Dredged Material Management Plan
Soft-Bottom Suction Sampling Pilot Program

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Introduction

As part of the Dredged Material Management Plan (DMMP) process, it is important to determine if the proposed in-water disposal sites are occupied by juvenile lobster (*Homarus americanus*), particularly "early benthic phase" (EBP) lobster which range from ≈ 5 to 40 mm CL (Wahle & Steneck 1991). EBP lobster are highly cryptic (Barshaw & Bryant-Rich 1988; Wahle & Steneck 1992), gradually ranging out from their refuge as they grow (Hudon 1987; Wahle 1993). Barshaw & Bryant-Rich (1988) observed newly-settled lobster to spend over 99% of their time inside the burrow, apparently drawing in food (plankton) by fanning their pleopods to create a current. This shelter-dependent phase lasts for approximately two years, by which time the lobster (≥ 25 mm CL) may move more extensively (Wahle 1993). The presence of these animals would indicate areas of settlement habitat which may need to be excluded from consideration as disposal sites for resource and habitat protection.

To date, Division of Marine Fisheries (DMF) sampling for EBP lobster within Massachusetts waters has been conducted in areas of "hard bottom," in particular, cobble and small boulders. From work performed both in the laboratory (Botero & Atema 1982; Barshaw & Bryant-Rich 1988) and in the field (Hudon 1987; Wahle & Steneck 1991), cobble is believed to be the preferred habitat of EBP lobster. In the laboratory, Stage IV and V lobster exhibited such a marked preference for cobble bottom that they would delay permanent settlement for as long as two weeks if placed over a featureless sand bottom (Botero & Atema 1982). However, during similar trials, newly settled lobster were observed to construct and maintain burrows in mud substrate (Berrill & Stewart 1973; Berrill 1974; Botero & Atema 1982). Further, a 1998 survey of potential dredge sites in Portland Harbor, Maine revealed the presence of small lobster (≥ 28 mm CL) in burrows in soft mud substrate (Heinig & Cowperthwaite 1998).

The purpose of this pilot study was to determine if soft mud bottom is utilized as settlement habitat within the harbors under study. Sampling under the DMMP process would otherwise likely be limited to adjacent hard bottom areas, which may not accurately characterize the EBP lobster resource.

History of Maine sampling

In 1998, MER Assessment Corporation (MER) was charged with surveying for lobster at potential dredge sites on the bottom of Portland Harbor. Initial visual surveys (with SCUBA) of these soft-bottom areas in March and April 1998 yielded no sightings of lobster on open bottom. However, upon subsequent closer examination and excavation of burrows observed in the substrate, many were found to contain lobster ranging in size from 28 to 120 mm CL in size. Occupancy rates in the burrows were nearly 100%; the divers believed that zero findings resulted from the lack of sighting lobster during excavation due to poor visibility (C. Heinig, personal communication). It was their contention that the bottom was too soft for a burrow to maintain its structural integrity if unoccupied. This supposition is supported by the work of Botero & Atema (1982) and Barshaw & Bryant-Rich (1988) who reported that burrows constructed in mud required constant maintenance, and often collapsed. All burrows were at least u-shaped with two openings, although some more complex burrows were also exposed. Follow-up work consisted of video transect surveys to estimate burrow density. Occupancy estimates for these burrows were based on the earlier excavation work. Interestingly, when adjacent cobble areas were sampled via suction, no lobster were found (C. Heinig, personal communication).

Methods

Salem Harbor was chosen as the pilot study site because of its close proximity to existing DMF hard-bottom EBP sampling sites (Bakers and Coney Islands, and Peaches Point), to allow for qualitative comparison of findings. Sampling took place in October 1998, at three areas (Figure 1.) within the harbor:

1). along transects across the contiguous ATC CAD/OD areas (S6, S14, & S15);

2). at CAD sites S16 - Long Point/Derby Wharf;

3). at CAD site S19 - Cat Cove.

