4.5 Plankton

4.5.1 Introduction

The term "plankton" includes very small, usually microscopic, plants and animals that occupy the marine water column. They are divided in this section into phytoplankton (algae and protozoans) and zooplankton (tiny animals or life stages of larger animals, including eggs and larvae). The eggs and larvae of finfish are an important group within the zooplankton and are treated separately for the purposes of this analysis. The environmental setting, found in Section 4.5.2, is based on available literature. No site-specific study was conducted for this Project. The potential impacts of Port and Pipeline Lateral construction and operation on plankton are described in Section 4.5.3. Section 4.5.4 identifies proposed mitigation measures. Section 4.5.5 discusses the No Action and Port alternatives.

Project Area: The Project area for the Port and Pipeline Lateral includes the ports and harbors along the shoreline of Massachusetts Bay closest to the project, the waters of Massachusetts Bay extending east to boundary of the SBNMS, Gloucester to the north, and on the south to the edge of the in-bound Boston Harbor Traffic Lane. Both the Northeast Port and Pipeline Lateral will require onshore loadout yards for offshore construction materials located at existing industrial or commercial sites. The Pipeline Lateral also includes modifications at two existing onshore aboveground facilities located in the City of Salem and the Town of Weymouth.

Issues: The following issues related to plankton were considered in the preparation of this section:

- Estimated quantity of species intake from daily operations;
- Potential construction and operations impact on plankton;
- Potential impacts of discharge water temperature changes on plankton, eggs, and larvae;
- Potential impacts on plankton, eggs, and larvae of impingement and entrainment from routine shipboard operations and ballast intake; and
- Potential impacts of an oil or LNG spill on marine life, including plankton.

4.5.2 Environmental Setting

4.5.2.1 Regulatory Framework

There are no regulations that apply specifically to plankton, though they are indirectly regulated as part of the habitat for species with EFH designations. See Section 4.7.2.1 for a discussion of EFH.

4.5.2.2 Phytoplankton

Phytoplankton are free-floating microscopic algae and protozoans that drift at or near the surface of the ocean. They obtain energy through photosynthesis and form the basis of the food chain in the marine environment. They also have key ecosystem roles in the distribution, transfer, and recycling of nutrients and minerals. Phytoplankton serve as food for zooplankton, including some ichthyoplankton species, which in turn are consumed by larger crustaceans, small fish, and whales. Within Massachusetts Bay, phytoplankton abundance is controlled by both abiotic (i.e., nutrients, water temperature, light) and biotic (i.e., consumption) factors. Highest densities of phytoplankton occur in the photic zone (zone where light penetrates). In offshore waters, the depth of the photic zone is about 100 feet (30 meters) (Hubbard et al. 1988).

The phytoplankton community in Massachusetts Bay is a small part of the larger community characteristic of the Gulf of Maine. The plankton community in Massachusetts Bay is usually dominated year round by unidentified microflagellates (<10 microns in diameter) (Libby et al. 2004). The annual phytoplankton cycle is marked by blooms large and abrupt increases in cell abundance) in the winter-spring period (February), associated with increasing day length, and in the fall period (September through December), associated with the breakdown of the thermocline (thermal layering) and water column mixing that allows introduction of nutrients to surface waters. The winter-spring bloom is characterized by abundant numbers of diatoms, such as *Stephanopyxis turris*, *Thalassiosira nordenskioldii, Thalassionema nitzschioides,* and *Cylindrotheca closterium*. The summer phytoplankton community is a relatively stable, mixed assemblage of unidentified microflagellates, which reach peak annual abundances in the summer, as well as unidentified cryptomonads (*Cryptomonas* spp. <10 microns long) and diatoms (various small-sized species of *Chaetoceros*). The fall bloom consists of a mixed community of diatoms (*Skeletonema costatum, Asterionellopsis glacialis, Dactyliosolen fragilissimus*), cryptomonads, and various dinoflagellates, but blooms of single species have also occurred. While species composition may vary from year to year, the general pattern has been documented in several studies starting in the early 1970s (Hubbard et al. 1988; NAI 1998).

Blooms of the nuisance alga *Phaeocystis pouchetii* in Massachusetts Bay, when present, usually occur in the spring (April). Annual blooms have occurred every year since 2000 (Libby et al. 2004). Prior to that, *Phaeocystis* blooms followed a 3-year cycle. These blooms are a regional event and occur throughout Massachusetts and Cape Cod Bays. The toxic dinoflagellate, *Alexandrium tamarense*, which causes "red tide," is rarely found in Massachusetts Bay and when present, is usually observed at low concentrations in the late spring. A regional fall bloom of the potentially-toxic diatoms of the genus *Pseudo-nitzschia* occurred in Massachusetts Bay in 2003.

4.5.2.3 Zooplankton

This section presents information on the invertebrate zooplankton resource within the Project area. The zooplankton comprises three ecologically distinct fractions, the holoplankton (species present throughout all lifestages in the plankton), the meroplankton (typically larval stages of benthic invertebrates), and the hyperbenthos (species typically associated with the substrate, but which migrate into the water column on a regular basis or are spatially concentrated in the water immediately above the substrate). Seasonal changes in species composition are consistent over much of the Gulf of Maine. These characteristics are described in this section. Zooplankton may be impacted during operation of the Project through entrainment with the seawater used during routine shipboard operations and ballast water intake (see Section 2.5.12.1, Table 2.5-3).

The zooplankton community comprises an extremely diverse assemblage of microscopic free-floating animals, with most marine invertebrate phyla represented as eggs, larvae, or adults. Zooplankton feed on phytoplankton, detritus, and other zooplankton, and provide a link between the primary production of the ocean (i.e., phytoplankton) and the higher trophic levels in the food web. Predators of zooplankton include fish, shellfish, whales, and other zooplankton. Most zooplankton are capable of movement within the water column and some species show a strong diurnal vertical migration in and out of the photic zone, while others tend to augment wind and tidal currents by “swimming” to move laterally.

The zooplankton community in Massachusetts Bay is a small part of the larger community characteristic of the Gulf of Maine (Kropp et al. 2003). The Massachusetts Bay community is dominated throughout the year by various species, including small (*Oithona similis, Pseudocalanus* spp., *Paracalanus parvus*, and *Microsetella norvegica*) and larger copepods (*Centropages typicus, Temora longicornis, Metridia lucens,* and *Calanus finmarchicus*) (Libby et al. 2004). These copepod species are widespread throughout the Gulf of Maine and are characteristic of the waters of the northwest Atlantic Ocean. Occasionally, strong pulses of meroplankton (i.e., organisms that spend only their larval and/or juvenile stages in the planktonic community) can be seasonally important and include barnacle nauplii, larval polychaetes, and mollusc veliger larvae. These benthic organisms have evolved planktonic larvae to aid in dispersal and colonization of new habitats through metamorphosis and settlement from the water column to the seafloor. Settling planktonic larvae exhibit a variety of behaviors and while the exact mechanisms of benthic substrate selection by larvae remains largely unknown, each species typically has preferred substrate characteristics. In addition, ichthyoplankton include the planktonic eggs and larvae of many fish species, as discussed in Section 4.5.2.4.

The annual cycle of zooplankton is influenced by both abiotic (i.e., temperature) and biotic (i.e., predation) factors. Seasonal zooplankton cycles are related primarily to fluctuations in temperature, rather than light and nutrients, as is the case for phytoplankton (Kropp et al. 2003). Zooplankton abundances are highest in mid-summer, lower in the spring and fall, and typically reach lowest levels in late winter, with variable seasonal trends for individual species. Some larger copepods (e.g., *Calanus finmarchicus*) and barnacle nauplii are colder-water taxa and are most abundant in the winter and spring. Warmer-water taxa, such as *Acartia tonsa*, *Centropages hamatus*, and *Paracalanus parvus*, reach peak abundances during summer. The summer and fall are often marked by blooms of ctenophores (*Mnemiopsis leidyi*), predators of zooplankton (Libby et al. 2004). As a result of these blooms, the abundance of copepods and other zooplankton species can substantially decline during these periods. Large-scale regional and global factors, such as climatic changes (i.e., the North Atlantic Oscillation), appear to have a greater affect on zooplankton communities than do small-scale local factors.

Benthic species whose early lifestages occur in the plankton (meroplankton) are highly seasonal in their occurrence. Investigations for Seabrook Station, located approximately 33 miles (53 kilometers) north of the Project, also provide valuable insight into the meroplankton likely to occur in the vicinity of the Project because the Gulf of Maine circulation links these areas hydrographically. NAI (2004) has recorded eight species of bivalves that occur routinely in the plankton. One or more species has always been present during the April through October survey period. The Saxicave bivalve *Hiatella* sp., jingle shell (*Anomia squamula*) and blue mussel (*Mytilus edulis*) are by far the most abundant. Dominant arthropod species occurring in the meroplankton included the shrimp *Eualus pusiolus* and *Crangon septemspinosa*, the crabs *Cancer* sp., *Carcinus maenas* and *Pagurus* sp., and barnacle larvae. Larval stages of echinoderms and coelenterates may be seasonally abundant. These larval lifestages are typically most abundant in the summer months (Table 4.5-1).

Lobster larvae are most abundant from mid-June through late September (Jury et al. 1994). There are no abundance data available for the project area. NAI (2004a) found that abundances off Seabrook, New Hampshire and Johns Bay, Maine were similar for the period 1995 through 1999, however, and these data can provide an indication of the order of magnitude of this resource in this portion of the Gulf of Maine. From 1999 through 2002, the average abundance of lobster larvae (all stages combined) found off Seabrook, New Hampshire for the weeks between the first appearance and last appearance of larvae in the neuston (upper half meter of the water column) ranged from 4.2 (2002) to 4.6 (2001) larvae per 1,000 cubic meters (NAI 2000, 2001, 2002, 2003). Larvae were present for 14 to 19 weeks, averaging 16 weeks for these years. Larvae were predominantly Stage I and Stage IV.

4.5.2.4 Ichthyoplankton

The ichthyoplankton (fish eggs and larvae) resources of Massachusetts Bay and the eastern Gulf of Maine have been summarized by Jury et al. (1994) using existing published and unpublished data sources. The relative abundance and seasonal occurrence of ichthyoplankton in Massachusetts Bay were tabulated in Jury et al. (1994) for 45 species based on their values as commercial, recreational and ecological value, and as indicators of environmental stress. Of these 45 species, 25 were listed as common, abundant, or highly abundant in Massachusetts Bay, and their relative seasonal occurrence is presented in Table 4.5-2.

Potential impacts from the Project on the ichthyoplankton resources include entrainment of ichthyoplankton with the seawater used during routine shipboard operations and ballast water intake (see Section 2.5.12.1, Table 2.5-3). Prior to estimating the importance of these impacts, it is important to describe the existing ichthyoplankton resources.

Table 4.5-1. Seasonal Distribution of Meroplankton in Massachusetts Bay

Species	Lifestage	J	F	M	A	M	J	J	A	S	O	N	D
Blue mussel	egg				C	H	H	H	H	H			
Mytilus edulis	larvae				C	H	H	H	H	H	H		
Sea scallop	egg								C	C	C		
Placopecten magellanicus	larvae								C	C	C	C	
Northern quahog	egg						C	C	C				
Mercenaria mercenaria	larvae						C	C	C				
Softshell clam	egg			A	A	A	A	A					
Mya arenaria	larvae			A	A	A	A	A					
Daggerblade grass shrimp	egg					C	C	C	C				
Palaemonetes pugio	larvae						C	C	C				
Northern shrimp	egg	A	A	A	A							A	A
Pandalus borealis	larvae		A	A	A	A							
Sevenspine shrimp	egg				A	A	H	H	H	A	C		
Crangon septemspinosa	larvae				C	A	H	H	H	H	A		
American lobster *Homarus americanus*	larvae						C	C	C	C			
Jonah crab *Cancer borealis*	larvae						C	C	C	C			
Atlantic rock crab *Cancer irroratus*	larvae						C	C	C	C	C		
Green crab *Carcinus maenas*	larvae					C	C	C	C	C	C		
Green sea urchin *Strongylocentrotus droebachiensis*	larvae					C	C	A	A	A	C		

C=common, A=abundant, H=highly abundant Source: Jury et al. 1994.

From Table 4.5-2 it is apparent that ichthyoplankton are present in Massachusetts Bay year round, and at least one species is listed as "Abundant" each month. During the winter months of January through March, the eggs and larvae of white hake, longhorn sculpin, American sand lance, and winter flounder were listed as abundant by Jury et al. (1994) in Massachusetts Bay (Table 4.5-3). In addition, American plaice eggs and Atlantic herring larvae were also listed as abundant. Of these species and lifestages, winter flounder and American sand lance eggs are not expected to occur in the Project area because they are demersal and adhesive, and usually deposited in shallow, coastal waters, although winter flounder eggs occur on Georges Bank (Collette and Klein-MacPhee 2002).

During the spring, the eggs and larvae of red and white hake, Atlantic silverside, cunner, American sand lance, cunner, Atlantic mackerel, American plaice, winter flounder, and yellowtail flounder, and the larvae of American eel are considered abundant or highly abundant in Massachusetts Bay by Jury et al. (1994) (Table 4.5-3). Due to their inshore spawning habitats, eggs and larvae of Atlantic silverside, and eggs of American sand lance and winter flounder are not expected to occur in the Project area.

Table 4.5-2. Relative Abundance and Seasonal Occurrence of Ichthyoplankton in Massachusetts Bay

Species	Lifestage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
American eel	Larvae				C	A	A	C					
	Egg												
Atlantic menhaden	Larvae						C	C	C	C			
	Egg					C	C	C	C	C			
Atlantic herring	Larvae	A	C	C	C	C					A	A	A
	Egg												
Atlantic cod	Larvae	C	C	C	C	C							C
	Egg	C	C	C	C								C
Silver hake	Larvae					C	C	C	C	C	C		
	Egg					C	C	C	C	C	C		
Pollock	Larvae	C	C	C									C
	Egg	C	C	C									C
Red hake	Larvae						A	A	A	A	C	C	
	Egg						A	A	A	A	A		
White hake	Larvae			A	A	A	A	A	A	A	A	A	
	Egg			A	A	A	A	A	A	A	A		
Mummichog	Larvae					C	C	C	C				
	Egg					C	C	C	C				
Atlantic silverside	Larvae				C	H	H	A	C				
	Egg				A	H	H	C					
Northern pipefish	Larvae				C	C	C	C	C	C			
	Egg												
Grubby	Larvae	C	C	C	C	C							
	Egg	C	C	C	C	C							C
Longhorn sculpin	Larvae	A	A	A	C	C	C						
	Egg	A	A	C	C								C
Tautog	Larvae						C	C	C	C			
	Egg					C	C	C	C				
Cunner	Larvae						H	H	H	A	C		
	Egg						H	H	H	A			
Ocean pout	Larvae								C	C	C	C	
	Egg												
Rock gunnel	Larvae	C	C	C	C	C	C						
	Egg	C	C	C	C								C
American sand lance	Larvae	A	A	A	A	A	A	C					C
	Egg	A	A	A	A	A	C					A	A
Atlantic mackerel	Larvae				C	A	A	A					
	Egg				C	A	A	A					
Butterfish	Larvae												
	Egg						C	C	C	C			
Windowpane	Larvae					C	C	C	C	C	C		
	Egg					C	C	C	C	C			
American plaice	Larvae			C	A	A	A	A					
	Egg			A	A	A	A						
Winter flounder	Larvae		A	H	H	H	A	C					
	Egg	C	A	A	A	A	A	C					
Yellowtail flounder	Larvae				C	A	A	A	A	C			
	Egg				C	A	A	A	C	C			

C= Common; A = Abundant; H = Highly Abundant

Source: Jury et al. 1994.

Table 4.5-3. Seasonal Occurrence of Abundant Ichthyoplankton in Massachusetts Bay

Season	Abundant Egg Species	Abundant Larval Species
Winter (Jan. - Mar.)	white hake, longhorn sculpin, *American sand lance,* American plaice, *winter flounder*	Atlantic herring, white hake, longhorn sculpin, American sand lance, winter flounder
Spring (Apr. – Jun.)	red hake, white hake, *Atlantic silverside*, cunner, *American sand lance*, Atlantic mackerel, American plaice, *winter flounder*, yellowtail flounder,	American eel, red hake, white hake, *Atlantic silverside*, cunner, American sand lance, Atlantic mackerel, American plaice, winter flounder, yellowtail flounder
Summer (Jul. – Sep.)	red hake, cunner, Atlantic mackerel, yellowtail flounder	red hake, cunner, *Atlantic silverside*, Atlantic mackerel, American plaice, yellowtail flounder
Fall (Oct. – Nov.)	*Atlantic herring*, red hake, white hake, American sand lance	White hake

Note: Species in italics are not expected to be abundant in the Project area.
Source: Jury et al. 1994.

The summer ichthyoplankton community in Massachusetts Bay may be expected to be dominated by the eggs and larvae of red and white hake, cunner, Atlantic mackerel, and yellowtail flounder, with the larvae of American plaice and Atlantic silverside also abundant (Table 4.5-3). These species, with the exception of Atlantic silverside, could also be expected to be abundant in the Project area. During the fall, white hake eggs and larvae, and the eggs of Atlantic herring, red hake, and American sand lance may be abundant in Massachusetts Bay (Table 4.5-3). Of these species and lifestages, the eggs of Atlantic herring and American sand lance are not expected to occur in the Project area. Atlantic herring eggs are demersal and adhesive, and are deposited on gravelly substrates with strong tidal currents (Reid et al. 1999). American sand lance eggs are usually deposited farther inshore (Auster and Stewart1986).

The data of Jury et al. (1994) provide an indication of the relative abundance of ichthyoplankton in Massachusetts Bay, but not an indication of the absolute abundance. Ichthyoplankton sampling associated with the Seabrook Station environmental monitoring program has taken place approximately 33 miles (53 kilometers) north of the Project area in water about 65 feet (20 meters) deep. Both these locations are in the western Gulf of Maine, although the Seabrook Station sampling occurs in waters that are shallower compared to the 250 to 270 foot (76 to 82 meters) depths of the Project area. Therefore, it is likely that the data from the Seabrook Station program will be more representative of an inshore ichthyoplankton community, than the community found in the Project area. However, the Seabrook Station data do provide a good indication of the seasonal absolute abundance and species composition of ichthyoplankton in the western Gulf of Maine. Furthermore, the Seabrook Station data are more current than the historical data presented in Jury et al. (1994).

The fish egg community off Seabrook, New Hampshire, can be divided into two seasonal assemblages by numerical classification (NAI 1998). A late fall through early spring (November through April of most years) assemblage of fish eggs was characterized by a lower density of eggs compared to the rest of the year (Table 4.5-4). American plaice, pollock, Atlantic cod and haddock eggs were dominant in the late fall through early spring. During the mid-spring through fall (May through October of most years), density of fish eggs was highest and cunner, windowpane, Atlantic mackerel, hake, fourbeard rockling, American plaice, and yellowtail flounder were the dominant species (Table 4.5-4).

These data on the fish egg community are in general agreement with those of Jury et al. (1994). During the late fall through early spring (November through April), American plaice, pollock and Atlantic cod eggs were either abundant or common according to Jury et al. (1994). Longhorn sculpin eggs were also abundant in the data of Jury et al. (1994), but these adhesive eggs are often found near the bottom and were not captured by the oblique tows used in the Seabrook Station study. During the mid-spring through fall (May through October) cunner, windowpane, Atlantic mackerel, red and white hake, and yellowtail flounder eggs were either abundant or common in Jury et al. (1994). Atlantic silverside and winter flounder eggs were listed as abundant and highly abundant in Massachusetts Bay by Jury et al. (1994) in the mid-spring through fall, but these eggs usually occur too far inshore to be abundant in either the Project area or the Seabrook Station sampling area.

The larval fish community off Hampton, New Hampshire, can also be divided into two seasonal assemblages, with the fall through spring (October through May of most years) assemblage generally having lower densities of fish larvae than the late spring through early fall (June through September of most years) assemblage (Table 4.5-5). The fall through spring assemblage was dominated by American

Table 4.5-4. Dominant Members of the Fish Egg Community off Hampton, New Hampshire and Massachusetts Bay

Season	Hampton, NH, Taxa	Geometric Mean Density (no./1000 m^3)[a/]	Massachusetts Bay Abundant Taxa[b/]
Late Fall-Early Spring (Nov.-Apr.)	American Plaice	0-56	American plaice
	Pollock	0-2	Pollock
	Atlantic cod/haddock[c/]	5-32	Atlantic cod
			Longhorn sculpin
Mid Spring-Fall (May-Oct.)	Cunner/yellowtail flounder[c/]	0-17,305	Cunner
	Windowpane	0-290	Windowpane
	Atlantic mackerel	0-200	Atlantic mackerel
	Hake	5-167	Hake
	Fourbeard rockling/hake	1-385	Yellowtail flounder
	American plaice	0-57	*Atlantic silverside*
			Winter flounder

[a/] NAI 1998.
[b/] Jury et al. 1994.
[c/] Some taxa are grouped because the eggs cannot be distinguished.
Note: Species in italics are not expected to be abundant in the Project area.

Table 4.5-5. Dominant Members of the Fish Larvae Community off Hampton, New Hampshire and Massachusetts Bay

Season	Hampton, NH, Taxa	Geometric Mean Density (no./1000 m^3)[a/]	Massachusetts Bay Abundant Taxa[b/]
Fall - Spring (Oct. - May)	American sand lance Atlantic seasnail Atlantic herring Winter flounder	0-228 0-34 0-31 0-5	American sand lance Hake Atlantic herring Winter flounder Longhorn sculpin Atlantic mackerel
Late Spring – Early Fall (Jun. – Sep.)	Cunner Atlantic mackerel Winter flounder Fourbeard rockling	3-305 0-42 0-12 3-39	Cunner Atlantic mackerel Winter flounder Hake American sand lance Yellowtail flounder *Atlantic silverside*

[a/] NAI 1998.
[b/] Jury et al. 1994.
Note: Species in italics are not expected to be abundant in the Project area.

sand lance, Atlantic seasnail, Atlantic herring, and winter flounder larvae. The late spring through early fall assemblage was dominated by cunner, Atlantic mackerel, winter flounder, and fourbeard rockling larvae (Table 4.5-5).

The larval community data collected off Hampton, New Hampshire, are in general agreement with the data from Massachusetts Bay summarized by Jury et al. (1994). American sand lance, hake, Atlantic herring, winter flounder, and longhorn sculpin were all listed as abundant or highly abundant in the fall through spring by Jury et al. (1994). The Massachusetts Bay listing did not include Atlantic seasnail, possibly because it was not considered commercially, recreationally or ecologically important. The late spring through early fall assemblage was also generally similar between Hampton, New Hampshire and the Project area. Cunner, Atlantic mackerel, and winter flounder were all dominant larval species in both areas. Atlantic silverside larvae were listed as abundant in Massachusetts Bay but probably would not occur in the offshore Project area. Other differences in the community listings may be due to interannual differences among the years studied.

Significant annual differences in the ichthyoplankton community of the western Gulf of Maine have occurred in recent years. Starting in 1988, Atlantic mackerel, cunner/yellowtail founder eggs have increased in abundance while hake eggs have decreased (NAI 2004b). In the larval community, starting in 1989, cunner and fourbeard rockling larvae became much more abundant while abundance of Atlantic mackerel decreased to a lesser degree. These changes in the ichthyoplankton community indicate that data collected prior to 1988 probably do not represent current conditions.

4.5.3 *Impact Analysis*

4.5.3.1 General Port Impact Analysis

Aspects of construction and operation that have the potential to impact components of the plankton communities in the Project area are described in this section. Impacts could occur through disturbance of the substrate that causes changes in water quality or through withdrawal of seawater for various processes. The specific potential impacts are described for each plankton component in the following sections and are summarized in Table 4.5-6.

Port Construction

Construction will entail the placement of spools, flowlines, and the PLEM on the seafloor. The spools and flowlines will be trenched and buried. The 1,900-foot-long (579-meter-long) Flowline A will be trenched using a diver-operated jet. Trenching and burial of the 3,700-foot-long (1,128-meter-long) Flowline B will be accomplished using a deepsea plow. Burial of the flowlines and spools will necessarily disturb the fine-grained sediments prevalent in the Project area, suspending them in the water column. Results of water quality monitoring conducted during construction of the HubLine pipeline provide insight into the likelihood of water quality impacts from construction. In water depths up to 130 feet (39 meters), plowing, and jetting along the HubLine route produced negligible temporary increases in turbidity (TRC 2004b). Although the fine-grained sediments present in the Northeast Gateway Port area will be easily suspended, the relatively short distances along which construction will occur and the substantially greater water depth (compared to HubLine) suggest that turbidity generated during construction will be limited in concentration, duration, and spatial extent. It is unlikely that any increase in turbidity will be evident in the upper portions of the water column.

Table 4.5.6. Summary of Port Construction and Operational Activities Potentially Impacting Plankton Communities

Activity	Phytoplankton	Zooplankton	Ichthyoplankton
Construction			
Spool installation	minor indirect	minor indirect	most species minor indirect
Flowline installation	minor indirect	minor indirect	most species minor indirect
Suction anchor installation	minor indirect	minor indirect	most species minor indirect
PLEM installation	minor indirect	minor indirect	most species minor indirect
Flowline hydrostatic testing	minor direct	minor direct	minor direct
Operation			
Anchor sweep	minor indirect	minor indirect	most species minor indirect
Daily water use	direct	direct	direct
Ballast water intake	direct	direct	direct

Placement of the suction anchors will also disturb the substrate, but the disturbance will be limited to the period when the anchors first contact the seafloor. Any turbidity generated will be dissipated quickly. Placement of the hollow anchors on the substrate will trap the volume of water lying directly above the substrate. This water will be pumped out over a period of several hours; the pumping action creates the suction that draws the anchors deeply into the substrate.

Placement of the PLEM on the seafloor will briefly disturb the substrate and cause a temporary increase in suspended sediments in its immediate vicinity.

Once the flowlines are fully installed, their integrity will be tested hydrostatically. Hydrostatic testing of the two flowlines will require the one-time use of 27,000 gallons (102 cubic meters) for Flowline A and 48,000 gallons (182 cubic meters) for Flowline B or 75,000 gallons (284 cubic meters) total of filtered seawater. Water will be withdrawn from surface waters, filtered to remove debris that could damage the valves, and piped into the flowlines where it will be contained for up to 2 days. THPS, a biocide that demonstrates low toxicity in aquatic organisms (Section 4.4.3.2) may be used if required to inhibit microbially induced corrosion. After the test is complete, the water will be returned to the construction vessel and discharged back into Massachusetts Bay. THPS was used for the HubLine with no water quality impacts to the receiving water (Fore River in Weymouth).

Port Operation

Three aspects of operation of the Northeast Port have the potential to affect the water column and the biota associated with it. Anchor cables attached to the STL™ buoy will rest on the seafloor while the buoy is submerged. Coupling with the EBRV will pull the anchor cables up through the water column, but it will also increase the swing in these lines because of the ship's weathervaning in response to wind and surface currents. The ship's movements will cause the anchor cables to sweep across the substrate, suspending sediments for the duration of the period the buoy is occupied. It is likely that any increase in turbidity will be restricted to the lower portion of the water column.

Each EBRV will require up to 54 MGD (205,000 cubic meters per day) of seawater for typical hotelling uses as well as to generate steam to aid in the regasification process. Of this quantity, 250,000 gallons per day (950 cubic meters per day) will be desalinated for gray water uses on the ship. The remaining volume will be diverted past the boilers and converted to steam to produce electricity necessary to meet the needs of the vessel (see Section 2.5.12.1 for further detail). The desalinated water will be recombined with the rest of the volume prior to discharge. Water temperature at the discharge point will be about 10°F (5.5°C) higher than at the intake, but the temperature difference at the surface will be less than 1°C (see Section 4.4.3).

Intake of ballast water will occur continuously as the LNG is regasified and pumped into the flowlines. A total volume of 13.5 million gallons (51,000 cubic meters) per 7- to 8-day ship visit at the Port will be required. On average, each EBRV will require 1.4 to 2 MGD (5,200 to 7,600 cubic meters per day) of ballast water intake depending on the duration of regasification.

4.5.3.2 Phytoplankton Port Impact Analysis

Direct Impacts of Port Construction

Installation of the spools, flowlines, anchoring system and PLEM for the Northeast Port will have no direct impacts on phytoplankton. Because the anchors will be placed in water depths of 270 to 290 feet (82 to 88 meters), well below the photic zone of about 100 feet (30 meters), phytoplankton will not be affected by this action.

It is anticipated that hydrostatic testing of the flowlines will occur in the spring. Phytoplankton cells contained in the test water will likely stop growing, but may or may not be killed. Historically, the spring phytoplankton bloom has been dominated by diatoms and dinoflagellates with a bloom of the prymnesiophycid *Phaeocystis pouchetii* occurring about every 3 years. Since 2000, *Phaeocystis* has bloomed on an annual basis, so there is a reasonable likelihood that hydrostatic testing will occur during a bloom of this species. While hydrostatic testing will result in a very minor net loss of phytoplankton from the ecosystem, *Phaeocystis* is not a valuable food resource for planktivores, so there should be negligible food web implications from this loss. Any cells killed during the testing, as well as any living cells, will be returned to Massachusetts Bay when the test water is discharged so that there will be no change in their contribution to the nutrient cycle.

Indirect Impacts of Port Construction

Although each of the construction activities will cause minor disturbance of the sediment, causing a near-bottom turbidity plume and release of sediment-bound nutrients, there are several reasons why these actions will not affect phytoplankton. First, most viable phytoplankton exist in a much higher portion of the water column (above a depth of 100 feet [30 meters]) than will be affected by construction-induced turbidity.

Second, disturbance of the sediments may introduce nutrients to the water column. Any nutrient enrichment of bottom waters from these activities will be limited spatially and temporally. Such activity during the period of the breakdown of the thermocline in the fall may introduce incrementally more nutrients to surface waters than would occur normally. It is unlikely that any increase in nutrients from this source would have a detectable effect on phytoplankton.

Third, some species of both diatoms and dinoflagellates have been found to have resting cells that can be associated with the substrate (Garrison 1984; Steidinger and Walker 1984). Although not documented, it is possible that some nuisance species, such as the toxic dinoflagellate *Alexandrium* or the diatom *Pseudo-nitzschia* have resting cells. If these cells are present in the sediments disturbed by construction, they may be released into the water column. They will only contribute to the phytoplankton community dynamics if they reach the photic zone. It is unlikely that any resuspension of sediments and associated resting cells will be detectable in the photic zone, so release of resting cells into the water column is unlikely to be significant.

Direct Impacts of Port Operation

Seawater withdrawn for the ship operations will be withdrawn from a depth of 23 to 38 feet (7 to 12 meters). Because this depth is in the upper third of the photic zone, this portion of the water column supports an active phytoplankton community. Future production of phytoplankton entrained in the ships' water systems will be lost from the Massachusetts Bay ecosystem, although dead cells will be discharged so that the nutrients they contain will be reintroduced to the water column.

Libby et al. (2004) found that the total phytoplankton densities in Stellwagen Basin and Stellwagen Bank ("Offshore Area" in MWRA monitoring program) ranged from about 0.25×10^6 to 1.5×10^6 cells per liter over an annual cycle. Seawater use by the Project would, therefore, remove 5.3×10^{13} to 32×10^{13} cells on a daily basis from production in Massachusetts Bay, assuming that mortality is 100 percent. The significance of this loss is difficult to grasp, but it is unlikely that this change would be detectable by standard monitoring techniques. To place this impact in perspective, Seabrook (New Hampshire) Station included phytoplankton in its monitoring program for its 600 MGD (2.3 million cubic meters) intake. After 7 years of monitoring operations, it was determined that effects of the plant's operation were indistinguishable from natural variability and the program was dropped from subsequent studies (NAI 1998).

Indirect Impacts of Port Operation

The regular disturbance of the seafloor by movement of the anchor cables while the ship is connected to the buoy will cause regular near-bottom turbidity events. As described for sediment disturbance during construction, however, it is unlikely that this action will affect the phytoplankton community.

Temperature is sometimes implicated in changes in the phytoplankton community. While the water withdrawn for ship use will be returned to Massachusetts Bay at a slightly elevated temperature, it will reach ambient conditions rapidly (Section 4.4.3.1). Given the dynamic oceanographic conditions, phytoplankton cells do not "reside" in a particular location and will not, therefore, be continuously exposed to elevated temperatures at the discharge. It is unlikely that the heated discharge will affect the phytoplankton community in the receiving water.

Rapid cycling of water through ship operations (1 day) will prevent the onset of decomposition of dead organisms prior to discharge, minimizing the likelihood that the nutrient content of the discharge is elevated. Even if there is some elevation in nutrient content, the rapid dissipation of the discharge will likely prevent this nutrient addition from causing any changes in the phytoplankton community. Libby et al. (2003) found that MWRA's outfall, discharging an average of 320 MGD of nutrient-enriched municipal wastewater into Massachusetts Bay, has had no discernable effect on the phytoplankton community of this ecosystem.

4.5.3.3 Zooplankton Port Impact Analysis

Direct Impacts of Port Construction

Installation of the spools, flowlines, anchoring system, and PLEM for the Northeast Port will have no direct impacts on zooplankton. Because the anchors will be placed in water depths of 270 to 290 feet (82 to 88 meters), most zooplankton species are unlikely to be affected by this activity. Hyperbenthic species that regularly swim into the water column may, however, be entrapped within the suction anchors and killed. Several factors suggest that this impact is negligible. The benthic habitat is very uniform throughout the entire area surveyed for buoy placement, the footprint of the anchors is small (0.18 acre), and the volume of water initially entrapped in the anchors is small.

