DREDGE MATERIAL MANAGEMENT PLAN
EARLY BENTHIC PHASE LOBSTER SURVEY
FOR SALEM HARBOR

Prepared for

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1.0 INTRODUCTION

Sampling for early benthic phase (EBP) lobsters was conducted in Salem Harbor in October 1998 in support of the development of Dredged Material Management Plans for Salem Harbor. EBP lobsters have been defined as having a carapace length (CL) of 5-40 mm (Incze and Wahle 1991) and are highly shelter-dependent, gradually ranging out from their refuge as they reach 35-40 mm CL (MacKenzie and Moring 1985). This shelter dependent phase lasts for about two years, and when they reach about 45 mm CL they may begin nocturnal foraging away from their shelters (Cooper and Uzmann 1980). The occurrence of these animals in the CAD sites (potential disposal areas) may indicate the presence of lobster settlement habitat that would need to be considered in the evaluation of these sites as disposal sites.

Sampling for EBP lobsters has traditionally focused on hard substrate such as cobble and boulders, as this is preferred habitat (Palma et al. 1998). However recent work in Portland Harbor indicated that soft bottom habitat may also be used to some extent as habitat for EBP lobsters (Heinig and Cowperthwaite 1998). Small juvenile lobsters >28 mm CL were found in burrows in soft bottom substrate of Portland Harbor. Burrows occupied by lobsters were "U" shaped and the diameter of the openings was at least 40 mm.

The areas in Salem Harbor selected as potential disposal sites had a soft-bottom composition, and could provide some habitat for EBP lobsters. Therefore, it was decided to assess these areas as EBP lobster habitat using diver observations and soft-bottom suctioning. The finding that soft-bottom habitat may be used to some extent by EBP lobsters is a relatively new development. Therefore, the technique for assessing this habitat has not been standardized. The purpose of this study was to develop suctioning techniques that could be used in Salem Harbor and other areas, and to use the data collected in the development of these techniques as a preliminary assessment of the three CAD sites in Salem Harbor as EBP lobster habitat.

2.0 METHODS AND MATERIALS

Three areas in Salem Harbor, the navigation channel, S16-CAD and S19-CAD were assessed as habitat for juvenile lobsters by divers (Figure 2-1, 2-2). As this was a pilot study intended to develop the techniques necessary to assess soft-bottom areas as juvenile lobster habitat, all of the area in the designated CADs was not sampled.

In each CAD, divers swam along transects in an attempt to locate burrows that may contain EBP lobsters (Table 2-1). At each transect, observations were made as to substrate type, the presence of and type of burrows, and other biological observations including the presence of fish, shellfish and lobsters. These biological observations were only made at Transects 1 and 2 at S16-CAD. The beginning and end of each transect were located with differential GPS. Based on the observations made by divers, decisions were made on-site through consultation with the Massachusetts Division of Marine Fisheries (DMF) on where to attempt suction sampling.

Table 2-1. Location of Sampling Transects in Salem Harbor.

		Beginning		End		
CAD	Transect	Latitude	Longitude	Latitude	Longitude	Length (m)
Channel	1	42°32.153	70°50.967	42°32.290	70°51.242	400
	4	42°31.832	70°51.300	42°31.964	70°51.574	400
	6	42°31.618	70°51.526	42°31.751	70°51.788	400
	8	42°31.534	70°52.010	42°31.403	70°51.749	400
16	1	42°31.150	70°52.920	42°31.112	70°52.790	200
	2	42°31.106	70°52.921	42°31.074	70°52.877	200
	3	42°31.101	70°52.899	42°31.056	70°52.833	100
	4	42°31.095	70°52.960	42°31.039	70°52.920	100
	5	42°31.063	70°52.985	42°31.013	70°52.945	100
	6	42°31.182	70°52.906	42°31.123	70°52.834	100
19	1	42°31.547	70°52.450	42°31.456	70°52.357	200
	2	42°31.511	70°52.485	42°31.517	70°52.481	200
	3	42°31.563	70°52.434	42°31.473	70°52.367	200