The areal boundaries and reference points for these stations were determined through consultation with the contractor, Normandeau Associates.

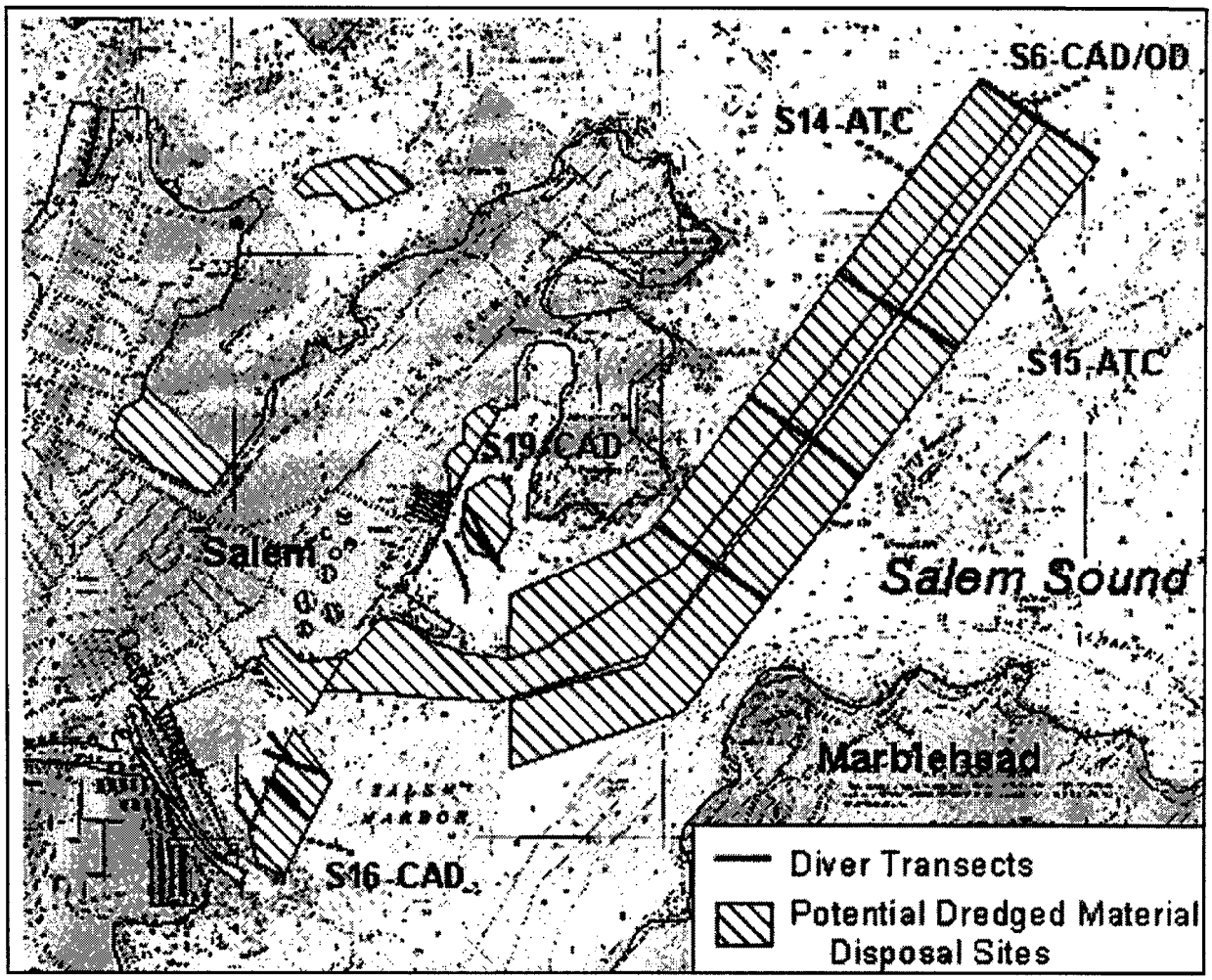

Figure 1: Position of early benthic phase (EBP) lobster sampling in Salem Sound (A. Wilbur, MCZM).

