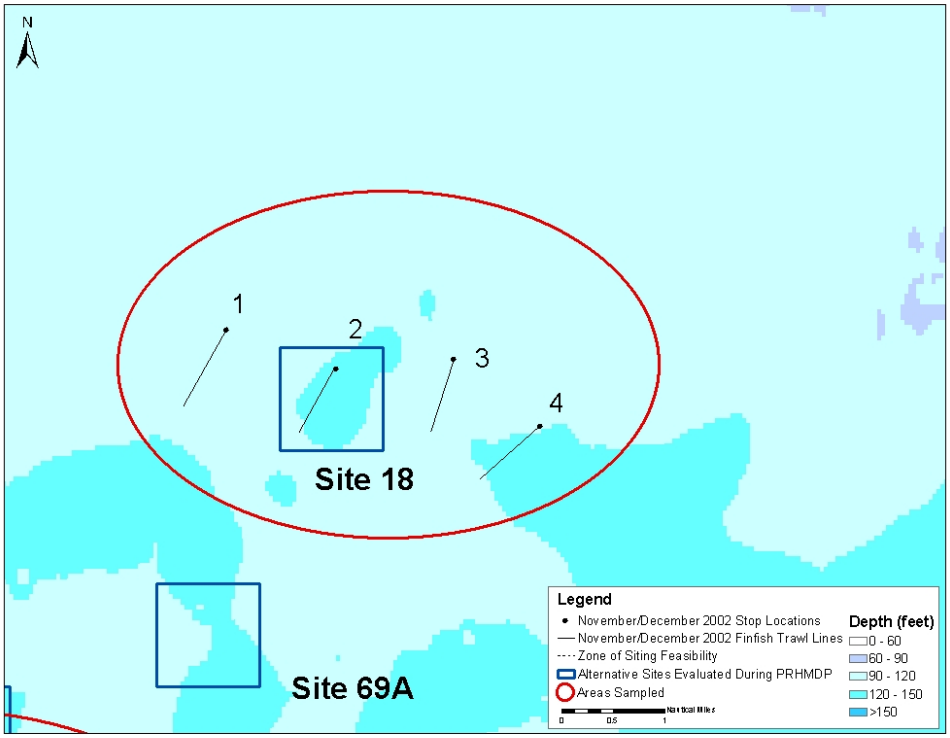

Figure 5. Location of "Deep" and "Shallow" Otter Trawls within the Site 18 Sampling Area.

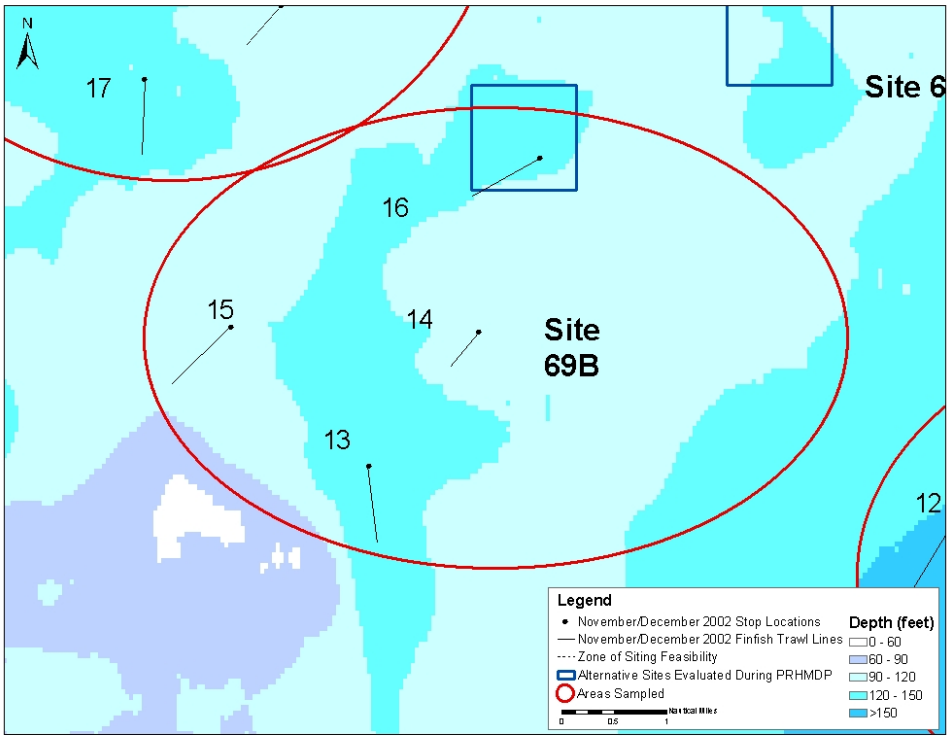

Figure 6. Location of "Deep" and "Shallow" Otter Trawls within the Site 69B Sampling Area.

Simple t-tests analyses were conducted to address whether CPUE was significantly different in deep and shallow areas within the overall Rhode Island Sound area. Small sample sizes precluded conducting statistical analyses on each specific area. T-tests were also used to evaluate whether CPUE of specific species (i.e., scup and winter flounder) was significantly different in deep and shallow areas.

A Hydrolab 4A MiniSonde was attached to the headrope of the otter trawl and used to measure physical water quality parameters such as water temperature, salinity, dissolved oxygen, and conductivity during each tow. An Acoustic Doppler Current Profiling (ADCP) instrument was used to measure current direction and speed during several tows. To evaluate sediment type, sediment grab samples were collected near the start and stop point of each tow (two samples per tow) and submitted for grain size analysis. The two sediment samples for each tow were only collected once (i.e., either during the November or December survey) for a specific tow. A summary of which physical parameters and sediment samples were collected during the November survey and December survey are presented in detail in the Field Survey Report (Battelle, 2003a).

3.0 RESULTS

3.1 Physical Water Quality Parameters

The physical water quality parameters measured during the November and December surveys are summarized in Table 3. During the November survey, temperatures at most tow locations and depths remained fairly consistent ranging between 11.9 and 12.4 degrees Celsius (°C). Only at tow #12, a deeper tow location in Area #2, was the temperature slightly higher (12.6°C). In Area #3, temperatures were lower than those from the other areas. At the two shallow tows (tow # 5 and #6) and one deep tow (tow #7) temperatures again were similar, ranging from 11.1 to 11.2°C. Temperatures observed during the deep tow #8 in the area averaged 11.6 °C.

During the December sampling, water temperatures were cooler than those observed in November. Water temperatures at all tow locations, both deep and shallow, averaged between 7.7 and 8.6°C. The lowest temperature (5.9°C) was observed during a shallow tow (tow #5) in Area #3.

