5.0 BIOLOGICAL CHARACTERISTICS OF THE CANDIDATE SITES

This section provides summaries of comprehensive, detailed characterizations of the habitat and populations of aquatic species at candidate sites 1 and 2, relying on both extensive field survey efforts and evaluations of available information from other studies. A substantial amount of information on the sites is available in these reference sources. The emphasis of the discussion in these sections of the DEIR is to provide an indication of the suitability of the sites for dredged material disposal based on the existing biological resources (e.g., are there any obvious, limiting factors that will preclude or discourage use of either site). This discussion also provides a comparison of the biological conditions at candidate sites 1 and 2, important in the determination of whether one site will be the preferred alternative for continued dredged material disposal relative to the other. Anticipated impacts to the conditions and resources of each site are discussed in detail separately in Section 7 of the DEIR.

The following are included in this section on biological characterization of the sites:

Section 5.1: A description of the benthic community at candidate sites 1 and 2, including a description of the benthic habitat characteristics and results of benthic community characterizations (i.e., identification of species present in the sediments) for each site.

Section 5.2: Finfish and shellfish resources, including sections focused on motile finfish species likely to utilize the area of the bay in the vicinity of the sites; potential use of the sites by aquatic species for nursery and spawning areas; and suitability of the sites for lobster and shellfish habitat.

Section 5.3: Essential Fish Habitat (EFH) is defined for the area of Buzzards Bay expected to be moderately impacted by disposal of clean dredged material. Economically important EFH designated species and their life stages are presented relative to seasonal restrictions that might be placed on any future dredged material disposal activities.

Section 5.4: Discussion of the potential use of the water column in the vicinity of candidate sites 1 and 2 by threatened, rare and endangered species is provided as a separate section to ensure compliance with the state and federal regulations focused on protection of these important species.

Section 5.5: Discussion of the use of the water column in the vicinity of candidate sites 1 and 2 by other wildlife, particularly avifauna.

Section 5.6: Discussion of the proximity of candidate sites 1 and 2 to wetland resources and submerged aquatic vegetation (SAV).

5.1 Benthos

5.1.1 General

The benthic community includes organisms living within and on top of the sediments. Motile species such as finfish and lobster that utilize the substrate, and commercially and recreationally harvested shellfish, are discussed in Section 5.2. Benthic organisms include a wide variety of mollusks, crustaceans, and worms that provide an important food source for aquatic species and birds. The benthic habitats present at the candidate sites are a function of factors such as sediment composition (e.g., grain size), degree of sediment oxygenation (as reflected in the depth of the redox-potential discontinuity or RPD), degree of physical sediment disturbance at the site, and chemical stressors that may affect suitability of the substrate for sensitive species.

Characterizations of the existing benthic community are required to predict the likely impacts from disposal activities. The benthic habitat at the candidate disposal sites has been characterized from SPI surveys, and the benthic community has been characterized by identification of the organisms inhabiting the sediment. The SPI surveys provided information on the physical and biological characteristics of the surface sediments, such as the type and quality of the benthic habitat, while the grab samples provided more detailed information on the type (species) and abundance of macrofauna present in the sediments. The combination of these two survey methods therefore provides complimentary, detailed information to characterize existing benthic conditions within each site and compare the two sites.

Sediment-profile imaging is a benthic sampling technique in which a specialized camera is used to obtain undisturbed, vertical cross-section photographs (profiles) of the upper 15 to 20 centimeters of the seafloor. This is a reconnaissance survey technique used for rapid collection, interpretation and mapping of data on physical and biological seafloor characteristics; it has been employed in estuarine, coastal and deep-sea environments worldwide for almost 20 years. Measurements obtained from sediment-profile images are used to characterize sediment types, evaluate benthic habitat quality, map disturbance gradients, and follow ecosystem recovery after disturbance abatement. This technique was first introduced under the name REMOTS (REmote Ecological Monitoring Of The Seafloor). REMOTS is a formal and standardized technique for sediment-profile imaging and analysis, as described by Rhoads and Germano (1982; 1986) and traditionally practiced by Science Applications International Corporation (SAIC). In recent years, this survey technique has come to be known by the more generic name of SPI.

Grab sampling utilizes a specialized stainless steel device called a grab sampler. This is essentially a hinged bucket that is lowered to the bottom from a boat and, upon contact, closes with a scooping motion to capture a sample of the surface sediment and associated organisms. The grab sampler is then brought back up to the boat for onboard examination and processing of the captured sediment. For the present study, grab samples were collected using a 0.04 square meters (m^2) modified van Veen grab sampler having a maximum penetration depth of 12 centimeters. Upon retrieval, each grab sample was sieved through a 0.5 milimeters screen to separate out the benthic macroinvertebrates. These were preserved and sent to a laboratory for identification to the lowest practical taxonomic level (usually species).

Results of SPI surveys of the candidate sites are presented in Section 5.1.2, and results of the benthic grab sample survey are presented in Section 5.1.3. Anticipated impacts to the benthic community from disposal activities at the candidate sites are discussed in Section 7.4.

5.1.2 Benthic Habitat Characterization

As part of the comprehensive survey effort undertaken in November 2000 to characterize baseline physical, chemical, and biological conditions at the two candidate disposal sites, SPI images were collected within candidate sites 1 and 2 and two nearby reference areas (Maguire 2001c). Three replicate sediment profile images were collected at each of 81 stations located in and around candidate site 1 (Figure 5-1), 54 stations located in and around candidate site 2 (Figure 5-2), and, for comparative purposes, nine stations located in each of two nearby reference areas. The three replicate images at each station were generally separated by a space of a few meters (i.e., the estimated space between individual drops of the sediment-profile camera while the vessel maintained a constant position at the water's surface). Each sediment-profile image was subsequently analyzed for a suite of standard measurement parameters, including sediment grain size, depth of the RPD, presence of methane gas, surface relief, sediment layering, successional stage, and Organism-Sediment Index (OSI, a measure of overall benthic habitat quality).

Sediment grain size is a composite grain size estimated for the entire imaged depth using a grain size comparator, which averages grain size information across any layers that may be present in the profile image. A benthic habitat characterization can be ascribed based on grain size, such as unconsolidated soft bottom (UN), fine sand (SA.F), medium sand (SA.M), or hard rock/gravel substrate (HR). Unconsolidated soft bottom can be further described based on the grain sizes present, such as fine sand/silty substrate (grain sizes between 2 and 4 phi denote habitat type UN.SS), silty substrate (grain sizes from 3 to >4 phi denote habitat type UN.SI), and very soft mud (grain sizes >4 phi denote habitat type UN.SF).

The depth of the apparent RPD depth gives an indication of the degree of oxygenation of the surface sediments. The apparent RPD depth is measured in SPI images as the thickness of the surface layer of lighter-colored sediment that typically overlies darker-colored, anoxic sediment at depth. Because it is based on this visual color difference and not an actual Eh measurement, it is called the apparent RPD. SPI images are also used to characterize benthic communities on the basis of functional groups or "infaunal successional stages" that are present, rather than quantifying the number of individuals and actual species present. Successional stages are described as Stage I, II, or III communities and are a function of the dynamic processes occurring in the sediments.

Stage I assemblages consist of pioneering organisms that colonize the sediments quickly following a seafloor disturbance (e.g., erosion, trawling, dredged material disposal, near-bottom hypoxia, etc.). Stage I typically is characterized by dense aggregations of small, tube-dwelling polychaetes or opportunistic bivalves observed in SPI images at or near the sediment surface (Rhoads and Germano 1982, Santos and Simon 1980a). Stage I functional types are usually associated with shallow RPD and bioturbation depths.

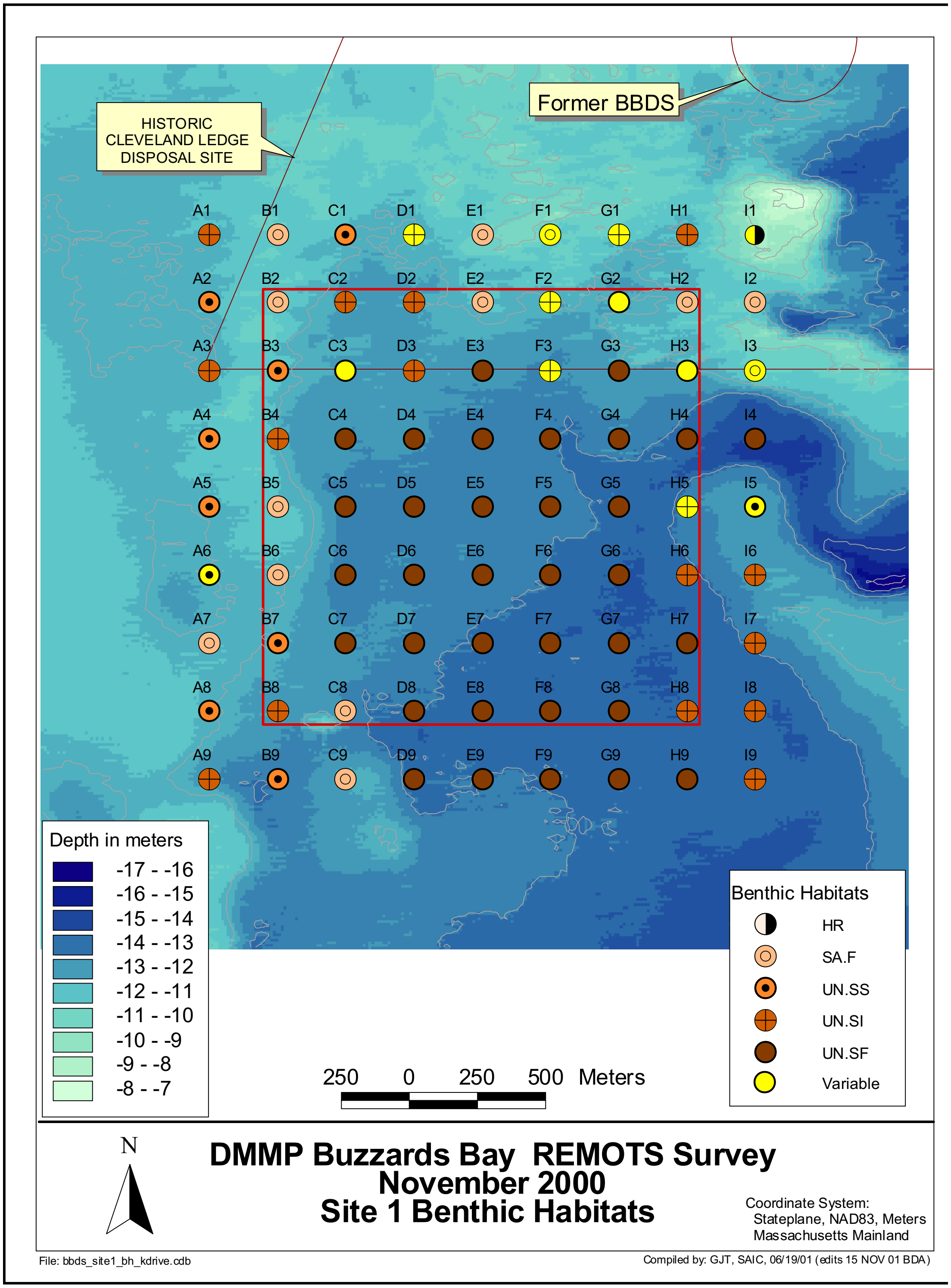

Figure 5-1. Map of SPI survey stations and benthic habitat types at candidate site 1. Stations having more than one habitat type present are shown as “variable,” with the most common or predominant habitat type at such stations depicted on the map.

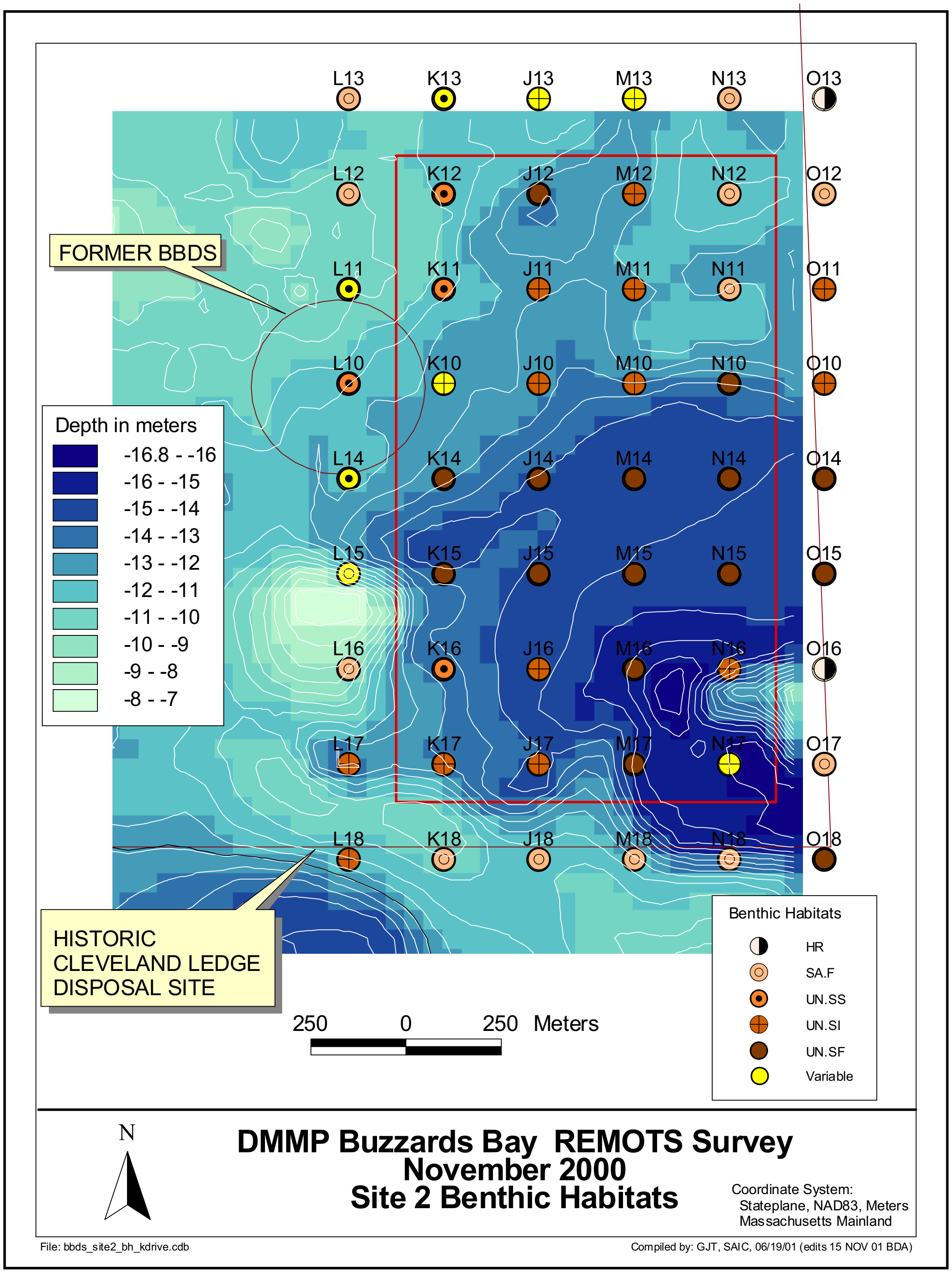

Figure 5-2. Map of SPI survey stations and benthic habitat types at candidate site 2. Stations having more than one habitat type present are shown as "variable," with the most common or predominant habitat type at such stations depicted on the map.

In the absence of further disturbance, these early successional assemblages are eventually replaced by infaunal deposit feeders; the start of this "infaunalization" process is designated arbitrarily as Stage II. Typical Stage II species are shallow dwelling bivalves or, as is common in New England waters, tubicolous amphipods. In studies of hypoxia-induced benthic defaunation events in Tampa Bay, Florida, ampeliscid amphipods appeared as the second temporal dominant in two of the four recolonization cycles (Santos and Simon 1980a and b).

Stage III taxa, in turn, represent higher-order successional stages typically found in low-disturbance regimes. These invertebrates are infaunal, and many feed at depth in a head-down orientation, which creates distinctive feeding voids and helps aerate the sediments, causing the RPD depth to be located several centimeters below the sediment-water interface. Where two types of assemblages are visible in an SPI image, the image is designated as having either a Stage I on Stage III (I-III) or Stage II on Stage III (II-III) successional state. Additional information on SPI image interpretation can be found in Rhoads and Germano (1982, 1986).

The OSI is a summary metric that is calculated using information from the other habitat parameters evaluated in each SPI image; it is intended to provide an estimate of the overall degree of disturbance to the benthic habitat observed in each image (Table 5-1). OSI values can range from -10 for highly disturbed or degraded habitat (low or no dissolved oxygen in the overlying bottom water, no apparent macrofaunal life, and methane gas present), to +11 for non-disturbed or high quality habitat (aerobic bottom with a deep RPD, evidence of a mature macrofaunal assemblage, and no apparent methane gas bubbles at depth). OSI values of +6 or less are generally considered to represent disturbed or degraded benthic habitat conditions, with lower numbers indicating a greater degree of degradation. The index has proven to be a useful parameter for mapping disturbance gradients in areas of soft sediments and documenting ecosystem recovery after disturbance (Germano and Rhoads 1984; Revelas et al. 1987; Valente et al. 1992).

The OSI may be subject to seasonal changes because RPD depths can vary as a result of temperature-controlled changes in bioturbation rates and sediment oxygen demand. Furthermore, the successional status of an area may change over the course of a season related to recruitment and mortality patterns or the disturbance history of the bottom. The sub-annual change in successional status is generally limited to Stage I (polychaete-dominated) and Stage II (amphipod-dominated) taxa. Stage III communities tend to be maintained over periods of several years unless they are eliminated by increasing organic loading, extended periods of hypoxia, or burial by thick layers of dredged material. The recovery of Stage III communities following abatement of such events may take several years (Rhoads and Germano 1982).

Generally speaking, in the areas sampled, mid-summer (July-August) is considered to be the period of time when ecological responses to pollution exposure are likely to be most severe. During mid-summer, dissolved oxygen concentrations are most likely to approach stressful low levels, and the adverse effects of contaminant exposure are generally greatest at the low dilution flows and high temperatures that occur at this time of year. Because the sampling for the present study occurred during late fall, the resulting OSI values are probably higher than might be found during mid-summer. They are therefore considered to be “conservative” in terms of reflecting higher benthic habitat quality than might be found during the warmest months.

Table 5-1. Calculation of the organism sediment index.

A. CHOOSE ONE VALUE:	
Mean RPD Depth	Index Value
0.00 centimeters	0
>0 – 0.75 centimeters	1
0.75 – 1.50 centimeters	2
1.51 – 2.25 centimeters	3
2.26 – 3.00 centimeters	4
3.01 – 3.75 centimeters	5
>3.75 centimeters	6
B. CHOOSE ONE VALUE:	
Successional Stage	Index Value
Azoic	-4
Stage I	1
Stage II on II	2
Stage II	3
Stage II on III	4
Stage III	5
Stage I on III	5
Stage II on III	5
C. CHOOSE ONE OR BOTH IF APPROPRIATE:	
Chemical Parameters	Index Value
Methane Present	-2
No/Low Dissolved Oxygen*	-4
REMOTS® ORGANISM-SEDIMENT INDEX = Total of above subset indices (A+B+C) RANGE: -10 to +11	

*This is not based on a Winkler or polarigraphic electrode measurement. It is based on the imaged evidence of reduced, low reflectance (i.e., high oxygen demand) sediment at the sediment-water interface.

5.1.2.1 Candidate Site 1 Benthic Habitat Characterization

Grain Size

The majority of the SPI images obtained at candidate site 1 (67 of 81 images, or 83%) exhibited surface sediments having a grain size major mode of > 4 phi (silt-clay), while sediments in the remainder of the images (14 of 81, or 17%) had a major mode of 4 to 3 phi (very fine sand). There was very little within-station variability in sediment grain size (i.e., among the three replicate images collected at a single station). Among-station variability consisted of the occurrence of slightly coarser sediments (muddy fine sand or sandy mud) in the shallower depths (8 to 12 meters) along the northern and western perimeter of candidate site 1 (Figure 5-3), and very soft mud without a substantial sand component at the deeper-water stations (>12 meters) throughout the southern basin that comprises the major portion of site 1 (Figure 5-4).

One replicate image from the far northeastern station (Station I-1 located outside the candidate site 1 boundary) showed a grain size major mode of 2 to 1 phi (medium sand). This station was located in an area of shallower water corresponding to the historical dredged material disposal mound located south of the former BBDS. In general, there was a gradient of increasingly softer, finer-grained sediments moving from the northwest to southeast across the survey grid into deeper water at candidate site 1.

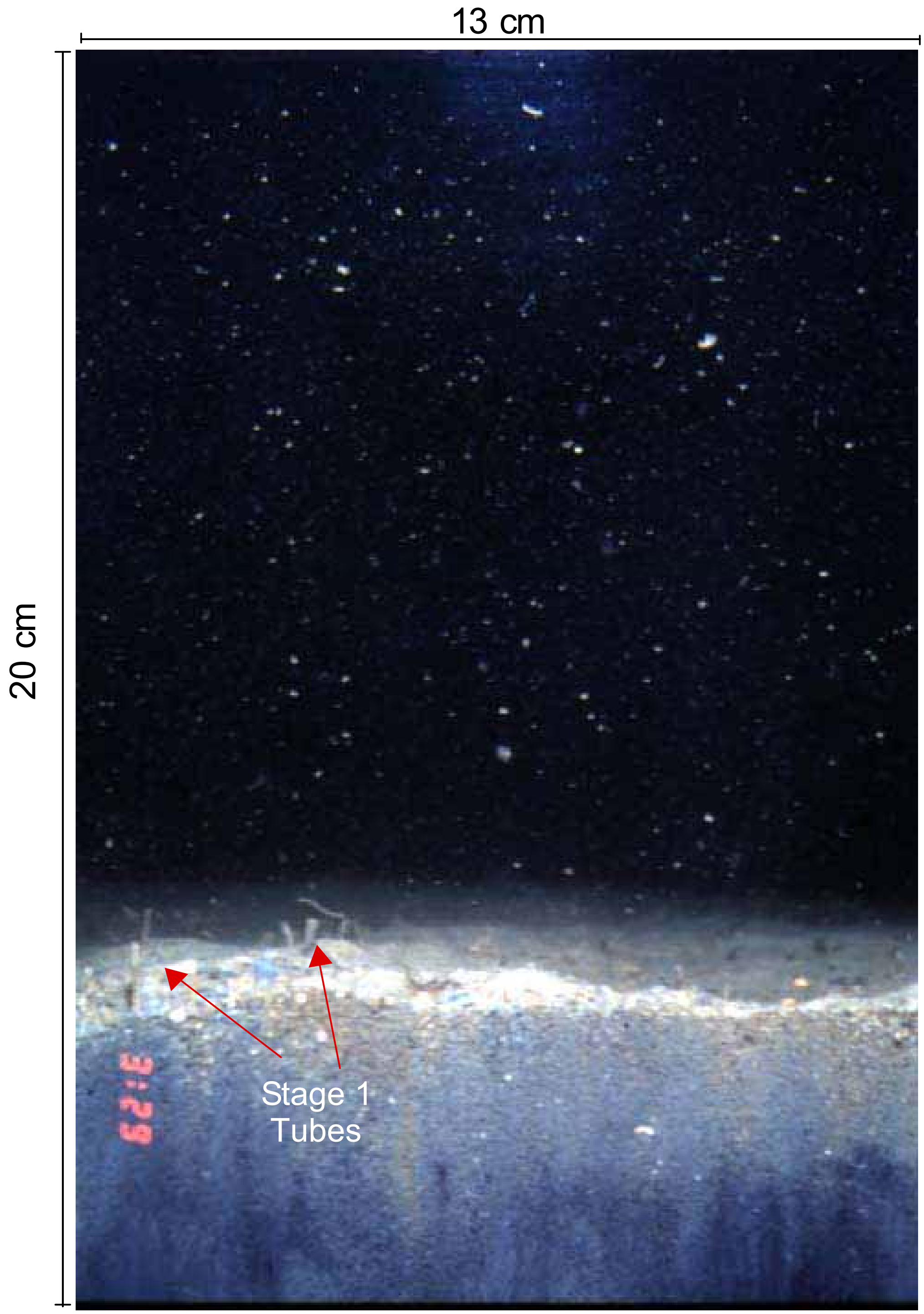

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Figure 5-3. SPI image from the shallow, northern portion of site 1 (Station E2 in Figure 5-1) showing small tubes of opportunistic Stage I polychaetes present at the surface of very fine sand (habitat type SA.F).

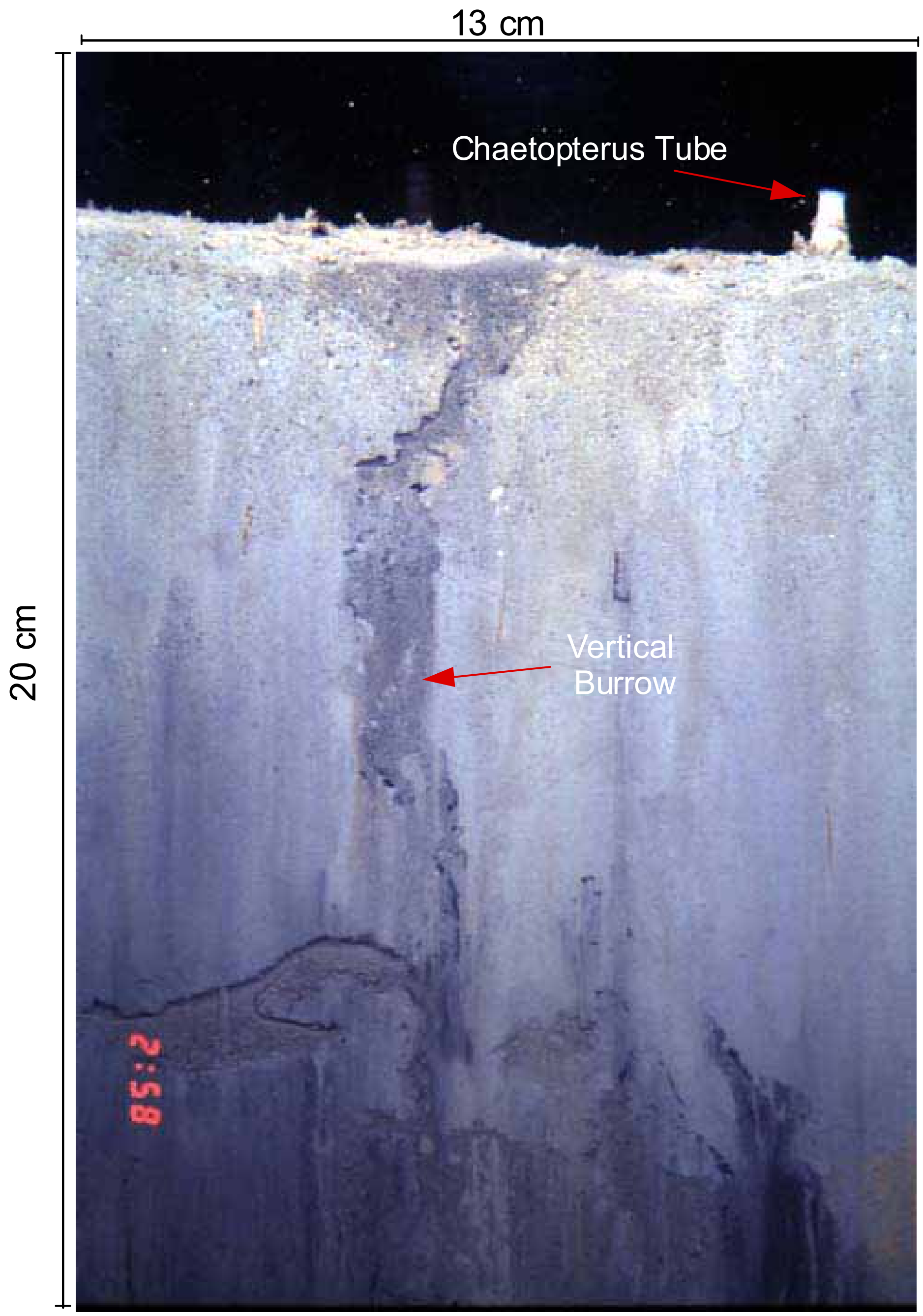

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Figure 5-4. SPI image from a station in the basin area of site 1 (Station F7 in Figure 5-1) illustrating the fine-grained surface sediment (>4 phi) which was found throughout the deeper portion of candidate site 1.

This is an example of the UN.SF benthic habitat type (unconsolidated soft mud), with relatively deep camera penetration (18 centimeters) reflecting the unconsolidated, soft nature of the silt-clay sediment. A vertical burrow structure and a surface tube of the polychaete *Chaetopterus* sp. also are visible in this image.

The grain size and benthic habitat results indicate that, with the exception of the extreme northern and western edges of the site, most of the bottom within the boundary of candidate site 1 represents a lower-energy seafloor environment that appears to favor the deposition and long-term accumulation of very fine-grained (i.e., soft mud) sediment. The depth to which the sediment-profile camera penetrated into the substrate at each station provides additional evidence for the widespread presence of unconsolidated, fine-grained sediments. Camera penetration depths were generally greater than 10 centimeters, and the greatest penetration depths corresponded to the deepest water areas of the survey. Somewhat shallower penetration depths of 5 to 10 centimeters were encountered in the firmer, sandier sediments at stations around the perimeter of candidate site 1.

Boundary Roughness

The mean boundary roughness values measured in the sediment-profile images at candidate site 1 were predominately in the range 0.0 to 2.0 centimeters, indicating only a small amount of fine-scale surface relief (Maguire 2001c). Five of the stations, located intermittently throughout the survey area, had slightly higher mean boundary roughness values of 2.01 to 4.0 centimeters. The boundary roughness was attributed to physical processes in all except two images (from two different stations) where the boundary roughness was attributed to biological activity (e.g., fecal mounds).

Successional Stage

The majority of the stations located within candidate site 1 (59 of 81, or 73%) had at least one replicate image that showed the presence of a mature benthic community comprised of Stage III organisms (Maguire 2001c). Stage III by itself was the highest successional stage observed at 25 of the 81 stations (31%), while Stage III in combination with Stage I (Stage I on III) was the highest successional stage observed at 34 of the 81 stations (42%).

Stage III, alone or in combination with Stage I, was most commonly observed at the stations in deeper water having unconsolidated, soft mud. This habitat type is favored by the larger-bodied deposit-feeders comprising the Stage III community. The images throughout candidate site 1 also showed numerous vertical and horizontal burrow openings within the sediment column (Figure 5-4), evidence of the widespread presence of both larger, sub-surface dwelling polychaetes and motile burrowers such as crabs, benthic shrimp, and possibly lobster. In addition, the distinct white tubes of the polychaete *Chaetopterus* sp. were observed at the sediment surface at many stations located in both deep and shallower water across the survey area.

A number of stations (20 of 81, or 25%), primarily located along the periphery of the site boundaries in shallower water, showed only surface-dwelling Stage I organisms to be present (Figure 5-3). These stations generally had a higher sand component and may experience periodic scouring disturbance and winnowing of fines by bottom currents. In Buzzards Bay, it has been demonstrated that sediments comprised primarily of sand or firm mud tend to be characterized by Stage I and II communities dominated by surface-dwelling suspension feeders (Sanders 1958, 1960; Rhoads and Young 1970).

Stage I, alone or in combination with Stage III, was widespread throughout candidate site 1 (Maguire 2001c). Stage I was observed in 204 of the 241 images (85%). Stage III, alone or in combination with Stage I, also was observed in the majority of images (132 of 241, or 55%) obtained at candidate site 1. These results, together with the observation of numerous burrow openings in images throughout the site, suggest that the benthic community in and around candidate site 1 was relatively abundant and diverse, comprised of a mixture of small, surface-dwelling opportunists, deeper-dwelling deposit-feeders, and motile megafauna.

Apparent RPD Depths

The mean apparent RPD depths at each station varied widely throughout candidate site 1, ranging from 0.8 centimeters to 4.6 centimeters (Maguire 2001c). A little more than half of the stations (48 of 81, or 60%) had a mean RPD depth greater than 2.0 centimeters, which is generally indicative of normal or healthy oxygen penetration into the surface sediments. However, a significant number of stations (33 of 81, or 41%) had relatively shallow mean RPD depths ranging from 0 to 2.0 centimeters.

In general, there were no consistent spatial patterns in mean RPD depths across the site; the RPD depths varied widely among the individual stations. Although the site appeared to have an active benthic community capable of extensive bioturbation and hence aeration of the surface sediments, there may also be periodic inputs or "pulses" of organic matter to the sediment. Such pulses are not uncommon in estuaries like Buzzards Bay, and inputs to the sediment can vary widely in both space and time. For example, Anderson and Taylor (2001) observed pulses of nutrients following rainfall events that acted to stimulate phytoplankton production in the surface waters of western Long Island Sound; subsequent sinking of the phytoplankton blooms created pulses of organic matter to the sediment and variability in near-bottom dissolved oxygen concentrations. An additional effect of such variable inputs of organic matter to the bottom is to create localized patches of increased sediment oxygen demand and concomitant variability in RPD depths (Webb 1993; Maughan and Oviatt 1993).

OSI Values

The majority of stations throughout candidate site 1 (52 of 81, or 64%) had OSI values of greater than +6.01, indicative of undisturbed benthic habitat quality (Figure 5-5; Maguire 2001c). These high OSI values reflect the well-developed apparent RPD depths at these stations (greater than 2 centimeters) combined with the presence of a diverse and abundant benthic community consisting of a combination of Stage I and III taxa. A significant number of stations (27 of 81, or 33%), located mainly around the perimeter of candidate site 1, had OSI values between +3.01 to +6.0. Such values indicate moderately disturbed benthic habitat quality and mainly reflect the dominance of lower-order, opportunistic successional stages at these stations (Stage I or Stage I to II) in combination with mean apparent RPD depths that were generally less than 3 centimeters. As previously indicated, the "moderate disturbance" at these shallower, sandy stations is most likely natural (i.e., periodic scouring and/or winnowing of fines by bottom currents) as opposed to anthropogenic in nature.

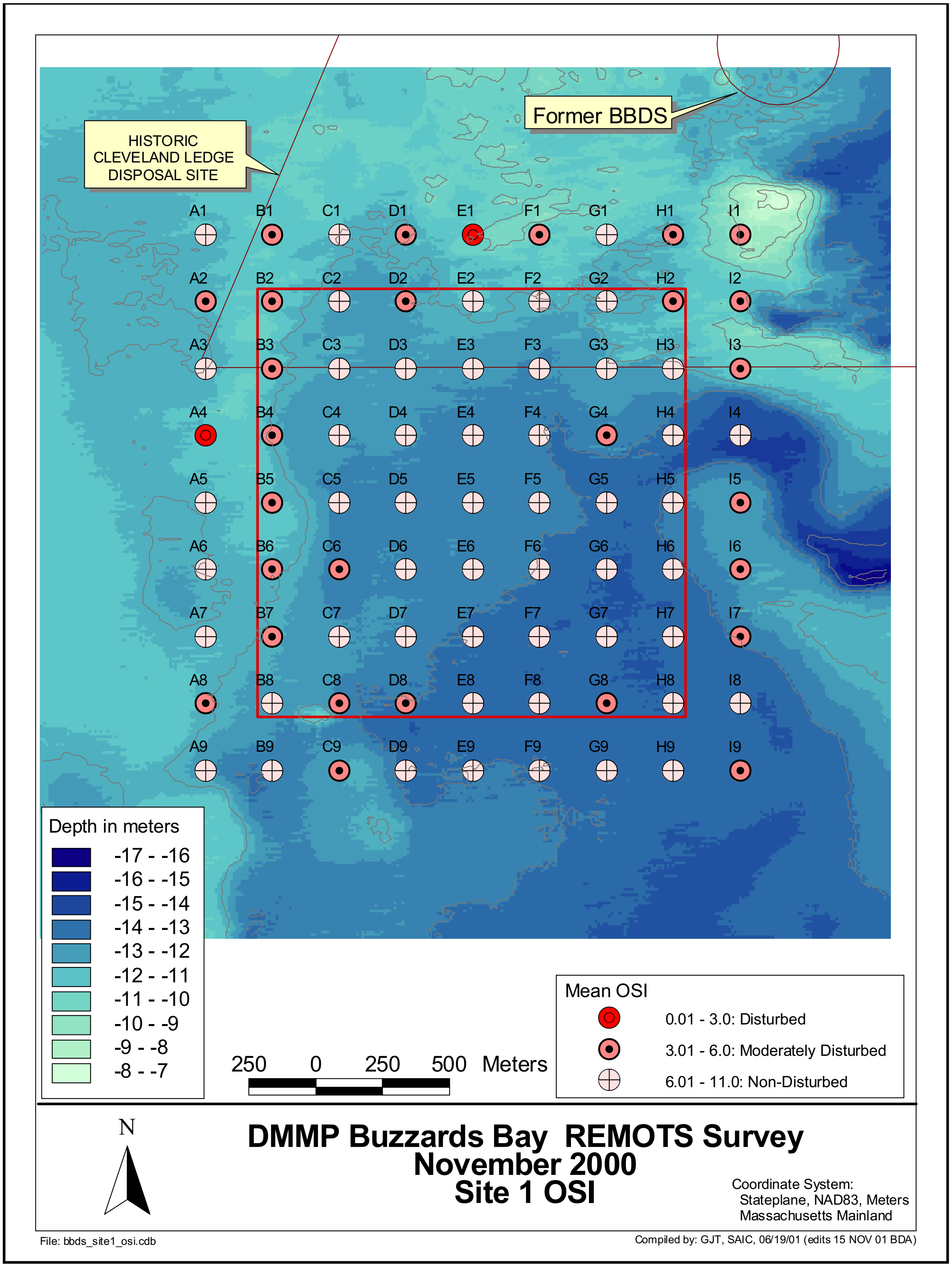

Figure 5-5. Map of mean OSI values at the site 1 sampling stations.

Replicate images from two stations located outside the boundary of candidate site 1 had OSI values of +0.01 to +3.0, suggesting disturbed benthic habitat quality. The lower OSI values occurred along the northern and northwestern perimeter of the survey area and were due to relatively shallow RPD depths (0 to 2.0 centimeters) and/or a lower-order successional stage (Stage I).

The majority of images (133 of 241, or 55%) had OSI values greater than +6.01, while a significant number (96 of 241, or 40%) had OSI values less than +6.0. These results suggest that there was considerable within-station variability in OSI values, which appears to be due to both the spatial patchiness in the apparent RPD depths, as well as the uneven distribution of Stage I and III organisms throughout the site. In general, lower OSI values tended to occur at the sandy, shallower stations along the northern and western perimeter of the site, in areas that may experience periodic physical disturbance (e.g., occasional scouring and winnowing of fines by bottom currents) and therefore are dominated by surface-dwelling, opportunistic taxa (i.e., Stage I). The higher OSI values, indicating relatively undisturbed benthic habitat quality, generally occurred in the deeper areas having soft, muddy sediments that better support deeper-dwelling, deposit-feeding taxa (i.e., Stage III).

5.1.2.2 Candidate Site 2 Benthic Habitat Characterization

Grain Size

Silt clay (>4 phi, representing habitat types UN.SI or UN.SF) was the dominant sediment grain size within candidate site 2, occurring at 39 of the 54 stations (72%), as well as in a total of 117 of the 161 replicate images (73%) from all stations (Figure 5-2; Maguire 2001c). Very fine sand (4 to 3 phi, representing habitat types UN.SS or SA.F) was observed at 11 of the 54 stations (20%), located primarily in shallower water depths on the perimeter of the survey area.

Several stations immediately beyond the candidate site 2 boundary had sediments with a higher sand content, including a predominance of fine to very coarse sand at the stations on the historical dredged material disposal mound just west of the candidate site 2 boundary, on the north side of Gifford Ledge located east of the candidate site 2 boundary, the northeastern corner of the candidate site 2 boundary, and along the east-west trending ridge that parallels the southern boundary of candidate site 2. All of these stations are located in relatively shallow water where winnowing of fines by bottom currents may occur.

The majority of the stations within the candidate site 2 boundaries had a benthic habitat classification of unconsolidated soft bottom, which consisted of silt-clay mixed with varying amounts of silt and sand (Figure 5-2). There was a general correlation between water depth and habitat types, with the apparent amount of sand present in the sediment decreasing with increasing water depth (Figure 5-6). For example, the habitat type comprised of very fine sand (SA.F) was consistently associated with the shallowest depths of between 7 and 10 meters, which occurred in the northern half of candidate site 2 and along the western and southern edges. Habitat types consisting of silt-clay mixed with significant components of silt or very fine sand (UN.SI or UN.SS) were found primarily between depths of 10 to 13 meters. Habitat characterized as soft mud (UN.SF) was observed at the stations within the trough around Gifford Ledge (greater than 13 meters depth) that dominates the southern half of candidate site 2 (Figure 5-6).

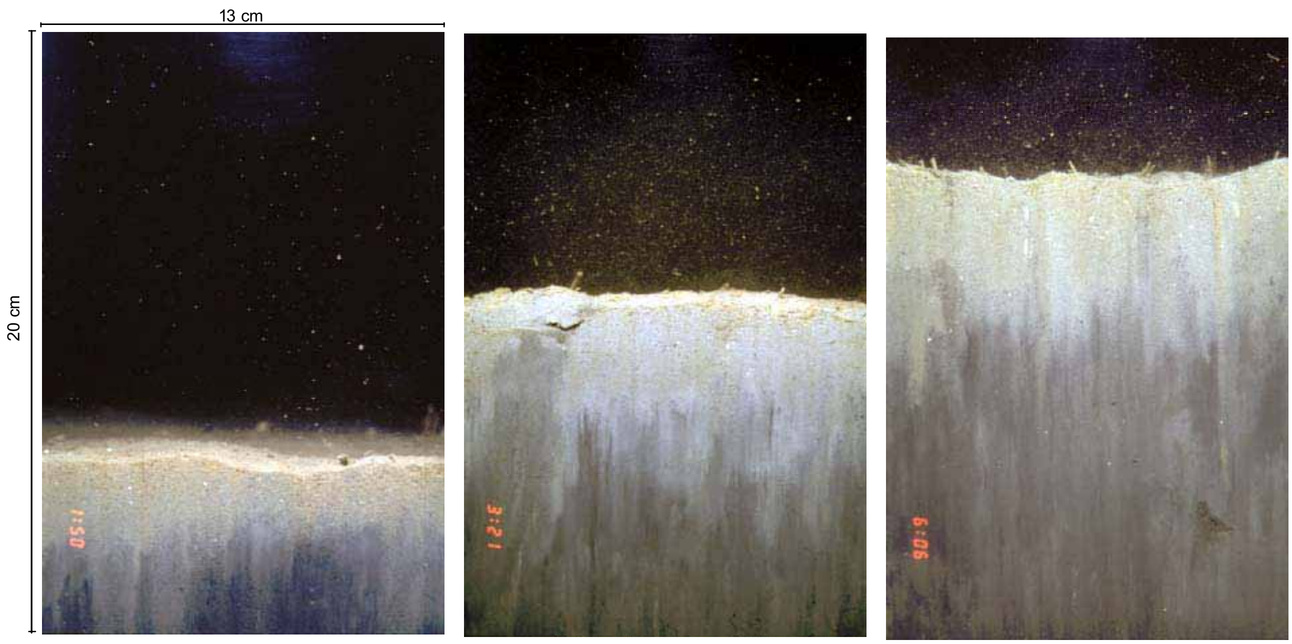

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Figure 5-6. SPI images from site 2 illustrating three different benthic habitat types: SA.F, UN.SI and UN.SF.
Left image: Shallow, northern end of site 2 (Station L13, Figure 5-5) with very fine sand overlying silt-clay sediment (SA.F). *Center image:* Intermediate water depth (Station J11, Figure 5-5) with silt-clay sediments mixed with minor amounts of silt and very fine sand (UN.SI). *Right image:* Topographic depression in the southern half of site 2 (Station M16, Figure 5-5) with very soft silt-clay (UN.SF). Note the difference in the penetration depth of the sediment-profile camera with increasing silt-clay content moving from the northern to the southern half of the site.

Camera penetration depths were generally greater than 10 centimeters, reflecting the predominance of fine-grained sediments throughout the basin in the southern half of candidate site 2. The northern half of candidate site 2, where sediments consisted of silt-clay mixed with very fine sand, had intermediate camera penetration depths, between 5 and 15 centimeters. The sandier stations located just beyond the candidate site 2 boundary had the shallowest camera penetration depths, consistent with the more compact nature of the substrate (Figure 5-6).

Boundary Roughness

Almost all the mean boundary roughness values for the candidate site 2 survey area fell in the range 0 to 2 centimeters, indicating a general lack of significant small-scale surface relief due to either physical or biological process (Maguire 2001c). The higher values (greater than 4 centimeters) identified in some candidate site 1 replicate images were not observed in the candidate site 2 images.

Successional Stage

The majority of the candidate site 2 stations (31 of 54, or 57%) had at least one replicate image that showed the presence of a mature benthic community comprised of Stage III organisms (Maguire 2001c). Stage III by itself was the highest successional stage observed at 7 of the 54 stations (13%), while Stage III in combination with Stage I (Stage I on III) was the highest successional stage observed at 24 of the 54 stations (44%).

Stage III, alone or in combination with Stage I, was most commonly observed at the stations in deeper water having unconsolidated, soft mud. Lower-order successional stages (i.e., Stage I, Stage I going to II, or Stage II) were observed at 21 of the 54 stations (40%), mainly those located in shallower water where more compact sand or sandy mud was prevalent. In the images classified as "Stage I going II" or "Stage II," it was typically due to Stage II amphipod tubes (probably *Ampelisca* sp.) observed at the sediment surface.

Similar to candidate site 1, the primary evidence of Stage III in the sediment-profile images from candidate site 2 was feeding voids observed at depth within the sediment. The images throughout candidate site 2 also showed numerous vertical and horizontal burrow openings within the sediment column, indicating the presence of motile burrowers. The distinct white tube ends of the polychaete *Chaetopterus* sp. also were observed at the sediment surface at numerous stations, as with candidate site 1.

Stage I, alone or in combination with Stage III, was widespread throughout candidate site 1. This successional stage was observed in 139 of the 161 images (86%). Stage III, alone or in combination with Stage I, also was observed in a significant number of the images (70 of 161, or 43%) and at the majority of stations within candidate site 2. These results indicate that Stage I opportunists were ubiquitous and abundant throughout the site, while Stage III organisms were comparatively more sparsely distributed. Overall, the results are similar to those from candidate site 1 in showing that the benthic community at candidate site 2 was comprised of a diverse mixture of surface-dwellers, subsurface deposit-feeders, and motile megafauna.

Apparent RPD Depths

The mean apparent RPD depth at 19 of the 54 stations (35%) was greater than 2 centimeters, while the majority of stations (35 of 54, or 65%) exhibited relatively shallow mean RPD depths of 2 centimeters or less (Maguire 2001c). Apparent RPD depths less than 2 centimeters are generally considered shallow and may be indicative of sediments that are experiencing high levels of organic loading and/or are inhabited by organisms whose bioturbational activity occurs at or just below the sediment surface (e.g., Stage I organisms). Apparent RPD depths less than 2 centimeters generally occurred at the sandier stations within the northern half of candidate site 2 and those on the outer perimeter, where lower-order successional stages were prevalent. Stage I organisms tend to be surface-dwelling opportunists; bioturbation by these organisms is limited to the upper 1 to 2 centimeters of the sediment column and therefore they are often found in association with shallower RPD depths. Apparent RPD depths greater than 2.0 centimeters are generally indicative of normal or “healthy” oxygen penetration into the surface sediments. The deeper RPD depths at candidate site 2 were observed most consistently at the stations having soft, muddy sediments within the topographic depression in the southern half of the site. Most of these stations had a benthic community comprised of larger-bodied, deeper-dwelling Stage III organisms. These organisms consume excess sediment organic matter and aerate the sediment column relatively deeply through bioturbation, resulting in the observed deeper RPD depths.

OSI Values

The mean OSI values at all of the candidate site 2 stations fell in the range of either +3 to +6 (indicative of moderate disturbance) or +6 to +11 (indicating undisturbed benthic habitat quality; Figure 5-7; Maguire 2001c). The majority of all replicate images (128 of 161, or 80%) had OSI values greater than +3.0. Most of the stations located in the topographic depression in the southern half of the site had OSI values greater than +6, reflecting the fact that sediments in this area were well-aerated and inhabited by a diverse benthic community consisting Stage I, II and III organisms. It is notable that OSI value for the station located in the center of the former BBDS (> +6) indicated relatively undisturbed habitat conditions. In addition, stations located at the historical dredged material mound had only moderately disturbed benthic habitat quality (OSI values between +3 and +6) comparable to that observed in the wider region. These results indicate that the seafloor in this area has fully recovered, as expected, from any negative impacts associated with past dredged material disposal.

The moderately disturbed conditions observed at the sandier stations in the northern half of the site and on the perimeter of the station grid were mainly due to the combination of shallow RPD depths in combination with lower-order successional stages. As with the shallower areas around candidate site 1, it is possible that the seafloor in the northern part of candidate site 2 experiences periodic natural physical disturbance (i.e., winnowing of fines by elevated bottom currents during storm events) that is being reflected in the lower OSI values. However, the results as a whole indicate that benthic habitat quality across candidate site 2 was consistently high, falling in the range of either non-disturbed or only moderately disturbed as a result of natural, as opposed to anthropogenic, processes.

