Appendix 5.3-C

Lewis Bay Benthos and Shellfish Survey 2003

Lewis Bay Benthos and Shellfish Survey 2003

CAPE WIND ENERGY PROJECT

PREPARED FOR	Cape Wind Associates 75 Arlington Street Boston, MA
PREPARED BY	ESS Group, Inc. 888 Worcester Street, Suite 240 Wellesley, Massachusetts 02482
	Project No. E159-002.5
	October, 2003

TABLE OF CONTENTS

SECTION **PAGE**

1.0 INTRODUCTION ... 1

2.0 METHODS ... 1
2.1 Field Collection ... 1
2.2 Laboratory Analysis ... 3

3.0 RESULTS ... 4

4.0 DISCUSSION ... 5

5.0 REFERENCES ... 5

TABLES

Table 1 Distance from mean-low-low-water and sample techniques employed in Lewis Bay, August 14, 2003
Table 2 Area (in square meters) sampled using a clam rake in Lewis Bay August 14, 2003
Table 3 Macroinvertebrate Sampling Data for Lewis Bay, August 2003

FIGURES

Figure 1 Marine Invertebrate Sample Locations – Lewis Bay
Figure 2 The Ekman Dredge
Figure 3 A Clam Rake With Attached Basket
Figure 4 Typical Recovery In A Box Sieve With ¼ Inch Mesh Size

1.0 INTRODUCTION

ESS Group Inc. conducted an assessment of the benthic macroinvertebrate community along the preferred submarine cable route for the proposed Cape Wind Energy Project, in the near-shore section of Lewis Bay, on August 14, 2003. This assessment supplements previous benthic assessments conducted for the Project during 2001 and 2002 (ESS 2001, 2002). The assessment utilized techniques that enabled characterization of the commercially viable shellfish community, in particular the northern quahog (*Mercenaria mercenaria*), as well as the remainder of the benthic community (or benthos), which includes worms, crustaceans, small clams and snails.

The purpose of this focused assessment of the near-shore section of Lewis Bay, was to quantify the potential direct impacts (associated with "jet plow" techniques) to the recreational shellfish bed along the proposed cable route. The shellfish bed is approximately 600 feet wide at the point where the project work would be conducted.

2.0 METHODS

2.1 Field Collection

Three different sampling techniques were employed at the four sample sites in the nearshore area of Lewis Bay. Techniques included quantitative and semi-quantitative approaches in order to document all organisms present. The location of each sample site was mapped (Figure 1) using a Differential Global Positioning System (DGPS) unit. Sample locations were selected along the path of the proposed cable route in water depths that were accessible by wading during low tide. The following table summarizes the distance measured from mean-low-low-water to each sample site and the sample techniques employed at each:

Table 1: Distance from mean-low-low-water and sample techniques employed in Lewis Bay, August 14, 2003

Site identification (Refer to Figure 1)	Distance from Mean-Low-Low-Water	Sample techniques employed
BGL1c	42 feet	Dredge, rake, scoop & sieve
BGL1b	178 feet	Dredge, rake, scoop & sieve
BGL1b2	410 feet	Rake
BGL1A	655 feet	Dredge, rake

The "clam rake technique" was the only method used to sample at site BGL1b2, as this was deemed an "extra" site and only sampled in order to characterize the shellfish community at the edge of the shellfish bed seeded by the Town of Yarmouth. At site BGL1A the "scoop and sieve technique" could not be used due to excessive water depth at this location

The three sample techniques employed during this study were:

1) **Ekman Dredge (Quantitative technique)**: The Ekman dredge (Figure 2) was found to provide adequate sample recovery in the sandy sediment and shallow water depths encountered throughout the study area. The Ekman dredge (measuring 6 inches by 6 inches) was lowered through the water column with the jaws open and locked then set securely down onto an area of sediment. Care was taken not to walk through the sample area prior to sampling, to prevent disruption of the macroinvertebrate community. Although very limited in number, any large rocks or other physical obstructions were avoided when selecting an area to sample to ensure full closure of the dredge jaws and to minimize the loss of any fine sediment. Once the dredge was securely embedded into the sediment, its jaws were deployed and manually set around the sample to ensure that they were completely closed before the sample was retrieved. The dredge was then raised to the surface and the sample contained inside was transferred into a bucket for safe transport back to shore. Once back on shore the samples (bottom material and benthos) were then placed directly into a pre-labeled one-quart sample jar.