It is anticipated that hydrostatic testing of the flowlines will occur in the spring, a period when the copepod-dominated holoplankton abundances are typically increasing from their winter lows, although peak abundances are not achieved until June to August (Libby et al. 2004). Bivalve larvae are typically relatively low in abundance in the spring in coastal New Hampshire waters (NAI 1998) and it is likely to be similar in the Project area. Lobster larvae are most likely to be in the area in June through September and so they will not be exposed to this activity. Benthic sampling in the buoy area revealed few amphipods and mysids that are the most likely components of the hyperbenthos. Zooplankton contained in the test water may be killed. Dead (and living) organisms will be returned to Massachusetts Bay when the test water is discharged so that there will be no change in their contribution to the nutrient cycle.

Indirect Impacts of Port Construction

Although each of the construction activities will cause minor disturbance of the sediment, causing a near-bottom turbidity plume and release of sediment-bound nutrients, they will not affect zooplankton. Most holoplankton species are associated with the same portion of the water column as their primary food source, phytoplankton (above a depth of 100 feet [30 meters]) and will therefore not be exposed to the disturbed sediments. Hyperbenthic species may be temporarily suspended in the water column or killed. The small area affected by the flowlines will minimize this potential impact.

Direct Impacts of Port Operation

Seawater withdrawn for the ship operations will be withdrawn from a depth of 23 to 38 feet (7 to 12 meters), a depth zone that supports zooplankton. Zooplankton may not survive entrainment, resulting in a net loss of living biomass will be lost from the Massachusetts Bay ecosystem. The discharge will include all living and dead zooplankton so that the nutrients they contain will be reintroduced to the ecosystem.

Libby et al. (2004) found that the total maximum zooplankton densities in the vicinity of the MWRA outfall ranged from about 30,000 to 275,000 individuals per cubic meter over an annual cycle. Seawater use by the Project could, therefore, remove 6 x 10^6 to 60 x 10^6 zooplankters from Massachusetts Bay on a daily basis. This loss is not significant and it is likely that this change would not be detectable by standard monitoring techniques. To place this impact in perspective, Seabrook (New Hampshire) Station included microzooplankton in its monitoring program for its 600 MGD (2.3 million cubic meters) intake, over ten times the uptake of an EBRV. After 7 years of monitoring operations, it was determined that the effects of the plant's operation were not distinguishable from natural variability and the program was dropped from subsequent studies (NAI 1998). Bivalve larvae and macrozooplankton (that includes the majority of the hyperbenthos and many meroplankton species) are still monitored for Seabrook, but 13 years of operational monitoring have not indicated that the station has affected these components of the ecosystem (NAI 2004b).

Lobster larvae may be entrained with the seawater withdrawn by the EBRVs. Using the average density of lobster larvae observed off Seabrook New Hampshire in recent years (4.4 larvae per 1,000 cubic meters) for an average period of 16 weeks, and assuming that all of the larvae are residing in the water column affected by the intakes, it is estimated that up to 105,000 lobster larvae could be entrained annually. Incze et al. (2003) used larval mortality rates and postlarval (Stage IV) settlement success rates to estimate the recruitment to the adult population. Using the conservative assumption that all the larvae entrained were Stage IV and using a conservative postlarval settlement rate of 2.5 percent (Incze et al. 2003), entrainment by the EBRVs would, worst case, prevent the settlement of 2,625 EBP lobsters (young-of-the-year). Using the highest age-specific survival rates presented in Incze et al. (2003), and assuming no fishing mortality, entrainment during operation of the EBRVs would remove about 550 age 5 (age at which lobster start being recruited into the fishery) or about 350 age 8 (age at which all individuals are likely to have been recruited into the fishery and are sexually mature) lobsters from the population on an annual basis.

Indirect Impacts of Port Operation

The regular disturbance of the seafloor by movement of the anchor cables while the ship is connected to the buoy will cause regular near-bottom turbidity events. As described for sediment disturbance during construction, however, it is unlikely that this action will affect the zooplankton community.

4.5.3.4 Ichthyoplankton Port Impact Analysis

Direct Impacts of Port Construction

Aspects of construction that disturb the substrate have the potential to impact early life stages of fish species whose eggs are demersal. Winter flounder and American sand lance are the only species common in Massachusetts Bay with this life history strategy. It is unlikely that winter eggs of either species will be present in the Project area because both species spawn preferentially in shallow water (winter flounder generally less than 30 feet [10 meters] and sand lance inshore in waters less than 6 feet [2 meters] deep).

Fish eggs and larvae may be entrained in the hydrostatic test water withdrawn from near the sea surface for testing the flowlines. Assuming that Project construction is initiated in the fall, hydrostatic testing of the flowlines is likely to take place in the March through May timeframe. Jury et al. (1994) reported that eggs of 14 fish species and larvae of 13 fish species are likely to be common to highly abundant in Massachusetts Bay during those months (Table 4.5-2). An estimate of the number of fish eggs and larvae affected by this process is shown in Table 4.5-7 based on average densities observed during the spring in

Table 4.5-7. Estimated Worst-Case Entrainment of Fish Eggs and Larvae during Hydrostatic Testing of the Flowlines for the Port

Species	2003[a/]	2002[b/]	2001[c/]	2000[d/]	1999[e/]	5-Year Average	Total Entrainment[f/]
Eggs; Annual Mean Spring Densities (no./1,000 m^3)							
American plaice	143.4	203.1	82.9	37.8	96.5	112.7	32.0
Atlantic cod	4.8	96.1	30.2	2.7	28.6	32.5	9.2
Atlantic mackerel	552.8	1,970.7	2,098.2	3,802.7	9,523.5	3,589.6	1,019.4
Cod/witch flounder	4.1	190.2	3.4	0	53.0	50.1	14.2
Cunner/tautog/yellow-tail flounder	70.5	2004.2	497.9	1457.6	373.2	880.7	250.1
Fourbeard rockling	87.9	74.9	88.7	13.4	4.1	53.8	15.3
Fourbeard rockling/hake	386.7	216.7	149.7	12.6	62.8	165.7	47.1
Haddock	0	1.9	0	0	0	0.4	0.1
Hakes	73.7	6.7	9.6	100.8	11.1	40.4	11.5
Windowpane	11.1	238.7	20	96.5	23.6	78.0	22.1
Yellowtail flounder	0.1	4.2	4.3	3.6	0.3	2.5	0.7
Larvae; Annual Mean Densities (no./1,000 m^3)							
Alligatorfish	2.5	0.9	1.7	7.8	4.1	3.4	1.0
American plaice	1.5	6.4	1.2	2.4	27.1	7.7	2.2
American sand lance	312.6	184.2	560.8	154.5	94.8	261.4	74.2
Atlantic cod	0.2	1.4	0.7	0.1	0	0.5	0.1
Atlantic herring	5.5	1.8	28.8	23.8	38.6	19.7	5.6
Atlantic mackerel	0	0	761.1	6.1	0	153.4	43.6
Cunner	0	0	135.8	0	0	27.2	7.7
Fourbeard rockling	0	1.4	220.5	2.5	0.3	44.9	12.8
Pollock	4.4	0	1.3	0.4	0.3	1.3	0.4
Radiated shanny	51.3	16.3	936.5	44.2	8.7	211.4	60.0
Rock gunnel	102.2	5.7	197.1	49.6	51.4	81.2	23.1
Sculpins	96.5	16.1	170.5	55.0	28.6	80.3	23.1
Snailfish	18.1	24.7	395.1	31.0	158.3	125.5	35.7
Winter flounder	4.9	28.2	5.5	15.2	9.6	12.7	3.6
Yellowtail flounder	0.1	1.0	1.5	0.5	1.5	0.9	0.3

[a/] NAI 2004b; [b/] NAI 2003; [c/] NAI 2002; [d/] NAI 2001; [e/] NAI 2000; [f/] Based on a one-time withdrawal of 75,000 gallons of seawater.

the Seabrook Station offshore monitoring program. Entrainment during hydrostatic testing is predicted to affect fewer than 2,000 fish eggs and fewer than 500 fish larvae.

Ichthyoplankton could be impacted from accidental spills and unintentional release of substances such as diesel fuel, lubricants, and hydraulic fluid. However, the Port will be constructed with an approved SPCC Plan that will serve to minimize potential impacts on ichthyoplankton from spills.

Indirect Impacts of Port Construction

Vertical distribution of ichthyoplankton in Massachusetts Bay has not been documented, but it is likely that most individual post-yolk-sac larvae are located in the upper layers of the water column because they feed on other planktonic organisms. The majority of the ichthyoplankton in the Project area will not, therefore, be exposed to construction-related turbidity.

Direct Impacts of Port Operation

Use of seawater for daily ship operations and for ballasting will have similar effects on the ichthyoplankton fauna in the Project area. Ichthyoplankton residing in the volume of water that is withdrawn for either purpose will likely be entrained in the ship's intake system. To be conservative, it is assumed that mortality of organisms entrained in the daily operations system will be 100 percent. Nevertheless, this represents an insignificant net loss of production to the Massachusetts Bay ecosystem. Ichthyoplankton entrained in the ballast water may survive, but they will be removed from the system as well because ballast water will not be discharged in Massachusetts Bay.

Site-specific ichthyoplankton data are not currently available; therefore, results of the Seabrook Station ichthyoplankton offshore monitoring program were used to provide a preliminary estimation of the potential impact from the Northeast Port activities. Seabrook Station withdraws an average of about 600 MGD (2.3 million cubic meters) of seawater a day, over 10 times the uptake from EBRVs. Although ichthyoplankton entrainment is monitored at Seabrook Station, the plant's intake is located in the lower half of the water column (about 10 to 20 feet [3 to 6 meters] above the seafloor in 60 feet [18 meters]of water) while the EBRV will be withdrawing water within about 30 feet (9 meters) of the surface in water depths of greater than 250 feet (76 meters). Fish eggs and larvae are generally not evenly distributed vertically in the water column and with the large difference in water depths, it is likely that entrainment at Seabrook would not be representative of entrainment at the Northeast Port. Offshore sampling at Seabrook samples the entire water column, so these data may provide a reasonable basis for assessment of entrainment impacts at the Northeast Port. It is anticipated that a NOAA ichthyoplankton database for the Gulf of Maine will become available in several months. This database will be evaluated for its applicability to the Northeast Gateway project and, if warranted, the impact assessment will be revised.

Table 4.5-8 provides preliminary entrainment estimates for federally managed species with egg or larval stages likely to occur in the Project area based on densities observed in waters off Seabrook, New Hampshire. Of these species, annual entrainment is projected, using worst-case assumptions, to affect more than 50 million eggs of Atlantic mackerel, red hake, and silver hake; more than 10 million eggs of

Table 4.5-8. Estimated Entrainment of Fish (federally managed species with early lifestage EFH in project area) Eggs and Larvae during Port Operation

Species	2003[a/]	2002[b/]	2001[c/]	2000[d/]	1999[e/]	5-Year Average	Daily Entrainment[f/]	Annual Entrainment[g/]
Eggs: Annual Mean Densities (no./1,000 m^3)								
American plaice	40	80	23	9	29	36.2	7,674	2,800,931
Atlantic cod	45	77	96	94	29	68.1	14,440	5,270,703
Atlantic halibut							0	0
Atlantic mackerel	766	726	900	1,003	2,339	1,146.8	243,102	88,732,268
Butterfish	0	0	0	3	0	0.6	129	47,198
Goosefish							0	0
Haddock	0	2	0	0	0	0.4	85	30,950
Ocean pout							0	0
Red hake	350	592	98	3374	646	1012.0	214,527	78,302,281
Silver hake	277	2477	74	303	238	673.8	142,834	52,134,463
White hake							0	0
Winter flounder							0	0
Windowpane		169	188	326	360	260.8	55,275	20,175,217
Witch flounder	4	643	3	0	0	129.9	27,541	10,052,403
Yellowtail flounder	5	12	63	17	7	20.8	4,415	1,611,594
Larvae: Annual Mean Densities (no./1,000 m^3)								
American plaice	5	4	5	1	11	5.2	1,102	402,344
Atlantic cod	9	6	7	3	1	5.2	1,102	402,344
Atlantic halibut							0	0
Atlantic herring	27	35	49	21	47	35.8	7,589	2,769,982
Atlantic mackerel	17	50	218	7	5	59.4	12,592	4,596,003
Butterfish	0	0.05	1	0	0	0.2	45	16,248
Goosefish							0	0
Ocean pout							0	0
Red hake	38	3	9	100	14	32.8	6,953	2,537,860
Silver hake	46	351	24	48	23	98.4	20,859	7,613,581
White hake							0	0
Winter flounder	19	10	6	5	3	8.6	1,823	665,415
Windowpane	16	20	9	6	6	11.4	2,417	882,061
Witch flounder	9	14	1	0.05	2	5.2	1,104	403,117
Yellowtail flounder	1	10	11	1	1	4.8	1,018	371,394

[a/] NAI 2004b; [b/] NAI 2003; [c/] NAI 2002; [d/] NAI 2001; [e/] NAI 2000; [f/] Based on daily withdrawal of 56 MGD of seawater (54 MGD for hotelling and steam generation, 2 MGD for ballast; [g/] Assumes that one ship will be present at all times.

windowpane and witch flounder; and more than 5 million Atlantic cod eggs. Larval densities are typically much lower than egg densities. Most of the eggs would not become adult fish due to a variety of natural causes. Entrainment at the Northeast Port is expected to affect more than 2 million larvae of Atlantic herring, Atlantic mackerel, red hake, and silver hake.

Equivalent Adult (EA) analysis is a tool that can be used to place entrainment losses in perspective. This analysis has not yet been done for the Northeast Port and will be done when the NOAA Gulf of Maine ichthyoplankton database becomes available and revised entrainment estimates are complete. Because Seabrook Station likely affects a similar suite of species to that occurring at the Northeast Port, the results of the EA conducted for the power plant for 2003 are shown in Table 4.5-9. Entrainment of seven species of commercially-important fishes at Seabrook Station in 2003 resulted in the estimated loss of between less than 1 (yellowtail flounder) and 1,025 (Atlantic herring) fish in 2003 (Table 4.5-9; NAI 2004b). Saila et al. (1997) and NAI (2001) concluded that despite entrainment losses of up to 1,250 million eggs and 375 million larvae annually between1990 and 1997, losses that are 20 to 100 times greater than the worst-case projected for the Port withdrawal of water for Seabrook Station's cooling system has had a negligible adverse ecological impact.

Equivalent adult estimates are dependent on several factors that introduce substantial uncertainty into the results. Results of these estimates should, therefore, be considered as order-of-magnitude predictions. Critical factors necessary for the calculations include the number and age of fishes lost to entrainment and impingement, and other sources of mortality such as fishing mortality.

Equivalent adult estimates also assume that stocks are in equilibrium, meaning that an adult female fish produces enough eggs during her lifetime to replace herself and one male (Goodyear 1978). On a larger scale, this assumption means that there are no significant changes in stock size during the average lifespan of the fish in question. Large changes in the estimates of fishing mortality indicate that the stocks are not in equilibrium and the equivalent adult estimates for these fishes are suspect. The direction of the bias in

Table 4.5-9. Total Entrainment and Mean Annual Equivalent Adult Losses of Seven Commercially Important Species Entrained at Seabrook Station in 2003

Annual Entrainment			
Species	**Eggs**	**Larvae**	**Equivalent Adults**
Atlantic cod	8,000,000	2,500,000	781
Atlantic herring	0	15,300,000	1,025
Atlantic mackerel	26,400,000	0	22
Pollock	1,000,000	600,000	35
Red hake[a/]	5,000,000	100,000	44
Winter flounder	300,000	20,000,000	342
Yellowtail flounder	0	0	0

[a/] Includes red and white hake.
Source: NAI 2004a.

equivalent adult estimates varies indirectly with the trends in stock size. A stock decreasing in size (overfished stocks such as yellowtail flounder and Atlantic cod) will have an overestimate of equivalent adults because the probability of a fish surviving to spawn repeatedly decreases. Similarly, underexploited stocks that are increasing in size, such as winter flounder, will have underestimates of equivalent adults because lifetime fecundity increases.

Although comparisons of the intake systems between Seabrook Station and the Northeast Port are incomplete, there is roughly a ten-fold difference in the volume of water withdrawn. Considering that no discernable effect on the adult fish population as a result of operation of Seabrook Station's cooling system has been demonstrated, it is reasonable to extrapolate that the substantially lower water usage by the Northeast Port will not have a significant effect either.

Indirect Impacts of Port Operation

A 42-acre (17-hectare) area within the anchor arrays for the two buoys will be regularly disturbed by movement of the anchor cables across the substrate when the buoy is occupied, causing a turbidity cloud near the bottom. Because most ichthyoplankton is likely to reside in or near the photic zone, fish eggs and larvae will generally not be exposed to this turbidity. Substrate conditions at the Port do not provide preferred habitat for any of the species with demersal eggs (winter flounder, sand lance, herring).

4.5.3.5 General Pipeline Impact Analysis

Pipeline Construction Impacts

PLP with backfill plowing is proposed as the primary method of pipe lowering for approximately 96 percent of the pipeline route. Jetting will be used at discrete sites along the pipeline route to excavate sediment that could not be removed by the plow. One of the primary impacts to the water column from these proposed pipeline construction activities is the potential release of sediments into the water column and the creation of a turbidity plume. Increased turbidity in the water column can reduce light penetration, which may reduce photosynthesis of phytoplankton in the area. In addition, nutrients have the potential to be released from disturbed bottom sediments during construction.

Monitoring of five plowing events for the HubLine construction (TRC 2004) indicated that PLP had limited potential to resuspend significant quantities of sediments into the water column. Turbidity measurements taken at varying intervals within 820 feet (250 meters) of the disturbance were generally low (did not exceed 10.1 NTU), and average values (0.94 to 5.06 NTU) generally did not exceed average reference site readings (0.5 to 2.56 NTU). Average turbidity readings for backfilling (7.65 to 8.11 NTU) and jetting (0.27 to 28.9 NTU) were generally higher than reference values (1.78 to 2.51 NTU and 1.06 to 2.11 NTU, respectively). Elevated turbidity readings from jetting did not persist beyond 820 feet (250 meters) from the disturbance site. The Massachusetts Surface Water Quality Standards do not specify a numeric standard for turbidity, but of the coastal states that do have numeric criteria for turbidity, most recommend that turbidity not exceed 5 to 50 NTU over background turbidity when background turbidity is 50 NTU or less (EPA 2003).

Pipeline Operation Impacts

Under normal operating conditions, the Pipeline Lateral will have no effects on the water column environment. In the event that maintenance is required on a segment of the pipeline that would involve exposing the pipeline, jetting would probably be used, resulting in a short-term, localized increase in turbidity and nutrients. In this instance the impacts discussed for each community in the following sections could occur for this short, discrete section of the pipeline.

4.5.3.6 Phytoplankton Pipeline Impact Analysis

Pipeline Construction Impacts

Pipeline construction is proposed to take place from the late summer through the spring, although the greatest sediment disturbing activities will occur during the winter. Phytoplankton are most abundant during the early spring (February through March) and fall (September through December) blooms. Therefore, larger populations of phytoplankton may be present during a portion of construction operations compared to other times of the year. Chlorophyll data (a surrogate measure for phytoplankton abundance) collected from Station F19 during the 2003 MWRA water column monitoring surveys, indicate that during these blooms, the highest concentrations of chlorophyll, and therefore phytoplankton, occur in the upper portion of the water column (16 to 49 feet) (Libby et al. 2004). Pipeline construction will occur in water depths between 130 and 260 feet (40 to 79 meters) and there will be minimal transport of the turbidity plume upward in the water column during plowing and backfill plowing. Vertical transport will be limited due to the settling of particles and the rapid dilution of the plume within the bottom of the water column. Thus, turbidity plumes resulting from construction activities are not likely to affect phytoplankton abundance or distribution because these parameters are more a function of conditions in the upper portion of the water column. Furthermore, the phytoplankton community is not unique to Massachusetts Bay but is a small part of the larger community characteristic of the Gulf of Maine. Any phytoplankton mortality within the Pipeline Lateral area will likely be replaced by members of the larger Gulf of Maine population.

Disturbance of bottom sediments could also include the release of nutrients from sediments. Nutrient levels released during construction could exceed levels found in the surrounding water column, which could result in a localized increase in plankton productivity. Pipeline trenching and backfilling activities for most of the pipeline are likely to advance at rates between 1 and 2 miles (1.6 and 3.2 meters) per day, and therefore any sediment or nutrient release would be spread out over the length of the pipeline route (more than 16 miles [26 kilometers]). In addition, plowing results in a minimal amount of sediment resuspension, particularly when compared to dredging and jetting, because sediments are cut out from under the pipe and rolled off to the side. Therefore, the nutrient mass released would be temporary, small, and localized relative to the volume of the water within the construction area. Furthermore, the substantial increase in ammonium concentrations in Massachusetts Bay caused by the creation of an offshore outfall have not resulted in significant increases in phytoplankton biomass (Libby et al. 2004). The contribution of nutrients from effluent being discharged by the Massachusetts Bay outfall (27.5 tons of ammonia per day) (Wu 2003) is much larger than any anticipated release from bottom sediments. Therefore, pipeline construction is not likely to measurably result in a nutrient release resulting in an increase in plankton community productivity.

Pipeline Operation Impacts

In the event that maintenance is required on a segment of the pipeline, the impacts discussed above would occur in a localized area.

4.5.3.7 Zooplankton Pipeline Impact Analysis

Pipeline Construction Impacts

Pipeline construction activities are expected to have little impact on the zooplankton community within the construction area. The construction period (i.e., fall through spring) will avoid peak zooplankton abundances of mid-summer, though some larger copepods (e.g., *Calanus finmarchicus*) and barnacle nauplii are most abundant in the winter and spring. *C. finmarchicus* overwinters in the deeper waters of the ocean to avoid predators (i.e., fish). Individuals emerge from diapause and molt to adults in the spring (February through April). Therefore, *C. finmarchicus* will be present within the Pipeline Lateral area during the time of construction. Some zooplankton may occur within the small and temporary turbidity plume associated with jetting, but these plumes would occur for a very short time frame and include a miniscule volume of Massachusetts Bay. The rapid dilution of the plume, as detected during HubLine construction water quality monitoring (TRC 2004) and the limited area it occupies, will keep these effects to a minimum. In addition, the movement of construction vessels and equipment during pipe laying, trenching, and backfilling precludes the development of a large plume in any one location.

Some zooplankton may be entrained into the water used during jetting and, given the high velocity at the exit ports, would experience mortality. However, this effect is localized to the pump intakes in an offshore setting and would occur for a few days along short discrete portions of the pipeline. The loss of these zooplankton would not affect the overall zooplankton community nor any species that rely on this community as a food source because the percent cropped of the entire Massachusetts Bay community would be negligible.

Seasonal zooplankton cycles are influenced primarily by temperature, rather than light and nutrients, as is the case for phytoplankton, and are not expected to be directly impacted by releases of nutrients from the bottom sediments. The Project will not affect water temperatures during construction and operation. If contaminants are present in bottom sediments, they may be suspended in the water column and exhibit some acute toxicity on zooplankton life stages in the area, but these effects will be short-lived because of the rapid dilution and settling of the plume. In addition, contaminants are not anticipated in sediments.

Any impact to the zooplankton community will be localized and transitory, especially given the patchy distribution of zooplankton. Furthermore, the zooplankton community is not unique but is a small part of the larger community characteristic of the Gulf of Maine. Any zooplankton mortality within the Pipeline Lateral area will likely be replaced by members of the larger Gulf of Maine population.

Pipeline Operation Impacts

In the event that maintenance is required on a segment of the pipeline, the impacts discussed above would occur in a localized area.

4.5.3.8 Ichthyoplankton Pipeline Impact Analysis

Pipeline Construction Impacts

Aspects of construction that disturb the substrate have the potential to impact early life stages of fish species whose eggs are demersal. American sand lance and winter flounder are the only species common in Massachusetts Bay with this life history strategy. It is unlikely that eggs of either species will be present in the Pipeline Lateral area. American sand lance spawns in water depths less than 6 feet (2 meters; Auster and Stewart 1986) and winter flounder spawns preferentially in water depths of less than 30 feet (10 meters).

Fish eggs and larvae within the water column may be entrained within the approximately 3 million gallons (11,400 cubic meters) of seawater to be withdrawn from near the sea surface for flooding the pipeline prior to backfilling and for hydrostatic testing. Assuming that construction is initiated in the fall, hydrostatic testing of the pipeline is likely to take place in the March through May timeframe. Jury et al. (1994) reported that eggs of 14 fish species and larvae of 13 fish species are likely to be common to highly abundant in Massachusetts Bay during those months. An estimate of the number of fish eggs and larvae affected by this process is shown in Table 4.5-10 based on average densities observed during the spring in the Seabrook Station offshore monitoring program.

Entrainment of seven species of commercially important fishes at Seabrook Station in 2003 resulted in the estimated loss of between less than 1 (yellowtail flounder) and 1,025 (Atlantic herring) fish in 2003 (NAI 2004b). Saila et al. (1997) and NAI (2001) concluded that despite entrainment losses of up to 1,250 million eggs and 375 million larvae annually between 1990 and 1997, withdrawal of approximately 600 MGD of seawater for Seabrook Station's cooling system has had a negligible adverse ecological impact. In comparison, the 1- or 2-day withdrawal for hydrostatic test water would have an insignificant entrainment impact to fish species when compared to the daily withdrawals occurring for years at Massachusetts power plants and the Seabrook Station in New Hampshire.

Discharge of the seawater will result in a localized plume that will be rapidly diluted in the open water setting of the pipeline corridor. The discharge water will be non-toxic and not degrade water quality to an extent that affects marine organisms, including ichthyoplankton. The discharge of a greater volume of flood and hydrostatic test water on the recently completed HubLine did not result in any observable or measurable harm to marine life, and fish were observed swimming within 10 feet of the end of the discharge pipe for many hours during the discharge.

Table 4.5-10. Estimated Entrainment of Fish Eggs and Larvae during Hydrostatic Testing of the Pipeline Lateral

Species	2003[a/]	2002[b/]	2001[c/]	2000[d/]	1999[e/]	5-Year Average	Total Entrainment[f/]
Eggs; Annual Mean Spring Densities (no./1000 m³)							
American plaice	143.4	203.1	82.9	37.8	96.5	112.7	1,285.3
Atlantic cod	4.8	96.1	30.2	2.7	28.6	32.5	370.3
Atlantic mackerel	552.8	1970.7	2098.2	3802.7	9523.5	3589.6	40,921.0
Cod/witch flounder	4.1	190.2	3.4	0	53.0	50.1	571.6
Cunner/tautog/yellowtail flounder	70.5	2004.2	497.9	1457.6	373.2	880.7	10,039.8
Fourbeard rockling	87.9	74.9	88.7	13.4	4.1	53.8	613.4
Fourbeard rockling/hake	386.7	216.7	149.7	12.6	62.8	165.7	1,889.0
Haddock	0	1.9	0	0	0	0.4	0.1
Hakes	73.7	6.7	9.6	100.8	11.1	40.4	460.3
Windowpane	11.1	238.7	20	96.5	23.6	78.0	889.0
Yellowtail flounder	0.1	4.2	4.3	3.6	0.3	2.5	28.5
Larvae; Annual Mean Spring Densities (no./1000 m³)							
Alligatorfish	2.5	0.9	1.7	7.8	4.1	3.4	38.9
American plaice	1.5	6.4	1.2	2.4	27.1	7.7	87.9
American sand lance	312.6	184.2	560.8	154.5	94.8	261.4	2,979.9
Atlantic cod	0.2	1.4	0.7	0.1	0	0.5	5.6
Atlantic herring	5.5	1.8	28.8	23.8	38.6	19.7	224.8
Atlantic mackerel	0	0	761.1	6.1	0	153.4	1,749.2
Cunner	0	0	135.8	0	0	27.2	309.7
Fourbeard rockling	0	1.4	220.5	2.5	0.3	44.9	512.3
Pollock	4.4	0	1.3	0.4	0.3	1.3	14.4
Radiated shanny	51.3	16.3	936.5	44.2	8.7	211.4	2,410.1
Rock gunnel	102.2	5.7	197.1	49.6	51.4	81.2	925.5
Sculpins	96.5	16.1	170.5	55.0	28.6	80.3	927.2
Snailfish	18.1	24.7	395.1	31.0	158.3	125.5	1,430.3
Winter flounder	4.9	28.2	5.5	15.2	9.6	12.7	144.6
Yellowtail flounder	0.1	1.0	1.5	0.5	1.5	0.9	10.7

[a/] NAI 2004a; [b/] NAI 2003; [c/] NAI 2002; [d/] NAI 2001; [e/] NAI 2000; [f/] Based on a one-time withdrawal of 75,000 gallons of seawater.

While construction will generate some small, localized turbidity plumes, these will occur outside the portion of the water column with high ichthyoplankton abundance. In addition, these plumes will be located near the bottom and will therefore affect only a small percentage of ichthyoplankton, which are more oriented to mid and surface water depths. Lastly, because plumes will only persist in any one location for a short period as the construction progresses along the pipeline, the duration of exposure to suspended sediments will be short.

Ichthyoplankton could be impacted from accidental spills and unintentional release of substances such as diesel fuel, lubricants, and hydraulic fluid. However, the Pipeline Lateral will be constructed with an approved SPCC Plan that will serve to minimize potential impacts on ichthyoplankton from spills. A similar plan was implemented during construction of the HubLine, and while some releases occurred and were properly reported, no measurable environmental harm occurred because of the implementation of the SPCC Plan.

Pipeline Operation Impacts

Operation of the pipeline will have no direct or indirect impacts on finfish eggs and larvae. If a section of pipe needs to be exposed for maintenance work, the sediment disturbance and turbidity would be negligible and not harm these lifestages to a level even measurable as adult equivalents.

4.5.4 Mitigation Measures

Port

The following measure is proposed to minimize or eliminate the potential impacts of Port construction and operation on plankton:

- The Port will be constructed with an approved SPCC Plan that will serve to minimize potential impacts on ichthyoplankton from spills.

Pipeline Lateral

Plankton impacts in the offshore environment have been minimized through the siting of the proposed Pipeline Lateral and through the use of the proposed construction methods. In addition, Algonquin is planning to construct the Pipeline Lateral beginning in September 2006 extending into May 2007. The main construction activities, including pipelay, plowing, backfill plowing, and jetting, are planned to occur during the winter months. The schedule for these activities will occur during a period, when on balance considering both direct and indirect effects, impacts to water quality and to the majority of marine resources occurring along the Pipeline Lateral will be minimized.

- **Siting of the Pipeline Lateral -** As described in Section 3.0, and Supplement 4 to the Northeast Port Application, Algonquin spent considerable time conducting geophysical and geotechnical surveys across a broad area in an effort to locate the Pipeline Lateral in an area with relatively uniform substrate/habitat conditions where the least environmentally impacting construction procedures could be effectively utilized. The preferred route meets this objective. Geophysical survey data indicate a seafloor composed of largely silt/sand/clay with no surficial rock. As such, the preferred route has a low probability of encountering rock requiring blasting, dredging, or surface armoring. Due to the relative simplicity of construction and fewer number of construction method transitions, this route is expected to require the shortest duration of construction activities, result in the least amount of sediment resuspension and transport, and entails the narrowest direct disturbance width along the trenched pipe.

- **Construction Methods** - Algonquin will utilize a single pass of the PLP to lower the pipeline for the majority of the route (96 percent) as the principal impact minimization measure. Offshore, where plume dilution occurs more rapidly because of water depth, plowing is the preferred construction technique because it is much faster than other techniques, causes the least amount of sediment resuspension and, thereby, reduces the duration of water column effects. The selection of plowing as the primary pipe burial process minimizes the footprint adjacent to the trench where material will be sidecast, thereby minimizing the total impact area.

Algonquin is planning to backfill the majority of the pipeline with one pass of the backfill plow. The backfill plow operates in a similar manner to the plow, but has reversed mold boards, that are used to pull the spoil back into the trench. HubLine post-construction surveys showed that in areas where only plowing and backfill plowing were used, the contours more closely match pre-existing conditions than areas that also involved dredging, jetting or blasting, which is why the Pipeline Lateral was located, as previously noted, in an area that avoided sediment types that would have otherwise required methods with greater impact as the primary construction technique.

In the limited areas along the route where jetting is proposed to excavate the trench, the Pipeline Lateral will be backfilled with sand (placed by tremie tube), concrete mats, or diver-placed sand bags depending on the operational requirements of the site. Whatever material is used, it will be placed over the pipeline using a tremie tube or by divers. No imported backfill material will be dumped from vessels on the surface.

The primary construction barges will use mid-line buoys on all anchor cables to minimize scouring of the seafloor and the release of sediments resulting from cable sweep that will occur during movement of the construction vessels.

Algonquin and its construction contractors will also implement a SPCC Plan to minimize the potential impacts of any unintentional fuel spills or similar releases.

4.5.5 Alternatives

4.5.5.1 No Action Alternative

Under this alternative, the Project would not proceed and existing conditions would remain. Other methods for satisfying the nation's energy demands might result in increased use of existing land-based terminals, greater reliance on declining domestic oil and gas resources, or development of alternate means of importing LNG.

4.5.5.2 Port Alternative

The use of Buoys B and C rather than Buoys A and B would result in impacts essentially similar to those discussed for the Project. The biological habitats, including ocean depth and seafloor type, are very similar at the two sites. The moderate difference in location would not be expected to materially alter the impacts to marine mammals.

The Port Alternative of Buoys B and C would have no different effects on any of the plankton resources of Massachusetts Bay than the Project.

4.6 Benthic and Shellfish Resources

4.6.1 Introduction

Three types of benthic resources are discussed in the following sections: marine vegetation, macrofauna, and shellfish. The environmental setting for these resources is described based on available literature for aquatic vegetation and shellfish, and on available literature and a site-specific study, detailed in Section 4.6.2. Impacts related to construction and operation of the Port and Pipeline Lateral are evaluated in Section 4.6.3. Sections 4.6.4 and 4.6.5 describe proposed mitigation measures and Project alternatives. The planktonic stages of these organisms are discussed in Section 4.4, finfish resources in Section 4.6, the commercial aspects of the fisheries under Socioeconomic Resources in Section 4.12, and general human ocean uses in Section 4.13. Section 4.2, Geology, contains further details of benthic studies.