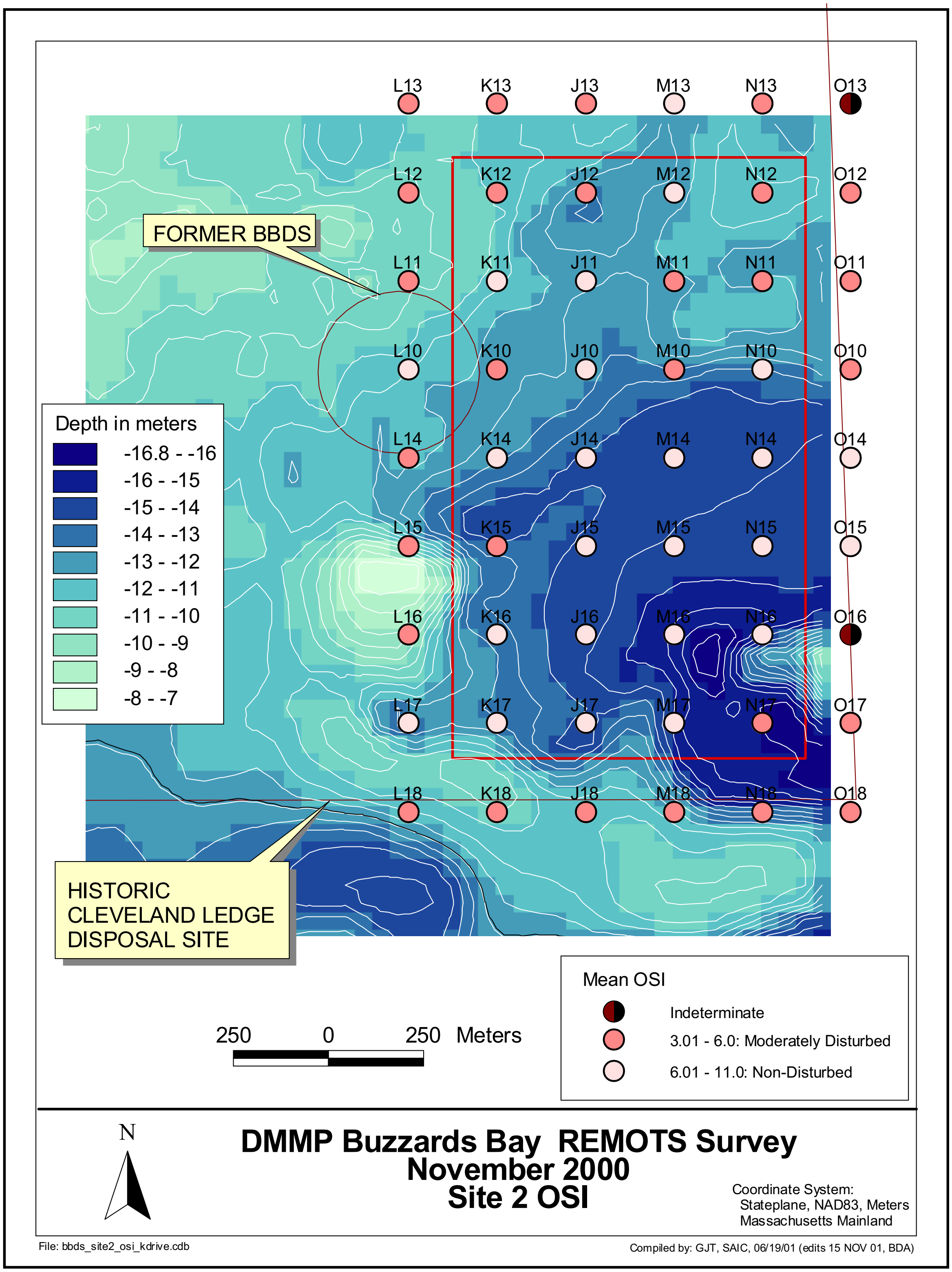


Figure 5-7. Map of mean OSI values at the site 2 sampling stations.

5.1.3 Summary of Benthic Habitat Characterization Results

Overall, the SPI survey results indicate that both candidate disposal sites are characterized by relatively abundant and diverse benthic communities and habitat conditions indicative of moderate to low disturbance regimes (Maguire 2001c). Apparent RPD depths across both sites were highly variable, attributed to temporal and spatial patchiness in sediment organic loading rates, typical of estuarine environments like Buzzards Bay that have experienced increased eutrophication in recent decades (Howes, et al. 1999). Populations of both surface-dwelling, opportunistic polychaetes (Stage I) and deeper-dwelling, subsurface deposit-feeding benthic taxa (Stage III) were widespread across candidate sites 1 and 2, particularly in the soft sediments comprising the basin areas of both sites. Stage III organisms were less frequently observed at the shallower, sandier stations at both sites. Numerous burrow openings also were observed throughout the sediment column at many stations in both sites, evidence of the widespread presence of both larger-bodied, sub-surface polychaetes and motile burrowers such as crab, benthic shrimp, and possibly lobster.

The OSI values indicated that benthic habitat quality in and around candidate sites 1 and 2 was primarily non-disturbed, reflecting healthy sediment aeration and the presence of a diverse and abundant benthic community comprised of Stage I, II and III organisms. Some stations indicated moderately disturbed benthic habitat quality, attributed primarily to natural physical disturbance by bottom currents in the shallower, sandier areas of each site.

Two reference areas with similar grain size distributions were also characterized in the SPI surveys. Benthic habitat conditions at the majority of the stations in candidate sites 1 and 2 were comparable to the reference areas, in terms of successional stages present, evidence of extensive burrowing by larger invertebrates, and a range of RPD depths encountered throughout the sites.

The subtle differences between candidate sites 1 and 2 that were identified in this survey can be summarized as follows:

1) There are slightly coarser sediments, and occurrence of sand as a substantial component of the grain size distribution, to slightly deeper depths at candidate 2 compared to candidate site 1. This yields a greater percentage of stations at candidate site 1 classified as very soft mud habitat, and a greater percentage of stations at candidate site 2 classified as very fine sand and silt-clay having substantial components of silt and fine sand.

2) Boundary roughness at both sites was relatively small (0 to 2 centimeters) and primarily due to physical processes. Minor occurrences of biogenic surface relief were identified at candidate site 1 stations, resulting in a slightly larger range of overall surface relief values for that site (0 to 4 centimeters).

3) Deeper-dwelling, subsurface deposit-feeding benthic taxa (Stage III) were present at a greater percentage of stations at candidate site 1 (73%) compared to candidate site 2 (57%). This reflects the higher proportion of soft, muddy habitat within site 1 compared to candidate site 2.

4) While RPD depths at both sites were variable, values greater than 2 centimeters occurred at a greater percentage of candidate site 1 stations (60%) compared to candidate site 2 (35%). This also reflects the higher proportion of stations within candidate site 1 that were located on soft, muddy bottom dominated by a Stage III community whose bioturbation activities serve to enhance sediment aeration and increase the RPD depths.

5) Candidate site 1 had two stations with OSI values between 0 and +3, while candidate site 2 did not have any stations with average OSI values that low. However, candidate site 1 had slightly more stations (64%) with mean OSI values greater than +6 compared to candidate site 2 (44%), again reflecting the higher proportion of stations on muddy bottom in candidate site 1 that were dominated by an advanced Stage III community and well-developed RPD depths

These differences between candidate sites 1 and 2 are relatively minor and primarily reflect evidence of slightly greater current and/or wave influence on the substrate at candidate site 2. While the overall type and character of benthic habitat at candidate sites 1 and 2 are very comparable, minor differences in benthic habitat characteristics suggest that the large, muddy topographic depression that dominates most of candidate site 1 provides slightly more stable and/or optimum conditions for the establishment of an advanced (i.e., Stage III) benthic community. Candidate site 2 characteristics that are less desirable for productive, soft-bottom, benthic habitat include the occurrence of slightly coarser grain sizes, fewer deep deposit feeders, slightly shallower RPD depths, and a corresponding decrease in occurrence of average OSI values greater than +6.

5.1.4 Benthic Community Structure

As previously indicated, the benthic macroinvertebrate communities inhabiting the surface sediments within candidate sites 1 and 2 were quantified using grab samples collected at a total of 6 sampling stations within each site (Figure 5-8). For comparative purposes, three additional grab samples were collected at each of two nearby reference areas (called REF-NEW and REF-2, as indicated in Figure 5-8 from Maguire 2001d) (Also see Appendix I). Grab samples were collected using a 0.04 m^2 Young-modified van Veen grab sampler having a maximum penetration depth of 12 centimeters. A single grab sample was collected at each station and sieved through a 0.5 milimeters screen for later laboratory identification of benthic macroinvertebrates to the lowest practical taxonomic level (usually species).

As summarized in Table 5-2, the benthic communities at both sites were found to be comprised of roughly similar proportions of the following major groups (in order of decreasing percent of overall abundance): annelids (site 1,= 54% and site 2,= 62%), molluscs (site 1 = 22% and site 2 = 13%), crustaceans (site 1 = 12% and site 2 = 10%), nematodes (site 1 = 6% and site 2 = 7%) and nemerteans (site 1 = 5% and site 2 = 7%). The most abundant species was the polychaete *Mediomastus ambiseta*, which was either the first or second most abundant organism at each site. The following taxa, in decreasing order of total abundance, also were found among the top ten numerical dominants across the two candidate disposal sites and two reference areas: the polychaetes *Prionospio perkinsii* and *Aricidea catherinae*, the nemertean *Carinomella lactea*, the bivalve *Macoma tenta*, the gastropod *Cylichna oryzna*, nematodes and ostracods. Oligochaetes, the polychaetes *Caraziella hobsonae*, *Nephtys incisa*, *Ninoe nigripes,* and the

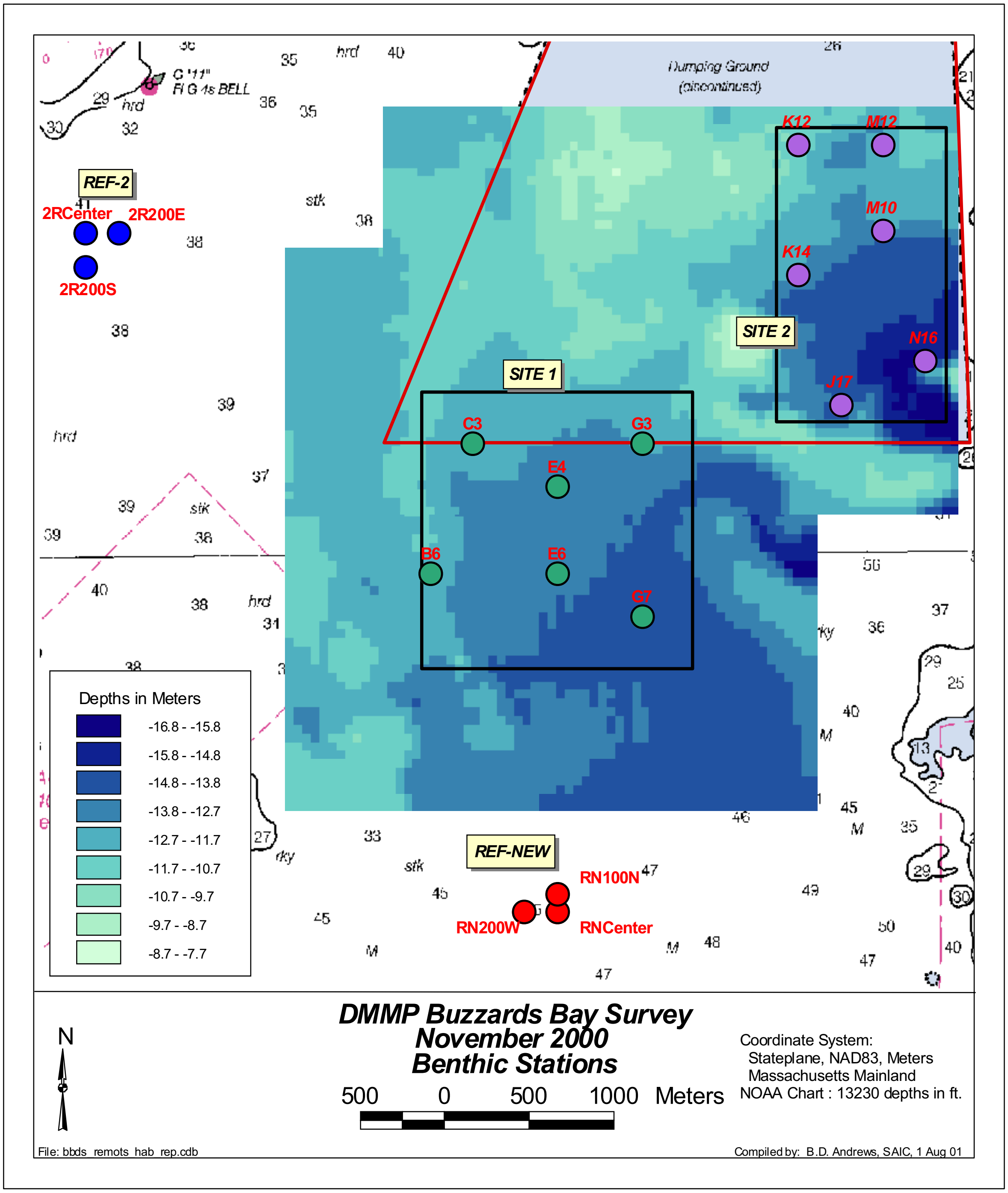


Figure 5-8. Map showing the location of benthic community sampling stations at candidate disposal sites 1 and 2 and reference areas REF-NEW and REF-2.
Color bathymetry results underlying sites 1 and 2 are in meters, from SAIC surveys conducted in May 1998 and October 2000. Depth values on the underlying NOAA chart are in feet.

Table 5-2. Summary statistics for benthic community data from candidate sites 1 and 2 and the two reference areas (from Maguire 2001d).

	SITE 1	SITE 2	REF-2	REF-NEW
Number of stations (samples)	6	6	3	3
Total number of individuals (all samples combined)	34,182	56,833	25,203	16,551
Total number of taxa (all samples combined)	67	107	60	41
Average number of individuals/m^2 per station (± 1 s.d.)	5,697 ± 1,876	9,472 ± 4,329	8,401 ± 2,974	5,517 ± 1,597
Average number of taxa per station (± 1 s.d.)	31 ± 6	42 ± 8	36 ± 5	25 ± 4
Average Shannon-Wiener diversity (H') ± 1 s.d.	2.77 ± 0.2	2.96 ± 0.19	2.57 ± 0.25	2.50 ± 0.03
Average Pielou's evenness (J') ± 1 s.d.	0.80 ± 0.04	0.78 ± 0.04	0.71 ± 0.06	0.78 ± 0.03
Average Margelef's species richness (d)	3.57 ± 0.63	4.83 ± 0.91	4.05 ± 0.62	2.79 ± 0.33
Total abundance (all samples combined) of: annelids (% of total) mollusks crustaceans nematodes nemerteans others	 18,475 (54%) 7,450 (22%) 4,000 (12%) 2,100 (6%) 1,550 (5%) 607 (2%)	 35,475 (62%) 7,375 (13%) 5,500 (10%) 4,150 (7%) 3,850 (7%) 483 (1%)	 14,875 (59%) 4,275 (17%) 1,425 (6%) 1,150 (5%) 2,975 (12%) 503 (2%)	 9,000 (54%) 4,950 (30%) 1,400 (8%) 700 (4%) 400 (2%) 101 (1%)
Ten most-abundant taxa (% of total abundance)	Mediomastus ambiseta (10.2%) Ostracoda (8.6%) Caraziella hobsonae (8.1%) Macoma tenta (8.0%) Aricidea catherinae (7.5%) Cylichna oryza (6.8%) Nematoda (6.1%) Prionospio perkinsii (5.2%) Carinomella lactea (4.2%) Nephtys incisa (4.2%)	Mediomastus ambiseta (14.1%) Oligochaeta (8.4%) Nematoda (7.3%) Carinomella lactea (6.7%) Carazziella hobsonae (5.4%) Prionospio perkinsii (5.2%) Ostracoda (4.6%) Aricidea catherinae (4.3%) Macoma tenta (3.9%) Cylichna oryza (3.7%)	Prionospio perkinsii (26.4%) Mediomastus ambiseta (15.3%) Carinomella lactea (11.5%) Macoma tenta (6.2%) Ninoe nigripes (6.0%) Nematoda (4.6%) Ostracoda (4.2%) Cylichna oryza (3.8%) Aricidea catherinae (3.1%) Oligochaeta (2.2%)	Aricidea catherinae (18.3%) Mediomastus ambiseta (15.6%) Nucula annulata (14.5%) Ostracoda (8.3%) Cylichna oryza (7.7%) Nephtys incisa (5.1%) Macoma tenta (4.5%) Nematoda (4.2%) Prionospio perkinsii (2.6%) Carinomella lactea (2.4%)

bivalve *Nucula annulata* were also relatively abundant. The benthic community at both candidate sites was broadly comparable to those found in previous studies of other areas of Buzzards Bay, with many of the same taxa being among the numerical dominants.

More detailed statistical analyses revealed subtle differences among the sites. Candidate site 2 had higher average abundance, number of taxa, species richness and diversity than candidate site 1 and the reference areas. However, a multivariate statistical analysis did not indicate a significant difference in community structure between candidate site 1 and 2. Statistically significant differences were identified between each of the candidate sites and references areas, although these differences were due to relative abundances of the dominant taxa, as opposed to different taxa being present at the sites.

Overall, the results of the November 2000 survey indicated that the benthic communities at candidate sites 1 and 2 (as well as the nearby reference areas) were dominated by opportunistic taxa, mainly polychaetes (Table 5-2; Maguire 2001d). These organisms have high population turnover rates and therefore are capable of recovering rapidly from the physical disturbance associated with dredged material disposal.

Standard univariate statistics were used to summarize the benthic community data at each site, including calculation of both total and average abundance per site, total and average number of taxa, and the percentage breakdown of abundance by both major taxonomic groups and species. Additional analyses were performed to calculate species richness, diversity, and evenness index values for each station (sample), using the PRIMER (Plymouth Routines in Multivariate Ecological Research) software package developed at the Plymouth Marine Laboratory, UK (Clarke and Warwick 1994).

Species richness was determined using Margalef's index (d), which provides a measure of the number of species (S) present for a given number of individuals (N) according to the following equation:

$$d = (S\text{-}1)/\log_2 N$$

Diversity was calculated using the Shannon-Weiner (H') index:

$$H' = -\Sigma_i \, p_i \, (\log_2 p_i),$$

where p_i is the proportion of the total count arising from the *ith* species.

Equitability, the evenness of the species distribution, was determined using Pielou's evenness index (J'):

$$J' = H' \text{ (observed)}/ \; H' \text{ max},$$

where H' max is the maximum possible diversity which will be achieved if all species were equally abundant = $\log_2$ (S). All three indices were determined using the DIVERSE routine within the PRIMER software package.

For each of the three indices indicated above, a value was calculated for each of the six stations in each of candidate sites 1 and 2 and each of the three stations in each reference area. The individual station values were averaged to produce a mean value for each candidate disposal site and reference area, along with 95% confidence intervals around each mean. Means and 95% confidence intervals likewise were calculated for the parameters "number of taxa" and "number of individuals" (i.e., abundance). In addition, the Games and Howell method (Sokal and Rohlf 1981) was used to provide a statistical test of the equality of the means. This test was performed in lieu of single classification Analysis of Variance (ANOVA) based on the assumption that the variances were heterogeneous. The Games and Howell method performs unplanned comparisons between pairs of means using a studentized range with specially weighted average degrees of freedom and a standard error based on the averages of the variances of the means (Sokal and Rohlf 1981).

The univariate statistics described in the previous section each provide a measure of a single community attribute (e.g., species richness, diversity, evenness). In contrast, multivariate statistical techniques involve looking at the benthic community structure as a whole when trying to discern spatial patterns or when comparing among different samples (Clarke 1999). The term "benthic community structure" refers to the concept of looking simultaneously at both the taxa that are present and their relative numbers when comparing different samples to each other.

Using the PRIMER software package, two independent but complimentary multivariate techniques were used to evaluate both the among-station and among-site patterns in overall benthic community structure: hierarchical clustering and non-metric multi-dimensional scaling (MDS). Each of these techniques serves to classify the stations into groups having mutually similar benthic community structure. Details of these multivariate statistical techniques are described in the original benthic community assessment report (Maguire 2001d). In addition, the ANOSIM (Analysis of Similarities) randomisation test within the PRIMER software package was used to test for statistical differences in overall benthic community structure between candidate sites 1 and 2 and the two reference areas. The ANOSIM procedure is analogous to standard parametric ANOVA but is based on a non-parametric permutation procedure applied to the Bray-Curtis similarity matrix underlying the ordination of samples (see Clarke and Green 1988; Clarke 1993). Following the ANOSIM test for differences, the program called SIMPER (Species Contributions to Similarity) in the PRIMER package was used to identify the taxa that were the "key discriminators" in contributing to significant differences in benthic community structure among areas.

5.1.4.1 Candidate Site 1 Benthic Community Characterization

A total of 34,182 individuals (on a "per m^2" basis) belonging to 67 taxa were collected at the six stations within candidate site 1 (Table 5-2). Of this total, the majority (54%) of individuals were annelids (including both oligochaetes and polychaetes), followed by molluscs (22%), crustaceans (12%), nematodes (6%), nemerteans (5%), and others (2%, including cnidarians, platyhelminthes, phoronids, echinoderms, and hemichordates).

Of the 34,182 individuals collected at the six stations in candidate site 1, over 90% belonged to 21 of the 67 total taxa found at the site. The list of the top ten most-abundant taxa (Table 5-2) shows that the capitellid polychaete *Mediomastus ambiseta* was numerically dominant within candidate site 1, accounting for 10.2% of the overall total number of individuals. Other dominant taxa at candidate site 1 included ostracods, the polychaetes *Caraziella hobsonae*, *Aricidea catherinae*, *Prionospio perkinsii*, and *Nephtys incisa*, the tellinid bivalve *Macoma tenta*, the gastropod *Cylichna oryza*, nematodes and the nemertean *Carinomella lactea*. These top ten taxa accounted for a substantial majority (69%) of all the individuals collected within the site.

The average abundance (mean of n = 6 grab samples) at candidate site 1 was 5,697 individuals per m^2, while the average number of taxa per station was 31 (Table 5-2). Average Shannon diversity (H') was 2.77, while the average evenness was 0.80 and the average species richness was 3.57 (Table 5-2).

5.1.4.2 Candidate Site 2 Benthic Community Characterization

A total of 56,833 individuals (on a "per m^2" basis) belonging 107 taxa were collected at the six stations within candidate site 2 (Table 5-2). The majority of individuals were annelids (62%), followed by molluscs (13%), crustaceans (10%), nematodes (7%), nemerteans (7%), and others (1%).

Over 90% of the 56,833 individuals collected at the six stations in candidate site 2 belonged to 27 of the 107 total taxa found at the site. Similar to candidate site 1, the polychaete *Mediomastus ambiseta* was the numerically dominant species at candidate site 2, accounting for 14.1% of the total number of individuals collected (Table 5-2). Oligochaetes (8.4%) and nematodes (7.3%) were the second and third most abundant taxa. The other dominant taxa at candidate site 2 also were similar to the dominants at candidate site 1, including ostracods, the polychaetes *Caraziella hobsonae*, *Aricidea catherinae*, and *Prionospio perkinsii*, the bivalve *Macoma tenta*, the gastropod *Cylichna oryza*, and the nemertean *Carinomella lactea*. Similar to candidate site 1, these top ten taxa accounted for the majority (64%) of all the individuals collected within candidate site 2.

The average abundance (mean of n = 6 grab samples) at candidate site 2 was 9,472 individuals per m^2, while the average number of taxa per station was 42 (Table 5-2). The average Shannon diversity (H') was 2.96, the average evenness was 0.78, and the average species richness was 4.05 (Table 5-2).

5.1.4.3 Univariate Statistical Comparisons

One way to evaluate the survey results is to compare the benthic communities found at the sites in both a qualitative way and using the univariate statistics presented in Table 5-2. Qualitatively, the communities at the two candidate sites and the two reference areas were similar in terms of having roughly similar proportions of the "major" taxonomic groups, with the majority of organisms collected in each site being annelids, followed by mollusks, and then crustaceans (Table 5-2). Generally, one reference area had a higher proportion of molluscs and the other reference area had higher numbers of nemerteans compared to the candidate disposal sites, but aside from these differences, the breakdown among major taxa at each site was consistent.

Overall, the majority of the organisms collected at each site belonged to a relatively small number of taxa, and there was a substantial amount of overlap among the sites in the taxa comprising the top ten dominants. This is summarized in Table 5-2, which indicates there were 13 taxa comprising the lists of the top ten numerical dominants across all of four sites. Since a total of 126 taxa were collected across all four sites in the survey, these results indicate that there were many taxa represented by a relatively small number of individuals.

Compared to candidate site 1, candidate site 2 had both a higher average number of taxa per station (i.e., per grab sample) and a higher average abundance per station (Table 5-2). However, the statistical test of the equality of these means (Games and Howell method) showed that the differences in average number of taxa and average abundance between candidate sites 1 and 2 were not significant at the $P = 0.05$ level (Figure 5-9). candidate site 2 had both higher average species richness and higher average diversity than candidate site 1, and slightly lower evenness, but these differences also were not statistically significant (Figure 5-10).

Statistically significant differences were identified for species richness and diversity between candidate site 2 and one reference area ($P < 0.05$ using the test for equality of means by the Games and Howell method; Figure 5-10). In contrast, there were no statistically significant differences detected among candidate sites 1, 2, or the other reference area in average species richness or diversity, and no significant differences among all four sites in average species evenness (Figure 5-10).

5.1.4.4 Multivariate Statistical Comparisons

Multivariate analyses performed on the benthic community data included cluster analyses to identify groupings of stations at the 55% similarity level (Maguire 2001d). In general, the cluster analysis results indicated that there were both among-station and among-site differences in overall benthic community structure. One of the similarity groupings included a sub-set of stations from both candidate disposal sites, reflecting both spatial variability in community structure within candidate sites 1 and 2, and some similarity in benthic communities from selected locations within each site.

The results of the MDS were generally consistent with the cluster analysis, although only a loose and inconsistent association between sediment grain size and benthic community structure was indicated. The grouping of sandier stations from candidate site 2 provided the most distinct grouping from the evaluation. Similarly, three reference stations that formed a distinct group all had very high silt-clay content. However, the relationship between community structure and grain size was not consistent across all stations/sites.

The ANOSIM procedure provided a formal test of the null hypothesis of “no significant difference in overall benthic community structure among the four sites.” Results indicated no significant difference between candidate sites 1 and 2, but a strong difference between the two reference areas. Candidate site 2 differed significantly from one of the reference areas but not the other. Conversely, candidate site 1 differed significantly from the opposite reference area.

The SIMPER routine within the PRIMER software package was used to examine which taxa contributed most strongly to the significant differences detected between specific sites. In general, it was found that these statistical differences were due primarily to differences in the abundance of the numerically-dominant taxa, as can be seen from a careful examination of the

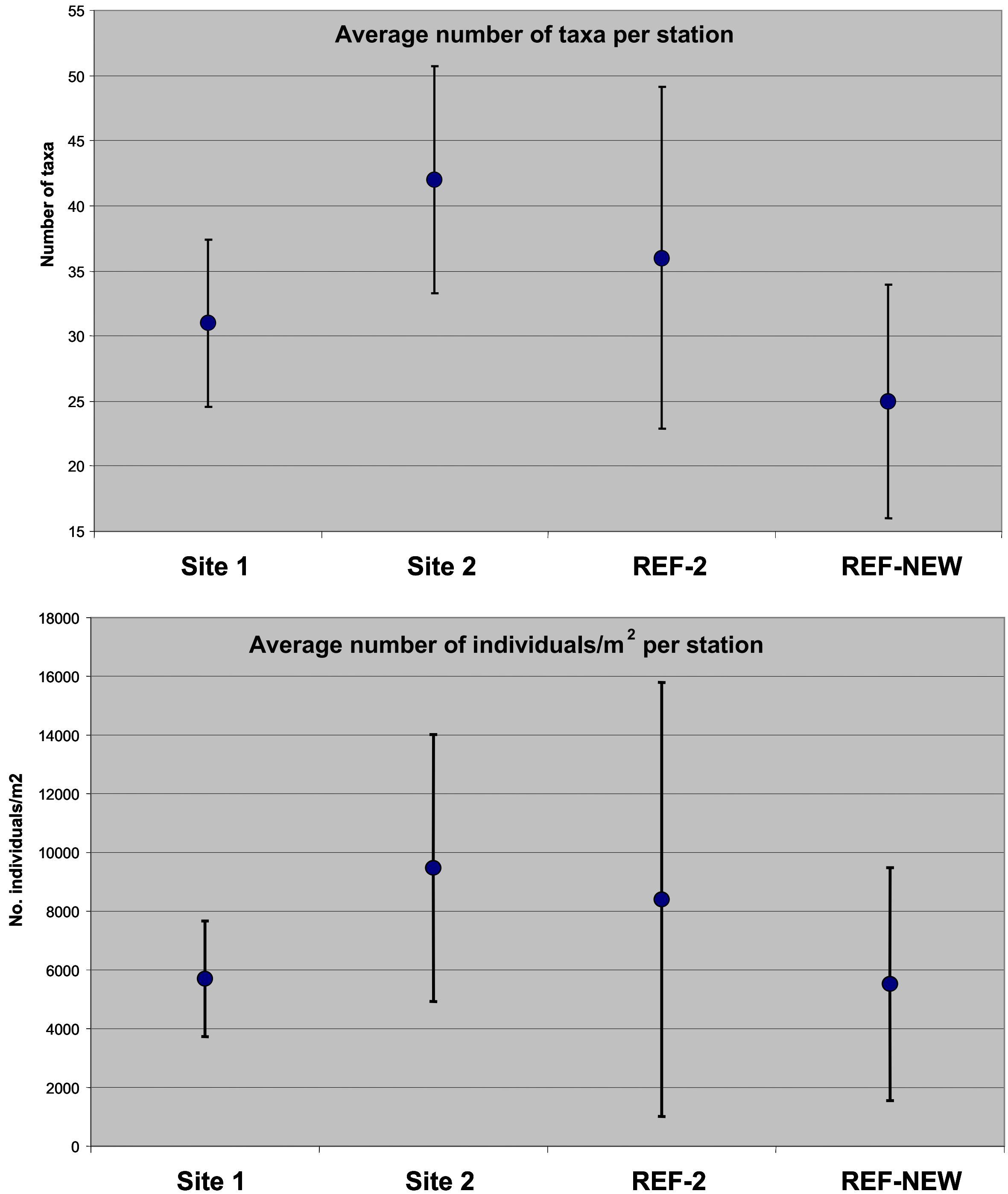


Figure 5-9. Among-site comparisons of average number of taxa per station (top) and average number of individuals/m2 per station (bottom). Error bars are 95% confidence intervals.

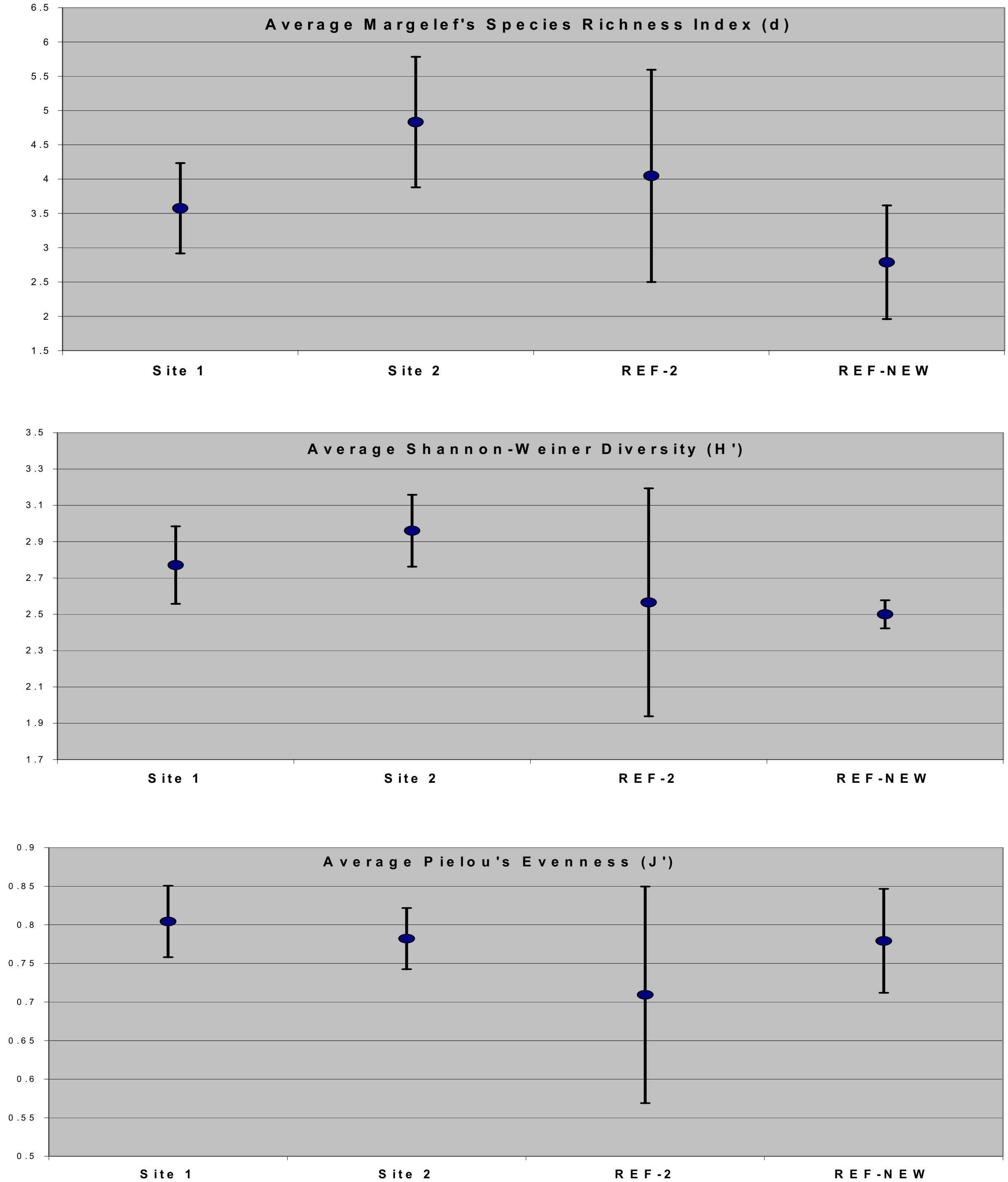


Figure 5-10. Among site comparisons of average species richness (top), diversity (middle) and evenness (bottom). Error bars are 95% confidence intervals.

"top ten" lists comprising the bottom row of Table 5-2. For example, *Mediomastus ambiseta* was the most abundant species at candidate sites 1 and 2, but only the second most abundant at REF-2 and REF-NEW (Table 5-2). Likewise, Oligochaeta were relatively abundant at candidate site 2 but had much lower relative abundance at the other three areas. It is such differences in the relative proportions of the dominant taxa that most strongly contributed to the overall differences in community structure among areas.

This baseline evaluation of benthic community composition at specific stations within each candidate site and the reference areas can be used in selecting locations in future long-term monitoring. Based solely on the similarity among the four sites in the taxa comprising the numerical dominants, it is possible to conclude that at the time of the November 2000 survey, these sites were inhabited by roughly comparable benthic communities. In the event that either one or both proposed candidate disposal sites are designated for use, the reference sites would be logical seafloor locations to provide a comparative assessment of benthic recolonization patterns at the dredged material disposal locations. Section 11.0 provides additional detail about the proposed SMMP in the event that one of the candidate sites is officially designated as the new BBDS.

5.1.4.5 Comparison to Other Studies

A significant number of the dominant taxa identified at the candidate sites in this study were also found by Whitlach et al. (1980) at a station located in western Buzzard Bay (e.g., *Nucula annulata*, *Mediomastus ambiseta,* and *Nephtys incisa*). Hampson (1988) sampled benthic infauna along a transect of stations in western Buzzards Bay, south of New Bedford Harbor, and found the dominant taxa to include *Mediomastus ambiseta*, *Mulinia lateralis*, *Nucula annulata*, *Nephtys incisa*, *Asychis elongata* and *Yoldia limatula*. Three of these were among the numerical dominants in the present study.

In sampling conducted during March 1990 by the USACE's DAMOS, very high numbers of *Mediomastus ambiseta* were found at stations located in and around the former Buzzards Bay Disposal Site (BBDS) and nearby reference areas (SAIC 1991). Four of the seven dominant taxa found in that 1990 sampling effort were also dominant in the present study, including in particular *Mediomastus ambiseta* as the overall numerical dominant. The USEPA's Environmental Monitoring and Assessment Program (EMAP Virginia Province) sampled benthic infauna at several stations in Buzzards Bay during the period 1991 through 1993, and almost all the numerical dominants found in the EMAP sampling were also among the dominants in the present study.

These results suggest that the benthic communities found at candidate sites 1 and 2 and the reference areas are broadly comparable to those found in other studies of Buzzards Bay, in terms of being dominated by roughly the same group of relatively few taxa. However, to provide a more detailed comparison of *overall* benthic community structure across different stations/ studies, a multivariate approach similar to that described previously was employed. Cluster and MDS analyses were performed using the species abundance data from: 1) the five EMAP stations, 2) the 1990 DAMOS sampling effort at REF-2, and 3) the 18 stations sampled in the present study.

Results of comparisons using these other locations in Buzzards Bay indicated that the 18 stations sampled in the present study generally form a group (greater than 45% similarity), while the EMAP stations and 1990 BBDS stations had dissimilar community structure. Therefore, although there was some overlap between the results of the present study and those from previous studies in terms of the consistent presence of a relatively small group of dominant taxa, the multivariate results indicated that overall community structure (which takes into account the presence and abundance of *all* the taxa, both abundant and rare) was essentially different. Such results are not surprising and might be due to a number of factors, including: 1) differences in taxonomic accuracy and/or nomenclature among the different studies, 2) seasonal differences (i.e., differences in the time of year that each study was conducted), 3) differences in water depth and station locations among studies, which can strongly influence grain size distributions and organic carbon concentrations, and 4) longer-term temporal trends (i.e., years to decades) in the populations of different benthic species in Buzzards Bay.

5.1.5 Summary of Benthic Community Characterization Results

Despite minor differences observed in the benthic habitat parameters based on the SPI survey described in Section 5.1.2 above, the benthic communities inhabiting candidate sites 1 and 2 as well as two nearby reference sites were comparable. They were comprised of roughly similar proportions annelids, molluscs, crustaceans, nematodes, and nemerteans. In addition, the same group of 13 taxa consistently was among the most abundant organisms in each of the four sites. There was variability among sites in the absolute and relative abundances of both the dominant and sub-dominant taxa, which is typical of estuarine benthic communities dominated by small-bodied, surface-dwelling, opportunistic, "Stage I" polychaetes (e.g., *Mediomastus ambiseta*, *Prionospio perkinsii, Caraziella hobsonae*) known to have high population turnover rates and therefore wide spatial and temporal variance. The consistent presence of the dominants across the four sites, despite differences in their relative proportions, leads to the conclusion that the sites were comparable at the time of the November 2000 survey.

Univariate statistics revealed some differences among the four sites, but differences in total numbers of individuals, number of taxa, species diversity, and species richness were not significant between candidate sites 1 and 2. Significant differences in diversity and species richness between candidate site 2 and one of the reference areas can most readily be attributed to the substantial differences in sediment grain size.

Multivariate statistics, providing information on the overall community structure (i.e., inclusive of all species information), indicated no strong groupings by station, which would be expected given the close proximity of the sites, the general lack of site disturbance, and similarities in substrate (unconsolidated soft bottom). Minor differences were evident between candidate sites 1 and 2, primarily a reflection of somewhat sandier sediments at the latter. Therefore, despite minor differences in grain size (likely attributable to differences in hydrodynamic regime) and benthic habitat characteristics, there were no substantive qualitative differences in the structure of the benthic community at candidate sites 1 and 2 evident from the detailed benthic community characterization. The minor differences noted between candidate sites 1 and 2 and the nearby reference areas reflect both differences in sediment grain size and normal spatial variability in the distribution of benthic infauna.

5.2 Finfish and Shellfish

The marine fish and shellfish of Buzzards Bay are part of the faunal communities that comprise the Atlantic temperate biogeographical region. This region is characterized by moderate temperatures and longer summer warming, and therefore a wider annual temperature range, than waters north of Cape Cod (the boreal region). Many northern species of fish reach the southern limit of their range at Cape Cod, while many southern species reach their northern range limit. The following studies are the primary sources of information used to evaluate finfish communities in this DEIR:

- *Buzzards Bay Disposal Site Report: Massachusetts Division of Marine Fisheries Trawl Data Analysis from Survey Years 1978-2000* (Maguire 2002a) (Also see Appendix J).

- *Buzzards Bay Disposal Site Fisheries Trawl Survey Report March 2001 – March 2002* (Camisa and Wilbur 2002) (Also see Appnedix K).

The Maguire (2002a) report provides an analysis of trawl survey data collected in Buzzards Bay by the Massachusetts Division of Marine Fisheries over a 22-year period, 1978 to 2000. It was used as the primary source of information to characterize the regional finfish profile of Buzzards Bay, with a focus on the subregion that includes the former CLDS and candidate sites 1 and 2 (Section 5.2.1). The Camisa and Wilbur (2002) study presents the findings of a 13-month trawl survey conducted within and proximal to the candidate disposal sites to characterize the site-specific finfish profile (Section 5.2.2). This information, coupled with what is known about environmental conditions at the candidate disposal sites (e.g. substrate type, water quality, water depth), allows for a reasonable characterization of finfish at and near these sites.

5.2.1 Regional Finfish Profile of Buzzards Bay

The spatial and temporal trends in the Buzzards Bay finfish community were characterized through analysis of a long-term trawl dataset collected by DMF (Maguire (2002a). This section provides a synopsis of the information contained in the Maguire (2002a) technical report describing the fisheries resources throughout Buzzards Bay, including the former CLDS and vicinity. This technical report provides greater detail than what is presented here; however, the information contained herein compliments the site-specific trawl data provided by Camisa and Wilbur (2002) that is summarized in Section 5.2.2. By providing an examination of relative abundance of nekton throughout the bay for a long-term time series (1978 to 2000), the importance of fish and invertebrate resources potentially affected by disposal can be evaluated in a larger context.

Many of the fish in Buzzards Bay are migratory, moving along the southeastern New England coast and into the bay in spring and summer. Some species, including bluefish and striped bass, frequently continue the migration through the Cape Cod Canal into Cape Cod Bay. Some resident species also move throughout the bay or disperse from the bay into adjacent coastal waters (e.g., winter flounder, tautog, skate). As a result, the nekton of Buzzards Bay is connected to a much larger population of fish and invertebrates affected by regional conditions of stress and opportunity. These populations are dynamic and will continue to change spatially and temporally in response to a variety of biotic and abiotic environmental factors.

The primary objective of the Maguire (2002a) study was to characterize the baseline distribution of nekton in Buzzards Bay by analyzing trawl data collected by the Massachusetts DMF. The existing DMF dataset provided a robust randomized sample of nekton population and biomass within the bay that, through comparative analysis, can be used to provide an indication of relative location of resources within the bay. Secondary objectives were to characterize the existing fisheries habitats and associated fish communities known or anticipated (based on historical data) to be present within the two candidate disposal sites and in the immediate surrounding area.

For the purpose of the Maguire (2002a) analysis, Buzzards Bay was divided into two depth strata: the 9110 strata (less than 9.1 meters) and the 9120 strata (9.1 to 18.3 meters; Figure 5-11). The bay was further divided into north and south regions, marked by a line running between West Island and Weepeckett Island (Figure 5-11). This produced four subregions of the bay and four corresponding data groupings: the shallow (9110) southern, shallow (9110) northern, deep (9120) southern, and deep (9120) northern. The candidate disposal sites and former historic CLDS are located in the deep northern subregion (9120N).

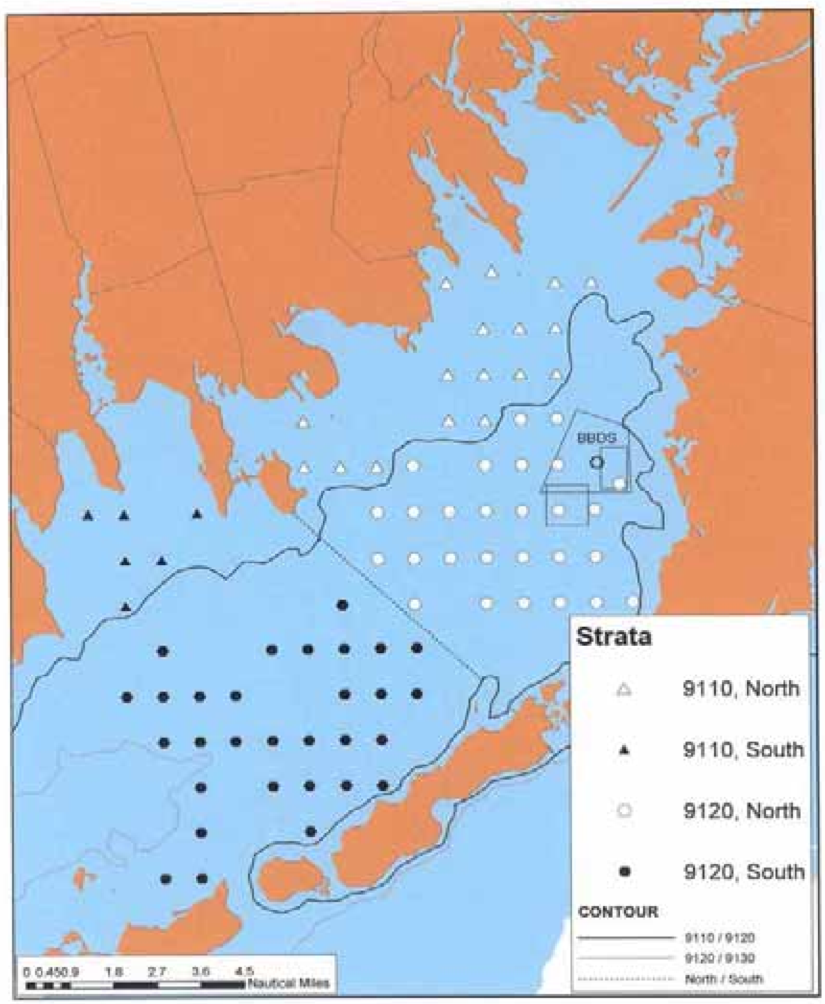


Figure 5-11. Location of DMF trawl stations in Buzzards Bay. 9110 Stations represent shallow subregions while 9120 stations represent deep subregions (Maguire 2002a).

Sampling was conducted each year during two three-week sampling periods: one in May (spring sampling period) and the second in September (fall sampling period).

The bottom trawl survey catch data were also grouped into two categories: total catch and select species. The total catch consisted of all finfish and invertebrate species collected in the bottom trawl survey from strata 9110 and strata 9120 within the Buzzards Bay study area. Select species were those high in numerical abundance (within the top 80% of the total catch in either season). These species were determined to be representative species of the Buzzards Bay community.

5.2.1.1 Results of Total Catch Analysis

Results of the total catch analyses were summarized by season as total finfish or total invertebrates, while results for each of the select species were presented individually. Length frequency data were analyzed for five of the 17 finfish species (black sea bass, scup, summer flounder, tautog, and winter flounder), which permitted more detailed results by lifestage for these taxa.

The Buzzards Bay catch data were analyzed for the following parameters:

- Average catch-per-unit-effort (CPUE): a measure of relative abundance, determined as the average number of fish caught per unit of effort (King 1995). One 20-minute tow was chosen as the unit of effort.
- Average biomass: the weight, in kilograms, of fish caught in the trawl survey. Average biomass was determined by dividing the total weight of the total catch or a particular species by the total number of tows in a given season or region.
- Species Richness: The mean number of species caught per tow. Species richness was calculated by summing the mean number of species per station by season, stratum, and section.

For each parameter, the data were summarized by season (spring or fall), "station" (i.e., one of 80 separate data aggregates representing all DMF trawl sampling locations that occurred within the cells of a sampling grid superimposed on the bay), strata (i.e., 9110 or 9120), and section (i.e., North or South). For the total catch data only, the parameters also were summarized by year and season to provide an overview of temporal patterns. Average total CPUE and average total biomass were calculated for all finfish and invertebrate species captured in the trawl survey. Average CPUE and average biomass also were calculated for each of 18 species selected for individual analyses by CZM and DMF biologists (Individual Species CPUE). For black sea bass, scup, summer flounder, tautog, and winter flounder, mean CPUE of both juvenile and adult fish were calculated based on length frequency data. This information was used to help assess the nursery and spawning potential of the bay in the area of the candidate disposal site (Sections 5.2.5 and 5.2.6).