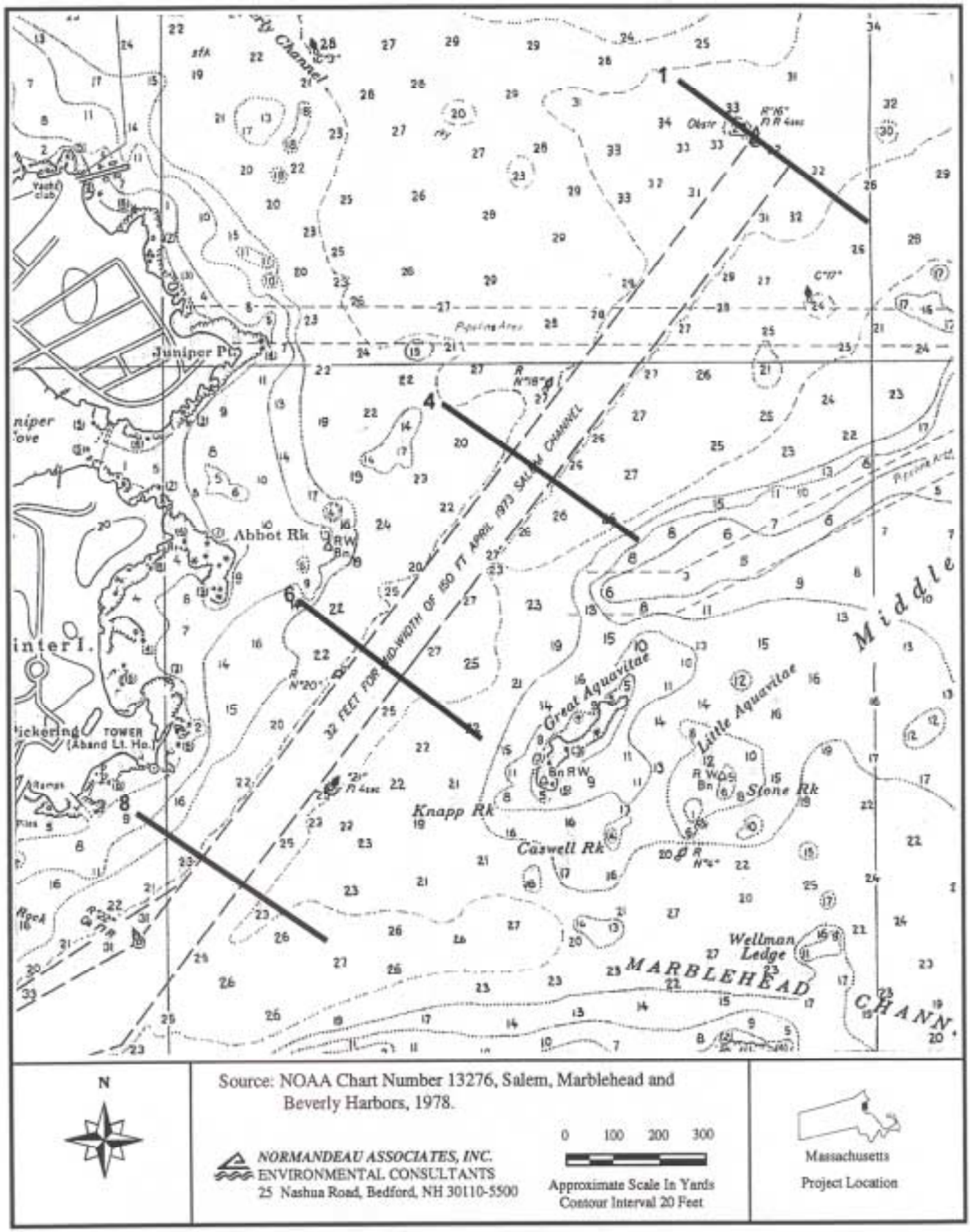

Figure 2-1. Approximate locations of juvenile lobster sampling transects in the channel CAD, Salem Harbor.