Project Area: The Project area for the Port and Pipeline Lateral includes the ports and harbors along the shoreline of Massachusetts Bay closest to the Project, the waters of Massachusetts Bay extending east to boundary of the SBNMS, Gloucester to the north, and on the south to the edge of the in-bound Boston Harbor Traffic Lane. Both the Northeast Port and Pipeline Lateral will require onshore loadout yards for offshore construction materials located at existing industrial or commercial sites. The Pipeline Lateral also includes modifications at two existing onshore aboveground facilities located in the City of Salem and the Town of Weymouth.

Issues: The following issues related to benthic and shellfish resources were considered in the preparation of this section:

- Potential impacts to habitats and individual organisms; and
- Potential entrainment of plankton larval stage.

4.6.2 Environmental Setting

4.6.2.1 Regulatory Framework

Two species of squid (northern shortfin and longfin inshore squid) and one species of shellfish (sea scallop) are indirectly regulated as part of the habitats for species with EFH designations under the MFCMA. The details of this EFH designation can be found in section 4.7.2.1.

4.6.2.2 Marine Vegetation

Marine vegetation, including macroalgae and seagrass, requires sufficient light to exist. Substrate in the study area for the Port and the Pipeline Lateral is well below the photic zone; therefore, these resources cannot exist in the Project area.

4.6.2.3 Macrofauna

Benthic resources in the general area of Stellwagen Basin have previously been surveyed during the siting of the MBDS (SAIC 1987; Hubbard et al. 1988) and the designation of the Stellwagen Bank National Marine Sanctuary (U.S. DOC 1991). The entire Project area for the Port and the Pipeline Lateral was surveyed for benthic resources in winter to early spring 2004-2005 using several methods: benthic grab sampling for infauna, grain size and total organic carbon (TOC) analysis; Sediment Profile Imagery (SPI); and ROV videography (see Figures 4.6-1 and 4.6-2).

Summary of Survey Methods

Areas north, west, and south of the MBDS were considered as potential port locations during initial reconnaissance visits. Preliminary geophysical results revealed that substrate in the entire area being considered for the Port was homogeneous whereas conditions along the Pipeline Lateral route varied. To provide information that covered all possible sites, a benthic survey was designed to characterize the entire area. Distribution of sampling effort in the two portions of the project area reflected the differences in substrate conditions. The specific details of the survey methodologies were outlined in a detailed field investigation plan that was submitted to a variety of federal and state permitting and resource agencies in

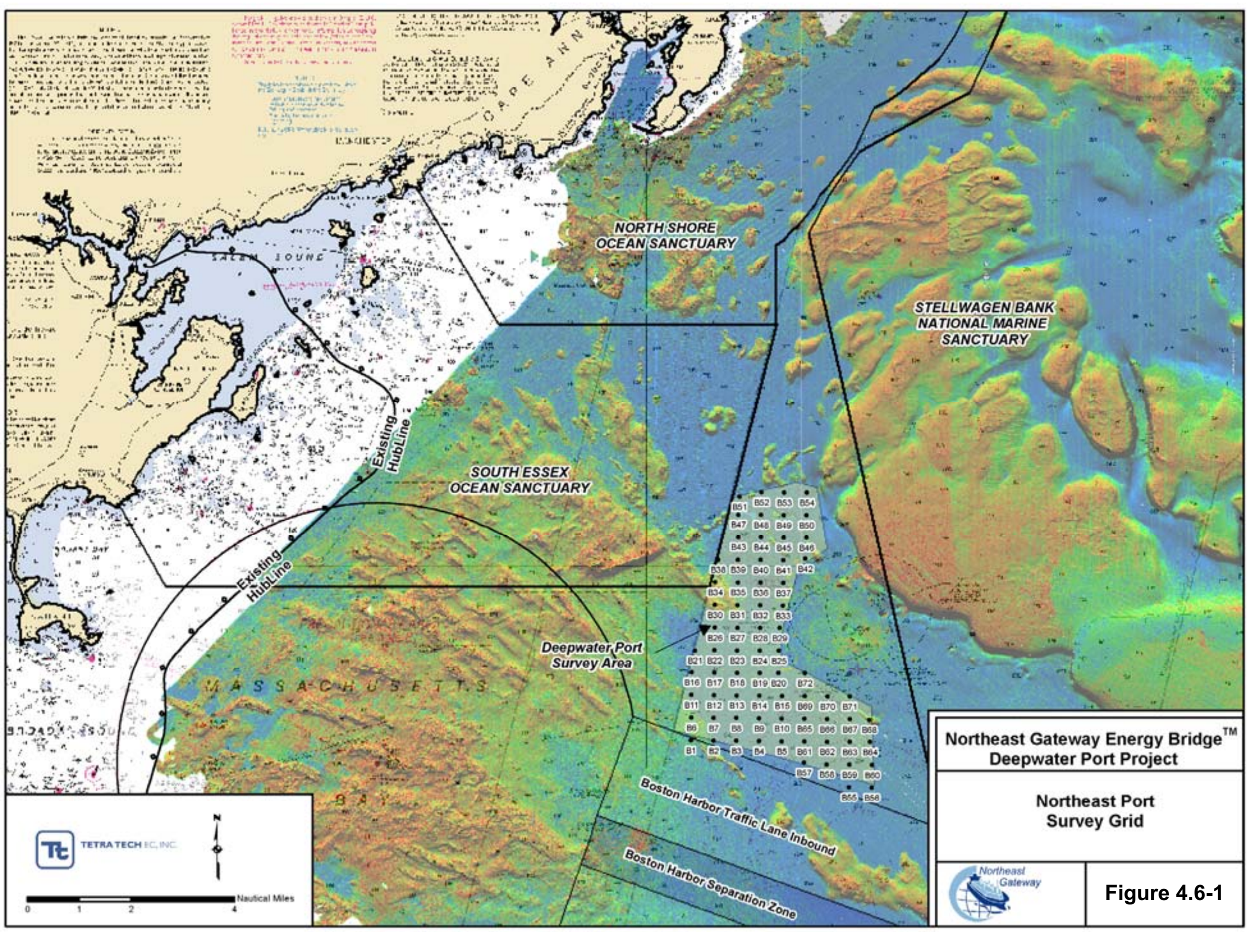

Figure 4.6-1. Northeast Port Survey Grid

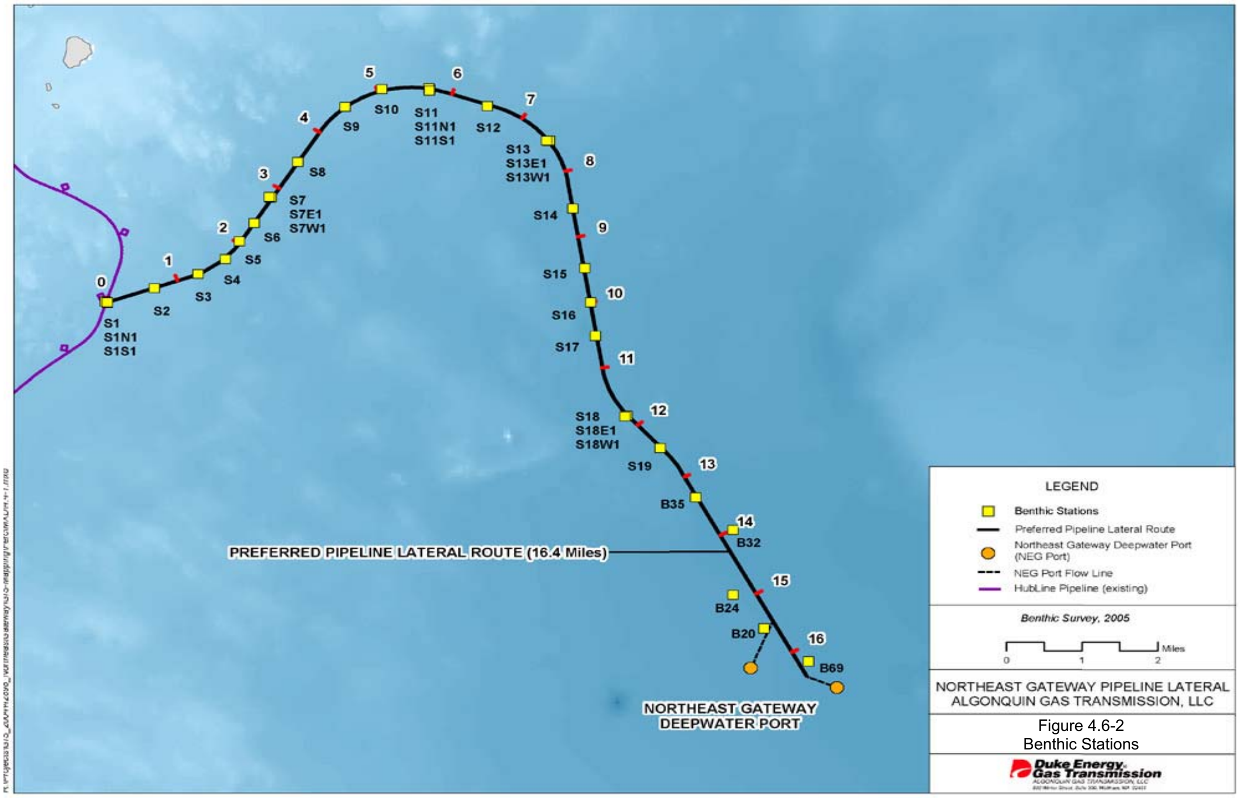

Figure 4.6-2. Benthic Stations

January 2005 for review and comment. The biological survey work was initiated in December 2004 with the completion of the benthic grab sampling effort. The SPI surveys were completed in February 2005 while the ROV survey was completed in March 2005.

Northeast Port

For the Port, sampling was laid out in a grid with spacing of 0.5 mile (0.8 kilometer), resulting in 72 stations (Figure 4.6-1). Each station was sampled using SPI, and approximately half (35) of the stations were sampled with a 0.04 square meter grab sampler. Grabs were analyzed for grain size composition, TOC, and benthic infauna. Grain size analysis confirmed the consistent substrate conditions throughout the Port survey area. A ROV survey was conducted at representative stations within each of the potential buoy locations. A single 800-foot-long (224-meter-long) transect was filmed at each of the selected stations. Results of the surveys are summarized in this section. Complete details of the benthic survey are provided in Appendix 4.6-1.

Pipeline Lateral

A total of 29 station locations were selected to represent the benthic conditions along the Pipeline Lateral (Figure 4.6-2) based on the Phase 1 geophysical survey results. Nineteen of the stations were located on the centerline, while at five of the centerline stations, 100-foot (30-meter) offset stations were selected as well. A number of criteria were evaluated in siting the stations, including the targeting of different depth zones, the potential for different grain size sediment, and different hydrodynamic conditions associated with depth and seafloor topography.

The locations along the Pipeline Lateral that were targeted for the SPI survey were preferentially assigned with more stations in the heterogeneous areas in order to characterize the habitat. All of the 19 centerline pipeline locations on the centerline plus two, 100-foot (30-meter) offsets sampled by grab sample were revisited for the SPI survey. In areas of possibly more variable sediment material based on the geotechnical results, 200-foot (61-meter) and 400-foot (122-meter) offsets were sampled. In total, there were 69 individual SPI sample locations along the pipeline, 29 of which corresponded to the 29 grab sample stations.

The ROV survey along the pipeline was designed to be conducted in two phases so that any features of interest either biologically or for pipeline construction could be reexamined in greater detail. No targets for biological characterization were identified for the Phase 2 effort.

Survey Results

Results from the various survey methods were taken together to provide a complete picture of the soft-substrate habitat and the faunal communities that characterize them for each portion of the Project.

Northeast Port

Surface (< 6 inches [15 centimeters]) sediment samples were collected at 35 locations within the Buoy Survey Area. Grain size at most stations averaged >95 percent silt-clay (Table 4.6-1). The exceptions, Stations B02 (Area C), B06 (Area C), and B68 (Area A), were each located near an apparent topographic high and are slightly outside the areas now being considered for buoy deployment (Figure 4.6-1).

TOC averages slightly above 2 percent in most areas. These values are lower than observed by SAIC (1987) for the disposal site (2.70-3.05 percent) and mud reference site (2.67 percent; located to the southeast of the MBDS). Blake et al. (1993) noted a direct relationship between sediment grain size (percent fines [silt/clay]) and TOC in the vicinity of the MWRA outfall. Data from the buoy area are consistent with that pattern.

Table 4.6-1. Average Grain Size and Total Organic Carbon Characteristics in the Buoy Areas

Buoy Area	All Samples		Without Outliers	
	Silt/Clay (%)	TOC (%)	Silt/Clay (%)	TOC (%)
1	95.44	2.17		
2	96.00	2.05		
3	95.85	2.32		
4	96.78	2.15		
A	93.37	2.36	97.65	2.40
B	98.10	2.17		
C	91.90	1.69	97.58	1.80

Results from the SPI survey (Appendix 4.6-2) also showed sediments to be primarily fine sand-silt-clay. Sediments at one station (B34) located on the western boundary of the survey area near an apparent bathymetric high (and north of the area proposed for siting the buoys) were cobbly, although the cobbles were covered with a heavy drape of fine sediment and animal tubes. Surface conditions at most stations were dominated by biogenic, rather than physical, processes and all stations showed signs of infaunal organisms.

While the surveys were being undertaken, focus shifted from a northerly to a southerly location for the Port within the survey area. The following characterization of benthic resources in the Port area centers on buoy areas A, B, and C because the combinations of A/B and B/C are the alternative sites being proposed for the Port. Data from all stations sampled are presented in Appendix 4.6-2.

Benthic infaunal community, like grain size, appears to be homogeneous in the survey area. The mud bottom supports a polychaete-dominated infauna with relatively high abundance (ranging from 17,000 to 23,500 individuals per square meter, Table 4.6-2) and species richness (84 to 106 unique taxa within each area). Differences in species richness among the buoy areas is likely related to the differing number of stations representing each area because there are numerous taxa with low abundances. Most stations yielded 40 to 50 taxa per sample. Within each buoy area, 22-25 taxa comprise ≥ 85 percent of the total abundance.

In each buoy area, one or two taxa contribute a substantial portion (10 to 17 percent) of the total abundance (Table 4.6-2). The ampharetid polychaete *Anobothrus gracilis* and the cirratulid polychaete *Chaetozone setosa* dominate in all three areas. Oligochaetes and the polychaetes *Aricidea quadrilobata* share dominance in Area A and oligochaetes are also numerically important in Area B. In each area, 22 or more taxa represent at least 1 percent of the total abundance. Included among those taxa are several molluscan taxa. The rarer taxa comprise numerous arthropods, echinoderms, and other phylogenetic groups. While the dominant taxa are primarily oriented near the surface of the substrate, the rarer taxa include a variety of species, such as maldanid and lumbrinerid polychaetes, that burrow more deeply into the substrate and are considered to be indicators of a stable benthic community. The dominant polychaetes exhibit a range of feeding types, including surface deposit feeding (*Anobothrus, Aphelochaeta, Aricidea, Chaetozone, Galathowenia, Levinsenia, Prionospio, Spio,* and *Terebellides*), subsurface deposit feeding (*Cossura, Dorvillea, Eteone,* Euclymeninae, *Heteromastus, Ninoe,* and *Sternaspis*), and carnivory (*Nephtys, Paramphinome,* and *Syllides*) (after Fauchald and Jumars 1979), another indicator of a balanced community.

Results of the infaunal analysis were borne out by the SPI assessment. Coloration of the sediments, an indication of oxidation, reflected high levels of subsurface biological activity. The successional stage of all the stations where benthic grabs were analyzed within the three buoy areas was Stage III, an indication that benthic communities were composed mainly of equilibrium species such as large tube-building species, head-down deposit feeding polychaetes, and large infauna. Surface and subsurface conditions exhibited a high degree of bioturbation, consistent with an equilibrium stage fauna. While few epifaunal

Table 4.6-2. Percent Composition of Dominant (> 1% of Mean Abundance) Taxa

Taxon	Buoy A	Buoy B	Buoy C	MBDS
Oligochaeta	11.2	10.5	4.6	a/
Anobothrus gracilis (P)	10.0	13.5	17.2	a/
Aphelochaeta marioni (P)	7.3	7.8	5.7	
Aricidea quadrilobata (P)	11.1	7.6	5.0	a/
Chaetozone setosa (P)	10.0	10.4	9.6	a/
Cossura longicirrata (P)	2.8	2.6	2.2	a/
Euclymeninae (P)	1.2	2.1	3.4	
Galathowenia oculata (P)	1.5	1.9	2.4	a/
Heteromastus filiformis (P)	1.8	2.0		a/
Levinsenia gracilis (P)	3.3	2.9	1.5	a/
Nephtys incisa (P)		1.6	1.3	a/
Ninoe nigripes (P)	1.8	2.1	1.7	a/
Paramphinome jeffreysii (P)	1.4	2.4	2.4	
Prionospio steenstrupi (P)	2.7	3.8	3.5	a/
Spio limicola (P)	4.5	4.8	5.0	a/
Sternaspis scutata (P)			2.4	a/
Syllides longocirrata (P)	1.7	1.1		
Terebellides sp. (P)			1.4	
Bathymedon obtusifrons (A)		1.1		
Crenella decussata (B)			1.4	
Nucula tenuis (B)	1.4	2.2	2.1	a/
Yoldia sapotilla (B)	1.8	1.8	3.0	
Periploma papyratum (B)	1.3	2.0	2.4	
Thyasira gouldii (B)	4.1	3.0	3.3	a/
Onoba pelagica (G)	1.5	1.1	2.0	
Emplectonematidae A (N)	1.0		1.1	
Tubulanus sp. (N)	1.7		1.0	
Dentalium entale (S)			1.2	
Cumulative Percent	85.1	88.3	86.8	
Mean abundance (no./m^2)	23,500	17,175	20,675	
Total No. of Taxa	106	84	103	
No. of Taxa $\geq$ 1%	22	22	25	

a/ dominant species (or closely related species) during MBDS site designation survey organisms were actually observed in the ROV survey, there was evidence of biological activity in the form of burrows, tracks, and trails that confirmed the interpretation of the SPI photographs. Burrows were likely formed by decapod crustaceans and fish. Decapods walking across the sediment surface left slash-like tracks. Starfish, gastropod snails, and flounders created distinctive patterns (trails) in the sediment. The various features analyzed from SPI photographs are used to calculate an Organism Sediment Index (OSI) to characterize soft-bottom habitats. OSI values greater than 6 are considered to be indicators of good habitat conditions, representing substrates that are not heavily influenced by either physical or anthropogenic stresses (Rhoads and Germano 1986). The stations within the three buoy areas all were rated with an OSI value of 11.

Benthic resources at the Mud Reference Site (42°24.686', 70°32.814') southeast of the MBDS were assessed in 1985-1986 in support of the site designation process (Hubbard et al. 1988). SPI showed a stable benthic habitat characterized by head-down deposit feeders. Total abundance was about 4,300 individuals per square meter (SAIC 1987), substantially lower than the abundances observed in the Buoy Survey Area (~25,000 individuals per square meter), although the number of species per sample was similar between the two surveys. In 1985-1986, the benthic community was dominated by annelids (about 90 percent of total abundance), with the most abundant species being *Levensenia (Paraonis) gracilis* (accounting for 20 to 38 percent), a small deposit feeder. The two surveys show similarities in the relatively abundant species. Differences can be attributed to temporal and spatial variability and sample size.

SAIC (1987) performed BRAT (Benthic Resource Assessment Technique) on sediments from the disposal site in order to assess the value of the benthic infaunal community to the finfish resources. This survey compared samples from areas where dredged material had been deposited to areas of natural bottom within the disposal area. Stomach contents of several fish species were analyzed. American plaice fed primarily on echinoderms, a relatively small component of the community observed in the Project area. Witch flounder preyed mostly on polychaetes, including *Chaetozone*, *Spio*, *Sternaspis*, and *Tharyx*, three of which currently rank among the dominants in the Project area. The prey items of Atlantic cod included benthic amphipods, polychaetes, and other crustaceans. The current study found several species of amphipods and other crustaceans but they were not particularly numerous. Hakes were found to feed exclusively on pandalid shrimp, a species that cannot be effectively sampled with benthic grabs. SAIC (1987) found that food availability (biomass) was somewhat elevated on dredged material, where the prey was concentrated near the substrate surface, compared to natural bottom, where the prey was slightly deeper in the sediment. Because the benthic community structure observed in the buoy area survey is similar to that during the MBDS site designation survey, it is likely that the buoy area would provide the same value for demersally feeding fish as the MBDS did in 1986.

Pipeline Lateral

The faunal communities present in the sediments collected along the Pipeline Lateral area are described relying primarily on grab-sample data supplemented with ROV and SPI observations. Data were collected primarily along the Pipeline Lateral centerline and some lateral stations extending 100, 200, and

400 feet (30, 61, and 122 meters) to either side of the centerline. It is assumed that similar substrates at the various water depths elsewhere within the anchor corridor provide for a similar benthic community. The additional habitats and corresponding benthic communities that occur off of the centerline, but within the anchor corridor, are cobble/till areas and possibly boulder/bedrock area, as determined from an analysis of side-scan sonar imagery.

Water depths (based on data gathered during the grab-sampling survey and not adjusted for tidal changes) ranged from 136 feet to 289 feet (41 meters to 88 meters) proceeding west to east along the pipeline route at which 34 benthic samples were collected (Figure 4.6-1 for the benthic stations and Appendix 4.6-1 for the benthic report). Water depth gradually increased (about 30 feet [9 meters]) along the first third of the Pipeline Lateral (approximately MP 5 to 6), with a sharper increase (about 120 feet [37 meters]) along the more easterly two-thirds of the route, reaching the deepest depths (>270 feet [82 meters]) near the terminus of the pipeline.

Sediment texture along the Pipeline Lateral was predominantly coarse (>75 percent sand + gravel) in the shallower portion (MP 0 to 2), medium texture (~60:40 percent coarse: fine) approaching the middle section (about MP 3 to 5), and mostly fine (>70 percent silt + clay) along the deeper portion (about MP 6 to 13). Stations from about MP 13 to 16, the deepest portion of the pipeline route, were very fine, with sediments containing 95 percent to 99 percent silt + clay. These observations were confirmed by the SPI analyses that showed predominantly fine and medium sands in the shallower reaches of the Pipeline Lateral and predominantly very fine sand and fine-sand-silt-clay in the deeper portions (Diaz and Battelle 2005; see Appendix 4.6-2 for the SPI report). SPI also showed that bedforms occurred at about one-third of the stations, most located shallower than about 150 feet (MP 6). SPI of substrates at all five stations in the deepest portion of the pipeline route (in federal waters) showed fine-sand-silt-clay sediment, and the complete absence of bedforms.

ROV images showed heavily rippled, coarse sand at shallower depths and faintly rippled, fine-silty sand at deeper depths. Physical and biological/physical processes primarily contributed to sedimentary structural features in the shallower reaches of the Pipeline Lateral Area (MP 0 to 6), with only physical processes predominant at the two shallowest stations (MP 0 to 1). In deeper areas of the Pipeline Lateral, biological and biological/physical processes predominated. Sediment structure in the deepest portion of the Pipeline Lateral Area (depths > 270 feet [82 meters]; about MP 13 to MP 16) was primarily affected by biological processes.

SPI provides an estimate of the apparent color redox potential discontinuity (RPD) layer depth, which is an estimate of the depth at which the sediment geochemical processes change from being primarily oxidative to being primarily anaerobic or reducing (Diaz and Battelle 2005). Generally, deeper RPD depths are associated with higher habitat quality (Rhoads and Germano 1986). Most stations along the Pipeline Lateral had RPD values that exceeded 4 centimeters (Diaz and Battelle 2005), indicating that sediments were well-oxygenated. Additionally, sediments below the RPD layer were relatively light gray in color indicating that intense reducing or sulfitic (dark gray-blue in color) sediments did not occur at any of the Pipeline Lateral stations.

Marks made by fishing gear were observed between MP 8 and MP 12.5. These marks usually consisted of gouges or furrows in the seafloor that had been smoothed over and frequently were overlain by faint ripples. These marks were particularly evident at MP 8.4–8.5, MP 8.8–8.9, MP 9.1, MP 10–10.3, MP10.7–10.8, MP 11.3–11.6, and MP 12.1. Gouges were usually oriented in an east-west direction. Additionally, washboard-like striations probably made by the "cookies" on trawling gear, were observed between MP 9 and MP 9.1 and between MP 10 and MP 10.3. Actively fishing lobster gear was also observed between MP 4.8 and MP 5. The seafloor along the Pipeline Lateral from MP 12.5 to MP 14.3 was predominantly structured by fishing activity. The seafloor in this region was a mosaic of the imprints made by different types of fishing gear. Very little of the seafloor in this region was untouched by some form of fishing gear. Large areas had been heavily gouged (from some form of dredging) such that the sediment appeared as though it had been plowed and then was slightly weathered. Other areas bore many, less dramatic, furrows (possibly caused by trawl doors) that caused smoothed indenting of the seafloor. The seafloor of other areas was very flattened and smoothed, possibly by trawl nets, with areas of washboard-like striations that were possibly caused by the cookies of trawls. The seafloor between MP 12.5 and MP 16.4 was mainly structured by biological activity, and only rarely bore the imprint of fishing gear. The seafloor in this region consisted of a gentle hummocky, silty sediment that was marked by many fish and crab burrows, invertebrate and fish trails and tracks, and occasional craters created by benthic fish.

Shell debris, primarily from the ocean quahog (*Arctica islandica*), was more common in shallow waters than in deeper waters. Features attributable to biological activities, such as large excavations and large depressions caused by the activities of larger crustaceans and fish, were more noticeable in ROV images collected from deeper regions of the Pipeline Lateral than from shallower ones. Also noticeable were the distinctive gouges, furrows, and washboard-like striations made by fishing gear that was dragged along the seabed. The combined information from the three surveys indicated that the shallower portions of the Pipeline Lateral were dominated by physical processes, which probably include higher currents and the effects of storm-generated waves, and deeper stretches of the Pipeline Lateral were more quiescent and dominated more by biological processes, such as bioturbation. The TOC of the sediment, based on grab samples, along the Pipeline Lateral ranged from 0.2 percent to 2.4 percent (dry weight) and showed a strong negative correlation (Pearson $r = -0.79$, $p < 0.01$) with the coarse sediment fraction. The pattern of increasing TOC content with increasing depth reflects the transition from a physically dominated shallower part of the Pipeline Lateral to the route's deeper, more depositional portion.

Analyses of sediment grab samples showed that two clearly distinguishable infaunal communities, and one outlier station, occurred in the sediments found along the pipeline route (TRC and Battelle 2005a). The outlier station, which was located just before MP 1, was characterized by very coarse sediment (90 percent sand and gravel) that had very low TOC content (0.2 percent) and showed little similarity (Bray-Curtis similarity equaled 37 percent) to the remaining two groups of stations. Water depth at this station was approximately 140 feet (43 meters). The infaunal community at this station was estimated to contain about 13,600 individuals per square meter and included 57 species. Species diversity was moderately high for Massachusetts Bay samples. Characteristic taxa included those more typically found in sandy sediment including the polychaete worms *Exogone verugera*, *Tharyx acutus*, *Dipolydora socialis*, and *Owenia fusiformis*, which accounted for about 42 percent of the infaunal abundance at the station. Other distinctive taxa included the cumacean crustacean *Eudorella pusilla*, peanut worm *Phascolion strombi*, and the clam *Astarte undata*, which combined to account for about 16 percent of the infaunal abundance.

The two main infaunal communities were not very similar to each other (Bray-Curtis similarity equaled 47 percent) and aligned primarily with water depth and secondarily with sediment texture. The shallower community included coarse-grained (averaging 63 percent sand and gravel) stations located in water depths from 136 feet to 167 feet (41 to 51 meters; approximately MP 0 to 6); TOC content in the sediment was low, averaging about 0.5 percent. Infaunal abundance within the community was high, averaging about 25,000 individuals per square meter. Species numbers were moderate for Massachusetts Bay (Kropp et al. 2002; Maciolek et al. 2003), averaging about 66 species per sample but species diversity was moderately high for Massachusetts Bay samples. The shallower community was characterized by four species of polychaete worms (*Prionospio steenstrupi*, *Spio limicola*, *Anobothrus gracilis*, and *Aricidea quadrilobata* in decreasing order of relative abundance) that accounted for about 44 percent of the total infaunal abundance. Additionally, two small bivalve mollusks (*Nucula tenuis* and *Thyasira gouldii*), which accounted for about 11 percent of the total infaunal abundance, helped to distinguish this community.

The deeper community included fine-grained (averaging 85 percent silt and clay) stations in water depths from 177 feet to 289 feet (54 meters to 88 meters; MP 7 to 16); TOC content in the sediment was moderately low, averaging about 1.4 percent. Infaunal abundances within this community were high, averaging about 19,600 individuals per square meter. Species numbers, averaging about 51 species per sample, and species diversity were moderate for Massachusetts Bay (Kropp et al. 2002; Maciolek et al. 2003). The deeper community was characterized by the same four species of polychaete worms (about 46 percent of the total infaunal abundance) that were found in the shallower community, but in slightly different order of relative abundance: *Anobothrus gracilis*, *Prionospio steenstrupi*, *Aricidea quadrilobata*, and *Spio limicola*. The small bivalve mollusks, *Nucula tenuis* and *Thyasira gouldii*, also were common, but accounted for a smaller proportion of the total abundance (6 percent) than for the shallower group. Within the deeper community, the stations located near the terminus of the Pipeline Lateral (about MP 13 to MP 16) also clearly separated from those located in shallower water (about MP 7 to MP 12).

The two main infaunal communities (shallow and deep) were distinguished primarily by differences in the relative contributions of the four predominant polychaetes and in the secondary taxa that characterized them. Secondarily-important species within the shallower community were among those often found at coarse-sediment areas of Massachusetts Bay (Kropp et al. 2002; Maciolek et al. 2003). These included the small clams *Thyasira gouldii*, *Nucula tenuis*, and *Periploma papyratium*, and the polychaete worms

Tharyx acutus, *Owenia fusiformis*, and *Aricidea catherinae*. Among deeper stations, the secondarily important species included oligochaete worms (not identified to species), three species of polychaetes (*Spio thulini*, *Galathowenia oculata*, *Chaetozone setosa*), the small snail *Alvania pseudoareolata*, and the horse mussel *Modiolus modiolus*. Small peracarid crustaceans were curiously lacking in numerical importance within either community. At shallower, sandy Massachusetts Bay stations sampled for the MWRA program, ranging from about 5 to 8 miles (465 kilometers) south to southwest of Station 1 (MP 0), crustaceans, such as *Crassicorophium crassicorne* and *Unciola inermis*, can be abundant periodically (Kropp et al. 2002; Maciolek et al. 2003). The characteristic fauna of the deeper pipeline route stations are similar to those typically found at one of the deeper MWRA stations, station FF14, located about 2.6 miles (4.2 kilometers) southwest of grab sample Station 19 (about MP 12), which is often characterized by *Spio limicola*, *Aricidea quadrilobata*, *Prionospio steenstrupi*, and *Anobothrus gracilis* (Kropp et al. 2002; Maciolek et al. 2003).

SPI data showed that the sediments in the Pipeline Lateral region could be characterized as highly bioturbated (i.e., well mixed by infaunal animals), with many surface feeding pits and mounds and subsurface burrows and feeding voids present. Larger infauna were occasionally seen. These observations indicated that the infaunal communities in the region probably were predominantly comprised of fauna typical of successional stage III, which is the equilibrium community stage (Rhoads and Germano 1986). Stage III organisms often burrow 3 to 5 centimeters below the sediment surface actively mixing the sediments and providing the mechanism by which oxygen reaches subsurface sediments. The deepest stations along the Pipeline Lateral (MP 13 to MP 16) also showed successional stage III faunal communities, although one station (near MP 15) also showed some evidence of pioneering Stage I fauna.

ROV images are particularly useful in capturing information about the larger or more motile surface-dwelling fauna than either of the other two sampling methods. The visible macrofauna changed gradually along the Pipeline Lateral. Most of the species observed were found along the entire route, but their relative abundance varied with depth and substrate type. Invertebrates commonly seen in the rippled sand between grab sample Stations 1 and 3 (about MP 0 to 1) were sand dollars (*Echinarachnius parma*) and sea stars (*Leptasterias tenera* and *Asterias vulgaris*). Invertebrates commonly seen in the slightly siltier sand found between grab sample Stations 2 and 9 (about MP 1 to 4) included: burrowing cerianthid (*Cerianthus borealis*) and mud anemones (*Edwardsia elegans*), sea scallops (*Placopecten magellanicus*), and Cancer (*Cancer irroratus* and *C. borealis*) crabs. Sand shrimp (*Crangon septemspinosa*) were the most common invertebrates seen in the siltier areas found between grab sample Stations 10 and 19 (about MP 5 to 12). Sand shrimp (*Crangon septemspinosa*) and mud sea stars (*Ctenodiscus crispatus*) were the most abundant invertebrates encountered from MP 12.5 to MP 16.4. Sand shrimp were most abundant in the area impacted by fishing gear, where they were frequently near or on top of topographic highs. Other invertebrates encountered included a few scallops (*Placopecten magellanicus*), some Cancer crabs, one lobster (*Homarus americanus*), some cepahlopods, a few pandalid shrimp, and several unidentified sea stars and gastropods.

Information on other larger benthic invertebrates, such as lobster or scallops, are included in Section 4.6.1.2.