The data analyzed in the Maguire (2002a) study represented the compilation of a total of 255 tows collected in the spring (n=131) and fall (n=124) from 1978-2000. Fall finfish catch dominated the abundance totals (Figure 5-12a) with 572,879 fish representing 69 species. Spring finfish catch was an order of magnitude lower in abundance with 50,356 fish representing 49 species. The fall catch of invertebrates was also much larger than spring with 87,412 individuals

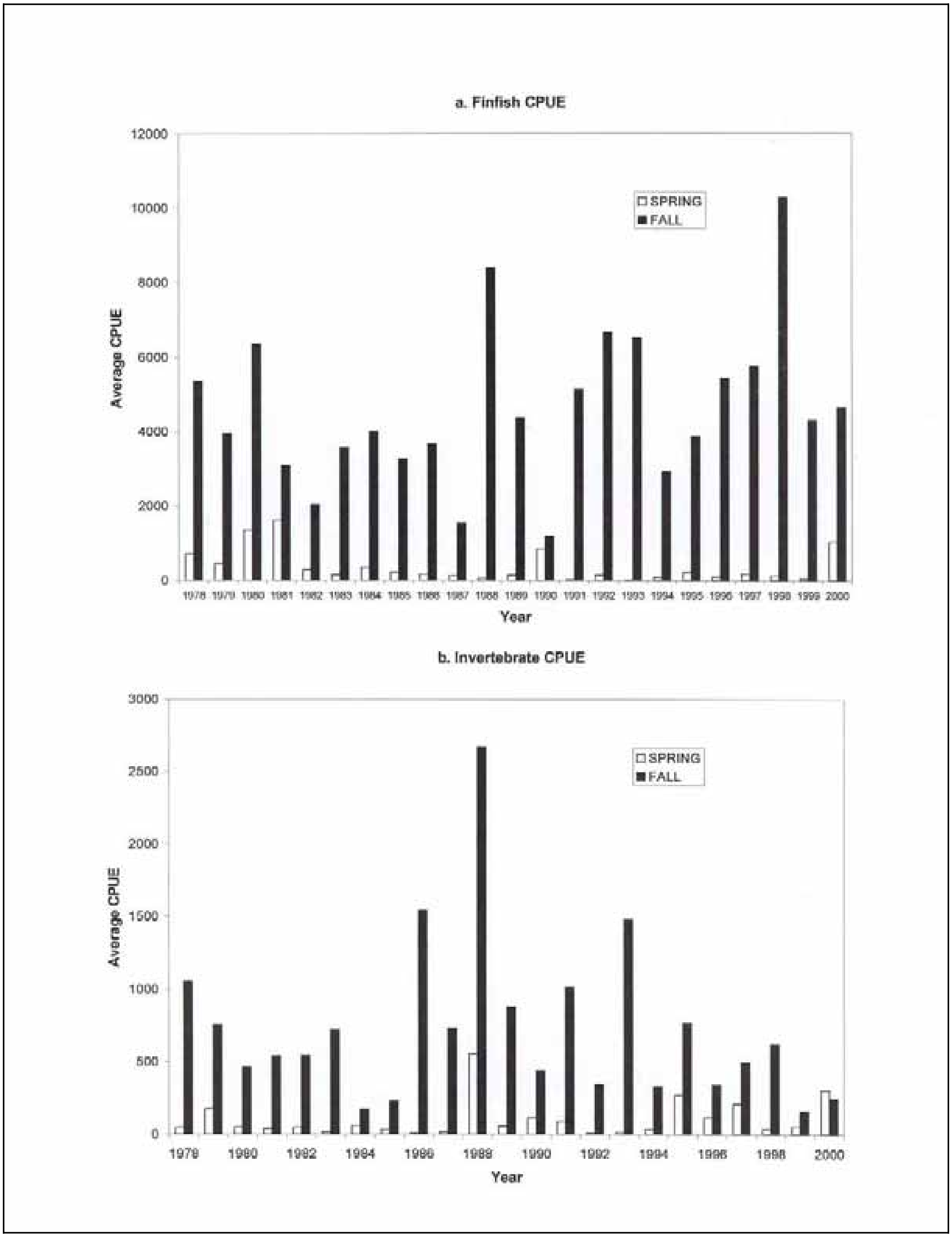


Figure 5-12 (a and b). Average biomass per tow by season and year.

representing 15 species (Figure 5-12b). Spring catch was lower (12,377 individuals), but represented a larger number of species (19).

The biomass data revealed a shift in seasonal dominance due to a precipitous drop in spring finfish biomass after 1990 (Figure 5-13a). In 1990, the spring biomass was dominated by a high catch (abundance and biomass) of scup (Figure 5-14), possibly a result of inshore movement of adult fish to spawn. However, in subsequent years, scup catch returned to the low levels observed in the five years preceding 1990, and the catch of tautog also declined markedly after 1990. These factors combined to make the spring biomass average lower than the fall biomass average after 1990. Fall biomass did not show a specific trend among the dominant finfish species (Figure 5-14). A higher biomass in fall compared to spring may occur as a result of adult fish spawning in deeper offshore waters, followed by the inshore movement of both adult and young-of-year (YOY) fish, the latter of which most likely also recruited to inshore stocks. Most of the variation was attributed to changes in scup and butterfish catch from year to year. Apart from low years in 1982, 1990 and 1995, fall scup biomass was high throughout the survey. Fall tautog catch declined after a peak in 1989, but butterfish catch increased. The invertebrate biomass results show a few anomalous years, with unusually high weights in either spring or fall of several years (i.e., 1988, 1993, 1995, and 1997; Figure 5-13b). However, in general, the spring and fall invertebrate biomass values were comparable. Species richness (mean number of species per tow) did not exhibit any distinct pattern over time, apart from an apparent drop in spring species richness between 1987 and 1993, followed by a recovery corresponding to a period of relatively high fall catch for both finfish and invertebrates (Figure 5-15).

In the original report (Maguire 2002a), detailed results of the trawl analyses are presented in a series of tables and synthesized into maps that depict the regional and seasonal distribution of relative abundance and biomass of the select species. In addition, this report presents and discusses the following: limitations of the survey methods and gear employed, a comprehensive list of fish and invertebrate resources generated from the 22-year data set, a comprehensive bay-wide evaluation of select species represented by the data set, temporal trends, and limitations regarding interpretation of the data. The information provided in the following section summarizes the information that is relevant to characterizing the finfish community in the deep (9120) northern region, where the two candidate disposal sites are located.

5.2.1.2 Comparison of 9120N Subregion to Other Areas of the Bay

The spatial structure and intensity of the sampling did not support a site-specific analysis of the finfish and mobile invertebrate communities associated with the historic or proposed dredged material disposal sites. However, these sites are consistent with the characteristics of the north sub-region of stratum 9120 (i.e., waters ranging in depth from 9.1 to 18.3 meters). Maguire (2002a) examined the groupings of stations within this sub-region for comparison with the other sub-regions in Buzzards Bay (Figure 5-16). With few exceptions, this sub-region did not support a community distinct from, or different in scale from, the comparable habitats within the south sub-region of stratum 9120.

Specific habitat characteristics of the two candidate disposal sites (water depth, grain size, structure) were reviewed using data compiled during site surveys to provide a more detailed predictive comparison. The combination of habitat characterization (e.g., Maguire 1998b;

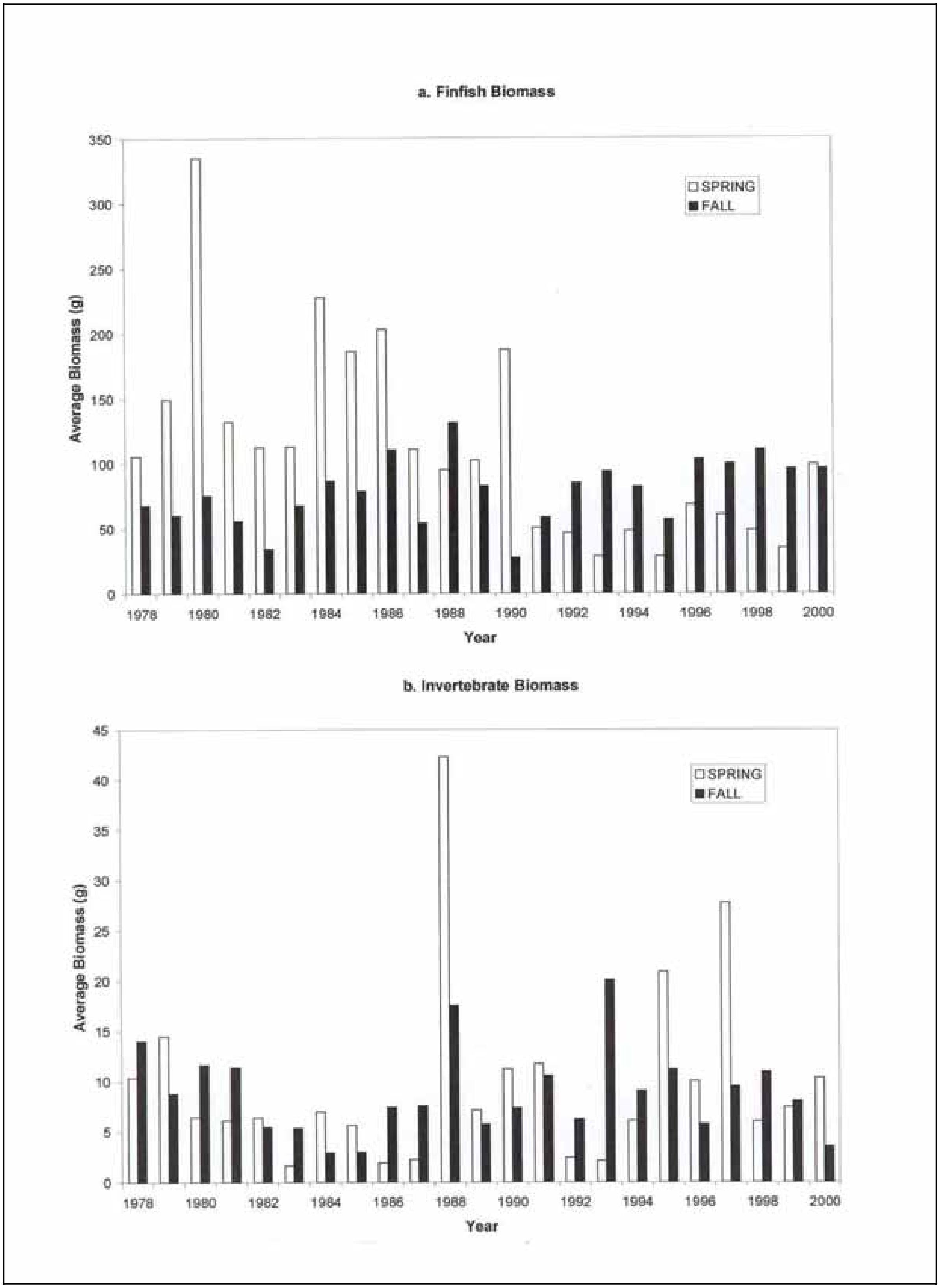


Figure 5-13. Average biomass per tow by season and year for a) finfish (top) and b) invertebrates (bottom).

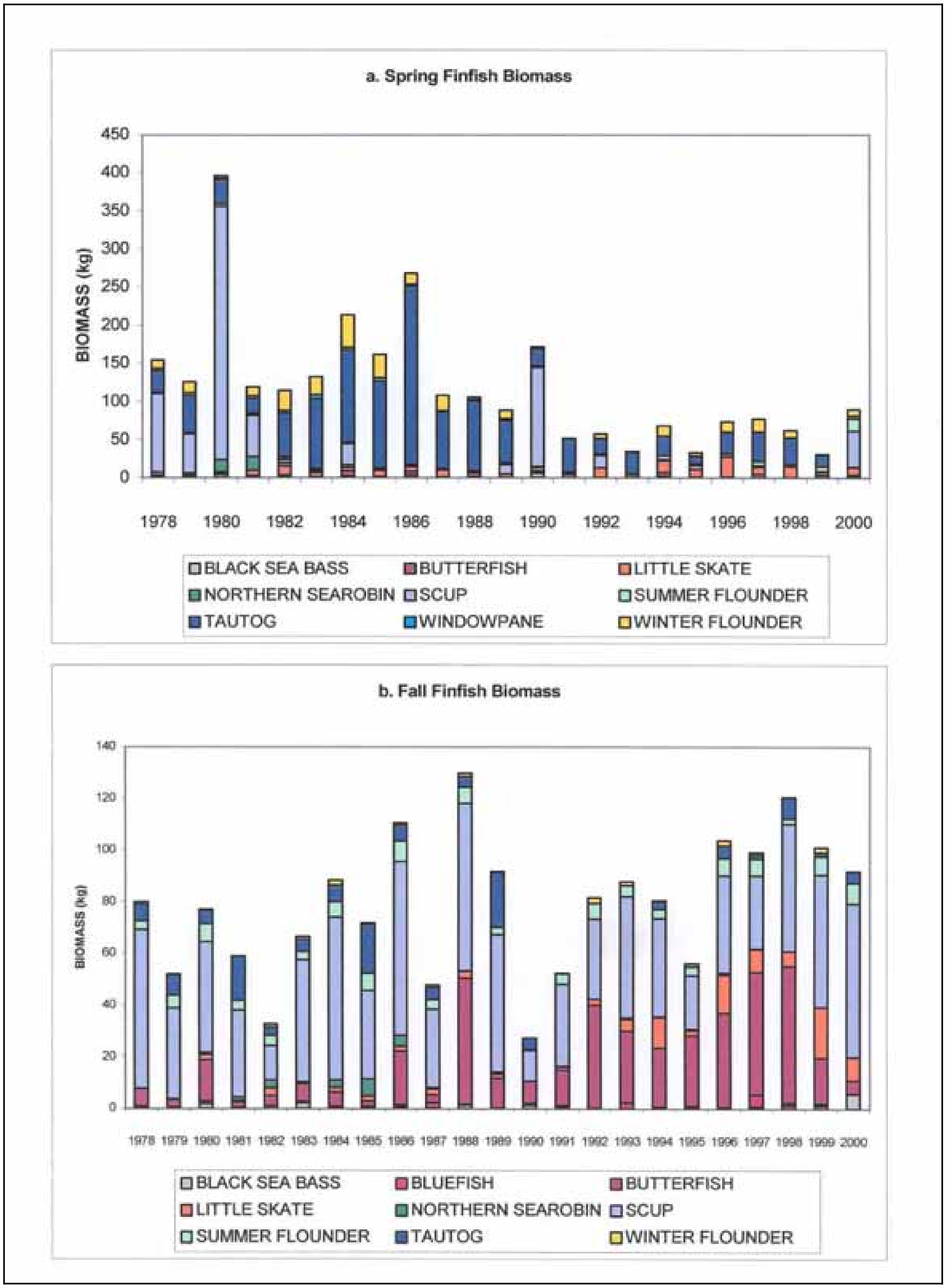


Figure 5-14. Biomass of top nine finfish species by year for a) spring and b) fall.

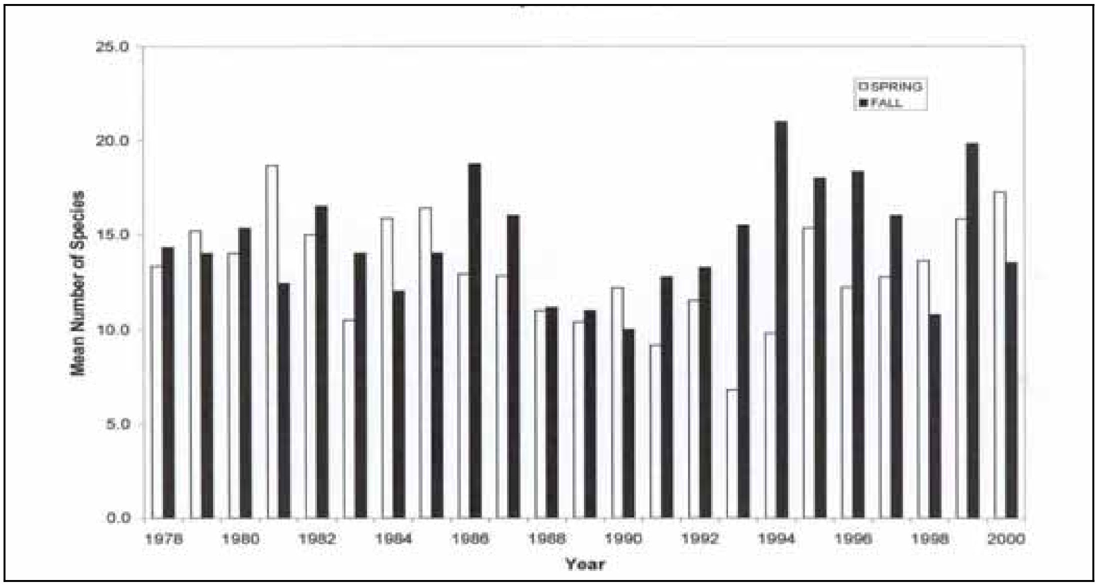


Figure 5-15. Average species richness per tow by season and year.

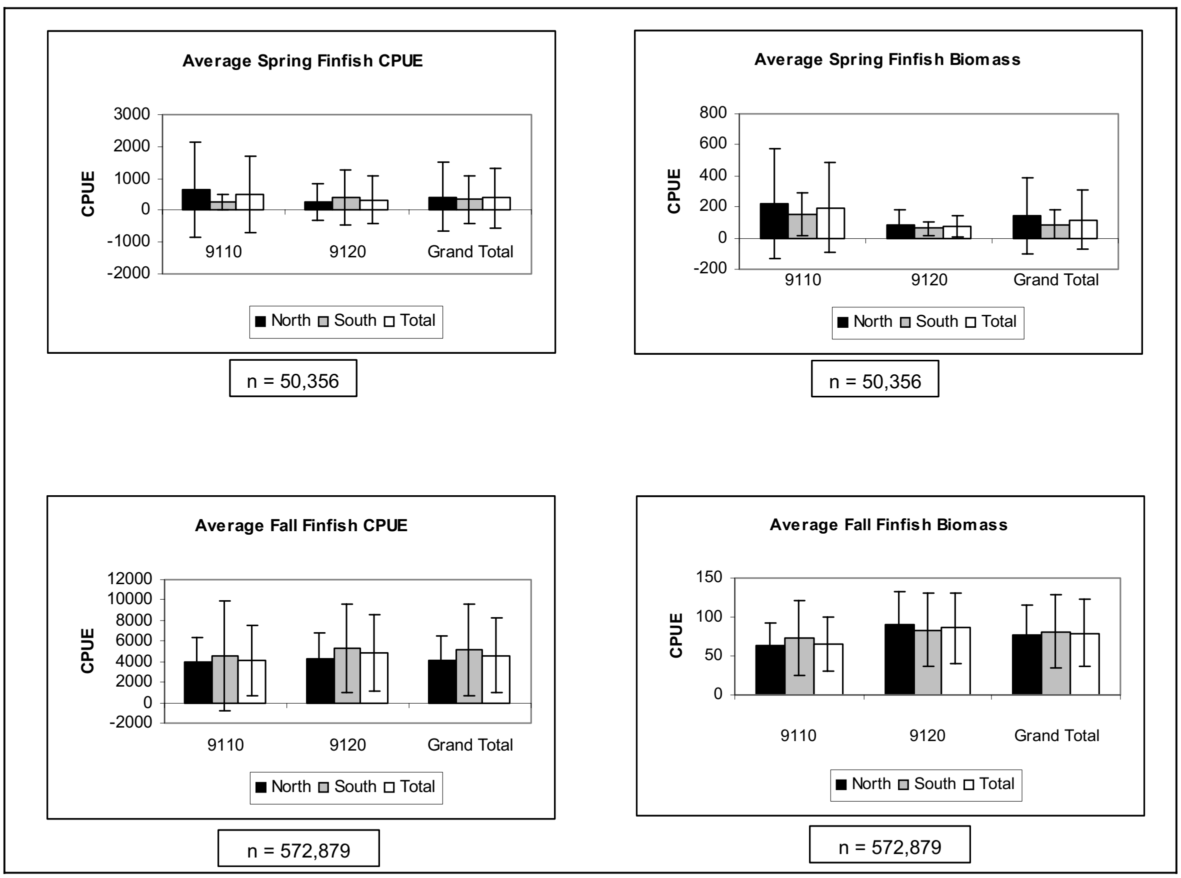


Figure 5-16. Finfish results by subregion. Error bars are plus and minus one standards deviation from the mean (from Maguire 2002a).

2001b, 2001c and 2002d) (Also see Appendix L) and documentation of species distributions provides a clear indication of the fish populations potentially effected by disposal activity. Both candidate sites 1 and 2 had benthic habitats that correlated with depth (Maguire 2001c and d). Below a depth of about 12 meters, each site was found to contain unconsolidated soft mud and relatively undisturbed benthic infauna. Portions of the sites shallower than 12 meters contained very fine sand mixed with mud, and in the shallowest areas, the benthic infauna and sediments reflected some moderate physical disturbance attributed to the winnowing action of bottom currents. Both the shallow and deeper areas within each site represent benthic habitats capable of supporting finfish and both motile and sessile invertebrates, by providing feeding grounds, as well as refuge and spawning areas for some demersal species. It is the deeper, muddier sediments that define the North 9120 sub region. The historic disposal area was not sampled directly by DMF because it has long been marked on nautical charts as a disposal area, with no information on depth or potential hangs (i.e., areas potentially snagging and tearing the bottom trawl). The shallower sediments are more consistent with the North 9110 stratum (i.e., depths less than or equal to 9.3 meters) and reflect the conditions of a nearshore supply of fine sand and higher wave and current energies.

The habitat conditions represented by the deeper portions of northern Buzzards Bay are widely distributed and appear to be relatively uniform in character and finfish distribution. Those portions of the candidate disposal sites that contain unconsolidated mud and water depths greater than nine meters are consistent with these areas. The data analyzed in Maguire (2002a) allow for neither comparisons of the suitability of each candidate disposal site as fisheries habitat, nor between them and the regional habitat as a whole. However, environmental characteristics of the seafloor, such as the presence of vertical structure (e.g., shallow rock ledges, shoals, etc.) and soft sediments with emergent epifauna, within and proximal to the sites are likely to provide suitable habitat for a variety of fish, such as scup, tautog, and black sea bass. Additional information regarding these species is provided in Section 5.2.3.

In general, squid and finfish species were distributed in Buzzards Bay according to known habitat preferences (e.g., nearshore species, such as cunner, were concentrated in stratum 9110). The analysis of CPUE and biomass by strata and geographic section for the select species indicated specific zones of seasonal concentration for most species. Although fish may regularly move among the bay's four sub regions, the long time-series of CPUE data in the bottom trawl survey can be used to highlight species that will most likely be affected by disposal activity at the BBDS. Species that concentrate within the northern extent of stratum 9120 vary seasonally. During the spring, the season of lowest finfish abundance and relatively high biomass in the bay, Atlantic herring and striped anchovy appeared to concentrate within this region (Table 5-3). Both species are pelagic, schooling fish, and their high relative occurrence in spring trawls is due to a few very high catches (post-larval brit herring). However, other important species were also present with notable biomass in this subregion, including black sea bass, tautog and windowpane. In the fall, a more diverse assemblage of demersal and pelagic fish concentrates in the northern extent of the deep stratum, indicating that the area provides suitable habitat for a variety of species. Species with notable biomass in this sub region in the fall include: blueback herring, long-finned squid, northern searobin, scup, striped anchovy, summer flounder, and tautog (Table 5-4). Summary accounts for select species are provided in Section 5.2.3.

Table 5-3. Distribution of spring average CPUE, biomass, species richness, and highest relative abundance of select finfish species, by sub region in Buzzards Bay (Maguire 2002a).

Parameter	Strata			
	9110 North	9110 South	9120 North	9120 South
Finfish CPUE	640	252	260	383
Finfish Biomass (kg)	223	151	86	61
Invertebrate CPUE	34	75	44	168
Invertebrate Biomass (kg)	4	7	5	15
Species Richness	11	13	12	16
Highest Rel. abundance (CPUE; #/tow) among squid and select species	Black sea bass No. Sea robin Scup (A) Summer flounder (A) Tautog (A)	Cunner Little Skate Tautog (J) Windowpane Winter Flounder (A, J)	Atlantic Herring Striped Anchovy	Alewife Winter Flounder (A) Blueback Herring Butterfish Long-finned squid Little Skate Scup Summer Flounder (J)

Key: A – Adult J – Juvenile YOY – Young of Year CPUE – Catch Per Unit Effort kg - Kilogram

Table 5-4. Distribution of fall average CPUE, biomass, species richness, and highest relative abundance of select finfish species, by sub region in Buzzards Bay (Maguire 2002a).

Parameter	Strata			
	9110 North	9110 South	9120 North	9120 South
Finfish CPUE	3892	4560	4267	5255
Finfish Biomass (kg)	62	71	90	83
Invertebrate CPUE	244	387	948	877
Invertebrate Biomass (kg)	8	4	9	9
Species Richness	14	12	15	15
Highest Rel. abundance (CPUE; #/tow) among squid and select species	Bay anchovy Black sea bass (A, YOY) Cunner Scup (A) Summer flounder (J)	Little skate Scup (YOY) Striped anchovy Tautog (A, J) Windowpane	Blueback herring Bluefish (YOY) Long-finned squid No. searobin Striped anchovy Summer flounder (A) Weakfish	Alewife Atlantic herring Butterfish Little skate Winter flounder (A, J)

Key: A – Adult J – Juvenile YOY – Young of Year CPUE – Catch Per Unit Effort Kg – Kilogram

5.2.2 Candidate Site Finfish Data

As previously indicated, the DMF and CZM conducted a 13-month fisheries trawl survey within and adjacent to the candidate disposal sites from March 2001 to March 2002 (Camisa and Wilbur 2002). The primary objective was to characterize nekton occurrence, distribution, and relative abundance in the environs of the two candidate disposal sites. The secondary objective was to collect geographic and hydrographic data for each tow. The results of the study are summarized below and presented in greater detail in the original technical report (Camisa and Wilbur 2002).

To conduct the 13-month trawl survey, seven trawl stations were established in eastern Buzzards Bay, within or proximal to both the historic CLDS and the two candidate disposal sites. The locations of these trawl stations were chosen to allow sampling of areas known to have different types of sediments and other seafloor features. Trawl Stations 2, 3 and 4 were located within or close to candidate site 1, while Station 6 was located within candidate site 2 (Figure 5-17). The remaining stations were located proximal to the southern (Stations 5 and 7), southwestern (Station 3), and western (Station 1) boundaries of the historic CLDS.

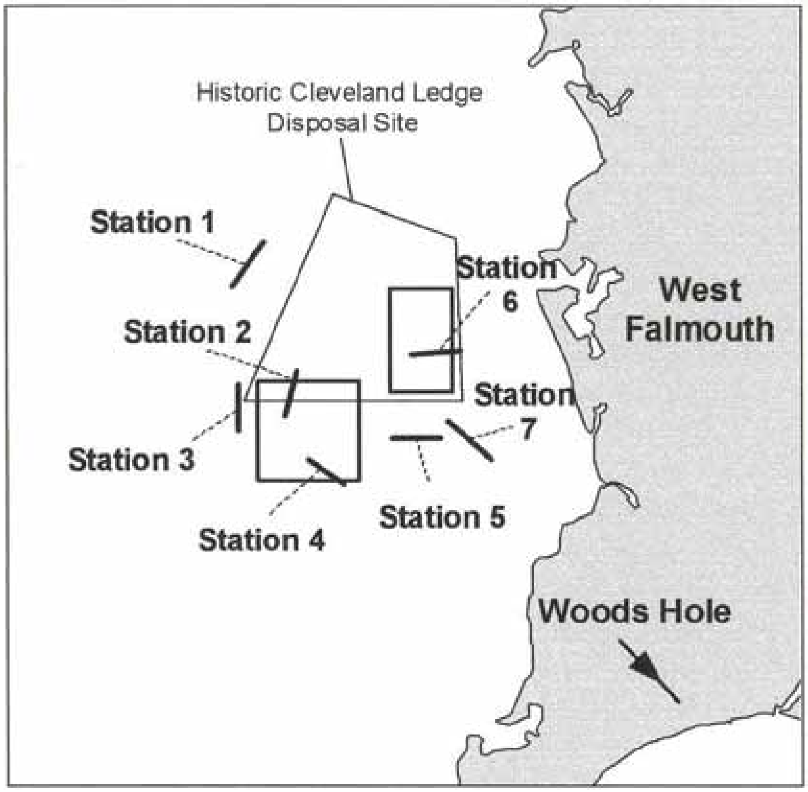


Figure 5-17. Trawl stations for the March 2001 to March 2002 monthly fisheries surveys (Camisa and Wilbur 2002).

5.2.2.1 Station Characterization

Characteristics of the seafloor at the seven trawl stations were identified from side-scan sonar records, direct video observations, fish survey fathometer readings, information from NOAA Nautical Chart #13230, and by extrapolating from nearby areas that had been surveyed, Bathymetry and SPI survey data were not collected at Stations 1, 5 and 7, so substrate firmness and RPD depths were not measured and water depths were estimated. The data collected from the side-scan sonar and video observations were used to describe landscape and substrate features (Maguire 2002d). General descriptions of the physical characteristics at each trawl station are presented in Table 5-5.

5.2.2.2 Data Collection, Description, and Analysis

Each station was towed monthly in March 2001 and from November 2001 through March 2002, and twice per month from April 2001 through October 2001 (20 sample periods). Each tow was 0.5 nautical miles in length, with a tow speed of 2.5 knots (roughly 12 minutes). A complete description of regime and gear specifications/limitations is provided in the original technical report (Camisa and Wilbur 2002). The tow start time, beginning and end coordinates, and average depth were recorded from the vessel's differential Global Positioning System (dGPS) unit and depth sounder. Surface and bottom water temperature, salinity, and dissolved oxygen concentration were recorded for each tow with a YSI 650 Multiparameter Display System and a YSI 6-series sonde. For all species caught, Camisa and Wilbur (2002) recorded number, total weight (nearest 0.1 kilogram), and length (total or fork length; nearest 0.5 centimeter). Standard subsample procedures were employed when catch size and time constraints dictated their use.

Table 5-5. General description of fisheries trawl stations in Buzzards Bay (from Camisa and Wilbur, 2002).

Station	Average Latitude & Longitude (Start / End)	Water Depth (M)	Predominant Substrate (Phi)	Topography	SPI	Direct Observation	Location Description
1	41.6061°N, 70.7110°W 41.6125°N, 70.7050°W	~13	soft mud (>4) sandy mud (4-3)	smooth	N/A		NW of CLDS
2	41.5871°N, 70.7012°W 41.5936°N, 70.6988°W	10-13	soft mud (>4) sandy mud (4-3) sand (2)	variable			N of site 1
3	41.5849°N, 70.7100°W 41.5916°N, 70.7099°W	11-12	sandy mud (4-3)	smooth			W of site 1
4	41.5769°N, 70.6900°W 41.5806°N, 70.6968°W	13-16	soft mud (>4)	broad depression			SE of site 1
5	41.5836°N, 70.6806°W 41.5836°N, 70.6716°W	13-16	soft mud (>4)	submerged valley	N/A		S of CLDS
6	41.5962°N, 70.6676°W 41.5957°N, 70.6767°W	14-16	soft mud (>4)	submerged valley		frequent snags	Middle of site 2
7	41.5859°N, 70.6698°W 41.5805°N, 70.6620°W	14-16	Soft mud (>4)	broad depression	N/A	drift algae seasonally abundant	SE of CLDS

N/A – not available

CPUE was calculated by number and weight for all species and all stations combined to determine seasonal relative abundance of species. CPUE of all species combined was also calculated for each station to compare catch differences among stations. Descriptive statistics (means and 95% confidence limits) were applied to summarize hydrographic and catch data. A length-frequency analysis was applied to scup, butterfish, and squid (the three numerically dominant species) to show seasonal size distribution.

5.2.2.3 Results

The sampling effort resulted in the collection of seventy-two species (fifty-seven finfish and fifteen invertebrate) in one hundred thirty-two trawls completed over twenty sampling days from March 2001 to March 2002. A total of 196,854 fish and invertebrates were collected having a total weight of 4,431 kilograms. The three most abundant species collected were scup (66.0%), butterfish (21.8%), and longfin squid (7.6%). These three species comprised 95.4% of the total number of fish caught and 58.6% of the total weight (Table 5-6). Seven out of the 72 species (scup, butterfish, little skate, summer flounder, tautog, smooth dogfish, and longfin squid) combine for just over 90% of the total biomass during the 13-month study. Several less common mid-Atlantic and tropical species were also encountered during the survey effort; a list of all species collected is provided in Camisa and Wilbur (2002).

5.2.2.4 Relative Abundance and Distribution

The mean number per tow for all species and all stations combined peaked in August 2001 at 7,138 (Figure 5-18), and mean weight per tow for all species and all stations combined peaked in June 2001 at 116 kilograms (Figure 5-19). YOY scup dominated the August peak in mean number, and adult scup dominated the June peak in mean weight, reflecting the inshore migration of adult fish. Figures 5-20 and 5-21 depict mean number per tow and mean weight per tow for scup versus all species combined. They show that the total catch numbers and weights were largely driven by scup.

Table 5-6. Number, weight and percentage for top 90% of all species collected from March 2001 through March 2002 (Camisa and Wilbur 2002).

Common Name	Num.	%	Common Name	wt. (Kg)	%
scup	129,896	66.0%	scup	1,834.2	41.4%
butterfish	42,913	21.8%	butterfish	634.4	14.3%
longfin squid	14,898	7.6%	little skate	555.3	12.5%
			summer flounder	477.6	10.8%
			tautog	213.9	4.8%
			smooth dogfish	158.6	3.6%
			longfin squid	126.5	2.9%

Additional species contributing notable YOY numbers included Atlantic herring, Atlantic moonfish, bay anchovy, black sea bass, blueback herring, butterfish, longfin squid, and weakfish. The large numbers of YOY fishes encountered during the survey demonstrate the importance of Buzzards Bay as a nursery for juveniles of these species (see Section 5.2.5).

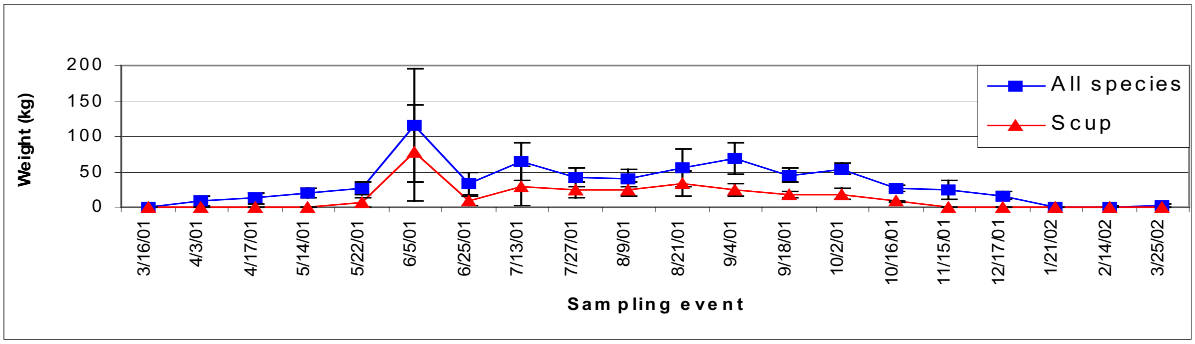


Figure 5-18. Mean number per tow for all species and all stations combined over time (with 95% confidence interval (CI)).

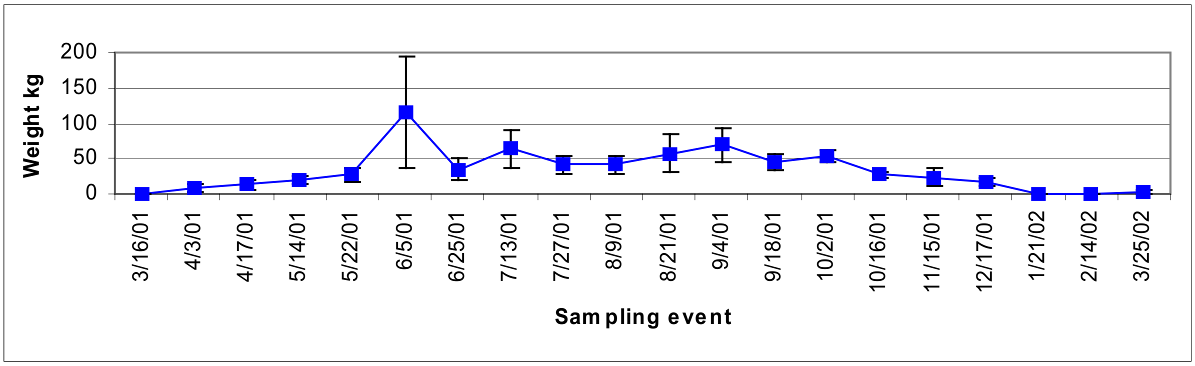


Figure 5-19. Mean weight per tow for all species and all stations combined over time (95% CI).

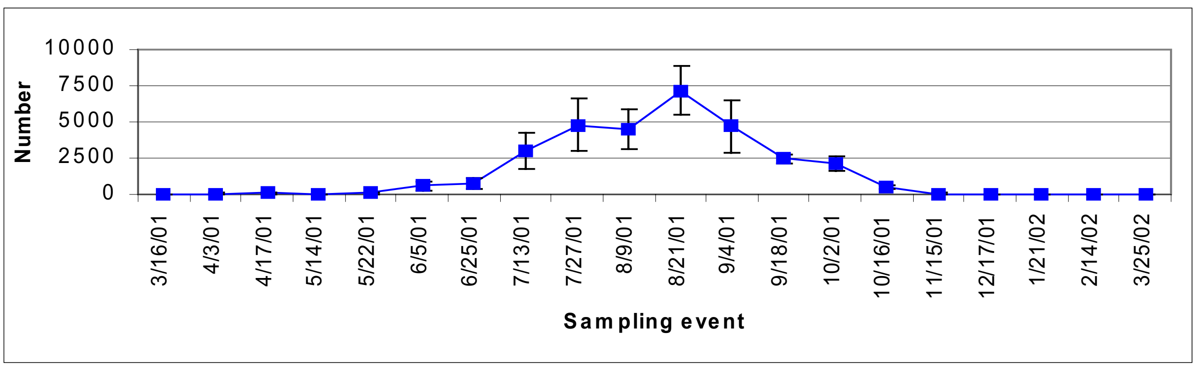


Figure 5-20. Mean number per tow for scup vs. all species, stations combined (95%CI).

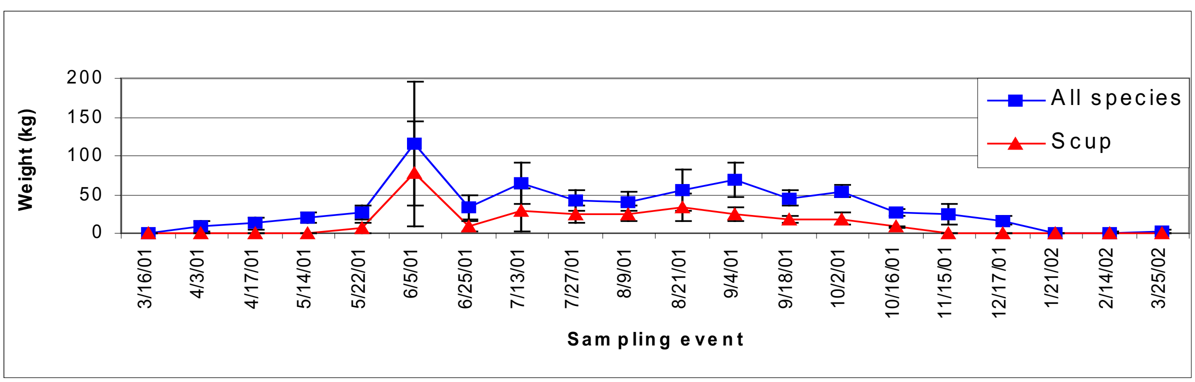


Figure 5-21. Mean weight per town scup versus all species, stations combined (95% CI).

Mean number per tow by station for all species combined ranged from 2,106 at Station 2 to 1,099 at Station 5 (Figure 5-22). Mean weight per tow by station for all species combined ranged from 45 kg at Station 3 to 23 kg at Station 4 (Figure 5-23). Camisa and Wilbur (2002) noted only nominal differences in mean number or weight per tow among stations, which they attributed to the relatively small study area with short distances between stations, similar mean depths at each station (ranging from 12.5 to 18.3 meters), and similar substrate types (silt and mixtures of silt and sand).

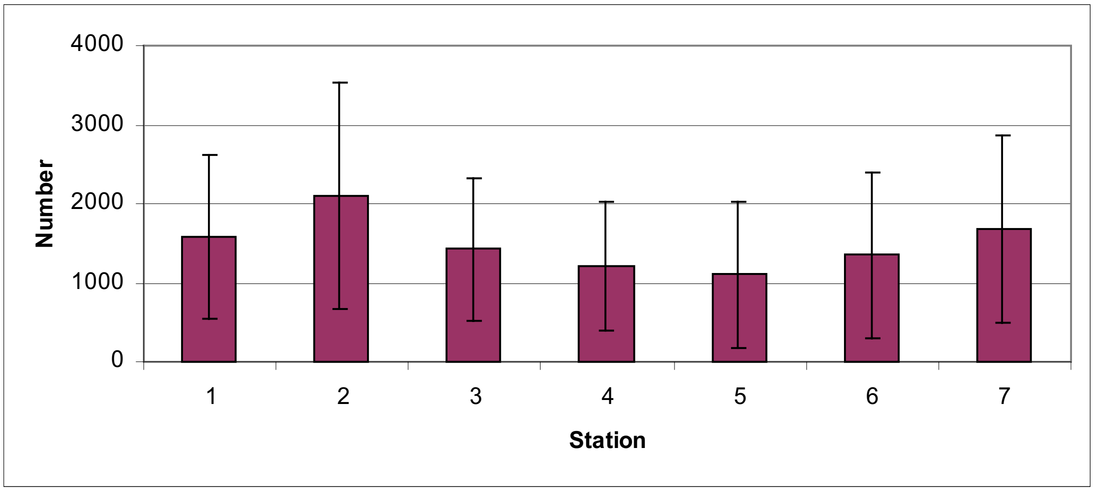


Figure 5-22. Mean number per tow by station, all species combined (95% CI).

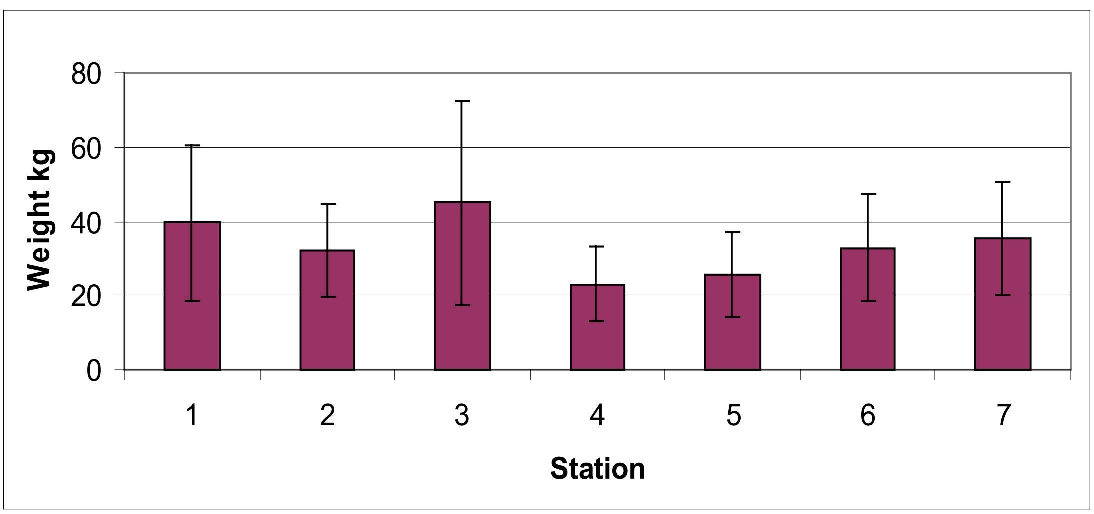


Figure 5-23. Mean weight per tow by station, all species combined (95% CI).

5.2.2.5 Station Description

Species richness (total number of species per tow) for each station, and for all stations pooled for each sampling event, are presented in Table 5-7. These data show that species richness peaked from the middle of May to the middle of August. Station 7 had the highest mean number of species per tow at 11.9 (53 species total), and Station 4 had the lowest mean number of species per tow at 8.5 (37 species total), but differences in species richness among the stations were considered nominal. Figure 5-24 shows the total number of individuals and total weight of all the species caught at each station during each sampling event. Total number and weight trends varied little between stations, excluding a spike in total weight at Stations 1 and 3 in June consisting primarily of adult scup. In addition, higher numbers of YOY scup, butterfish, and longfin squid were the main reasons for the observed increase in the total number of fish caught between July and September at all stations (Figure 5-24).

Table 5-7. Species richness by station and sampling event.

Sampling Event	Station							
	1	2	3	4	5	6	7	Pooled
3/16/01	3	-	3	2	5	-	7	14
4/3/01	6	5	9	5	5	5	12	18
4/17/01	8	8	8	6	6	7	-	15
5/14/01	11	11	11	6	11	12	12	22
5/22/01	12	10	14	9	17	12	18	31
6/5/01	19	17	18	14	13	18	16	27
6/25/01	16	13	13	10	18	14	20	28
7/13/01	13	11	14	13	11	17	17	29
7/27/01	15	7	12	12	-	11	16	27
8/9/01	16	9	17	12	16	15	15	32
8/21/01	14	12	14	13	-	8	-	24
9/4/01	10	14	13	7	10	13	13	20
9/18/01	15	14	11	14	16	17	16	25
10/2/01	14	14	13	10	10	9	9	25
10/16/01	10	12	10	9	7	9	7	20
11/15/01	6	7	8	7	8	8	6	20
12/17/01	8	-	7	8	7	7	7	20
1/21/02	3	4	4	2	6	7	6	14
2/14/02	8	7	5	3	8	5	12	19
3/25/02	5	7	8		7	3	6	22
Total Spp.	50	42	47	37	46	51	53	72
Total Tows	20	18	20	19	18	19	18	20
Mean No. of Spp.	10.60	10.11	10.60	8.53	10.06	10.37	11.94	22.60
Std Error	1.03	0.84	0.91	0.89	1.01	1.01	1.10	1.20

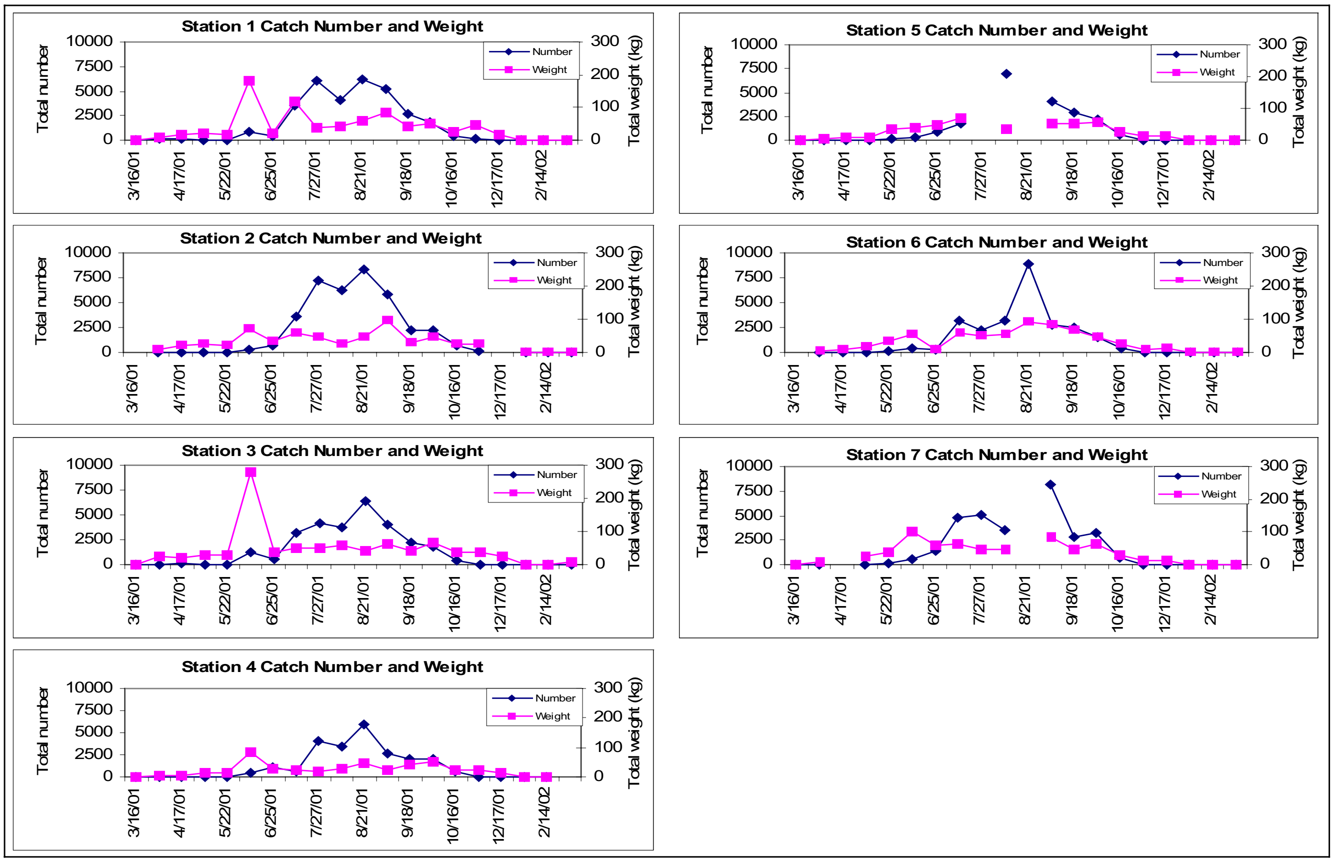


Figure 5-24. Total catch (species pooled) in number and weight (kilograms) over time by station (Camisa and Wilbur 2002).