Salinities during the November and December sampling were similar and did not vary much between tow locations or depths. In November, salinities ranged from lows of 30 parts per thousand (ppt) at shallow tow locations in Area #3 to highs of 32.1 ppt in a shallow and deep tow at the Site 18 Area. December salinity values were similar ranging from 30.7 ppt to 31.9 ppt. The lowest salinities were again observed in Area #3. The highest salinities were observed at both shallow and deep tow locations in the Site 69B Area and the shallow tow location in Area #2. Because Area #3 consistently had lower salinity values than the other areas sampled, this region may experience more freshwater input. Area #3 is close in proximity to Buzzards Bay than the other areas and may experience somewhat lower salinities as more estuarine water from within Buzzards Bay moves out into the Sound. The similarity in salinities between deep and shallow tows at all locations suggests that at these depths the water column was fairly well mixed during the sampling events.

DO concentrations were not collected during the November survey due to inappropriate calibration of the Hydrolab Minisonde for this parameter. During December, DO values in the shallow tow locations ranged from 9.8 milligrams per liter (mg/L) at Area #1 to 10.8 mg/L in Area #3. DO concentrations for deeper tows ranged from 10 mg/L at Area #2 and Area #3 to 10.4 mg/L at Area #1 and the Site 69B Area. DO concentrations were consistent across locations and depths and were above the Rhode Island Department of Environmental Management (RIDEM) DO criteria for Class SA waters (> 6.0 mg/L). DO concentrations greater than 6 mg/L are expected for RIS since these waters are all Class SA and the water circulation patterns keep the waters well mixed and oxygenated.

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Table 3. Summary of Physical Water Quality Parameters Collected During the Otter Trawl Surveys in November and December 2002.

			Temperature (^{o}C)				Salinity (ppt)				Dissolved Oxygen (mg/L)			
			November		December		November		December		November		December	
Area	Tow	Depth Status	mean	std dev	mean	std dev	mean	std dev	mean	std dev	mean	std dev	mean	std dev
Site 18	1	Shallow	12.1	0.02	8.0	0.05	32.1	0.01	31.6	0.01	NA	NA	10.0	0.04
	3	Shallow	12.0	0.07	7.8	0.04	31.7	0.02	31.5	0.02	NA	NA	10.3	0.10
	2	Deep	12.2	0.01	7.8	0.04	32.1	0.01	31.5	0.02	NA	NA	10.2	0.04
	4	Deep	12.4	0.02	7.7	0.08	31.9	0.03	31.5	0.02	NA	NA	10.3	0.18
Site 69B	14	Shallow	12.2	0.06	8.6	0.03	31.7	0.06	31.7	0.01	NA	NA	10.4	0.03
	15	Shallow	12.0	0.01	8.2	0.09	31.5	0.07	31.6	0.03	NA	NA	10.3	0.03
	13	Deep	12.2	0.02	8.6	0.04	31.5	0.04	31.7	0.01	NA	NA	10.4	0.02
	16	Deep	12.3	0.02	8.3	0.03	31.8	0.04	31.6	0.01	NA	NA	10.2	0.04
Area #1	19	Shallow	12.0	0.03	8.3	0.02	31.3	0.03	31.6	0.02	NA	NA	9.8	0.04
	20	Shallow	11.9	0.06	8.1	0.01	31.5	0.05	31.6	0.01	NA	NA	9.9	0.03
	17	Deep	12.1	0.07	8.0	0.09	31.3	0.04	31.5	0.03	NA	NA	10.4	0.27
	18	Deep	12.0	0.04	8.0	0.01	31.6	0.02	31.5	0.01	NA	NA	10.1	0.12
Area #2	10	Shallow	12.3	0.03	8.5	0.01	31.6	0.05	31.7	0.01	NA	NA	10.1	0.06
	9	Deep	12.1	0.12	8.4	0.05	31.5	0.09	31.6	0.02	NA	NA	10.0	0.01
	11	Deep	12.2	0.20	8.0	0.02	31.4	0.06	31.5	0.01	NA	NA	10.3	0.05
	12	Deep	12.6	0.02	NA	NA	31.5	0.02	NA	NA	NA	NA	NA	NA
Area #3	5	Shallow	11.2	0.02	5.9	0.17	30.0	0.04	30.7	0.04	NA	NA	10.8	0.06
	6	Shallow	11.1	0.03	7.8	0.26	30.0	0.01	31.1	0.06	NA	NA	9.9	0.05
	7	Deep	11.2	0.16	NA	NA	30.1	0.06	NA	NA	NA	NA	NA	NA
	8	Deep	11.6	0.02	8.3	0.03	30.3	0.01	31.3	0.02	NA	NA	10.0	0.03

std dev = Standard Deviation

NA = not available

3.2 Currents

Shipboard Acoustic Doppler Current Profiler (ADCP) velocity measurements were collected during each tow. The ADCP measures the current in a profile from surface to bottom, compensating for ship motion by bottom tracking. A summary of the velocity data is presented in Table 4 for the November and December surveys. Table 4 shows average current velocity - vertically averaged over the water column and averaged over the duration of the tow - providing an indication of the mean flow throughout the water column during each tow. The magnitude of the current velocities ranges from 3 centimeters per second (cm/s) to 31 cm/s and are consistent with expected tidal velocities for RIS. The observed currents vary in both magnitude and direction, reflecting the fact that measurements were made at various times during the tidal cycle.

Table 4. Summary of the Water Currents Collected During the Otter Trawl Surveys in November and December 2002.

			November		December	
Area	**Tow**	**Depth Status**	**Current Speed (cm/s)**	**Current Direction (degrees)**	**Current Speed (cm/s)**	**Current Direction (degrees)**
Site 18	1	Shallow	7.88	215.01	9.56	353.22
	3	Shallow	8.93	131.30	8.57	220.75
	2	Deep	10.99	166.11	9.02	15.00
	4	Deep	8.33	105.26	5.52	43.88
Site 69B	14	Shallow	3.06	228.20	8.90	87.05
	15	Shallow	14.40	91.58	4.33	2.53
	13	Deep	20.54	140.37	12.79	113.20
	16	Deep	14.61	73.14	2.65	306.62
Area #1	19	Shallow	4.56	17.66	2.68	235.41
	20	Shallow	7.13	37.14	11.90	18.80
	17	Deep	13.50	254.89	13.24	95.73
	18	Deep	25.45	156.09	16.82	179.53
Area #2	10	Shallow	11.42	40.77	12.34	174.92
	9	Deep	12.74	203.95	6.35	287.70
	11	Deep	13.90	129.34	8.09	82.95
	12	Deep	11.77	101.82	NA	NA
Area #3	5	Shallow	31.29	58.91	NA	NA
	6	Shallow	11.90	208.99	NA	NA
	7	Deep	19.58	337.79	9.50	200.99
	8	Deep	30.41	115.82	NA	NA

NA = not available

3.3 Sediments

Sediments found in RIS are characterized as predominantly sandy with some areas of silty sand, sandy silt, sandy gravel, and gravel (Battelle, 2003b). In general, sediment composition is highly variable across most of the area, as demonstrated by the wide range in sediment grain size fractions (Table 5). Fine sand was the dominant fraction of the majority of the sediments, followed, for the most, part by silt-, clay-, and medium sand-fractions (Table 5; Figure 7).