The anchor corridor can be characterized by using the benthic data that were collected directly along the proposed Pipeline Lateral, with some stations located as far as 400 feet (122 meters) to the side of the route. However, the environmental setting within the anchor corridor must be described by assuming that the fauna resident there will be very comparable to that located in similar substrates along the main pipeline route. Within the anchor corridor, soft sediments predominate, comprising about 86 percent of the total corridor area of about 13,300 acres (5,382 hectares). Along the shallowest part of the Pipeline Lateral (136 to 161 feet; 41 to 49 meters; MP 0 to MP 5), soft-bottom habitat comprises about 82 percent (about 3,551 acres; 1,437 hectares) of the available habitat. Infaunal communities in this part of the anchor corridor are likely to be very similar to that described above as the shallow community, except that any sandier substrates might house communities more similar to the outlier community described above for the area near MP 1. Along the middle portion of the Pipeline Lateral (154 to 233 feet; 47 to 71 meters; MP 5 to MP 10), soft substrates occupy about 90 percent (about 3,269 acres; 1,323 hectares) of the habitat area in the anchor corridor. The infaunal communities inhabiting soft substrates along this portion of the Pipeline Lateral are likely to be similar to that described above as the deeper community, not including that found among the deepest stations near the end of the pipeline route. Substrates in the anchor corridor between MP 10 and MP 16 (233 to 289 feet [71 to 88 meters] deep) probably consist of fine sediments, with those near the deepest section (about MP 13 to MP 16) having a silt and clay fraction that exceeded 94 percent. Infaunal communities in this part of the anchor corridor should also be similar to that described above as the deeper community, especially those located near the end of the Pipeline Lateral.

Using side-scan sonar and USGS shaded relief seafloor mapping, the occurrence of areas of hard-bottom habitat within the anchor corridor were assessed. Hard-bottom habitat in the shallowest region of the anchor corridor (MP 0 to MP 5) comprises about 18 percent of the available habitat (775 acres; 314 hectares). Most of this habitat consists of relatively large patches located between MP 1 and MP 3 on both sides of the pipeline route. Many smaller patches are located along the outer boundary of the anchor corridor between MP 3 and MP 5. Along the middle section of the anchor corridor (MP 5 to MP 10), hard-bottom habitat accounts for about 10 percent (354 acres; 143 hectares) of the area. Most of this is located near the outer boundaries of the anchor corridor on both sides of the pipeline route in the vicinity of MP 6 and MP 7. Smaller, more-scattered patches of hard bottom occur between MP 8 and MP 9. Along the eastern third of the pipeline route (MP 10 to MP 16), hard-bottom habitat occupies about 14 percent (741 acres; 300 hectares) of the area. One large area of hard bottom occupies about half of the area on the right side of the pipeline route between MP 10 and MP 11. Scattered patches of hard bottom are found on either side of the pipeline route in the vicinity of MP 12, with some patches very close to the pipeline. Another large hard-bottom region occupies about half of the area on the right side of the anchor corridor from about MP 13 to MP 14. Between MP 14 and MP 16, several smaller patches of hard bottom occur, with some being located directly on the proposed pipeline route.

Two areas of hard substrate were observed during the ROV survey along the Pipeline Lateral at MP 15.15 and MP 15.5 at depths of about 270 feet (82 meters). These consisted of many angular rocks ranging in size from cobbles (3 to 8 inches; 8 to 20 centimeters) to small boulders or slabs (8 to 36 inches; 20 to 91 centimeters). The rocks were frequently partially or almost totally buried, or in the case of slabs, were projecting out of the sediment. The spacing and angularity of the rocks suggests that they may have been dumped in this area by barges intending to use the MBDS. The surfaces of the rocks were usually draped with a heavy layer of sediment. Fauna attached to the rocks included many massive lobular sponges (one species of these may be the fig sponge, *Suberites ficus*), some encrusting sponges, many hydroids, a few northern red anemones (*Urticina felina*), and possibly some brachiopods (*Terebratulina septentrionalis*). Mobile fauna on or near the rocks included the sea stars *Henricia sanguinolenta* and *Leptasterias tenera*, lobster (*Homarus americanus*), rosefish (*Sebastes fasciatus*), and several unidentified small fish (1 to 2 inches long; 2.5 to 5 centimeters long). There are no direct observations of the fauna/flora living on hard substrates in other portions of the Pipeline Lateral anchor corridor. However, unpublished information from other parts of Massachusetts Bay may be used to predict the types of organisms that may be found along the Pipeline Lateral (Barbara Hecker, unpublished information, personal communication).

Algae, with the possible exception of small coralline algae, are not likely to occur because of the light limitations present even at the shallowest Pipeline Lateral depths. The fauna residing on the hard substrate can vary substantially by location and depth, and by the amount of sediment drape covering the rocks. Several species of sponges may occur along the Pipeline Lateral including *Polymastia* sp. (an unidentified sponge that is encrusting with raised areas), *Suberites ficus* (observed near MP 15), *Haliclona oculata* (finger sponge), and *Halichondria panacea* (breadcrumb sponge) (Barbara Hecker, unpublished information, personal communication). Hydrozoans and upright bryozoans may occur at all depths, with hydroids often locally abundant. Sea anemones (*Metridium*, *Urticina*, and *Actinauge*) are likely to be found, but will become sparse as depth increases. Colonial and/or solitary tunicates may occur, but are not likely to be abundant. Motile fauna may include several species of sea stars including sun stars (*Crossaster papposus* and *Solaster endeca*), badge star (*Porania*), horse star (*Hippasterias phrygiana*), blood star (*Henricia sanguinolenta*), and slender-armed star (*Leptasterias tenera*) (Barbara Hecker, unpublished information, personal communication).

All three data sets showed that the general habitat quality along the Pipeline Lateral was good and that there was little evidence of anthropogenic impacts, except for fish-trawling scars more common at deeper depths.

4.6.2.4 Shellfish

Shellfish species include crustaceans, mollusks, and echinoderms that are considered harvestable for human consumption. Shellfish that may occur in the vicinity of the Port or Pipeline Lateral are listed in Table 4.6-3. Hubbard et al. (1988) reported that crustacean shellfish occurring in the vicinity of the MBDS included American lobster (*Homarus americanus*), rock crab (*Cancer irroratus*), Jonah crab (*Cancer borealis*), red crab (*Geryon quinquedens*), and northern shrimp (*Pandalus borealis*). Molluscan

Table 4.6-3. Shellfish Species Potentially Occurring in the Vicinity of Northeast Gateway Deepwater Port and Pipeline Lateral

Species	Buoy	Pipeline Lateral
Crustaceans		
Lobster	observed, potentially abundant	observed, potentially abundant
Cancer sp. crabs	observed, potentially abundant	observed, potentially abundant
Deep sea red crabs	rare	rare
Northern shrimp	observed, potentially abundant	observed, potentially abundant in eastern end
Mollusks		
Sea scallops	unlikely, absence of suitable substrate	observed, areas of suitable habitat
Ocean quahogs	potential habitat	observed, areas of suitable habitat
Softshell clams	observed	mapped habitat
Short-fin squid	rare	rare
Long-fin squid	potentially abundant	potentially abundant
Echinoderms		
Green sea urchin	unlikely, absence of suitable habitat	unlikely, suitable habitat limited to portion of construction anchor corridor

shellfish included short-fin squid (*Ilex illecebrosus*), long-fin squid (*Loligo pealei*), sea scallops (*Placopecten magellanicus*), and ocean quahog (*Arctica islandica*). Studies specifically targeting shellfish species have not been conducted for this project, although the winter 2005 ROV survey of the

Port and Pipeline provides some qualitative site-specific information. Lobsters, Cancer crabs, and northern shrimp were observed in the ROV survey of the buoy area. These species, along with sea scallops, were also observed in the ROV survey along the Pipeline Lateral. Because the videos, by necessity, cover only a small fraction of the Buoy Survey Area, absence of a particular species cannot be interpreted to mean the species does not occur in the area.

Crustacean Shellfish

American Lobster (Homarus americanus)

American lobsters occur throughout Massachusetts Bay on virtually any type of substrate. Although juvenile and adult lobsters prefer shelter such as that available where there is a sand, gravel, or bedrock base with a rock overlay (Cooper and Uzmann 1980), they are also common on soft substrates. On the soft substrates that occur in the Project area, they can either excavate burrows if the substrate is cohesive enough or make shallow depressions to provide some shelter. They forage opportunistically, feeding on a variety of living or dead invertebrates and vertebrates. While molting and growing a new carapace, lobsters are largely immobile and vulnerable and they typically take refuge in burrows or rocky crevices. After several hours, the new shell begins to harden. This is a critical period because mating takes place while the female's new shell is hardening. This soft-shell phase generally occurs during the summer months.

Lobsters produce free-swimming larvae that are phototactic and usually found near the water surface during the day (upper 1 meter) and at greater depth at night although in offshore waters, the larvae may occur throughout the upper mixed layer above the thermocline. Further detail on larval behavior is provided in Section 4.5.2.3 (zooplankton). Lobster larvae are often concentrated in the areas of oceanographic fronts, such as the front caused by the upwelling along the edges of Stellwagen Bank. Lobster larvae are likely susceptible to limited entrainment because the ship's intake structure is located on the bottom of the hull at a depth of about 40 feet.

Older larvae (Stage IV, or postlarvae) settle to the bottom and actively select habitat for benthic life. They exhibit "bottom-testing" behavior where they swim to the bottom and alternately ascend from and descend to the substrate (Cobb et al. 1989). After several days of bottom-testing behavior, they will actively seek a preferred habitat. Newly settled, or early benthic phase (EBP), larvae seek complex habitat that provides shelter, preferably cobble beds (Palma et al. 1998). Descent through the water column is strongly influenced by the presence of thermoclines (a layer of the water column in which the temperature decreases significantly with depth relative to the layers above and below). A difference of 5 °C is sufficient to significantly reduce the likelihood of EBP larvae settling to the bottom (Boudreau et al. 1992). Several researchers (Lavalli and Kropp 1998; Wahle and Steneck 1991; Wilson and Steneck, unpublished data) have found that lobster settlement occurs primarily in shallow water (preferentially in depths of 33 feet or less), such as on the submarine banks and in nearshore waters.

Environmental conditions at the Port and along the Pipeline Lateral fail to provide suitable conditions for EBP lobsters. The siting process for both the Port and the Pipeline Lateral selectively avoided areas of hard substrate to minimize construction impacts. Substrate in the Port area is uniformly silty-clay and does not provide the crevices needed for refuge. The sediment along the pipeline route gradually transitions from coarse sand at the inshore end to fine, silty sand at the offshore end. Water depth at the Port is approximately 280 feet (85 meters) and depths along the Pipeline Lateral range from 128 to 282 feet (39 to 86 meters). In Massachusetts Bay, there is a strong thermocline present at 33 to 66 feet (10 to 20 meters) deep representing 11 to 12 °C of temperature stratification between surface and near-bottom waters from roughly April through October (Cibik et al. 1998) that is likely sufficient to inhibit postlarvae from descending through the water column.

Lobsters offshore can migrate great distances, with migrations of up to 214 (344 kilometers) miles in 71 days being reported (Uzmann et al. 1977). During the spring and summer (May through September), about 30 to 50 percent of the offshore lobster population moves from the outer shelf and upper slope to shallow water to molt, mate, and extrude eggs (MacKenzie and Moring 1985; Cobb and Phillips 1980). This migration behavior is probably initiated by increasing water temperature, since the shallower bottom waters in the inshore areas provide more suitable water temperatures for molting and mating than the cooler offshore waters. In late summer and early winter (November), when inshore water temperatures cool, the offshore migrants return to the outer continental shelf. Anecdotal evidence from fishermen indicates that lobsters travel through Stellwagen Basin during their migrations following boundaries created by the hard bottom features to the west and Stellwagen Bank to the east.

ROV surveys of the Port and Pipeline Lateral (Appendix 4.6-1) during winter 2005 showed evidence of lobsters in the Project area. Although only a few lobsters were actually observed, the softer, siltier, and more cohesive sediments in the deeper portions of the Project area were marked with large, deep excavations or burrows that were likely to have been created by lobsters and crabs.

Based on the widespread commercial fishery for lobsters and the wide range of suitable lobster habitats present in Massachusetts Bay, it can be expected that adult lobsters may occur almost anywhere in the vicinity of the Port along the proposed Pipeline Lateral.

Cancer Crabs (Rock Crab – Cancer irroratus and Jonah Crab – Cancer borealis)

Cancer crabs are distributed from Nova Scotia to the South Atlantic States (Estrella 2003). Rock crabs (*Cancer irroratus*) are found in rocky habitat, but can be displaced onto sandy areas by competition with lobsters for habitat. Jonah crabs (*Cancer borealis*) prefer exposed, rocky habitat but are common on muddy substrates in deeper waters. Egg-bearing females prefer soft sediments, where they can dig and live in pits in the sediment (Canada Department of Fisheries and Oceans 2003). Male crabs molt in the winter, and females molt just prior to mating in the fall. Females lay their eggs and keep them under their abdomen for about one year. Cancer crabs produce large numbers of eggs that hatch into planktonic larvae in the summer. The larvae (zoea stage) are present in the water column from mid-June to mid-September. In the fall, the larvae molt into small crabs (megalopes) and settle both in cobble and sand (Palma et al. 1998). Juvenile crabs (less than 0.6 inch carapace width) concentrate in sheltered areas in shallow depths (Canada Department of Fisheries and Oceans 2003). Cancer crabs are currently a by-catch fishery with modest consumer demand (Estrella 2003). Results from the ROV survey showed that Cancer crabs are present along the proposed pipeline route (Appendix 4.6-1).

Rock crab and Jonah crab are both landed by fishermen, primarily lobstermen, from Massachusetts Bay. Rock crabs are generally considered to predominate near shore while Jonah crabs are more common in deeper waters, although they can co-occur (Krouse 1980). In a study for NOAA evaluating the effects of a smooth bottom trawl on the seabed, Boat et al. (2003), examined mud and sand bottom areas in Massachusetts Bay. In this survey, Cancer spp. crabs were substantially more abundant on the mud bottom, suggesting that the Port Project area is likely to support this resource. Because rock crabs prefer rock, sand, or gravel bottoms it is likely that Jonah crabs are more abundant in the Project area. Larvae of these species may be susceptible to entrainment.

Deep Sea Red Crab (Chaceon (Geryon) quinquedens)

Trawl surveys conducted during designation studies for the MBDS collected a few specimens of the deep sea red crab (*Chaceon (Geryon) quinquedens)* (Hubbard et al. 1988). Distribution maps for this species show that juveniles have been found offshore of Massachusetts in waters west of 70°W (Steimle et al. 2001), but that the primary distribution is on the edge of the continental shelf and on the continental slope.

Northern Shrimp (Pandalus borealis)

SAIC (1987) quantified the occurrence of pandalid shrimp within the boundaries of the MBDS using a submersible vessel. The area covered by the survey included both natural silt/clay substrate, similar to conditions in the Project area, and dredged material. Abundance of large shrimp ranged from 0.5 to 2.3 individuals per square meter. Small shrimp ranged from 0.9 to 16.8 individuals per square meter. Northern shrimp exhibit a preference for mud or silt substrates in 50 to 500 feet of water (McInnes 1986). This species was overharvested in the 1960s and has exhibited substantial interannual variability. Regardless, shrimp abundances in the Project area are likely to be similar to those in the MBDS. Shrimp may be susceptible to entrainment during their vertical migration. Northern shrimp were observed in the ROV surveys in the buoy area and along the Pipeline Lateral.

Molluscan Shellfish

The MDMF, in collaboration with the MCZM and the NOAA Coastal Services Center (CSC), developed a map of shellfish suitability areas that shows the approximate location of potential habitats suitable for ten species of shellfish along the coast of Massachusetts (Figure 4.6-2). The areas covered include sites where shellfish have historically been sighted, but may not currently support any shellfish. Based on this mapping, no potential molluscan shellfish habitat exists in the Port area but potential habitat for Atlantic sea scallop and soft-shelled clam (*Mya arenaria*) occur along the proposed pipeline route. As noted above, however, Hubbard et al. (1988) observed short-fin and long-fin squid, sea scallops, and ocean quahogs in the vicinity of MBDS so these species are assessed in this section for the Port. Juvenile softshell clams were present in some of the benthic grab samples in the buoy area. In addition, scallop and ocean quahog surveys conducted along the HubLine route in the proximity of the proposed tie-in for the Pipeline Lateral indicated that these species are likely to be present at least along the inshore portion of the Pipeline Lateral. Of these species, all but softshell clams are federally managed and the entire Project area (Port and Pipeline Lateral) is designated as EFH for all of them.

Short-Fin (Ilex illecebrosus) and Long-Fin Squid (Loligo pealei)

Short-fin and long-fin squid are pelagic species that typically migrate between coastal and offshore waters. They are more common in deep waters in the summer and early autumn. Long-fin squid pre-recruits and recruits ($\geq$ 9 cm) are more abundant in the fall than spring in Massachusetts Bay, although this species is more common in Cape Cod Bay and south of Cape Cod (Cargnelli et al. 1999a). Long-fin squid make seasonal migrations apparently related to bottom temperatures, moving offshore in late autumn to overwinter along the edge of the continental shelf.

Short-fin squid appear to undergo a migration of 1,000 miles (1,609 kilometers) or more (Cargnelli et al. 1999b). This species occurred in low numbers in the Massachusetts Inshore Trawl Surveys from 1978 to 1994 (reported in Cargnelli et al. 1999b). Squid may be susceptible to entrapment in the water withdrawn for hydrostatic testing and impingement against the grid covering the sea chests as a result of water withdrawal for engine cooling or ballast.

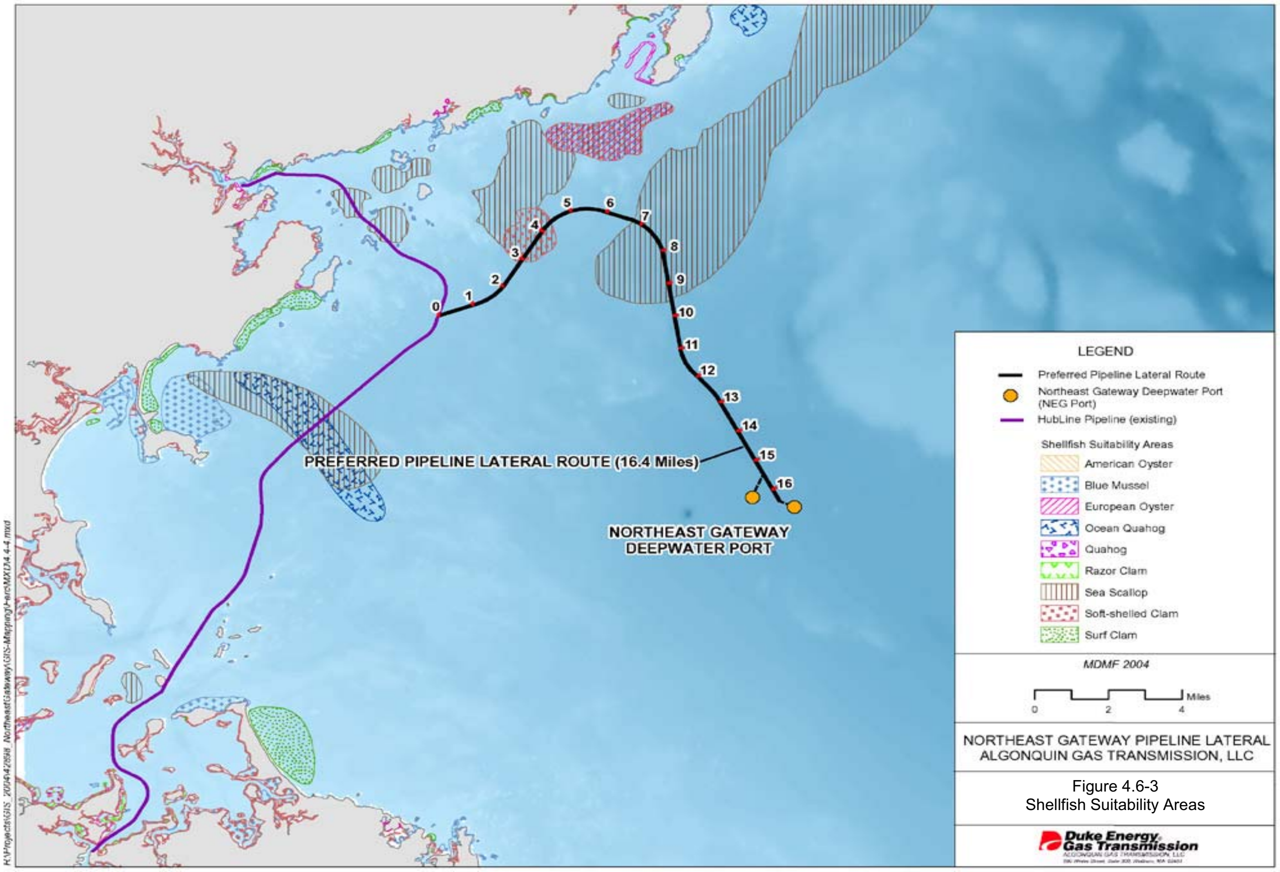

Figure 4.6-3. Shellfish Suitability Areas

Sea Scallops (Placopecten magellanicus)

Sea scallops are unlikely to occur in the Port area. Adult sea scallops are typically found on sand to gravel and cobble substrates, although juveniles can be found on silt as well (Packer et al. 1999). No sea scallop spat were found in the benthic grab samples collected for either the buoy or the pipeline area survey. No scallops were observed during the ROV survey of the buoy area, but sea scallops were commonly observed in the ROV footage between MP 1 and MP 4 of the Pipeline Lateral. The HubLine post-construction scallop survey completed in 2004 indicated that at the closest sample station to the tie-in location for the Pipeline Lateral, about 1.5 miles (2.4 kilometers) north of the interconnect location, density ranged from 1 to 2 scallops per 10 square meters. At this location, sediment type was characterized by diver as coarse-grained sediments, primarily coarse sand and gravel (TRC and NAI 2005b).

Sea scallops spawn in September and October and larvae remain in the plankton for about a month. Limited swimming capability leaves the larvae at the mercy of the currents, thus even if adult scallops are not in the Project area, larvae may occur there. During their planktonic stage, scallop larvae would be susceptible to entrainment with water withdrawn for engine cooling or ballast.

Ocean Quahog (Arctica islandica)

Ocean quahog is the most likely bivalve of interest to harvesters to occur in the Project area. This species resides just below the sediment surface in fine-grained sediments. While fine-grained sediments predominate in the Buoy Survey Area, they are mostly silty-clay, finer than the medium- to fine-grained sands preferred by ocean quahogs (Cargnelli et al. 1999c). No quahogs or quahog shell hash was observed in the ROV in the Port area. No juvenile ocean quahogs were found in the grab samples collected during site investigations. It is likely that ocean quahogs occur along the route of the Pipeline Lateral based on the ocean quahog survey conducted prior to construction of the HubLine. The HubLine survey had several stations located in relative proximity to the western end of the proposed Pipeline Lateral (MP 0.0). HubLine station #5, located about 0.25 mile south of the proposed HubLine tie-in location, had an estimated density of 0.74 quahogs per square meter in 2002 (TRC and NAI 2003). Sediments in this area consisted of 85 percent fine sand and 12 percent fines (silt/clay). Consistent with the HubLine survey, the ROV survey conducted in 2005 along the proposed Pipeline Lateral route noted that shell debris, consisting mostly of ocean quahog shells, was common between MP 0 and MP 2 near the inshore end of the proposed pipeline route (Appendix 4.6-1).

Like scallops, ocean quahogs have planktonic larvae and whether or not adults are present, larvae may be carried into the Project area, potentially exposing them to entrainment.

Softshell Clam (Mya arenaria)

The softshell clam is found along the Atlantic coast from Labrador to South Carolina and inhabits the bottom sediments of intertidal and subtidal waters up to depths of 328 to 653 feet (100 to 199 meters) (Theroux and Wigley 1983). They prefer fine sediments (soft mud and sand, compact clay) as well as coarse gravel and stones (Newell and Hidu 1986). Softshell clams usually spawn when their shell length is greater than 0.79 inch long (Coe and Turner 1938), with spawning peaking in the summer (June through September) (Ropes and Stickney 1965). The planktonic larval stage of the softshell clam lasts for 12 to 14 days and begins when the fertilized egg hatches into a trochophore and then enters the early veliger stage and late veliger phase (Newell and Hidu 1986). The larval stage (i.e., spat) then settles to the bottom, where it develops a foot and attaches to the bottom. The juvenile seed clams may migrate up to several hundred yards toward shore, with movement peaking in the fall (September and October) (Dow and Wallace 1961). Adult clams are sedentary and burrow deep into the sediment up to a depth of 16 inches (41 centimeters). Their preferred diet is plankton (i.e., flagellates and diatoms), but they can also feed on bacteria and organic detritius (Eaton 1983). Softshell clams may occur along the proposed pipeline route given the presence of suitable habitat between MP 3 and MP 4 and its potential distribution in deeper waters.

Planktonic softshell clam larvae may occur in the Project area and would be susceptible to entrainment.

Echinoderm Shellfish

Sea Urchin (Strongylocentrotus droebachiensis)

The green sea urchin is harvested in certain areas within Massachusetts Bay. Green sea urchins are common in the rocky subtidal of the Massachusetts Bay and the Gulf of Maine in association with their primary food sources, foliose and coralline algae (Maciolek et al. 2004). Spawning occurs from January through April. Urchins are harvested from September through April both through dragging and diving. There is no management plan currently in effect for this species. Sea urchins are unlikely to occur along the pipeline centerline route because of the predominance of soft sediments. Further, foliose and coralline algae do not occur in the water depths occurring along the pipeline route, including the anchor corridor. Sea urchins have planktonic eggs and larvae that may drift through the Pipeline Lateral area during summer months before settling on appropriate substrates in shallower water along the coast of Massachusetts.

4.6.3 Impact Analysis

4.6.3.1 Port Impact Analysis

Introduction

Aspects of construction and operation that have the potential to impact components of the benthic communities in the Project area are described in this section. Impacts could occur through disturbance or alteration of the substrate. The specific potential impacts are described for each type of benthic resource in the following sections and are summarized in Table 4.6-4.

Construction

Construction will entail the placement of spool, flowlines, and PLEM on the seafloor. Trenching for the spools and flowlines will disturb the largest area, a total of 36.8 acres (15 hectares). Flowline A will be trenched using a diver-operated jet and Flowline B will be accomplished using a deepsea plow, equipment that has been shown to minimize bottom disturbance and resuspension of sediments. Burial of the flowlines and spools will necessarily disturb the fine-grained sediments prevalent in the Project area, suspending them in the water column.

Placement of the suction anchors will also disturb the substrate, but the disturbance will be limited to the period when the anchors first contact the seafloor. Any turbidity generated will be dissipated quickly. Suction anchors minimize bottom disturbance and duration of construction.

Placement of the PLEM on the seafloor will briefly disturb the substrate and cause a temporary increase in suspended sediments in its immediate vicinity. The anchors and the PLEMs will extend above the seafloor resulting in a permanent loss of fine-grained substrate.

Table 4.6-4. Summary of Construction and Operational Activities Potentially Impacting Benthic and Shellfish Resource

Activity	Vegetation	Benthos	Shellfish
Construction (temporary)			
Flowline installation	no resource	36.8 acres	36.8 acres
Suction anchor installation	no resource	0.18 acre	0.18 acre
PLEM installation	no resource	0.08 acre	0.08 acre
Anchor chains and cables	no resource	5.4 acres	5.4 acres
Hydrostatic testing of flowlines	no resource	minor direct	minor direct
Operation (permanent)			
Cable sweep	no resource	42 acres	42 acres
Anchor chain	no resource	4 acres	4 acres
Anchors	no resource	0.18 acre	0.18 acre
Flowlines	no resource	0.18 acre	0.18 acre
PLEMs	no resource	0.08 acre	0.08 acre
Daily water use	no resource	direct	direct
Ballast water intake	no resource	direct	direct

Hydrostatic testing of the flowlines will require the use of 75,000 gallons (283 cubic meters) of seawater. Early planktonic lifestages of benthos and shellfish could be entrained by this process, depending on the time of year.

Operation

The anchors, PLEMS, and a small portion of the flowlines will be permanent features on the seafloor for the life of the Project, creating a 0.44-acre footprint of hard bottom features in the fine-grained substrate. While the buoys are unoccupied, anchor chains will rest on the bottom, covering 4 acres (1.6 hectare) of soft substrate. When an EBRV is linked to the buoy, the ship will weathervane in response to wind and surface currents, causing the anchor cables to sweep across the substrate. Cable sweep will affect a total of 42 acres (17 hectares) at the two buoys.

Each EBRV will require up to 54 MGD (205,000 cubic meters per day) of seawater for typical hotelling uses as well as to generate steam to aid in the regasification process. Of this quantity, 250,000 gallons per day (950 cubic meters per day) will be desalinated for gray water uses on the ship. The remaining volume will be diverted past the boilers and converted to steam to produce electricity necessary to meet the needs of the vessel (see Section 2.5.12.1 for further detail). The desalinated water will be recombined with the rest of the volume prior to discharge. Water temperature at the discharge point will be about 10 °F (5.5 °C) higher than at the intake, but the temperature difference at the surface will be less than 1 °C (see Section 4.4.3).

Intake of ballast water will occur continuously as the LNG is regasified and pumped into the flowlines. A total volume of 13.5 million gallons (51,000 cubic meters) per ship visit of 7 or 8 days will be required. On average, each EBRV will require 1.4 to 2 MGD (5,200 to 7,600 cubic meters per day) of ballast water intake depending on the duration of regasification. This water use could entrain larval stages of some benthic species.

Marine Vegetation

Because the Northeast Port is located in an area where the substrate is well below the photic zone, there is no vegetation other than phytoplankton (see Section 4.5) in the Project area. Hence, the Project will have no impacts on bottom-dwelling vegetation.

Macrofauna

Construction –Direct Impacts

Benthic macroinvertebrates that are in the 42.5-acre (17-hectare) construction footprint (flowline, suction anchors, PLEM, and anchor chains) are unlikely to survive construction. Once the flowline is buried, approximately 35 acres (14 hectares) of this area will be restored to the original substrate condition. The homogeneity of the substrate and the benthic infaunal community indicates that there is an available source of organisms to recolonize the restored substrate. If construction is completed in the spring, as proposed, some recolonization is likely to start within the first few weeks to months following completion because benthic reproduction rates are generally highest in the summer in New England. Complete recovery of this area to the equilibrium stage community (Stage III) that presently exists in the area will take some time. Rhoads et al. (1978) found that organisms colonized azoic sediments in 10 to 29 days in Long Island Sound. Dredged material at the Western Long Island Sound disposal site was colonized in 1 to 2 weeks (Murray and Saffert 1999). Table 4.6-5 shows results of studies tracking the recovery of late-stage benthic communities. Recovery to Stage III community took from several months to as long as 5 years, depending on the nature of the disturbance and the baseline characteristics of the habitat. The Project area is in the vicinity of the areas studied by Germano et al. (1994) and MWRA, so it is likely that these studies are reasonable predictors of the recovery rate of the benthic community affected by construction.

Refer to Section 4.5.3.3 for discussion of impacts of hydrostatic testing on planktonic lifestages of benthic organisms.

Construction – Indirect Impacts

It is unlikely that benthic resources would experience indirect impacts from construction because withdrawal and discharge of water for hydrostatic testing will occur at the surface.

Operation – Direct Impacts

Benthic resources will be affected in three ways during operation of the Northeast Port: loss of habitat (anchor chains and cable sweep), alteration of the habitat conditions (anchors, flowlines, and PLEM), and entrainment of larval stages in the EBRV intake system (daily water use and ballast water intake).

In each buoy area, approximately 21 acres (9 hectares) (for a total of 42 acres; 17 hectares) of the seafloor will be subjected to movement of the anchor cables in response to the EBRV's weathervaning around the

Table 4.6-5. Summary of Studies Documenting Recovery of Soft Substrate Benthos to Equilibrium (Stage III) Community

Study	Location	Stressor	Time to Recovery
Germano et al. 1994	Coastal New England	Dredged material disposal	6 months to 1 year
Rosenberg 1971	Sweden	Paper mill (sulfite)	3 years
Rosenberg 1976	Sweden	Enrichment	5 years
Murray and Saffert 1999	Western Long Island Sound	Dredged material disposal	1 to 4 months
MWRA	Massachusetts Bay	Storms	1 to 2 years
Rhoades et al. 1978	Long Island Sound	Dredged material disposal	1 to 2 years
Rhoades et al. 1978	Long Island Sound	Azoic sediments	6 to 8 months
SAIC 2004	Long Island Sound	Dredged material disposal	≤ 5 years

buoy. Any benthic organisms that settle in or on the substrate during the intervals when the buoy is unoccupied will be exposed to cable sweep within days of settlement, so these sediments will remain essentially azoic for the life of the Project.

In addition to the areas affected by cable sweep, the anchor chains will lie across the substrate, occupying 2 acres (0.8 hectare) at each buoy (for a total of 4 acres; 1.6 hectares). The chain could potentially provide hard substrate for attachment of fouling organisms, but its movement during operations may prevent successful colonization.

Existing soft substrate will be replaced by artificial hard substrate (anchors, flowlines, and PLEMs) in 0.44 acre of bottom. The hard surfaces of these port components will be available for settlement by fouling organisms. Because each of the anchors will extend approximately 1.5 feet (.5 meter) above the bottom, the 16 anchors potentially provide an additional 0.05 acre of attachment area. Hard bottom is relatively rare in the vicinity of the Northeast Port, although there is a rock outcrop east of Buoy A. Studies have not been conducted on this feature to determine what the structure of the fouling community is. The Northeast Port is located in an area that is too deep to support vegetation, but it is likely able to support faunal communities, including such species as sponges, hydroids, and bryozoans.

Refer to Section 4.5.3.3 for discussion of impacts of water use on planktonic lifestages of benthic organisms.

Operation – Indirect Impacts

It is unlikely that the benthic community will experience indirect impacts from operation of the Northeast Port.