5.2.3 Select Species Summary Accounts

Information on the dominant species collected in the trawl surveys in and around candidate sites 1 and 2 is provided below. These descriptions provided a short narrative of the significant commercial and recreational fishery resources of the bay. Information presented in this section regarding the species life history was obtained from NMFS publications and other existing literature. Information on seasonal and spatial abundance within Buzzards Bay was provided by the Maguire (2002a) analysis. This information, along with the seasonal abundance and biomass information provided by Camisa and Wilbur (2002), was used to characterize the fisheries resources of the two candidate disposal sites. A summary of the select species relative to the proposed candidate disposal sites is included in Section 5.2.2.16.

Also provided is information regarding each species' life history classification, as defined by Ayvazian et al. (1992):

> Residents: species that spawn in the bay and spend all or a significant portion of their life there.
> Nursery: species that use the bay as a nursery ground, either spawning in the bay or offshore. The majority of adults move offshore in the winter.
> Marine: species indigenous to the local neritic waters (e.g., Long Island Sound, Block Island Sound, Vineyard Sound, etc.) and which visit the bay as adults.

Species known to be diadromous (i.e., anadromous and catadromous) are discussed separately in Section 5.2.4. Additional information regarding nursery potential is provided in Section 5.2.5.

5.2.3.1 Atlantic Herring (*Clupea harengus)*

The Atlantic herring is a schooling, planktivorous, coastal pelagic species found on both sides of the Atlantic Ocean (Reid et. al. 1999). The herring have complex adult and juvenile migration patterns that include the waters of Buzzards Bay. In the western North Atlantic, they range from Labrador to Cape Hatteras, where spring and autumn spawning populations support major commercial fisheries (Messieh 1988). Juveniles and adults undergo complex north-south and inshore-offshore migrations for feeding, spawning and overwintering.

Spawning herring deposit demersal eggs on a variety of bottom substrates that range from rocks, boulders, sand and gravel, sand, shell fragments and small vegetative matter in depths from 66 to 263 feet (20 to 80 meters; Reid et al. 1999). Spawning usually occurs between July and November in well-mixed waters, with currents between 1.5 and 3.0 knots and a temperature below 15º C.

The free-floating, pelagic larvae between 0.20 and 1.97 inches (5 to 50 milimeters) in length are effected by the currents and may be dispersed from the spawning site. The larvae perform extensive vertical migrations and instinctually gravitate to school formation, feeding opportunistically on various zooplankton of appropriate size, their primary prey being copepods (Reid et al. 1999). Juvenile metamorphosis occurs when the herring are between 1.6 and 1.97 inches (40 to 50 milimeters) in length, which they typically attain by early spring (April to May).

Juveniles 1.6 to 9.4 inches (4 to 24 centimeters) in length tend to form large schools in coastal waters of southern New England in May and June. In the summer and fall, juveniles move out of nearshore waters to overwinter in deep bays or near the bottom in offshore areas (Kelly and Moring 1986). Juveniles and adults tend to undertake diel vertical migrations in the water column, in response to the light-dark cycle and presumed linked to predation (Blaxter 1985). Juvenile herring feed on up to 15 different groups of zooplankton; the most common are copepods and crustacean larvae. Juvenile and adult herring are preyed on by many marine species, including sand lance, cod, pollock, haddock, silver hake, white hake, striped bass, mackerel, tuna, salmon, and winter flounder. Fish predation in this life stage can be a significant source of mortality (Reid et al. 1999).

Adult herring make extensive feeding, spawning, and over-wintering migrations. In autumn, they move south to waters off Massachusetts and Rhode Island and return to Maine in the following spring. Both males and females of adult Atlantic herring generally mature at 3 to 4 years of age, attaining a length between 1 to 1.1 inches (2.5 to 2.7 centimeters; Kelly and Moring 1986; O'Brien et al. 1993). Adults almost invariably occur in large schools. Spawning typically takes place between July and November. Adults have a diet dominated by euphausiids, chaetognaths, and copepods (Bigelow and Schroeder 1953).

The analysis of the DMF long-term bottom trawl survey data revealed that Atlantic herring were fairly numerous during spring sampling, but quite rare in the fall survey (Maguire 2002a). The higher number of fish collected per tow in the spring was due to large catches of post-larval (brit) herring. Aside from being relatively more abundant in the spring trawl survey, Atlantic herring were also more widely distributed in Buzzards Bay during this season. In the spring, much higher catches were collected at one station within the northern extent of Buzzards Bay in stratum 9120. Mean biomass of Atlantic herring was also higher at this station. Only one station sampled in the fall, in the southern portion of the bay in stratum 9120, yielded an average of more than one herring per tow (Maguire 2002a).

Camisa and Wilbur (2002) found Atlantic Herring within and proximal to the candidate disposal sites during the winter and early spring (February to April). However, this species was absent in trawl samples collected during the late spring, throughout the summer, and during fall. Although not a significant part of the biomass or abundance of the finfish community, individuals were collected at each of the seven trawl sampling locations during the study.

5.2.3.2 Atlantic Menhaden (*Brevoortia tyrannus*)

Atlantic menhaden are a commercially important resource, primarily used for fishmeal and oils rather than direct human consumption. These non-residents spawn both at sea and in inshore waters, generally between April and October (Howes and Goehringer 1996). Sampling within Buzzards Bay revealed menhaden to be most abundant in August. The diet of these fish is predominantly phytoplankton, smaller crustaceans, and various larvae (Howes and Goehringer 1996). These fish are also an important prey species for most carnivorous marine fish. Since this species spawns in both inshore and offshore waters, offshore populations of menhaden may avoid the disturbance areas associated with sediment disposal. However, inshore populations may be subjected to the same impacts as described for blueback herring. Menhaden are an important commercial finfish species; they represent a prey item for some commercially and recreationally important finfish.

Atlantic menhaden were found among the species collected in the DMF trawl surveys conducted from 1978-2000 (Maguire 2002a). However, based on its relatively low abundance and biomass, it was not found to be a significant part of the finfish community within the subregion of the bay that includes the candidate disposal sites. Camisa and Wilbur (2002) found Atlantic menhaden to occur within and proximal to the disposal sites only during mid-September. They were absent from the project area during the remainder of the year. Menhaden were captured at only two of the seven stations (Stations 1 and 5), both of which were located outside of the candidate disposal sites.

5.2.3.3 Bay Anchovy (Anchoa mitchilli)

The bay anchovy is a pelagic estuarine species reported to range from Maine to Mexico (Robins et al. 1986). This species generally spawns in waters less than 20 meters deep, although some individuals may spawn out to the continental shelf. Spawning generally occurs in the early evening primarily from April through July, although some studies show evidence of year-round spawning. Sexual maturity is reached in one year. Bay anchovy feed primarily on copepods, zooplankton, and other micro-invertebrates. Bay anchovy can tolerate a wide range of temperatures and is a euryhaline species (USFWS 1983).

The analysis of the DMF long-term bottom trawl survey data revealed that although bay anchovies were not collected during spring sampling, the species was commonly collected during the fall (Maguire 2002a). Bay anchovies ranked third in numerical abundance, behind scup and butterfish, among all species captured in the fall sampling. The catch of bay anchovy varied widely in this survey. The distribution of bay anchovy observed in the trawl survey is consistent with other reports of the species' preference for nearshore, mud habitats (Bigelow and Schroeder 1953). Bay anchovy were mainly collected in the northern extent of Buzzards Bay and were relatively more abundant in the shallow stratum. However, relatively large catches of bay anchovy were also obtained in the northern extent of stratum 9120.

Bay anchovy were found to occur within and proximal to the candidate disposal sites from late June to early October, with a peak abundance occurring in mid-September (Camisa and Wilbur 2002). They were collected from each of the seven trawl sampling locations within the study area. Among the seven stations, bay anchovy was most abundant at Station 5, where it was the fourth most-abundant fish species collected overall. However, Bay anchovy were not a significant part of the total abundance or biomass of the finfish community within the project area, based on data for all stations combined.

5.2.3.4 Black Sea Bass (Centropristis striata)

Black sea bass is considered a summer resident species in the bay, migrating to bay waters in the summer, then retreating to warmer, deeper waters in winter (Howes and Goehringer 1996). Young are born as females and after the first spawn transform to males. They utilize Buzzards Bay as a nursery, appearing in nearshore waters from August to December, with peak densities occurring in either August or September. Immature black sea bass are bottom feeders, existing mainly on mysids in shallow areas, while the diet of adult black sea bass consists of crustaceans, mollusks, and fish (Steimle et. al. 1999a). The adult fish are sought by both commercial and recreational fishermen (Maguire 2002b).

The DMF long-term bottom trawl survey data showed that black sea bass exhibited strong seasonal variations in abundance within Buzzards Bay (Maguire 2002a). Most of the black sea bass collected during the DMF trawls were YOY fish (≤ 10 centimeters total length) taken in fall tows. In the spring, nearly all the black sea bass collected were adult fish. In both seasons, average catches of black sea bass were highest at shallower stations in the northern part of the bay. In the spring, relatively high catches of adult black sea bass also were taken at deeper stations within the southeastern quadrant of the bay (Maguire 2002a).

Although black sea bass also were collected at similar stations in the fall, the analysis showed that this species was more widely distributed in stratum 9110 and consisted of YOY. Spring and fall sample sizes of adult black sea bass was nearly equal. A shift in the size distribution of adult black sea bass between the two strata suggests that larger fish tend to occur at greater depths during the spring to fall season (Maguire 2002a). This is consistent with other studies that indicate adult black sea bass are typically found at greater depths than juveniles during the summer and early fall (Bigelow and Schroeder 1953; Howes and Goehringer 1996; Steimle et al. 1999a). The distribution of YOY black sea bass in the fall was similar to the distribution of adult black sea bass. Relatively high catches of YOY black sea bass were taken at several stations throughout stratum 9120.

Sea bass were found to occur within and proximal to the disposal sites from mid-May to mid-November, with a peak abundance occurring in August (Camisa and Wilbur 2002). They were collected from each of the seven trawl sampling locations within the study area. Among the seven stations, sea bass were most abundant at Station 3. However, due to the proportionately larger contributions to biomass and abundance provided by scup, black sea bass were not among the species contributing more than 90% of the total abundance or biomass within the project area as a whole.

5.2.3.5 Bluefish (Pomatomus saltatrix)

Bluefish are fast-moving, migratory fish that are non-resident in Buzzards Bay. They are very important as both a commercial and recreational resource in the Bay. Bluefish spawn offshore, and both adults and juveniles enter Buzzards Bay waters, appearing from July through September. Peak densities typically occur in August. They feed voraciously by sight on almost any organism in the water column. Favorite bluefish prey items are silversides, clupeids, striped bass, and bay anchovy (Fahay et al. 1999). Historically, this fish has been a documented food staple for the Buzzards Bay region for over 100 years (Howes and Goehringer 1996).

Since bluefish are a fast-moving species, they are rarely captured in spring trawls in Buzzards Bay. They are much more abundant in fall sampling, when YOY bluefish ("snappers") are common in southern New England waters, including Buzzards Bay. The broad distribution of bluefish captured in the fall reflects a period when juvenile bluefish actively chase smaller prey species throughout the bay. During this season, however, some regions have higher relative concentration and biomass of bluefish than others. The tendency for juvenile bluefish to school while foraging results in large individual catches of this species and, hence, a broad range in the number of bluefish caught per tow (Maguire 2002a).

Stations with the highest CPUE and greatest biomass of bluefish were those within the northern section of stratum 9120, which includes the project area. Previous analyses of juvenile bluefish distribution in inshore waters of Massachusetts showed that juveniles were most common at depths ranging from 5 to 10 meters (Fahay et al. 1999).

Bluefish were found within and adjacent to the project area from the end of May to early October, with a peak abundance in mid-September. They were collected at each of the seven trawl sampling stations within the study area. Among the seven stations, bluefish were most abundant at Station 4 (which lies within candidate site 1). However, they were not among the species that collectively contributed >90% of the total abundance or biomass within the project area as a whole.

5.2.3.6 Butterfish (Peprilus triacanthus)

Butterfish are common to the mid-Atlantic region, and Buzzards Bay provides an important nursery area for this species. The juvenile butterfish grow quickly and migrate to deeper waters, usually in late fall, only to return to shallow inshore areas in April. The diet of the non-resident butterfish consists of copepods, small fish, jellyfish and various marine polychaete worms (Cross et al. 1999). Butterfish are harvested commercially, and they are another important prey species for many higher-trophic-level predators, such as bluefish and striped bass. Historically, the butterfish has been documented as an important species in Buzzards Bay (Howes and Goehringer 1996). Due to the migratory nature and schooling behavior of these fish, year-to-year abundance statistics are variable (Howes and Goehringer 1996).

The DMF bottom trawl survey analysis revealed that butterfish were abundant in both the spring and fall, although they were considerably more abundant in fall samples (Maguire 2002a). Following scup, butterfish were the second most abundant species collected in Buzzards Bay during the fall. Butterfish were widely distributed in the deeper stratum during both seasons and were virtually ubiquitous in fall. Butterfish reportedly exhibit a preference for sandy bottoms over mud or rocky bottoms (Bigelow and Schroeder 1953; Cross et al. 1999). The species' greater relative abundance in the middle section of the bay, away from rocky nearshore habitat, appears to support this pattern of habitat preference. The fall population, however, is sufficiently numerous to occupy most habitats.

Butterfish were found within and adjacent to the candidate disposal sites from mid-May to mid-December, with a peak abundance occurring in mid-July. They were collected from each of the seven trawl sampling stations within the study area. Among the seven stations, butterfish were consistently found to be the second most abundant species (second only to scup) and comprised a significant percentage (14%) of the total biomass of the finfish community.

5.2.3.7 Cunner (Tautoglabrus adspersus)

Cunner is a nearshore, benthic species known to occur among eelgrass and over rocky bottoms. Due to the preference of cunner for habitats containing structure, where trawl gear is infrequently deployed, the species is likely to be under-sampled in most trawl surveys. The analysis of the

DMF bottom trawl survey data revealed that cunner were distributed mainly within stratum 9110 during both seasons (Maguire 2002a). This species was three times more abundant in stratum 9110 in the fall, while in the spring it was seven times more abundant in the shallower stratum.

Camisa and Wilbur (2002) found cunner to occur at very low abundance within and proximal to the candidate disposal sites. Most were caught in trawl samples during winter months. Cunner were not captured at Stations 1 and 4. Based on their low abundance and biomass contributions, they were not a significant part of the finfish community within the project area.

5.2.3.8 Little Skate (*Raja erinacea*)

Little skate are found from the Gulf of St. Lawrence to Virginia (Woods Hole Oceanographic Institute 2002). The center of distribution for this species is Georges Bank and Southern New England, and it tends to move seasonally in response to changes in water temperature, generally offshore in summer and early autumn and *vice-versa* during winter and spring (Sosebee 2000). It feeds on decapod crustaceans as well as amphipods, polychaetes, squid, and fishes. The little skate is found in water depths ranging from 0 to 90 meters, over sand, pebbly, or mud bottoms (Bigelow and Schroeder 1953).

The analysis of the DMF long-term bottom trawl survey revealed that little skate were abundant during both survey seasons, although more than twice as many skate were collected in the spring than in the fall (Maguire 2002a). In the spring, little skate were widely distributed and were collected from all regions of Buzzards Bay. Little skate were relatively more abundant at the southern end of Buzzards Bay in the spring, with nearly equivalent average catches between the two sampling strata.

In the fall, when relatively fewer little skate were captured in the trawl survey, they were mainly found in the deeper stratum. Similar to their spring distribution, skate captures in the fall were higher, on average, in the southern extent of Buzzards Bay.

Camisa and Wilbur (2002) found little skate to occur at generally low abundance within and proximal to the candidate disposal sites. Little skate were captured at all seven trawl stations, confirming their presence within the candidate disposal sites. They were caught during spring months from early April to early June, as well as later in the year from mid-September to mid-December. They were not found in trawls collected during the summer months. Peak abundance was reached in mid-November. Despite their relatively low abundance, they comprised a significant part of the finfish community biomass at Stations 3 through 7. At Station 3, they had the second highest biomass of all species caught, and at Stations 4 through 7 they had the fourth highest.

5.2.3.9 Long-finned Squid (*Loligo pealeii*)

In North America, long-finned squid (Family Loliginidae) range from southern Maine to the Caribbean, with greatest abundance from Cape Ann south to Cape Cod. This species is of great economic importance as a bait source and for consumption overseas in Italian fish markets (Gosner 1978). Juveniles (pre-recruits) are found in greatest abundance in open water ranging in depth from shore to 700 feet (213 meters) deep, and in temperatures from 39 to 81º F (4 to 27º C) (Cargnelli et al. 1999). Adults (recruits) are found in greatest abundance in open water ranging in depth from shore to 1,000 feet (305 meters) deep, and prefer the same temperature range as juveniles (Cargnelli et al. 1999).

The analysis of the DMF long-term bottom trawl survey dataset for Buzzards Bay revealed that long-finned squid were highly abundant in both spring and fall (Maguire 2002a). They were the second most abundant species collected in the spring and the third most abundant in the fall trawls. Squid were broadly distributed in Buzzards Bay during both seasons, although they were most abundant in the deeper sampling stratum in the fall. In the spring, the highest average catches of squid occurred in the southern extent of stratum 9120. The CPUE for squid in the fall was high across the deep stratum. Squid were least abundant at shallow stations in the north during both seasons.

Long-finned squid were collected at each of the seven trawl sampling stations within and near candidate sites 1 and 2 and were consistently found to be the third most abundant species collected at each station (Camisa and Wilbur 2002). This species was found from mid-May to mid-November, with a peak abundance occurring in late July. A length-frequency analysis was performed by Camisa and Wilbur (2002) based on 2,766 individual long-finned squid collected during their trawl sampling survey of the project area. The data revealed that in May, when the squid return to Buzzards Bay from warmer offshore shelf waters (Cargnelli, et al. 1999), they exhibited a wide range of mantle lengths (from 15 to 35 milimeters). With the onset of summer, the frequency distribution of long-finned squid mantle lengths was found to narrow and shift toward <10 milimeters. The predominance of mantle lengths less than 10 milimeters in July indicates recruitment of juveniles (hatched from eggs that were spawned in May) to nearshore stocks. By September, the length-frequency distribution again became broader, with the majority of individuals exhibiting mantle lengths of 10 to 20 milimeters. No individuals were captured in November or December, reflecting the migration of longfin squid to deeper, offshore waters outside Buzzards Bay (Cargnelli et al. 1999).

5.2.3.10 Northern Searobin (*Prionotus carolinus*), Striped searobin (*Prionotus evolans*)

Northern searobins are found from Nova Scotia to Florida (Whitworth 1996). Individuals of this species inhabit smooth, hard grounds of coastal waters and tend to stay near the bottom where they actively swim. They appear in inshore waters in May or June, where they spend the summer. Northern sea robins leave the coast in October to winter on the continental shelf in deeper waters. When threatened, they will bury themselves in the sand, revealing only their eyes and the top of their heads. This species spawns from June to September, peaking between July and August. It feeds on shrimp, crab, amphipods, squid, mollusks, annelid worms, and fish (Bigelow and Schroeder 1953).

Northern searobin were found to be moderately abundant in Buzzards Bay, based on the analysis of the DMF long-term trawl survey dataset (Maguire 2002a). Because they are demersal (i.e., bottom-dwelling) fish, they are readily captured in bottom trawls. Although their abundance varied little from season to season, they were slightly more numerous in the spring. The distribution of northern searobin was also more discrete during this season. Stations with the highest average catches of searobin were located in the shallow stratum at the northern end of Buzzards Bay. Relatively few searobins were collected in spring sampling in the deeper water of the northeastern section of the Bay. The data from the trawl survey suggest that in the fall, northern searobin are more widely distributed in Buzzards Bay. During this sampling period, the deeper stations in the northern extent of the bay supported the highest average catches of Northern searobin.

The Northern searobin was found in the vicinity of candidate sites 1 and 2 in the Camissa and Wilbur (2002) survey. However, the striped searobin (*Prionotus evolans*) also was found at very low abundances at various times of the year at each of the seven trawl stations. They were generally found to be absent during winter months. Based on their low abundance and biomass contributions, neither the Northern searobin nor the striped searobin were a significant part of the finfish community within the project area.

5.2.3.11Scup (Stenotomus chrysops)

Scup, also known as porgy, are a marine species that are the most abundant finfish in Buzzards Bay from late spring through early fall. These fish are both an important recreational and commercial resource in the region and an important prey item for cod, bluefish, and weakfish (Steimle et al. 1999b). During the winter scup migrate to deeper, warmer waters and return to inshore regions (estuaries) in the spring to spawn. Peak spawning usually occurs in June (Bigelow and Schroeder 1953). These fish are primarily bottom feeders existing on small crustaceans, worms, mollusks, squid and occasionally small fish (Steimle et al. 1999b). Scup appear to be temperature sensitive; sudden decreases in temperature occurring in late fall have been identified as a major contributor of mortality in bays and estuaries (Clayton et al. 1978). Results of past finfish sampling conducted in Buzzards Bay revealed that scup typically appear from June to December, with peak densities occurring from late July through early September.

Scup were found to be the most abundant species collected during each season of the DMF long-term bottom trawl survey (Maguire 2002a). Although scup were plentiful in spring sampling, there were nearly 13 times as many scup collected in fall sampling. This marked increase in fall abundance of scup represents recruitment of YOY scup to the relatively protected inshore waters of Buzzards Bay.

Adult scup slightly outnumbered juveniles in the spring samples. As expected, the majority of the juveniles collected in the spring were age 1+ fish (10.1 to 15.4 centimeters total length). Some smaller yearling fish (less than 10 centimeters total length) were also taken during this sampling period. Most adult scup were collected in the shallow stratum in the north end of Buzzards Bay. Highest spring catches of juvenile scup (mean of 219 fish per tow) were taken at stations in the southeastern region of the bay in stratum 9120 (Maguire 2002a). The distribution of adult scup in the fall was comparable to their spring distribution.

Juvenile scup were evenly distributed throughout Buzzards Bay in the fall. Most of the individuals collected in this season were YOY fish. The lowest mean catch of YOY scup in the fall occurred at stations in the northern end of stratum 9120. There did not appear to be any notable differences in the size classes of juvenile scup inhabiting deep versus shallow strata in the fall (Maguire 2002a).

Scup were found in the vicinity of the candidate disposal sites from mid-May to mid-October, with peak abundance recorded during August and peak biomass occurring in early June (Camisa and Wilbur 2002). Scup were the most abundant species collected at each of the seven stations over the course of the 13-month trawl survey. Overall, scup comprised 60% of the total abundance and 41% of the total biomass of all organisms collected during the trawl survey (Camisa and Wilbur 2002).

5.2.3.12 Striped Anchovy (*Anchoa hepsetus*)

Like the bay anchovy, the striped anchovy ranges primarily from Massachusetts to Mexico, and is sometimes found north to the Gulf of Maine. The striped anchovy spawns in estuaries, but typically in deeper waters than the bay anchovy. Feeding habits are similar to the bay anchovy. The striped anchovy tolerates a narrower temperature range than the bay anchovy, and tends to winter in deeper water (USFWS 1983).

The DMF long-term bottom trawl survey revealed that striped anchovy increase in abundance in Buzzards Bay as the summer progresses (Maguire 2002a). By far, most striped anchovy are collected in fall samples. In the spring, when striped anchovy abundance is lower, the species was only collected at stations in the north end of stratum 9120. Striped anchovy are more widely distributed in the fall, occurring at nearly all sampling stations in the bay. As is the case for other schooling fish species collected in the trawl survey, the size of striped anchovy catches were highly variable due to the "hit or miss" limitation associated with trawl sampling tightly concentrated pelagic fish. In the fall, striped anchovy were abundant in the northern extent of stratum 9120.

Camisa and Wilbur (2002) found this species to be generally absent in the vicinity of the two candidate disposal sites. Only three individuals were captured during various trawl sampling events over the course of their thirteen-consecutive-month study.

5.2.3.13 Summer Flounder (Paralichthys dentatus)

The summer flounder is a demersal species that is distributed in the northwest Atlantic from the Gulf of Maine to South Carolina. The summer flounder, also commonly referred to as "fluke", is a "left-eyed" flounder that is found over sand, mud, grass, around pilings, in tidal channels or salt ponds (Bigelow and Schroeder 1953). This species ranges from the shallow estuarine waters to the outer continental shelf from Nova Scotia to Florida (Grimes et al. 1989). A strong migration pattern is keyed to the seasons: the fish move offshore in the colder months and return to shallower coastal areas in the warmer months.

Spawning occurs during the offshore migration in autumn and early winter. Summer flounder are pelagic and eggs may float up near the surface, drifting with currents. Large concentrations of eggs occur between Cape Cod and Long Island Sound south to Cape Hatteras, typically in October and November (Able et al. 1990). Eggs are generally found within 9 to 28 miles (14.5 to 45 kilometers) of the shoreline, at depths of 33 to 230 feet (10 to 70 meters). Eggs have been found as far down as 361 feet (110 meters) in the coldest months.

Summer flounder larvae are negatively buoyant and may drop down to the substrate when not actively swimming. Early larvae will concentrate at depths of 72 to 187 feet (22 to 57 meters) at distances of 12 to 52 miles (19 to 83 kilometer) offshore, generally between September and February. As the larvae mature, they will move inshore with the currents, where they gravitate to the bottom in bays and estuaries and bury themselves in the sediment to begin the metamorphosis to the juvenile stage.

Juvenile summer flounder 7 to 10 inches (18 to 25 centimeters) tend to inhabit inshore waters (Walsh et al. 1999) in a variety of habitats and grow at a rapid rate during this stage. These habitats include estuarine marsh creeks, seagrass beds, bays, sounds, and surf zones, and typically these areas all have pronounced water circulation. The juveniles do not exhibit the strong migration patterns of the adults, especially in the middle to southern portion of their habitat range. The juveniles are present in waters above 3°C and salinities that range between 10 and 30 ppt (Packer et al. 1999).

From April through October, adult summer flounder generally are present in nearshore waters between the shoreline and depths of 82 feet (25 meters). During summer months they are an important component of the demersal finfish community. The adults appear to prefer sandy substrates and are most active in feeding during daylight hours. As an opportunistic predator, the summer flounder may feed in all parts of the water column, actively pursuing its prey of other fish and squid (Packer et al. 2001; Bigelow and Shroeder 1953).

In the DMF long-term trawl survey, summer flounder abundance was found to vary seasonally in Buzzards Bay, with three times as many fish collected in fall samples than in the spring (Maguire 2002a). Most of the summer flounder captured in both seasons were adults (greater than or equal to 37 centimeters total length). The size distribution of summer flounder varied little between the two sampling strata. Adult summer flounder were broadly distributed in Buzzards Bay in the spring, although relatively few fish were collected among the northern stations of stratum 9120.

In contrast to the adults, a higher number of juvenile summer flounder were captured in the spring in stratum 9120. Most of these were age 1+ or older fish. The size distribution of juvenile fish, like the adults, exhibited little variation between the depth strata, suggesting that individual size classes of summer flounder do not segregate by depth (Maguire 2002a).

In the fall, when adult summer flounder abundance was found to increase, adult fish were more uniformly distributed. The adult size distribution indicated only slight variation between the sampling strata. During the fall, adult summer flounder were relatively more abundant at stations in the northern end of stratum 9120. Overall, adult catches in the fall were three times greater than in the spring; however, the number of juvenile summer flounder taken in Buzzards Bay in the fall was only slightly higher than the number collected in the spring. Juvenile summer flounder were uniformly distributed between the depth strata with respect to size (Maguire 2002a).

Summer flounder was found to occur within and proximal to the candidate disposal sites from mid-May to mid-November, with a peak abundance occurring in mid-July (Camisa and Wilbur 2002). Summer flounder collected in the trawl survey were adults or older juveniles; young-of-year were not present. This species was collected at each of the seven trawl stations and was consistently among the dominants, based on its relatively high biomass (Camisa and Wilbur 2002).

5.2.3.14 Tautog (Tautoga onitis)

Tautog is a recreationally important species in Buzzards Bay. A majority of the tautog population inhabits Buzzards Bay waters from October to May, with peak densities occurring in November. Some individuals remain in the bay year round. Many migrate to deeper offshore waters during the summer, returning to shallow inshore waters in the spring. The tautog diet consists of crustaceans, mollusks, lobsters, worms and mussels (Howes and Goehringer 1996).

The analysis of the DMF bottom trawl survey long-term dataset revealed that tautog were more numerous in the spring than the fall (Maguire 2002a). Adults were more abundant than juveniles, especially during the spring. Very few YOY tautogs were collected in either the spring or fall sampling; thus the majority of the juvenile fish were age 1+ fish. In the spring, adults were most concentrated in the shallow stratum and least abundant at stations in the southern deep stratum (9120S). Adult tautogs also were collected at stations in the northern deep stratum (9120N), although CPUE was nearly seven times lower than the CPUE observed at shallow stations within Buzzards Bay. Fewer juvenile tautogs were taken in the spring compared to the adult catch (Maguire 2002a).

The fall CPUE for adult tautog was lower than the spring CPUE. In the fall, stations in the southern end of stratum 9110 yielded the highest average catches of adult fish. Overall, the fall CPUE of juvenile tautog was quite low in all regions of Buzzards Bay. Juvenile tautog exhibited similar distributions in the fall and spring, with only slightly greater abundance in the southern extent of stratum 9110 than at stations in the north. Overall, the average fall catch of juvenile tautog at shallow sites (mean of 1.6 fish per tow) was four times greater than the CPUE of juvenile tautog at deeper stations (Maguire 2002a).

The distribution observed for tautog is consistent with earlier records of the species occurrence in Buzzards Bay. Howes and Goehringer (1996) report that tautog move into inshore areas in the spring to inhabit weedy areas of the bay. Spawning occurs within the eelgrass beds found in many of the Bay's numerous embayments and coves. The high concentration of adult tautog in the spring trawl survey within the northeastern portion of the bay supports this pattern of movement and habitat preference. Like cunner, tautogs are common among ledges and rocky shoreline habitat, where preferred invertebrate prey species are abundant (Bigelow and Schroeder 1953). The southerly shift seen in the distribution of tautog from spring to fall within the shallow stratum suggests a transition away from spawning habitat towards more productive feeding areas.

Tautog were found to have low abundance within and proximal to the candidate disposal sites during fall, winter, and spring months, but were abundant during summer months (Camisa and Wilbur 2002). Peak abundances were recorded in May and June. Maximum biomass was recorded at Station 1 in early September. They were collected at each of the seven trawl stations, confirming their presence within the candidate disposal sites. Due largely to their summer abundance and their contribution to the total biomass, tautog were found to be among the dominant finfish collected at Stations 1 through 4 and Station 7.

5.2.3.15 Weakfish (Cynoscion regalis)

Weakfish belong to the family Sciaenidae or "drums." Weakfish inhabit the western Atlantic Ocean from Florida to Massachusetts, and records show isolated populations occurring as far north as Nova Scotia. This species is most abundant from North Carolina to Florida in the winter and from Delaware to New York in the summer (Mercer 1989). An important recreational game fish in the region, weakfish usually occur in shallow coastal waters over sand and sandy mud bottoms. During summer, the fish move to their nursery and feeding grounds in river estuaries. In the estuary, adult weakfish occur in schools and frequent shallow sandy bottom areas with salinities above 10 ppt. Estuaries provide feeding areas and spawning grounds for adult weakfish and are also important as nursery areas for juveniles.

Weakfish were collected at relatively low abundances in the DMF long-term trawl survey in Buzzards Bay (Maguire 2002a). The vast majority of captures of this species occurred in the fall. During this period, weakfish were most common at stations within the northern extent of stratum 9120. Although weakfish were taken in all other regions of the bay, average catches were low and roughly equal among each stratum/section (mean of less than 1 fish per tow).

Weakfish are seasonal migrants to southern New England; appearing in estuaries like Buzzards Bay in late spring or early summer after water temperature rises. Therefore, the virtual absence of captures in the spring is not surprising. Weakfish are less vulnerable to capture in bottom trawls while they are feeding on pelagic prey species. Like bluefish, weakfish are swift swimmers and capable of evading capture in trawl gear. Bigelow and Schroeder (1953) describe weakfish as an inshore species during their summer residence in New England waters, where they rarely occur in water deeper than 20 meters. This distribution pattern is consistent with the distribution of weakfish observed in the DMF long-term trawl survey (Maguire 2002a).

YOY weakfish were found within and near the candidate disposal sites from late July to mid-September, with peak abundance occurring in early September. They were absent from the project area during fall, winter, and spring months. Among all seven trawl sampling stations, weakfish were found to be most abundant at Station 6 (candidate site 2), where they were the fourth most abundant species collected. This species was found to be a dominant member of the finfish community, based on its contribution to total biomass.

5.2.3.16 Windowpane (Scophthalmus aquosus)

Windowpane is a demersal species that is distributed in the northwest Atlantic along the continental shelf from the Gulf of St. Lawrence to Florida; it is particularly common in large estuaries in waters less than 184 feet (56 meters). Individuals are found over sand or mixtures of sandy silt and mud. Spawning generally occurs from April through December, with peaks from May through October, in waters below 21°C and salinities between 5.5 and 36 ppt. However, spawning can occur throughout the year (Chang et al. 1999).

Eggs and larvae are pelagic and float near the surface, drifting with currents, while juveniles are most often observed in sublitorral zones at water depths of 20 to 46 feet (6 to 14 meters). Fish spawned in the spring grow at a faster rate than those spawned at other times of the year. Generally, one year after spawning, the fish have attained a size greater than 6.3 inches (16 centimeters) total length. Larvae are approximately 0.08 inches (2 milimeters) long after hatching (Able and Fahay 1998).

Adult windowpane tolerate a wide range of temperature. Both juveniles and adults tend to migrate to deeper, warmer waters for over-wintering. Windowpane are sensitive to hypoxic conditions (dissolved oxygen (DO) less than 3 mg/L) and will avoid hypoxic areas (Chang et al. 1999). Juveniles tend to be most abundant where the water temperature ranges between 5 and 23°C, at depths between 23 and 56 feet (7 to 17 meters) and salinities of 22 to 30 ppt. Adult windowpane can attain a total maximum length of 46 centimeters (Chang et al. 1999). Adults show a strong preference for sandy and mud substrates off southern New England and throughout the mid-Atlantic Bight (Chang et al. 1999).

Windowpane were found to be distributed broadly in Buzzards Bay during the spring, when most individuals were collected in the DMF long-term bottom trawl survey (Maguire 2002a). A few stations within the 9120N stratum yielded relatively high catches and biomass of this species, indicating localized abundance in the vicinity of the two candidate disposal sites in late spring. Average catches of windowpane during the spring were comparable among other areas of Buzzards Bay.

There was little seasonal variation in the distribution of windowpane. Lower numbers of windowpane were collected in the fall, and, therefore, their CPUE during this season was relatively low. As in the spring, the region with the highest CPUE of windowpane in the fall was the southern extent of the shallow stratum (mean of 2 fish per tow). Unlike the spring, however, stations in stratum 9120 that border the area containing the two candidate disposal sites did not yield high catches of windowpane in the fall (Maguire 2002a).

Despite being detected at each of the seven trawl sampling stations, Camisa and Wilbur (2002) found windowpane to occur within the project area in relatively low numbers. In terms of abundance and biomass contributions, therefore, they were not a significant part of the finfish community within the project area.

5.2.3.17 Winter Flounder (Pseudopleuronectes americanus)

Winter flounder is considered a resident species of Buzzards Bay that is both a commercially and recreationally significant resource, despite serious declines in number throughout much of its range (Howes and Goehringer 1996). The precise reasons for this population decline remain unclear, although overfishing, habitat loss and habitat degradation have been cited as likely causes (Atlantic States Marine Fisheries Commission 1998). This species burrows into the sediments, and this may increase exposure to chemical contaminants in degraded habitats compared to other species that live within the water column. The habit of burrowing is thought to result in a higher incidence of fin rot and hepatic carcinomas in areas with contaminated sediments (Landahl et al. 1990; Johnson et al. 1992).

The fish are believed to return to the estuaries of their origin for spawning (Saila 1961). Young winter flounder tend to remain within the embayments during their first year and move out into more open waters during the summer months, returning to the inshore areas in the fall.

Spawning usually occurs in February and March. The diet of winter flounder is primarily comprised of worms, bivalves, crustaceans, snails, and mollusks (Pereira et al. 1999).

The analysis of the DMF long-term bottom trawl survey dataset revealed that, in general, winter flounder were widely distributed in Buzzards Bay in the spring (Maguire 2002a). Adult winter flounder were concentrated at many stations in the southern range of stratum 9110 and 9120. Winter flounder are among the group of Buzzards Bay fish that undergo a seasonal inshore-offshore migration. Thus, they are more abundant in the bay during the spring before they move to deeper water offshore. Nearly as many juveniles as adults were collected in spring trawl samples. Adult winter flounder were evenly distributed in number and size between the two depth strata during this season. The CPUE of adult winter flounder in the northern end of Buzzards Bay was lower than in the south, although high numbers of winter flounder were taken at a few stations in the former.

The spring distribution of juvenile winter flounder resembled the distribution of adult fish. Although the size distribution of juvenile fish was comparable between strata, the total number of juveniles collected from each stratum varied. More juvenile winter flounder were captured in the deep stratum than in the shallow region. On average, however, stations in the southern range of stratum 9110 supported the largest catches of juvenile winter flounder. Juveniles were equally abundant within both regions of stratum 9120.

Winter flounder, predominantly adults, move offshore to deeper water as water temperatures increase during the summer (Bigelow and Schroeder 1953; Pereira et al. 1999). Accordingly, very few adult winter flounder were collected in fall samples in Buzzards Bay. The small numbers of individuals remaining in the Bay during the fall were smaller in size than those taken in the spring. The CPUE of adult winter flounder in the fall was very low.

Juvenile winter flounder were also less abundant in the fall. Stratum 9120 supported most of the juvenile fish in this season. Among the four major regions of the bay, stations within the south and north of stratum 9120 had the highest mean catches of juvenile winter flounder in fall sampling. Within 9120N, juvenile winter flounder were most abundant at one station within the vicinity of the former CLDS. In general, young winter flounder are known to occur in deeper regions of coastal bay waters during the summer months to escape thermal stress (Howes and Goehringer 1996; Pereira et al. 1999). The seasonal distribution patterns exhibited by adult and juvenile winter flounder in the DMF long-term trawl survey are consistent with other studies of the species in northeast embayments (Pereira et al. 1999).

Camisa and Wilbur (2002) found winter flounder to occur at generally low abundance within and proximal to the candidate disposal sites throughout the year. Abundance for this species was greatest from mid-March to mid-July, peaking during early April (58 individuals caught on April 3). From late July through December, abundance decreased substantially. The highest numbers of winter flounder were found at Station 4 (which lies within candidate site 2), Station 5 and Station 7.

5.2.3.18 Summary of Select Species at Candidate Sites 1 and 2

Table 5-8 summarizes the occurrence of the select species within and near the two candidate disposal sites. Presence and peak abundance of each species are characterized relative to time of year, and overall occurrence is summarized as either "minor" or "major." Five of the select species (little skate, long-finned squid, scup, summer flounder and weakfish) were considered to have a major occurrence at the candidate disposal sites.

Table 5-8. Summary of select species relative to the proposed candidate disposal sites and proximal areas.

Species	Presence/Peak Abundance	Appearance
Atlantic herring	Winter to early spring/February to April	Minor
Atlantic menhaden	Mid-September	Minor
bay anchovy	Late June to early October/mid-September	Minor
black sea bass	Mid-May to mid-September/mid-September	Minor
bluefish	Late May to early October/mid-September	Minor
butterfish	Mid-May to mid-September/mid-July	Minor
cunner	Winter	Minor
little skate	Early April to early June Mid-September to mid-December	Major
long-finned squid	Mid-May to mid-October/July	Major
striped searobin	Limited to low, absent in winter	Minor
scup	Mid-May to mid-October/early June	Major
striped anchovy	Generally absent	Minor
summer flounder	Mid-May to mid-July	Major
tautog	Fall, winter, spring/May-June	Major
weakfish	July to mid-September/early September	Major
wndowpane	Little seasonal variation low yields	Minor
winter flounder	Mid-March to mid-April/site 2	Minor

- Catadromy: the periodic and obligatory migration of fish from fresh water into marine waters to spawn. An example in the Buzzards Bay ichthyofaunal community is the American eel (*Anguilla rostrata*).

- Amphidromy: the periodic movement of immature or juvenile fish between fresh and marine waters. Winter flounder tolerate a wide range of salinities, from freshwater to seawater (Pereira 1999); this is an example of an amphidromous fish species known to inhabit the Buzzards Bay ichthyofaunal community.

The following sections cover explanations and more detailed descriptions of anadromous, catadromous, and amphidromous fish species common in Buzzards Bay and in the vicinity of candidate sites 1 and 2.

5.2.3.19 Anadromous Fish

The restoration of anadromous fish runs in Buzzards Bay has been the focus of recent and ongoing habitat restoration projects within Buzzards Bay by NMFS (personal communication, Jim Turek, NMFS Habitat Restoration Unit, 2002). The following anadromous and catadromous fish species were caught in the DMF otter trawl surveys conducted over the period 1978 to 2000: alewife, American eel, American shad, blueback herring, rainbow smelt, and striped bass

(Maguire 2002a). Howes and Goehringer (1996) also list the white perch as an anadromous fish in Buzzards Bay. Important anadromous fish of Buzzards Bay are discussed below.

Alewife

Alewives inhabit the marine environment from Newfoundland and the Gulf of Saint Lawrence to South Carolina. Alewives enter freshwater rivers to spawn, typically running farther upstream than other anadromous fish (Robins et al. 1986). They return each year with regularity and are important both as a recreational and commercial resource. A substantial number of early laws and regulations in the Commonwealth of Massachusetts were designed to protect the alewife fishery (Howes and Goehringer 1996). Alewives return to their freshwater spawning grounds beginning in late April to early May. During migratory movements, they may be common throughout all the major coves of Buzzards Bay. The young typically spend their early stages in upstream ponds, and as early as July, migrate out to the estuaries to spend their first year (Cooper 1961). The diet of the alewife mainly consists of copepods, shrimp, eggs and larvae (Howes and Goehringer 1996).

The analysis of the DMF long-term bottom trawl survey dataset suggests that alewives are moderately abundant in Buzzards Bay (Maguire 2002a). This analysis showed that slightly more fish were collected in the spring than in the fall. However, as a pelagic species, alewives are less vulnerable to capture in bottom trawls than demersal species. Therefore, total sample sizes observed in the long-term DMF survey may underestimate the abundance of alewives in Buzzards Bay during either season. This survey showed that alewives were widely, though not evenly, distributed in Buzzards Bay during the spring and fall. The highest average catches of alewives during both seasons occurred at only a few stations within the deeper (9120) sampling stratum. During both seasons, alewives were relatively more abundant in the southern extent of Buzzards Bay, at stations within stratum 9120. The stations and sections with higher mean catch contained a greater mean biomass of alewives (Maguire 2002a).

Alewives were not collected in great abundance in the shallower stratum during either season. Although alewives travel through shallower nearshore areas on their way to spawn in several of Buzzards Bay's tributaries, the spring spawning run occurs earlier than the time period when the spring trawl surveys were conducted. In the fall, the alewives' return migration to sea occurs over a more protracted period and consists of smaller groups of fish (Maguire 2002a). During the 13-month trawl survey, Camisa and Wilbur (2002) found alewife within the area of the candidate disposal sites from late July to early October, with a peak abundance 205 individuals occurring in mid-September. They were absent in trawls collected from March to July 2001 and mid-October 2001 to March 2002, with the exception of one sampling date in mid–December 2001, when 20 individuals were caught.

American Shad

American shad are found along the Atlantic seaboard from Newfoundland and the Gulf of Saint Lawrence, south to northeastern Florida (Robins et al. 1986). Shad are an important food source for predators like bluefish and striped bass. They return to their natal streams in response to rising spring ocean temperatures. Males arrive at spawning areas first, followed by egg-laden females. Adult shad return to the ocean soon after spawning. Larvae hatch within 4 to 12 days, and juveniles spend their first summer in freshwater. By autumn, the young shad first gather in schools, then swim to the ocean where they live from three to six years until sexually mature. Upon maturity, they return to their freshwater natal streams to complete their life cycle.

American shad was not among the numerically abundant species reported for the 22-year DMF trawl data set analyzed in Maguire (2002a). Camisa and Wilbur (2002) caught a single individual during their 13-month trawl sampling study at candidate sites 1 and 2. Shad stocks in the northeast are considered to be fully exploited and at historically low levels of abundance (Kocik 2000). This may explain the low abundance of this species during the 13-month trawl survey in Buzzards Bay conducted by Camisa and Wilbur (2002).

Blueback herring

Blueback herring is a species found from Nova Scotia to northeastern Florida. Like their cousins, the alewife, blueback herring enter the lower reaches of freshwater rivers to spawn, after which adults return to the sea. Adults winter close to continental shelf bottom waters (Robbins et al. 2002). Like alewives, blueback herring spawn in tidal tributaries of Buzzards Bay during the spring. Blueback herring usually enter the brackish waters of the Bay by mid-May to spawn. They tend to be more tolerant of saline water and therefore do not depend on the freshwater nursery habitat as much as alewives (Chittenden 1972; Clayton et al. 1978). The diet of the blueback herring consists of copepods, pelagic shrimp, fish eggs and larvae (Howes and Goehringer 1996). Both the alewives and the blueback herring are an important prey source for many other species of fish, most notably bluefish and striped bass. Howes and Goehringer (1996) report that blueback herring are abundant in Buzzards Bay in late summer and fall.

Blueback herring were collected in moderate abundance in the DMF bottom trawl surveys, with higher abundances in the spring versus the fall sampling events. Few bluebacks were collected in trawls in the northern extent of the bay or within the shallow stratum during spring sampling (Maguire 2002a). Blueback herring were more widely distributed in the fall, albeit with lower numbers. Higher catches occurred in the northern region of the deeper stratum than in the other quadrants of the bay. As a pelagic species, blueback herring are less susceptible to capture in bottom trawls and, therefore, their total abundance may be under-represented in the DMF long-term trawl survey (Maguire 2002a).

Camisa and Wilbur (2002) collected this species from late May to mid July at all seven of their trawl stations within and proximal to the candidate disposal sites. A peak abundance of 247 individuals occurred in late June. From early August to mid September, only one to three individuals were caught per tow at each of the seven stations. Among the seven stations overall, blueback herring were most abundant at Station 5. However, they were not a significant part of the total abundance or biomass of the finfish community at this station or within the project area as a whole, due to the proportionately larger contributions to biomass and abundance provided by scup.

Rainbow Smelt

This anadromous species is distributed along the Atlantic coast from eastern Labrador and the Gulf of the St. Lawrence to the mouth of the Delaware River. Rainbow smelt are valued as a commercial and recreational resource. This species moves upstream in late winter and early spring, depending on water temperature, to spawn. Large numbers spawn primarily at night. Eggs adhere to any substrate, and the young are given no care (Whitworth 1996). In coastal water, larval and juvenile smelt feed on copepods and other planktonic crustaceans. Larger juveniles and adults feed on euphausiids, amphipods, polychaetes, and fish. Adults feed on small mummichogs, cunner, anchovies, sticklebacks, Atlantic silversides, and alewives (USFWS 1989). Significant rainbow smelt runs occur in Buzzards Bay in the early spring and again in summer, with peak densities occurring in March and July. The DMF trawl sampling surveys, conducted in May and September from 1978 to 2000, likely missed the periods of time when this species was at its peak abundance. Camisa and Wilbur (2002) found rainbow smelt to occur in low numbers (six individuals) from late January to mid-April. This species was absent from trawls conducted during other months. A total of only seventeen individuals were caught in the 20 tows conducted during the 13-month survey at the candidate disposal sites.

Striped bass

Striped bass typically spawn in high numbers in Chesapeake Bay and Hudson River waters and in lower numbers in other embayments of the mid-Atlantic Bight. After spawning, they migrate north to inhabit inshore areas, including brackish rivers. These non-residents, like bluefish, are very aggressive feeders. Their diet consists of fish and invertebrates such as squid, herring, menhaden, alewives, shrimp, lobsters, crabs, and polychaetes. Striped bass are predominantly summertime residents of Buzzards Bay and one of its most important recreational species (Maguire 2002b). However, this species was not among the numerical dominants of the sampled fish community (Maguire 2002a; Camisa and Wilbur 2002). As strong and fast swimmers, they are most likely able to escape capture by bottom trawl sampling gear. The importance of this species as a recreational resource in the bay is discussed in Section 6.1).