Table 5. Summary of Grain Size Results for Surface Sediments Collected in November 2002 and January 2003 from Rhode Island Sound.

Station	Site	Depth (ft)	Gravel 4.75 mm (%)	Coarse Sand 2 mm (%)	Medium Sand 0.425 mm (%)	Fine Sand 0.074 mm (%)	Silt 0.074 to 0.005 mm (%)	Clay <0.005 mm (%)	Fines (a) (%)
1A	Site 18	108	0.00	0.04	5.73	86.53	3.71	4.00	7.71
1B	Site 18	108	0.00	0.41	78.22	17.19	2.52	1.66	4.18
2A	Site 18	125	0.00	0.01	0.54	53.50	31.45	14.50	45.95
2B	Site 18	121	0.00	0.22	2.25	46.64	30.89	20.00	50.89
3A	Site 18	121	0.29	0.28	6.80	64.98	15.15	12.50	27.65
3B	Site 18	112	0.41	0.23	6.11	86.46	2.67	4.11	6.78
4A	Site 18	128	0.00	0.08	2.28	59.87	23.27	14.50	37.77
4B	Site 18	121	3.41	0.26	9.97	43.66	28.20	14.50	42.70
5A	Area #3	78.7	0.00	0.07	1.00	73.34	14.70	10.89	25.59
5B	Area #3	85.3	0.00	0.50	0.44	89.86	3.91	5.29	9.20
6A	Area #3	118	0.00	0.00	0.64	66.09	22.28	11.00	33.28
6B	Area #3	115	0.00	0.05	0.55	43.95	39.97	15.50	55.47
7A	Area #3	118	2.37	0.11	2.39	54.81	25.46	14.88	40.33
7B	Area #3	121	6.74	2.77	5.47	71.14	5.36	8.50	13.86
8A	Area #3	131	0.06	0.09	0.55	89.96	2.19	7.17	9.36
8B	Area #3	118	0.00	0.01	0.62	78.46	8.91	12.00	20.91
9A	Area #2	128	0.00	0.10	3.99	90.97	1.83	3.11	4.94
9B	Area #2	125	0.00	0.24	3.00	93.45	0.11	3.19	3.30
10A	Area #2	98.4	0.76	1.65	32.97	63.46	0.16	1.00	1.16
10B	Area #2	98.4	0.00	0.34	19.51	76.61	1.47	2.07	3.54
11A	Area #2	187	0.00	0.00	0.47	11.08	52.46	36.00	88.46
11B	Area #2	180	0.00	0.00	0.15	14.53	53.32	32.00	85.32
12A	Area #2	167	0.00	0.76	4.84	48.64	28.76	17.00	45.76
12B	Area #2	157	0.79	0.58	2.17	48.53	32.92	15.00	47.92
13A	Site 69B	128	0.68	2.94	22.63	57.38	8.62	7.75	16.37
13B	Site 69B	135	0.92	1.01	16.55	55.21	14.56	11.75	26.31
14A	Site 69B	108	18.93	17.27	30.19	29.58	0.62	3.40	4.02
14B	Site 69B	105	17.29	6.47	57.78	17.62	0.84		0.00
15A	Site 69B	102	3.01	58.83	31.42	5.55	1.19		0.00
15B	Site 69B	102	10.44	14.32	67.82	4.71	0.72	2.00	2.72
16A	Site 69B	112	0.00	0.84	6.94	81.75	4.27	6.20	10.47
16B	Site 69B	118	1.66	1.42	4.96	80.38	5.59	6.00	11.59
17A	Area #1	125	0.00	0.00	1.69	74.76	12.54	11.00	23.54
17B	Area #1	121	0.00	0.00	2.10	75.08	10.82	12.00	22.82
18A	Area #1	128	0.00	0.79	13.71	58.48	13.03	14.00	27.03
18B	Area #1	141	0.00	0.02	1.12	66.60	20.76	11.50	32.26
19A	Area #1	118	1.17	0.37	6.14	76.22	7.60	8.50	16.10
19B	Area #1	115	0.00	0.14	9.49	84.50	0.25	5.62	5.87
20A	Area #1	98.4	2.73	1.26	6.63	73.57	6.30	9.50	15.80
20B	Area #1	112	0.00	0.04	0.95	62.29	21.23	15.50	36.73