Shellfish – Mollusks

Construction – Direct Impacts

A video survey of the buoy areas revealed few epibenthic mollusks. The sediment texture in the buoy areas is finer-grained than preferred by ocean quahogs, an infaunal species. Construction of the Project, therefore, will not have a substantial impact on molluscan shellfish. Larvae of molluscan shellfish may be present in the Project area. Assuming construction follows the proposed schedule, hydrostatic testing of the flowlines will occur in the spring, avoiding peak periods of abundance of molluscan larvae. (Refer to Section 4.5.3.3 for discussion of impacts of hydrostatic testing on planktonic lifestages of benthic invertebrates.)

Long-fin and short-fin squid are likely to occur in the Project area and may be subject to impingement during the withdrawal of water for hydrostatic testing, although the through-screen velocity is estimated to be about 0.8 feet per second. This relatively slow velocity may enable squid to avoid impingement. Squid that are impinged are likely to be injured or killed. The extent of this impact can not be quantified because distribution of squid is likely to be highly patchy.

Construction –Indirect Impacts

It is unlikely that molluscan shellfish resources would experience indirect impacts from construction because withdrawal and discharge of water for hydrostatic testing will occur at the surface.

Operation – Direct Impacts

The loss of substrate area will not materially affect molluscan shellfish because they do not appear in significant populations in the Project area.

Long-fin and short-fin squid will be exposed to impingement impacts during operation as described for the hydrostatic testing.

Operation – Indirect Impacts

No indirect impacts to molluscan shellfish resources are identified.

Shellfish - Crustaceans

Construction – Direct Impacts

Epibenthic (lobsters and crabs) and hyperbenthic (pandalid shrimp) crustacean shellfish have been identified in the Project area. Construction will disturb 34.7 acres (14.0 hectares) of substrate. Some individuals will be crushed or buried, although some will be able to escape, particularly along Flowline A where trenching will be accomplished by a diver-operated jet.

Lobsters, crabs, and shrimp all have planktonic larvae. Larvae of all these species are likely to occur primarily above the thermocline and lobster larvae may be more concentrated in the neuston, or uppermost layer of the water column. If water withdrawal occurs within several feet of the sea surface, lobster larvae, as well as crab and shrimp larvae, could be entrained. Withdrawal of water from deeper in the water column will likely reduce the exposure of lobster larvae to entrainment. Assuming that hydrostatic testing takes place in the spring, lobster and crab larvae will not be exposed to entrainment. A delay in hydrostatic testing would increase the risk of exposure of these species. Pandalid shrimp larvae are abundant in Massachusetts Bay in the spring (Table 4.5-1) and will be exposed to entrainment losses during hydrostatic testing.

Construction – Indirect Impacts

During construction, disturbance of the substrate may be an attractant for lobsters and crabs. Large infaunal organisms may become exposed to predation during and after construction. Lobsters and crabs attracted to the area could be subjected to burial, but both are capable of excavation and may be able to survive.

It is unlikely that adult crustacean shellfish resources would experience indirect impacts from construction because withdrawal and discharge of water for hydrostatic testing will occur at the surface.

Operation – Direct Impacts

Crustacean shellfish resources will be affected in three ways during operation of the Northeast Port: loss of habitat (anchors, flowlines, and PLEMs), alteration of the habitat conditions (anchor chains and cable sweep), and water use (daily water use and ballast water intake).

Lobsters, crabs, and shrimp will be unable to use the hard substrates created by the anchors, flowline, and PLEMs, so 0.44 acre (0.2 hectare) of existing habitat will be unavailable to these species.

Pandalid shrimp burrow into the mud and may recruit to the areas affected by cable sweep when the buoy is unoccupied. Cable sweep when a ship is docked, however, will likely make 32 acres (17 hectares) uninhabitable for this species. Some individuals will be killed, although some may be able to escape by swimming into the water column and settling elsewhere.

Lobsters and crabs are motile and will be likely to traverse the area affected by cable sweep. They may be able to feed on benthic organisms that are exposed by the cables. Lobsters and crabs that are in this area when a ship is docked may be injured or killed by the cables, however.

Water use and ballast water uptake during port operation will impact crab and shrimp larvae Refer to Section 4.5.3.3 for discussion of entrainment effects on benthic larval stages. The location of the intake structures 20 to 30 feet (6 to 9 meters) below the sea surface will minimize entrainment of lobster larvae.

Operation – Indirect Impacts

Crustacean shellfish will not be able to inhabit the artificial hard surfaces placed on the seafloor for the Northeast Port but lobsters and crabs may find refuge adjacent to the anchors and the PLEMs. Lobsters typically like to burrow adjacent or under hard surfaces. The presence of these structures may provide a slight increase in habitat complexity in an otherwise featureless area.

4.6.3.2 Pipeline Lateral Impact Analysis

Introduction

Potential impacts to the benthos arise from factors associated with the construction of the Pipeline Lateral including the methods used for pipe-laying, trenching the pipeline, the anchoring process used to position and move the pipe-laying, plow, and backfill plow barges, and the processes for returning cover over the pipeline. The different components of the construction process result in both direct and indirect impacts to benthic species and benthic habitats, and the nature and extent of these impacts varies during the construction process.

The potential locations and area of seafloor disturbance of various trenching methods (jetting and plowing, and transitions between them), anchoring, and other activities (concrete mats, side taps) have been estimated by MP along the Pipeline Lateral route, which allows the overall extent of benthic impacts related to them to be estimated. To characterize the area impacted by these methods, the pipeline construction corridor was separated into three MP zones (MP 0 to MP 5; MP 5 to MP10; MP 10 to MP 16.4) and the total areal impact of each method within each zone was determined. The MP zones were chosen to match those used for the estimation of the areal extent of soft- and hard-bottom habitat along the Pipeline Lateral (Section 4.4.1.1). However, it is not possible to separate areal impacts into habitat type (soft bottom and hard bottom) primarily because the exact placement of anchors and the corresponding area of cable sweep are not known. The location of the trench created by plowing and jetting should directly affect only soft-bottom habitats.

Within each zone, 7 to 8 percent of the sea floor will be disturbed by activities associated with trenching of the pipeline, including a single anchor pass. Plowing will disturb the largest area of the sea floor within each zone, and for the Pipeline Lateral overall, with a total areal impact of about 176 acres (71 meters). Jetting will impact only about 32 acres (13 hectares) of the seafloor. The crossing of the Hibernia cable at MP 5.7 will result in concrete mat placement over the pipe and on top of sediments equaling 0.2 acres. Impacts to soft-bottom and hard-bottom habitats are discussed below.

Accidental spills and releases could adversely affect the planktonic larvae of benthic species, either through toxicity or by contact and immobilization.

Use of the Pipeline Lateral during operation of Northeast Gateway will not typically cause further disturbances to the seafloor. In the event that a section of pipe requires repair or maintenance, impacts will be very localized.

Marine Vegetation

Because the Pipeline is located in an area where the substrate is below the photic zone, there is no vegetation other than phytoplankton (Section 4.5) in the Project area. The Pipeline Lateral, therefore, will have no impacts on bottom-dwelling vegetation.

Macrofauna

The proposed primary trenching method is PLP, which will be used for more than 96 percent of the route because it will result in the least disturbance of the substrate and overlying water column. PLP method is described in Section 2.4.3.1. The lateral extent of disturbance to the sea floor from plowing and backfill plowing of the trench is expected to be about 75 to 80 feet (23 to 24 meters) wide. After the plowing pass is completed, a backfill plow, which has reversed mold boards, is used to pull the spoil back into the trench.

The immediate, direct impact to the benthos will be from the localized removal, turn over and sidecasting of the sediment in to the immediate vicinity of the pipeline during the plowing of the trench. The backfill plow pass will impact about 7 percent of the soft-bottom habitat within the anchoring corridor, similar to the plow pass. PLP is likely to cause an almost complete turnover of the sediment as the material is excavated from the trench and sloughed over onto the sea floor adjacent to the trench. The net result of this is that sub-surface sediment will now temporarily lay on the surface. Most benthic infauna and epifauna live on or within about the upper six inches of the sediment surface. Impacts from this sediment turnover will result in the burial of the fauna living directly on the pipeline path and in the sediment adjacent to the pipeline. Because most infaunal animals have limited capabilities to successfully emerge after burial by more than a few inches of sediment (Kranz 1974, Maurer et al. 1986), much of the moderately diverse and abundant infaunal community that was found along the pipeline (Section 4.6.2) will be lost. Some animals that live near where the outer edge of the spoil mound will be located are likely to be covered by less material and may be able to emerge from burial. Backfill plowing will return the sediment to the trench, but the sediments probably will still show some degree of turnover or mixing, with portions of more compact sediments from the bottom of the trench mixed with somewhat less compact surficial sediments. Depending on the length of time between the plowing and backfilling, some organisms may survive the entire trenching and backfilling process. This conclusion is supported by the post-construction monitoring on the HubLine Pipeline project, in which evidence of older aged individuals of species such as quahogs were observed in ROV video, or a robust epifaunal community was observed on hard surfaces such as cobble (TRC and NAI 2005a).

Post-lay jetting is intended to be used when sediment cannot be removed from under the pipe by the plow, primarily at pipeline ends, foreign utility crossings, and the in-line sidetap flanges. Section 2.4.3.3 describes the jetting process. Sediment is put into suspension and settles out at varying distances from the trench with heavier sediments settling closer to the trench. Because of the dispersion of the sediment, backfilling may be more difficult and may require the importation of fill material. Impacts from this trenching method are likely to be more severe than those from PLP although only occurring in very short, discrete areas. Spoil is broadcast to both sides of the trench from a jet sled discharge point that is about 20 feet (6 meters) off the seafloor. Coarse sands and gravels typically settle out within 10 to 25 feet (3 to 8 meters), but finer material settles out at increasing distances that may reach 100 feet (30 meters) or more on either side of the trench. Sediment transport and deposition modeling done for the HubLine construction suggested some jetted fine material (silts and clay) could be deposited in a 1-millimeter-thick layer as far as one-quarter mile away from the discharge point. However, as described in Section 4.3.3, HubLine construction water quality monitoring detected only slightly elevated turbidity levels 500 feet (150 meters) or so from the jet sled.

Impacts to the soft-bottom benthos from jetting may be somewhat similar to those caused by plowing, but extend a greater distance from the trench. Jetting will occur only along about 0.5 mile of the route. Overall burial depth adjacent to the trench may be shallower and the covering material may be less compact than that from plowing. However, as described in the modeling done for the HubLine Pipeline Project FERC application, jetting is likely to result in a gradual tapering spoil that may be several feet thick adjacent to the trench tapering off to less than an inch several hundred feet away (Algonquin 2000). The characteristics of jetting spoil are highly dependent upon the grain size of jetted sediments, with gravel and coarser sand settling out quickly while fine sand and silt may be carried farther away and deposited in a thinner layer. Increased suspended sediments may cause relatively minor distress to nearby filter-feeding animals, but the reduction in respiration and feeding is likely to be short-lived.

Benthos that survive the trenching process, including burial, may experience indirect impacts. Probably the most important of these is that the increased energetic cost of recovering from burial under spoils may result in decreases in reproductive output and increased susceptibility to predation (Hall 1994). Changes in food availability resulting from the sediment turnover may also adversely impact animals that survive the initial burial. These indirect impacts may become expressed as changes in population densities, recruitment, and dispersion (Hall 1994). Indirect impacts may not be immediately recognizable through traditional benthic monitoring. Zajac and Whitlatch (1989) found that although population abundance data for the polychaete worm *Nephtys incisa* showed no differences between dredged material and references sites in Long Island Sound, the populations had very different age and size-class structures that were related to dredged material disposal.

If the Pipeline Lateral crosses unexpected surface or subsurface hard-bottom areas, the rock will not be removed and the pipe will be laid on or near the sediment surface and protected by a rock cover or concrete mats on top of the pipe. Based on the extensive geophysical surveys completed, surface rock does not occur along the pipeline route and unanticipated armoring is not expected. However, in this instance, a narrow strip of new hard-substrate habitat will replace the previously existing soft-sediment habitat. Similarly, a short section of new hard-substrate habitat will replace previously existing habitat where surface armoring is currently planned at the Hibernia cable crossing at MP 5.7. The net change in the area is the elimination of a soft-bottom habitat and its replacement by an artificial hard-bottom substrate. The substrate in this area ranges from sand to a primarily fine textured sediment (65 to 83 percent silt and clay). Infaunal abundances can be high (27,700 individuals per square meter) and include a diversity of species (up to 70 species). This community will be lost. Fortunately, the area impacted is relatively small, consisting of a single location of less than 0.2 acre (0.1 hectare). After a period of time, the concrete mats will likely be colonized by sessile epifaunal taxa such as those found on hard bottoms in the area and elsewhere in Massachusetts Bay.

The anchors themselves will cause disruption to the benthos, the extent of which depends on the size of the anchors and the degree to which they "pull" through the sediment as they set. The anchoring process is described in Section 2.3.1. Anchor cables have the potential to create additional disturbance by sweeping along the bottom. The impacts to the seafloor communities caused by the barge anchoring process are most likely to result from direct damage as the anchor lands on the bottom, some scouring as the anchor is set, and additional sediment disturbance that may result as the anchor is retrieved and any sediment on the flukes falls off. In soft sediments, anchor cable sweep may cut through the top few inches of the sediment layer, while in hard substrate areas the cable will scrape across the surface of cobble and boulders. Tube-dwelling polychaetes, solitary anemones, and other larger infauna are probably the most susceptible to harm from anchor cable sweep in soft sediments.

There are several studies that describe the impacts of anchors used in recreational boating on seagrass beds and coral reefs, but few on impacts to soft sediment habitats. One study that examined small anchor (44-pound) impacts to soft-bottom areas showed that some larger animals, especially clams, could be severely damaged by anchors and were then subject to attacks from scavengers (Backhurst and Cole 2000). The study also showed that repeated anchoring in an area, which covered about 20 percent of the available habitat in the study plot, created some local damage to the community but did not significantly change the overall characteristics of the infaunal community from those observed for undamaged areas. Anchors scars persisted as long as three months after the damage was incurred. Impacts caused by anchoring the construction barges will probably be more extensive than that described by Backhurst and Cole (2000) because of differences in anchor sizes (15-ton Stockless anchors will be used during the pipe laying). However, the percent area impacted by project anchoring will be small, relative to the entire anchor corridor area. The impacts also may be compounded by the anchors being dropped and set for each phase of the operation. The anchor scars created during pipeline construction will persist longer than those described for small anchors primarily because they will be much larger and heavier. Scars in shallower pipeline areas probably will not last as long as those in deeper areas because they are more likely to be filled in by wave action and currents than the deeper more quiescent portion of the route. Anchor and cable-sweep impacts may be similar to those caused by trawling, although they will be smaller and more localized.

Impacts to hard-bottom habitats will result primarily from anchoring since the centerline route passes through soft-bottom habitats. The main damage from anchoring in hard substrate areas will likely be attributable to the direct impact of the anchor on the substrate. This will crush attached epifauna and further imbed rocks and cobble into the sediment. Organisms that generally might be affected include the various species of sponges, anemones, and tunicates as described in the Environmental Setting section (Section 4.4.1.1). Some motile epifauna, such as an occasional seastar, lobster, or crab, may be impacted, but there should not be noticeable impacts to the general populations. Damage from cable sweeps will likely be caused by direct impacts as the cable strikes the bottom and from scraping as the cable drags along the bottom. The potential for these impacts will be minimized by the placement of buoys on the cables to help keep them off the bottom. It is not possible to predict the precise damage to hard-bottom habitats because the exact locations of the anchor placements cannot be known prior to construction. It can be expected that the highest probability of damage to hard bottoms will occur where their areal extent is relatively extensive. These locations include the areas along the Pipeline Lateral route from about MP 1.3 to MP 2.5, MP 5.7 to MP 6.4, MP 10 to MP 11, and MP 12.7 to MP 14. Note that the hard-bottom habitat at MP 5.7 is not near the center of the Pipeline Lateral route, and therefore is not near the Hibernia cable crossing.

Often, disturbance-related impacts to the benthos are temporary as the native community either recolonizes the area or a new community develops from the emigration of animals from nearby areas or from larval settlement. However, some long-term or cumulative effects to the benthos may result. The rate at which the fauna recolonizes a disturbed area depends on many physical and biological factors. One consideration is the texture of the plowed and back-filled material. Any substantial change in texture, or compactness, reduces the chances that the community present after backfilling would be similar to that present before pipeline placement. Any portions of the back-filled sediments that are more compact than the native sediments they replaced may be more difficult for infaunal animals to recolonize. Also, sediments that have been turned over from 3-foot (1-meter) depths, or greater, may be hypoxic [SPI data showed the RPD along the pipeline ranged from about 1 to 3 inches (about 2 to 7 centimeters)]. Diffusion is the main process by which these sediments can become oxygenated because they may be compact and not inhabited by many infaunal animals. Diffusion is a relatively slow process and is limited in how deeply it can penetrate the sediment (Diaz and Rosenberg 1995). Thus, the initial recolonization of an area disturbed by pipeline construction may initially be slow, but may eventually occur (Lewis et al. 2002, 2003). Physical disturbance to the sea floor, such as storms in the shallower reaches of the pipeline route or fish trawling, could also affect the timing, and perhaps the nature, of recovery.

Biological factors strongly influencing recovery of the benthic community include the variability naturally inherent in the general Massachusetts Bay ecosystem. This variability is expressed by spatial and temporal differences in the availability of larvae, juveniles, or adults to colonize newly established habitats (Ólafsson et al. 1994). It is often presumed that larval recruitment constitutes the primary mechanism by which recolonization occurs. However, Zajac and Whitlatch (1988) found that the initial recruitment after sediment disposal may be facilitated by adults migrating from other areas. Subsequent population increases then would occur by recruitment of new age classes to the area. Importantly, Zajac and Whitlatch (1988) discovered that this recruitment rate may not be directly related to the disturbance event, but may be related to factors (e.g., temperature, dissolved oxygen) other than those arising from the disturbance. Post-recruitment processes, such as predation on larvae by resident suspension feeders, predation on infauna disturbed by physical events, variation in the food supply, and emigration and immigration, also influence the community that eventually develops in new habitats (Ólafsson et al. 1994). Thus, initial recruitment into and subsequent community development of the disturbed area may not follow predicted successional models. It is now recognized that more than one stable ecosystem type may occur in a given marine area, in which case the system is said to have multiple stable states (Knowlton 2004). If this is the case, it is difficult to predict the nature of the community that will eventually exist in a disturbed area, especially if historical information about the community is lacking or poor. The eventual recolonization of a disturbed area may be compounded by secondary disturbances (e.g., storms, trawling over the recovering area) that happen while initial recolonization is occurring (Paine *et al.* 1998). Thus, the return to a completely similar predisturbance condition may be delayed or not occur at all but instead an alternative community may develop. However, Paine et al. (1998) also pointed out that the basic character of an ecosystem is not often transformed by large, infrequent disturbances.

Recently completed (2004) post-construction benthic monitoring of the HubLine pipeline construction area provides some insights into the impacts to soft-bottom habitats caused by the pipeline construction process. Data from the 2004 survey were compared to the pre-construction surveys. Although several significant differences for several of the measured infaunal parameters differed between the two surveys, few showed any potential direct link to the construction activities (TRC and Battelle 2005a). Infaunal abundances and numbers of species found along the pipeline in 2004 following construction varied considerably, as is typical of benthic habitats in Massachusetts Bay (Kropp et al. 2002), but relatively well-developed infaunal communities were present at all stations. For example, in the Massachusetts Bay section of the HubLine project, which has more direct relevance to the Pipeline Lateral than the more inshore segments of the HubLine alignment, infaunal abundance at most stations ranged from about 5,000 to 22,000 animals per square meter (per 10.7 square feet) and species numbers ranged from about 17 to 41 per station. The fauna was not dominated by an overwhelming abundance of opportunistic species, but rather was comprised of species characteristically found in the Bay. Sediment profile image data also showed little significant habitat change between 2002 (preconstruction) and 2004 (post-construction), and indicated that soft-bottom habitats in the construction zone were not of poor quality, and showed substantial evidence of a viable benthic community (TRC et al. 2005b). These results predict that the impact area associated with the construction of the Pipeline Lateral will continue to support a viable benthic community shortly after construction, although the specific nature of that community may differ from the one that was present before construction. However, some differences in the rate of recovery of the sediment, and the colonizing species, along the Pipeline Lateral route can be expected because of differences in the sedimentary environment and depth of the route compared to the HubLine.

It is unlikely that spilled material would reach the seafloor, given the project's water depths and offshore location, unless the spill was large and inadequately contained. Algonquin and its contractors will perform construction under an approved SPCC Plan, which will serve to minimize the potential for adverse effects on benthos and benthic habitats from spills

Shellfish

In general, many of the potential impacts from pipeline construction that affect benthos and lobster may also impact shellfish populations in the project area. The most significant impact is the mortality through direct contact with equipment and burial of shellfish by sidecast spoil that are in the direct footprint of pipeline laying and trenching. Softshell clams and most other bivalves live on the sediment surface or just below it and thus may have limited abilities to recover from burial. Significant mortality (2 to 60 percent) was observed in softshell clams that were buried at depths of 20 inches (50 centimeters) or more in sandy substrates (Emerson et al. 1990). It is also suggested that in muddy sediments, a burial depth of 10 inches would be lethal. However, impacts to softshell clam populations will be negligible because only a small portion of the Pipeline Lateral route (MP 3 to MP 4) occurs within habitat suitability areas identified by MDMF for the species. Because the plowing spoils could be up to several feet thick, it is likely that other shellfish such as quahogs that are buried will be too deep under the plowing spoils to burrow to the surface. However, the HubLine post-construction monitoring revealed that either colonization had occurred to some extent in the first year following construction and/or that some organisms survived the pipe-laying and burial processes. This is particularly true for what appeared to be individuals whose size suggest they were older than one year (TRC and NAI 2005a; TRC and NAI 2005b).

Increased water column turbidity, decreased light penetration, and the release of nutrients or contaminants from sediments, all may impact all life stages of shellfish, though such disturbances would be spatially limited and short-lived. In particular, increased turbidity in the water column from plowing or jetting activities may interrupt feeding and respiration by filter-feeding bivalves. Most filter feeders stop feeding and reduce respiration while the sediment content in the water is high. Softshell clams may continue filtering when total suspended solids exceed 300 milligrams per liter (Eaton 1983), but individuals were unable to obtain adequate nutrition and began metabolizing protein when exposed to suspended sediments of 100 to 200 milligrams per liter (Grant and Thorpe 1991). Therefore, exposure to particle loads of greater than 100 milligrams per liter for more than two weeks would result in reduced growth and condition and increased mortality (Grant and Thorpe 1991). There is about a 1:1 relationship between suspended solid concentration (milligrams per liter) and turbidity (measured as Nephelometric Turbidity Units [NTU]). Because average turbidity measurements taken during the HubLine project construction did not exceed 28.8 NTU (TRC 2004), the turbidity plume generated during construction of the Pipeline Lateral is not expected to impact the growth or survival of softshell clams in the Project area. Suspended sediments occurring in any one area during construction will be for short durations, typically hours to no more than a few days, because the construction process involves movement along the pipeline corridor. In the short or discrete areas where specialized work, such as the hot tap or the Hibernia cable crossing will occur, only a localized turbidity or sedimentation event will occur, affecting few shellfish.

Impacts to shellfish from anchors and cable sweep in areas of soft sediment will be similar to those described above for benthos. Rocky areas within the anchor corridor would provide some protection for crabs in these areas from contact with cables. Impacts to eggs and larval stages of shellfish present at the construction area will be lessened if construction occurs primarily during the winter because spawning and the subsequent presence of planktonic larvae generally occur during the late spring and summer months. Also, if plowing results in a substantial change in surficial sediment characteristics, settlement of larvae may be affected if the sediment no longer provides the correct settlement cues. Over time through natural processes, the sediment should provide suitable settlement habitat.

Accidental spills and releases could adversely affect the planktonic larvae of shellfish, either through toxicity or by contact and immobilization. Algonquin and its contractors will perform construction under an approved SPCC Plan, which will serve to minimize the potential for adverse effects on zooplankton from spills. In addition, most of these larvae are present during summer months, outside the timeframe proposed for construction.

Shellfish - Crustaceans

Some mobile species, such as crabs, may not be able to move rapidly enough to avoid construction areas and may suffer mortality or injury from plowing or burial from spoil material. One species of Cancer crab (*Cancer magister)* was shown to burrow to the surface in less than one day when buried by 4 inches (10 centimeters) or less of sand, but none reached the surface after burial by 8 inches (20 centimeters) (Chang and Levings 1978). Burial experiments conducted by Maurer et al. (1981) found that the mud crab (*Dyspanopeus sayi*) could migrate vertically through 12.6 inches (32 centimeters) of sand and silt-clay but that mortalities increased greatly from burial depths of 6.3 inches (16 centimeters) to 12.6 inches (32 centimeters) of sand. Although Cancer crabs occur throughout the Pipeline Lateral route, they generally do not aggregate and, therefore, impacts to the species' general populations are likely to be minimal.

The density of lobsters within the project area has not been well characterized and lobster populations in the area are likely to vary seasonally and annually. Molting and mating occur during the spring and summer in the warmer inshore waters and would not be impacted by the offshore pipeline construction in the winter. However, the inshore movement of migrating lobsters in the spring and their offshore movement in the fall may be impeded or altered by construction activities. A supplemental lobster monitoring survey was conducted during the HubLine project to assess the impacts from surface laid pipe or open trenches to the late-spring onshore movement of lobsters (TRC and NAI 2003). Construction activities (i.e., plowing, jetting and backfill plowing) were ongoing during the survey. Video was collected by ROV in early June and August 2003 at 28 sampling stations along the HubLine, with divers visiting seven of those stations. Adult lobsters were observed all along the HubLine route, occurring on the seafloor, on the pipe, and in burrows. The greatest number of lobsters was observed in plowed trench areas (161 of 302 individuals) compared to jetted trench areas (126 of 302 individuals), and laid pipe (16 of 302 individuals). When the ROV data were standardized for the length of surveyed area (100 meters [328 feet]), surface laid pipe areas had a higher density of lobsters (2.8 lobsters) than plowed trench areas (1.6 lobsters) or jetted trench areas (1.2 lobsters). The differences in lobster density may be because the surface laid pipe areas had been undisturbed from late February until early June, while plowing (March to June) and jetting (May to July) occurred just prior to sampling in June and August. Lobsters were observed on the eastern (43 percent) and western (57 percent) sides of the pipeline, and crossing over the pipeline. These results suggest that lobster migration would be unaffected by the physical presence of the pipe or trench, particularly since the Pipeline Lateral has more of an east-west orientation than the HubLine pipeline.

Impacts to lobsters occurring in the trenched area will include some mortality regardless of which construction method is employed. Vibrations associated with the plowing, jetting, and backfill plowing operations may elicit an escape response, in which lobsters swim away from a threat using multiple rapid tail flips, thereby escaping burial or contact with the trenching equipment. Juvenile lobsters (soft- and hard-shelled individuals) and some adults (hard-shelled) show this behavior (Cromarty et al. 1991; Cromarty et al. 2000). Lobsters that have acquired and retained shelter for an extended period of time become aggressive when threatened and tend to remain in their territories instead of fleeing (Cromarty et al. 1999). Therefore, lobsters inhabiting burrows along the pipeline route are less likely to flee than non-resident lobsters (i.e., migrants). In addition, lobsters located immediately adjacent to the trench may be buried by spoil material. The lobster's ability to burrow may enable it to escape from the spoil mounds, depending upon how deeply they are buried. The plowing and jetting of the seafloor can alter the habitat of juvenile and adult lobsters by disrupting and burying shelter and food resources. Varied bottom topography or substrate types have been identified as desirable locations to find lobsters. During the HubLine lobster monitoring survey, 56 lobsters (19 percent of total lobsters) were observed on spoil mounds (TRC and NAI 2003). Burrows, both with and without lobsters, were observed along most of the HubLine route following construction, indicating that recolonization of the pipeline corridor had occurred weeks to months after disturbance had ended. EBP lobsters are not likely to be impacted by pipeline construction because they do not typically occur at the water depths found along the pipeline route (Wahle and Steneck, 1992; Lavalli and Kropp 1998) and because the Pipeline Lateral route was sited to avoid the cobble and glacial till areas that form EPB habitat (see Section 4.4.1.2). Any cobble and glacial till found away from the pipeline centerline but within the anchor corridor occurs at water depths greater than typical EBP habitat.

The anchors used to position and move the barges during construction may impact lobsters within the anchor corridor as described above for benthos. Lobsters occurring directly under where anchors strike the bottom will suffer mortality, and contact with anchor cables moving across the seafloor may kill or injure lobsters that are unable to avoid the cable. Some areas of the anchor corridor may contain rock outcroppings, which may provide some protection for lobster in these areas from contact with cables.

Turbidity plumes created during construction are unlikely to impact lobsters. Experimental studies have demonstrated that mortality of lobster, attributable to exposure to high sediment concentrations, was not observed after exposure for 24 hours at up to 3,200 ppm of clean estuarine silt (Saila et al. 1968). Because lobster are capable of withstanding relatively high concentrations of suspended sediments and experience major changes in turbidity during storms, the increase in turbidity created by construction activities is not likely to adversely affect lobster in the area.

Accidental spills and releases could adversely affect the planktonic larvae of lobster, either through toxicity or by contact and immobilization. Algonquin and its contractors will perform construction under an approved SPCC Plan, which will serve to minimize the potential for adverse effects on planktonic lobster larvae from spills. In addition, most of these larvae are present during summer months, outside the timeframe proposed for construction.

4.6.4 Mitigation Measures

Northeast Port

Construction

- Use of deepsea plow has been shown to minimize bottom disturbance and resuspension of sediments.
- Assuming construction follows the proposed schedule, hydrostatic testing of the flowlines will occur in the spring, avoiding peak periods of abundance of molluscan larvae.

Operation

- Use of suction anchors minimizes bottom disturbance.
- The through-screen velocity is estimated to be about 0.8 feet per second. This relatively slow velocity may enable squid to avoid impingement.
- The location of the intake structures 20 to 30 feet (6 to 9 meters) below the sea surface will minimize entrainment of lobster larvae.
- Anchors and the PLEMs may provide a slight increase in habitat complexity in an otherwise featureless area, of particular importance to lobsters.

Pipeline Lateral

Benthic impacts in the offshore environment have been minimized through the siting of the proposed Pipeline Lateral and through the use of the proposed construction methods. In addition, Algonquin is planning to construct the Pipeline Lateral beginning in September 2006 and extending into May 2007. The main construction activities including pipelay, plowing, backfill plowing, and jetting are planned to occur during the winter months. The schedule for these activities will occur during a period when on balance, impacts to benthos and benthic habitats occurring along the Pipeline Lateral will be minimized.

Siting of the Pipeline Lateral

As described in Section 2, Algonquin spent considerable time conducting geophysical and geotechnical surveys across a broad area in an effort to locate the Pipeline Lateral in an area with relatively uniform substrate/habitat conditions where the least environmentally impacting construction procedures could be effectively utilized. The preferred route meets this objective. Geophysical survey data indicate a seafloor composed of largely silt/sand/clay with no surficial rock. As such, the preferred route has a low probability of encountering rock requiring blasting, dredging, or surface armoring. Because of the relative simplicity of construction and fewer number of construction method transitions, this route is expected to require the shortest duration of construction activities, result in the least amount of sediment resuspension and transport, and entail the narrowest direct disturbance width along the trenched pipe.

Construction Methods

Algonquin will utilize a single pass of the PLP to lower the pipeline for the majority of the route (over 95 percent) as the principal impact minimization measure. Offshore, where plume dilution occurs more rapidly because of water depth, plowing is the preferred construction technique because it is much faster than other techniques, causes the least amount of sediment resuspension and, thereby, reduces the duration and extent of water column effects. The selection of plowing as the primary pipe burial process minimizes the footprint adjacent to the trench where material will be sidecast, thereby minimizing the total impact area. In addition, minimizing the number of plow passes avoids additional impacts associated with the barge anchoring process.

Algonquin is planning to backfill the majority of the pipeline with one pass of the backfill plow. The backfill plow operates in a similar manner to the plow, but has reversed mold boards that are used to pull the spoil back into the trench. HubLine post-construction surveys showed that in areas where only plowing and backfill plowing were used, the contours more closely match pre-existing conditions than areas that also involved dredging, jetting, or blasting, which is why the Pipeline Lateral was located in an area that avoided sediment types that would have otherwise required the use of these methods as the primary trenching technique.

In the limited areas along the route where jetting is proposed to excavate the trench, the Pipeline Lateral will be backfilled with sand (placed by tremie tube), concrete mats, or diver-placed sand bags depending on the operational requirements of the site. Whatever material is used, it will be placed over the pipeline using a tremie tube or by divers; no imported backfill material will be dumped from vessels on the surface.

The primary construction barges will use mid-line buoys on all anchor cables to minimize scouring of the seafloor and the release of sediments resulting from cable sweep that will occur during movement of the construction vessels.

Algonquin and its construction contractors will also implement a SPCC Plan to minimize the potential impacts of any unintentional fuel spills or similar releases.

4.6.5 Alternatives

4.6.5.1 No Action Alternative

Under this alternative, the Project would not proceed and existing conditions would remain. Other means to satisfy the nation's energy demands might result in increased use of existing land-based terminals, greater reliance on declining domestic oil and gas resources, or development of alternate means of importing LNG.

4.6.5.2 Port Alternative

As an alternative to locating the Port at Buoys A and B (Preferred Alternative), the Project considered using Buoys B and C (Alternative 2). Substrate conditions in Buoy Area C showed little difference from Buoy Areas A and B. As a result, benthic resources were similar among the three locations. Locating the Port at Alternative 2 would have the same types of impacts as locating the Port at the Preferred Alternative, although there would likely be a slight difference in the length of flowline versus pipeline needed to reach Buoy C compared to Buoy A.