White Perch

White perch are found along the Atlantic coast of North America from the Gulf of St. Lawrence and Nova Scotia to South Carolina. This species breeds in fresh or brackish water, as well as in freshwater streams and landlocked ponds, spawning in southern New England during April, May, and June (Bigelow and Schroeder 1953). The absence of this species from the comprehensive list of species caught in DMF trawls from 1978 to 2002 (Maguire 2002a) and during Camisa and Wilbur's (2002) 13-month trawl survey of the candidate disposal sites is most likely a result of this species' habit of congregating near shore and within the mouths of rivers, areas which lie outside of the DMF otter trawl sampling locations.

5.2.3.20 Other Northeastern Anadromous Fish Species

Atlantic Salmon

The Atlantic salmon is a highly prized game and food fish that is native to New England rivers; it originally ranged from the rivers of Ungava Bay in Canada to Long Island Sound. However, most New England native populations have been extirpated. Remnant native populations of Atlantic salmon in the United States now persist only in eastern Maine, despite restoration and rehabilitation efforts in the Connecticut, Pawcatuck, Merrimack, Penobscot and other rivers of New England.

Atlantic salmon populations of the North Atlantic have decreased dramatically within the last two decades, with minimum documented returns to rivers in the United States. Declines in runs have prompted a “no retention” policy in many New England States; therefore, actual landings in these states have been recorded as zero. Other recreational Atlantic salmon fisheries have been closed or depend heavily on local broodstocks. Management authority for Atlantic salmon in U.S. waters resides with the states and the New England Fishery Management Council. The commercial fisheries in Canada and Greenland are managed under the auspices of the North Atlantic Salmon Conservation Organization (NASCO) through international agreement of the member countries, which also includes the United States. Data collected from tag returns during tagging studies conducted from 1975 to 1988 indicated that U.S. 1-seawinter and 2-seawinter stocks were overexploited. The Gulf of Maine Distinct Population Segment has since been listed as endangered under the Endangered Species Act (Federal Register 2000).

This species was not collected in the vicinity of the candidate disposal sites by Camisa and Wilbur (2002) in 20 tows over 13 months, nor was it included on the comprehensive species list developed on the basis of the DMF trawl surveys conducted in Buzzards Bay from 1978 to 2000 (Maguire 2002a).

Sturgeons

Two species of sturgeons are found in New England estuaries: the Atlantic sturgeon (*Acipenser oxyrhynchus*) and the shortnose sturgeon (*Acipenser brevirostrum*). Since colonial days, sturgeons have been prized as a high-quality food fish and a source of caviar. Native U.S. species are distributed as far south as Florida, but the Atlantic sturgeon is found as far north as Labrador, Canada, while the shortnose sturgeon ranges only to New Brunswick, Canada.

Sturgeon once supported a substantial commercial fishery, but like other anadromous species, their populations have plummeted due to overfishing and the industrial use of rivers beginning in the 1800s. Following their demise, only remnant populations of both species remain throughout their former range. This has prompted enactment of state management measures to protect the Atlantic sturgeon and an endangered species listing of the shortnose sturgeon under the federal Endangered Species Act (ESA). Today, the lack of fish passage facilities at dams and poor habitat conditions remain as impediments to the re-establishment of many sturgeon populations.

A large commercial fishery for sturgeon once existed, but in recent years the fishery has been limited and directed specifically at Atlantic sturgeon. There is currently a moratorium on commercial sturgeon fishing and no significant sport fishery for sturgeon. Management of the species occurs under the Atlantic States Marine Fisheries Commission's Interstate Fishery Management Plan for Atlantic Sturgeon in coordination with state regulations. A recent amendment addresses the dramatic decline in sturgeon population abundance. Fishing is now prohibited in all participating states' waters and a moratorium has also been enacted in the exclusive economic zone (EEZ) under provisions of the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA). The National Marine Fisheries Service and U.S. Fish and Wildlife Service received a petition to list Atlantic sturgeon as endangered, which was denied. Shortnose sturgeon management is guided by a recovery plan under the ESA. The endangered status of some shortnose sturgeon populations has been reviewed, and a number of populations may be large enough to allow reclassification of their status (Fiedland 2001).

This species was not collected in the vicinity of the candidate disposal sites by Camisa and Wilbur (2002) in 20 tows over 13 months, nor was it included on the comprehensive species list developed on the basis of the DMF trawl surveys conducted in Buzzards Bay from 1978 to 2000 (Maguire 2002a).

5.2.3.21 Catadromous Species

American Eel

The American eel is a catadromous fish species, spending most of its life in freshwater or estuarine environments. American eels perform extensive migrations from freshwater streams to the Sargasso Sea of the western Atlantic Ocean; eggs and larvae are then dispersed and transported by the Gulf Stream to areas along the eastern coast of the United States. Larval eel (leptocephali) metamorphose through a variety of life stages as they migrate toward land, entering estuaries and then freshwater. Upon reaching sexual maturity (from 8 to 24 years of age), they begin a downstream migration toward the Sargasso Sea spawning grounds to complete their life cycle (ASMFS 1999).

Eels have been harvested by Native American tribes for the purposes of food and cultural sustenance since the early 17th century. Today, commercial and recreational fisheries for American eel are seasonal, but economically important in some areas. However, landings of American eel fluctuate widely as the fisheries are market driven. Commercial landings have declined in recent years. Between 1970 and 1998, the lowest harvest occurred in 1998 (885,267 pounds). Recreational data concerning eel harvests has indicated a decline in abundance. Management of this resource is directed through the Atlantic States Marine Fisheries Commission Fishery Management Plan for American eel adopted in November of 1999 (ASMFC 1999).

This species was not collected by Camisa and Wilbur (2002) in 20 tows over 13 months at the candidate disposal sites. However, American eel is included on the comprehensive species list developed from the analysis of the DMF trawl survey data covering the period 1978 to 2000 (Maguire 2002a). Howes and Goehringer (1996) identify American eel as a non-dominant species of the Bay, frequenting the numerous salt marshes around its perimeter.

5.2.3.22 Amphidromous Species

Winter flounder is an amphidromous fish species known to inhabit the Buzzards Bay ichthyofaunal community. They are able to tolerate a wide range of salinities, from freshwater to seawater (Pereira 1999). Additional information about this species is provided in section 5.2.3.

5.2.3.23 Relationship to Candidate Sites 1 and 2

Results of the 13-month trawl survey conducted during 2001-02 suggest that diadromous fish resources are not a significant resource at the candidate disposal sites due to their limited abundance and distribution. Only four diadromous fish species were found within the candidate disposal sites during the 13-month trawl survey (Camisa and Wilbur 2002). All species had similar relative abundances and occurred during similar times of year. Alewife was the most abundant diadromous fish species found within the candidate disposal sites, being most abundant at Station 4 (candidate site 1).

5.2.4 Nursery Potential

Certain intertidal and subtidal habitats are favorable for finfish nurseries because they provide areas for cover, feeding, and development. For instance, intertidal salt marshes and subtidal beds of SAV provide nursery habitat for numerous fish species. Certain other benthic substrate conditions, outside of salt marsh or SAV, can also provide suitable nursery habitat. The importance of the subtidal seafloor environments at the two candidate disposal sites as nursery habitat for finfish in Buzzards Bay is discussed below. The nursery potential of the sites was evaluated using the information obtained from sediment profile imaging (Maguire 2001c), benthic grab sampling (Maguire 2001d), side-scan sonar (Maguire 2002d), and the extensive trawl data (Maguire 2002a; Camisa and Wilbur 2002).

Nursery potential was estimated using the following empirical formula developed by Wilbur (2000):

$$\text{HABITAT COMPLEXITY} + \text{JUVENILE PRESENCE} = \text{NURSERY POTENTIAL (HIGH, MODERATE, LOW)}$$

Habitat complexity was ranked on a scale from 1 to 12, with the highest values indicating significant variation in substrate conditions and a relatively high amount of vertical relief (i.e., seafloor “structure”). The lowest scores apply to sites with little vertical relief and a basically flat, featureless seafloor. As the physical complexity increases, so too does the complexity score. Sites with the most variable or unique seafloor features (e.g., seagrass beds or boulder reefs) have the greatest complexity score due to the abundance of interstices and associated macrofauna, which provide a high level of cover and food.

Juvenile presence or absence was determined based on the relative numbers of the dominant commercial, recreational and non-target species actually collected at the sites or known to utilize similar habitats. The determination was based on the results of the two primary fisheries studies conducted in support of this DEIR. It includes those species whose YOY and 1+ year juveniles were identified as abundant within the 9120N subregion of the bay based on the analysis of the long-term DMF dataset (Maguire 2002a), as well as those species whose YOY contributed significant proportions of the catch during the 13-month trawl survey conducted within and proximal to the candidate disposal sites (Camisa and Wilbur 2002).

The following sections present length-frequency analyses of select species in Buzzards Bay, based on the DMF long-term dataset (section 5.2.5.1) and the Camisa and Wilbur site-specific trawl survey data (section 5.2.5.2). These are used to determine juvenile presence/absence in the subsequent analysis of the nursery potential of the two candidate sites (section 5.2.5.3).

5.2.4.1 Length-Frequency Analysis of Select Species within Buzzards Bay

The analysis of the DMF long-term trawl survey dataset resulted in a list 22 species of fish that use Buzzards Bay as a nursery (Maguire 2002a). The list includes representative species of both the pelagic and benthic zones of the marine environment. These species, the habitat zone they occupy, and their life history strategy is presented in Table 5-9. A length-frequency analysis of of the DMF long-term trawl survey datset identified the northern subregion of the bay as important habitat for YOY of various species (Maguire 2002a). The contribution of select important commercial and recreational fish species is discussed below.

Table 5-9. Nursery species reported to occur in Buzzards Bay, their seasonal occurrence within candidate sites and vicinity, life zone, and life history.

Common Name	Scientific Name	Occurrence within candidate site & Vicinity [1,2]	Habitat Zone [2]	Life History [3]
Atlantic butterfish	*Peprilus triacanthus*	Mid-May to mid-Dec[1]	P-B	M
Atlantic herring	*Clupea harengus*	Mid-Dec to mid April[1]	P	
Atlantic menhaden	*Brevoortia tyrannus*	Spring[2]	P	
Atlantic silverside	*Menidia menidia*	Mid-Dec to mid April[1]	P	
Atlantic tomcod	*Microgadus tomcod*	Spring[2]	B	R
Bay anchovy	*Anchoa mitchilli*	Late June to October[1]	P	M
Black sea bass	*Centropristus striata*	Mid-May to mid-Nov[1]	B	M
Bluefish	*Pomatomus saltatrix*	June to mid-September[1]	P	M
Cunner	*Tautoglabrus adspersus*	January to April[1]	B	M,R
Northern kingfish	*Menticirrhus saxatilis*	Fall[2]	B	
Northern searobin	*Prionotus carolinus*	Late May to mid-Nov[1]	B	M
Red hake	*Urophycis chuss*	May to June[1]	B	M
Scup	*Stenotomus chrysops*	Mid-May to mid-Oct[1]	B	M
Spotted hake	*Urophycis regia*	Mid-April to late June[1]	B	M
Striped searobin	*Prionotus evolans*	Mid-May to mid-Oct[1]	B	M
Tautog	*Tautoga onitis*	Mid-May to mid-Oct[1]	B	M,R
Winter flounder	*Pseudopleuronectes americanus*	Throughout the year[1]	B	M

Key: P – Pelagic; B – Benthic; N – Nursery, M – Marine, R – Residents
[1] (Camisa and Wilbur 2002)
[2] (Maguire 2002a)
[3] (Ayvazian et al. 1992)

Black Sea Bass

Most black sea bass collected during the DMF trawls were YOY fish (less than or equal to 10 centimeters total length (TL)) taken in fall tows. In both spring and fall seasons, relatively high catches of YOY black sea bass were taken at several stations throughout the deep stratum (9120), signifying the use of this subregion as nursery for this species (Maguire 2002a). Camisa and Wilbur (2002) also found black sea bass to contribute notable YOY numbers to the area within and proximal to the disposal sites.

Bluefish

The northern subregion section of stratum 9120 also had stations with the highest CPUE and greatest biomass of bluefish. Bluefish are rarely captured in spring trawls in Buzzards Bay. However, they are much more abundant in fall sampling when YOY bluefish ("snappers") are common in southern New England waters, including Buzzards Bay. The broad distribution of bluefish captured in the fall reflects a period when juvenile bluefish actively chase smaller prey species throughout the bay. The trawl data analysis revealed that some regions of the bay have higher relative concentration and biomass of bluefish than others (Maguire 2002a). Camisa and Wilbur (2002) also found bluefish to contribute notable YOY numbers to the area within and proximal to the disposal sites.

Scup

Scup were the most numerous species collected during each season of the DMF long-term bottom trawl survey (Maguire 2002a). Although scup were plentiful in spring sampling, there were nearly 13 times as many scup collected in fall sampling. This marked increase in fall abundance of scup represents recruitment of YOY scup to Buzzards Bay. Juvenile scup were evenly distributed throughout Buzzards Bay in the fall, with most of the individuals collected in this season identified as YOY fish (less than or equal to 10 centimeters TL). Camisa and Wilbur (2002) found YOY scup (20 to 50 milimeters fork length) to dominate the August peak in mean number within and proximal to the disposal sites. Scup begin to recruit to Buzzards Bay in mid-May. Peak abundance occurs by late August, after which abundance begins to decrease. By mid-November, scup are generally absent from Buzzards Bay.

Summer Flounder

In the DMF bottom trawl survey dataset, higher numbers of juvenile summer flounder were captured in the spring in stratum 9120 (Maguire 2002a). Most of the juvenile summer flounder collected in this season were age 1+ or older fish. The size distribution of juvenile fish, like the adults, exhibited little variation between the strata, suggesting that size classes of summer flounder do not segregate by depth. The number of juvenile summer flounder taken in Buzzards Bay in the fall was only slightly higher than the number collected in the spring. Juvenile summer flounder were uniformly distributed between the depth strata with respect to size.

Tautog

The DMF long-term dataset revealed that tautog were more numerous in the spring versus the fall sample (Maguire 2002a). Very few YOY tautog were collected in either spring or fall sampling; thus the majority of the juvenile fish were age 1+ fish. A comparable size distribution for both life stages was observed between the two strata in each season, suggesting that the size of tautog captured does not vary with depth. Overall, the fall CPUE of juvenile tautog was quite low in all regions of Buzzards Bay. Juvenile tautog had similar spatial distributions in the fall and spring. Overall, the average fall catch of juvenile tautog at shallow sites was four times greater than the CPUE of juvenile tautog at deeper stations.

Winter Flounder

Winter flounder were found widely distributed in Buzzards Bay in the spring (Maguire 2002a). Nearly as many juveniles as adults were collected in the DMF spring trawl samples over the period 1978 to 2000. Adult winter flounder were evenly distributed in number and size between the two depth strata during this season. The spring distribution of juvenile winter flounder resembled the distribution of adult fish. Although the size distribution of juvenile fish was comparable between strata, the total number of juveniles collected from each stratum varied. More juvenile winter flounder were captured in the deep stratum than in the shallow region. Juveniles were equally abundant within both the north and south regions of the bay's deeper (9120) stratum (Maguire 2002a).

Juvenile winter flounder were also less abundant in the fall. Stratum 9120 supported most of the juvenile fish in this season. Among the four major regions of the bay, stations within 9120N and 9120S had the highest mean catches of juvenile winter flounder in fall sampling. Within the 9120N subregion, juvenile winter flounder were most abundant at one station within the boundary of the former CLDS. Young winter flounder are known to occur in deeper regions of coastal bay waters during the summer months to escape thermal stress (Howes and Goehringer 1996; Pereira et al. 1999). The seasonal distribution patterns exhibited by juvenile winter flounder in the DMF long-term trawl survey dataset are consistent with other studies of the species in northeast embayments (Pereira et al. 1999).

5.2.4.2 Length-Frequency Analysis of Species within and Proximal to the Disposal Sites

Camisa and Wilbur (2002) found the area within and proximal to the disposal sites to provide nursery habitat for numerous species including scup, butterfish, and long-finned squid (Table 5-9). Figure 5-25 illustrates length-frequency distributions for scup by month for all the individuals that were collected by Camisa and Wilbur (2002) from May to October 2001. YOY scup (20 to 50 milimeters fork length) were absent from spring-collected trawls. They first appeared within the area of the two candidate disposal sites in July, and remained through the summer and into fall. By October, most of the scup population was composed of YOY fish.

Figure 5-26 depicts length-frequency distributions for all the butterfish collected from May through December 2001 (Camisa and Wilbur 2002). The capture of butterfish began in May with the collection of 1+ year old fish. YOY butterfish were present in the study area from June through December. Additional butterfish year classes could not be discriminated from the length-frequency data.

Length-frequency distributions for long-finned squid by month are depicted in Figure 5-27. YOY were present from May through November, with a peak in July. Additional longfin squid cohorts could not be discriminated from the length-frequency data due to their two extended spawning periods, an offshore winter spawning event and an inshore summer spawning event.

Additional species contributing notable YOY numbers included Atlantic herring, Atlantic moonfish (*Selene setapinnis*), bay anchovy, black sea bass, blueback herring, bluefish, butterfish, northern searobin, and weakfish (Table 5-9). The large numbers of YOY fishes encountered during the survey demonstrate the importance of Buzzards Bay as a nursery ground for juveniles.

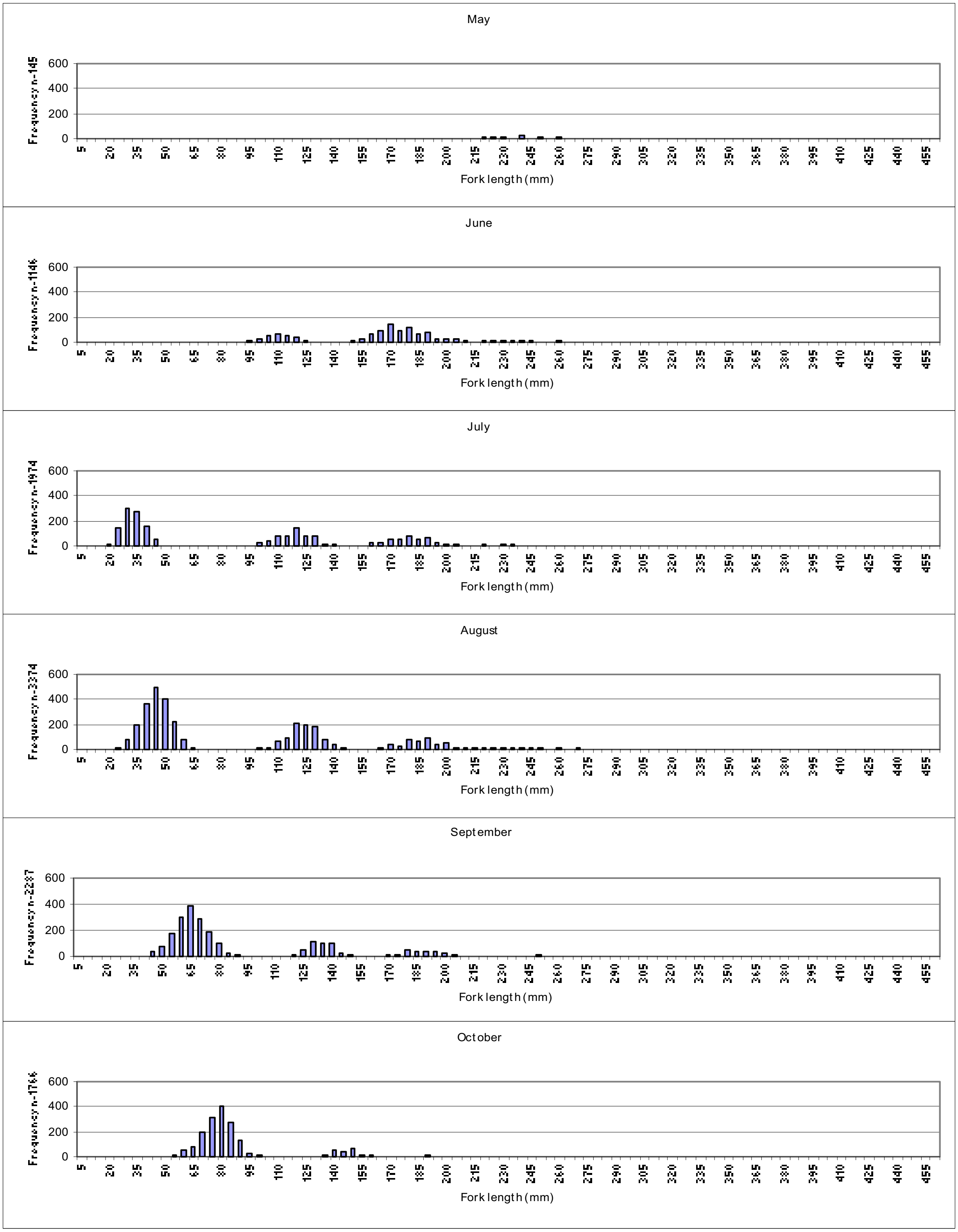


Figure 5-25. Scup length-frequency for all fish sampled, May through October (fork length in millimeters, n = 10,692).

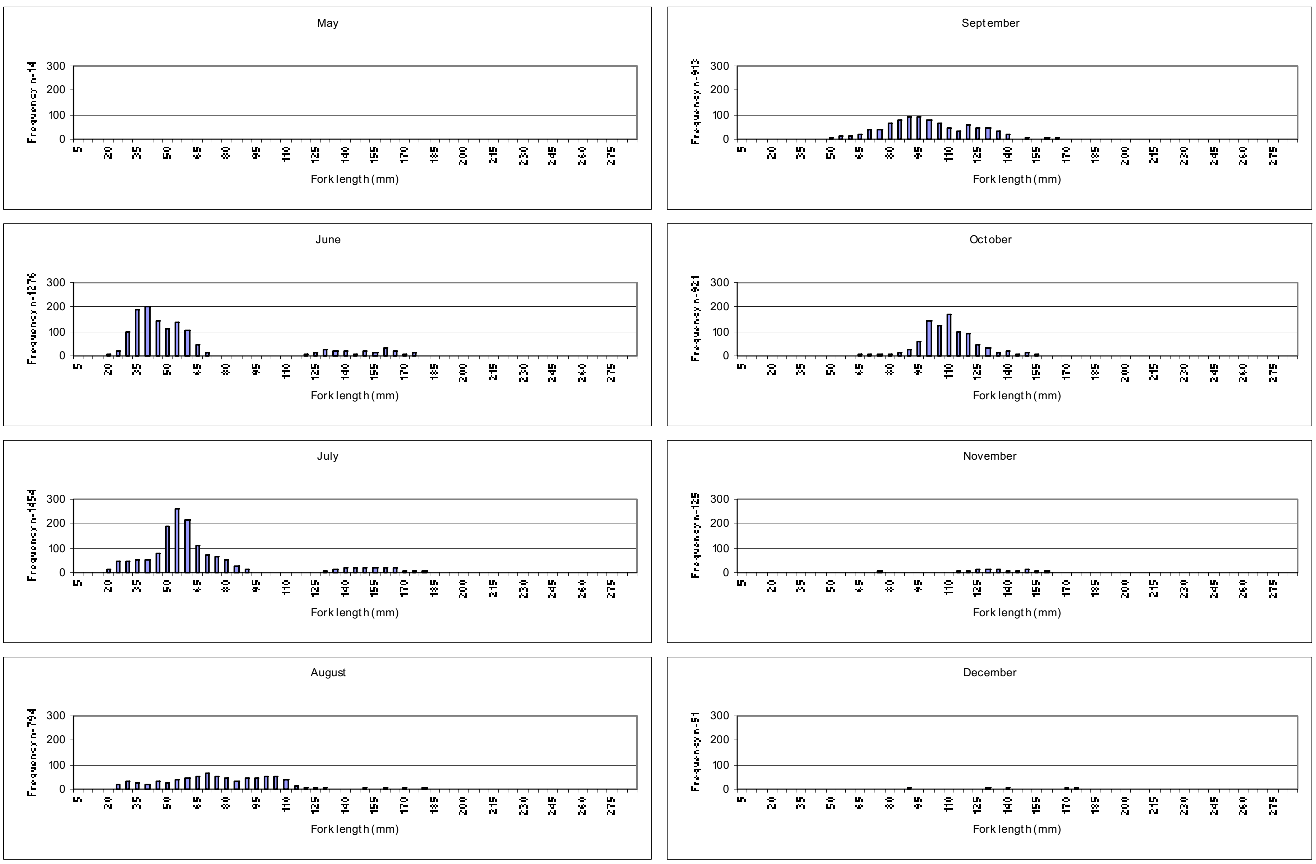


Figure 5-26. Butterfish length-frequency for all fish sampled, May through December (Fork length in millimeters, n = 5,548).

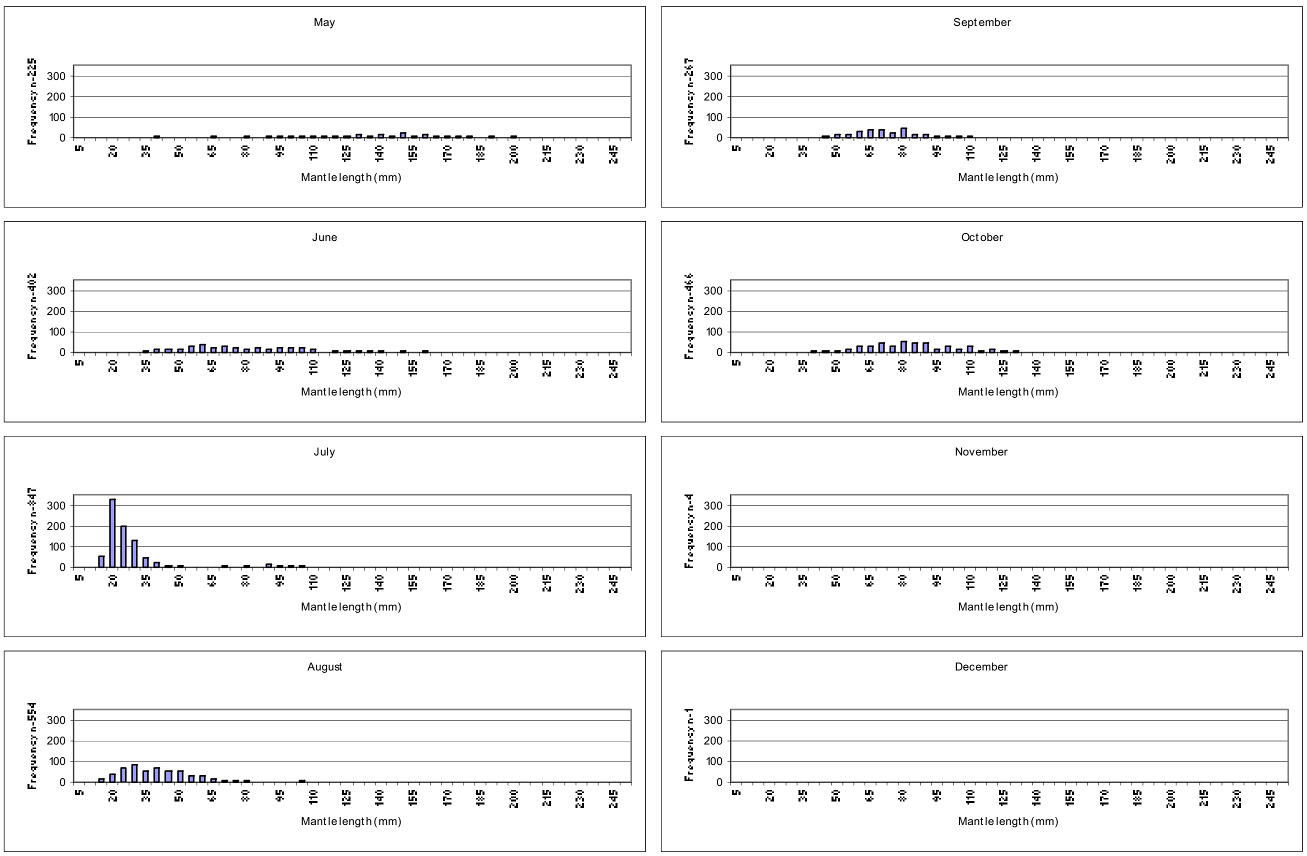


Figure 5-27. Longfin squid length-frequency, May – December (Mantle length in millimeters, n = 2,766).

5.2.4.3 Evaluation of Nursery Potential of the Candidate Disposal Sites

By applying the data of the benthic habitat type and distribution of juvenile fish and long-finned squid, the overall nursery potential of the candidate disposal sites was determined using the empirical formula developed by Wilbur (2000). Both candidate disposal sites were assigned a high habitat complexity score due to the presence of a relatively wide variety of sediment types bedforms, biogenic structure, and epifauna (Table 5-10). The complexity score was slightly higher at candidate site 2 due to the presence of a wider range of sediment types, higher vertical relief provided by nearby rocky areas (e.g., Gifford Ledge), and steeper changes in topography (Maguire 2001a and b; Maguire 2002d). As indicated in the preceding sections and summarized in Table 5-10, juveniles of a significant number of select species also were found at both sites. The candidate disposal sites, therefore, were each determined to have high nursery potential for juvenile fish.

Table 5-10. Nursery potential assessment for each candidate disposal site.

Candidate Site	Complexity Score	Juvenile Presence	Nursery Potential
Site 1	10	Atlantic and blueback herring, scup, tautog, winter flounder, butterfish, bay anchovy, bluefish, summer flounder, Atlantic moonfish, black sea bass, longfin squid, and weakfish	high
Site 2	12	Atlantic and blueback herring, scup, tautog, winter flounder, butterfish, bay anchovy, bluefish, summer flounder, Atlantic moonfish, black sea bass, longfin squid, and weakfish	high

5.2.5 Spawning Potential

Spawning periods for the most common fish and invertebrates within a given area are commonly used as a model for assessing overall spawning potential for that area. Dredging and dredged material disposal are often limited to the months of year when spawning is minimal. Spawning times vary among finfish species, by geographic area, and through time. Local surveys have identified important habitat associations (sand and cobble, eelgrass) that appear to be essential for the reproduction and development of fish and invertebrates. Spawning potential within and proximal to the candidate disposal sites was estimated during this assessment based on available information on substrate types, habitat complexity, and water quality. Both disposal sites were determined to provide suitable spawning habitat for certain fish species. Spawning activity at these sites vary seasonally with species. Generally speaking, few of the Buzzards Bay fish species spawn in late fall and early winter, with the exception of windowpane and Atlantic cod. The former has a peak spawning period in May, and the latter reach peak spawning activity in January in southern New England waters (Bigelow and Schroeder 1953).

5.2.5.1 Buzzards Bay

The abundance of mature adult fish and invertebrates within the candidate disposal sites and vicinity during their respective reproductive season suggests that the project area provides spawning potential for various species, provided that other criteria for spawning are met (e.g., requisite temperature, depth, substrate, etc.). To provide a conservative characterization of spawning potential, in the absence of direct study on spawning of fishes and megainvertebrates within the sites, the information presented herein discusses species collected as adults that have potential to spawn. The primary finfish studies conducted for this DEIR (Maguire 2002a; Camisa and Wilbur 2002) revealed that the project area most likely provides spawning potential for the following economically important species: black sea bass, butterfish, long-finned squid, scup, tautog, windowpane, and winter flounder. The spawning requirements of these species are summarized in Table 5-11.

The seasonality of spawning for the dominant fish and invertebrates is an important factor in planning dredging and disposal activities. For instance, dredging and disposal restrictions are imposed by DEP for Massachusetts coastal waters to protect the spawning activities of dominant shellfish (primarily lobster) and finfish species within the region. Since spawning for many of these organisms occurs in the spring, summer and early fall, dredging has historically been limited to the late fall and early winter season to protect peak spawning activity and subsequent presence of finfish larvae. The imposition of seasonal restrictions avoids impacts to sensitive eggs and larvae within the water column (pelagic) and on the seafloor (demersal). The appropriate dredging “window” (i.e., the period of time when dredging will have the least impact to fisheries resources) is determined via an essential fish habitat assessment, which is discussed in Section 5.3.

5.2.5.2 Comparison of Candidate Site 1 to Candidate site 2 Spawning Potential

The physical characteristics of candidate sites 1 and 2 are similar and appear to support the requirements for spawning of Atlantic butterfish, long-finned squid, scup, tautog, and windowpane. Both sites provide the required temperature, substrate type, and depth for these species, all of which spawn at typical seawater salinity. However, the average depth at candidate site 1 does not fall within the optimum depth range requirement for spawning of black sea bass. Therefore, candidate site 1 may not provide optimal spawning conditions for this species. In contrast, candidate site 2 has a deeper average depth and lies proximal to Gifford Ledge, where spawning black sea bass can utilize for refuge after spawning. Candidate site 2 also appears to support the requirements for spawning of Atlantic butterfish, long-finned squid, tautog, and windowpane. Neither site meets the preferred depth requirement of 2 to 5 meters for inshore populations of spawning winter flounder. However, winter flounder may spawn in shallower areas near and to the east of the candidate disposal sites.

5.2.6 Lobsters

Lobsters are abundant and the basis of a fishery in Buzzards Bay. In contrast to the waters of Cape Cod Bay and the Gulf of Maine to the north, the warmer waters of Buzzards Bay allow for a greater number of females to become gravid before reaching the legally harvestable size. As such, these gravid females enhance spawning stocks and contribute significant larvae to more northern waters of the state via dispersal through the Cape Cod Canal (Howes and Goehringer 1996).

Since lobsters are mobile and are found throughout the region, it is difficult to differentiate among the candidate disposal sites on the basis of potential impacts of dredged material disposal to adult lobsters. Surveys of the marine resources of the bay’s areas, while reporting on the overall importance of the lobster fishery, do not specify which sites or areas are more productive than others. However, very young lobsters tend to be more stationary than older juveniles and adults. These lobsters, referred to as early benthic phase (EBP) lobsters, therefore are more susceptible to negative impacts from dredged material disposal activities.

Table 5-11. Spawning requirements of economically important finfish species identified as having spawning potential in the vicinity of the candidate disposal sites.

Spawning Species (Reference)	Spawning Requirements			
	Season	Temperature	Substrate	Depth
Black Sea Bass (Steimle at al 1999a)	May to July in Mid-Atlantic Bight	Not identified Eggs most frequently collected at 12 to 24°C	Sand bottoms broken by ledges, after spawning fish disperse to ledges and rocks in deeper water	20 to 50 meters
Butterfish (Cross et al 1999)	June to August in eastern LIS, Narragansett Bay, Mass Bay	>15°C	None (Upper water column)	0 to 4 meters
Long-finned Squid (Cargnelli et al 1999)	Potentially spawn year round, May to Aug in New Eng. Waters; Peak in May,	Eggs found at 10 to 23°C	Attached to rocks and small boulders on sandy/muddy bottoms and on aquatic vegetation such as *Fucus* sp., *Ulva*, *Laminaria*, and *Porphyra*.	<50 meters
Scup (Steimle at al 1999b)	May to late June Peaks in June	24°C	Over weedy and sandy areas	<10 meters
Tautog (Steimle and Shaheen 1999)	Begins in April peaks in June – July in so. New Eng.	9°C or >	Hard bottom sites Greatest abundance of eggs found in eelgrass vegetated sites; however many viable eggs also found to be buoyant	25 to 35 meters
Windowpane (Chang et al 1999)	Begins in Feb or Mar peaks in May	8.5 to 13.5°C	On or near bottom over sand substrates	<30 meters
Winter Flounder (Periera et al 1999)	Winter through spring with peak in Feb and Mar	< 10°C 3 to 5°C preferred	Sand, muddy sand, mud and gravel, although sand is most common	2 to 5 meters in inshore populations

EBP lobsters prefer hard substrates, such as cobbles and boulders (Palma et. al. 1998). The sediment-profile imaging and benthic grab surveys revealed that the substrate within the disposal sites consists predominantly of soft, unconsolidated silt-clays and muddy fine sands. Hard bottom substrate does occur but is relatively limited in area. Results of the side-scan sonar survey of the disposal sites and proximity were consistent with the findings of the SPI survey. Burrows identified as possible juvenile lobster burrows were detected by underwater video at some side-scan sonar trawl sampling lanes established along the eastern edge of the BBDS, but were not detected at other sampling lanes (Maguire 2002d). Therefore, primary EBP lobster habitat appears to be limited within much of the candidate disposal sites. More suitable or extensive primary EBP lobster habitat most likely occurs around known rock reefs and other hard bottom substrates located east of the candidate disposal sites.

5.2.6.1 Comparison of Potential Lobster Habitat of Candidate Site 1 with Potential Lobster Habitat of Candidate Site 2

Although not a preferred method of sampling lobsters, they were found at extremely low abundance (one individual at Station 2 within site 1 and one individual at station 5 outside of site 1 to the east) in the 13-month otter trawl sampling undertaken by Camisa and Wilbur (2002). However, given the characteristics of environments normally preferred by lobster, both candidate sites appear to represent sub-optimal habitat compared to other areas of Buzzards Bay. Candidate site 2 does appear to offer slightly more suitable potential lobster habitat in comparison to candidate site 1. This is due to the proximity of hard substrate (cobble/rock) areas that lie adjacent to the site at the northeast, southeast, and southwest corners of candidate site 2, the proximity of Gifford Ledge to the east of candidate site 2, and the more extensive coverage of soft mud at candidate site 1. Large burrows that were identified as potentially belonging to juvenile lobsters were noted during side-scan sonar and bottom video surveys along Station 6, located within candidate site 2. Burrows like these were not observed within candidate site 1 (Maguire 2002d).

5.2.7 Shellfish

The phylum mollusca is comprised of invertebrate organisms belonging to one of three taxonomic classes: the cephalopoda (octopi and squid), gastropoda (snails and sea slugs), and pelecypoda (bivalve mollusks or “shellfish”). The dominant cephalopod mollusk within Buzzards Bay is the long-finned squid (*Loligo pealeii*), which supports an important fishery in the region and is therefore discussed in the preceding finfish resources sections. The other two taxonomic classes, the gastropod and pelecypod mollusks, are discussed below. Commercial and recreational shellfisheries in Buzzards Bay include quahog (*Mercenaria mercenaria*), bay scallop (*Argopecten irradians*), soft-shell clam (*Mya arenaria*), and oyster (*Crassostrea virginica*). Harvesting of commercial and recreational shellfish is discussed in Section 6.

5.2.7.1 Gastropods

In general, gastropod mollusks are not viewed as economically important shellfish and are not regulated as such. Smaller gastropods, such as snails and the rice bubble (*Cylichna oryza*), are part of the benthic macroinvertebrate communities at the candidate disposal sites, and details of their abundance are provided in the benthic community characterization study (Maguire 2001d). The grabs used for sampling in the benthic community study take relatively small volumes of sediment, and therefore are not effective for characterizing population densities of larger gastropods like the channeled whelk (*Busycon canaliculatum*). This gastropod mollusk, commonly known as the conch, is of some economic importance in Buzzards Bay and is found within the benthic communities of the candidate disposal sites and vicinity. This species occurs from Cape Cod south to northern Florida and the Gulf of Mexico (Gosner 1978). Details regarding the human use of this resource are provided in Maguire (2002b) and summarized in Section 6.2.

5.2.7.2 Bivalves

Many of the bivalve mollusks are not viewed as economically important in Buzzards Bay and therefore their harvest is not regulated as such. The narrowed macoma (*Macoma tenta*) is a small, delicate bivalve that was among the ten most-abundant benthic macroinvertebrate species at both candidate sites. Further details of the occurrence of various bivalves at candidate sites 1 and 2 are provided in the benthic community characterization report (Maguire 2001d). Similar to the gastropods, the grab device used for sampling in the benthic community study generally is not effective for characterizing population densities of larger, commercially valuable shellfish.

The predominant commercially and recreationally harvestable mollusks found in Buzzards Bay were identified by Howes and Goehringer (1996) as the quahog (*Mercenaria mercenaria*), soft-shelled clam (*Mya arenaria*), and bay scallop (*Aequipecten irradians*). Maguire (2002b) included the blue mussel (*Mytilus edulis*) and the oyster (*Crassostrea virginica*) as additional bivalve mollusks of economic importance. Towns bordering eastern Buzzards Bay have designated seasons for the harvest of these shellfish from bay waters. Maguire (2002b) discusses the commercial and recreational harvest of the predominant shellfish resources within Buzzards Bay and the candidate disposal sites (Section 6.2).

In addition to the above species, Howes and Goehringer (1996) identified the black clam (*Arctica islandica*), the duck clam (*Pitar morrhuanus*), and the razor clam (*Ensis directus*) as additional edible shellfish that as of yet are not considered important economic resources in comparison to those identified by Maguire (2002b). However, the razor clam is often harvested by clam diggers and supports a recreational fishery (Weiss 1995; Howes and Goehringer 1996). Furthermore, the bay is designated as EFH for the surf clam (*Spisula solidissima*), an apparently under-exploited species in Buzzards Bay (see Section 5.3). Table 5-12 lists the shellfish species of economic importance or potential within the bay and their respective habitat.

Table 5-12. Shellfish species of economic importance in Buzzards Bay.

Common Name	Scientific Name	Habitat
Quahog	*Mercenaria mercenaria*	Harbors, tidal and subtidal flats around the bay
Soft-shelled clam	*Mya arenaria*	Protected harbors, tidal and subtidal flats around the bay
Bay scallop	*Aequipecten irradians*	Eelgrass beds, subtidal sand flats
Channeled whelk (Conch)	*Busycon canaliculatum*	Deeper water benthic habitat
Oyster	*Crassostrea virginica*	Tidal creeks
Blue mussel	*Mytilus edulis*	Intertidal rock reefs
Surf clam	*Spisula solidissima*	Subtidal benthic habitat
Black Clam or Ocean Quahog	*Arctica islandica*	Muddy sand of deeper waters offshore
“Duck” clam	*Pitar morrhuana*	Bottom mud
Atlantic jackknife clam or razor clam	*Ensis directus*	Sand and mud near low tide level

Species like the oyster and blue mussel inhabit intertidal areas and are unlikely to be found in the subtidal seafloor habitats of the candidate disposal sites. However, as filter feeders, they are susceptible to turbidity and other water quality impacts from off-site sources. In addition to their economic importance, many of these shellfish are an important food resource for fish and waterfowl.

In Buzzards Bay, the primary shellfish fisheries are quahogs, scallops, soft-shelled clams, and conch. Quahogs are found throughout Buzzards Bay and are the dominant commercially and recreationally harvested shellfish species. Both candidate disposal sites lie in areas mapped as "approved" shellfish harvesting areas (Figure 5-28; MADMF 1999).

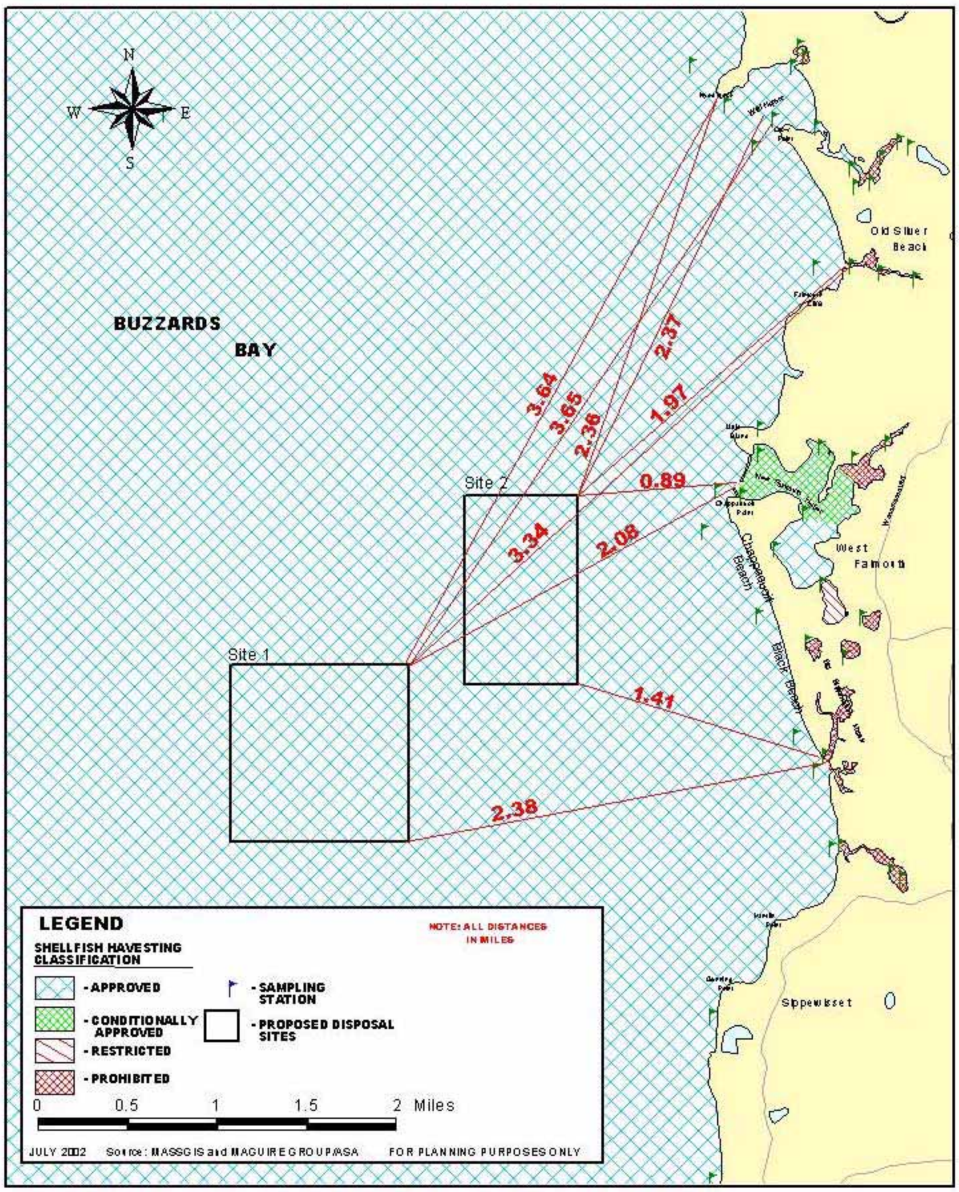


Figure 5-28. DMF shellfish harvesting classifications within and proximal to the candidate disposal sites.

5.2.7.3 Shellfish Within and Adjacent to the Candidate Sites

Shellfish presence/absence was determined largely via the results of the SPI survey and the benthic macroinvertebrate community characterization employing grab sampling (Maguire 2001c; 2001d). These results were supplemented with data obtained during 13-month otter trawl sampling and the side-scan sonar/underwater video survey (Camisa and Wilber 2002; Maguire 2002d. Although these various surveys and the gear they employed were not designed to sample or harvest specific shellfish populations *per se*, the results in many cases serve to confirm the presence of some shellfish species within and adjacent to the candidate sites.

Gastropod Mollusks

Camisa and Wilbur (2002) confirmed the presence of channeled whelk within both candidate site 1 (two individuals at each of Stations 2 and 4) and candidate site 2 (five individuals at Station 6). During the bottom classification survey, channeled whelk also were observed by underwater video at Station 5, which lies to the east of candidate site 1 and south of candidate site 2 (Maguire 2002d).

Smaller gastropods were found at each site in the benthic macroinvertebrate survey effort using a grab sampler. The channeled barrel-bubble (*Acteocina canaliculata*) was found to be the sixteenth most-abundant species at candidate site 1. At candidate site 2, *Acteocina canaliculata* also was among the 27 most-abundant species, along with Adam's baby bubble (*Rictaxis punctostriatus*) and the elegant tubonille (*Turbonilla elegantula*). An unidentified slipper shell (*Crepidula* sp.) was present at both sites as well. Although all these gastropods, except the channeled whelk, are not important economic resources, they are important food resources for finfish and birds.

Bivalve Mollusks

The false quahog *Pitar morrhuana* was found at both candidate sites, but it was not among the numerical dominants (Maguire 2001d). Bivalve mollusks that occurred with significant abundance (i.e., among the species comprising greater than 90% of the total abundance) include the nuts clam *Nucula annulata* and *Nucula* sp., the tellins *Macoma tenta* and *Tellina agilis*, *Yoldia limatula*, and an unidentified mussel (Family Mytilidae).

A single blue mussel (*Mytilus edulis*) was collected during an otter trawl at candidate site 1 (Camisa and Wilbur 2002). Outside of the candidate sites, Northern quahog was found at Station 5, located east of candidate site 1 and south of candidate site 2. The bay scallop was found at Station 7, also located east of candidate site 1 and south of candidate site 2. During the side-scan sonar and underwater video bottom classification survey, the Northern quahog was found at the western border of candidate site 1 (Station 3) and at Station 7 (Maguire 2002d).