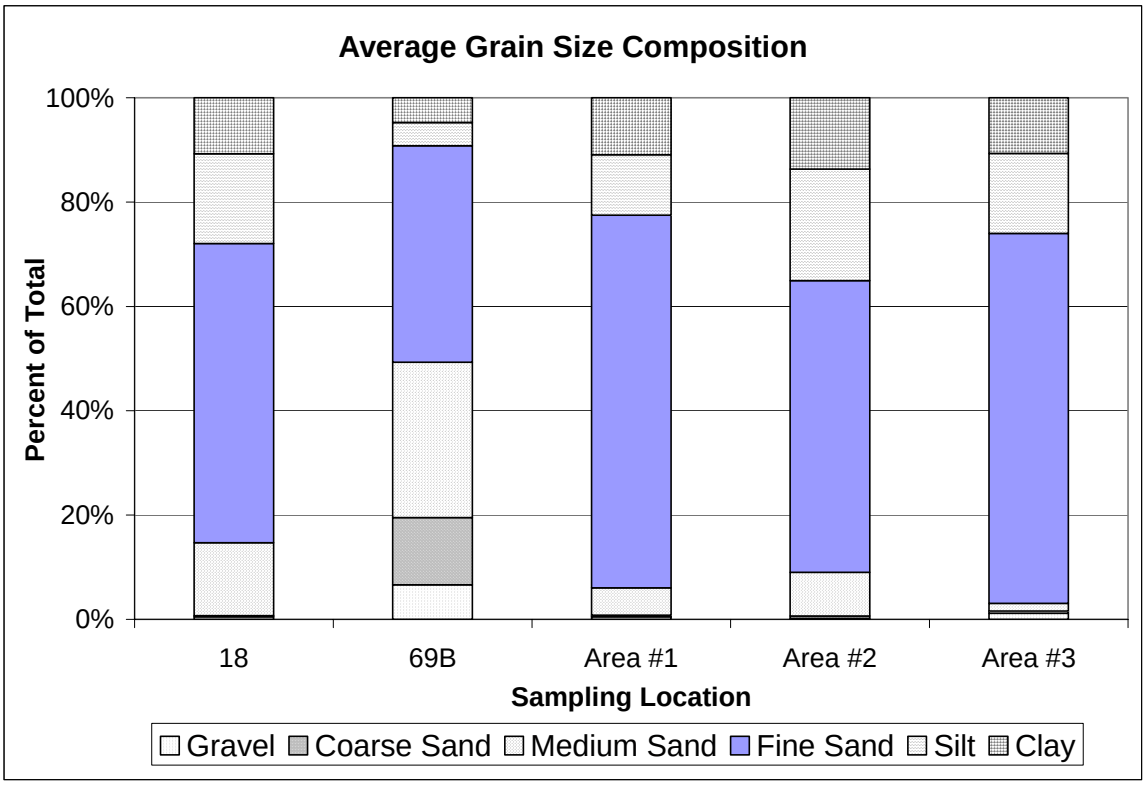
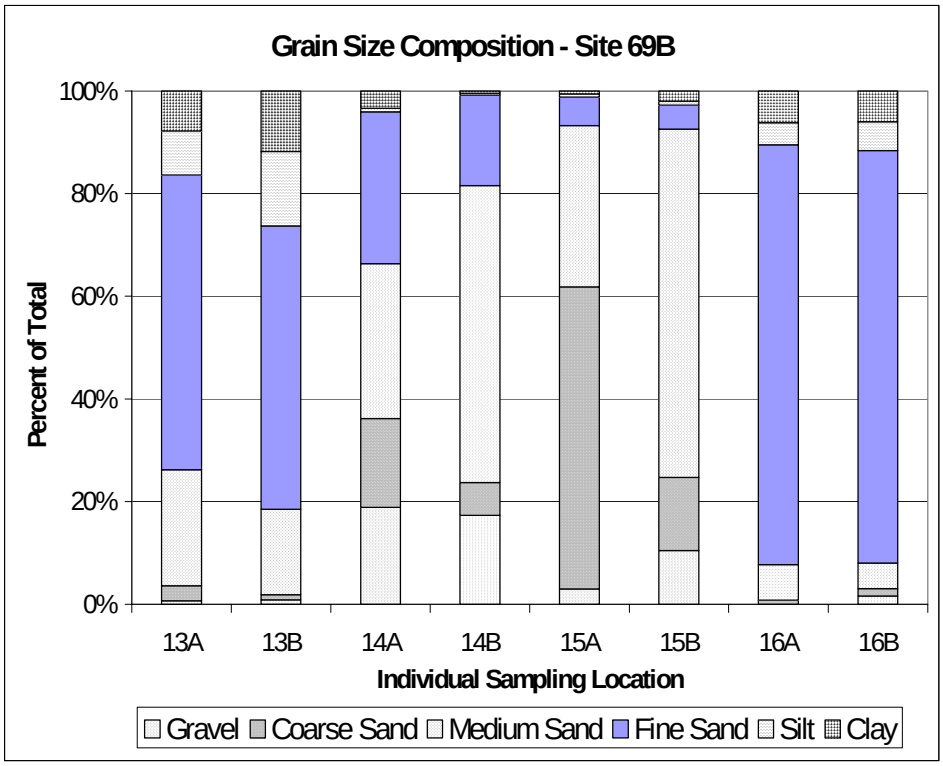


Figure 7. Average Grain Size Composition of Surface Sediments Collected in November 2002 and January 2003 from Rhode Island Sound.

While most sediments are comprised predominantly of sand, sediment composition is highly variable across most of the area. For example, patterns in sediment composition are more variable at Site 69B, compared to other sampling locations; and in contrast, Area #1 sediments are the most uniform by comparison (Figure 8).

Unlike sediment samples collected in the fall of 2001 (Battelle, 2003b), approximately half of the samples collected in November 2002 and January 2003 contained 10% clay or more. (Note: Timing, weather and mechanical difficulties prohibited completing the sediment sampling during the December survey. Sediment sampling was completed in January 2003). A comparison between sediment grain size (i.e., percent fines) and depth show that sediments with higher fine-grained deposits are generally found in deeper, lower energy environments (Table 5; Figure 9). Table 5 also shows that there is a wide range in grain size (5% - 55% fines) between 115 to 130 ft, with coarser-grained deposits (<5% fines) found, for the most part, in depths less than 108 ft. These findings suggest that increased erosion is likely at depths less than 108 ft.



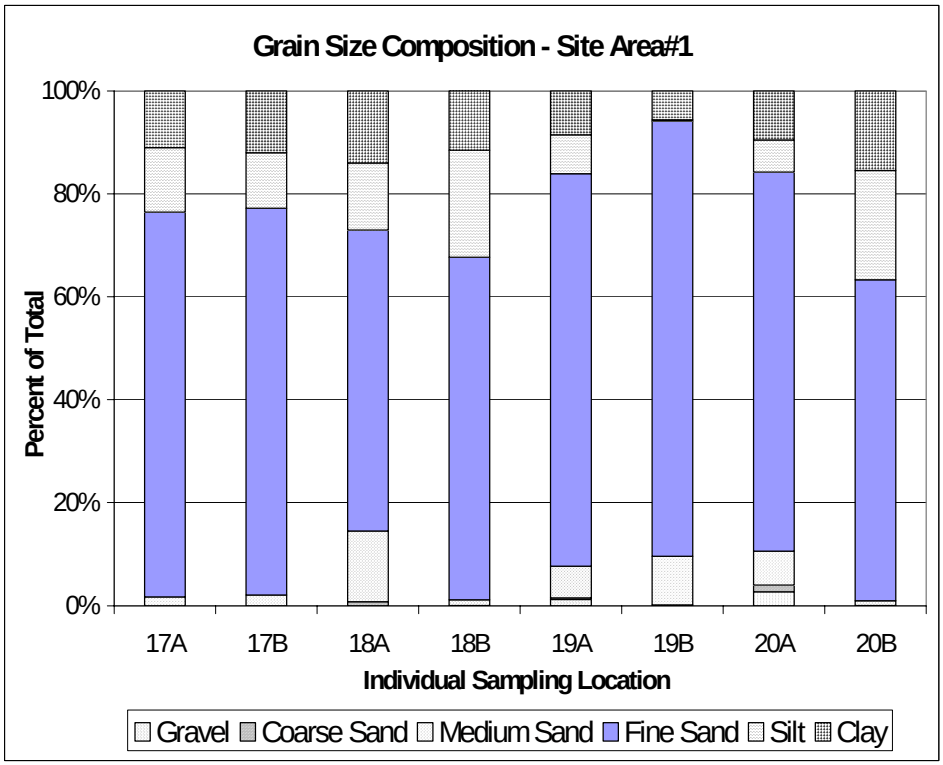


Figure 8. Grain size Composition for Individual Sediment Samples Collected at Site 69B (top), an Area Representative of Highly Variable Grain Size Composition, and Area #1 (bottom), an Area Representative of More Consistent Grain Size Composition.