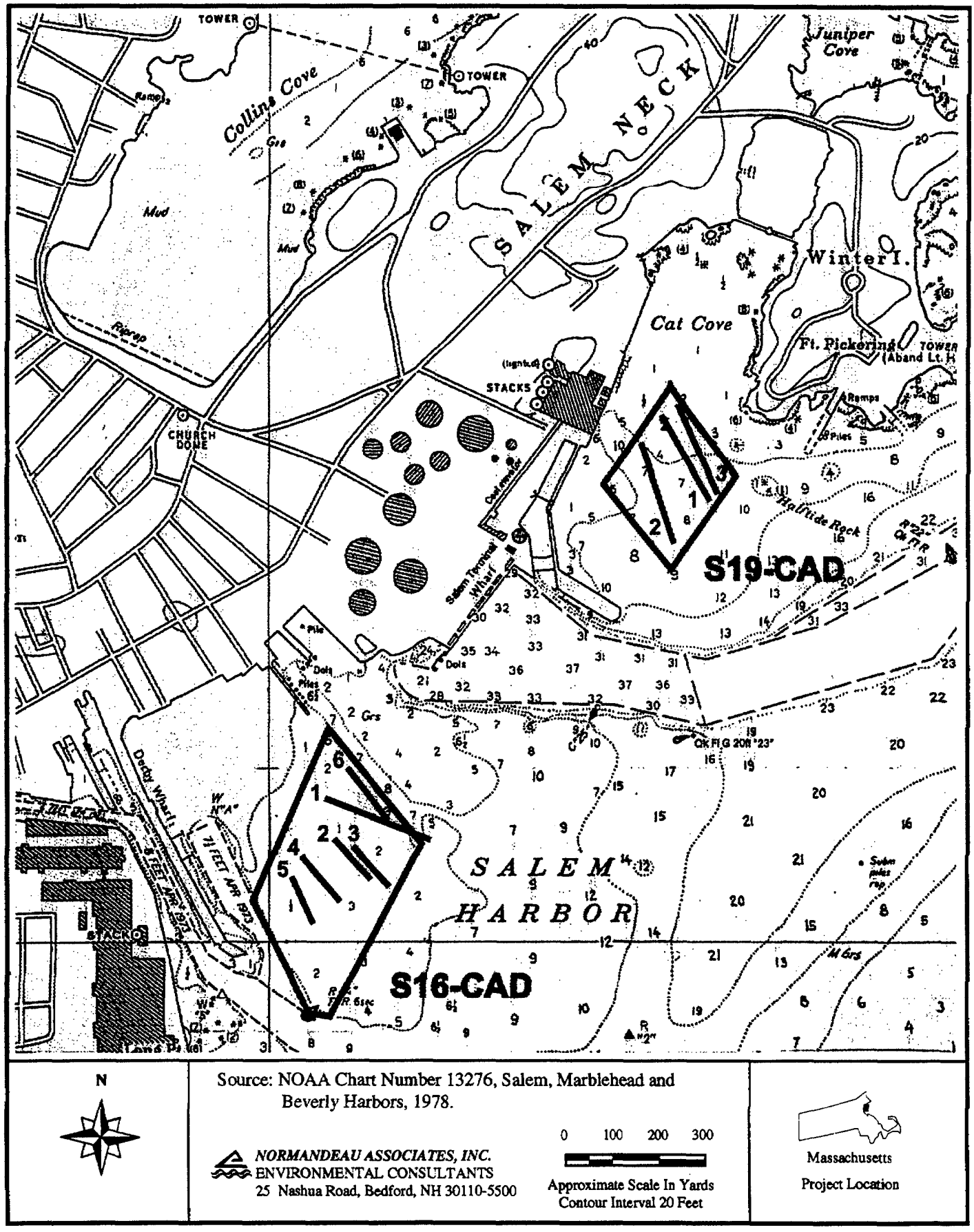

Figure 2-2. Approximate locations of juvenile lobster sampling transects in S16-CAD and S19-CAD, Salem Harbor.

Typically suction sampling was conducted in areas that had a high density of burrows with diameter > 40 mm, because we were developing the technique and wanted to collect samples that had a higher probability of occurrence of EBP lobsters. Because the allocation of suction sampling was neither random nor systematic, but was biased for the presence of burrows, these data should not be used to develop an estimate of standing crop, but instead are best used as an assessment of each area as EBP habitat.

Suction samples were collected using a PVC tube connected by an air hose to a SCUBA tank. The valve on the SCUBA tank was opened and air entered the PVC tube near the bottom and the resulting suction carried water and sediment up the pipe. At the top of the pipe a 0.8 mm mesh bag was mounted at a 45-degree angle where the sample was collected. Air and fine sediment exited the sampling bag through the mesh and coarse sediment and EBP lobsters (if present) were retained by the mesh. A 1/16 m^2 frame was placed on the quadrat to be sampled, and all sediment within the quadrat was suctioned to a depth of about 15-20 cm in the channel CAD and S19-CAD, and to a depth of about 10 cm in the harder substrate of S16-CAD. Later this technique was modified through the placement of a floating curtain on the quadrat. This curtain helped prevent EBP lobsters from exiting the quadrat during suction sampling.