Immediately thereafter, each sample was preserved by adding sufficient Formalin solution to yield a concentration of approximately 10% formalin and 90% sample/seawater. The formalin solution was gently mixed throughout the sample so that benthic organisms were adequately preserved but not damaged. The preserved samples were returned to ESS for subsequent laboratory analysis.

2) **Clam Rake (Quantitative technique)**: The clam rake used during this study was a standard clam rake with an attached collection basket, much like the one depicted in Figure 3. At each sample site the clam rake was dragged over a measured distance down to a depth of approximately 6 to 8 inches in order to collect the larger shellfish present. The following table summarizes the bottom area of sediment sampled with the clam rake at each site:

Table 2: Area (in square meters) sampled using a clam rake in Lewis Bay August 14, 2003

Site identification (Refer to Figure 1)	Area sampled with clam rake
BGL1c	51 m^2
BGL1b	81 m^2
BGL1b2	64 m^2
BGL1A	48 m^2

Once shellfish were retrieved with the clam rake they were brought up to the surface and identified by an ESS scientist in the field. Species that could not be identified in the field were transferred into a pre-labeled Whirlpack© bag and preserved in a 10% formalin solution. These bags were transported back to the laboratory for identification using taxonomic keys.

3) **Scoop and Box Sieve (Semi-quantitative technique)**: A five gallon scoop container was dragged by hand through the top 6 to 8 inches of sediment within the sample site area. Once filled, the scoop container was emptied into a large box sieve with a ¼ inch mesh screen (Figure 3) and shaken gently to allow smaller material to pass through the screen while retaining larger material, including many benthic organisms. The contents of the sieve were then transferred into a pre-labeled Whirlpack© bag and preserved in a 10% formalin solution. Bags containing the organisms and debris were transported back to the laboratory for identification using taxonomic keys. Figure 4 depicts the typical recovery achieved using the box sieving technique.

Figure 2: The Ekman Dredge

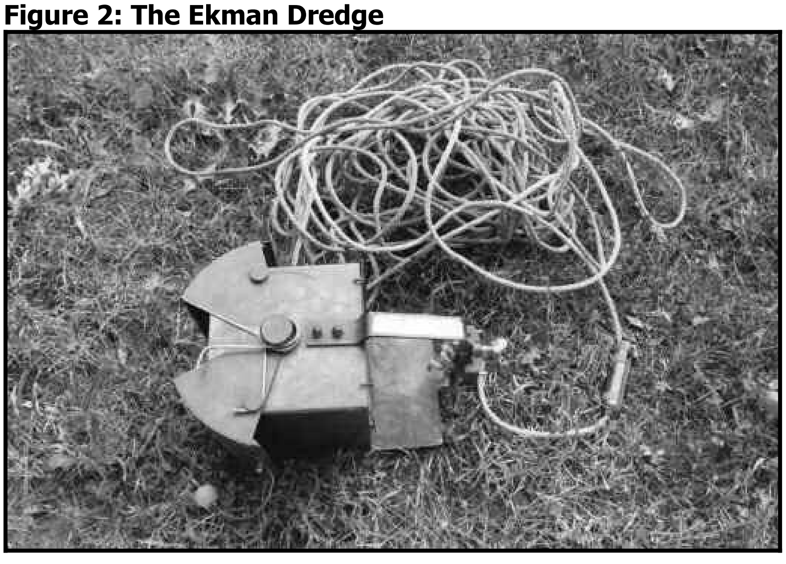
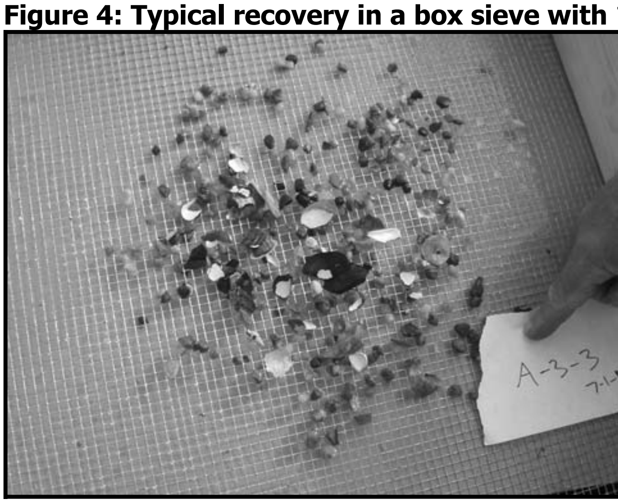


Figure 3: A clam rake with attached basket

Figure 4: Typical recovery in a box sieve with ¼ inch mesh size



This photo was taken during the 2002 benthic macroinvertebrate assessment for the Cape Wind Energy Project.