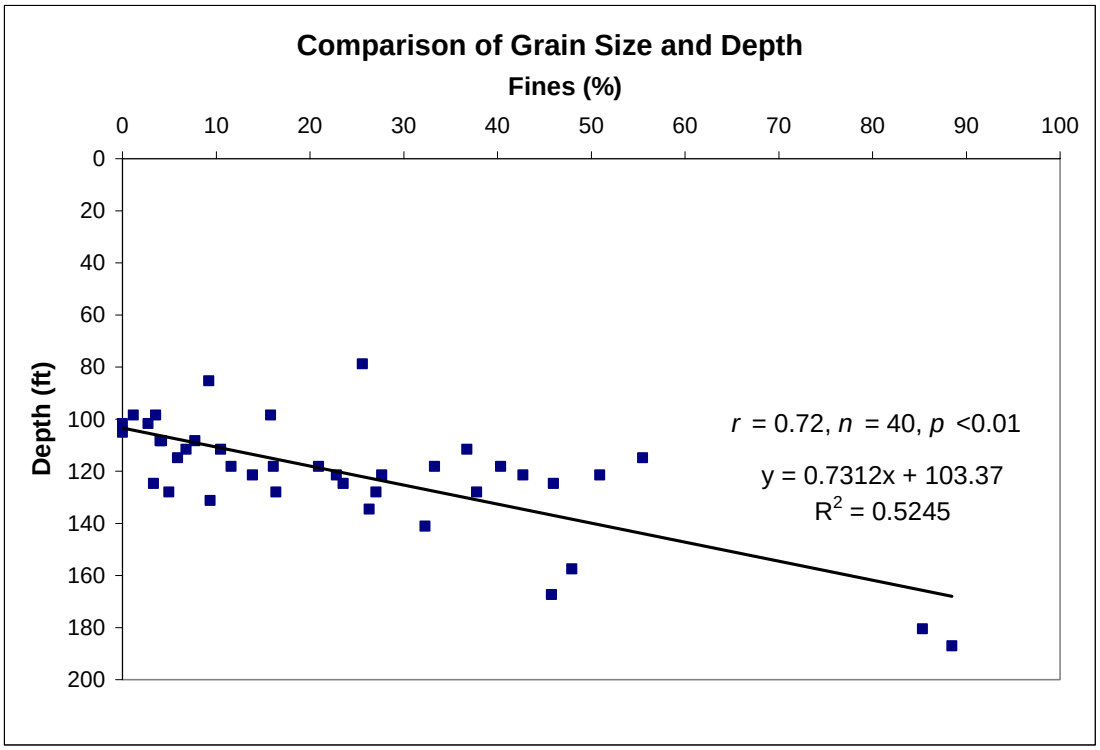


Figure 9. Correlation between Percent Fines and Depth for Surface Sediments Collected from Locations within Rhode Island Sound in November, 2002 and January 2003.

3.4 Fish

The Catch Per Unit Effort (CPUE) was calculated as the number of fish collected per tow standardized to a 15-minute tow. The CPUE for each tow conducted during the November survey and December survey is presented in Table 6. All 20 tows were conducted during November, while only 19 of the 20 tows were conducted in December. Tow #12 could not be conducted in December because of an abundance of lobster gear at the location.

Overall, the average CPUE for all tows during November was significantly greater than the average CPUE during December (average CPUE = 984.8 fish/tow and 124.9 fish/tow, respectively; $p < 0.001$). Although no statistics were conducted between individual areas for each month, results suggest that during the November survey CPUE at Area #2 was higher than the other areas surveyed. An average of 1633.8 fish per tow was collected in Area #2 during November. CPUE at Area #3 was also high (average CPUE = 1213.5 fish per tow). The lowest CPUE values were observed at the Site 69B Area (514.5 fish per tow) and Area #1 (660.9 fish per tow).

Table 6. CPUE Summary for Otter Trawl Surveys Conducted in November and December 2002.

Area	Tow #	Depth Status	CPUE	
			November	December
Site 18	1	Shallow	483	216
	3	Shallow	715	44
		shallow average	*599*	*130*
	2	Deep	1210	85
	4	Deep	1365	87.4
		deep average	*1287.5*	*86.2*
Site 18 Average			**943.3**	**108.1**
Site 69B	14	Shallow	155	110.5
	15	Shallow	456	59
		shallow average	*305*	*84.75*
	13	Deep	637	277
	16	Deep	811	162
		deep average	*724*	*219.5*
Site 69B Average			**514.5**	**152.1**
Area #1	19	Shallow	407.7	112
	20	Shallow	1125	55.3
		shallow average	*766.35*	*83.65*
	17	Deep	512	42
	18	Deep	599	47
		deep average	*555.5*	*44.5*
Area #1 Average			**660.9**	**64.1**
Area #2	10	Shallow	2250	307
		shallow average	*2250*	*307*
	9	Deep	1460	161
	11	Deep	1104	121
	12	Deep	1721	NA
		deep average	*1428.3*	*141*
Area #2 Average			**1633.8**	**196.3**
Area #3	5	Shallow	1659	69
	6	Shallow	1636	100
		shallow average	*1647.5*	*84.5*
	7	Deep	828	157
	8	Deep	731	89
		deep average	*779.5*	*123*
Area #3 Average			**1213.5**	**103.8**

During the December surveys, CPUE was again greatest at Area #2 (average CPUE = 196.3 fish/tow), similar to patterns observed during November. Unlike November, however, CPUE at the Site 69B Area was not lowest during December, but was high (average CPUE = 152.1 fish/tow), second only to Area #2. CPUE was lowest at Area #1 (average CPUE = 64.1) during December than at the other areas.

Twenty-eight species were collected in tows during the November survey, and 22 species were collected during the December survey (Table 7, Appendix A). Eleven of the 28 species collected during the November survey were not present in the trawls collected during the December survey. These species were the three-bearded rockling, black sea bass, bluefish, goosefish, rough scad, round herring, sea raven, sea robin, spot, tautog and weakfish. Five species were caught only in December. These were Atlantic mackerel, blueback herring, ocean pout, silverside and yellowtail flounder.

The most abundant species collected during the November survey were scup, butterfish, spiny dogfish, squid, various skate species, winter flounder, and summer flounder. In December, the most abundant species were butterfish, various skate species, spiny dogfish, winter flounder, and longhorn sculpin. The December catches were substantially smaller, and only windowpane flounder had somewhat similar catches in both November and December. Scup, which were the most abundant species during November, were essentially missing from tows during December. Alewife, Atlantic herring, cunner, longhorn sculpin, and sea scallops were greater in the December tows.

CPUE was not significantly different between deep and shallow areas in November ($p > 0.05$) or December ($p > 0.05$) for the Rhode Island Sound area. The average CPUE for shallow and deep tows for both the November and December surveys is shown in Figure 10 and summarized in Table 8. Although statistical comparisons between deep and shallow tows within a specific sampling area were not conducted, some general observations can be made with regards to the use of deep and shallow regions within a specific sampling area. During the November survey, the CPUE in deep areas was greater than the CPUE in shallow areas at the Site 18 and Site 69B areas only (Figure 10). In both areas, the CPUE from the deeper tows were more than double those of the shallower tows. In Areas #1, #2 and #3, CPUE was greater in the shallower tows. It is important to note, however, that the shallow tow in Area #2 contained only spiny dogfish. Eighteen hundred spiny dogfish were collected in the 12 minute tow (i.e., 2250 fish in a 15-minute tow). No other species were caught.