Visual transect surveys of the substrate found within the selected areas preceded benthic sampling. Differential geographic positioning system (DGPS) coordinates were recorded at the beginning and end points of each transect, and a metered transect line with surface buoys was used to delineate position on the bottom. Divers noted the presence and location of any burrows, the occurrence of finfish, macroalgae, and other invertebrates, and recorded a qualitative description of the bottom, i.e., mud, rock, sand, etc. In the event that no burrows were found within the selected area, the divers continued on to a preselected alternate site. Underwater video was used to document the visual surveys.

Current DMF hard-bottom methodology employs the use of a 0.5 m quadrat to quantify sampling

effort, allowing spatial and temporal comparisons. For the purposes of this study, our original intention was to duplicate this procedure, however, given the erratic occurrence of burrows, quantification of burrow density was nearly impossible. Further, as quantitative comparisons between harbors were not required, the unit of sampling effort was defined as the burrow. Soft-bottom habitats are typically featureless, and construction of a burrow is often the only way to obtain cover. If there are no burrows present, it is highly unlikely that there will be any lobster present. Sampling quadrats were deployed by the Normandeau divers to aid in defining the areal extent of the burrow and the number of openings.

All burrows observed along a transect were excavated to determine if lobster were present. In Portland Harbor, burrows < 40 mm in diameter did not contain lobster. However, in the current study at least a portion of any such burrow was excavated to determine if they contained recent settlers or age 1+ lobster. Both suction sampling and hand excavation were used to expose the burrows.

A modification to the sampling protocol was made after the surveys on 6 October 1998. In the soft substrate of the open channel areas, the contractor was able to utilize a single diver suction technique. This allowed for greater coverage of the sampling area. However, at CAD Site S16, the substrate was much harder, and the lobster were found in close association with mixed clusters of European oysters (*Ostrea edulis*) and macroalgae (*Codium* and/or *Ulva* spp.). During the visual survey, several small lobster (≤ 30 mm CL) were observed (but not captured) by the DMF divers. However, the Normandeau team obtained no lobster of this size at that time. The presence of the oyster/algae clusters may have prevented the diver from seeing lobster escaping to the side of the suction sampler. To diminish the potential for undetected escapement, subsequent sampling was performed by a pair of divers using a quadrat with a floating curtain to surround the clump. After placing the quadrat, the divers suctioned across the top of the algae to capture any "loose" lobster before overturning the clusters. The open portions of these transects - lacking clusters - were not excavated.

Results

A comprehensive reporting of these data can be found in the survey report by Normandeau Associates, Inc. (1999). To aid the reader, a summary table (Table 1) has been included here.

Table 1: Summary of suction and hand sampling of early benthic phase lobster (EBP) and scuba observations of potential dredged material disposal sites in Salem Harbor (compiled from Normandeau Associates, Inc. 1999 by A. Wilbur, MCZM).

Disposal Site	Number of EBP Lobster (mm CL)	Number of Burrows*	Burrow Diameter Range (mm)	Substrate Type	Benthic Characteristics
S14 ATC	None collected	149 / 600m	10 – 100	silt, silt/rocks	*Cancer* crabs, lobsters, mussels, skate, hake, kelp
S15 – ATC	3 (42, 42, 31)	117 / 500m	20 – 110	silt, silt/mud	*Cancer* crabs, shrimp, lobster, mussels, urchins, winter flounder, skate, hake, kelp
S6 - OD CAD	None collected	196 / 500m	20 – 90	silt, silt/rocks, silt/mud	*Cancer* crabs, lobsters, mussels, skate, hake
S16 – CAD	Suction sampling: 3 (12, 13, 24); hand collection: 4 (10, 20, 27, 28)	not available		sand, sand/silt, silt	green crabs, lobster, oyster shells, *Codium*, *Ulva*, juvenile winter flounder (high abundance)
S19 – CAD	None collected	39 / 600m	20 – 90	silt	*Cancer*, green & hermit crabs, lobsters, oysters, mussels, hake, winter flounder, kelp, eelgrass