2.2 Laboratory Analysis

The methods used for sorting, identifying and preserving benthic samples collected with the Ekman dredge were consistent with those performed and reported for the 2001 and 2002 Cape Wind benthic macroinvertebrate community assessments (ESS 2001, 2002). Please refer to Section 2.2 of the ESS report entitled "Cape Wind Energy Project Benthic Macroinvertebrate Community Assessment (October 2001)" (ESS, 2001) for a detailed description of these methods. All quality assurance and quality control (QA/QC) for the sorting and identification phases of lab analysis were also completed as reported in the 2001 study (ESS, 2001).

Macroinvertebrates collected using the clam rake and the scoop and box sieve techniques were emptied from the Whirlpack© bags into a 500 μm sieve and gently washed with tap water to eliminate all traces of formalin.

Once rinsed and separated from the sample debris, the macroinvertebrates were identified to the lowest practical taxonomic level using a dissecting microscope (up to 45x magnification) and readily available taxonomic keys. Taxonomic keys used to aid in identification during this study included Gosner, 1978; Martinez, 1999; Smith, 1964; and Weiss, 1995.

3.0 RESULTS

The benthic macroinvertebrate community in the vicinity of the Town of Yarmouth's recreational shellfish bed was comprised of a variety of organisms including worms, snails, clams and crustaceans. A total of 31 benthic macroinvertebrate taxa from 7 taxonomic Classes were recorded in the samples analyzed from the four sites, using the three different sample techniques. A complete list of benthic organisms identified during this study is presented in Table 3.

In general, the sample site located furthest from shore (BGL1A) had the highest overall macroinvertebrate abundance (organisms/m^2), as assessed using the dredge technique. However, the abundance of large shellfish, including the northern quahog, as assessed by the clam rake technique, was very similar at all four sites, though slightly higher at the site located near the center of the shellfish bed (BGL1b).

The diversity of macroinvertebrates (as measured by the number of distinct taxa collected per sample) was found to be the highest at BGL1b, as assessed using both the dredge and the clam rake. The site closest to shore (BGL1c) was found to have the lowest diversity, as assessed using the dredge and the second lowest using the clam rake. A complete summary of the macroinvertebrate community statistics (abundance and diversity) for each of the four sample sites using each sample technique, is provided in Table 3.

Of all the macroinvertebrates found in Lewis Bay, the Polycheata (bristle worms) were by far the most diversely represented Class, with thirteen different taxa being present in the dredge and sieved samples combined. Of these taxa, *Streblospio benedicti* (mud worms) were the most abundant. These worms are tube dwellers, generally found in estuaries intertidally and subtidally at shallow depths, living in sandy mud and burrowing into soft ground (Gosner, 1978). *Streblospio benedicti* is known to be an early colonizing species, perfectly adapted for colonizing stressed or disturbed habitats and is typically associated with these environments (Lowe and Thompson, 1997). Another common mud worm in the bay was *Prionospio spp.* These have similar habitat requirements to *Streblospio benedicti* (Gosner, 1978) and have also been noted as early colonizing species that become abundant in marginally polluted areas (Pratt, 1973). Another common Polycheata Family was Syllidae, represented by both *Syllides spp*. and *Brania clavata*. Both of these species are commonly found in sand and mud sediments as well as in shellfish beds (Smith, 1964). Capitellid thread worms were also present in large numbers in all dredge samples. In general, these worms live in the muddy sand of estuaries and the intertidal zone to subtidal at shallow depths. They are known to eat their way through the substratum when they feed and are tolerant of poor conditions on bay mud flats and harbor bottoms (Gosner, 1978).

The most abundant Class observed using the dredge technique was the Nematoda (round worms), which clearly dominated every dredge sample (Table 3). Nematoda are generally known to be the most numerous marine invertebrates and are adapted to live literally everywhere (Gosner, 1978).

Another abundant Class observed using the dredge technique was the Oligochaeta (aquatic earthworms). In general most aquatic earthworms are intertidal, burrowing in sand and under rocks and sometimes swimming among bits of floating weed and decaying sea grasses; however some are subtidal and live in deep water sediments. Many of these worms are highly tolerant of degraded habitats including polluted areas (Gosner, 1978).