5.3 Essential Fish Habitat

The Magnuson-Stevens Act of 1976 (the Act) promotes fish conservation and management. Under the Act, NMFS was granted legislative authority for fisheries regulation in the United States within a jurisdictional area located between three miles to 200 miles offshore, depending on geographical location (American Oceans 2001). The NMFS also was granted authority to establish eight regional fishery management councils responsible for the proper management and harvest of fish and shellfish resources within these waters. Measures to ensure proper management and harvest are outlined in Fisheries Management Plans prepared by the eight councils for their respective geographic regions. Buzzards Bay lies within the management jurisdiction of the New England Fishery Management Council (NEFMC) and the Mid-Atlantic Fishery Management Council (MAFMC).

Recognizing that most marine fisheries are dependent on nearshore and estuarine environments for at least part of their life cycles, the Act was reauthorized, and changed extensively via amendments in 1996. The amendments, among other things, aimed to stress the importance of habitat protection to healthy fisheries. The authority of the NMFS and their councils was strengthened by the reauthorization to promote more effective habitat management and protection of marine fisheries. The marine environments important to marine fisheries are referred to as EFH in the Act; they are defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. To delineate EFH, coastal littoral and continental shelf waters have been mapped and superimposed with ten minute by ten-minute square coordinate grids (10-minute grid).

Buzzards Bay lies within a 10-minute by 10-minute grid area designated as EFH for the New England Groundfish, and other fishery management plans. The grid is depicted in Figure 5-29, and its coordinates are provided in Table 5-13. It is described by NMFS as follows:

> "Atlantic Ocean waters within the square within Buzzards Bay affecting the following: west of Woods Hole, MA, surrounding from Hiller Cove south to Penzance and Woods Hole, MA, including Nonamesset Island, West Island, and the northern part of Naushon Island. Also affected are: Nasketucket Bay, Cormorant Rock, Nye Ledge, Mattapoisett Neck, south of Mattapoisett, MA, Cleveland Ledge, East Cleveland Ledge, a dumping ground west of West Falmouth, MA, a disposal area south of East Cleveland Ledge, Weepecket I., and Weepecket Rock."

Table 5-13. Summary of essential fish habitat (EFH) designation ten-minute square coordinates.

Boundary	North	East	South	West
Coordinate	41° 40.0' N	70° 40.0' W	41° 30.0' N	70° 50.0' W

All economically important fish species that NMFS has determined seek suitable habitat within the ten-minute grid are listed as EFH species. Within the grid for Buzzards Bay, EFH is designated for specific life stages of 20 species (Table 5-14). A separate EFH assessment was conducted as part of the preparation of this document; it evaluates the occurrence of the most susceptible life stages (i.e., spawning adults, eggs, larvae, and juveniles) for various select managed species within and near the candidate disposal sites (Appendix M). This information is used by regulatory agencies to determine the timing of "open" and "closed" dredging windows (i.e., periods of time during the year when dredging and disposal are permitted or not permitted, respectively) to avoid impacts to fisheries resources.

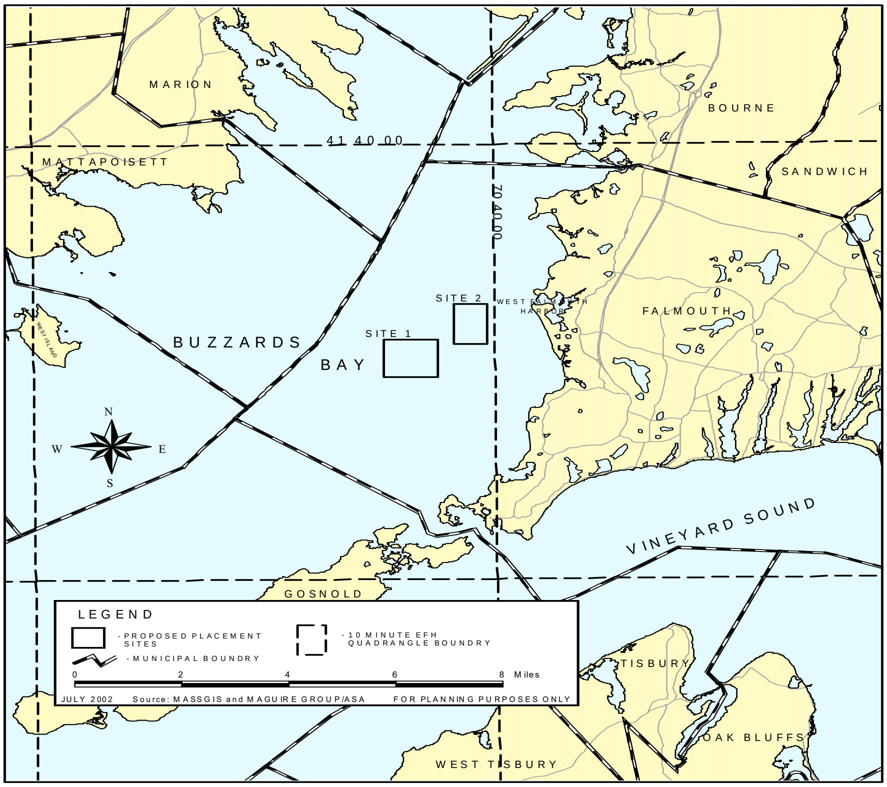


Figure 5-29. Ten-minute square coordinate EFH grid for Buzzards Bay (NOAA, NMFS).

Table 5-14. EFH-designated species and their life stages (denoted by "x") associated with the grid described in Table 5-13 (includes finfish, invertebrates, and shellfish).

Species	Eggs	Larvae	Juveniles	Adults
Atlantic cod (*Gadus morhua*)	X	X	X	X
Haddock *(Melanogrammus aeglefinus)*	X	X		
Red hake *(Urophycis chuss)*		X	X	X
Winter flounder *(Pseudopleuronectes americanus)*	X	X	X	X
Windowpane flounder *(Scophthalmus aquosus)*	X	X	X	X
American plaice *(Hippoglossoides platessoides)*			X	X
Atlantic sea herring *(Clupea harengus)*			X	X
Bluefish *(Pomatomus saltatrix)*			X	X
Long finned squid *(Loligo pealei)*	n/a	n/a	X	X
Atlantic butterfish *(Peprilus triacanthus)*	X	X	X	X
Atlantic mackerel *(Scomber scombrus)*	X	X	X	X
Summer flounder *(Paralichthys dentatus)*	X	X	X	X
Scup *(Stenotomus chrysops)*	X	X	X	X
Black sea bass *(Centropristus striata)*	n/a	X	X	X
Surf clam *(Spisula solidissima)*	n/a	n/a	X	X
King mackerel *(Scomberomorus cavalla)*	X	X	X	X
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
Cobia *(Rachycentron canadum)*	X	X	X	X
Sandbar shark *(Charcharinus plumbeus)*				X
Bluefin tuna *(Thunnus thynnus)*			X	

n/a = denotes that life stage is not applicable to that particular species

When determining an appropriate open dredged material disposal window, additional consideration by the regulatory agencies may be given to other fisheries resources (including shellfish and megainvertebrates) that may have life stages with seasonal occurrence within the project area and which may be susceptible to impacts associated with dredged material disposal. This is especially important because many of these additional species in their various life stages are important food resources for EFH species. Consideration may also be given to the seasonality of commercial and recreational activity centered around these fishery resources, which is described in Section 6.

The information provided in the EFH assessment (Appendix F) is summarized graphically in Figures 5-30 to 5-33. These figures depict seasonal occurrence of susceptible life stages of EFH and dominant non-EFH finfish (Figures 5-30 and 5-31), as well as shellfish and other invertebrate species (Figure 5-32) that have been found to occur within or adjacent to the candidate disposal sites. This information was obtained from the analysis of the DMF long-term trawling survey dataset (Maguire 2002), the site-specific otter trawl sampling conducted by DMF and CZM (Camisa and Wilbur 2002), and other sources as noted on the figures. Additional information regarding the occurrence of the EFH species and their respective life stages is provided in Appendix F and in the preceding Sections 5.2.1 through 5.2.6. The seasonality of commercial and recreational activity centered about these fishery resources is illustrated in Figure 5-33 and discussed in greater detail in Sections 6.1 through 6.3.

5.4 Use of the Candidate Sites by Rare or Endangered Species

Information on the potential for Massachusetts- and/or Federally-listed rare, threatened and endangered species and critical habitat for such species was investigated for the open waters of Buzzards Bay in the vicinity of the candidate disposal sites, as well as the nearby shoreline in West Falmouth. Available information on these areas was reviewed and the appropriate state and federal agencies were contacted to determine the potential presence or likelihood of occurrence of such species, including state-designated species of special concern, or critical habitat areas that may be impacted by disposal activities at candidate sites 1 and 2.

The nearest shoreline in West Falmouth is located approximately 1,500 meters from the closest portion of candidate site 2. While this is a considerable distance away, resources along the shoreline were investigated in addition to the open water areas of the Bay to ensure a complete characterization of potential impacts associated with disposal activities at the candidate sites.

5.4.1 State-Listed Species

The Massachusetts DEP Division of Fisheries and Wildlife Natural Heritage Program was contacted to determine the potential likelihood of occurrence of Massachusetts-listed endangered, threatened, or special concern plant or animal species in or adjacent to the marine waters of the Buzzards Bay candidate disposal sites. A review of their files by DEP Endangered Species Review program personnel revealed no known rare plants or animals or exemplary natural communities within the project area (DEP 2002) (Also see Appendix O).

There are a variety of inland and coastal species that are state-listed species for the Town of Falmouth, although their potential habitat areas along the shoreline of West Falmouth occur more than 1,500 meters from the closest boundary of candidate site 2. Two endangered fish

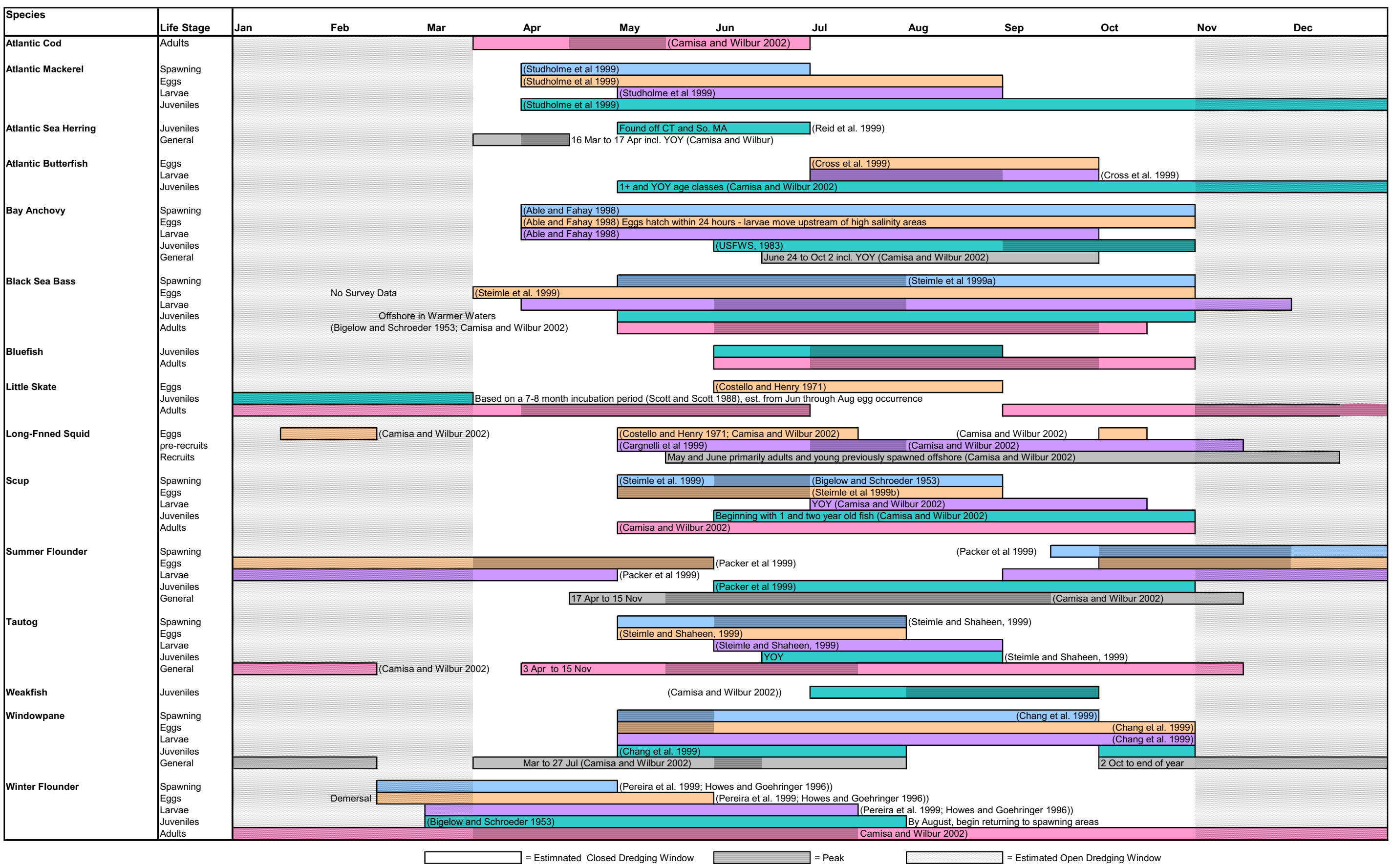


Figure 5-30. Finfish species and long-finned squid, their respective life stages confirmed within the candidate disposal sites, and seasonal occurrence of life stages most susceptible to dredged sediment disposal activities.

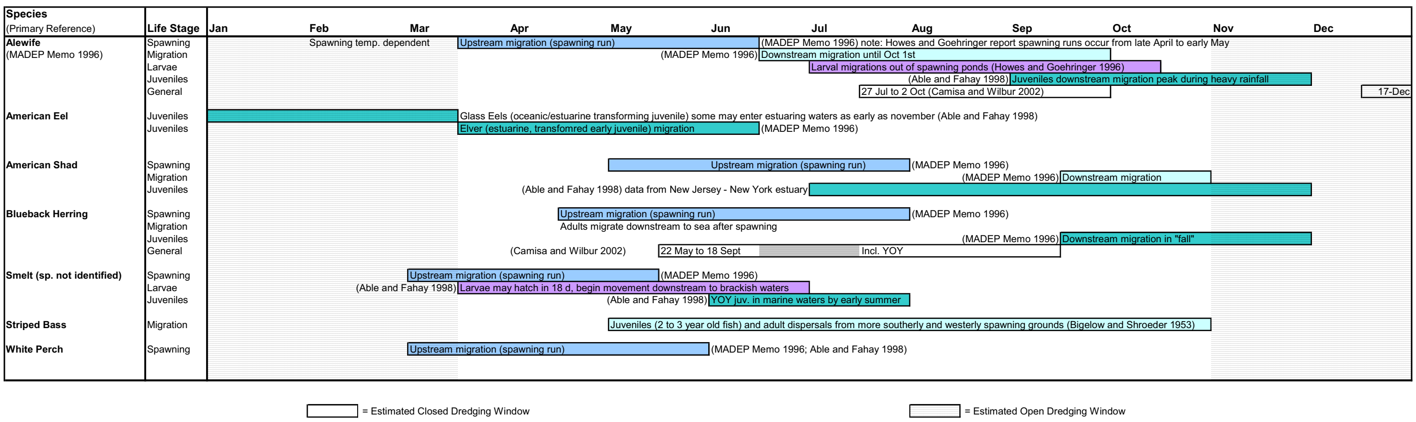


Figure 5-31. Diadromous fish species confirmed within the candidate disposal sites – seasonal occurrence of life stages most susceptible to dredged sediment disposal activities.

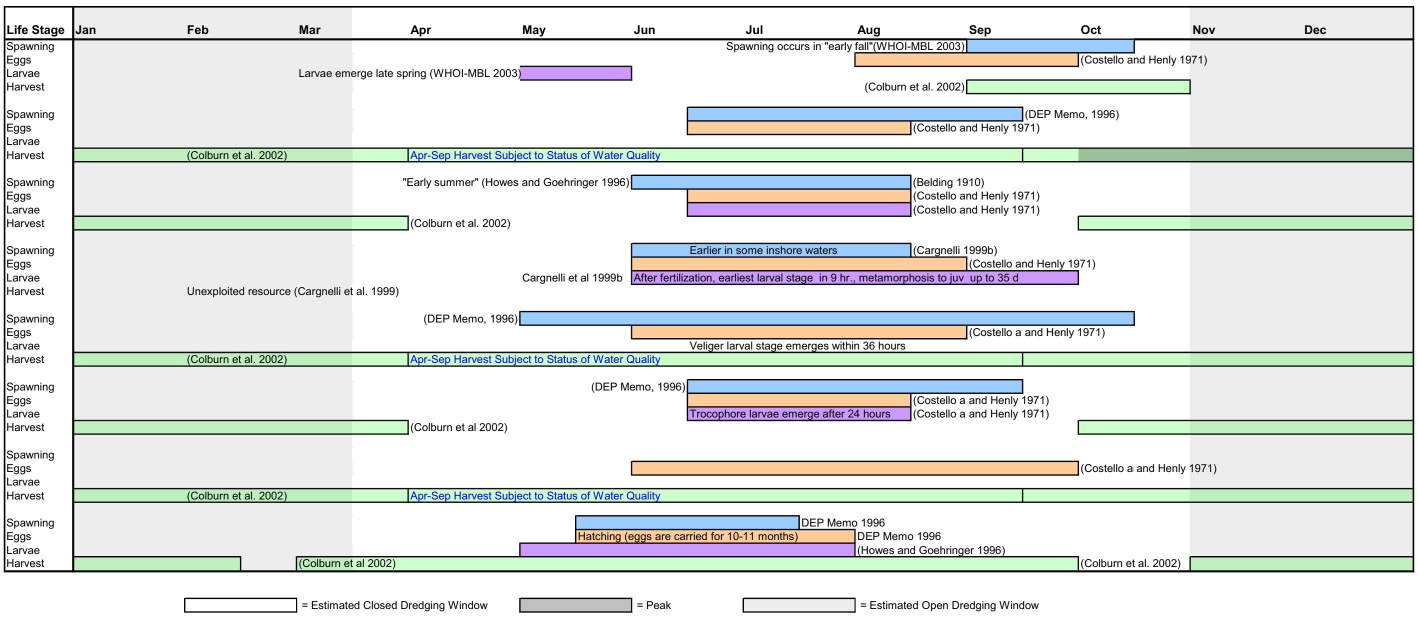


Figure 5-32. Seasonal occurrence of shellfish and lobster life stages in Buzzards Bay and Falmouth legal harvest seasons.

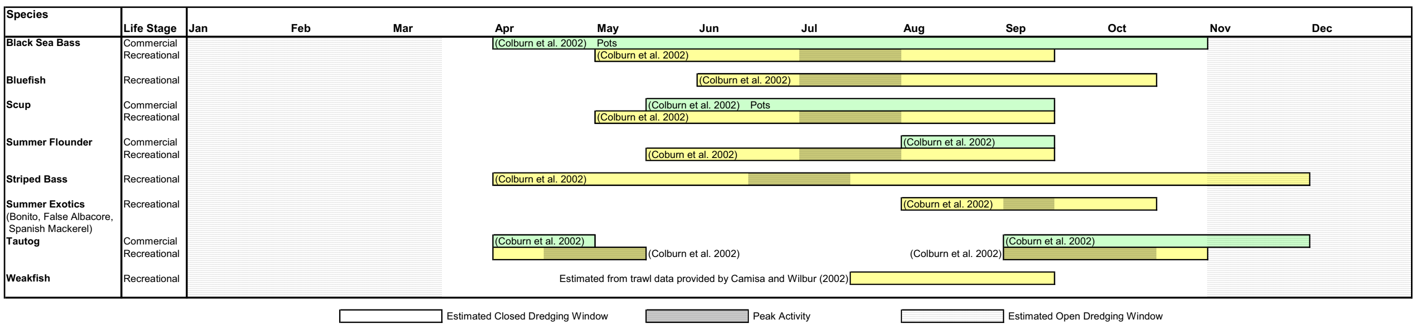


Figure 5-33. Species confirmed within the candidate disposal sites – seasonal occurrence of commercial and recreational catch.

species that inhabit estuarine embayments are the shortnose sturgeon (*Acipenser brevirostrum*), and Atlantic sturgeon (*Acipenser oxyrhynchus*). The former is also a federally endangered species, while the latter is a federally threatened species. Sturgeon utilize estuarine habitat areas in the winter and migrate into freshwater rivers in the spring. Both species have very limited distribution in Massachusetts, with only three extant populations of shortnose sturgeon and one extant population of Atlantic sturgeon known to occur within the Commonwealth, none of which occurs in Buzzards Bay (MADFW-NHESP 1991).

Two coastal birds are listed for Falmouth, the state- and federally-listed piping plover (*Charadrius melodus*) and the least tern (*Sterna albifrons*). Regions of sparsely vegetated barrier beaches above the high-tide line make ideal nesting habitat for these species. The eastern boundary of candidate site 2 is located closest to the shoreline but occurs more than 1,500 meters from the beaches and intertidal flats of West Falmouth that may provide potential habitat areas for these species.

The Massachusetts Natural Heritage and Endangered Species program has designated the Black Beach/Sippewissett Marsh area as a "high priority site of rare species habitat and exemplary natural community." The Town of Falmouth has proposed designation of this area as a District of Critical Planning Concern. These designations include consideration of the presence of Federal- and state-listed species, including the piping plover, the perennial orchid, arethusa (*Arethusa bulbosa*), and New England blazing star (*Liatris scariosa v. novae-angliae*). The Black Beach peninsula forms the southern portion of the shoreline area closest to the candidate sites, and the Sippewissett Marsh complex lies behind the peninsula to the southeast. Black Beach is located more than 1,500 meters from the southeast corner of candidate site 2, and the channel leading to the Sippewissett Marsh complex is more than 2,000 meters away.

5.4.2 Federally-Listed Species

The USFWS and the NMFS were contacted to determine the potential likelihood of occurrence of federally-listed threatened and endangered species or critical habitat in the vicinity of candidate sites 1 and 2.

No federally listed or proposed threatened or endangered species under the jurisdiction of the USFWS are known to occur in the project area (USFWS 2002). The NMFS indicated that the threatened loggerhead turtle (*Caretta caretta*), endangered Kemp's ridley sea turtle (*Lepidochelys kempi*), endangered green sea turtle (*Chelonia mydas*), and endangered leatherback sea turtle (*Dermochelys coriacea*) can be found in New England waters, including Buzzards Bay, during the summer months (Table 5-15). The Atlantic hawksbill (*Eretmochelys I. imbricata)* is a fifth endangered sea turtle that is rarely found in southern New England waters (Table 5-15). Information regarding the preferred habitat and food of these threatened or endangered sea turtles is summarized in Table 5-16.

The following information on the occurrence of leatherback and Kemp's ridley turtles in Buzzards Bay is taken from the Buzzards Bay Comprhensive Conservation and Management Plan (Buzzards Bay Project 1991). The leatherback turtle is the species most frequently encountered in Buzzards Bay, generally from July through November. They can be adversely

Table 5-15. Marine turtles, their federal and state status and occurrence in southern New England waters.

Species (*Scientific Name*)	Federal Status [1]	State Status [2]	Occurrence in Southern N.E. [3]
Kemp's Ridley Turtle (*Lepidochelys kempii)*	Endangered	Endangered	Immature turtles occur in NE in summer and fall
Leatherback Turtle (*Dermochelys coriacea)*	Endangered	Endangered	Regularly enters NE in the summer and occasionally enters bays, sounds, and estuaries.
Loggerhead Turtle (*Caretta caretta*)	Threatened	Threatened	Occasionally seen in Southern NE bays and sounds in summer.
Green Turtle (*Chelonia mydas*)	Threatened	Threatened	Immature turtles occur in southern NE in summer and fall.
Atlantic Hawksbill (*Eretmochelys I. imbricata)*	Endangered	Endangered	Rarely found in southern NE, although sometimes found far offshore.

[1] http://endangered.fws.gov/
[2] http://www.state.ma.us/dfwele/dfw/nhesp/nhare.html
[3] Weiss 1995

Table 5-16. Habitat and food preferences of marine turtles found in southern New England waters.

Species (*Scientific Name*)	Habitat	Food
Kemp's Ridley (*Lepidochelys kempii*)	Young juveniles live in shallow coastal waters. Older turtles move to deeper water and concentrate in seagrass. [1]	Mostly crabs, also shrimp, snails, clams, jellyfish, sea stars, squid, sea urchins, coelenterates, and small fish. [1]
Leatherback Turtle (*Dermochelys coriacea*)	Large marine grassbeds. [1]	Eats grasses and small animals that they find near the ocean floor and in large marine grass beds, but primarily feeds on jellyfish. [2]
Loggerhead Turtle (*Caretta caretta*)	Brackish waters of coastal lagoons and river mouths. [2]	Primarily bottom feeders, eating conchs, clams, crabs, horseshoe crabs, shrimps, sea urchins, sponges, fishes, squids, and octopuses in coastal waters. During migrations loggerheads eat jellyfish, floating mollusks, floating egg clusters, squids, and flying fish. [2]
Green Turtle (*Chelonia mydas*)	Shallow sea areas abundant with sea grasses and algae. Mostly migrate along the coast. [2]	Mostly feed on sea grasses and algae with small amounts of animal foods; sponges, crustaceans, sea urchins, and mollusks. [2]
Atlantic Hawksbill (*Eretmochelys I. imbricata)*	Most common where coral reef formations are present. [2]	Diet consists mostly of invertebrates such as sponges, jellyfish, crustaceans, sea urchins and mollusks. [2]

[1] Weiss 1995
[2] http://endangered.fws.gov/

impacted from entanglement (and subsequent drowning) in lobster gear, collisions with boats, and intestinal blockage due to the ingestion of plastics.

The Kemp's ridley turtle is known to frequent areas adjacent to Buzzards Bay, as indicated by reports of individuals caught in fishing nets or stranded within Cape Cod Bay. The fact that sightings within Buzzards Bay are rare may be due to the absence of commercial fishing with nets and seines in the Bay and corresponding lack of direct observations. Given the distribution of the species and the favorable conditions found in Buzzards Bay, the bay may be a potentially important foraging area for juveniles and subadults of this species during late summer and early fall.

This information, as well as the time-of-year and feeding preferences summarized in Tables 5-15 and 5-16, suggest that it will not be routine for turtles to be encountered in Buzzards Bay during the times of year when disposal activities are likely to occur (winter and early spring). Additionally, while turtles may seek a fairly broad array of prey items, these prey items will typically be most concentrated in shallow coastal waters and seagrass beds, neither of which occur at the two candidate disposal sites.

In addition to marine turtles, NMFS reported that the North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), and fin whale (*Balaenoptera physalus*) might also be found seasonally within New England waters. However, these species are found mainly at offshore upwelling sites like Stellwagen Bank, Nantucket Shoals, and Georges Bank, which are topographic seafloor features located outside of Buzzards Bay that concentrate prey species for cetaceans. These marine mammals rarely, if ever, enter the bay (Howes and Goehringer 1996). Exceptions may occur when an animal is sick or injured, but it would be a highly unusual experience to encounter one within Buzzards Bay.

5.5 Avifauna and Wildlife

The shoreline of Buzzards Bay includes beaches, marshes, tidal flats, and shallow, subtidal areas that represent ideal nesting and forage habitats for a variety of seabirds, shorebirds, and waterfowl. Of these coastal habitat areas, the nearest to the candidate sites is Chappaquoit Beach, which is located roughly 1,200 meters east of the eastern boundary of candidate site 2.

Seabirds and waterfowl frequent the open-water area of the Bay overlying the candidate disposal sites. In general, seabirds known to frequent open-water marine habitats in Massachusetts include the Gulls and Terns (Laridae), as well as occasional pelagic species (e.g., Procellariidae) and alcids (Alcidae). Waterfowl known to use the open-water habitats of the candidate sites include various species of loons (Gaviidae), grebes (Podicipedidae), cormorants (Family Phalacrocoracidae), and diving ducks (Family Anatidae, Subfamily Anatinae, Tribes Aythyini and Mergini). Many species can be found in Massachusetts's embayments, including Buzzards Bay, at any time of year.

5.5.1 Avifauna

5.5.1.1 Seabirds

Of the various seabirds that may frequent the open-water areas of the candidate disposal sites, the most abundant are the gulls and terns (Laridae), which forage for fish and invertebrate sea life from the water's surface. Due to their low abundance within Massachusetts's embayments, other seabirds are likely to be found within the open-water habitat of the disposal sites infrequently, or, in the case of the alcids, irregularly (i.e., at unpredictable intervals from year to year).

5.5.1.2 Waterfowl

Loons and grebes are mainly absent as summer residents, but tend to be rare to locally common winter residents (Veit and Petersen 1993). The species of loons (e.g., Common - *Gavia immer* and Red-throated - *G. stellata*) and grebes (e.g., Horned - *Podiceps auritus* and Red-necked - *Podiceps grisegena*) reported by Forster (1994) to winter in the coastal embayments of eastern and southeastern Massachusetts (including Buzzards Bay) feed mainly on fish by diving in open waters (Terres 1980).

Of the cormorants, double-crested cormorants (*Phalacrocorax auritus*) are most abundant during the summer months, while great cormorants (*Phalacrocorax carbo*) appear in the Bay in winter months. Both nearshore (littoral) and off-shore waters are used for feeding. Both species of cormorant feed primarily on fish (such as sculpin, haddock, cod, flounder, and herring), but crustaceans such as spider crabs and shrimp may also be consumed (Terres 1980). Food is caught by diving in open-water areas. However, the many reefs and rocky promontories of Buzzards Bay are used by these species for roosting and sunning.

By far the most abundant waterfowl to use the open-water areas of the candidate disposal sites are the diving ducks. By late November, when many species that breed farther north have arrived in the waters of eastern and southeastern Massachusetts as winter residents, species richness and total abundance of diving ducks increases (Forster 1994). The total abundance may fluctuate throughout the late fall to mid-winter months, with the arrival and departure of somewhat transient loose flocks and individuals. Species richness and total abundance usually increase once again in late winter to early spring as the wintering waterfowl begin to stage for their flights to northern breeding grounds (Leahy 1994). The various species of diving ducks found within Buzzards Bay during the winter months feed primarily on fish or mollusks. Therefore, they may be attracted to feeding in the relatively shallow waters over Gifford Ledge immediately east of candidate site 2. Additionally, some of the common waterfowl species occurring the bay are capable of diving to depths up to 20 meters and therefore could potentially utilize either of the candidate disposal sites for feeding. Waterfowl species known to winter within Massachusetts open-water marine habitats are listed in Table 5-17.

5.5.2 Wildlife

As discussed previously, marine turtles may enter Buzzards Bay from time to time as post-breeding summer dispersals. All marine turtles are Massachusetts- and Federally-listed species that are protected by laws of both governing bodies.

Table 5-17. Avifauna expected to frequent the offshore open water environment within and adjacent to buzzards bay within the vicinity of the candidate disposal sites (adapted from Howes and Goehringer 1996; Veit and Peterson 1993)

Species Name (Scientific Name)	Seasonal Occurrence and MA Status[1]
Common Loon (*Gavia immer*)	Rare and local breeder. Common to very common migrant at the coast; uncommon inland; uncommon winter resident.
Red-throated Loon (*Gavia stellata*)	Common to abundant migrant. Uncommon to rare winter resident; very rare in midsummer.
Horned Grebe (*Podiceps auritus*)	Uncommon to very common migrant and winter resident. Abundance varies considerably from year to year.
Red-necked Grebe (*Podiceps grisegena*)	Erratic; occasionally very common to abundant migrant; uncommon winter resident in coastal waters. Rare to uncommon inland.
Gannet (*Morus bassanus*)	Abundant migrant and winter resident offshore.
Great Cormorant (*Phalacrocorax carbo*)	Rare breeder. Common to very common migrant and winter resident. Occasional and increasing inland in small numbers.
Double-crested Cormorant (*Phalacrocorax auritus*)	Abundant breeder and migrant; rapidly increasing. Rare but increasingly regular in winter.
Red-breasted Merganser (*Mergus serrator*)	Rare breeder. Very abundant migrant and abundant winter resident on Cape Cod and the Islands; less numerous elsewhere along the coast and uncommon inland.
Common Goldeneye (*Bucephala clangula*)	Very common to abundant migrant and winter resident on the coast; common migrant inland.
Bufflehead Duck (*Bucephala albeola*)	Abundant migrant and winter resident on the coast; fairly common migrant inland.
Oldsquaw (*Clangula hyemalis*)	Abundant migrant and locally abundant winter resident; rare migrant inland.
King Eider (*Somateria spectabilis*)	Uncommon to rare but regular winter resident on the coast.
Common Eider (*Somateria mollissima*)	Several recent breeding records in Buzzards Bay and Boston Harbor. Very abundant migrant and winter resident off Cape Cod and the islands; locally common to abundant elsewhere along the coast.

Table 5-17, continued.

Species Name (Scientific Name)	Seasonal Occurrence and MA Status[1]
Greater Scaup (*Aythya marila*)	Common to abundant migrant and winter resident, greatly outnumbering Lesser Scaup throughout most of the state in all seasons.
Canvasback (*Aythya valisineria*)	Local and occasionally abundant winter resident and uncommon migrant.
Black Scoter (*Melanitta nigra*)	Abundant migrant and uncommon to fairly common winter resident on the coast; uncommon migrant inland.
Surf Scoter (*Melanitta perspicillata*)	Common spring and abundant fall migrant and uncommon winter resident on the coast; rare migrant inland.
White-winged Scoter (*Melanitta fusca*)	Abundant migrant and winter resident on the coast; rare migrant inland.
Ruddy Duck (*Oxyura jamaicensis*)	Breeds erratically at Plum Island and Monomoy Island. Locally common to occasionally abundant fall and very uncommon spring migrant; rare in winter.
Herring Gull (*Larus argentatus*)	Common year-round resident; locally very abundant breeder, migrant and winter resident.
Great Black-backed Gull (*Larus marinus*)	Common year-round resident; locally abundant breeder, more numerous in late summer, fall, and winter on the coast.
Ring-billed Gull (*Larus delawarensis*)	Abundant migrant and locally common winter resident
Common Tern (*Sterna hirundo*)	Locally abundant breeder and abundant coastal migrant. Numbers variable over decades, large colony at Bird Island in Marion.
Least Tern (*Sterna antillarum*)	Locally abundant breeder on sandy beaches
Roseate Tern (*Sterna dougallii*)	Locally abundant breeder and migrant but decreasing, large colony at Bird Island in Marion.

[1] Veit and Peterson 1993

The northern diamondback terrapin (*Malaclemys t. terrapin*), an estuarine turtle species found from Cape Cod, south to the Florida Keys and westward along the Gulf coast, reaches the northern limits of its range in southern New England. East of the Connecticut River, terrapin populations are very localized. In the waters of Massachusetts, they are known only from Wellfleet. The distribution of this species therefore is limited in Massachusetts, with the Town of Wellfleet the only known location that supports a population of this species (Klemens 1993). As an estuarine species, it is unlikely to be found in the subtidal open-water area of the candidate disposal sites.

In addition to the Federally-listed threatened and endangered marine mammals and sea turtles that may occasionally occur in Buzzards Bay (Section 5.3), harbor seals (*Phoca vitulina*) are known to inhabit harbors, bays and estuaries in New England from mid-fall (i.e., late September to early October) to early May (Maguire 2002c). Although a few seals are observed throughout the year, most move north to coastal Maine and eastern Canada prior to the pupping season, which occurs from mid-May through early July. Harbor seals occur in Buzzards Bay and throughout the Elizabeth Island chain throughout the winter (Buzzards Bay Project 1991). In addition to the harbor seal, gray seals are occasionally seen on rock ledges in the Bay, but in very small numbers.

5.6 Wetlands and Submerged Aquatic Vegetation

Coastal wetlands and submerged and intertidal resource areas are regulated under Section 404 of the CWA, the Massachusetts Wetland Protection Act, 310 CMR 10.21 through 10.37, and under the Falmouth Bylaw FWR 10.21 through 10.41.

The Clean Water Act regulations, including the 404(b)(1) guidelines, specify wetlands, mudflats, and vegetated shallows as “special aquatic sites”, and prohibit discharges in these areas if there is a less-damaging, practicable alternative to achieve the project purpose. Vegetated shallows include areas of SAV, such as eelgrass. The Massachusetts Wetlands Protection Act regulates a broad range of coastal resource areas, such as Land Containing Shellfish, Salt Marshes and Land Under Ocean, which includes SAV. Furthermore, any activity which will remove, fill, dredge, build upon, degrade, or otherwise alter any area within its jurisdiction is subject to regulation under the Town of Falmouth’s Wetlands Bylaw. Areas subject to protection under the Falmouth Wetlands Bylaw include: Land Under the Ocean (FWR 10.25), Land Under Estuaries (FWR 10.26), and Land Containing Shellfish (FWR 10.34).

Salt marshes and intertidal sand and mudflats occur extensively along the shoreline of Buzzards Bay. The shoreline in closest proximity to the candidate sites is in West Falmouth and more than 1500 meters to the east. It consists of a sandy spit (Chappaquoit and Black Beaches) fronted in places by narrow intertidal sand flats. An extensive marsh system, the Sippewisset Marsh, is located behind this sandy peninsula on its south side. To the north, there are smaller pocket marshes and intertidal areas located within Falmouth Harbor. These resource areas are located a substantial distance from candidate sites 1 and 2. Eelgrass beds (*Zostera marina*) occur throughout Buzzards Bay, providing important habitat for a variety of marine species. While they are limited by turbidity to depths of 0.6 meters to 1.8 meters in numerous embayments along the shoreline, eelgrass beds occur generally to depths of 3 meters, and in places as deep as 6 meters, in the clearer waters of the open bay. The West Falmouth shoreline contains eelgrass beds, both in Falmouth Harbor and in nearshore areas south of the Black Beach peninsula, to a depth of 4.5 meters (from Costa 1988, cited in Howes and Goehringer 1996). Water depths throughout candidate sites 1 and 2 are too deep to support eelgrass beds, and the recent surveys do not give an indication that there are eelgrass beds associated with the shallow areas of Gifford Ledge (Howes and Goehringer 1996; Schwartz 2000). MASSGIS data layers indicate the closest eelgrass beds occur in a north-south trending bed that parallels the shoreline off Black Beach, a minimum of roughly 1200 meters east of the closest portions of candidate site 2 and substantially farther from site 1 (Figure 5-34).

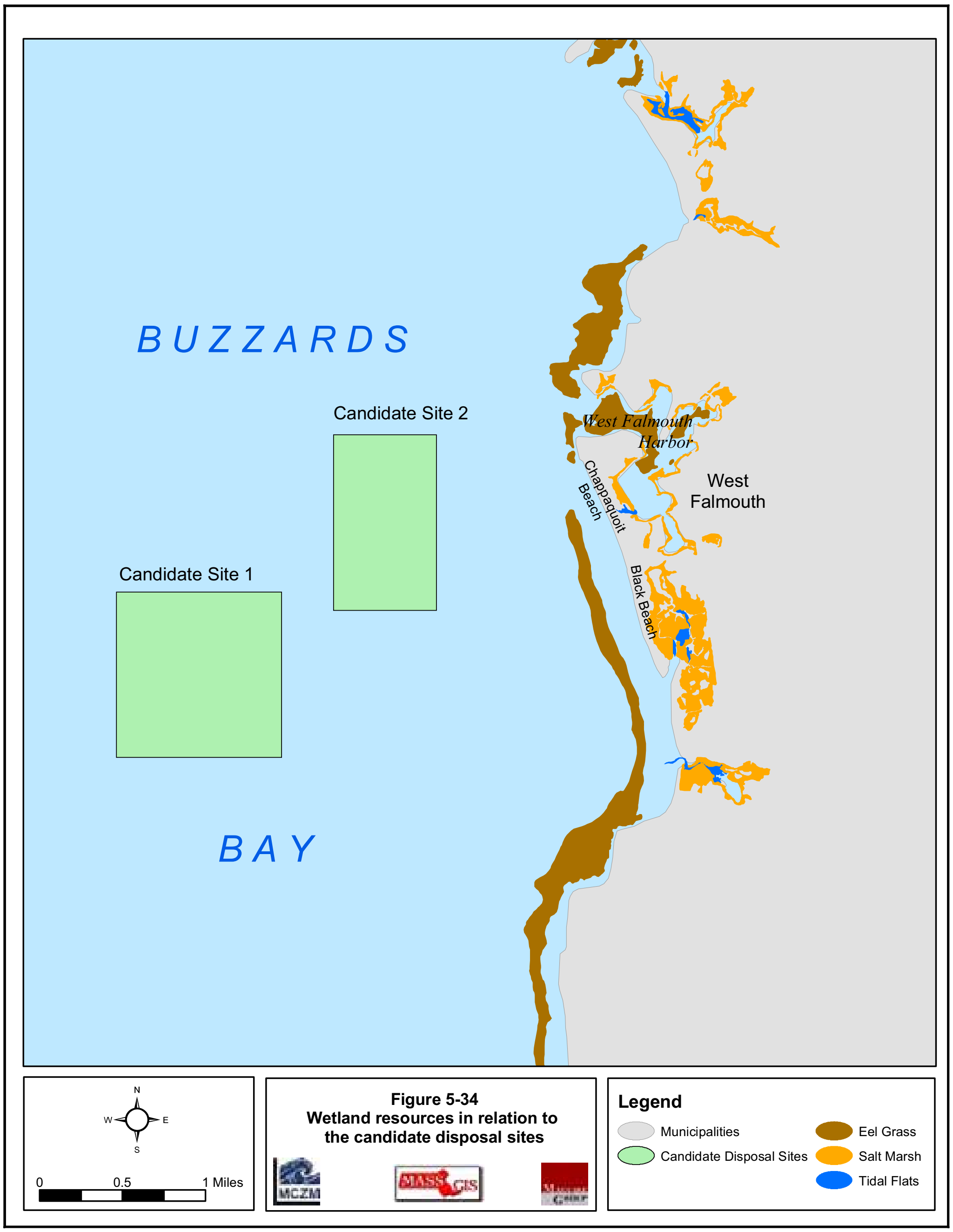


Figure 5-34
Wetland resources in relation to the candidate disposal sites

6.0 HUMAN USE CHARACTERISTICS OF THE CANDIDATE SITES

This section provides summaries of comprehensive, detailed characterizations of the human use aspects of Buzzards Bay within and proximal to the candidate sites. It draws largely from information provided by a competing site use assessment (Maguire 2002b) (Also see Appendix N). However, other relevant and pertinent information is provided and referenced herein. A substantial amount of information on the sites is available in these reference sources, and the emphasis of the discussion in the following sections is to provide an indication of the suitability of the sites for dredged material disposal in light of existing human use (e.g., are there any obvious, delimiting factors that will preclude or discourage use of the site). The information also is used to provide a comparison of the conditions at candidate sites 1 and 2 and thereby determine whether one or the other is preferred for continued dredged material disposal. Anticipated impacts to the conditions and resources of each site are discussed in detail separately in Section 7 of this DEIR (Disposal Site Impacts).

The following are included in this section on the human use characteristics of the sites:

Section 6.1: A description of the commercial and recreational finfishing patterns, practices, and seasonality in the Bay with an emphasis on human usage of the waters overlaying and proximal to the candidate sites.

Section 6.2: A description of the commercial and recreational shellfish harvesting patterns, practices, and seasonality in the Bay with an emphasis on human usage of the candidate sites.

Section 6.3: A description of the commercial and recreational lobster harvesting patterns, practices, and seasonality in the Bay with an emphasis on human usage of the candidate sites.

Section 6.4: A description of the known historical and archeological resources of the Bay in the proximity of the candidate sites.

Section 6.5: A discussion of the navigation and shipping practices within the waters proximal to the candidate sites.

Section 6.6: A discussion of applicable land use and special area designations coincident with the waters overlaying and proximal to the candidate sites.

Section 6.7: A description of the relative air quality and noise sources and receptors within the candidate sites and vicinity.

Section 6.8: A description of the recreational resources within the candidate sites and vicinity.

Section 6.9: A description of the economic environment in relation to the candidate sites and vicinity.

Section 6.10: A discussion of environmental justice issues applicable to the region.

6.1 Recreational and Commercial Harvesting of Finfish

The competing site use assessment provided the baseline information for characterizing the commercial and recreational fishing activities in Buzzards Bay that might conflict with usage of either candidate site for dredged material disposal (Maguire 2002b). Specifically, the goal of the competing use assessment was to characterize commercial and recreational finfishing, shellfishing and lobster harvesting activities in Buzzards Bay, particularly in relation to the candidate disposal sites. Based on interviews with people representing commercial and recreational fishing activities (e.g., bait and tackle shop owners, fishing boat captains, harbormasters, shellfish officers, etc.) and various municipalities within the region, information regarding the commercial and recreational usage of the Bay was compiled.

A series of tables and maps were used to synthesize the usage information and provide the basis for general descriptions of fishing activities for this section of the DEIR and for Sections 6.2 (Commercial and Recreational Harvesting of Shellfish) and 6.3 (Commercial and Recreational Harvesting of Lobsters). The original report (Maguire 2002b) discusses the details and limitations of the survey methods employed, and a list of fish and invertebrate resources described by respondents (Appendix V).

6.1.1 Recreational Usage

Recreational users of Buzzards Bay include the following: shore-based recreational anglers and shellfish gatherers, vessel-based anglers, recreational potters, and participants in charter vessel excursions. Recreational finfishermen compose a diverse group of people originating from municipalities surrounding the Bay and from other areas of New England, New York, New Jersey and further afield. Buzzards Bay supports a highly developed recreational fishery through numerous marinas, launch sites, bait and tackle shops, and charter boat operations.

Recreational fishing is primarily focused in the shallower waters of Buzzards Bay (twenty meters depth or less). The highest concentration of recreational fishing proximal to the candidate disposal sites occurs within the shallow waters around Cleveland Ledge and extends north to the entrance to the Cape Cod Canal. Specialized fisheries, including scup and exotic species such as bonito (*Sarda sarda*), false albacore (*Euthynnus alletteratus*), and Spanish mackerel *Scomberomorus maculatus*), are concentrated along the eastern margin of Buzzards Bay from West Falmouth north to the canal.

Recreational anglers follow distinct patterns of usage based on season, interest and access. In general, anglers focus on access to “structure”, (e.g., submerged rocks, shoals and holes) that is believed to appeal to various or particular types of fish. For this reason, the center of the Bay, which is a relatively flat, featureless area, is of relatively low interest to anglers. Recreational anglers perceive the center of the Bay as an area dominated by conch pots (Figure 6-1). Individual anglers that were interviewed had strong preferences for certain locations, such as the flats near Cleveland Ledge and areas adjacent to the entrance to the Cape Cod Canal, for fluke and flounder (Maguire 2002b). Most anglers agreed that the presence of a variety of habitats and the strong currents flowing into and out of the canal created ideal conditions for angling for the

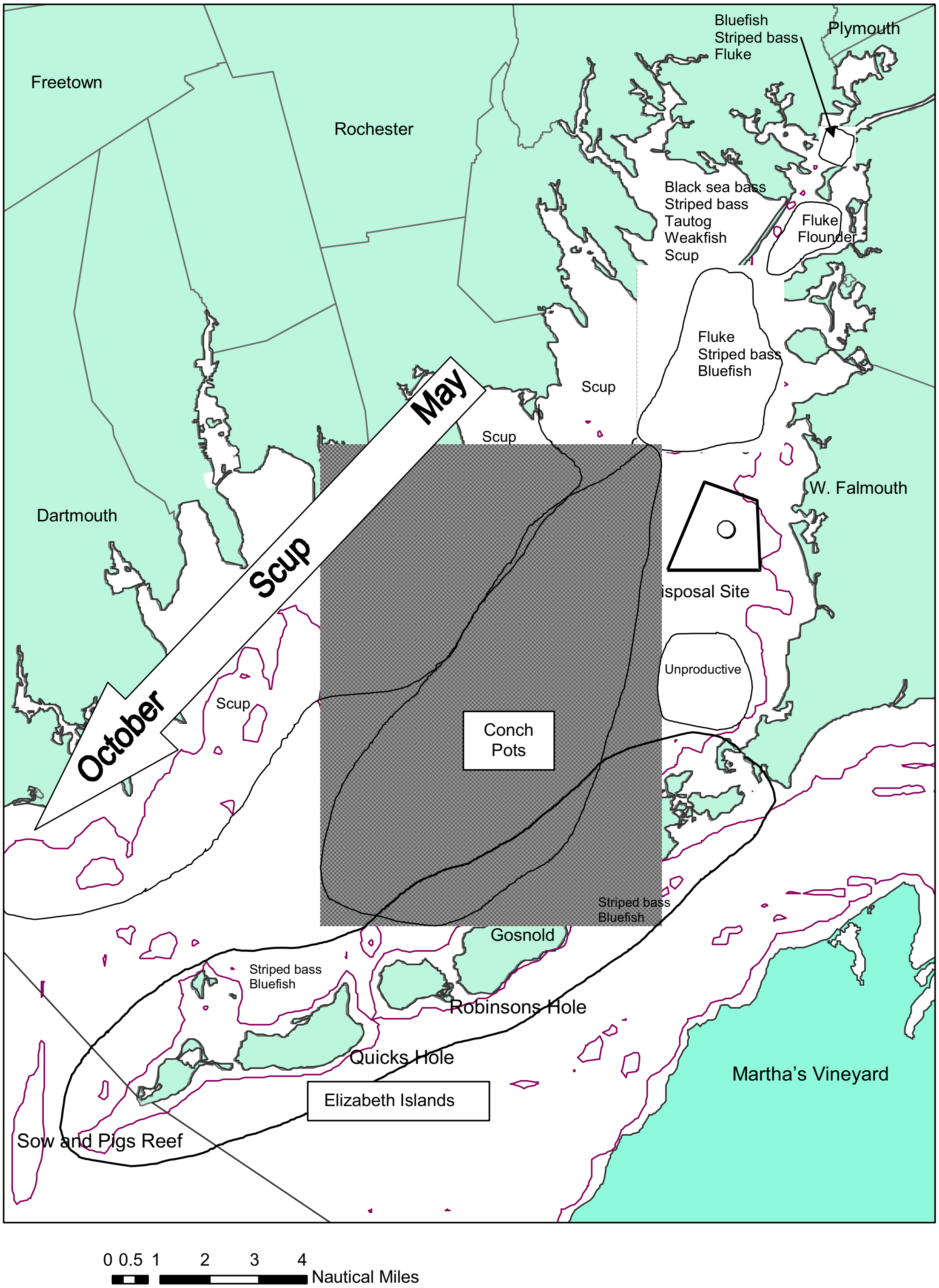


Figure 6-1. Usage patterns described by recreational anglers.

following species: scup, striped bass, bluefish, tautog, weakfish, black sea bass and fluke. The southern margin of this intensively used area was consistently described as Cleveland Ledge. Although anglers clearly fish the area surrounding the candidate disposal sites, it was not described as a preferred area.