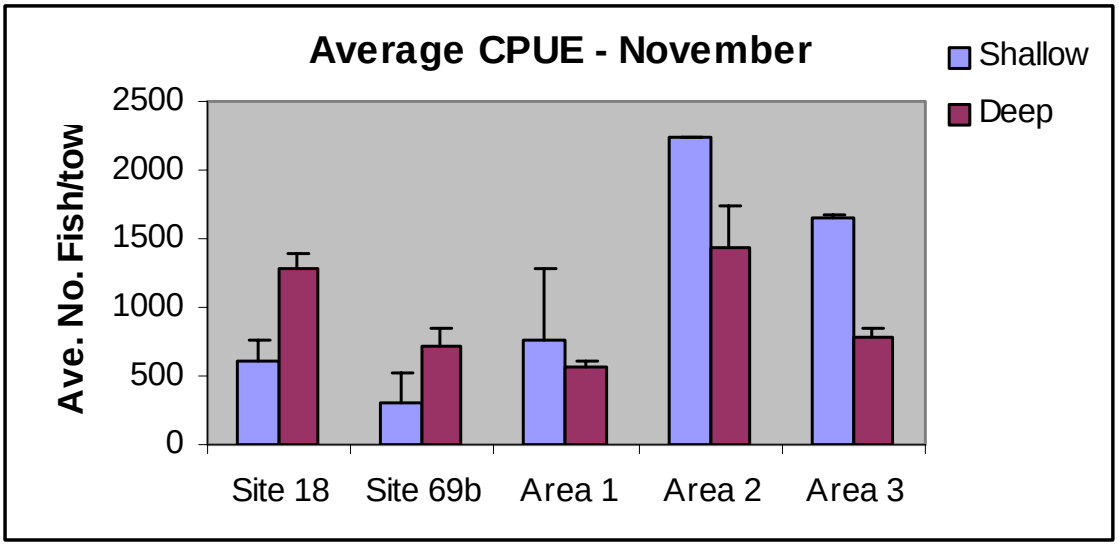
Similar patterns were not observed during the December surveys. Like November, CPUE was greater in deeper tows at the Site 69B Area (Figure 10). However during December, at the Site 18 Area, CPUE in the deeper areas were slightly less than the shallower locations. Additionally, the CPUE from the deep tows at Area #3 was slightly greater than that of the shallow tows. During November, CPUE from the shallow tows in Area #3 were more than double the CPUE in the deeper tows.

Similar numbers of species were collected in the deep water and shallow water tows. Twenty-seven species were collected from the deeper water tows and 28 species were collected from the shallower water tows (Table 8). Five species were only caught in deeper tows; the three-bearded rockling, sea raven, spot, tautog and weakfish. Blueback herring, cunner, rough scad, round herring, sea scallops and silverside were only caught in the shallower water tows.

Table 7. Average CPUE and Length of Species Collected from Otter Trawl Surveys During November and December 2002.

November			December		
Species	**Mean CPUE**	**Mean Length (cm)**	**Species**	**Mean CPUE**	**Mean Length (cm)**
three-bearded rockling	0.1	29	four-spot flounder	0.95	27.5
four-spot flounder	7.32	29	alewife	2.77	18
alewife	0.05	29	Atlantic herring	2.2	25.8
Atlantic herring	0.15	31.3	Atlantic mackerel	0.74	31.9
black sea bass	1.09	16	blueback herring	0.05	12
bluefish	0.35	49.1	butterfish	44.7	11.7
butterfish	291	10.5	cunner	0.22	34.3
cunner	0.05	27	lobster	0.74	8.09
goosefish	0.25	59	longhorn sculpin	7.42	31.7
lobster	4.06	8.58	ocean pout	0.59	46.2
longhorn sculpin	0.45	25.3	red hake	2.05	20.3
red hake	5.59	29.6	scup	0.05	13
rough scad	0.05	14	sea scallop	4.26	NA
round herring	0.08	15	silver hake	0.84	19.8
scup	378	23.6	silverside	0.05	11
sea raven	0.09	27	skate sp.	18.7	42.9
sea robin	1.44	14.7	spiny dogfish	13.6	73.5
sea scallop	1.67	NA	squid sp.	5.1	NA
silver hake	1.53	9.3	summer flounder	1.57	15.3
skate sp.	21.3	44.4	windowpane flounder	0.84	25.8
spiny dogfish	165	82.5	winter flounder	13.5	29.7
spot	0.05	20	yellowtail flounder	0.11	39
squid sp.	77.8	NA			
summer flounder	13.8	16.4			
tautog	0.24	30.3			
weakfish	0.05	23			
windowpane flounder	0.61	27.5			
winter flounder	19.6	28.8			

NA = not available



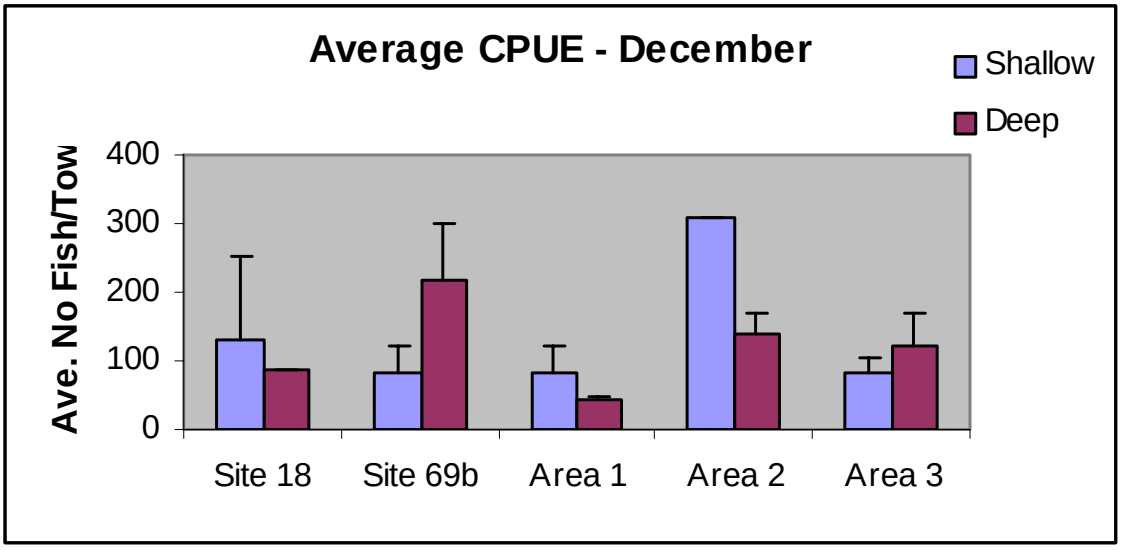


Figure 10. Average CPUE in Shallow Water and Deep Water Tows in November and December 2002.