4.7 Finfish Resources

4.7.1 Introduction

Finfish resources of the Port and Pipeline Lateral, including juvenile and adult (including spawning habits) lifestages, are discussed in this section. Section 4.7.2 is based on existing literature review and describes existing conditions, including seasonal distribution and relative abundances of the finfish resources, a summary of the EFH designation, and a brief description of the species utilization of commercial and recreational fisheries. No site-specific surveys have been conducted for this project for finfish. Environmental impacts of Project construction and operation are evaluated in Section 4.7.3, including an assessment of the effects of the Project on federally managed species. Proposed measures to mitigate or eliminate potential impacts of the Project on finfish resources are provided in Section 4.7.4, and Section 4.7.5 is a discussion of Project alternatives. Egg and larval lifestages are generally planktonic and are discussed in Section 4.5 on Plankton. Benthic resources, including shellfish, are discussed in Section 4.6. The detailed EFH Assessment is included as Appendix 4.7-1.

Project Area: The Project area for the Port and Pipeline Lateral includes the ports and harbors along the shoreline of Massachusetts Bay closest to the Project, the waters of Massachusetts Bay extending east to boundary of the SBNMS, Gloucester to the north, and on the south to the edge of the in-bound Boston Harbor traffic lane. Both the Northeast Port and Pipeline Lateral will require onshore loadout yards for offshore construction materials located at existing industrial or commercial sites. The Pipeline Lateral also includes modifications at two existing onshore aboveground facilities located in the City of Salem and the Town of Weymouth.

Issues: The following issues related to finfish resources were considered in the preparation of this section:

- Potential impact of operations on finfish (both commercial and non-commercial species);
- Potential impacts of construction and operation on EFH;
- Potential impacts of water temperature changes from discharges on finfish and commercially viable species;
- Potential for direct disturbance to both pelagic (water column dweller) and demersal (bottom-dweller) fish species during construction and operation;
- Potential for ongoing disturbance of benthic habitat from anchor placement and anchor chain sweep in the Port;
- Potential to impact pelagic species by the withdrawal of water for ship operations; and
- Potential noise disturbance and vibrations impacts on marine life and species behavior during construction and operation.

4.7.2 Environmental Setting

4.7.2.1 Regulatory Framework

None of the finfish species likely to be present in the Project area is listed under the Endangered Species Act, but several are covered under the Magnuson-Stevens Fishery Conservation and Management Act, which is administered by the National Marine Fisheries Service of National Oceanic and Atmospheric Administration (NOAA Fisheries or NMFS). The MFCMA of 1976 was established to promote conservation of marine fishery (shellfish and finfish) resources. This included the establishment of eight regional fishery management councils (FMCs) that develop fishery management plans to properly manage fishery resources within their jurisdictional waters.

The 1986 and 1996 amendments to the MFCMA, renamed the Sustainable Fisheries Act, recognized that many fisheries are dependent on nearshore and estuarine habitats for at least part of their lifecycles and included evaluation of habitat loss and protection of critical habitat. EFH is defined to include "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." The Act further mandates NMFS to coordinate with other federal agencies to avoid, minimize, or otherwise offset adverse effects on EFH that could result from proposed activities. To delineate EFH, coastal waters were mapped by regional FMCs and superimposed with 10-minute by 10-minute square coordinate grids. After thorough review of available information, the FMCs determined if these 10-minute by 10-minute grids support EFH for federally managed species.

4.7.2.2 Massachusetts Bay Fish Community

The fish community of the Gulf of Maine is among the most studied and best described in the world. The Gulf of Maine supports resident or migratory populations of 252 known species of fish in 118 families (Collette and Klein-MacPhee 2002). Cape Cod forms the southern border of the Gulf of Maine and is a major biogeographic boundary separating boreal northern fishes from temperate fishes in the Mid-Atlantic (Briggs 1974). There is substantial seasonal variation in the ichthyofauna (fish) of the Gulf of Maine due to the large seasonal variation in water temperatures. Most of the pelagic species (i.e., Atlantic herring, Atlantic mackerel, bluefish, bluefin tuna) exhibit seasonal migratory movements in response to changes in water temperatures, while seasonal movements among demersal species (i.e., Atlantic cod, haddock, cusk, and flatfish) are generally confined to shifts within the overall Gulf of Maine (NOAA 1991). Despite the long-standing assumption that the Gulf of Maine is dominated by boreal, non migratory species, recent analysis of fishes now known from the Gulf of Maine shows that only about a third of the species are year-round residents in the Gulf; another third are seasonal visitors from the south that travel around Cape Cod during the summer; and the final third are visitors from the north in the deeper water offshore (Collette and Klein-MacPhee 2002).

Based on temperature, depth, latitude, and ecology, the common fishes of the Gulf of Maine can be divided into four ecological groups (Murawski 1993):

Shallow-Water Sedentary—23 species, such as little skate, winter skate, longhorn sculpin, American sand lance, winter flounder, yellowtail flounder, and windowpane;

Deepwater Sedentary—23 species, such as thorny skate, pollock, white hake, Acadian redfish, witch flounder, and American plaice; this group is composed of fishes with boreal affinities;

Warmwater Migratory—92 species, mostly found in summer and autumn such as northern sea robin, bluefish, scup, black sea bass, butterfish, summer flounder; these species are primarily mid-Atlantic and make inshore and northward migrations in late spring and return migrations in late fall; and

Pelagic—9 species (Collette and Klein-MacPhee 2002).

Some common species such as spiny dogfish and goosefish do not fit neatly into any of the four categories.

System boundaries for many fish species may be provided by the circulation patterns of the Gulf of Maine. Massachusetts Bay, located at the southwestern end of the coastal distribution pattern, acts as a "catch basin" for a variety of species (NOAA 1991). Between Cape Ann and Cape Cod, in the southwest corner of the Gulf, is Massachusetts Bay. The Bay's most prominent submarine feature is Stellwagen Bank at the Bay's eastern edge. Stellwagen Bank is a shallow (65 to 300 feet; 19 to 914 meters), glacially-deposited, primarily sandy feature with high biological productivity that provides habitat to a number of fish species.

4.7.2.3 Non-EFH Species Descriptions

Finfish species common in the Project area are described in this section. The primary source of information was obtained from the Estuarine Living Marine Resources Program (ELMR). In 1985, NOAA launched the ELMR program to develop a consistent database on the distribution, relative abundance, and life history characteristics of ecologically and economically important fishes and invertebrates in the nation's estuaries. The database is divided into five study regions: West Coast, Gulf of Mexico, Southeast, Mid-Atlantic, and North Atlantic. For each species, five life stages are considered: adults, juveniles, larvae, spawning, and eggs. Ichthyoplankton data (fish eggs and larvae) are discussed in Section 4.5. Data presented in this section (Table 4.7-1) were obtained from the ELMR North Atlantic report for species occurring in Massachusetts Bay (Jury et al., 1994). Relative abundance of each life stage by month is categorized as blank=not present or rare, C=Common, A=Abundant, or H=Highly Abundant. Other data sources include fisheries data associated with the assessment of two disposal sites in Massachusetts Bay (NAI 1995) and fisheries data from the Massachusetts Bay Disposal Site (Hubbard et al. 1988).

Species and life stages classified by Jury et al. (1994) as highly abundant in Massachusetts Bay during any month of the year include: silversides (*Menidia* spp.), cunner (*Tautogolabrus adspersus*), American plaice (*Hippoglossoides americanus*), and winter flounder (*Pseudopleuronectes americanus*). Adult and juvenile silversides are highly abundant May through October (Table 4.7-1). Adults occur year-round in

Massachusetts Bay, although they are most abundant during warmer months. Atlantic silverside (*Menidia menidia*) are common inhabitants of intertidal creeks, marshes, and shore zones of estuarine embayments during spring, summer, and fall (Collette and Klein-MacPhee 2002) and are not expected to be numerous in the Project area. In winter, Atlantic silverside migrate offshore to continental shelf waters beginning in November in the Gulf of Maine (Conover and Murawski 1992). Most offshore captures were within 31 miles (50 kilometers) of the shoreline at water depths of 31 to 164 feet (10 to 50 meters). It is unlikely that disturbance of the substrate by construction activities will affect habitat for these species due to their preference for estuarine and shallow water marine habitats.

Adult and juvenile cunner are highly abundant in Massachusetts Bay during June, July, and August and adults and juveniles were abundant throughout the year (Table 4.7-1). Cunner occur primarily in coastal habitats, usually within 2 miles (3 kilometers) of shoreline and are most abundant from just below the low tide mark to about 98 feet (30 meters) (Collette and Klein-MacPhee 2002). Cunner live near the bottom and are strongly associated with structure. They are frequently observed around submerged aquatic vegetation, rocky outcroppings, pilings, wharves, boulders, and just about any other object offering shelter (Olla et al. 1979). Their numbers drop off rapidly just a short distance from cover. Upon metamorphosis, juveniles settle to the bottom and suffer extreme post-settlement mortality in less structurally complex habitats (Levin 1991). Juveniles are typically associated with rocky bottom, pilings, debris, eelgrass, or macroalgae beds.

Winter flounder and American plaice are commercially important flatfish and adults are highly abundant year round in Massachusetts Bay (Table 4.7-1). Both species are federally managed and are discussed in more detail in Appendix 4.7-1, EFH Assessment.

Other species likely to occur in the Project area with lifestages classified as "abundant" in Massachusetts Bay include spiny dogfish (*Squalus acanthias*), skates (*Raja* spp.), American eel (*Anguilla rostrata*), Alewife (*Alosa pseudoharengus*), Atlantic menhaden (*Brevoortia tyrannus*), Atlantic herring (*Clupea harengus*), rainbow smelt (*Osmerus mordax*), pollock (*Pollachius virens*), red hake (*Urophycis chuss*), mummichog (*Fundulus heteroclitus*), longhorn sculpin (*Myoxocephalus octodecemspinosus*), American sand lance (*Ammodytes americanus*), Atlantic mackerel (*Scomber scombrus*), and yellowtail flounder (*Limanda ferruginea*) (Jury et al. 1994). Spiny dogfish, skates, Atlantic herring, pollock, red hake, Atlantic mackerel, and yellowtail flounder have essential fish habitat designations in the Project area and are discussed further in Appendix 4.7-1. Species classified as "abundant" in Massachusetts Bay by Jury et al. (1994) that are not discussed in Appendix 4.7-1 are discussed below.

American eel is a catadromous species common in streams, rivers, lakes, tidal marshes, and estuaries throughout the Gulf of Maine. American eel adults are common in Massachusetts Bay in summer and juveniles in late spring and early summer (Table 4.7-1). After spawning in the Sargasso Sea, leptocephalus larvae drift at sea for up to a year and are transported north by the Gulf Stream. Leptocephali transform into early juveniles called glass eels as they approach the North American coast.

Table 4.7-1. Relative Abundance, Temporal Distribution, and Habitat (pelagic or demersal) Preferences of Fishes by Lifestage in Massachusetts Bay

Species	Habitat[a/]	Life Stage	Relative Abundance by Month[b/]											
			J	F	M	A	M	J	J	A	S	O	N	D
Spiny dogfish	D	Adults						C	A	A	A	C		
		(Spawning)	NA											
	D	Juvenile						C	A	A	A	C		
Skates	D	Adults	C	C	C	A	A	A	A	A	A	C	C	C
		(Spawning)	C	C	C	C	C	C	C	C	C	C	C	C
American eel	D	Adults									C	C		
		(Spawning)												
	D	Juvenile				C	A	A	C					
Blueback herring	P	Adults					C	C	C	C	C	C		
		(Spawning)												
	P	Juvenile					C	C	C	C	C	C	C	
Alewife	P	Adults				C	A	A	C	C	C	C		
		(Spawning)												
	P	Juvenile				C	C	A	A	A	A	C	C	
Atlantic menhaden	P	Adults					C	C	A	A	A	C	C	
		(Spawning)					C	C	C	C				
	P	Juvenile					C	C	C	C	C	C	C	
Atlantic herring	P	Adults	A	A	A	A	C				C	C	A	A
		(Spawning)												
	P	Juvenile	A	A	A	A	A	C	C	C	A	A	A	A
Rainbow smelt[c/]	P	Adults	C	C	C	C	C	C				C	C	C
		(Spawning)												
	P	Juvenile	A	A	A	A	A	A	A	A	A	A	A	A
Atlantic cod	D	Adults			C	C	C	C				C	C	C
		(Spawning)	C	C	C	C	C							C
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
Silver hake	D	Adults				C	C	C	C			C	C	
		(Spawning)					C	C	C	C	C			
	D	Juvenile				C	C	C	C	C	C	C	C	
Atlantic tomcod	D	Adults			C	C	C	C	C	C	C	C	C	
		(Spawning)												
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	
Pollock	P/D	Adults	C	C	C	C	C	C			C	C	C	C
		(Spawning)	C	C										
	P/D	Juvenile	C	C	C	A	A	A	C	C	A	A	C	C
Red hake	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		(Spawning)						C	C	C	C	C		
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
White hake	D	Adults			C	C	C	C	C	C	C			
		(Spawning)												

Table 4.7-1. Relative Abundance, Temporal Distribution, and Habitat (pelagic or demersal) Preferences of Fishes by Lifestage in Massachusetts Bay

Species	Habitat[a/]	Life Stage	Relative Abundance by Month[b/]											
			J	F	M	A	M	J	J	A	S	O	N	D
	D	Juvenile			C	C	C	C	C	C	C	C	C	
Mummichog[c/]	D	Adults	C	C	C	A	A	A	A	A	A	A	A	C
		(Spawning)					C	C	C	C				
	D	Juvenile	C	C	C	A	A	A	A	A	A	A	A	C
Silversides[c/]	P/D	Adults	C	C	A	A	H	H	H	H	H	H	A	C
		(Spawning)				C	H	H	A					
	P/D	Juvenile				A	H	H	H	H	H	H	H	C
Fourspine stickleback[c/]	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		(Spawning)												
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
Threespine stickleback	P/D	Adults	C	C	C	C				C	C	C	C	C
		(Spawning)												
	D/P	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
Northern pipefish	D	Adults			C	C	C	C	C	C	C	C	C	
		(Spawning)				C	C	C	C	C				
Northern searobin	D	Adults					C	C	C	C				
		(Spawning)												
	D	Juvenile					C	C	C	C				
Grubby	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		(Spawning)	C	C	C	C								C
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	
Longhorn sculpin	D	Adults	A	A	A	A	A	A	A	A	A	A	A	A
		(Spawning)	A	A	C	C								C
	D	Juvenile	A	A	A	A	A	A	A	A	A	A	A	A
Shorthorn sculpin	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		(Spawning)	C	C	C									C
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
Striped bass	P	Adults				C	C	C	C	C	C	C		
		(Spawning)												
	P	Juvenile				C	C	C	C	C	C	C		
Bluefish	P	Adults						C	C	C	C	C		
		(Spawning)												
	P	Juvenile						C	C	C	C	C		
Scup	D	Adults												
		(Spawning)												
	D	Juvenile							C	C	C			
Tautog	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		(Spawning)					C	C	C	C				
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C

Table 4.7-1. Relative Abundance, Temporal Distribution, and Habitat (pelagic or demersal) Preferences of Fishes by Lifestage in Massachusetts Bay

Species	Habitat[a/]	Life Stage	Relative Abundance by Month[b/]											
			J	F	M	A	M	J	J	A	S	O	N	D
Cunner	D	Adults	A	A	A	A	A	A	A	A	A	A	A	A
		(Spawning)						A	A	A	A			
	D	Juvenile	A	A	A	A	A	A	A	A	A	A	A	A
Ocean pout	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		(Spawning)								C	C	C		
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
Rock gunnel	D	Adults	C	C	C	C	C	C	C	C	C	C	C	C
		(Spawning)	C	C	C									C
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
American sand lance	D/P	Adults	C	C	C	A	A	A	A	A	A	A	C	C
		(Spawning)	C	C	C								C	C
	D/P	Juvenile	C	C	C	A	A	A	A	A	A	A	C	C
Atlantic mackerel	P	Adults					C	C	C	C	C	C		
		(Spawning)					C	C	C	C				
	P	Juvenile					C	C	C	C	C	C		
Butterfish	P	Adults							C	C	C			
		(Spawning)												
	P	Juvenile							C	C	C			
Windowpane	D	Adults			C	C	C	C	C	C	C	C	C	
		(Spawning)					C	C	C	C	C			
	D	Juvenile	C	C	C	C	C	C	C	C	C	C	C	C
American plaice	D	Adults	H	H	H	H	H	H	H	H	H	H	H	H
		(Spawning)			H	H	H	H						
	D	Juvenile	H	H	H	H	H	H	H	H	H	H	H	H
Winter flounder	D	Adults	H	H	H	H	H	H	H	H	H	H	H	H
		(Spawning)	C	A	A	A	C	C						
	D	Juvenile	H	H	H	H	H	H	H	H	H	H	H	H
Yellowtail flounder	D	Adults	A	A	A	A	A	A	A	A	A	A	A	A
		(Spawning)				A	A	A	A	A				
	D	Juvenile	A	A	A	A	A	A	A	A	A	A	A	A

[a/] D= Demersal, P= Pelagic
[b/] H= Highly Abundant A = Abundant C= Common
[c/] Inshore distribution and not likely to occur in Project area
Source: Jury et al. 1994.

Glass eels occur in Massachusetts Bay March through June; however they are not abundant (Table 4.7-1). As glass eels enter estuaries and ascend to brackish habitats, they undergo another metamorphosis and begin the elver stage. Elvers occupy a wide range of coastal habitats including eelgrass, tidal flats, marshes, harbors, barrier beach ponds, coastal rivers, and streams (Able and Fahay 1998). Juvenile and adults primarily occur in estuarine and freshwater habitats and are therefore not likely to occur in the deeper waters of the Project area.

Alewife (*Alosa pseudoharengus*) and the closely related blueback herring (*Alosa aestivalis*) comprise the commercially important river herring fishery in the Gulf of Maine. Both species are anadromous and form large schools during their spawning migrations into coastal rivers in the spring. Both species are euryhaline, coastal pelagic fish that spend most of their lives at sea, approaching the shore and returning to freshwater only to spawn (Collette and Klein-MacPhee 2002). Blueback herring occur year-round in Massachusetts Bay and adults and juveniles are considered "common" from May through November (Table 4.7-1). Alewife adults and juveniles also occur year-round and are more abundant than blueback herring in Massachusetts Bay from April through September (Table 4.7-1). Spawning and early life history stages for both species occur in coastal rivers and estuaries, so disturbance of the substrate by construction activities will not affect egg and larval habitat. Juveniles of both species emigrate from fresh and brackish waters during late summer and fall and overwinter in areas near their estuarine nurseries (Millstein 1981). Both juvenile and adult alewife and blueback herring are highly migratory, pelagic, plankton feeders not associated with benthic habitats; therefore, disturbance of the substrate by construction activities will not affect juvenile and adult habitat.

Atlantic menhaden (*Brevoortia tyrannus*) inhabit pelagic, euryhaline waters of estuaries and bays as well as polyhaline coastal waters on the inner continental shelf (Collette and Klein-MacPhee 2002). Menhaden form large schools both as juveniles and adults. Atlantic menhaden are a summer seasonal species in the Gulf of Maine. Seasonal appearance and disappearance of menhaden into and out of the Gulf of Maine in spring and fall, respectively, is a result of migration around Cape Cod and is a well-documented annual event (Collette and Klein-MacPhee 2002). In years when menhaden reach the Gulf of Maine, they usually appear in Massachusetts Bay about mid-May, when coastal waters have warmed to 10 ^{o}C or more (Collette and Klein-MacPhee 2002). Atlantic menhaden eggs are common in Massachusetts Bay from May through September (Table 4.7-1). Larvae enter estuaries where they transform into juveniles (Able and Fahay 1998). Juvenile and adult menhaden occur in Massachusetts Bay from May through November; adults are abundant from July through September (Table 4.7-1). Both juvenile and adult menhaden are migratory, pelagic, filter-feeding fish consuming phytoplankton and zooplankton. Atlantic menhaden are not associated with benthic habitats and disturbance of the substrate by construction activities should not affect Atlantic menhaden habitat.

Rainbow smelt (*Osmerus mordax*) are pelagic and anadromous, usually found in coastal waters (Collette and Klein-MacPhee 2002). Many smelt spend the whole year in estuaries and are not expected to be abundant in the Project area or the pipeline corridor. Their summer habitat varies in different parts of the Gulf of Maine, depending on water temperature and perhaps food supply (Collette and Klein-MacPhee 2002). Most rainbow smelt leave the harbors and estuaries of Massachusetts Bay during the warmest season, but they probably move out only far enough to find cooler water at a slightly greater depth (Collette and Klein-MacPhee 2002). Adults are rare in Massachusetts Bay in the summer and common throughout the rest of the year (Table 4.7-1). Juveniles are abundant throughout the year. In the fall, as water temperatures drop, juveniles move into the upper estuary, concentrating in channels, where they mix with the adult population (McKenzie 1964, Clayton 1976). Although smelt are mobile, pelagic fish they do occur in benthic habitats such as eelgrass (Crestin 1973, Wyda et al. 2002) and they feed on benthic invertebrates such as amphipods, shrimp, and polychaetes as well as fish. However, smelt are not reported more than 1.2 miles (2 kilometers) from shore or in water depths greater than 20 feet (6 meters) (Bigelow and Schroeder 1953), so they are not likely to occur in the Project area.

Mummichog (*Fundulus heteroclitus*) is a euryhaline fish found in shallow waters throughout the Gulf of Maine. Mummichog adults and juveniles occur in Massachusetts Bay year round and are abundant April through November (Table 4.7-1). Mummichog spawn in intertidal estuarine areas and demersal eggs are deposited in crevices in the substrate, between empty mussel shells, and on vegetation or mats of detritus (Able and Fahay 1998; Collette and Klein-MacPhee 2002). Juveniles and adults are most abundant in shallow estuarine habitats such as saltmarsh tidal creeks and eelgrass and are not likely to occur in the deep waters of the Port Project area or along the Pipeline Lateral corridor. Bigelow and Schroeder (1953) states “So closely, indeed, do they hug the shore that a line drawn 100 yards out from land would probably enclose practically all the mummichogs in the Gulf of Maine.”

Longhorn sculpin (*Myoxocephalus octodecemspinosus*) are benthic, slow-moving fish that are common in coastal waters throughout the Gulf of Maine from the shoreline to the offshore banks (Collette and Klein-MacPhee 2002). In Massachusetts Bay, longhorn sculpin adults and juveniles are common year-round (Table 4.7-1). Presumably the spawning season is the same in the Gulf of Maine (Collette and Klein-MacPhee 2002). Spawning occurs inshore in estuaries and shallow enclosed areas on rocky bottoms (Scott and Scott 1988). Juvenile and adult longhorn sculpin are caught in considerable numbers down to 90 meters and are likely to occur in the Project area or pipeline corridor. Because this is a demersal species, disturbance of the substrate by construction activities will affect juvenile and adult longhorn sculpin habitat.

American (or inshore) sand lance (*Ammodytes americanus*) adults and juveniles occur year-round in Massachusetts Bay and are abundant from April through October (Table 4.7-1). Many aspects of the ecology of *Ammodytes* spp. along the east coast of the United States are potentially confounded by taxonomic problems differentiating between *A. americanus* and the offshore sand lance *A. dubius* (Nizinski et al. 1990). American sand lance are primarily found in shallow (6 feet or less; 2 meters or less) coastal waters and estuaries, and are seldom seen along rocky shores (Collette and Klein-MacPhee 2002). Sand lance are most often found on sandy or fine gravel bottoms in which they burrow. American sand lance are believed to spawn in the Gulf of Maine on the continental shelf from November to March (Collette and Klein-MacPhee 2002; Auster and Stewart 1986). Larval fish survey data indicate that spawning occurs principally inshore, although some evidence exists of offshore spawning activity (Auster and Stewart 1986). Schools of 500 to 10,000+ have been observed on Stellwagen Bank (Meyer et al. 1979) which may provide spawning habitat for this species (NOAA 1991). The habitat of young of the year is poorly known (Able and Fahay 1998). Sand lance are an important trophic link between zooplankton production and fishes of commercial importance (Auster and Stewart 1986). They have been found in the stomachs of a wide variety of species including Atlantic Cod, haddock, silver hake, white hake, and yellowtail flounder, as well as cetaceans (Auster and Stewart 1986). This species is pelagic much of the time but is capable of diving into sandy substrates very quickly; therefore, any disturbance of the sandy substrates by construction activities will affect habitat for American sand lance.

4.7.2.4 Fisheries Monitoring and Survey Data

The MDMF conducts an inshore bottom trawl survey during the spring and fall using an otter trawl with a 50.8-foot (15.5-meter) footrope and a tow duration of 20 minutes. Data from 13 tows conducted in the spring, and 21 tows conducted in the fall in Massachusetts Bay from 1995 to 1999 are summarized in Table 4.7-2. Overall, catches and species richness were higher in the fall. In the fall, *Loligo* squid were the most abundant taxa collected, followed by winter flounder and butterfish. Most other abundant species listed in Table 4.7-2 can be considered demersal. In the spring, catches were lower and species composition was dominated by longhorn sculpin, winter flounder, Atlantic cod, yellowtail flounder, ocean pout, and little skate. With the exception of small catches of rainbow smelt and possibly spiny dogfish, all abundant fish collected in the spring are demersal. *Loligo* squid, winter flounder butterfish, spiny dogfish, silver hake, little skate, red hake, Atlantic herring, yellowtail flounder, Atlantic cod, ocean pout and white hake are all federally managed species with EFH designations and are discussed further in Appendix 4.7-1.

The most area-specific data for the Project come from the NMFS bottom trawl survey data that are summarized from 17 trawls (Table 4.7-3) including areas that most likely contained hard bottom substrate that is not typical of the Project. Of the 14 dominant species recorded from these trawls, all were demersal species except Atlantic herring and possibly spiny dogfish. This is to be expected because the otter trawl most effectively samples demersal species. As described in Section 4.7.2.3, Atlantic mackerel are also a pelagic fish that could also be expected to be found in the Project.

Studies conducted by the ACOE during 1985 and 1986 documented he occurrence of 35 fish species (Table 4.7-4) at the MBDS (Hubbard et al. 1988). Species composition was similar to the NMFS and MDMF samples and American plaice, witch flounder, and redfish were the predominant non-migratory, demersal species at MBDS (Hubbard et al. 1988). The resident finfish community on the muddy bottom of the MBDS is dominated by American plaice and witch flounder (Hubbard et al. 1988). Silver and red hake are abundant, commercially important seasonal migrants at MBDS (Hubbard et al. 1988). Hard bottom communities at MBDS (approximately 25 percent of the total area) are likely dominated byredfish, ocean pout, cusk, and Atlantic wolffish. The fish community described at MBDS by Hubbard et al. (1988) is likely to be generally representative of the community found in the deepwater areas of the proposed Port adjacent to the MBDS, although stock assessments over the past 20 years have shown changes in relative abundances.

Table 4.7-2. Catch per 20-minute tow (CPUE) and Percent Occurrence of Fish and Squid Collected in the MDMF Bottom Trawl Survey in Massachusetts Bay, Spring and Fall 1995-1999

Species	Fall (21 tows)		Spring (13 tows)	
	% Occurrence	CPUE	% Occurrence	CPUE
Loligo squid	100	540	0	0
Winter flounder	100	161	100	83
Butterfish	92	199	0	0
Longhorn sculpin	69	52	81	98
Spiny dogfish	23	49	0	0
Rainbow smelt	85	49	38	3
Silver hake	85	56	29	<1
Little skate	100	45	90	22
Red hake	85	20	24	<1
Atlantic herring	31	18	10	<1
Yellowtail flounder	77	17	90	33
Atlantic cod	85	13	90	52
Ocean pout	100	4	95	24
White hake	77	15	0	0
Others		19		6

Table 4.7-3. Biomass (pounds) per Trawl of Important Species from the NOAA Fisheries-NEFSC Spring and Fall Bottom Trawl Survey from 2000 through 2004

Species (lifestyle)[a/]	Average Biomass (pounds) per Trawl	
	Spring	Fall
American plaice (D)	73	27
Atlantic cod (D)	80	91
Atlantic herring (P)	11	0
Haddock (D)	8	18
Longhorn sculpin (D)	5	0
Ocean pout (D)	21	0
Redfish spp. (D)	5	1
Red hake (D)	1	12
Silver hake (D)	2	10
Spiny dogfish (P)	0	352
White hake	0	1
Winter flounder (D)	50	58
Witch flounder (D)	0	2
Yellowtail flounder (D)	72	8
Other	32	143
Total	359	740

[a/] D= Demersal, P = Pelagic

Source: NOAA Resource Survey Reports, Bottom Trawl Surveys, 2000-2004.

Table 4.7-4. Frequency of Occurrence of Fish Species in NMFS and MDMF Bottom Trawls in the Vicinity of MBDS

Abundance[a]	Spring Trawls	Fall Trawls
Common	American plaice (100)	American plaice (100)
	Atlantic cod (100)	Witch flounder (100)
	Yellowtail flounder (100)	Red hake (100)
	Witch flounder (100)	Silver hake (100)
	Ocean pout (89)	Alewife (84)
	Red hake (89)	Ocean pout (77)
	Silver hake (78)	Longhorn sculpin (69)
	Longhorn sculpin (78)	Atlantic cod (69)
	Sea raven (66)	White hake (69)
	Winter flounder (66)	
	Blueback herring (66)	
	Alligator fish (66)	
	Daubed shanny (66)	
Occasional	Thorny skate (56)	Sea raven (60)
	Snakeblenny (56)	Thorny skate (54)
	Fourspot flounder (56)	Atlantic herring (54)
	Fourbeard rockling (44)	Goosefish (54)
	Haddock (44)	Fourbeard rockling (38)
	White hake (44)	Butterfish (38)
	Alewife (33)	Haddock (38)
	Goosefish (33)	Redfish (38)
		Cunner (38)
Infrequent	American sandlance (11)	Alligator fish (31)
	Pollock (11)	Snakeblenny (31)
	Atlantic herring (11)	Yellowtail flounder (31)
	Redfish (11)	Wrymouth (23)
	Winter skate (11)	Winter flounder (23)
		Mailed sculpin (23)
		Daubed shanny (23)
		Blueback herring (15)
		Atlantic mackerel (15)
		Fourspot flounder (15)
		American shad (15)
		Pollock (15)
		Windowpane (8)
		Cusk (8)
		Scup (8)
		Spiny dogfish (8)

[a] Based on percentage of trawls where present regardless of number of individuals
Source: Hubbard et al. 1988.

Because pelagic species are highly mobile and not closely associated with bottom habitats, they are not as vulnerable to trawling gear as demersal species. While the majority of available information regarding the fish community of Massachusetts Bay is based on bottom trawls, gill nets were used in October 1994 and May 1995 to describe the fisheries resources at two potential dredge disposal sites in Massachusetts Bay. The first site, Meisburger 2, was located approximately 3.2 miles (5.1 kilometers) east of Great Point in Nahant in about 100 feet (30 meters) of water. A second site, Meisburger 7, was located about 9 miles (14 kilometers) east of Deer Island. Both sites were sampled with two four-panel experimental gill nets (NAI 1995). One net was set just off the bottom and the other was set near the surface. Catch per unit effort was expressed as the catch per 24-hour set for both nets combined.

At the Meisburger 2 site, Atlantic mackerel were the most abundant fish in October followed by cunner and longhorn sculpin (Table 4.7-5). Alewife and winter flounder were also collected. In May, overall Catch Per Unit Effort (CPUE) was greater and was primarily driven by large catches of Atlantic herring. Cunner and yellowtail flounder were common and longhorn sculpin, Atlantic cod, and winter flounder were collected. At Meisburger 7, overall CPUE in October was similar to Meisburger 1, although more species were collected. Atlantic mackerel was the most abundant species collected followed by Atlantic cod, hake spp., skate spp., and longhorn sculpin (Table 4.7-5). Alewife, cunner, scup, and silver hake were also collected. In May, catches were greatly reduced and species composition differed. Atlantic cod, sea raven, and winter flounder were the most abundant fishes. Atlantic herring, longhorn sculpin, ocean pout, and yellowtail flounder were also collected.

Table 4.7-5. Catch per 24-hour set (CPUE) in Gill Net Collections from Massachusetts Bay, October 1994 and May 1995

Species	Station CPUE				Total CPUE	Percent Species Composition
	Meisburger 2		Meisburger 7			
	October	May	October	May		
Alewife	0.7		0.3		1	0.8
Atlantic cod		0.3	1.3	1.3	2.9	2.4
Atlantic herring		71.7		0.3	72	58.4
Atlantic mackerel	6.3		12.3		18.6	15.1
Atlantic menhaden		0.3			0.3	0.2
Cunner	3	3	0.3		6.3	5.1
Hake spp.			1		1	0.8
Lobster	5	2	4.3	1.3	12.6	10.2
Longhorn sculpin	2	0.7	0.7	0.3	3.7	3.0
Ocean pout				0.3	0.3	0.2
Sea raven				0.7	0.7	0.6
Scup			0.3		0.3	0.2
Silver hake			0.3		0.3	0.2
Skate sp.			0.7		0.7	0.6
Winter flounder	0.3	0.3		0.7	1.3	1.1
Yellowtail flounder		1		0.3	1.3	1.1
Total	17.3	79.3	21.5	5.2	123.3	100.0

Source: NAI 1995.

When data from both stations were combined, Atlantic herring (spring) and Atlantic mackerel (fall) were the dominant pelagic fish, comprising 73 percent of the total (Table 4.7-5). Both species are federally managed and are discussed further in Appendix 4.7-1.