The most abundant Class of macroinvertebrates in the clam rake samples was Bivalves and of these, the most abundant species was the northern quahog, although *Anadara ovalis* (blood ark) was also commonly found. In general the habitat of the northern quahog varies from sand or muddy sand in bays and along ocean beaches (Gosner, 1978). However, northern quahogs can be found in waters up to fifteen meters (49 feet) deep and prefer firm bottom areas consisting of sand or shell fragments (NOAA, 2003). Northern quahogs are often found in very polluted habitats; adults can tolerate wide ranges in water quality and can survive in changing concentrations of ammonia, nitrites, nitrates and phosphates (NOAA 2003).

4.0 DISCUSSION

A comparison of the data collected in this survey of Lewis Bay with previous benthic macroinvertebrate assessments conducted in Nantucket Sound for the Cape Wind Energy Project (ESS 2001, 2002) shows that the abundance of macroinvertebrates in dredge samples taken from nearshore Lewis Bay during August 2003 was markedly higher than the abundance recorded in samples collected on Horseshoe Shoal. The density of macroinvertebrates collected during this survey averaged 58,168 individuals per m^2 in comparison to an average of 5,558 per m^2 on Horseshoe Shoal in August 2001 and 9,060 per m^2 on the Shoal in 2002 (ESS 2001, 2002). The difference in macroinvertebrate abundance is even greater between this survey of Lewis Bay and the study conducted by ESS during 2001 (ESS, 2001), when the deeper offshore waters of Lewis Bay were assessed. The density of macroinvertebrates collected during the 2001 survey of the deeper waters of Lewis Bay averaged only 2,017 individuals per m^2, even lower than the densities recorded from Horseshoe Shoal at that time.

Other recent studies conducted in bay and harbor areas of comparable habitat type, however, report abundances of a magnitude similar to the levels recorded in this study. For example, a study in New Haven Harbor, Connecticut found densities to range from 2,250 per m^2 to 60,675 per m^2 (ENSR, 2000) and a multi year study in the same area documented a mean density of 14,000 per m^2 (DeLeuw et al., 1991). The average diversity as measured by the taxonomic richness of macroinvertebrates documented in Lewis Bay is also slightly higher compared to the communities assessed on Horseshoe Shoal and the other areas studied during 2001 and 2002 by ESS (ESS, 2001, 2002).

Further comparison with previously collected Nantucket Sound data notes the marked absence of the Order Amphipoda in Lewis Bay during this study. Amphipods, in particular the families Ampeliscidae (four eyed amphipods) and Ischyroceridae (fouling amphipods) were found in very high density in the shallow waters of Nantucket Sound during the 2001 and 2002 studies (ESS, 2001, 2002). One reason for the absence of amphipods in Lewis Bay could be their sensitivity to environmental disturbance or stresses (Pratt, 1973). As noted in the results section of this report, many of the dominant taxa found in Lewis Bay during this study are either pollution tolerant, early colonizers following environmental disturbance, or opportunistic in nature.

The findings of this study suggest that the waters of Lewis Bay are likely to be of poorer quality than the waters of Nantucket Sound. A case study conducted in the Yarmouth area in 2000 noted that the apparent degradation of the Lewis Bay ecosystem was most likely attributable to effluent from septic systems affecting groundwater within the watershed, resulting in nutrient or nitrogen loading into the bay from the watershed (EFC, 2000). In addition, the "Cape Cod Coastal Embayment Project" identified the key contaminant causing the degradation of the water quality within Cape Cod's coastal embayments to be nitrogen from septic systems and treatment plants, stormwater runoff, and fertilizers (Cape Cod Commission, 1998).

It is possible that the high abundance and diversity of benthic macroinvertebrates found in Lewis Bay compared to the shoal areas of Nantucket Sound may simply be due to naturally greater food abundance. Food abundance for the benthos is known to be generally greater in shallow and coastal areas than in offshore and deeper areas (Rosenberg, 2001). In addition, the likely input of nutrients to Lewis Bay can also lead to increased primary production and therefore a greater accumulation of organic material on the bottom (Rosenberg, 2001) which is linked to greater food abundance for the benthos and would be likely to support a greater macroinvertebrate abundance.

5.0 REFERENCES

Cape Cod Commission 1998. Cape Cod Coastal Embayment Project. Excerpted from the Interim Final Report, September 1998. Prepared by the Cape Cod Commission.