In the channel, biological observations were made along four transects, and six suction samples were collected at Transect 6 at locations were many burrows were present. At S16-CAD the process was more systematic. Biological observations were made at Transects 1 and 2 initially, and based on these observations it was decided to collect suction samples at these transects, and at four more transects (3, 4,5,6) (Figure 2-2). Suction and hand excavation samples were collected within 10 m segments along these transects. Within the 10 m segments, sample sites were selected based on the presence of oysters or macroalgae that might be shelter for EBP lobsters. At S19-CAD, biological observations were made at three transects. Based on these observations, two suction samples were collected at Transect 2.

3.0 RESULTS

The Channel CAD was assessed as potential habitat for juvenile lobsters on 5 October. Four transects each 400 m in length were assessed by divers. Transect 1 was primarily silt at depths of 12.2 to 13.4 m (Appendix A). A total of 83 burrows were counted and diameters ranged from 20 to 90 mm. Biota observed included *Cancer* crabs, skates, adult lobsters and kelp (*Saccharina* sp.). Transect 4 was slightly shallower at 10.7 to 13.1 m. The substrate was silt with rocks present at 100 to 200 m. More burrows were observed (133) and diameters ranged from 20 to 90 mm. *Cancer* crabs, mussels, adult lobsters, and sea urchins were observed. Transect 6 was silty with depths between 8.8 and 14.3 m. Burrows observed (123) ranged in diameter from 20 to 110 mm. *Cancer* crabs, kelp, adult lobsters and skates were observed. Six suction samples were collected between 370 and 400 m of Transect 6 at locations where burrows were present. Three lobsters with carapace length of 42, 42 and 31 mm were collected in three samples and the other three samples were empty. Depths at Transect 8 ranged from 8.8 to 14.3 m and the substrate was

silty with silt and with mud present between 200 and 400 m. Burrows (125) ranged in diameter from 20 to 90 mm. Hake sp., adult lobsters, mussels, shrimp and winter flounder were present along this transect.

S16-CAD was assessed on 6 October and again on 29 October. On 6 October reconnaissance dives were made similar to those in the channel, except the transects were 100 m long, except for Transects 1 and 2 which were 200 m long. Transect 1 ranged in depth from 4.5 to 5.2 m (Appendix B). The substrate was silt and many age 0 and age 1 winter flounder were observed along with oysters. Based on qualitative observations by DMF, density of age 0 and age 1 winter flounder was estimated 6 to 12/m^2 with the distribution of flounders associated with the presence of cover. In Transect 1, 33 burrows were found, and four EPB lobsters (CL = 27, 10, 28, and 20 mm) were collected by divers and measured. Dives were also made along Transect 2 however, failing light conditions and falling tide required that a video record be made of this transect and then reviewed later. Review of the video indicated that the substrate was slightly more silty than in Transect 1. Sea lettuce (*Ulva*) and green fleece (*Codium*) were present at Transect 2 along with *Cancer* crabs, green and hermit crabs, oysters, and one adult lobster.

Based on the observations made in the reconnaissance dives, it was decided to take suction samples at each of the transects above, and at four new transects (3, 4, 5, and 6). Due to the harder substrate at S19-CAD, and the presence of macroalgae and oyster clumps that could prevent the diver from seeing lobsters escape from the sampling quadrat, the suctioning technique was modified from that used in the channel. A sampling frame with a floating curtain was used to prevent juvenile lobsters from exiting the quadrat. Furthermore, two divers were used to collect each sample. One diver operated the suction mechanism, while the second diver observed any lobsters that escaped from sampling. At each transect, burrows were sampled by both suctioning and by hand excavation. Three juvenile lobsters were found at Transects 1 and 2, and the carapace lengths were 12, 13, and 24 mm (Table 3-1).

S19-CAD was assessed on 13 October when three 200-m transects were investigated by reconnaissance dives. Transect 1 had a silty substrate and the depth was about 3.7 to 5.5 m (Appendix C). Oysters, green crabs and hermit crabs were observed, but more importantly a bed of eelgrass was present within the first 50 m of the northwestern end of the transect. The density of eelgrass shoots at this location ranged from 20 to 36 shoots per 1/16m^2. Patches of eelgrass were present throughout the rest of the rest of the transect and density of shoots was 6 to 18 per 1/16m^2. Conditions were similar at Transect 2, except no eelgrass was observed. The number of burrows observed was highest at Transect 2, but fewer than observed in the channel. Due to the paucity of burrows, only two airlift samples were collected and no juvenile lobsters were collected. At Transect 3, few burrows were observed, but eelgrass was present within 22 to 38 m of the northwestern end of the transect at a density of 25 to 37 shoots per 1/16m^2. Additional small patches (3 to 11 shoots per 1/16m^2) were present near the southeastern end of the transect.