** burrows represent biological activity, including the presence of fish, shrimp, crabs, lobster, etc.*

1. Channel Surveys – S14 & S15 ATC, and S6 CAD/OD:

Four 400 m transects were laid across the navigation channel so as to encompass the proposed over-dredge sites. The bottom was composed of soft silt/mud, and was nearly featureless, with a few ledge outcroppings observed near some of the channel edges. Numerous burrows were observed while swimming along the survey line. Most did not lay underneath the line, but were found in irregularly spaced small clusters (2 - 5 burrows) out to either side of the line. Lobster found in these burrows ranged in size from 31 - 60 mm CL; no newly-settled lobster were observed. Burrows that were unoccupied appeared to be collapsing. Numerous green crabs (*Carcinus maenas*), *Cancer* crabs, and little skate (*Raja erinacea*) were also observed.

2. CAD Site 16 – Long Point/Derby Wharf:

After appraising the area by boat, buoys were deployed for three 100 - 200 m diver transects. Given the much smaller footprint of this site, the 400 m line was not used. Instead, the DMF divers used an underwater compass and depth gauge to aid navigation. In the shallow portion of the site (8 ft at the

time of the survey; probably 1-2 ft at MLW), we observed many clusters of European oyster with attached *Codium* and/or *Ulva*. The substrate had a greater sand component, and was much firmer than in the channel. Burrows with small lobster could be seen underneath the oyster clusters. Most of the lobster were estimated to be between 30 - 50 mm CL in size, although some probable EBP lobster were also observed when the algae were disturbed. No attempts at quantification were made in order that the transect remain undisturbed for the contractor to suction sample (Table 1). When depth increased beyond 8', the substrate became softer, similar to that found in the channel. Some burrows with larger (> 45 mm CL) lobster were observed. Great numbers of juvenile winter flounder, both age-0 and age-1+, were seen sheltering in the algae/oyster clusters. Because of the bottom cover, accurate enumeration was not possible; however, the divers estimated 6 - 12 flounder per 0.5 m^2. Their dispersion would best be described as aggregated, and linked with the presence of cover.

Following modification of the sampling protocol, the three original transects were resampled, and four new ones within the proposed CAD boundaries were surveyed and sampled.

3. CAD Site 19 - Cat Cove:

Using a metered line, three 200 m transects were surveyed within the proposed boundaries of the CAD site. Starting at the ends nearest the power plant, the first 20 - 40% of each transect was covered with a dense stand of eelgrass (*Zostera marina*). Its distribution and density became more patchy as the divers moved away from shore, becoming sparser, and finally absent as the divers moved into the active mooring area of the harbor. Few burrows and no juvenile lobster were observed. Other invertebrates noted included green crabs and European oyster.

Discussion

1. Suitability of Technique

As previously stated, the purpose was to determine if the proposed in-water disposal sites serve as settlement habitat for EBP lobster. It is clear from the literature (Hudon 1987; Barshaw & Bryant-Rich 1988; Wahle & Steneck 1992; Wahle 1993), that newly settled lobster will be restricted to protective shelter for approximately the first two years of benthic life. Although not the preferred habitat, EBP lobster will settle on soft mud substrate, and can flourish there (Barshaw & Bryant-Rich 1988). The presence of EBP settlement habitat would indicate that a selected area should be excluded from consideration as a disposal site, particularly in light of the major concern with the current status of the lobster resource in Massachusetts' waters. Conversely, although abundance may vary from year to year, the absence of EBP lobster from this type of marginal settlement substrate provides evidence that the area is not important to settlement. Larger juvenile lobster (40-60 mm CL) may be observed during sampling, but since they are highly mobile, their presence would not necessarily indicate settlement to a given area.