DeLeuw, Cather, & Company. 1991. Technical Memorandum #8, An inventory of Selected Aquatic and Biological Resources in the vicinity of the Quinnipiac River Bridge.

EFC 2000. Hyannis Park on Lewis Bay: A Case Study. Yarmouth MA, September 21, 2000. Conducted by the Environmental Finance Centers of the University of Southern Maine and the University of Maryland System. (North East Environmental Finance Center Web Site).

ENSR. 2000. Application of Iroquois Gas Transmission System, L.P. for a Certificate of Public Convenience and Necessity. Volume 3 Biological Assessment. Biological Assessment of the Eastchester Extension Project: Pipeline Section.Gallagher, E.D. and K.E. Keay. 1998. Organism-Sediment-Contaminant Interactions in Boston Harbor. Pp. 89-132 in K.D. Stolzenbach and E.E. Adams, eds. Contaminated Sediment in Boston Harbor. MIT Sea Grant Press. 170 pp.

ESS 2001. Cape Wind Energy Project Benthic Macroinvertebrate Community Assessment, October 2001

ESS 2002. Cape Wind Energy Project Benthic Macroinvertebrate Community Assessment, November 2002.

Gosner, K.L. 1978. The Peterson Field Guide Series. A Field Guide to the Atlantic Seashore From the Bay of Fundy to Cape Hatteras. Houghton Mifflin Company.

Lowe, S. and B. Thompson. 1997. Identifying Benthic Indicators for San Francisco Bay. Regional Monitoring Program 1997 Annual Report.

Martinez, A.J. 1999. Marine Life of the North Atlantic, Canada to New England. Down East Books.

NOAA 2003. Bivalve Species Gallery. Web site accessed September 15, 2003. http://www.csc.noaa.gov/lcr/nyharbor/html/gallery/sgmercen.html

Pratt. S.D. 1973. Coastal and Offshore Environmental Inventory. Cape Hatteras to Nantucket Shoals. Marine Publication Series No. 2. University of Rhode Island, Kingston, Rhode Island.

Rosenberg R. 2001. Marine Benthic Faunal Sucessional Stages and Related Sedimentary Activity. Scientia Marina 65 (Suppl.2): 107-119.

Smith. R.I. 1964. Keys to the Marine Invertebrates of the Woods Hole Region. Marine Biological Laboratory.

Weiss. H.M. 1995. Marine Animals of Southern New England and New York. Identification Keys to Common Nearshore and Shallow Water Macrofauna. Bulletin 115 of the State Geological and Natural History Survey of Connecticut. Department of Environmental Protection.