Table 8. Average CPUE and Length of Species Collected from Deep and Shallow Otter Trawl Surveys During November and December 2002.

Deep			Shallow		
Species	**Mean CPUE**	**Mean Length (cm)**	**Species**	**Mean CPUE**	**Mean Length (cm)**
three-bearded rockling	0.1	29	four-spot flounder	1.7	29.1
four-spot flounder	6.42	28.7	alewife	2.76	17.8
alewife	0.19	23.3	Atlantic herring	2.11	26.3
Atlantic herring	0.33	25.4	Atlantic mackerel	0.72	32.1
Atlantic mackerel	0.05	30	black sea bass	0.17	12
black sea bass	0.9	16.6	blueback herring	0.06	12
bluefish	0.29	48	bluefish	0.06	56
butterfish	144	10.8	butterfish	202	10.8
goosefish	0.19	53	cunner	0.28	32.5
lobster	4.08	8.56	goosefish	0.06	83
longhorn sculpin	4.38	32	lobster	0.52	7.96
ocean pout	0.29	48.8	longhorn sculpin	3.22	30.3
red hake	5.23	28.7	ocean pout	0.29	43
scup	260	23.7	red hake	2.28	22.7
sea raven	0.09	27	rough scad	0.06	14
sea robin	1.28	15	round herring	0.09	15
silver hake	0.94	12.8	scup	116	23.5
skate sp.	17.8	44.7	sea robin	0.11	12
spiny dogfish	48.4	79.6	sea scallop	6.35	NA
spot	0.05	20	silver hake	1.49	13.5
squid sp.	57.5	NA	silverside	0.06	11
summer flounder	13.1	16.1	skate sp.	22.7	42.7
tautog	0.23	30.3	spiny dogfish	142	82
weakfish	0.05	23	squid sp.	24.7	NA
windowpane flounder	0.18	22.7	summer flounder	1.63	18.3
winter flounder	14.9	29.5	windowpane flounder	1.35	27
yellowtail flounder	0.05	42	winter flounder	20	28.8
			yellowtail flounder	0.06	36

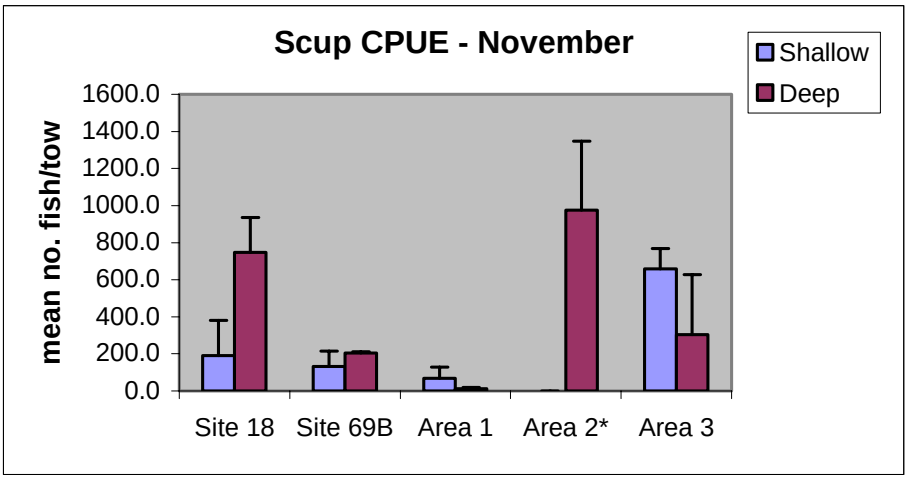
NA = not available

Scup, butterfish, squid, spiny dogfish, and various skate species were the most abundant species collected from both the shallower and the deeper water tows. Butterfish was the dominant species in the shallow areas, whereas scup was the dominant species in the deeper areas. Most species had a greater CPUE in either the deeper areas or shallow areas, but these differences may not be significant. Some species (i.e., yellowtail flounder, ocean pout, longhorn sculpin) had similar CPUE in both deep and shallow areas. There does not appear to be a significant difference in scup CPUE from deep and shallow areas ($P > 0.05$), nor does there appear to be a significant difference in winter flounder CPUE between deep and shallow areas ($p > 0.05$).

4.0 DISCUSSION

The November and December 2002 finfish surveys attempted to address the use of the deeper channels and depressions (i.e., topographic lows) on the ocean floor by various finfish species. The timing of these surveys attempted to capture the seasonal migration of finfish (particularly scup and winter flounder) to evaluate whether these fish use the deeper depressions during their movements in-shore and off-shore. It has been suggested that the route used during migrations is through these topographic low areas that lead from the more offshore locations to inshore areas and up into Narragansett Bay. Both winter flounder and scup, key commercial species in RIS, undergo migrations as water temperatures begin to cool in the fall and early winter. During the fall migration period, scup begin migration offshore and south, and winter flounder begin moving inshore. The design of this study did not allow for an adequate examination of the migration patterns of these two species. A repeated measurement sampling program with high spatial resolution would be required to identify true migratory activities and routes. However, the use of both deep and shallow areas by these species, as well as the use of the various regions surveyed, can be discussed.

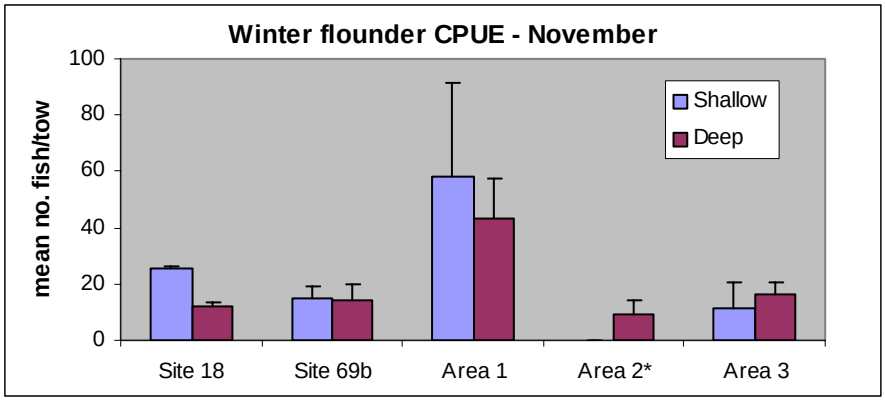
Based on the statistical results of the November and December surveys, it does not appear that scup prefer one habitat (i.e., deep areas or shallow areas) over the other during the timing of these surveys. However, it is important to note that this result is based on an analysis where there are a small number of samples and high variability in the data. Additional surveys would be needed to increase the power of the statistical analysis, which would increase the confidence in the findings. The results do suggest that scup appear to be fairly widespread throughout the Sound. During the November survey, scup were collected in all areas sampled (Figure 11). Both the Site 18 Area and Area #3 had the largest catches of scup, suggesting that, regardless of whether the location was deep or shallow, suitable habitat for this species exists in these areas. The very low catches at Area #1 may indicate less suitable habitat compared to the other areas.