4.7.2.5 Essential Fish Habitat Assessment

The Magnuson-Stevens Act of 1976 was established to promote conservation of marine fishery (shellfish and finfish) resources. This included the establishment of eight regional FMCs that develop fishery management plans to properly manage fishery resources within their jurisdictional waters. The 1986 and 1996 amendments to the Magnuson Act, renamed the Sustainable Fisheries Act, recognized that many fisheries are dependent on nearshore and estuarine habitats for at least part of their lifecycles and included evaluation of habitat loss and protection of critical habitat. The marine environments important to marine fisheries are referred to as EFH and are defined to include "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." The Act further mandates NMFS to coordinate with other federal agencies to avoid, minimize, or otherwise offset adverse effects on EFH that could result from proposed activities. To delineate EFH, coastal waters were mapped by regional FMCs and superimposed with 10-minute by 10-minute square coordinate grids or quadrats. After thorough review of available information, the FMCs determined if these 10-minute by 10-minute quadrats support EFH for federally managed species.

The proposed Project crosses four of the 10-minute by 10-minute quadrants that have been designated EFH for 28 species finfish, two species of squid, and three shellfish (Table 4.7-6). Each quadrant was assigned an arbitrary reference number (1-4) for this discussion. Quadrats 1 (northwest), 2 (northeast), and 3 (southwest) encompass the Pipeline Lateral, while Quadrat 4 (southeast) includes the Port area and part of the Pipeline Lateral. Appendix 4.7-1 presents a species-specific account of the habitat requirements for species and lifestages with designated EFH along the Pipeline Lateral route as well as our EFH Assessment prepared to assist the FERC and USCG in meeting their EFH obligations under the MFCMA.

Grab sampling in the Port area indicated that on average the surficial sediments were 95 percent silt-clay. We assume that this sampling is representative of the entire Port area and the primary benthic habitat that will be disturbed is soft substrate silt-clay. Side-scan sonar observations along the Pipeline Lateral corridor also indicate that the majority of the surficial sediments are soft substrate (Appendix 4.7-1).

The primary sources of information for the habitat requirements of the EFH species were the EFH source documents produced by NMFS. The EFH documents provide descriptions of the habitat for locations where fish have been found in some degree of abundance. The mere occurrence of fish in a particular habitat is not an indication that it is essential or even preferred habitat. It is only an indication that the fish was found in a particular habitat when sampling occurred. Regardless of these data limitations, the EFH source documents provide the best available descriptions of the habitat requirements for selected marine fishes.

Table 4.7-6. Summary of Species and Lifestages with Designated Essential Fish Habitat in the Northeast Gateway Pipeline Route Project Area

Species	EFH Quadrat			
	Eggs	Larvae	Juveniles	Adults
American plaice (*Hippoglossoides platessoides*)	1,3,4[a/]	1,3,4	1,2,3,4	1,2,3,4
Atlantic bluefin tuna (*Thunnus thynnus*)			1,2,3,4	1,2,3,4
Atlantic cod (*Gadus morhua*)	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
Atlantic halibut (*Hippoglossus hippoglossus*)	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
Atlantic herring (*Clupea harengus*)		1,2,3,4	1,2,3,4	1,2,3,4
Atlantic mackerel (*Scomber scombrus*)	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
Black sea bass (*Centropristis striata*)	[b/]			1,2
Bluefish (*Pomatomus saltatrix*)			1,3	1,3
Butterfish (*Peprilus triacanthus*)	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
Goosefish (*Lophius americanus*)	2,3,4	2,3,4	2,4	2,4
Haddock (*Melanogrammus aeglefinus*)	1,3,4	1,3	1,2,3,4	
Little skate (*Leucoraja erinacea*)			1,2,3	1,2,3
Longfin inshore squid (*Loligo pealei*)[d/]	N/A	N/A	1,2,3,4	1,2,3,4
Northern shortfin squid (*Illex illecebrosus*)[d/]	N/A	N/A	1,2,3,4	1,2,3,4
Ocean pout (*Macrozoarces americanus*)	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
Ocean quahog (*Artica islandica*)[d/]	N/A	N/A	2	2
Pollock (*Pollachius virens*)	1,3	1,3	1,3	1,3
Red hake (*Urophycis chuss*)	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
Redfish (*Sebastes fasciatus and S. mentella*)	N/A[c]	1,2,3,4	1,2,3,4	1,2,3,4
Scup (*Stenotomus chrysops*)			1,2,3	1,2,3
Sea scallop (*Placopecten magellanicus*)	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
Silver hake (*Merluccius bilinearis*)	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
Smooth skate (*Malacoraja senta*)			4	
Spiny dogfish (*Squalus acanthias*)	N/A[c/]	N/A	3	3
Summer flounder (*Paralichthys dentatus*)				1,2
Surf clam (*Spisula solidissima*)[d/]	N/A	N/A	1,2,3	1,2,3
Thorny skate (*Amblyraja radiate*)			1,2,3,4	4
White hake (*Urophycis tenuis*)	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
Windowpane (*Scopthalmus aquosus*)	1,3,4	1,3,4	1,3	1,3
Winter flounder (*Pseudopleuronectes americanus*)	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
Winter skate (*Leucoraja ocellata*)			1,2,3	2
Witch flounder (*Glyptocephalus cynoglossus*)	3,4	2,3,4	2,4	3,4
Yellowtail flounder (*Limanda ferruginea*)	1,3,4	1,2,3,4	1,2,3,4	1,2,3,4

[a/] The proposed faculties cross four of the EFH 10-foot-by-10-foot squares of latitude and longitude along the coast. The numbers presented in this table for each species and life stage represent the project-assigned square number where the species and specific life stage have designated EFH.
[b/] Empty spaces denote that EFH has not been designated within the square for the given species and life stage.
[c/] N/A indicates no data available, or the life stage is not present in the species/reproductive cycle.
[d/] Juveniles and adults correspond to pre-recruits and recruits, respectively.

Of the species for which the Project area has been declared EFH, 11 appear to prefer the soft substrates, based on the habitat descriptions found in the EFH source documents (Table 4.7-7). Of these, seven were dominant in the NOAA resources surveys (Table 4.7-3), although the other four apparently have occurred in the Project area and have an affinity for soft substrates.

Appendix 4.7-1 presents a species specific account of the habitat requirements for species and lifestages with designated EFH within the entire Project area. Species and lifestages with designated EFH in the Northeast Gateway Deepwater Port area and along the Pipeline Lateral corridor will be discussed separately.

4.7.2.6 Commercial Fisheries

Commercial fishing is an economically important human activity within the productive waters of the Gulf of Maine, including Massachusetts Bay (NOAA 1991). An active commercial fishery exists in the southwestern Gulf of Maine. Areas of concentrated effort include Stellwagen Bank, Jeffrey's Ledge, Cashes Ledge, Tillie's Bank, Brown Bank and Georges Bank. The proposed Pipeline Lateral route and Deepwater Port location were selected in part to avoid these productive fishery areas.

The fish species taken commercially in the area of Stellwagen Bank are managed by the New England Fishery Management Council (NEFMC) through a number of fishery management plans (FMPs). FMPs of the NEFMC currently in place are the: American Lobster Fishery Management Plan; Fishery Management Plan for the Northeast Multispecies Fishery; Fishery Management Plan for Atlantic Sea Scallops; and Atlantic Salmon Fishery Management Plan.

Table 4.7-7. Numerically Important Fishes that Prefer Soft Substrate and are Likely to be Found in the Port Area

Species (lifestyle)[a/]	EFH Lifestage[b/]	Average Biomass (pounds)/ Trawl in NOAA Survey	
		Spring	Fall
Butterfish (P-D)	J, A	ND[c/]	ND
Goosefish (D)	J, A	ND	ND
Redfish spp.	L,J,A	5	1
Red hake (D)	J, A	1	12
Silver hake (D)	J, A	2	10
Smooth skate (D)	J	ND	ND
Thorny skate (D)	A	ND	ND
White hake (D)	J, A	0	1
Winter flounder (D)	A	50	58
Witch founder (D)	J, A	0	2
Yellowtail flounder (D)	J, A	72	8

a/ D= Demersal; b/ J = juvenile, A= adult; c/ ND = not dominant, P = Pelagic

Several years ago, the NEFMC and NMFS jointly developed fishery management blocks (see Figure 4.11-1). These blocks were designated as 30-minute squares of latitude and longitude, which is shorthand to describe the locations. The Port is located within Block 125 and the Pipeline Lateral is located within the northern portion of Block 125 and the extreme southern end of Block 133. Block 125 includes portions of SBNMS, the South Essex Ocean Sanctuary (SEOS), and the MBDS. Block 133 lies directly to the north of Block 125.

Hubbard et al. (1998) describes a viable commercial fishery in the vicinity of MBDS. Catch is dominated by American plaice and witch flounder. Wolffish, redfish, cusk, haddock, and pollock are caught in lesser amounts. Witch flounder and American plaice are caught throughout the year on soft bottom. Redfish and wolffish are occasionally caught on or near patches of hard bottom. Directed fisheries capture silver hake in the fall and pollock in the winter. There is also a directed fishery for spiny dogfish on Stellwagen Bank during summer and fall. Winter flounder and yellowtail flounder are caught near the MBDS but are more abundant in shallower inshore waters and therefore are more likely to occur along the Pipeline Lateral corridor than in the vicinity of the Port. Atlantic cod are caught as bycatch or by directed fisheries in late winter and spring. Atlantic herring are caught on Stellwagen Bank and in Massachusetts Bay southwest of the MBDS (Hubbard et al. 1998). Finfish commercially taken in the Stellwagen Bank area (NOAA 1991) that are likely occur in the Project area have been grouped into three principal categories: groundfish, pelagics, and other finfish (Table 4.7-8).

The groundfish resource of the Gulf of Maine consists of commercially important demersal fishes such as flounders and members of the cod family. This status of this resource, as measured by the NMFS index for the aggregate groundfish stock, has undergone significant variation in the last 40 years. For the period 1963 through 1974 there was a significant decrease in stock size, primarily due to overfishing by foreign fleets. Recovery of groundfish stocks began in the late 1970s, and was attributed to more restrictive management as part of the implementation of the MFCMA in 1977.

The index peaked in 1978, and then began a slow decline until the late 1980s when the index was at its lowest. In 1989-1990 the index increased slightly due to improved recruitment of Atlantic cod, redfish, silver and red hake, and American plaice. However, the index decreased in 1991 and was at near record lows through 1994. Since the mid 1990s there has been a moderate increase in the index, possibly due to recovery of groundfish stock on Georges Bank. At present, the index remains well below historical highs in the 1960s and 1970s (Northeast Fisheries Science Center 2001).

Several types of commercial fishing gear are used in Stellwagen Basin. During the open months, both draggers and gill netters may use the area. The bottom trawl fishery is generally confined to smooth areas of mud, silty sand, or hard sand. Chain nets are suitable for this type of habitat, although rollers up to 12 inches are allowed. The Project area north of the Boston shipping lanes is viewed as important to the flounder fishery beginning in December. The primary targets are flounders (blackbacks, yellowtail, dabs, and grey sole), monkfish, whiting, cod, and lobster.

Table 4.7-8. Finfish Taken Commercially in the Stellwagen Bank Area

Groundfish Species	Atlantic cod
	Haddock
	Redfish
	Silver hake
	Red hake
	Pollock
	Yellowtail flounder
	Summer flounder
	American plaice
	Witch flounder
	Winter flounder
	Scup
	Ocean pout
	White hake
	Cusk
	Atlantic wolfish
	Fourspot flounder
	Windowpane flounder
	Atlantic halibut
	Kingfish
	Longhorn sculpin
	Tautog
	Sand lance
Pelagic Species	Atlantic herring
	Atlantic mackerel
	Butterfish
	Bluefish
	Menhaden
	Bluefin tuna
	Capelin
Other Species	American Shad
	Black sea bass
	Striped bass
	Spiny dogfish
	Skates
	Mako shark

Source: NOAA 1991.

Gillnetters traditionally have used the harder or more rugged bottom along the northeastern edge of the area and on the few ridges along the eastern boundary. Nets are set on the bottom. Primary species are the flounders, monkfish, and lobster.

NMFS provided a summary of fishing effort in the area within 70.58333 to 70.65 degrees West by 42.38023 to 42.46667 degrees North for fishing years 2002 (May 2002 through April 2003) and 2003 (May 2003 through April 2004) shown on Table 4.7-9. The category "Multispecies" includes species regulated under the Northeast Multispecies Fishery Management Plan (cod, haddock, yellowtail flounder, American plaice, winter flounder, witch flounder, windowpane flounder, redfish, white hake, and pollock).

Closures and Fishing Restrictions

Permanent closures near the Project area include the Western Gulf of Maine Closure Area, which is permanently closed to multispecies fishing. Seasonal closures surround the permanent closure at various times throughout the year and may be within portions of the Project area. Seasonal closures were implemented by the New England Fisheries Management Council to protect stocks of Gulf of Maine groundfish from overfishing. Several years ago, the New England Fishery Management Council and NMFS jointly developed blocks, replacing the latitude and longitude descriptions, which are more difficult to read. Block 125 includes portions of SBNMS, the South Essex Ocean Sanctuary, and the MBDS. These blocks were created for fishery management, and were designated as 30-minute squares of latitude and longitude, which is shorthand to describe the locations. The Port is located within Block 125 and the Pipeline Lateral is located in both Block 125 and Block 133.

Areas including and around the Project area are closed seasonally to multispecies fishing. Table 4.7-10 describes seasonal fishing closures as they relate to the Project area. Under the Gulf of Maine Seasonal Rolling Closure Areas, seasonal closures occur from March 1 to April 30 and September 1 to November 30 every year. Permanent closures are in effect surrounding the Project area in some locations. The southeastern portion of SBNMS is located in one of the year round fishing closure areas; however, this is not within the Project area. This area prohibits commercial fishing unless it is a vessel without a federal northeast

Table 4.7-9. Number of Vessel Trips within the Project Area during the 2002 and 2003 Fishing Seasons

Trip Category	Species Category		
	Lobster	Multispecies	Other Species
Commercial	553	591	407
Party	0	7	3
Charter	0	3	4
Total	553	601	414

Source: NMFS.

Table 4.7-10. Permanent and Temporary Closure Areas

Seasonal (Rolling) Closures			
Type of Species	**Dates of Closure**	**Where is Closure**	**Exemptions**
Multispecies[a/] (groundfish)	April 1 to May 31	Blocks 124-125 and 132-133	Closed to all fishing vessels except those vessels with federal NE multispecies permits (and are fishing only in State waters); charter, party, or recreation vessels; vessels fishing with spears, rakes, diving gear, cast nets, tongs, harpoons, weirs, dip nets, stop nets, pound nets, pots and traps, purse seines, mid-water and shrimp trawls, surf clam/quahog dredge gear, sea scallop dredge gear, and pelagic hook, line, longline, and gillnets.
Multispecies (groundfish)	June 1 to June 30	Blocks 124-125 and 132-133	Same as above
Multispecies (groundfish)	October 1 to November 30	Blocks 124-125	Same as above

Source: NOAA 2004b.
[a/] Multispecies include Atlantic cod; witch, yellowtail, winter, and windowpane flounder; American plaice; haddock; Pollock; redfish; white hake; Atlantic halibut; and ocean pout.

multispecies permit (and is fishing in state waters); charter, party, or recreational vessels; and vessels fishing with spears, rakes, diving gear, cast nets, tongs, harpoons, weirs, dip nets, stop nets, pound nets, pots and traps, purse seines, mid-water trawls, surf clam, quahog dredge gear, pelagic hook and line, pelagic longlines, single pelagic gillnets, shrimp trawls, and sea scallop dredge gear. A Letter of Authorization is required for charter and party vessels to fish in these areas.

4.7.2.7 Recreational Fisheries

Sportfishing is a significant recreational activity in Massachusetts Bay. The recreational fishery may be categorized by three types of commercial vessels (NOAA 1991): 1) Party boats are usually 50 feet (15 meters) or longer and carry 20 to 80 passengers who pay a set fee for their trip; 2) Charter boats generally measure 25 to 30 feet (8 to 9 meters) and carry an average of six paying passengers; and 3) Private rental boats measure 20 feet (6 meters) or longer and are used by individual anglers. Target species of sportfishermen near MBDS include Atlantic cod, cusk, haddock, Atlantic mackerel, bluefish, and bluefin tuna. Wolffish, flounder, and pollock are also caught (Hubbard et al. 1998).

The absence of relief on the mud bottom where the Port and the Pipeline Lateral corridor is proposed limits the interest to recreational fishermen in this area, as demonstrated in Table 4.7-9.

4.7.3 Impact Analysis

The impact analysis includes impacts due to construction and operation of the Northeast Port and the Pipeline Lateral. Construction impacts at the Port would include disturbance of the habitat by construction activities while operational impacts would include disturbance of the bottom by the mooring wire rope and chains, and impingement of fish during water withdrawal operations not related to regasification (hotelling and ballast water intakes). Construction impacts due to the Pipeline Lateral would include disturbance of benthic habitats used by demersal fish as well as some minor impacts within the water column, primarily associated with localized increases in suspended sediments. Because the Pipeline Lateral is a static fixture without moving parts, operational impacts should be minimal, but could include redisturbance of a small portion of the seafloor if any maintenance requiring exposing the pipe is needed in the future. Within each of the construction and operational impacts for Port and Pipeline Lateral are direct and indirect effects. Direct effects include those outlined below, while indirect effects are impacts on other resources that may influence the fish resources, such as alteration of benthic prey.

4.7.3.1 Port Impact Analysis

Construction Impacts

An estimated 35.5 acres of soft substrate habitat will be temporarily affected by construction activities for the Port. Direct impacts to the fisheries resources due to construction will include the temporary loss of the silt-clay habitat and disturbance of the surrounding areas due to increased turbidity. Fishes most likely to be affected by construction activities will be those that prefer soft substrate habitat. The response of the 11 species that prefer soft substrate (Table 4.7-7) and are likely to be found in the Port area will vary depending on their life history. Demersal fishes that are closely associated with the bottom such as the flounders and skates will be more directly affected. These impacts will likely include mortality if they come in direct contact with construction activities, or because of avoidance of the areas of increased turbidity. Those that have a more pelagic lifestyle, such as butterfish, will most likely be able to avoid any construction activities and the associated increases in turbidity. Although pelagic fishes such as Atlantic herring and Atlantic mackerel are not closely associated with any particular substrate, they are likely to be found in the water column in the Port area. It is expected that these pelagic fishes will also be able to avoid any construction impacts.

Indirect impacts are impacts on other resources that may influence the fisheries resources in the Port area. These impacts would likely include disturbance of benthic invertebrate food sources for demersal fishes. However, this indirect impact will only occur if food resources are a limiting factor to production of demersal fishes, which may not be the case. Assuming the worst-case scenario that demersal fish production is limited by food resources, which is unlikely, an estimated 35.5 acres of soft bottom invertebrate habitat will be disturbed in the Port area and will not be available as a food source for demersal fishes during construction. With regard to pelagic fishes, the disturbance of this bottom habitat will not be as important an impact for species that feed in the water column, such as Atlantic herring. Other pelagic species such as Atlantic mackerel that can feed on the bottom-dwelling organisms will be affected by the temporary loss of this habitat. Because the area of disturbance is small compared to adjacent available habitat, and because construction-related disturbance is temporary, adverse impact to both demersal and pelagic fishes in the area is expected to be minimal.

Operational Impacts

An estimated 42.4 acres of habitat used by fish for feeding and spawning will be regularly or permanently disturbed due to the operation of the of the flowlines, mooring wire rope and chain, anchors, and pipeline end manifolds. Most of this area will be disturbed by the operation of the mooring wire rope and chains. When an EBRV is on the buoy, an estimated 42.4 acres of bottom will be disturbed as the mooring wire rope and chains are dragged across the bottom due to the EBRV weathervaning into the prevailing wind. When disconnected, only 4 acres will be disturbed because the mooring wire rope and chains will settle onto a relatively small footprint on the bottom.

The disturbance of the 42.4 acres of soft substrate by the mooring wire rope and chain when the EBRVs are on the buoy will be the primary long-term impact to bottom habitat due to the operation of the Port. If the two buoys are used consecutively, as is planned, the benthic community will likely not be able to recover between uses. This disturbance is expected to continue for the life of the Port. Demersal fishes that come in direct contact with the mooring wire ropes and chains will probably be killed. This will likely include skates, sculpins, and flounders. Other demersal fishes that do not have such a close association with the bottom, such as members of the cod family and redfish, may be able to avoid the mooring wire ropes and chains. The operation of the Port could, therefore, effectively result in the exclusion of much of the demersal fish community from about 42.4 acres of habitat. Pelagic fishes would not be directly affected by this habitat exclusion because they occur in the water column and are expected to be able to avoid the mooring wire ropes and chains.

An additional direct impact due to Port operation includes potential impingement of fish at the water intakes of the EBRVs. Up to 56 MGD of water will be withdrawn by each vessel at the Port for hotelling operations and ballast water intake. Because the water intakes are located at depths of 23 to 38 feet (7 to 12 meters), it is expected that only pelagic fish will be subject to impingement, and in very small numbers. Approximately 47 MGD of the total volume will be withdrawn through the starboard sea chests with an open area of 88.3 square feet (8.2 square meters), resulting in a through-screen intake velocity of about 0.82 feet per second (0.25 meters per second). The remaining daily volume of 9 MGD will be withdrawn from the port sea chests; therefore, the through-screen velocity of 0.82 feet per second represents the highest through-screen velocity that fish will experience. Atlantic mackerel and Atlantic herring are two of the common pelagic fishes that might be expected to be exposed to impingement. However, Atlantic mackerel are very strong swimmers and only two have been impinged at Seabrook Station since 1994 (NAI 2004), where daily withdrawal volumes are ten times those of an EBRV. Therefore, it is not expected that impingement of Atlantic mackerel will be significant. A total of 1,810 Atlantic herring have been impinged at Seabrook Station since 1994, with an annual mean impingement of 181 fish per year. However, it is expected that Atlantic herring will also be able to escape the through screen velocity of 0.82 feet/second. The intakes at Seabrook Station[1] have a much larger estimated opening of 2,000 square feet (186 square meters) compared to the estimated openings of 88.3 square feet (8.2 square meters) for the EBRVs; therefore, impingement of pelagic fishes at the EBRVs would be expected to be much lower than 181 Atlantic herring per year.

Indirect impacts will include disturbance of benthic invertebrate food sources for demersal fishes. However, this indirect impact will only occur if food resources are a limiting factor to production of demersal fishes, which may not be the case. Assuming the worst-case scenario that demersal fish production is limited by food resources, an estimated 42.4 acres of soft bottom invertebrate habitat will not be available as a food source for demersal fishes during the operational lifetime of the Port.

With regard to indirect impacts on pelagic fishes, it is possible that the discharge of saline heated water from the EBRVs may cause avoidance of the discharge plume by these fishes and their prey items, although the size of the plume will be small and temperature rise minimal (see Section 4.4.3). Disturbance of 42.4 acres of bottom habitat will not be an important impact for species that feed in the water column, such as Atlantic herring. Other pelagic species such as Atlantic mackerel that can feed on the bottom-dwelling organisms will be affected by the loss of this habitat.

As discussed in Section 4.5.3, the entrainment of plankton during hotelling and ballast water uptake does not constitute a significant reduction in plankton availability. Therefore, there is no significant indirect impact on food sources for finfish through hotelling and ballast water uptake.

Essential Fish Habitat

The Port area has been designated as EFH for at least one lifestage of 23 species (Table 4.7-11). Although most of these 23 species could occur in the Port area, further analysis of the habitat requirements of each of the lifestages of these species indicated that the silt/clay substrate in the Port area was EFH for at least one lifestage of 11 species (Appendix 4.7-1). These species are those that have a close affinity for soft substrates. The estimated affected EFH area for butterfish is probably an overestimate, because it is based on the reported association between juveniles and adults and silty substrates. This fish is generally pelagic, however, and does not appear to be closely associated with demersal habitat. The remaining ten species have either juvenile or adult lifestages that are found in close association with soft substrates and will be affected by the loss of this type of habitat.

Eggs and larvae of most of these species are pelagic and will not be affected by disturbance of the substrate, with the exception of winter flounder, which has demersal eggs. However, winter flounder are primarily inshore spawners on firmer substrate, and it is not expected that any winter flounder spawning will occur in this deep, offshore, soft substrate habitat of the Port area. Pelagic eggs and larvae are

[1] The intake velocity at Seabrook Station ranges from an estimated 0.5 feet per second at the offshore trash racks to an estimated 6 feet per second at the transition from the offshore intake structures to the vertical riser that leads to the horizontal intake tunnel.

Table 4.7-11. Summary of Species and Lifestages with Designated Essential Fish Habitat (EFH) and Estimated Impacts to EFH in the Northeast Gateway Port Area

Species	Designated Lifestages[a/]	Estimated EFH Acreage Impacted by Construction (Lifestages)	Estimated EFH Acreage Impacted by Operation (Lifestages)
American plaice (*Hippoglossoides platessoides*)	E,L,J,A	0	0
Atlantic bluefin tuna (*Thunnus thynnus*)	J,A	0	0
Atlantic cod (*Gadus morhua*)	E,L,J,A	0	0
Atlantic halibut (*Hippoglossus hippoglossus*)	E,L,J,A	0	0
Atlantic herring (*Clupea harengus*)	L,J,A	0	0
Atlantic mackerel (*Scomber scombrus*)	E,L,J,A	0	0
Butterfish (*Peprilus triacanthus*)	E,L,J,A	42.5 (J,A)	42.4 (J,A)
Goosefish (*Lophius americanus*)	E,L,J,A	42.5 (J,A)	42.4 (J,A)
Haddock (*Melanogrammus aeglefinus*)	J	0	0
Longfin inshore squid (*Loligo pealeii*)[d/]	J,A	0	0
Northern shortfin squid (*Illex illecebrosus*)[d/]	J,A	0	0
Ocean pout (*Macrozoarces americanus*)	E,L,J,A	0	0
Red hake (*Urophycis chuss*)	E,L,J,A	42.5 (J,A)	42.4 (J,A)
Redfish spp. (*Sebastes fasiatus and S. mentella*)	L,J,A	42.5 (J,A)	42.4 (J,A)
Sea scallop (*Placopecten magelanicus*)	E,L,J,A	0	0
Silver hake (*Merluccius bilinearis*)	E,L,J,A	42.5 (J,A)	42.4 (J,A)
Smooth skate (*Malacoraja senta*)	J	42.5 (J)	42.4 (J)
Thorny skate (*Amblyraja radiata*)	J,A	42.5 (J,A)	42.4 (J,A)
White hake (*Urophycis tenuis*)	E,L,J,A	42.5 (J,A)	42.4 (J,A)
Windowpane (*Scopthalmus aquosus*)	E,L	0	0
Winter flounder (*Pseudopleuronectes americanus*)	E,L,J,A	42.5 (A)	42.4 (A)
Witch flounder (*Glyptocephalus cynoglossus*)	E,L,J,A	42.5 (J,A)	42.4 (J,A)
Yellowtail flounder (*Limanda ferruginea*)	E,L,J,A	42.5 (J,A)	42.4 (J,A)

[a/] E=eggs, L=larvae, J=juveniles, A=adults.

subject to entrainment through the water intakes of the EBRVs and this impact is discussed in Section 4.5.3.4.

4.7.3.2 Pipeline Lateral Impact Analysis

Construction Impacts

A description of the construction process is provided in Section 1.0. For the purposes of assessing potential impacts to the marine fishery resource, the following key features of the construction process were considered. The vast majority of the trenching will be performed by plowing, with a number of short discrete sections involving jetting. The trench will generally be approximately 25 feet (8 meters) wide at the top with spoil pushed by the plow 25 feet (8 meters) to either side of the trench. Material mobilized by jetting will be deposited onto the adjacent substrate. Once the pipe is installed, the trench will be primarily backfilled by pulling a BFP to restore the spoil over the pipe. The deepwater lay barge and plow/BFP barge will be positioned and moved by a series of anchors with assistance by anchor handling tugs.

The Port area has been designated EFH for the egg and larval lifestages of many of the 23 species listed in Table 4.7-11. Eggs and larvae of most of these species are pelagic and will not be affected by disturbance of the substrate, with the exception of winter flounder, which has demersal eggs. However, winter flounder are primarily inshore spawners on firmer substrate, and it is not expected that any winter flounder spawning will occur in this deep, offshore, soft substrate habitat of the Port area. Pelagic eggs and larvae are subject to entrainment through the water intakes of the EBRVs and this impact is discussed in Section 4.5.3.4.

4.7.3.3 Pipeline Lateral Impact Analysis

Construction Impacts

A description of the construction process is provided in Section 1.0. For the purposes of assessing potential impacts to the marine fishery resource, the following key features of the construction process were considered. The vast majority of the trenching will be performed by plowing, with a number of short discrete sections involving jetting. The trench will generally be approximately 25 feet (8 meters) wide at the top with spoil pushed by the plow 25 feet (8 meters) to either side of the trench. Material mobilized by jetting will be deposited onto the adjacent substrate. Once the pipe is installed, the trench will be primarily backfilled by pulling a BFP to restore the spoil over the pipe. The deepwater lay barge and plow/BFP barge will be positioned and moved by a series of anchors with assistance by anchor handling tugs.

An estimated 1,022 acres of habitat used by fish for feeding and spawning will be disturbed due to installation of the Pipeline Lateral (Table 4.7-12). The sediment types shown in Table 4.7-12 are the dominant types, but each category may include mixtures of other sediments. The majority (92 percent) of the Pipeline Lateral will pass through clay to medium sand substrate (Class 1). Clay to medium sand with

Table 4.7-12. Estimated Acreage of Habitat Type in the Pipeline Corridor Affected by Construction

Dominant Sediment Type	Acreage	Percent Composition
Class 1[a/] (clay to medium sand)	935	92
Class 1-2 (mixture of clay to gravel)	7	1
Class 1 HC (clay to medium sand with high concentration of boulders)	31	3
Class 2[b/] (medium sand to gravel)	0.0	0.0
Class 3 (gravel to boulders)	0.0	0.0
Class 4 (bedrock)	0.0	0.0
Class 5[c/] (combination of Classes 1,2, and 3 with unknown non native material)	49	5
TOTAL	**1,022**	**100**[d/]

[a/] May include fractions of coarser sediments and isolated boulders.
[b/] May include fractions of finer and coarser sediments as well as isolated boulders.
[c/] These areas may be associated with activities in the MBDS.
[d/] Total does not sum exactly to 100 due to rounding.

boulders (3 percent; Class 1 HC) and a combination of sediments with non native material (5 percent; Class 5) are the remaining substrate types that comprise more than 1 percent of the Pipeline Lateral corridor. The Class 5 material occurs primarily near the MBDS and may be a result of dumping activity outside the confines of the disposal site.

Section 4.7.2.2 provides an overview of the fish community of Massachusetts Bay. The most area-specific data come from the NMFS bottom trawl survey data that are summarized from 17 trawls that took place in the vicinity of the Port area and Pipeline corridor (Table 4.7-3). These trawls took place in a variety of habitats near the Pipeline Lateral corridor, including areas that most likely contained hard bottom substrate that is not typical of the corridor, and none of which occurs along the pipeline centerline. Of the 14 dominant species, all were demersal species except Atlantic herring and spiny dogfish. This is to be expected as the otter trawl most effectively samples demersal species. Based on Section 4.7.2.2, Atlantic mackerel are also a pelagic fish that could also be expected to be found in the Pipeline Lateral corridor.

The primary impacts to marine ichthyofauna will occur during construction and are discussed in the Plankton Section (Section 4.5.3). These impacts will generally be temporary and short term. Demersal species with low mobility in the immediate path of the trench or the anchors will suffer some mortality. Others adjacent to the trench may be buried. Fish that feed by filtering microorganisms out of the water column, such as Atlantic herring, may experience clogging of gills when a construction-related turbidity plume passes near them. In a limited number of short distances, habitat changes will be permanent (i.e., soft-sediment areas converted to hard substrate by the placement of concrete mats); in others, habitat changes will be temporary. The type and degree of impacts depend on the specific behaviors of the individual species occurring in the vicinity of the Pipeline Lateral.

Direct impacts to the fisheries resources due to construction will include the physical disturbance of the clay to medium sand habitat within the trenching and spoil areas along the centerline and disturbance of the surrounding areas due to increased turbidity and sediment deposition. Fishes most likely to be affected by construction activities will be those that prefer soft to medium sand substrate habitat. The Pipeline Lateral corridor has been declared juvenile or adult EFH for 33 species based on presence or absence data (Section 4.7.2.4). Of these 33 species, most could occur in the habitat types defined for Pipeline Lateral corridor, and 13 were dominant (EFH is not designated for longhorn sculpin) in the NOAA resources surveys (Table 4.7-3).

The response of the species that are likely to be found along the Pipeline Lateral corridor will vary depending on their life history. Demersal fishes that are closely associated with the bottom such as the flounders and skates will be more directly affected. These impacts will likely include mortality if they come in direct contact with construction activities, or avoidance of the areas of increased turbidity. However, low-level vibration and noise transmitted through sediments and the water column in association with the movement of the forward end of the plow or BFP across the seafloor have the potential to elicit an avoidance behavior from demersal fish, thereby preventing direct impact with construction equipment or burial by sidecast or retrieved spoil. A slightly greater amount of noise and vibration is likely to occur in the short sections of proposed jetting.

It should be noted that along the pipeline, various indications of commercial fishing activities were visible during an ROV video survey, evidence that the fishery and fish habitat of the area is more regularly impacted than the proposed one time pipeline construction effort. The seafloor along the centerline of the pipeline in the MP 12.5 to MP 14.3 section was predominantly structured by fishing activity. The seafloor in this region was a mosaic of the imprint made of different types fishing gear and different stages of recovery. Very little of the seafloor in this region was untouched by some form of fishing gear. Large areas of the seafloor had been heavily gouged (from some form of dredging) to the point that the sediment appeared as though it had been plowed and then allowed to slightly weather. Other areas bore numerous, less dramatic, furrows (possibly caused by trawl doors) that caused smoothed indenting of the seafloor. The seafloor of other areas was very flattened and smoothed, possibly by trawl nets, with areas of washboard-like striations that were possibly caused by the cookies of trawls. Superimposed on these large-scale topographic impressions were the marks of biological activities (such as animal burrows, trails and tracks) and the smoothing of currents (Hecker 2005, personal communication).