Charter boat captains described similar usage patterns for recreational fishing but indicated that their preferred usage was around the candidate disposal sites (Figure 6-2). Most of the charter activities focus on scup and tautog angling. The structure at the northern margin of the CLDS is apparently a strong attraction for these species. The captains indicated a more limited area for commercial conch potting and a more generalized area of sea bass potting but concurred that the center of the Bay was usually less productive for them than the margins.

Proprietors of bait and tackle shops provided some of the greatest detail in describing recreational fishing activities, especially for scup. Bait and tackle proprietors and charter boat captains indicated that scup spawn south of Marion and that juveniles recruit to the area south of Mattapoisett. Both of these areas lie adjacent to Falmouth town waters and are north of the candidate disposal sites (Figure 6-3).

6.1.1.1 Recreational Boat Fishing

The largest recreational fishing group is based on pleasure boats moored and trailed from the various launch sites, harbors, and marinas around the Bay. It is estimated that at least 100,000 people fish in Buzzards Bay each year. The estimated number of motor vessels in the Bay is in excess of 25,000, with an additional 10,000 to 15,000 brought in via trailer annually. A substantial proportion of these pleasure vessels are used for recreational fishing, for at least part of the boating season. With two to three anglers per boat, the number of active recreational boaters who are fishing in the Bay may be as much as 50,000 to 75,000. While these estimates are only based on interviews with experienced respondents, the numbers clearly dwarf any other usage type. Estimates of the number of people who use the Bay for recreational fishing are difficult to pinpoint, as licensing is not required for saltwater recreational fishing in Massachusetts. The exception to this is for recreational shellfishing licensing that includes a state permit and a local permit managed by and restricted to town-level administration.

Six Pack Charters

From the recreational fishing perspective, a six-pack charter or “six-packer” refers to the smallest scale charter operations in the Bay. It involves boats eighteen to twenty-four feet in length with “six” referring to the maximum number of passengers. It is primarily a catch-and-release fishery focused on sport rather than subsistence fishing. At the time the Competing Site Use Assessment was conducted, there were approximately twelve six-pack charter operators working in the Bay, doing an average of 50 trips per season with two to four anglers per trip.

Striped bass and bluefish are the key species targeted by six-packers. It is estimated that there are about twelve six-pack charter operators who fish the Elizabeth Islands and beyond intensively, and to a lesser extent the Bay. These charters primarily focus on pursuing species found in the holes and structures that border the Elizabeth Islands, but may follow striped bass

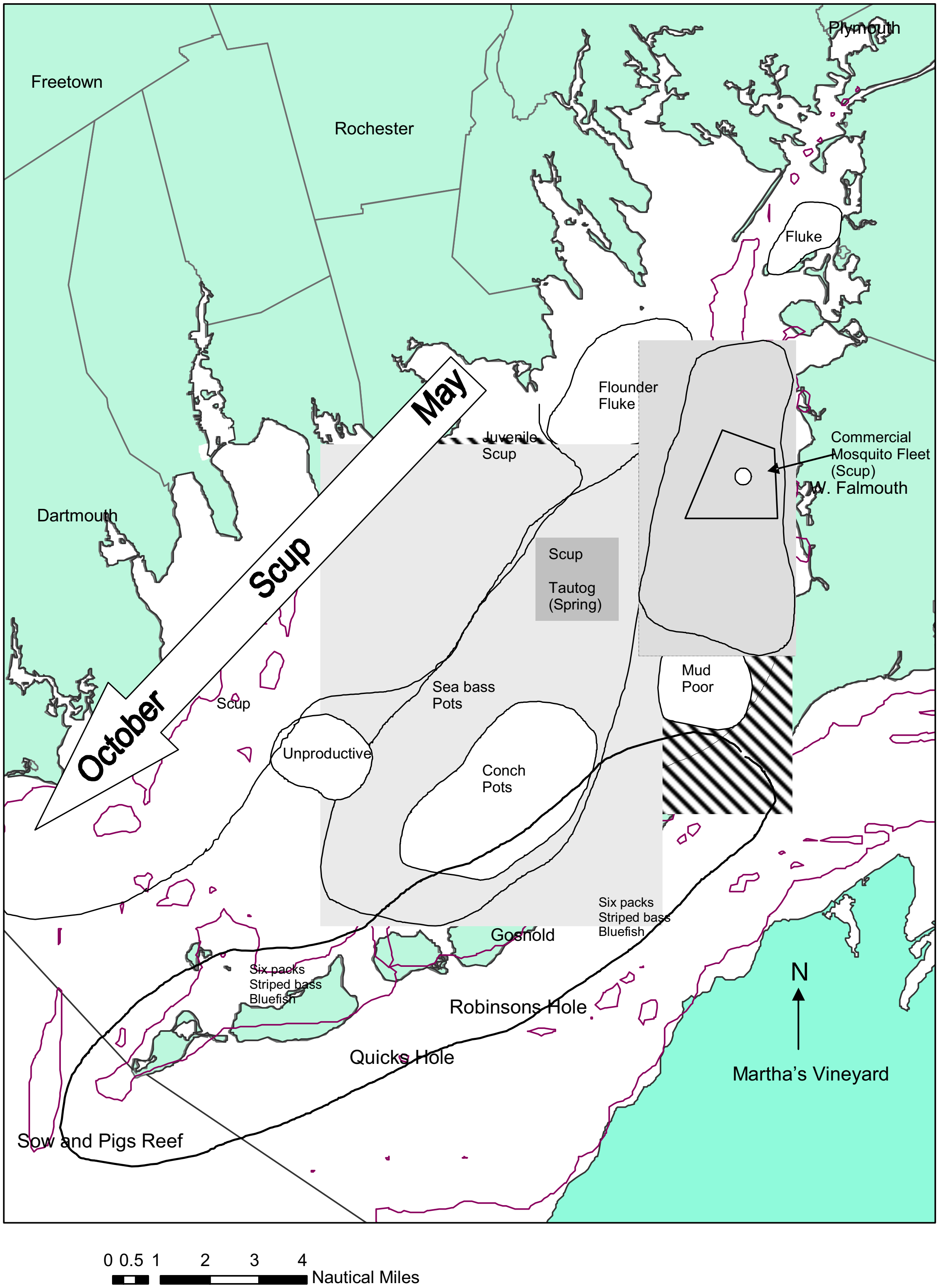


Figure 6-2. Usage patterns described by recreational charters.

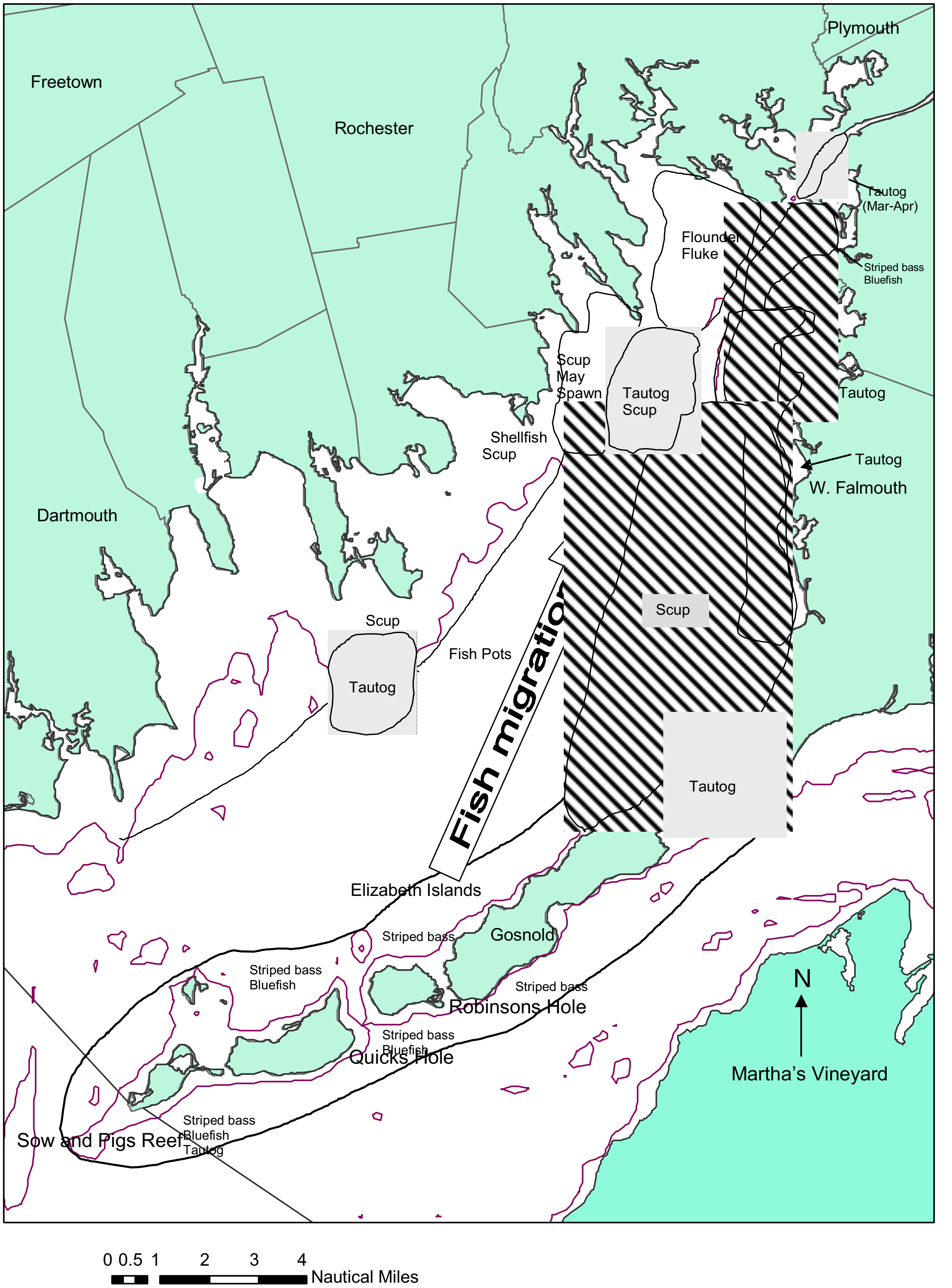


Figure 6-3. Usage patterns described by bait and tackle shop proprietors.

and bluefish into the Bay. Six-pack charters generally trailer their boats and use launch sites convenient to their destination.

A more-specialized charter operation targets additional summer “exotic” pelagic species, such as bonito, false albacore, and Spanish mackerel. These fishermen use fly rods or light tackle, and charters usually accommodate only one or two passengers and the charter operator (to permit room for fly casting). For these fishermen, the quality of the sport of fishing (in terms of the size of the catch and the fight involved in landing these species) is the most important characteristic of a successful trip. The target area for this fishery is from West Falmouth north to the Cape Cod Canal. Boats are frequently trailered and because of this, the launch location is determined by the accessibility of launch sites in this area (e.g., West Falmouth, North Falmouth, Cataumet, and Pocasset). This specialized fishery usually operates in the Bay between mid-August to September, when the target species are present. From May to June, they occasionally also target striped bass in the West Falmouth area.

Head Boats

Head boats (a.k.a. “party boats”) are larger-scale charter operators that cater to recreational fishermen. Both boat size (averaging sixty feet) and client capacity (25 to 100 people) is significantly greater than for six-packers. Head boats are based in the water often operating from home port marinas. The charter season lasts about six months, with the height of activity falling during the warmer summer months. Head boat charters primarily tend to target scup, followed by black sea bass, tautog, and fluke. The focus of this operation is similar to commercial fishermen, with an emphasis on profit rather than the sheer sport of fishing more frequently found amongst six-packers and private boat fishermen. Head boat operators are likely to pursue licensed commercial fishing activities within, but not excluded to, the Bay outside of the charter season. The charter season is focused between May and September, with lighter activity from March to May and October to December, depending on the target species.

6.1.1.2 Recreational Shore Fishing

Shore fishing in Buzzards Bay is largely limited to public access right-of-ways. Shore fishermen tend to view their catch as sport, a source of food for their households, or both. The primary species targeted by shore anglers is similar to recreational boat fishermen and consists of striped bass, bluefish, scup, tautog, and fluke.

6.1.1.3 Seasonality of Recreational Species

Seasonal harvesting for scup, sea bass, striped bass, bluefish, tautog, fluke, and summer exotics (i.e., bonito, false albacore, and Spanish mackerel) were evaluated. Of those species that are regulated, about half of them have a year-round open season. However, even though the legal recreational season allows for year-round harvesting, the actual period during which recreational users pursue these species is generally concentrated in the warmer months from April to November, with increased intensity between May and October and the highest intensity of activity for most species focused in July. Some species have a bimodal pattern of increased activity and, therefore, may be targeted during two separate times of the year. An example is tautog, which is reported to have two seasons, one on either end of the colder months of April/May and again during September/October (Maguire 2002b).

6.1.1.4 Value of Recreational Fishing

The value of specific species to recreational boat fishermen in the Bay can vary depending on a number of factors. Value may be applied by individual users to specific species of fish in terms of the following factors: 1) the effort (i.e., “sport”) involved in landing a particular species, 2) the size or quantity of catch, 3) the perceived value as a contribution to personal household level food supply, and/or 4) a combination of the above.

6.1.1.5 Usage of Candidate Sites for Recreational Fishing

Recreational anglers seek areas with the most heterogeneous structure. The candidate sites and their immediate vicinity are visited by private recreational anglers with their own craft much less frequently than the structurally complex areas along the perimeter shorelines of the Bay and the entrance to the Cape Cod Canal. However, recreational anglers generally frequent areas that are less than about 20 meters deep, and both candidate sites have this attribute. In fact, both candidate sites and their vicinity are frequented by charter and “mosquito fleet” fishing boats (see Section 6.1.2.1), which bring anglers to these waters in pursuit of scup and tautog. As such, both sites have value to the recreational angler pursuing these species with either their own craft or a chartered vessel. In contrast to candidate site 1, the bottom habitat of candidate site 2 exhibits more structural diversity due to its steeper slope, mosaic of sediment types, and proximity to structure (e.g., Gifford Ledge). This greater habitat complexity may serve to make candidate site 2 more attractive to the recreational angler as a productive fishing ground compared to candidate site 1.

6.1.2 Commercial Usage

Commercial fishermen are those people using the waters of Buzzards Bay for commercial fishing purposes (i.e., to earn a living). Since it is their primary means of achieving a household income, they maintain an interest in maximizing their harvest throughout the year. Within Buzzards Bay, these users primarily include vessel-based fish potters. A small number of commercial fishermen also may use angling equipment to obtain certain species (e.g., various scombrids - mackerel, bonito, tuna). An aging population of fishermen who come from families where multiple generations have been engaged in the industry characterizes the commercial fishing industry in Buzzards Bay.

While there is ample historical evidence of substantial finfish landings, the primary commercial fisheries in the Bay are now lobster and shellfish (Howes and Goehringer 1996). Commercial finfish trawling has been banned in Buzzards Bay since the late 1800’s (Howes and Goehringer 1996). However, this ban does not include fish potting and angling. Trawling and dragging have therefore been excluded from Buzzards Bay for over a century (with the exception of scallop and quahog dredging). The majority of commercial fishermen who homeport in the Bay fish offshore for lobster, scallops and groundfish in the coastal waters of Massachusetts and Georges Bank (New Bedford fleet). Declines in catch and regulatory restrictions have created significant contraction in the offshore fleet. High/low cycles in many fisheries have been documented on the Atlantic Coast and have had a significant impact on the commercial fishing industry (McHugh 1993).

6.1.2.1 Location of Commercial Fishing in Buzzards Bay

Commercial fishing usage patterns in Buzzards Bay are individualized and specific. Because the majority of this activity in the Bay utilizes fixed gear (fish pots), usage areas are well defined. The central area of the Bay is used extensively for conch potting, with some specific areas considered productive for lobster. Other deeper, muddy areas are considered unproductive. One area of central Buzzards Bay, known as “5 acres,” is a rocky shoal considered productive for scup. It is located on the southwest corner of candidate site 1. The northern perimeter areas of the bay, west and east, are fished in summer with pots for scup and black sea bass. Angling for fluke and scup overlaps the potting areas and includes the grounds east of the navigational channel near the entrance to the canal (Figure 6-4).

Commercial Anglers

There is a diverse group of fishermen with commercial angling licenses. Boat sizes range from sixteen to fifty feet. Hook-and-line set-ups are targeted largely at the striped bass fishery. The actual numbers are difficult to pinpoint; however, it is estimated to encompass about 10 boats that seriously pursue the species, and fewer than one-hundred who fish less intensively. This group was described as a diverse group of people pulling commercial licenses, with only a small fraction relying on them intensively. This is a quota-based fishery, with the season beginning the first Monday after the Fourth of July weekend. It runs in four-week cycles, with three consecutive weeks open for fishing followed by a one-week closure. This cycle is repeated until the quota for the whole state is filled (802,000 pounds for 2000 and 2001). This fishery mainly targets the Elizabeth Islands, south of the candidate sites.

Mosquito Fleet

The so-called “mosquito fleet” originates from Fairhaven and New Bedford Harbors. It is a hook-and-line fishery targeted on scup and black sea bass. For a period of two to three weeks beginning in early to mid-May, 12 to 30 boats can be found in and around the candidate disposal sites, using mid-size boats between 18 and 24 feet in length with approximately four people per boat. Historically, this group of fishermen has pursued all species of fish, but has focused on scup more recently. The mosquito fleet pursues these species as a source of food to be sold in smaller informal markets in the Fairhaven and New Bedford area, but the majority of the catch is shipped to the New York market.

6.1.2.2 Seasonality of Commercial Finfish Harvest

Commercial finfish (e.g., sea bass, scup, conch, striped bass, fluke, tautog) are pursued between April and mid-November, with the highest abundance and harvesting activities during the warmer summer months. The patterns of commercial use of Buzzards Bay are consistent across usage type. The western and eastern margins of the Bay are the haven of scup anglers and a growing group of light tackle specialists targeting summer pelagic species. Another strongly focused fishery targets the water movements and structure present around the Elizabeth Islands on the southern margin of Buzzards Bay, well to the south of the candidate disposal sites. This fishery specializes in striped bass and bluefish.

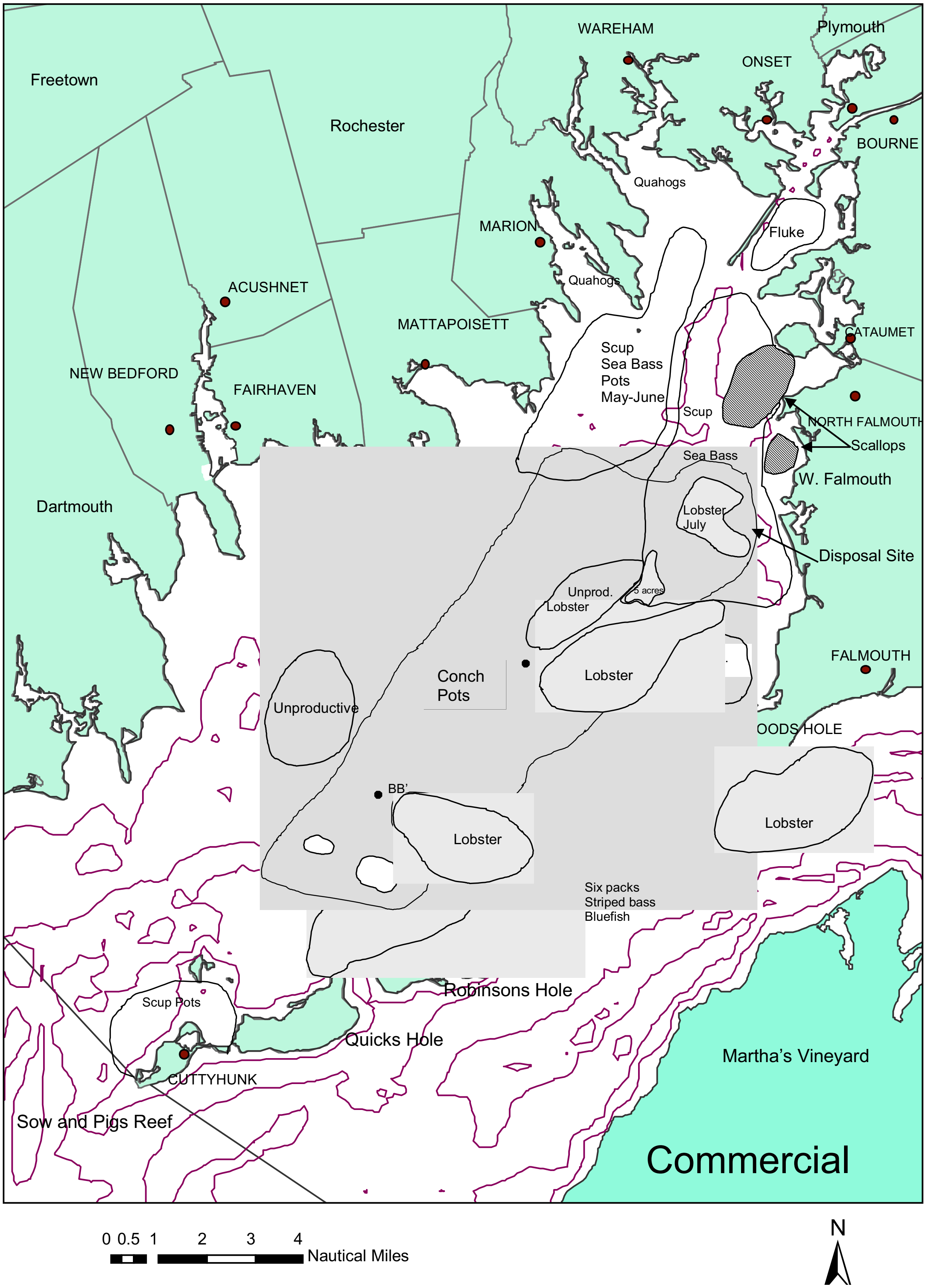


Figure 6-4. Usage patterns described by commercial fishermen.

6.1.2.3 Usage of Candidate Sites for Commercial Fishing

For the same reason recreational anglers seek areas with the most heterogeneous structure, so too do commercial fisherman, as benthic complexity inside Buzzards Bay usually translates to higher fish abundance for commercial potters who largely pursue scup and black sea bass in the vicinity of the candidate disposal sites. As discussed previously, the bottom habitat of candidate site 2 exhibits more structural diversity due to its steeper slope, mosaic of sediment types, proximity to structure (e.g. Gifford Ledge), and the fact that it lies closer to nearby eelgrass habitat. Therefore, the benthic complexity of candidate site 2 may render this site more attractive as a productive commercial fishing ground than candidate site 1.

6.2 Commercial and Recreational Harvesting of Shellfish

Maguire (2002b) provided the baseline information for characterizing the commercial and recreational shellfishing activities in Buzzards Bay that might conflict with usage of candidate site 1 or 2 for dredged material disposal. In general, the margins of the Bay are the most highly used areas for both commercial and recreational bivalve harvest. Limited areas in the deeper, central parts of the Bay are used for scallop and some quahog dredging. The central region of Buzzards Bay also is used for conch pot sets.

Maguire (2002b) also evaluated the seasonal nature of use for both recreational and commercial users of the Bay to identify potential conflicts in usage related to disposal activities. The results of their investigation revealed that although some shellfish types can be legally pursued year round, it appears to be primarily a fall, winter, and spring pursuit.

6.2.1 Recreational Shellfishing

Recreational shellfishermen are those people using the waters of Buzzards Bay for non-commercial shellfishing. They are typically shore-based shellfish gatherers that use bullraking or tonging techniques, but may also include some vessel-based potters. Recreational harvesting of shellfish reaches peak activity during the warmer summer months (Maguire 2002b). Soft-shelled clams are the primary focus of the recreational shellfisherman, with most beds concentrated within the shallow nearshore embayments around the Bay's perimeter (Howes and Goehringer 1996). The recreational harvest of shellfish is regulated on the municipal level. Although varying among municipalities, the regulations typically specify catch limits, identify allowable harvesting equipment, and establish seasons. Municipal regulations may be subject to additional closures set by the Commonwealth of Massachusetts, based on water quality issues.

The recreational shellfish beds closest to the candidate disposal sites are located along the shore in Falmouth, in the vicinity of Chappaquoit and Black Beaches. Neither candidate disposal site was identified in the competing site use assessment as coinciding with known or perceived recreational shellfishing areas (Figure 6-5).

6.2.2 Commercial Shellfishing

At the present time, the primary commercial fisheries in Buzzards Bay are lobster and shellfish (Howes and Goehringer 1996). Commercial shellfishermen include those people using the waters of Buzzards Bay for commercial fishing purposes and harvest shellfish as an occupation. Like the commercial finfisherman, an aging population of individuals from families where shellfishing has historically been a multi-generational pursuit characterizes the commercial

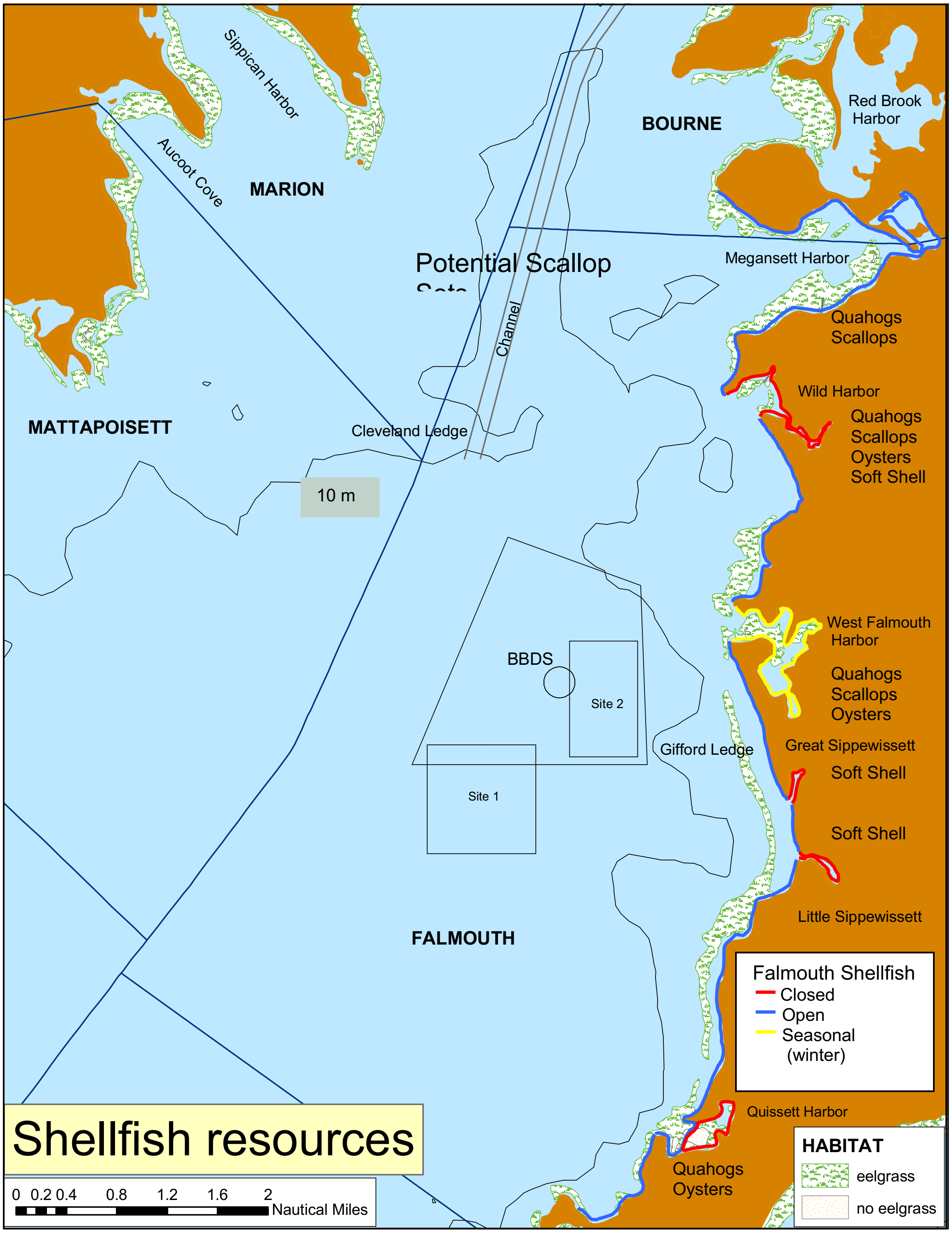


Figure 6-5. Shellfish usage areas near the proposed disposal sites.

shellfishing industry in Buzzards Bay. Among the individuals interviewed by Maguire (2002b), the number of years working in the industry ranged from twenty-five to fifty. These individuals typically include vessel-based potters and shellfish gatherers.

Shellfish licensing and management is administered at the municipal level and restricted to town boundaries. However, many coastal embayments contain large exclusion areas due to elevated levels of coliform bacteria derived from runoff and wastewater inputs. Maguire (2002b) identified the patterns of use of Buzzards Bay for shellfishing. Within and proximal to the candidate disposal sites, commercial shellfishing activities consist of the following: the central waters of the Bay support a pot fishery based on the whelk (also known as conch); the shallow waters around Cleveland Ledge support fluctuating stocks of scallops; and shoreward from the candidate sites, the shoreline embayments are the most important quahog areas of Buzzards Bay.

6.2.2.1 Commercial Whelk (Conch) Harvest

Whelks are gastropod mollusks that are used in a number of regional cuisines, including Italian (*scungilli*) and Portuguese. The central area of the Bay is used extensively for conch potting. Conch is pursued by commercial potters, many of whom also pursue sea bass and scup utilizing the same gear (pots or traps). Each of these species requires a separate permit, and many fish potters pursue all three species. In Massachusetts, the majority of fish potting occurs south of the Cape, including Buzzards Bay. The vast majority of individuals captured with pots are channeled whelk (*Busycon canaliculatum*). The similar knobbed whelk (*B. carica*) does not pot well (M. Camisa, personal communication). Conch landings dominate the fish potting activities in Buzzards Bay, Vineyard Sound, and Rhode Island Sound. In 1999, 900,000 pounds of conch were landed along with 600,000 lbs of sea bass from Management Area 14 (which is composed of Buzzards Bay waters out to the Territorial Line and, therefore, includes the area of the candidate disposal sites). Many of the individuals engaged in fish potting combine their efforts with lobstering, alternating seasons and/or areas between the two activities. In general, the boats used for fish potting are similar in size to those used for lobstering. The deeper areas along the central axis of Buzzards Bay, which extends northeastward to include the area of the candidate disposal sites, were identified by commercial fisherman during the competing site use assessment as a potential conch potting area. However, no distinction was made as to whether one or the other candidate disposal site was as a more valuable or productive potential conch set (Figure 6-4).

6.2.2.2 Seasonality of Commercial Conch Harvest

Conch is harvestable between mid-April and mid-December, with the highest levels of activity between August and November. This contrasts with the commercial harvest of lobster (Refer to Section 6.3), which is pursued during all but the months with the coldest water temperatures (e.g., January, February, March).

6.2.2.3 Commercial Bivalve Mollusk Harvest

The majority of shellfishing activity focuses on the harvest of bivalve mollusks from shallow, protected waters in Buzzards Bay. For instance, there are no extensive areas in the *open* Bay where bullraking or tonging for quahogs is pursued commercially (unlike Narragansett Bay). The exception to this is bay scallop harvesting. Bay scallop sets are most common in the deeper waters around Cleveland Ledge, with large fluctuations in the location and intensity of sets from year to year. Most respondents interviewed for the competing site use assessment indicated that the location and quality of scallop sets was variable from year to year and that this determined their effort and fishing locations. However, the scallop set is generally located at the northern end of Cleveland Ledge and extends northward to adjacent areas. Bay scallop recruitment is known to be improved by the presence of eelgrass beds that have fluctuated in location and density in Buzzards Bay (Costa 1988). The Towns of Mattapoisett, Marion, Bourne, and Falmouth share the scallop beds, but license activities only within their own waters.

Most shallow coves and embayments in the northern area are fished commercially for quahogs. Oysters, mussels, and soft-shelled clams also are harvested from various harbors and tidal/subtidal flats around the Bay. Because the candidate disposal sites are located in Falmouth town waters, this area was the focus of the mapping activity conducted during the competing site use assessment conducted by Maguire (2002b) and summarized in Figure 6-5. The majority of the deeper waters of the Bay to the north of the candidate disposal sites are regarded as potential bay scallop sets. To the east of the candidate disposal sites, the shallower waters along the shoreline support the harvest of quahogs, scallops, oysters, and soft shell clams. These areas include the flats from Crow Point south of Wild Harbor, south to Little Island; then south again from Chappaquoit Point to Woods Hole. However, Wild Harbor, Great Sippewisset and Little Sippewisset Marshes, and Quissett Harbor are closed to shellfishing, and West Falmouth Harbor is open only during winter months. The closure lines depicted in the Figure 6-5 are based on expected water quality results from each harbor.

6.2.2.4 Seasonality of Commercial Bivalve Mollusk Harvest

With the exception of quahogs, which are harvested year round, the commercial harvesting of bivalve mollusks occurs primarily during fall, winter, and spring months, with low activity levels in summer due to closures. This is a reversal of the recreational angling pattern where the greatest activity levels occur during the spring, summer, and fall. However, some shellfishermen will work year round, including the summer, if areas are open to commercial harvests. Certain harbor areas are closed by the local shellfish constables and DMF under the U.S. Food and Drug Administration because of the risk of transient releases of sewage by boaters. Although shellfishing is primarily managed at the municipal level, local shellfish constables follow certain regulations mandated by the Commonwealth. Commonwealth regulations for some shellfish types dictate the maximum allowable harvest season. The bay scallop fishery, in particular, is presently subject to Commonwealth-mandated harvesting restrictions. The maximum allowable bay scallop-harvesting season for any township is from October 1 to March 31. However, because shellfishing is managed at the municipal level, town administrators may choose to reduce the season, as needed, depending on the relative health of specific shellfish types and any public health concerns for each shellfish type or harvesting area. In rare circumstance, towns may petition the Commonwealth to increase a harvesting season.

The complexity and number of restrictions found in local shellfish regulations varies widely among townships. For example, Mattapoisett’s shellfish regulations consist of a single page, while Marion’s cover ten pages. Area closures are generally determined by local marine resource managers (e.g., shellfish officers), based on information about water quality, resource health, and species propagation produced at the local and/or Commonwealth level (e.g., DMF). Resource managers identify conditions that can result in contaminated water. Both runoff and discharges of untreated sewage occur more frequently during the rainiest seasons. Septic system failures occur more frequently as usage increases during the summer tourist season. These conditions may result in potentially unhealthy concentrations of fecal coliform and other pollutants in both surface waters and shellfish.

Closures in Falmouth town waters occur more frequently during the summer months, when human population pressures increase due to the seasonal influx of tourists and vacationers. Except during closures, quahogs, soft-shell clams, and mussels can be harvested year-round in Falmouth town waters, while scallop and oyster seasons are open only from October 1st through March 31st.

The Towns of Mattapoisett, Marion, Wareham, and Bourne are also located in the vicinity of the candidate disposal sites and have regulated shellfish harvesting seasons. These towns are considered here because their waters lie adjacent to Falmouth waters. Except for Mattapoisett, scallop harvesting in these towns appears to follow the Commonwealth's mandated season (October 1 through March 31). In Mattapoisett, tighter restrictions are placed on the season, which does not open until November 1. Like Falmouth, quahogs are harvestable year round in all of these towns. Softshell clam harvesting seasons are more variable, with Mattapoisett and Wareham having the most restrictive seasons (September 15 to May 30), followed by Marion. There appears to be no softshell clam harvesting permitted during the peak summer months in Mattapoisett, Marion, and Wareham. Bourne appears to be the only town with year-round softshell clam harvesting. The length of the oyster season, running approximately from October to April, showed the most variability among the towns. The longest oyster harvesting season (eight months) occurs in Marion and Bourne and the shortest in Mattapoisett (six months).

There is a history of the harvesting bay scallops, and, to a lesser extent, quahogs in the deeper waters in and around Cleveland Ledge (Paul Montague, personal communication). Although the Marion shellfish officer reported a harvest of about 200 bushels per year for the last five years, this represents a significant decline from ten years ago, when an annual harvest of one thousand bushels per was typical.

6.2.3 Value of Shellfishing Activity

Historically, there have strong landings of oysters and bay scallops in Buzzards Bay. After an almost total collapse in the late 1980s, landings have partly recovered in recent years. Bay scallops are particularly prone to wide fluctuations in abundance because they spawn only once each year and have a relatively short life cycle (Howes and Goehringer 1996). Quahogs currently are the shellfish with the highest landings in the Bay, and these landings have been fairly stable in recent years. Falmouth reported that the value of commercial and recreational shellfish landings from all town waters exceeded $2,200,000 in 1999. In addition to the revenue from commercial shellfish landings in the community, the Town of Falmouth received over $68,000 of revenue from commercial and recreational license fees (Maguire 2002b). A general decline in shellfishing has been reported by various harbormasters of the region. The loss of eelgrass habitat has contributed to the decline in the bay scallop fishery (Costa 1988). The Marion harbormaster reported a decline from 38 shellfishermen seven years ago to only a single individual in 2001 (Maguire 2002b).

6.2.4 Value of Candidate Sites 1 and 2 as Shellfishing Grounds

The deeper, muddy areas of the former CLDS (essentially the areas of the candidate sites 1 and 2) appear to be less valuable as potential scallop sets than the flats located within and to the north of the former CLDS. The deeper benthic habitats of the two candidate disposal sites do not support developed oyster or blue mussel beds and, therefore, these species are not harvested from this area. Both candidate sites contain deeper, muddy bottom fringed by shallower areas with coarser sediments. The muddy areas likely support conch, quahog, and surf clams; the latter remain an under-exploited resource within Buzzards Bay (Howes and Goehringer 1996). The results of the competing site use assessment (Maguire 2002b) revealed that usage areas identified as conch potting grounds overlap the boundaries of the candidate disposal sites. However, no bivalve mollusk shellfish usage areas overlapping the candidate disposal sites were identified in the report. To address concerns about potential impacts to adjacent shellfish resources, it appears that a disposal site located as far south from Cleveland Ledge and as far west from the Falmouth shoreline as practicable is most desirable. This suggests that while the characteristics of candidate site 1 are not much different from candidate site 2, the location of candidate site 1 helps make it more desirable as a designated disposal site.

6.3 Commercial and Recreational Harvesting of Lobsters

Catch rates of lobster from traps are the result of a wide number of variables: local abundance, effort, size at maturity, water temperature, bait type, soak time of gear, and the number of fishermen working an area. The local abundance of lobsters is also dependent on two variables of significance in Buzzards Bay: recruitment of young lobsters from larvae that settle in an area and migration of young and adults into an area (B. Estrella, personal communication). Buzzards Bay is not generally as productive a lobster fishery as many other coastal areas of Massachusetts (e.g. Boston Harbor and Massachusetts Bay), but it may have significance as a source of larvae due to relatively early hatching in its warmer waters (Collings et al. 1981). The warmer water means that females mature sooner and at a smaller size. As a result, many of them can generate eggs at a sub-legal size (i.e., before they obtain the size at which they can be legally harvested). These "eggers" ultimately may enhance recruitment of legal-size lobster to the fishery in Buzzards Bay and may also supply larvae to other areas via dispersal through the Cape Cod Canal. The strong recruitment of newly molted lobsters into legal (harvestable) size also coincides with intense fishing effort in the warmer months and again in the fall after each molt cycle in Buzzards Bay. Catch rates drop off when the production from each molt is exhausted, resulting in a "recruitment-dependent" fishery (B. Estrella, personal communication). Other inshore areas may see greater migration of adolescents and adults into suitable habitat or be better able to retain adults in colder months due to an abundance of high quality habitat.

The competing site use assessment provided the baseline information for characterizing the commercial and recreational harvesting of lobsters in Buzzards Bay (Maguire 2002b). This information was obtained in to ascertain whether or not lobster harvesting might conflict with usage of one of the candidate sites. The information was solicited through interviews and surveys of recreational and commercial lobsterman, regulators, and others familiar with the lobster industry (e.g., harbormasters).

Recreational lobstermen are those using the waters of Buzzards Bay for the non-commercial harvest of lobster. Recreational lobstermen are motivated by the pleasure derived from catching and eating lobster. For some, this catch may be a means to augment household food supply. These users include vessel and shore-based lobster potters, and Self-Contained Underwater Breathing Apparatus (SCUBA) divers.

Commercial lobstermen include those people using the waters of Buzzards Bay for commercial lobstering purposes. Commercial lobstermen are motivated to fish as a means to earn a living. For many commercial lobstermen, lobster harvesting is their primary occupation and as such, they aim to maximize their harvest throughout the year whenever possible. These users are largely composed of vessel-based potters, although a small number of commercial lobstermen use SCUBA equipment to obtain their catch.

6.3.1 Recreational Lobstering

Recreational lobstering is a popular pastime in Buzzards Bay. A non-commercial license costs $40 per year and allows the holder to harvest lobster anywhere in Commonwealth waters using either SCUBA gear or a maximum of 10 traps (or a combination of both). The catch may not be sold. Recreational lobstermen are asked to report on their license renewal application form the number of lobsters taken during the previous year, hours dived and number of traps fished (McBride and Hoopes 2000). In 1999, 11,633 licenses were issued. A total of 8,948 of the license holders (77%) reported fishing for a total of catch of 263,996 lobsters (about 2% of the commercial catch). Buzzards Bay commercial finfishermen account for somewhat less than 3% of the total commercial catch, but recreational lobstering in Buzzards Bay may represent a larger (or smaller) percentage of the Commonwealth-wide effort. The greatest recreational effort occurred very close to shore and was concentrated in the summer months (June, July, August, September). With the ten trap limit, mechanical pot haulers are not required and most traps are hauled by hand on boats that are used for other fishing or recreational uses. Recreational users focus their efforts in the warmer months of the year, with a much smaller number of stalwart fishermen making year-round trips. None of the areas within and proximal to the candidate disposal sites were identified by respondents as recreational lobster grounds (Maguire 2002b).

6.3.2 Commercial Lobstering

Like commercial finfishing, the commercial lobstering industry in Buzzards Bay is characterized by an aging population of fishermen who come from families where fishing has historically been a multi-generational pursuit. Lobstering has deep historical roots in Buzzards Bay, and many coastal lobster permits are still held by residents of local towns. However, the perception of local fishermen is that the commercial lobstering catch within the Bay has declined in recent years, causing many individuals to reduce their efforts or retire. The recent decline in the fishery has been attributed to various diseases acting to reduce the lobster population. The lowered catch has caused many younger fishermen to leave the industry because they cannot support their families on the limited income from fishing.

Lobster fishermen must report catch from management area(s) within which they harvest and abide by the rules set for those area(s). Buzzards Bay is located within Management Area 14 of the multi-state management plan (Figure 6-6). Management Area 14 consists of the waters of Buzzards Bay out to the Territorial Line and therefore includes the candidate disposal sites.

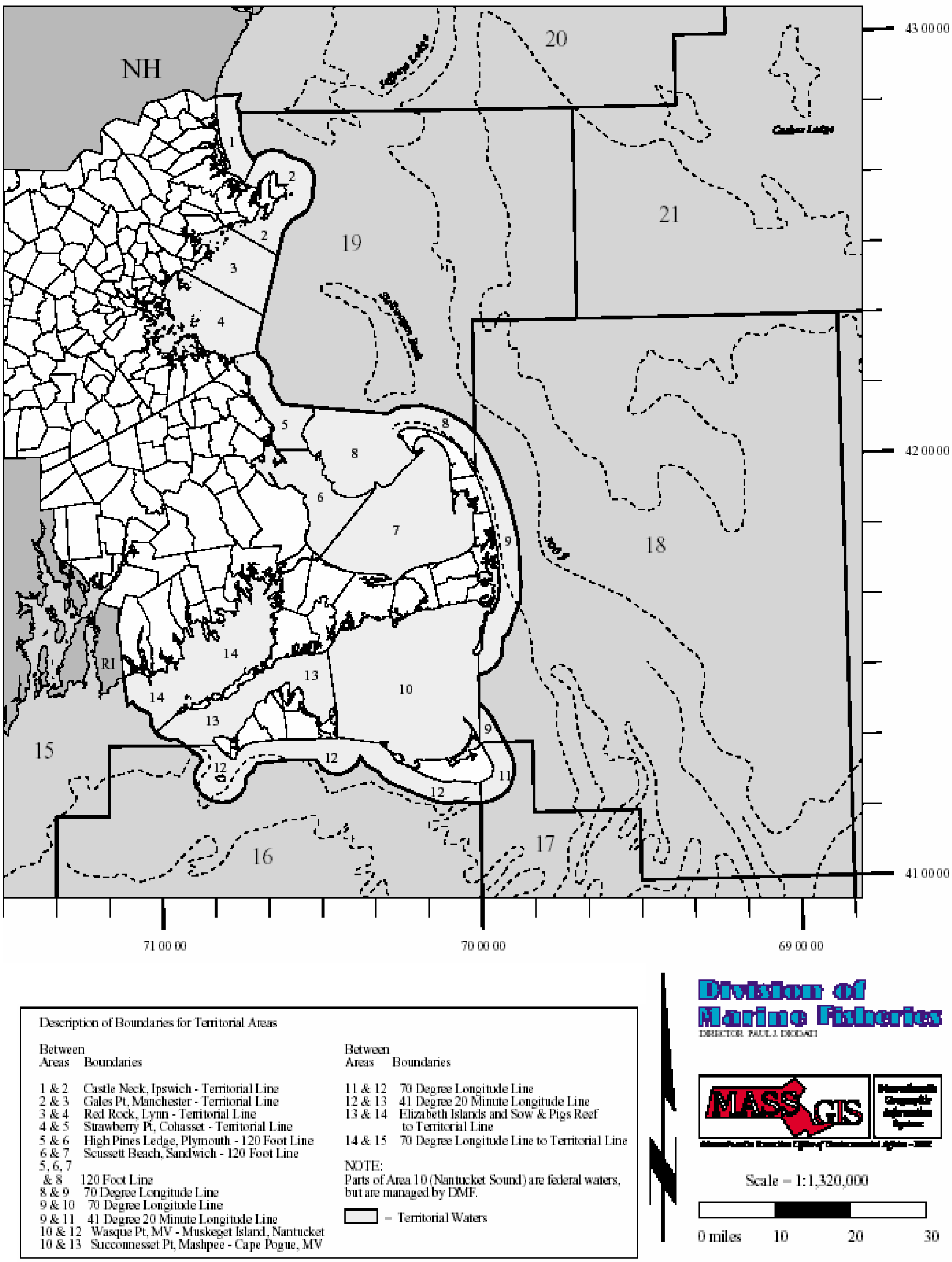


Figure 6-6. Statistical reporting map (lobster catch) showing territorial waters and outlying areas.

Catch landings for Management Area 14 represent the best estimate of American lobster harvest from Buzzards Bay.

Commercial lobstermen receive a detailed catch-report form with their license renewal application (McBride and Hoopes 2001). The report requests information on method of fishing, effort, pounds caught, areas fished, ports of landing and number and type of gear used. A partial picture of lobstering effort in Buzzards Bay can be drawn from these statistics. Management Area 14 (Buzzards Bay to the Territorial Line) is a statistical area for commercial lobstermen to report landings (Figure 6-6). However, the results for Area 14 do not necessarily report on effort solely within this Management Area, but they are a reasonable estimate of relative effort (B. Estrella, personal communication).