With regard to the purpose of determining if soft mud bottom is utilized as settlement habitat, this pilot study was a success. Under existing Division of Marine Fisheries EBP sampling protocol, areas with soft substrate are not sampled. As such, sampling effort for the DMMP process would have been conducted in the nearest adjacent hard bottom areas, with the result of an incomplete evaluation of available EBP lobster habitat within that harbor. Consequently, the techniques developed during this study are being considered for inclusion in current DMF sampling programs.

2. Survey of Proposed Salem Harbor Disposal Sites

When designing the pilot study, comparisons were planned between the findings of this study and DMF data from nearby hard bottom sites. However, upon completion of the field study, it became apparent that such comparisons could not be made due to the widely disparate sampling techniques. During suction sampling on hard bottom, the quadrat is set in a random/haphazard fashion, and the sampling unit is the quadrat; densities are reported as number of lobster per m^2. However, in soft substrate the sampling unit is the burrow. If burrows are not found, there are no lobster present. As the burrows are

irregularly distributed, sampling effort is highly directed. Given these differences, comparison between the two data sets was not possible.

As this pilot study was primarily intended to determine the viability of this substrate as settlement habitat, and to provide an opportunity for the divers to gain familiarity with the technique, we did not comprehensively survey the entire bottom designated as potential disposal sites. However, based on personal observation, and the data collected by Normandeau Associates, Inc., the Division of Marine Fisheries has sufficient information to characterize the proposed Salem Harbor in-water disposal sites.

A. Channel S14 & S15 ATC, and S6 CAD/OD Sites

Burrows found in the channel area are characterized as transient-use shelters, constructed and abandoned as needed. It is likely that the entire channel area serves in this capacity. Though still somewhat shelter-dependent, lobster collected from this area were large enough to be capable of movement toward suitable cover. This area was apparently not settlement habitat.

B. CAD Sites S16 & S19

1). At CAD Site S16, in the shallow, inner region of the harbor, hard sand substrate combined with the presence of bivalve/macroalgae clusters provided the structure and cover needed for construction of long-term shelters. Visual observation of small, highly shelter-dependent animals and the collection of EBP lobster by Normandeau would seem to support this contention. Additionally, this bottom type provides ideal cover and habitat for juvenile flounder, evidenced by the sighting of numerous YOY and age 1+ fish. The value of this portion of the harbor as lobster and finfish habitat should preclude its use as a disposal area.

2). Few burrows and no juvenile lobster were found at CAD Site S19. However, a dense bed of eelgrass covered large portions of this site. Aside from the intrinsic value of eelgrass as habitat, dense areal coverage can prevent detection of small animals or bottom constructs. Barshaw and Bryant-Rich (1988) observed that lobster burrows in areas of eelgrass were smaller and harder to

see than burrows in other substrates. Further, they found that mortality rates of EBP lobster sheltering in eelgrass were lower than in mud or cobble bottom. A shift of the proposed boundaries of this site toward the mooring field, which was devoid of eelgrass, may allow continued consideration of this area for disposal. However, issues of physical disturbance and siltation during dredging will remain.

Conclusions and Recommendations

1. Surveys for EBP lobster can be performed on soft-bottom in the harbors under study using the survey/suction protocols developed during this program.
2. Techniques developed during this pilot study are under consideration for inclusion in other DMF sampling programs.
3. No further changes in sampling methodology are planned prior to the Gloucester and New Bedford Harbor EBP surveys.
4. The visual survey portion of this methodology provides a valuable means of qualitatively assessing the potential for use of these habitats by other species of fish, invertebrates, and macroalgae.
5. Although not all-inclusive, the results of this survey are likely sufficient to characterize the EBP habitat potential of the proposed disposal sites:
   - The Channel ATC/CAD sites do not appear to be settlement habitat for EBP lobster.
   - CAD Site S16 provides habitat for both EBP lobster and juvenile winter flounder.
   - Portions of CAD Site S19 contain significant stands of eelgrass, which may provide habitat for EBP lobster and juvenile finfish.

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