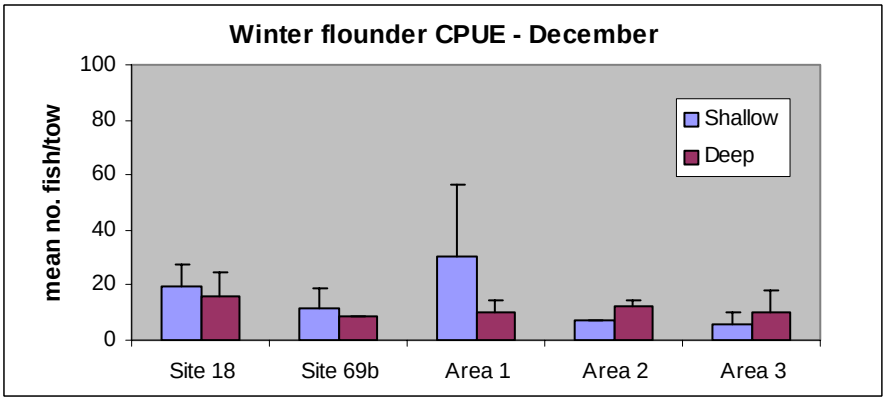


* No scup were collected in the shallow tow at Area 2 during November. Spiny dogfish were the only species collected in the shallow tow from Area 2.

Figure 11. CPUE of Scup Collected from Deep and Shallow Trawls during the November 2002 Finfish Surveys.

Like scup, winter flounder also do not appear to have a preference for deep or shallow habitats during the November and December surveys. Again, it is important to note that the statistical analysis used for this study is based on a small number of samples and high variability exists in the data. The results could be very different if additional samples were collected. The results do suggest, however, that winter flounder, like scup, are also widespread throughout the Sound. Winter flounder were collected at all areas sampled during both the November and December surveys (Figure 12), suggesting that adequate habitat exists at many locations for this species. The largest catches of winter flounder were within Area #1, the area that contained the smallest scup catches. The lowest catches of winter flounder were generally observed at Area #2, an area that contained high catches of scup. The low catches of winter flounder and high catches of scup at Area #2, and the high catches of winter flounder and low catches of scup at Area #1 suggest that prey availability, temperature preferences, or even species-specific interactions may select for one species or another at Areas #1 and #2 during the times of these surveys. Additionally, the absence of one species in a specific area may suggest the species has migrated out of the area, particularly if the species was present during the past survey.





* No winter flounder were collected in the shallow tow at Area 2 during November. Spiny dogfish were the only species collected in the shallow tow from Area 2.

Figure 12. CPUE of Winter Flounder Collected from Deep and Shallow Trawls during the November and December 2002 Finfish Surveys.

Although the abundance and distribution of many species may be related to physical parameters such as temperature and salinity, as well as sediment type, the abundance and distribution of scup and winter flounder (as well as the other finfish species caught during these surveys) does not appear to be related to the physical parameters observed during the surveys. Temperature, salinity, and DO did not fluctuate significantly at any of the geographic areas sampled (or within the deep and shallow locations within each area) to significantly alter which finfish species would be present.

In addition to physical water quality parameters, the surface sediments collected from the geographic areas also suggest that these areas are all fairly similar in sediment composition. That is, the sediments are generally characterized as predominantly sandy, with some areas of silty sand, sandy silt, sandy gravel, and gravel. Sediment type helps define which finfish prey species may be found in a specific region, and in turn, the abundance and distribution of prey species helps determine which finfish species may reside in an area. Therefore, a detailed evaluation of prey associated with sediment type would help discern whether the finfish abundance and distribution observed during these surveys could in any way be correlated with sediment type. The similarity in sediments across the areas sampled, in the absence of

information on prey species, suggests that the fish observed in these areas may not prefer one sediment type over another.

5.0 CONCLUSIONS

The information collected during the November and December surveys does not present a clear picture of the use of topographic lows (i.e., depressions) for migratory activities of finfish species in RIS. However, the information collected during these surveys does provide some insight as to the general abundance and distribution of various finfish in the five geographic areas sampled during November and December and provides some preliminary information pertaining to finfish use of shallow and deep areas within the Sound.

Significantly higher total catches occurred during the November sampling event. The largest catches were observed in Area #2 and Area #3, although one of the tows conducted in Area #2 was exceptionally high due to harvesting of a large school of spiny dogfish. During the December survey, the largest catches were observed at Area #2 and the Site 69B Area.

There does not appear to be a significant difference in the use of shallow and deep regions by finfish species during either November or December. However, the lack of significance observed may be entirely due to the high variability in the data. Regardless of whether or not the catch in the shallow and deep areas is significantly different, the fact that finfish species were caught in both deep and shallow regions of all geographic areas provides evidence that adequate habitat exists for finfish in all these locations. Until more scientific information is available, anecdotal information from local fishermen is the most reliable source of information available concerning the location of fish populations. While some species may prefer deep or shallow habitats and others may use both deep and shallow areas equally, the limited data from this survey does not support either preference. During different times of the year, shifts may occur in the use of these deep and shallow areas. Many more surveys throughout the year would be required to observe such a shift.

The two species of primary interest for this survey were scup and winter flounder because of their economic value and migratory activities in Rhode Island Sound. There does not appear to be a preference between the use of deep and shallow habitats by these species during the time of these surveys. Both species were found in deep and shallow habitats in all geographic regions, with the exception being the shallow habitat in Area #2 that contained only dogfish. The low catches of winter flounder and high catches of scup at Area #2, and the high catches of winter flounder and low catches of scup at Area #1 may indicate some preference for those geographic locations either due to habitat, prey availability, or species-specific interactions.

The physical conditions in all areas surveyed were similar and suggest that at least during the timing of the November and December surveys, the waters within Rhode Island Sound are well mixed and do not define the fish population. During colder or warmer periods, when waters within the Sound may stratify, fish may move into deeper or shallower areas to maintain a preferred temperature/salinity range.

6.0 REFERENCES

Battelle. 2003a. Final Survey Report, Fall 2002 Finfish Survey. Prepared under Contract No. DACW33-01-D-0004, Delivery Order No. 02. 16 pp.

Battelle. 2003b. Final Fall 2001 Sediment Characterization Report. Prepared under Contract No. DACW33-01-D-0004, Delivery Order No. 02. April 2003. 47 pp. plus Appendices.