Tables

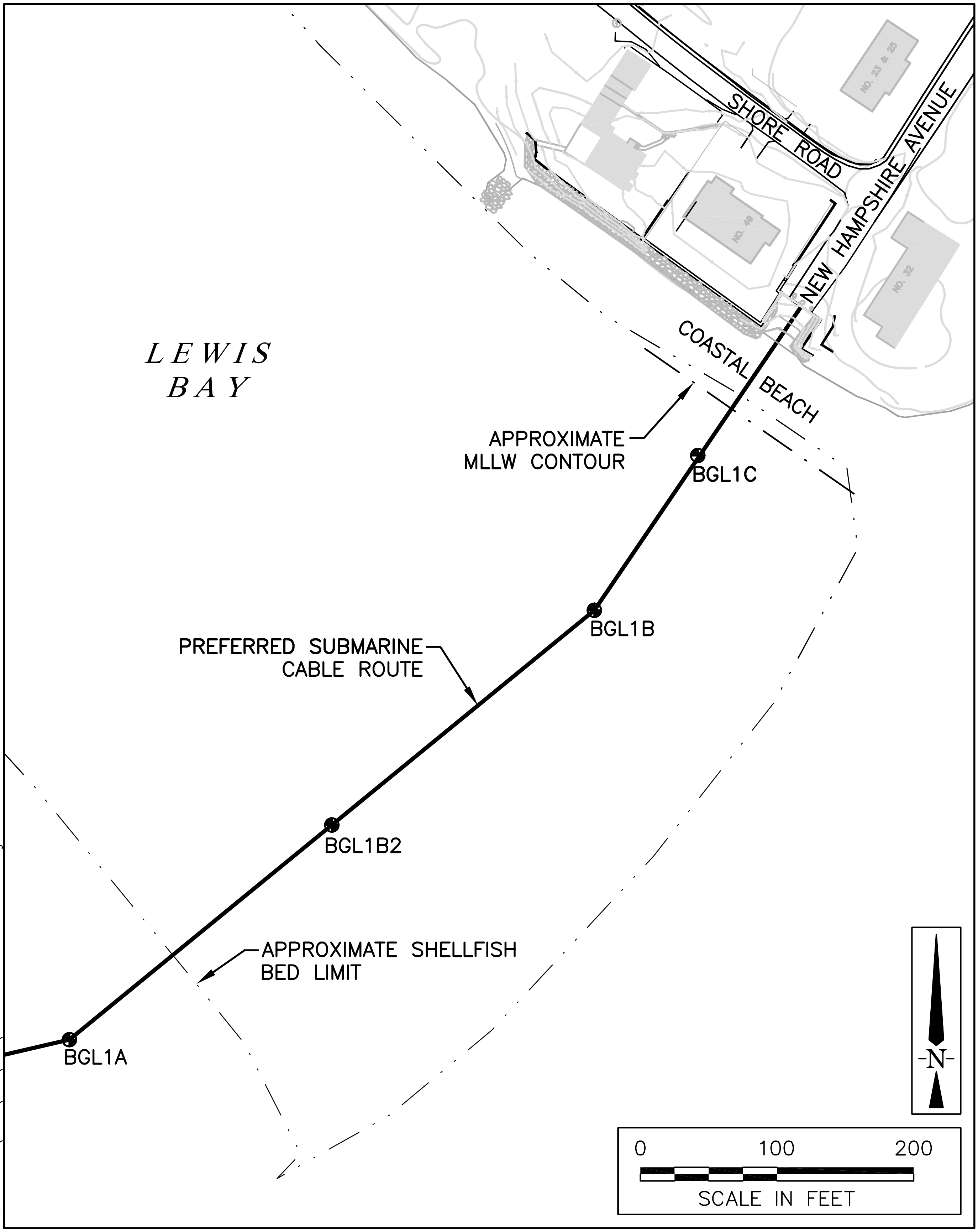
Table 3. Macroinvertebrate sampling data for Lewis Bay, August 2003.

Taxa	Number of Individuals per m^2								
	Dredge Sample BG-L1A	Dredge Sample BG-L1B	Dredge Sample BG-L1C	Sieve Sample BG-L1B	Sieve Sample BG-L1C	$48m^2$ Rake Sample BG-L1A	$81m^2$ Rake Sample BG-L1B	$64m^2$ Rake Sample BG-L1B2	$51m^2$ Rake Sample BG-L1C
Bivalvia									
Anadara ovalis							2	6	1
Crassostrea virginica								2	
Mercenaria mercenaria				P		5	7		4
Pandora gouldiana				P					
Spisula solidissima	5540	2424	3116						
Tellina agilis	692								
Crustacea									
Amphipoda									
Aoridae	346								
Cumacea									
Oxyurostylis smithi	346								
Decapoda									
Unidentified small crabs							2		
Ovalipes ocellatus				P					
Pagurus spp.					P				
Gastropoda									
Busycon carica							2		
Crepidula fornicata								2	
Retusa canaliculata		346							
Spisula solidissima									
Nematoda	36355	39125	33932						
Oligochaeta	5194	2424	3462						
Polychaeta									
Brania clavata	1731	2770							
Capitellidae	692	692	2077						
Driloneris spp.	1039								
Dispio uncinata		1039	346						
Eteone sp.	346	346							
Lumbrineris spp.		346		P	P				
Nereis pelagica				P					
Paraonis spp.	1731	692	1039						
Pectinaria gouldii		692							
Prionospio spp.	1039	692	692		P				
Scoloplos sp.		346	692		P				
Streblospio benedicti	4847	1731	8656		P				
Syllides spp.	1385	1385	3116		P				
Turbellaria		346	692						
Total	**61284**	**55398**	**57822**			**5**	**13**	**10**	**5**
Number of Taxa	**14**	**16**	**11**	**6**	**6**	**1**	**4**	**3**	**2**

P = taxon present in sample

Figures

XREF: E159xr100 [H:\E159\100_Thru21Oct03\E159xr100.dwg]



DATE: Apr 06, 2004 – 2:24PM
FILENAME: H:\E159\004\100\E159–marine–invertebrate.dwg

ESS Group Inc.

Engineers
Scientists
Consultants

Cape Wind Associates, LLC
Cape Wind Project

Marine Invertebrate Sample Locations
Lewis Bay

Figure 1