Fisheries statistics from Area 14 do not indicate a steep decline in effort, but low catch years of 1992 and 2000 coincide with the lowest number of fishermen pursuing commercial lobstering (94 in 2000 and 88 in 1992; Figure 6-7). The catch of 109,000 pounds in 2000 (the year prior to the interviews) was unusually low (less than half the catch in most other years) and may have contributed to additional fishermen leaving the industry in 2001. Area 14 estimates of CPUE are based on reported pounds per trap-haul per "set-over day" (a set-over day reflects the average time a trap is left in the water). The estimate for Buzzards Bay is generally below the average for Massachusetts waters, but is often comparable to seven or eight other statistical areas because the average CPUE in the Commonwealth is skewed upward by high CPUE in Boston Harbor and Massachusetts Bay (McBride and Hoopes 2001). The area within candidate site 1 was not identified by commercial lobsterman as coinciding with productive or harvested lobster grounds (Maguire 2002b). The area that includes candidate site 2, however, was identified as coinciding with productive or harvested lobster grounds, as were areas to the northwest within the former CLDS.

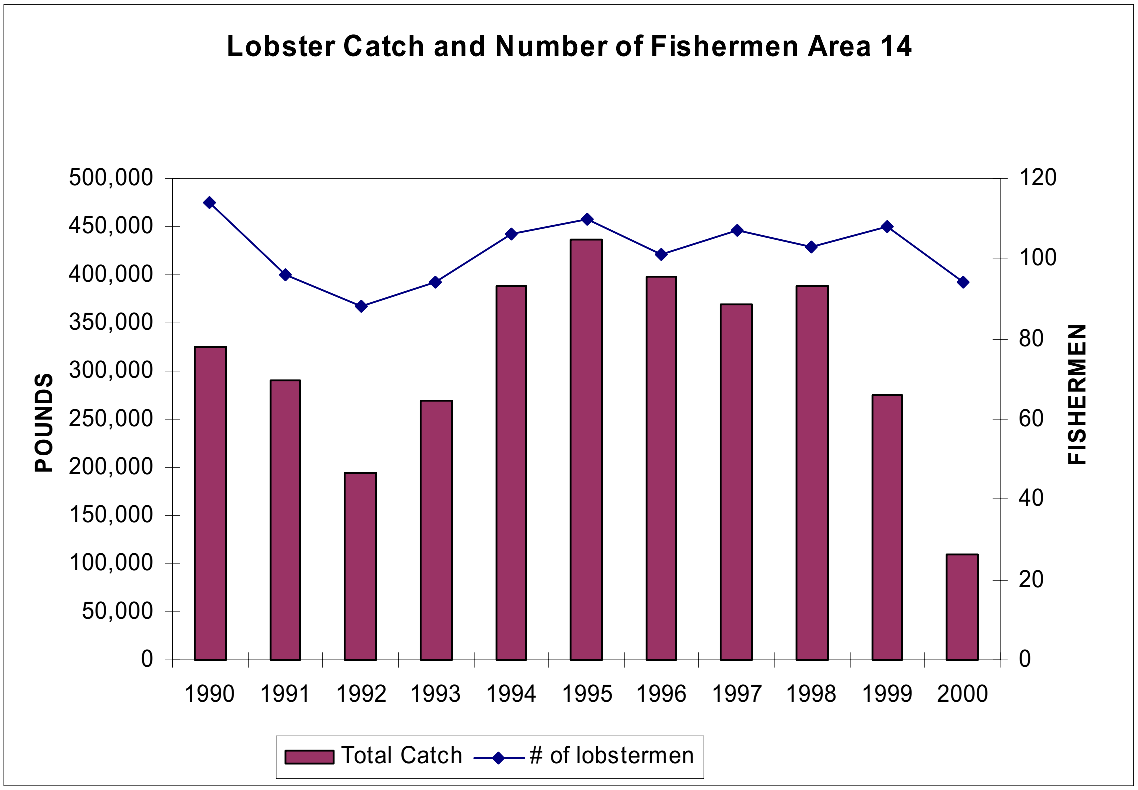
6.3.2.1 Seasonality of Commercial Lobster Harvest

Landing statistics suggest that the peak inshore lobster harvest in Massachusetts occurs between July and November (McBride and Hoopes 2001). Some commercial lobster fishermen that have multi-species permits (e.g., fish potting) may pursue a shorter lobster season. Several respondents to the competing site use assessment survey referred to peak efforts in Buzzards Bay in late spring and fall in relation to "runs" or post-molt recruitment.

6.3.2.2 Location of Commercial Lobstering in Buzzards Bay

Commercial fishing usage patterns are highly individualized and specific. Because the majority of commercial lobster fishing activity in Buzzards Bay utilizes fixed gear (pots), usage areas are well defined. The location information for commercial lobstering provided herein focuses on activities near the candidate disposal sites and does not include detailed information about commercial lobstering activity along the shorelines of Dartmouth, New Bedford, or Fairhaven.

Most respondents to the competing site use assessment survey indicated that a small number of older fishermen continued to work the waters around the candidate disposal sites, but it was believed that many had stopped fishing in the last two to three years. The number and distribution of fishermen reporting catch in Area 14 have stayed relatively constant over the last ten years, with the majority of individuals registered in Fairhaven, New Bedford and Westport.



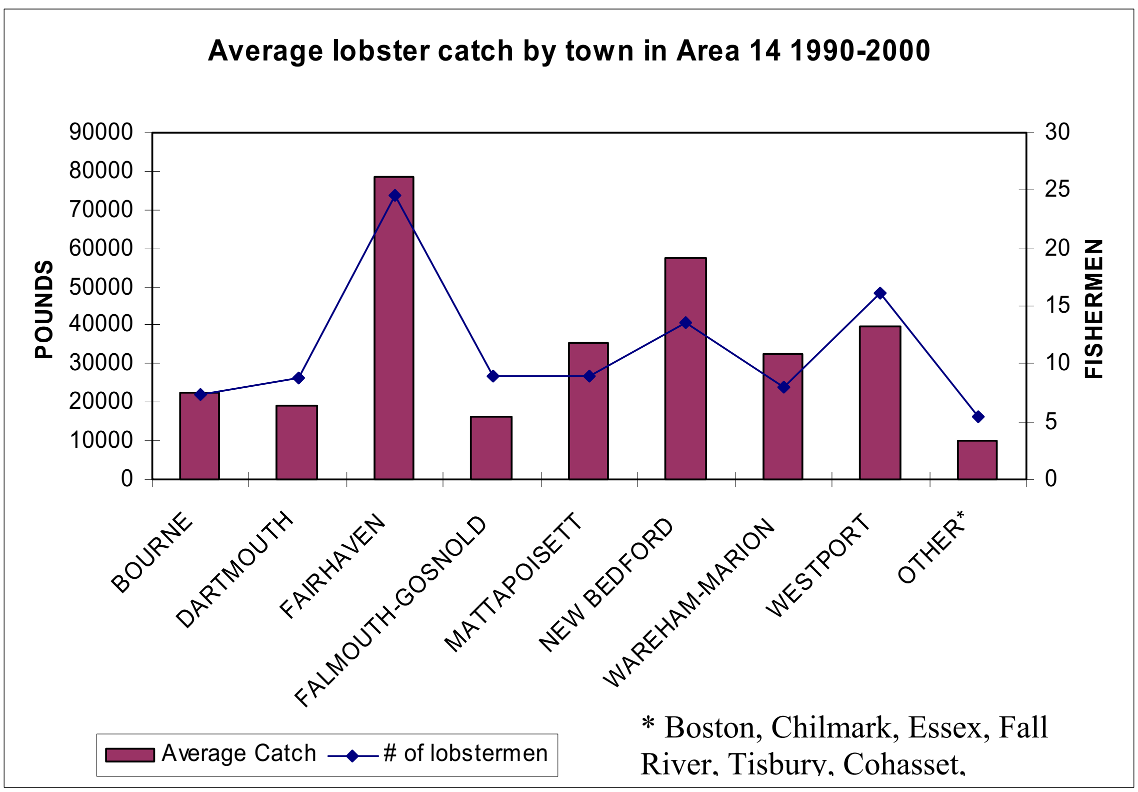


Figure 6-7. Commercial lobster catch statistics from Management Area 14, 1990-2000 (from H. McBride, personal communication).

Landings appear to track with the number of fishermen but may be due to a number of other factors as well (e.g., type of vessel, areas fished, seasons fished, etc).

Harbormasters from various municipalities reported that commercial lobstering vessels on the eastern side of Buzzards Bay were concentrated in Woods Hole. These harbormasters also provided estimates of the number of commercial and recreational fishing vessels in each harbor, as well as their impressions of the location and intensity of vessel usage. Commercial fishing vessels are those vessels that actively work in Buzzards Bay (excluding the large offshore fleet in New Bedford and Fairhaven). Commercial activity is limited by not only the absence of fuel depots along the coast between Woods Hole and Fiddlers Cove (Cataumet), but also the dominance of seasonal recreational marinas in the small harbors.

Based on the interviews with commercial and recreational lobsterman, the shallower, structure-filled areas of the old CLDS are prized lobster habitat. The deeper, muddy areas of this region appear to be less valuable as lobster habitat. Both candidate disposal sites contain deeper, muddy bottom and are fringed by shallower areas with coarser sediments. It appears that a site located as far south from Cleveland Ledge and west from the Falmouth shoreline as practicable would be most desirable from a lobster habitat usage perspective. Even though the substrate characteristics of candidate site 1 are not much different from candidate site 2, the location of candidate site 1 is more desirable in terms of avoiding negative impacts to the commercial lobster fishing industry.

6.4 Historical and Archaeological Resources

Buzzards Bay is rich in cultural history, as Native Americans and colonial settlers used its productive waters and its shoreline for harvesting fish and shellfish; for subsistence agriculture including harvesting salt marsh hay and tending cranberry bogs; and for water-borne transport (Maguire 1998a; Howes and Goerhinger 1996). Native Americans inhabited shoreline areas and utilized the many marine resources of the Bay, as they did in most coastal areas of New England. From earliest settlement times, Buzzards Bay has been used as a marine trade route by Native Americans and European settlers in the region. Use of two rivers at the north end of Cape Cod allowed waterborne transport between Buzzards Bay and the Cape Cod Canal, which eliminated the need to sail around Cape Cod. This made Buzzards Bay important for waterborne commerce between New England and the Dutch settlers in New York, and a trading post was established at what is now the western end of the Cape Cod Canal in the early 1600's (Howes and Goehringer 1996). The Colonial economy in Buzzards Bay developed to include important ports for the whaling and shipbuilding industries in the mid-eighteenth century. Naval battle engagements between British Warships and colonials during the War of 1812 took place in Buzzards Bay, including Falmouth. With the onset of the industrial revolution, industries such as textiles and metal product manufacture emerged in the region.

Prehistorical and historical inhabitants of the coast around Buzzards Bay have left important archaeological and cultural resources, many of which are preserved in museums and exhibits throughout the region. However, shipwrecks represent the primary historical and archaeological resource to be considered when evaluating underwater sites located in deeper water (i.e., more than 10 meters) some distance from the shoreline.

The Massachusetts Historical Commission and the Massachusetts Board of Underwater Archaeological Resources (MBUAR) are charged with protecting and preserving the rich cultural heritage of the Commonwealth. The Massachusetts Historical Commission (MHC) has authority under both state law (950 CMR 70.00 and M.G.L. Chapter 9 Sections 26-27C) and the National Historic Preservation Act to preserve and document historic and cultural resources in the Commonwealth, as well as properties listed, or eligible for listing, on the National Register of Historic Places. Under M.G.L. Chapter 6 Sections 179-180, and Chapter 91 Section 63, the Massachusetts Board of Underwater Archaeological Resources is charged with the responsibility of encouraging the discovery and reporting, as well as the preservation and protection, of underwater archaeological resources. Generally, those resources are defined as abandoned property, artifacts, treasure troves, and shipwrecks that have remained unclaimed for over 100 years, exceed a value of $5,000, or are judged by the Board to be of historical value. The Commonwealth holds title to these resources and retains regulatory authority over their use. The Board's jurisdiction extends over the inland and coastal waters of the state. Since little is known of early vessels, onboard fishing processes, or life aboard the early merchant vessels, each shipwreck is potentially of significant historical value on a local, regional, and national level.

Extensive research indicated that there were fifty-nine historical shipwreck occurrences in Buzzards Bay, but almost all the records were old and the shipwreck locations were not clearly indicated (Maguire 2002c). In general, historical records of shipwrecks are sparse, including government compilations of vessel losses dating from the late 1800s (Maguire 2002c). The Massachusetts-based Metro West Dive Club provides information on shipwrecks that may be explored by divers, but these documented shipwreck sites are all located in Vineyard Sound or near the entrance to Buzzards Bay, and not in its northern portion (Figure 6-8 from Metro West Dive Club (2000)).

Although it is reasonable to presume that shipwrecks may have occurred in the vicinity of the candidate disposal sites, side-scan sonar surveys conducted in the vicinity of the sites have not given any indication of their presence. This assumption is based on historical navigational use of the general area in Buzzards Bay and the proximity of the sites to two potential hazards to navigation, Cleveland Ledge and Gifford Ledge. There are no differences between candidate site 1 and candidate site 2 in reference to historical and archeological resources. Because of Falmouth’s long maritime historical significance, a reconnaissance survey of the potential shipwrecks and aboriginal (Native American) submerged sites within and near the candidate disposal sites may be conducted in the future for the MBUAR.

In comment letters received by MEPA from the MBUAR and the MHC in regard to the April 23, 2005 Notice of Project Change, both the MBUAR and the MHC identified the presence of a potentially significant archaeological/cultural resource within or near one of the two potential disposal sites. The cultural resource is believed to be the property of the US Navy, and MBUAR has had a series of discussions with the Department of the Navy-Naval Historical Center (NHC) regarding this resource. The cultural resource is near, but outside of the proposed boundary for candidate site 1. MBUAR believes that an appropriate buffer can be established that will be protective of this resource and not prohibit the use of site 1 for dredged material disposal. Both the NHC and the MHC seem prepared to let the MBUAR take the lead in establishing the size of the appropriate buffer. The details of the buffer will be addressed in the SMMP with input from

MBUAR through the Disposal Monitoring Advisory Committee (DMAC). For details on the SMMP and the DMAC please refer to Section 11 of this report.

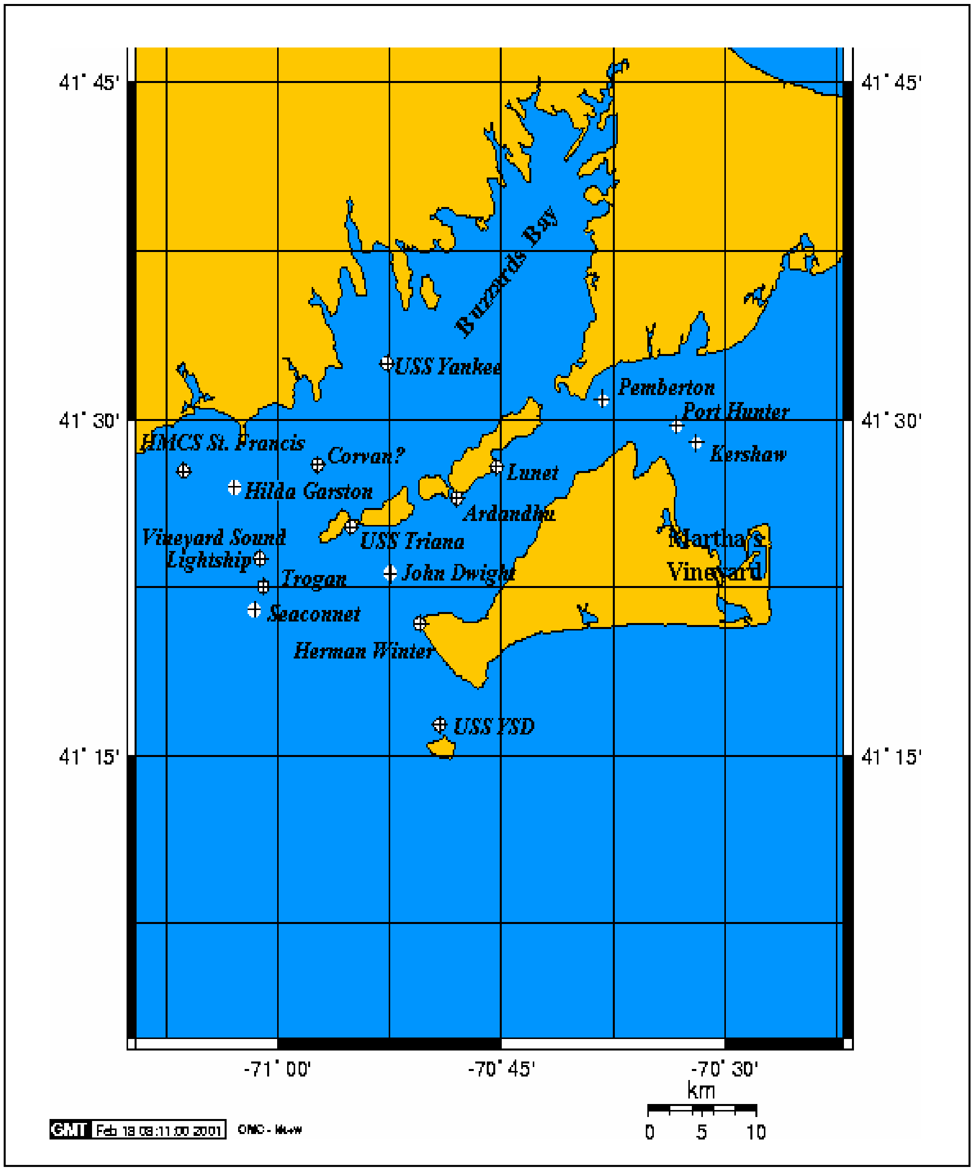


Figure 6-8. Shipwrecks in Buzzards Bay and vicinity.

6.5 Navigation and Shipping

The Cleveland Ledge Channel constitutes the approach to the Cape Cod Canal, and the channel and canal serve as a major marine thoroughfare between Buzzards Bay and Cape Cod Bay. The candidate disposal sites are located in the northeastern section of the Bay leading to the Cape Cod Canal. Existing navigation in the Bay is largely divided into four primary categories: 1) coastal shipping, 2) commercial fishing, 3) recreational boats, and 4) military vessels.

The NAE has evaluated the feasibility of reconfiguring the southern approach to the channel (personal communication, F. Donovan 2002). The proposed reconfiguration would move the existing approach segment (that trends southwest from Cleveland East Ledge) to the east, to be directly aligned with the rest of the channel that trends south-southwest from the Cleveland East Ledge. The reconfiguration would move the south end of the approach channel eastward approximately 700 meters, bringing it closer to the CLDS and candidate sites 1 and 2. The southern-most extent of the approach channel would be approximately 2,400 meters from the northwest corner of candidate site 2 to the southeast, and approximately 3,000 meters from the northern boundary of candidate site 1 directly south.

The waterway, where the formal navigation channel ends, consists of a broad portion of the Bay with relatively uniform depths to the south and southwest and shallower depths to the east in the northwestern portion of the CLDS. Buzzards Bay is an important, largely protected coastal passage for commercial shipping traffic. Traditionally, shipping has followed a generally central common course, for the most part in accordance with navigational aids. Deeper draft commercial shipping may favor deeper water east of the Buzzards Bay fairway marker, “BB” (personal communication w/Captain Brown 2004). Major spill accidents involving oil barges have occurred in Buzzards Bay. Most recently, in April 2003, the Bouchard Barge #120 was holed on a ledge near the mouth of Buzzards Bay and released oil through the hole as the tow proceeded to the head of the Bay.

At the Coast Guard’s request, shortly before 2004 and relative to Chart #13230, NOAA published a required passage through Buzzards Bay for tank vessels to stay within for safety reasons. This restricted area in Buzzards Bay is illustrated in Figure 6-9**.** Very recently published DEP guidance covers the recommended route and cites Chapter 251, Acts of 2004, *“An Act Relative to Oil Spill Prevention and Response in Buzzards Bay and Other Harbors and Bays of the Commonwealth”* (the “Oil Spill Act” or “Act”), which was signed into law by Governor Romney on August 4, 2004. Tank vessels operating in MA waters are now required to travel within a recommended vessel route designated by the Coast Guard *unless* no such recommended vessel route has been designated or special circumstances make travel outside such a route necessary to avoid an imminent navigational hazard. Based on extensive input from the public, industry, environmental groups and others, the Coast Guard identified a recommended route for Buzzards Bay prior to the enactment of the Act. However, the Coast Guard has not yet initiated the rulemaking process needed to formally designate this existing route as a “recommended vessel route” within the meaning of the Act. Although the designated tank ship area passes through a designated mooring area, it alters its course in a more northerly direction and avoids candidate site 1 by at least 0.21 nm (Figure 6-9). Non-tank ship commercial shipping traffic may continue to follow the slightly shorter traditional course which maintains an even greater margin from site 1.

While traffic to and from the channel generally transits this area west of the CLDS, shallower-draft vessel traffic transiting to or from the Woods Hole region will pass over the western portion of CLDS (to the east of an existing anchorage area) and likely directly over candidate site 1. Because candidate site 2 is located slightly east, it is further removed from commercial traffic in this area.

From the Cape Cod Canal log of traffic and tonnage by vessel type in the year 2000, the greatest number of vessels passing both east and west were in the coastal shipping category (Table 6-1).

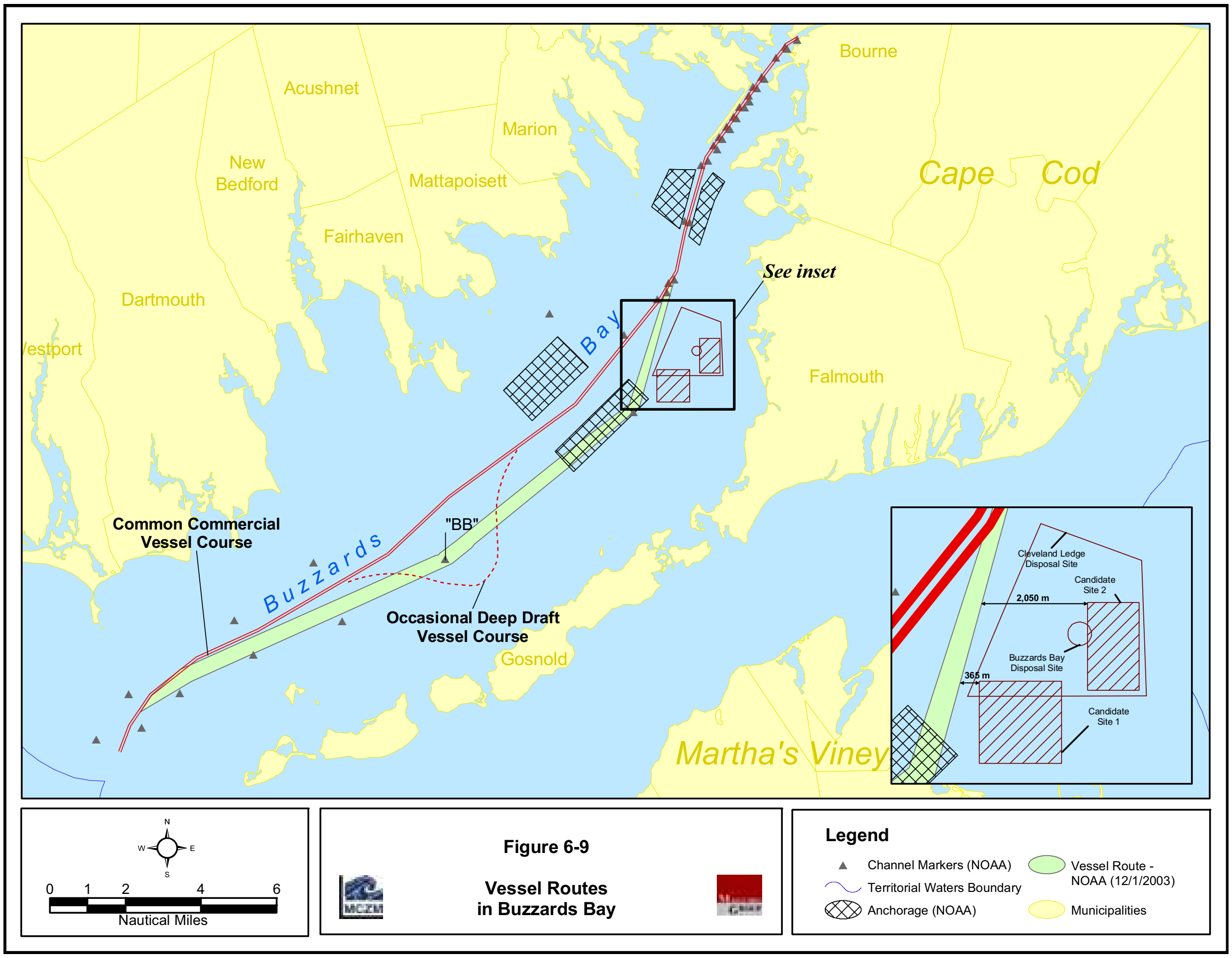


Figure 6-9

Vessel Routes in Buzzards Bay

Table 6-1. Cape Cod Canal total vessel traffic and tonnage by vessel type, 2000.

Classification Code	Number of Vessels			Net Tonnage		
	East	West	Total	East	West	Total
Passenger, Dry Cargo	828	765	1,593	850,275	770,417	1,620,692
Tanker	41	53	94	321,554	518,735	840,289
Towboats	1,619	1,542	3,161	202,270	192,650	394,920
Dry Cargo, Scows	380	362	742	1,135,434	1,116,041	2,251,475
Tanker Barges	812	738	1,550	4,372,812	3,959,774	8,332,586
Fishing Vessels	287	317	604	22,606	26,461	49,067
Yachts	328	332	660	28,859	28,214	57,074
Military Vessels	137	145	282	93,532	92,227	185,759
Others	73	70	143	61,709	59,140	120,849

Source: USACE, Cape Cod Canal Field Office, Buzzards Bay, 2002

This category includes passenger and dry cargo vessels, tankers, towboats and tanker barges. Commercial fishing vessels and recreational boats transited in nearly equal numbers and were ranked second to coastal shipping, while military vessels had the fewest transits of the four major categories.

The substantial marine traffic that is generated from the port of New Bedford/Fairhaven will not necessarily be recorded on the Cape Cod Canal traffic logs. Vessel traffic can conceivably cross the Bay from any location for access to the candidate disposal sites. However, the central and lower portions of the Bay are relatively open and expansive, and do not pose any substantial navigation hazards or restrictions that will preclude access to the candidate disposal sites. Therefore, detailed characterizations of vessel traffic throughout the lower and central Bay havenot been conducted. There are no significant differences between candidate site 1 and candidate site 2 with respect to through-Bay navigation and shipping.

6.6 Land Use, Special Area Designations and The Cape and Islands Ocean Sanctuary

6.6.1 Land Use

The shoreline in closest proximity to CLDS includes the West Falmouth shoreline from Wild Harbor (roughly 4 kilometers northeast to Nyes Neck) to Gunning Point (roughly 3 kilometers to the south), as shown in Figure 6-10. Residential uses, natural areas and water-based recreational uses dominate the coastline nearest to the candidate disposal sites. Residential areas are mostly low and medium density, with small areas of high density along Wild Harbor and near the commercial area at Old Silver Beach. Natural areas along the coast include beaches, salt marsh, emergent wetlands, and forest. Water-based recreation refers to beaches, marinas and pools. Commercial uses are located near beaches and landward of West Falmouth Harbor. There are also scattered areas categorized as "urban open" which includes parks, cemeteries, public open space and vacant undeveloped land. A wastewater treatment plant and an industrial park are located within 1,000 meters of the shoreline near West Falmouth Harbor.

Similar to Falmouth, the majority of the municipalities surrounding Buzzards Bay are comprised of residential developments, often clustered around harbors and other coastal embayments, set against a background of undeveloped forest. Much of the forested land is away from the coast

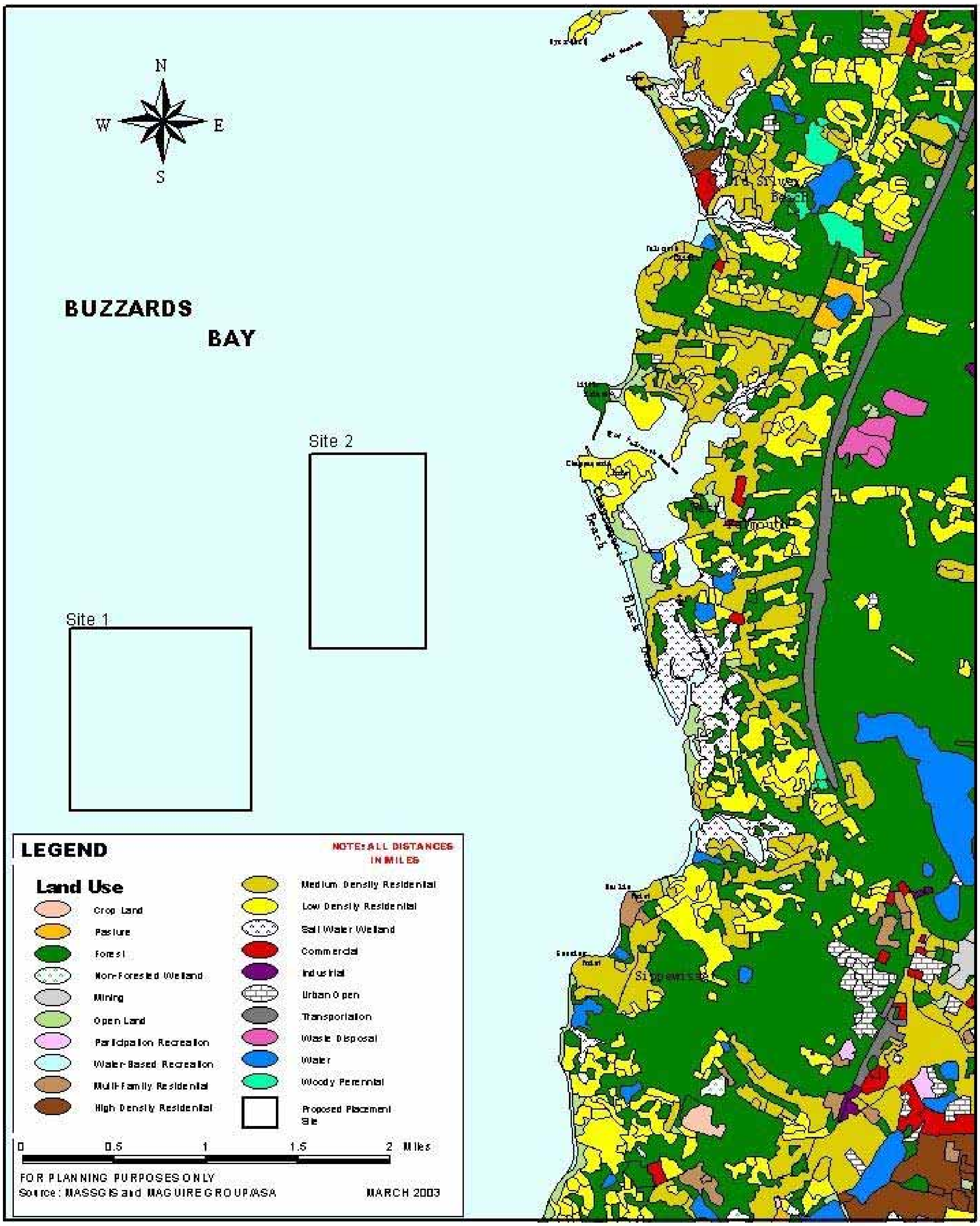


Figure 6-10. Falmouth land use map.

(Buzzards Bay Project 1991). According to the Buzzards Bay Project's land use statistics for North Falmouth, 57% of the land use near Megansett Harbor is classified as forest, while 9% is classified as residential use (between ¼ and ½ acre lots). Further south toward the Elizabeth Islands, land near West Falmouth Harbor is classified as 68% forested and 18% residential. Adjacent to Woods Hole in Falmouth, Quisset Harbor has a reported 50% forested land use and one third (34%) residential land (less than ½ acre lots). Land within one-half mile of the shoreline of Buzzards Bay is generally categorized as 40% forested, while more than 30% is developed (Buzzards Bay Project 1991). There will be no direct or indirect permanent impacts to land use in Falmouth as a result of dredged material disposal activities at either of the candidate disposal sites. These sites in the immediate vicinity of the historical Cleveland Ledge Disposal Site in Buzzards Bay are aquatic sites, located entirely underwater and therefore invisible from near-shore areas.

6.6.2 Special Area Designations

Regulatory programs in the Commonwealth provide special considerations for important natural resource areas, termed Areas of Critical Environmental Concern, or ACECs. ACECs are designated based on the quality, uniqueness, and significance of their natural and cultural resources. Sites are identified at the local level through a nomination process, and designated by the Secretary of Environmental Affairs, while the MA DEM administers the ACEC program. Any proposed activities that may affect an ACEC are reviewed with closer scrutiny to avoid and minimize adverse environmental impacts.

There are 26 ACECs designated in Massachusetts, including 12 inland ACECs and 16 coastal ACECs. In the general vicinity of the candidate disposal sites, the Bourne Back River ACEC is located immediately south of the Cape Cod Canal and including portions of Phinneys Harbor and the Back River. However, this site is located on land, greater than 6 km to the northeast of the candidate disposal sites.

The Bourne Back River Estuary was designated an estuary of National Significance by the USEPA in 1988. It is part of the Cape and Island Ocean Sanctuaries of Massachusetts, which covers the entire Bay including the proposed candidate disposal sites 1and 2. Recreational and educational groups including local school systems, the Northeast Marine Environmental Institute, and the Woods Hole research community use this area extensively.

6.6.3 The Cape and Islands Ocean Sanctuary

Massachusetts passed the Ocean Sanctuaries Act (MOSA) in 1970. The Act authorized the creation and maintenance of five ocean sanctuaries including the Cape and Islands Ocean Sanctuary. The Cape and Islands Sanctuary is managed by the EOEA. Management activities are carried out by the DCR, the DMF, the DEP, and the CZM.

MOSA obliges the DCR to protect the sanctuaries from any development or activity that would damage the ecology or aesthetics of the area. Specifically prohibited within Massachusetts Ocean Sanctuaries are the construction of physical structures on the seabed, the building of offshore or floating power plants, the drilling through or removal of mineral resources, gases or oils. Also banned are dumping of wastes and incineration of private or commercial wastes by any ship moored or floating within a sanctuary. Suitable dredged material is considered neither a physical structure nor a waste and is not prohibited from being disposed within a Massachusetts Ocean Sanctuary.

6.7 Air Quality and Noise

6.7.1 Air Quality

Background air quality in Buzzards Bay has been estimated using monitoring data reported by the DEP to the EPA Aerometric Information Retrieval System (AIRS). The reporting counties surrounding Buzzards Bay are Bristol, Plymouth, Barnstable and Dukes. Although the MA DEP does not operate any air pollution monitors within or near Falmouth, the air quality can be measured by surrounding air pollution monitors in either Easton (Bristol County), Plymouth (Plymouth County), or Truro (Barnstable County).

The EPA mandates monitoring of the following six criteria air pollutants: nitrogen dioxide (NO_2), particulate matter with diameters less than or equal to 10 microns (PM_{10}), sulfur dioxide (SO_2), ozone (O_3), carbon monoxide (CO), and lead. Ambient Air Quality Standards (AAQS) have been established for each of these pollutants to protect the public health and welfare, with a margin of safety. PM_{10}, O_3, and NO_2 emissions are those associated with operation of heavy equipment used in dredged material disposal operations (i.e., towboats and scows). Ozone is not a pollutant emitted by heavy equipment, but is formed in the atmosphere when "precursor" elements and compounds such as nitric oxides, hydrocarbons (e.g., from unburned fossil fuels) and oxygen are combined in the presence of sunlight.

A geographic area that meets or exceeds an AAQS is called an attainment area for that air pollutant standard. An area that does not meet an air standard is called a non-attainment area for that standard. The entire state of Massachusetts is in attainment of all criteria air pollutant standards except for ozone, for which it is classified as in serious non-attainment. A summary of existing air quality data for the Buzzards Bay counties are as follows:

Nitrogen Dioxide (NO_2): The nearest monitoring stations for this pollutant are in Truro and in Easton, Massachusetts. From 1997 to 2002, there were no violations of the annual standard of 0.053 ppm. Annual measurements ranged from 0.003 to 0.008 parts per million (ppm) in Truro and 0.004 to 0.009 ppm in Easton.

Particulate Matter 10-Microns (PM_{10}): In 1998, at monitoring stations in New Bedford (Bristol County) and Fall River (Bristol County), readings of 16.0 to 18.0 ppm (annual average) were recorded. This is well below the standard of 50 $\mu g/m^3$.

Sulfur Dioxide (SO_2): The nearest monitoring station for sulfur dioxide is in Fall River (Bristol County). From 1997 to 2002, there were no exceedances of the EPA standards. Annual means during this period were 0.003 to 0.005 ppm, which is well below the annual standard of 0.03 ppm.

Ozone (O_3): Monitoring stations for ozone are in Fairhaven, Truro, Easton and Scituate. Exceedances of the 1-hour standard of 0.12 ppm occurred five times from 1997 to 2002. The values in excess ranged from 0.121 ppm to 0.145 ppm (1996). Statewide, Massachusetts continues to be in non-attainment of the O_3 standard (0.12 ppm).

Carbon Monoxide (CO): The nearest monitoring station for CO is in East Providence, Rhode Island. No violations of the one-hour (35 ppm) or eight-hour (9 ppm) standards were recorded from 1997 to 2002.

Lead (Pb): The closest monitoring station for lead is in Boston. Since 1998, there have been no exceedances of EPA's lead standard of 1.5 micrograms per cubic meter ($\mu g/m^3$).
Overall, the existing air quality in the Buzzards Bay area is in compliance with all state and federal air quality standards except for ozone. Statewide non-attainment for the ozone standard requires that Massachusetts continue to make progress on implementing a State Implementation Plan (SIP) for attaining the standard. Given their proximity, there are no differences between candidate sites 1 and 2 in terms of air quality.

6.7.2 Noise

Buzzards Bay is a moderately commercialized waterbody, exhibiting noise levels typical of residential environments. The exception is New Bedford/Fairhaven Harbor, where noise levels are more typical of commercial environments. All internal combustion watercraft involved in the transport of dredged material to the candidate disposal sites in the Bay would be properly muffled in accordance with existing jurisdictional regulations. Commercial and recreational water-borne traffic/activities, as well as land-based noise related to commercial and industrial activities in the vicinity, all contribute to the existing noise environment. Generally speaking, the eastern shoreline areas of Buzzards Bay are quieter than more industrialized port areas. There are no differences between candidate sites 1 and 2 in terms of existing noise levels.

6.8 Recreational Resources

Buzzards Bay offers numerous recreational opportunities in and on the waterway itself and along the shoreline. Predominant among the recreational uses of the Bay waters are boating, sailing, swimming, fishing, and diving. Shoreline uses include hiking trails, bicycling, birding, shoreline fishing and shellfishing, hunting, camping and beach recreation including surfing and swimming. Opportunities for saltwater and freshwater fishing and shellfishing can be found throughout Buzzards Bay. Saltwater fishermen seek scup, bluefish, striped bass, cod and flounder. Shellfishing for clams, bay scallops and quahogs is common in Buzzards Bay and the Cape. There are numerous recreational marinas, boat yards and yacht clubs located in Buzzards Bay. However, there are no significant differences between candidate sites 1 and 2 in terms of existing uses or potential impacts to recreational resources.

6.9 Economic Environment

According to a 1995 Coast Alliance survey, coastal tourism in the Northeast represents more than 40 times the economic value of all seafood caught in the region (Cape Cod Commission 2002). To benefit from tourism and seasonal residents, Cape Cod continues to maintain its attractiveness and enhance its regional character through service-based industries such as restaurants and lodging. Resource-based industries are also supported on the Cape, including fishing, shellfishing, recreation and heritage tourism.

The largest fishing group in Buzzards Bay is based on pleasure boats moored from various launch sites, harbors and marinas around the Bay (Maguire 2002b). The local economic environment of the Buzzards Bay region is strongly linked to recreational marinas, boat yards and yacht clubs located in Buzzards Bay. As reflected in local harbor management plans, a major challenge of the local communities of Buzzards Bay is to maintain required depths to support the need for moorings. The increased pressure by the boating community for moorings has lead to an increase in dredging requirements for marinas and boat yards to maintain and expand operations to meet the demand of the maritime consumer. There are no differences between candidate site 1 and candidate site 2 with respect to impacts on the economic environment.

6.9.1 Cape Cod Economic Base

Generally, Cape Cod's economy is based on small businesses, with 92% of the region's companies employing fewer than 20 people (Cape Cod Commission 2001). Figure 6-11 illustrates the industries that sell goods and services to buyers. Almost half (48%) of the Cape Cod economy is defined by tourist and retirees.

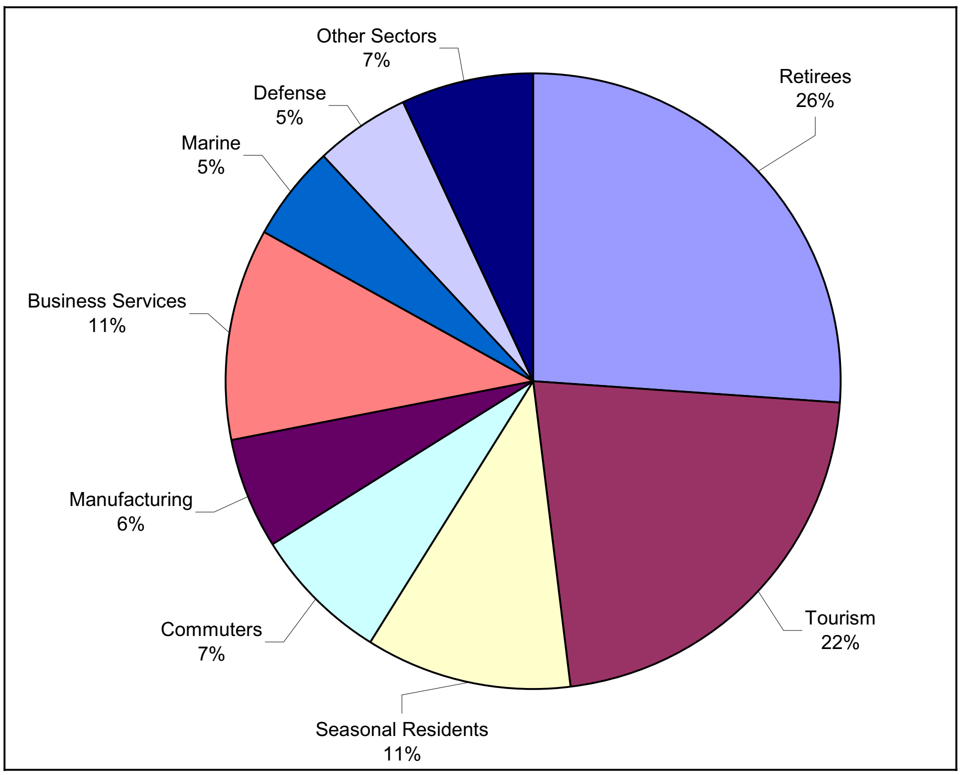


Figure 6-11. Breakdown of employing industries (Source: Cape Cod Commission, 2001).

In 2000, the Massachusetts Office of Travel and Tourism rated the top five counties in Massachusetts, according to expenditures from domestic travel. The top five counties, which included Suffolk, Middlesex, Barnstable, Norfolk and Essex counties, received $9.1 billon in direct domestic travel expenditures during 2000 (MOTT 2002). Barnstable County constitutes all of Cape Cod, including the entire eastern shoreline of Buzzards Bay (except the Elizabeth Islands). Direct domestic traveler spending in the top five counties generated more than $2.6

billion in payroll income (84.1%) and 100,000 jobs (82%; MOTT 2002). These five counties account for 81.5% of the state total (MOTT 2002).

In addition to Barnstable County, there are three other counties bordering Buzzards Bay: Bristol, Plymouth, and Dukes (Figure 6-12). Each county in Buzzards Bay reflects different expenditures due to domestic travel. The economic impact of tourism in Barnstable County in 2000 included $202 million generated in payroll and 9,390 jobs (MOTT 2002). Tourism in Plymouth and Bristol counties contribute to the state economy, with Plymouth County providing $70 million in payroll and 3,240 jobs, and Bristol County generating $63 million in payroll and 2,790 jobs (MOTT 2002). Tourism from Dukes County contributed $105 million and 1,310 jobs to the Massachusetts economy (MOTT 2002).

Figure 6-12. Counties in the Buzzards Bay area.

There are no differences between candidate sites 1 and 2 with respect to existing conditions or impacts on the Cape Cod economic environment.

6.9.2 Falmouth and Surrounding Buzzards Bay Communities

According to the Massachusetts Division of Employment and Training's (MA DET) MassStats Program and the 2000 U.S. Census Bureau, the Town of Falmouth has a population of 32,660 (2000 estimate). The population has increased slightly over the 3-year period of 1997 to 2000 by 5.5%. Almost half (47%) of the population of Falmouth are retired adults, 62 years or older (MA DET 2002a). Most (98%) of the population own their homes in Falmouth (MA DET 2000a). The unemployment rate in Falmouth (2.9%) is lower than the state's unemployment rate (4.2%) and the lowest in the Buzzards Bay region (MA DET 2002b). Unemployment in surrounding communities (New Bedford, 7.1% and Fairhaven, 4.3%) is slightly higher than the state average of 4.2%.

Over 30% of the major employment industries in Falmouth are health services, engineering and management services, and restaurants. Other major industries include: food stores, miscellaneous retail, hotel and other lodging places, contractors, automotive dealers and service stations, social and educational services, building materials and garden supplies. Together, all of these services represent over 50% of the industries in Falmouth.

The other communities surrounding Falmouth on the east side of Buzzards Bay have similar service-driven economies, primarily lead by health services and restaurants, as well as strong links to the fishing industry.

6.10 Environmental Justice

In Massachusetts, the draft Environmental Justice Policy of the EOEA defines environmental justice as "... all people have the right to be protected from environmental pollution and to a clean and healthful environment." It is EOEA's policy that environmental justice includes the equal protection and meaningful involvement of all people with respect to the development, implementation and enforcement of environmental laws, regulations, and policies and the equitable distribution of environmental benefits. This policy is implemented through regulatory and resource agencies of the Commonwealth.

The need for environmental justice has been most widely recognized in communities of color and in low-income communities. The EOEA utilizes specific indicators based on social/economic, sensitivity/vulnerability and environmental data. Under the draft guidelines of the EOEA, a region that has fifteen percent (15%) or more of the population as non-white and low income (U.S. Census Bureau) qualifies the municipality as an environmental justice community. Other criteria include sensitivity/vulnerability measures like low birth weight, incidence of cancer, and incidence of lung and bronchus.

Data from the U.S. Census Bureau for the Town of Falmouth was collected as a "census designated place" (CDP). The definition for a CDP is a statistical entity, comprising a densely settled concentration of population that is not within an incorporated place, but is locally identified by a name. CDPs are delineated cooperatively by state and local officials and the U.S. Census Bureau and follow U.S. Census Bureau guidelines. The environmental justice criteria analysis is established on the data from the U.S. Census CDP for Falmouth, North Falmouth, East Falmouth, and West Falmouth.

According to the following data, the Town of Falmouth does not qualify for status as an environmental justice community. The average CDP percentage of population that is non-white for Falmouth is below the state average at 4% and below the 15% threshold of the EOEA. The average CDP household income below $10,000 for Falmouth is 9%, which does not exceed the EOEA 15% standard (Table 6-2).

Table 6-2. Environmental justice criteria analysis for Falmouth (US Census designated place (CDP)).

	Falmouth CDP	North Falmouth CDP	East Falmouth CDP	West Falmouth CDP
Total Population for Urban and Rural Residence*	4,004	2,574	5,577	1,803
Population - non white (17.8% MA avg.)*	163 (4%)	7 (0.2%)	435 (8%)	73 (4%)
Population - low income Household Income <$10,000†	334 of 3,819 (9%)	171 of 2,467 (7%)	760 of 5,552 (14%)	96 of 1,799 (5%)
Population - foreign-born†	332 of 4,004 (8%)	120 of 2,574 (5%)	266 of 5,577 (5%)	101 of 1,803 (6%)
Population - non-English speaking†	20 of 3,857 (0.5%)	0 of 2,396 (0%)	88 of 5,183 (2%)	7 of 1,730 (0.4%)
Town of Falmouth				
Incidence of low birth weight (7.1% MA avg.)††	20 of 275 (7%)			
Incidence of all newly diagnosed cancer types for 1994 to 1998**	1,159 (obs) of 1,015 (exp)			
Incidence of lung and bronchus for 1994 to 1998**	164 (obs) of 153 (exp)			

References:
*1990 Social Characteristics – Sample Data, 1990 U.S. Census Data
†1989 Income and Poverty Status – Sample Data, 1990 U.S. Census Data
††Massachusetts Births 1999 for Falmouth
**Cancer Incidence in Massachusetts 1994-1998 for Falmouth

The data for cancer types and incidence of lung and bronchus are reported in Table 6-2 as observed versus expected. These data compare the observed cancer incidence in Falmouth versus the expected incidence based on statewide age-specific incidence rates. Low birth weight datum is at the state average and the observed cancer rate is slightly above state average. The results of this analysis lead to the conclusion that the Town of Falmouth does not qualify as an environmental justice community. There are no differences between candidate sites 1 and 2 with respect to the environmental justice status of Falmouth.