Table 3-1. Results of Suction Sampling and Hand Excavation for Juvenile Lobsters at S16-CAD in Salem Harbor.

Transect	Number of Samples	Number of Lobsters	Carapace Lengths (mm)
1	10 suction, 10 hand	2	12,13
2	10 suction, 40 hand	1	24
3	10 suction, 10 hand	0	--
4	10 suction, 10 hand	0	--
5	10 suction, 10 hand	0	--
6	10 suction, 10 hand	0	--

4.0 DISCUSSION

The suctioning technique was a successful method for collecting EBP lobsters in soft-bottom habitats. No EBP lobsters were observed escaping from the sampling frame with a curtain when one diver used the suction device and a second diver made observed the sampling process. EBP lobsters were captured in suction samples in the channel and at S16-CAD, but none were captured at S19-CAD. It is likely that this is an accurate representation of the quality of these areas as juvenile lobster habitat. Many juvenile and sublegal-sized lobsters (< 83 mm CL) lobsters were observed at these sites as part of the biological observations, while no lobsters were observed at S19-CAD. Furthermore, burrows observed at S19-CAD were not lobster shelters based on observations of the DMF biologist.

The substrate in the channel CAD was primarily soft-bottom silt or mud, and the three EBP lobsters captured in this habitat in the channel ranged in carapace length from 31 to 42 mm, and probably were at least two years old. Although lobsters of these sizes are still shelter dependent, they can begin to make excursions out from their shelters, particularly at night (MacKenzie and Moring 1985). Lobsters undergo a shift in behavior in their second year and begin to move actively between sheltering patches (Wahle and Incze 1997). Therefore these lobsters could either have been using burrows in the soft bottom, or making excursions between sheltering habitat provided by hard substrate. As there was little hard substrate habitat observed at any of the four transects in the channel, these lobsters may have been using soft substrate as their primary habitat. It is unknown if these lobsters settled on the soft-bottom habitat in the channel. Within their first two years of life these lobsters could have moved from their initial settlement habitat, which was likely to be hard substrate, to the soft-bottom area of the channel.

S16-CAD was primarily sand substrate, and there were numerous clumps of hard substrate formed by oyster shells with patches of *Ulva* and *Codium* present. The oyster shells and patches of macroalgae provided sheltering habitat for EBP lobsters and divers observed EBP lobsters associated with these features. Two of the three lobsters captured in the suction samples had CLs of 12 and 13 mm, and one lobster with a CL of 10 mm was observed by divers during reconnaissance dives. These lobsters were spawned in 1998 and settled to the bottom in the summer or early fall. Due to their small size, it is likely that these lobsters settled in S16-CAD and took advantage of the habitat provided by the oyster shells and patches of macroalgae. Furthermore, it was apparent that S16-CAD was used as nursery habitat for age 0 and age 1 winter flounder. Numerous winter flounder were observed moving away from the divers as they swam along the transects. The number observed was probably an underestimate of the true population as the poor visibility probably allowed many flounder to swim away undetected.

The substrate at S19-CAD was primarily silt, and no lobsters were observed in the reconnaissance dives or in the suction samples. Based on the lack of observed lobsters, S19-CAD did not appear to be good habitat for juvenile lobsters. However, an eelgrass bed was found at the northwestern ends of Transects 1 and 3. The precise extent of this eelgrass bed was not mapped

because it was not an objective of this study, but the bed appeared to extend for about 50 m to the southeast along Transects 1 and 3.

One of the goals of this study was to develop the technique for suction sampling for EBP lobsters on soft-bottom substrate. The sites for suction sampling were not randomly selected, but instead, were selected based on the presence of potential lobster burrows. Therefore, the areal extent of the burrows, and number of burrows helped determine the placement of the sampling unit, and the number of samples collected. For these reasons, mathematical expansion of these data over an entire disposal site would likely overestimate the density of EBP lobsters in an area, and our relative abundance cannot be directly compared with a sampling program where the sampling sites were randomly selected. The mean density of EBP lobsters in the channel was highest among the sites in Salem Harbor, at 0.5/quadrat. At Transects 1 and 2 of S16-CAD density was 0.04/quadrat (suction and excavation samples). No EBP lobsters were found at S19-CAD.

5.0 CONCLUSIONS

1.0 Suction sampling in soft-bottom habitats is a valid quantitative method for collecting EBP lobsters.

2.0 The channel CAD and S16-CAD contains habitat for EBP lobsters.

3.0 S19-CAD does not appear to contain habitat for EBP lobsters.

4.0 S16-CAD contains juvenile winter flounder habitat.

5.0 S19-CAD contains eelgrass habitat.

6.0 LITERATURE CITED

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APPENDIX

Appendix Table A. Biological Data Collected at the Channel CAD in Salem Harbor.

Transect	Segment (m)	Depth (m)	Substrate	Burrows No./Diameter (mm)	Observations
1	0-100	12.2-12.8	silt	1/40, 2/90, 2/60, 3/10	*Cancer* crabs, skates, 3 lobsters
1	100-200	12.2-13.4	silt	2/40, 2/60	*Cancer* crabs, skates, 3 lobsters
1	200-300	12.2-13.1	silt	6/90, 9/70 6/90, 2/20	*Cancer* crabs, 9 lobsters
1	300-400	12.2-13.1	silt	1/30, 20/90, 13/40, 8/20, 6/30	*Saccharina*
4	0-100	10.7	silt	20/20, 2/30, 4/40, 10/10-20	*Cancer* crabs
4	100-200	10.7-13.1	silt/rocks	1/30, 8/40, 50≥90	1 lobster
4	200-300	11.6-12.5	silt	6/20, 3/30, 6/90	7 lobsters, mussels
4	300-400	9.1-11.6	silt	20/20, 3/90	Mussels, urchins
6	0-100	8.8-10.4	silt	1/20, 9/30, 2/90, 10/100	*Cancer* crabs, *Saccharina*, mussels
6	100-200	10.7-13.7	silt	11/30, 1/40, 30/50, 5/70, 8/90	1 lobster, *Cancer* crabs
6	200-300	11.3-14.3	silt	1/30, 8/40, 6/50, 4/70	Skates, *Cancer* crabs
6	300-400	10.7-11.3	silt	3/20, 4/40, 4/50, 3/60, 3/70, 8/90, 2/110	Skates
8	0-100	8.8-11.0	silt	3/20, 3/30, 8/40, 2/60, 10/90	Hake, *Cancer* crabs, 3 lobsters
8	100-200	11.0-13.7	silt	2/30, 2/40, 16/60, 50/90, 10/>90	Hake, mussels, 4 lobsters
8	200-300	13.7-14.3	silt/mud	2/30, 7/40, 3/50, 1/60, 1/70	Shrimp, flounder, *Cancer* crab, skates, 1 lobster
8	300-400	14.3	silt/mud	2/40, 1/50, 1/60, 1/70	*Cancer* crabs, skate, hake, winter flounder

Appendix Table B. Biological Data Collected at S16-CAD in Salem Harbor.

Transect	Segment (m)	Depth (m)	Substrate	Burrows No./Diameter (mm)	Observations
1	0-100	4.5-5.2	sand	2/20, 4/40, 1/60, 2/90	Oyster, green crab, winter flounder, *Codium*
1	100-200	5.2	sand	3/90	Oyster, 3 lobster, green crab, *Ulva/ Codium*
2	0-100	5.2	silt, sand/silt	—[a]	*Ulva/Codium*, *Cancer* and green crabs, oysters, 1 lobster
2	100-200	5.2	silt	—	*Ulva/Codium*, Hermit crabs, oysters (few), green crabs

[a] Biological data for Transect 2 recorded from review of video. It was not possible to count or measure burrows from the video.

Appendix Table C. Biological Data Collected at S19-CAD in Salem Harbor.

Transect	Segment (m)	Depth (m)	Substrate	Burrows No./Diameter (mm)	Observations
1	0-100	3.7-4.6	silt	1/20, 2/80	Eelgrass, green and hermit crabs, oysters, winter flounder
1	100-200	4.6-5.5	silt	1/80	*Cancer*, green and hermit crabs, mussels
2	0-100	4.6-5.8	silt	1/20, 2/80, 3/90	Hermit and green crabs, 2 lobsters, mussels
2	100-200	4.6-4.9	silt	2/20, 2/30, 7/40, 4/50-70, 2/80, 6/90	Hermit and green crabs, oyster, mussels, *Saccharina*
3	0-100	1.8-2.7	silt	none	Eelgrass, hermit and green crabs, oyster, hake
3	100-200	2.7-3.0	silt	3/20, 1/80	Hermit, green and *Cancer* crabs, 3 lobster, mussels, *Saccharina*