Those fishes that have a more pelagic lifestyle such as Atlantic herring, Atlantic mackerel, and butterfish will most likely be able to avoid any construction activities and the associated increases in turbidity. Noticeable increases in turbidity are primarily expected with the small areas of jetting because turbidity monitoring of plowing performed during the HubLine did not detect measurable increases in turbidity (TRC 2003). Although pelagic fishes such as Atlantic herring and Atlantic mackerel are not closely associated with any particular substrate, they are likely to be found in the water column along the Pipeline Lateral corridor. It is expected that these and other pelagic fishes will also be able to avoid any construction impacts because they have behavioral mechanisms to avoid areas of increased suspended sediments or direct contact with the slow-moving construction equipment.

The impacts of suspended sediments on fishes were rated on a scale that included no effects, behavioral effects, sublethal effects, and lethal and paralethal effects depending on the concentration of suspended sediments and the duration of exposure (Newcombe and Jensen 1996). Usually, the severity of the impacts increased with increasing concentrations of suspended sediments and duration of exposure. At low concentrations and exposure times, only behavioral effects such as avoidance and alarm reactions occurred. At extremely high concentrations, reduced growth rates and mortality could occur. In practical terms for evaluating the impacts of construction activities on fishes, these findings imply that fish will use behavioral mechanisms to avoid areas of high suspended sediments that may cause lethal or paralethal effects, assuming that the turbidity plume is not so large as to completely prevent escape.

Juvenile and adult fish could be impacted from accidental spills and unintentional release of substances such as diesel fuel, lubricants, and hydraulic fluid. However, the Project will be constructed with an approved SPCC Plan which will serve to minimize potential impacts from spills. A similar plan was implemented during construction of the HubLine, and while some releases occurred and were properly reported, no measurable environmental harm occurred because of the implementation of the SPCC Plan. Specifically, no fish kills were observed at the HubLine spill locations.

Indirect impacts are impacts on other resources that may influence the fisheries resources along the Pipeline Lateral corridor. These impacts would likely include disturbance of benthic invertebrate food sources for demersal fishes. However, this indirect impact will only occur if food resources are a limiting factor to production of demersal fishes, which may not be the case. Assuming the worst-case scenario that demersal fish production is limited by food resources, an estimated 1,022 acres of habitat will be disturbed in the Pipeline Lateral corridor and will not be available as a food source for demersal fishes during construction and for a relatively short timeframe after construction while recovery occurs. Habitat for demersal eggs and adults would be temporarily disturbed in the immediate pipeline vicinity. However, the use of plowing instead of jetting or dredging reduces the extent of seafloor disturbance.

Commercially-important species with demersal eggs include winter flounder (present January through June but only in shallower in shore waters), ocean pout (present August through December), and Atlantic herring (present July through December). However, the primarily soft substrate found along the Pipeline Lateral corridor is not preferred habitat for egg deposition for any of these fishes. Larvae of winter flounder (present February through August, although typically in more inshore waters than the Pipeline Lateral corridor) and ocean pout, whose eggs hatch directly into juveniles, (November through February) are also demersal. Short-term decreases in water quality, including increased turbidity and habitat loss would have a negative effect on larval lifestages, as they are unable to move quickly away from adverse conditions. However, the use of plowing minimizes sediment resuspension and allows for more rapid progress of trenching than either jetting or dredging. Because their habitat is not limiting in the Project area, the effects of pipeline installation would not be significant.

Adult demersal fish species that feed on benthic infauna and epifauna include Atlantic cod, haddock, pollock, yellowtail, windowpane, witch, and winter flounders, American plaice, Atlantic halibut, hakes, scup, redfish, black sea bass, goosefish (monkfish), and silver hake (whiting). Habitat for these typical prey species would be temporarily disturbed, resulting in disruption to the benthic community and in some cases death to prey species. Benthic invertebrates would recolonize the area over a period of weeks to months, depending on the type of habitat and its resident species. This temporary loss of benthic food may cause a reduction in fish foraging in disturbed areas along the pipeline corridor until recruitment and recolonization of sediments increases the abundance of benthic prey. Demersally feeding finfish initially moving away from the construction operation may be attracted back to the area because injury or mortality of benthic organisms may provide short-term increased feeding opportunities.

With regard to pelagic fishes, the disturbance of bottom habitat will not be as important an impact for species that feed in the water column such as Atlantic herring. Other pelagic species such as Atlantic mackerel that can feed on the bottom-dwelling organisms will be affected by the temporary alteration of this habitat. Pelagic larvae and adults would be minimally affected by the Project. Adult species would avoid construction activities and be only temporarily displaced into nearby areas. Pelagic larvae might be unable to avoid increased turbidity and suspended solids and could therefore be adversely affected. However, diminished water quality is expected to be temporary, localized, and near the bottom.

During construction, there is also a potential to disturb contaminated bottom sediments, rendering a fraction of the chemical contaminants available to water-column species. Contaminants that may be mobilized by construction activities may accumulate in the food chain and directly in fish, but this is expected to have a very low probability of occurrence. Although there is a long history of disposal of dredged material and solid wastes in western Massachusetts Bay, the only indication that disposal has occurred along the pipeline route are a couple locations with mounds of coarse rocky material in the MP 13 to 16 area. A sediment chemistry sampling and analysis effort has been undertaken and results are expected to be available by mid-summer 2005 (see Section 4.4.3). If results reveal elevated levels of contaminants in sediments along the pipeline route, Algonquin will consult with NOAA Fisheries and MDEP to determine an acceptable course of action.

Pipeline Lateral Operation Impacts

For the vast majority of the operational lifespan of the pipeline, no impacts to juvenile and adult fish, including commercially or recreationally important species, will occur. Possibly, on rare occasions, operational impacts could occur in areas that might require re-exposing a short section of pipeline to perform future maintenance. In this instance, it is likely that jetting will be used to remove sediment from around the pipe, which will be dispersed laterally to resettle on the seafloor. Demersal fish and benthic prey may be lost in this area, but similar to the original pipeline construction, this area will become restored through natural processes after the maintenance work is completed.

The Pipeline Lateral corridor area has been designated as EFH for at least one lifestage of 33 species (Table 4.7-13). Although most of these 33 species could occur in the Port area, further analysis of the habitat requirements of each of the lifestages of these species indicated that the primarily clay to medium sand substrate in the Pipeline Lateral corridor was EFH for at least one lifestage of 24 species (Appendix 4.7-1). A more thorough presentation of EFH impacts is provided in Appendix 4.7-1, and is provided here in summary fashion. These species are those that have a close affinity for the substrates found in the Pipeline Lateral corridor. The estimated EFH area for some of these species, such as summer flounder and winter flounder, is probably an overestimate because the EFH quadrates 1 and 3 include nearshore areas that are not representative of the deeper water of the Pipeline Lateral corridor. Other species such as butterfish do not have a strong association with the substrate, but are reported to occur over the softer substrates found in the Pipeline Lateral corridor. Therefore, the acreages reported in Table 4.7-12 should be considered conservative (maximum) estimates.

The Pipeline Lateral corridor has been designated EFH for the egg and larval lifestages of many of the 33 species listed in Table 4.7-13. Eggs and larvae of most of these species are pelagic and will not be affected by disturbance of the substrate, with the exception of winter flounder, which has demersal eggs. However, winter flounder are primarily inshore spawners on firmer substrate, and it is not expected that any winter flounder spawning will occur in the deeper, offshore, primarily soft substrate habitat of the Pipeline Lateral corridor.

As described above for general fisheries habitat, indirect impacts to EFH relate to alteration of substrates and diminishment of prey. Except for a few short sections where concrete mat armoring will occur, the substrates along the Pipeline Lateral corridor will remain fundamentally the same as pre-existing conditions, and will allow for continued use by designated EFH species. Epifaunal and infaunal prey will recolonize disturbed sediments through mechanisms of larval recruitment. In addition, mobile macroinvertebrates will return to the pipeline trench area, which will continue to serve as foraging habitat for EFH species.

4.7.4 Mitigation Measures

Northeast Port

- Construction methods will minimize construction time and impact.
- Compliance with MARPOL Annex I and IV and other applicable regulations will minimize the risk of any accidental discharge. Northeast Gateway will require that all vessels working on the Northeast Port comply with an approved SPCC Plan.
- To minimize the potential for accidental discharges, the EBRVs will use Marine Sanitary Devices and comply with both USCG and IMO regulations regarding water discharge. Waste treatment and storage systems will be inspected by a qualified engineer annually. In addition, preparation and implementation of a spill response plan, including a spill contingency plan and maintenance of Material Safety Data Sheets for all hazardous materials stored on board, will help protect marine water quality at and near the Port. Absorbent materials will be maintained on board to contain and clean up small spills.

Table 4.7-13. Summary of Species and Lifestages with Designated EFH in the Northeast Gateway Pipeline Lateral Corridor Area

Species	EFH Quadrat (Designated Lifestage) B[a/]	Estimated EFH Acreage Affected by Construction (Lifestages)	Estimated EFH Acreage Affected by Operation (Lifestages)
American plaice (*Hippoglossoides platessoides*)	1,2,3,4 (E,L,J,A)[b/]	1,022 (J,A)	0.06 (J,A)
Atlantic bluefin tuna (*Thunnus thynnus*)	1,2,3,4 (J,A)	0	0
Atlantic cod (*Gadus morhua*)	1,2,3,4 (E,L,J,A)	0	0
Atlantic halibut (*Hippoglossus hippoglossus*)	1,2,3,4 (E,L,J,A)	1,022 (J,A)	0.06 (J,A)
Atlantic herring (*Clupea harengus*)	1,2,3,4 (L,J,A)	0	0
Atlantic mackerel (*Scomber scombrus*)	1,2,3,4 (E,L,J,A)	0	0
Black sea bass (*Centroprisies striata*)	1,2 (A)	0	0
Bluefish (*Pomatomus saltatrix*)	1,3 (J,A)	0	0
Butterfish (*Peprilus triacanthus*)	1,2,3,4 (E,L,J,A)	1,0222 (J,A)	0.06 (J,A)
Goosefish (*Lophius americanus*)	2,4 (E,L,J,A)	565. (J,A)	0
Haddock (*Melanogrammus aeglefinus*)	1,3,4 (E) 2,3,4 (L) 2,4 (J)	80 (J)	0
Little skate (*Leucoraja erinacea*)	1,2,3 (J,A)	530 (J,A)	0.06 (J,A)
Longfin inshore squid (*Loligo pealeii*)[C/]	1,2,3,4 (J,A)	0	0
Northern shortfin squid (*Illex illecebrosus*)[C/]	1,2,3,4 (J,A)	0	0
Ocean pout (*Macrozoarces americanus*)	1,2,3,4 (E,L,J,A)	31 (J,A)	0
Ocean quahog (*Artica islandica*)[C/]	2 (J,A)	73. (J,A)	0
Pollock (*Pollachius virens*)	1,3 (E,L,J,A)	457 (J,A)	0.06 (J,A)
Red hake (*Urophycis chuss*)	1,2,3,4 (E,L,J,A)	1,022 (J,A)	0.06 (J,A)
Redfish (*Sebastes fasiatus and S. mentella*)	1,2,3,4 (L,J,A)	492 (J)	0.06 (J,A)
Scup (*Stenotomus chrysops*)	1,2,3 (J,A)	0	0
Sea scallop (*Placopecten magelanicus*)	1,2,3,4 (E,L,J,A)	7 (J,A)	0
Silver hake (*Merluccius bilinearis*)	1,2,3,4 (E,L,J,A)	1,022 (J,A)	0.06 (J,A)
Smooth skate (*Malacoraja senta*)	4 (J)	492 (J)	0
Spiny dogfish (*Squalus acanthias*)	3 (J,A)	166 (J,A)	0
Summer flounder (*Paralichthys denatus*)	1,2 (A)	364 (A)	0.06 (J,A)
Surf clam (*Spisula solidissima*)	1,2,3 (J,A)	530 (J,A)	0.06 (J,A)
Thorny skate (*Amblyraja radiata*)	1,2,3,4 (J) 4(A)	1022 (J,A)	0.06 (J,A)
White hake (*Urophycis tenuis*)	1,2,3,4 (E,L,J,A)	1022 (J,A)	0.06 (J,A)
Windowpane (*Scopthalmus aquosus*)	1,3,4 (E,L) 1,3 (J,A)	457 (J,A)	0.06 (J,A)
Winter flounder (*Pseudopleuronectes americanus*)	1,2,3,4 (E,L,J,A	1022 (J,A)	0.06 (J,A)
Winter skate (*Leucoraja ocellata*)	1,2,3 (J) 2 (A)	530 (J,A)	0.06 (J,A)
Witch flounder (*Glyptocephalus cynoglossus*)	3,4 (E) 2,3,4 (L) 2,4 (J) 3,4 (A)	565 (J) 658.1 (A)	0
Yellowtail flounder (*Limanda ferruginea*)	1,3,4 (E) 1,2,3,4 (L,J,A)	1022 (J,A)	0.06

[a/] The proposed facilities cross four of the EFH 10-foot-by-10-foot squares of latitude and longitude along the coast. The numbers presented in this table for each species and life stage represent the Pipeline Lateral-assigned square number where the species and specific life stage have designated EFH.
[b/] E= Eggs, L=Larvae, J= Juveniles, A = Adults
[c/] Juveniles and adults correspond to pre-recruits and recruits, respectively.

Pipeline Lateral

Impacts to fisheries resources in the offshore environment have been minimized through the siting of the proposed Pipeline Lateral and through the use of the proposed construction methods. In addition, Algonquin is planning to construct the Pipeline Lateral beginning in September 2006 extending into May 2007. The main construction activities including, pipelay, plowing, backfill plowing, and jetting are planned to occur during the winter months. The schedule for these activities will occur during a period, when on balance considering both direct and indirect effects, impacts to water quality, and to the majority of marine resources occurring along the Pipeline Lateral will be minimized.

- **Siting of the Pipeline Lateral** - As described in Section 3.0, Supplement 6, Algonquin spent considerable time conducting geophysical and geotechnical surveys across a broad area in an effort to locate the Pipeline Lateral in an area with relatively uniform substrate/habitat conditions where the least environmentally impacting construction procedures could be effectively utilized. The preferred route meets this objective. Geophysical survey data indicate a seafloor composed of largely silt/sand/clay with no surficial rock. As such, the preferred route has a low probability of encountering rock requiring blasting, dredging, or surface armoring. Due to the relative simplicity of construction and fewer number of construction method transitions, this route is expected to require the shortest duration of construction activities, result in the least amount of sediment resuspension and transport, and entails the narrowest direct disturbance width along the trenched pipe.
- **Construction Methods** - Algonquin will utilize a single pass of the PLP to lower the pipeline for the majority of the route (96 percent) as the principal impact minimization measure. Offshore, where plume dilution occurs more rapidly because of water depth, plowing is the preferred construction technique because it is much faster than other techniques, causes the least amount of sediment resuspension and, thereby, reduces the duration of water column effects. The selection of plowing as the primary pipe burial process minimizes the footprint adjacent to the trench where material will be sidecast, thereby minimizing the total impact area.

Algonquin is planning to backfill the majority of the pipeline with one pass of the backfill plow. The backfill plow operates in a similar manner to the plow, but has reversed mold boards, that are used to pull the spoil back into the trench. HubLine post-construction surveys showed that in areas where only plowing and backfill plowing were used, the contours more closely match pre-existing conditions than areas that also involved dredging, jetting or blasting, which is why the Pipeline Lateral was located, as previously noted, in an area that avoided sediment types that would have otherwise required the use these methods as the primary construction technique

In the limited areas along the route where jetting is proposed to excavate the trench, the Pipeline Lateral will be backfilled with sand (placed by tremie tube), concrete mats, or diver-placed sand bags depending on the operational requirements of the site. Whatever material is used, it will be placed over the pipeline using a tremie tube or by divers, no imported backfill material will be dumped from vessels on the surface.

The primary construction barges will use mid-line buoys on all anchor cabled to minimize scouring of the seafloor and the release of sediments resulting from cable sweep that will occur during movement of the construction vessels.

Algonquin and its construction contractors will also implement a SPCC Plan to minimize the potential impacts of any unintentional fuel spills or similar releases.

4.7.5 Alternatives

4.7.5.1 No Action Alternative

Under this alternative, the Project would not proceed and existing conditions would remain. Other means to satisfy the nation's energy demands might result in increased use of existing land-based terminals, greater reliance on declining domestic oil and gas resources, or development of alternate means of importing LNG.

4.7.5.2 Port Alternative

The use of Buoys B and C would result in impacts similar to those discussed for the Project. The biological habitats, including ocean depth and seafloor type, are very similar at the two sites. The moderate difference in location would not be expected to materially alter the impacts to finfish resources.

4.8 Marine Mammals

4.8.1 Introduction

This section discusses only those marine mammals known to traverse or occasionally visit the waters within or surrounding the Project area that are not listed as threatened or endangered under the ESA, but are protected under the Marine Mammal Protection Act of 1972 as amended in 1994 (MMPA). Descriptions of biology, habitat use, abundance, and distribution in the Project area, and existing threats to these populations are described in Section 4.8.2. Impacts to these mammals are discussed in Section 4.8.3. Sections 4.8.4 and 4.8.5 describe proposed mitigation measures and alternatives, respectively. There are 12 species of whales, porpoises, dolphins, and seals covered in this section. Six species of whales that are listed as Endangered under the ESA are discussed separately in Section 4.9. Section 4.13 discusses the recreational aspects of whale watching.

Project Area: The Project area for the Port and Pipeline Lateral includes the ports and harbors along the shoreline of Massachusetts Bay closest to the Project, the waters of Massachusetts Bay extending east to the boundary of the SBNMS, Gloucester to the north, and on the south to the edge of the in-bound Boston Harbor traffic lane. Both the Northeast Port and Pipeline Lateral will require onshore loadout yards for offshore construction materials located at existing industrial or commercial sites. The Pipeline Lateral also includes modifications at two existing onshore aboveground facilities located in the City of Salem and the Town of Weymouth.

The study area for marine mammals is larger than the Project area, as it extends from the Port eastward to the edge of federal jurisdiction, 200 nautical miles (370 kilometers) from shore.

Issues: The following issues related to marine mammals were considered in the preparation of this section:

- Potential for marine mammals to become entangled in underwater construction and operation gear used to construct or operate the Port and Pipeline Lateral;
- Potential for marine mammals to be struck by vessels during construction of the Port or Pipeline Lateral, or during operation of the Port;
- Potential for the underwater noise created during Project construction or operation of the Port to harass or change the behavior of marine mammals in the area;
- Long-term viability of prey populations, including plankton and finfish, due to Port operation; and
- Potential to indirectly impact Stellwagen Bank National Marine Sanctuary and the marine mammals that utilize the Sanctuary, from the operation of the Port, including transiting LNG vessels.

4.8.2 *Environmental Setting*

4.8.2.1 Regulatory Framework

The MMPA established federal responsibility to protect marine mammals whose habitat is in waters under the jurisdiction of the United States (MMPA 1972). The Act prevents the "taking" of marine mammals in certain situations (MMPA 1972). The term "take" is statutorily defined to mean "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal" (MMPA 1972). The Endangered Species Act also protects some species of marine mammals, which are covered in Section 4.9.

4.8.2.2 Protected Areas

The proposed location of the Port in Massachusetts Bay is within areas known to be visited by marine mammals and is in proximity to the following marine protected areas and sanctuaries:

Federally Designated Marine Protected Areas

- The Gerry E. Studds Stellwagen Bank National Marine Sanctuary (842 square miles; 2,181 square kilometers) is located at the mouth of Massachusetts Bay on Stellwagen Bank in the Southern Gulf of Maine and just east of the proposed Project;
- The Great South Channel Northern Right Whale Critical Habitat Area (3,231 square miles; 8,368 square kilometers) is located east of Cape Cod and is approximately 71 miles (114 kilometers) south of the proposed Project;
- Cape Cod Bay Northern Right Whale Critical Habitat Area (643 square miles; 1,665) is located at the north end of Cape Cod Bay, approximately 21 miles (34 kilometers) south of the proposed Project.

State Designated Ocean Sanctuaries

- North Shore Ocean Sanctuary (175 square miles; 453 square kilometers) is located along the northern Massachusetts coast, the proposed Lateral Pipeline is within the southern end of the sanctuary;
- South Essex Ocean Sanctuary (56 square miles; 145 square kilometers) is located to the east of Marblehead and Salem, Massachusetts and encompasses the proposed Lateral Pipeline;
- Cape Cod Bay Ocean Sanctuary (616 square miles; 1,595 square kilometers) encompasses the entire Cape Cod Bay and is located approximately 21 miles (34 kilometers) south of the proposed Project; and
- Cape Cod Ocean Sanctuary (189 square miles; 490 square kilometers) is located east of Cape Cod along the entire outer Cape Cod peninsula and is approximately 27 miles (43 kilometers) south of the proposed Project.

The federally designated Great South Channel and Cape Cod Bay Northern Right Whale Critical Habitat areas have been designated specifically to protect marine mammals. The other protected areas and ocean sanctuaries protect natural habitats, which indirectly protects these marine mammals. The location of the Project area in relation to the areas listed above can be seen in Figure 4.8-1.

4.8.2.3 Non-Endangered or Threatened Marine Mammals

Table 4.8-1 lists the marine mammals protected under the MMPA whose habitat includes the waters off the Massachusetts coast. Data from the North Atlantic Right Whale Consortium (NARWC) Database, along with several published articles/books on marine mammals in the Massachusetts Bay, Cape Cod Bay, and Stellwagen Bank area, were used to verify their presence over the last few years. The NARWC Database "was established in 1986 as part of a cooperative right whale research program conducted by the University of Rhode Island, New England Aquarium, Center for Coastal Studies, Woods Hole

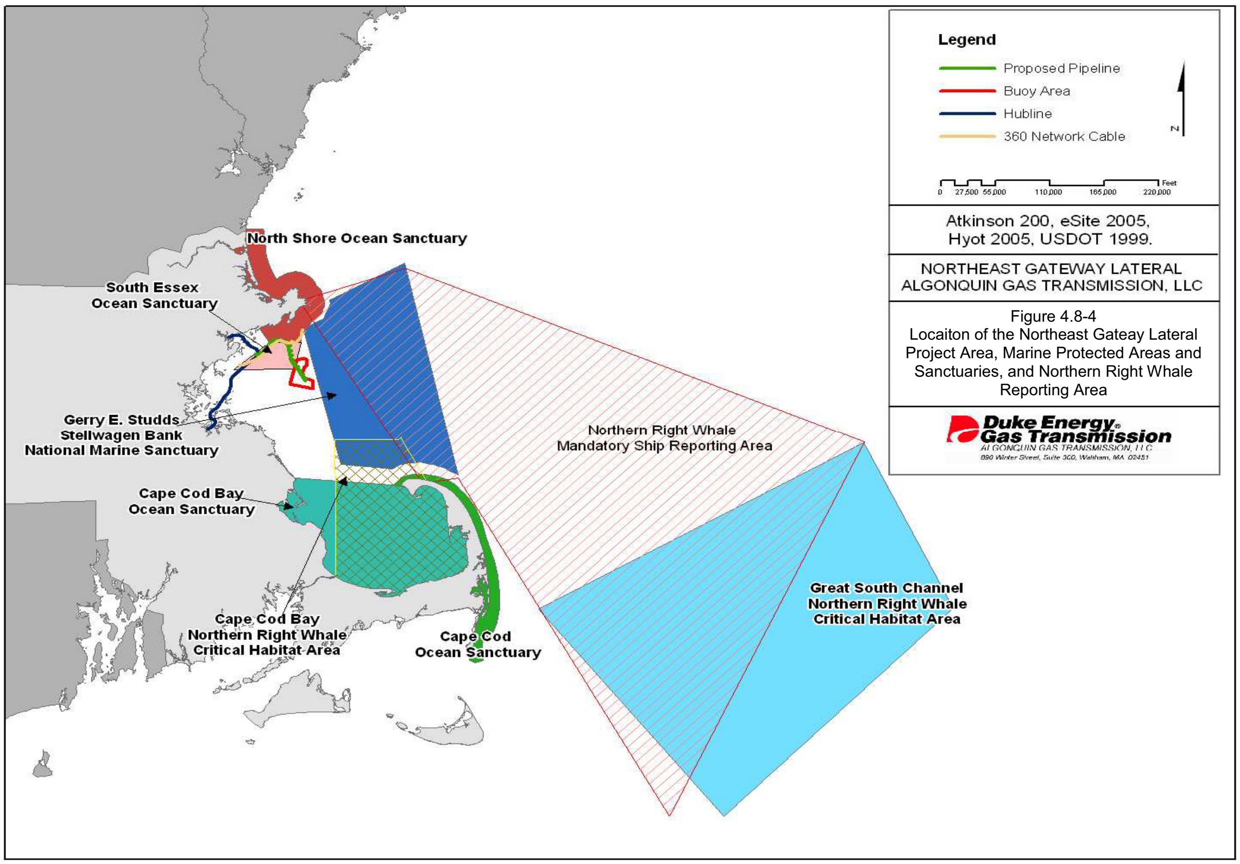

Figure 4.8-1. Location of the Northeast Gateway Lateral Project Area, Marine Protected Areas and Sanctuaries, and Northern Right Whale Reporting Area.

Table 4.8-1. List of Non-ESA Protected Marine Mammals Sighted in the Waters off the Massachusetts Coast

Common Name	Scientific Name	Season Found in Project area
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Year Round
Bottlenose dolphin	*Tursiops truncatus*	Late Summer, Early Fall
Common dolphin	*Delphinus delphis*	Fall and Winter
Harbor porpoise	*Phocoena phocoena*	Year Round (especially Sept-April)
Killer whale	*Orcinus orca*	July-September
Long-finned pilot whale	*Globicephala melaena*	Year Round (especially Sept-April)
Risso's dolphin	*Grampus griseus*	Spring, Summer, Autumn
Striped dolphin	*Stenella coeruleoalba*	Year Round
White-beaked dolphin	*Lagenorhynchus albirostris*	April-November
Minke whale	*Balaenoptera acutorostrata*	April-October
Gray seals	*Halichoerus grypus*	Year Round
Harbor seals	*Phoca vitulina*	Late September-Early May

Source: NMFS 1993; Waring et al. 2004; Wilson et al. 1999.

Oceanographic Institution, and other organizations" (North Atlantic Right Whale Consortium 2005). The data were retrieved from the Survey and Sightings Database (Sightings database), maintained and curated by the University of Rhode Island. The database contains records "of sightings of right whales in the North Atlantic Ocean, as well as sightings of many other species of whales, dolphins, sea turtles, seals, and large fishes. It also contains survey effort data associated with many of these sightings. Though most sightings in the Sightings database are from surveys conducted from the late 1970s to the present, some right whale historical records go back as far as the 18th Century. The sightings contained in the database come from a wide variety of contributors – both Consortium members and others" (North Atlantic Right Whale Consortium 2005). Following the table is a summary section for each of the mammals listed above. As noted, there is a substantial body of literature providing sufficient information regarding the present range and population of marine animals such that no additional site-specific surveys were conducted.

Cetaceans inhabit all of the world's oceans and are found in coastal, estuarine, and highly pelagic habitats. Whales are strong swimmers and are known to travel long distances during migrations between feeding and breeding areas. The smaller species are shallow divers, while the larger whales are capable of deep dives. There are two groups of cetaceans, toothed whales and baleen whales. The toothed whales, Odontoceti, all possess teeth, are very gregarious, generally feed on fish and invertebrates, and use echolocation for orientation and prey detection. Baleen whales, Mysticeti, do not have any teeth, but use a filtration system, consisting of baleen, to sieve prey from the water. Their prey primarily consists of zooplankton and small schooling fish. They usually forage in the upper 650 feet (198 meters) of the water column. Baleen whales are known to maintain small, unstable groups or remain as solitary individuals Wilson and Ruff 1999).

All cetaceans communicate by emitting a variety of underwater sounds. Most marine animals can perceive underwater sounds over a broad range of frequencies from about 10 hertz to more than 10,000 hertz (10 kilohertz). Many of the dolphins and porpoises use even higher frequency sound for echolocation and perceive these high frequency sounds with high acuity. Marine mammals respond to low-frequency sounds with broadband intensities of more than 120 db re 1 μPa, or about 10 to 20 decibels above natural ambient noise at the same frequencies (Richardson et al. 1991). Toothed whales create three types of sounds: tonal whistles; pulsed sounds of short duration to be used in echolocation; and less distinct pulsed sounds, such as cries, grunts, and barks. Toothed whales become very vocal when together, especially when interacting with each other.

Peak underwater sound detection in most baleen whales, including the endangered species discussed in Section 4.9.2.3, is in the range of 10 to 10,000 hertz, with greatest acuity below about 10,000 hertz. The lowest recorded ranges of frequencies for sounds of the sei whale are sweeps in the 1.5 to 3.5 kilohertz range (Richardson et al. 1995). The whales use these low-frequency sounds primarily for long-range communication. Determining the function of baleen whale sounds is difficult because they are normally not kept in captivity where their interaction and use of sounds can be examined (Richardson et al. 1995).

Pinnipeds include seals, sea lions/fur seals, and walrus. Two species of seals have been observed in the project area. Seals are usually found in the polar or temperate seas. Pinnipeds are primarily adapted for life in the water, but their limbs allow them to haul out on to intertidal rocks and beaches where they may sun themselves or rest. They are mainly known for their deep dives and long underwater stays. Most communication between seals is associated with mating, mother-pup interactions, and maintaining territories. Underwater communication for seals is mainly heard during mating season Wilson and Ruff 1999).

Based on available information, long-finned pilot whales, minke whales, Atlantic white-sided dolphins, and harbor porpoises have been sighted in the area of construction of the Port in February through May, and September through November (Kenney 2001).

Non-Threatened or Endangered Toothed Whales

Atlantic White-Sided Dolphin (Lagenorhynchus acutus)

The Atlantic white-sided dolphin has black, gray, and white coloring and is 7 to 9 feet (2.1 to 2.7 meters) long with an acutely pointed dorsal fin (Ward 2000). They are found at a depth of 330 feet (100 meters) in the cool temperate and subpolar waters of the North Atlantic, generally along the continental shelf between the Gulf Stream and the Labrador current to as far south as North Carolina (Bulloch 1993; Reeves et al. 2002).

NMFS recognizes three stocks of the Atlantic white-sided dolphin in the western North Atlantic: a Gulf of Maine stock, a Gulf of St. Lawrence stock, and a Labrador Sea stock (Waring et al. 2004). The Gulf of Maine stock occupies regions of both the Gulf of Maine (usually in the southwestern portion) and Georges Bank throughout the entire year. This species is highly social and is commonly seen feeding with fin whales. They feed on a variety of fish such as herring, hake, smelt, capelin, and cod, as well as squid (NMFS 1993). Atlantic white-sided dolphins are known to vocalize through whistles. Whistles are produced at a dominant frequency of 6 to 15 hertz (Richardson et al. 1995). Estimates of population size, which was arrived from summing the results of two separate aerial surveys, indicate that the population of the Gulf of Maine stock is approximately 51,640 individuals (Waring et al. 2004). Population estimates in U.S. shelf waters suggest around 30,000 individuals. An additional 12,000 animals have been estimated to summer in the Gulf of St. Lawrence (Reeves et al. 2002).

The biggest human-induced threat to the Atlantic white-sided dolphin is bycatch because they are occasionally caught in fishing gillnets and trawling equipment. Approximately 100 dolphins each year were killed by human activities during 1997 to 2001 (Waring et al. 2004). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2004).

Bottlenose Dolphin (Tursiops truncatus)

The bottlenose dolphin is a light- to slate- gray dolphin, roughly 8 to 12 feet (2.4 to 3.7 meters) long with a short, stubby beak. Because this species occupies a wide variety of habitats, it is regarded as possibly the most adaptable cetacean (Reeves et al. 2002). It occurs in oceans and peripheral seas at both tropical and temperate latitudes. In North America, bottlenose dolphins are found in surface waters with temperatures ranging from 50 to 90 °F (10 to 32 °C).

There are two distinct bottlenose dolphin populations: a shallow water and a deepwater population. The shallow water, coastal population resides along the inner continental shelf and around islands. These animals often move into or reside in bays, estuaries, and the lower reaches of rivers (Reeves et al. 2002). The deepwater population is the only one found in the northern latitudes of the North Atlantic, found in Gulf Stream waters. This deepwater population extends along the entire continental shelf-break from Georges Bank to Cape Hatteras during the spring and summer months, and has been observed in the Gulf of Maine during the late summer and fall. According to the species stock report, the population estimate for the western North Atlantic offshore bottlenose dolphin stock is 29,774 individuals (Waring et al. 2004).

Bottlenose dolphins feed on a large variety of organisms, depending on their habitat. The coastal, shallow population tends to feed on benthic fish and invertebrates, while deepwater populations consume pelagic or mesopelagic fish such as croakers, sea trout, mackerel, mullet, and squid (Reeves et al. 2002).

Bottlenose dolphins are known to vocalize through whistles, low-frequency narrowband signals, and a variety of calls such as rasps, grates, mews, barks, and yelps. Whistles are produced at a frequency range of 0.8 to 24 hertz, with a dominant frequency of 3.5 to 14.5 hertz, and a source level of 125 to 173 dB re 1 μPa at 1m. The low frequency vocalizations are produced at a frequency of less than 2 hertz, dominating at 0.3 to 0.9 hertz (Richardson et al. 1995). There is no information available characterizing the other known calls.

The biggest threat to the population is bycatch because they are frequently caught in fishing gear, gillnets, purse seines, and shrimp trawls (Waring et al. 2004). They have also been adversely impacted by pollution, habitat alteration, boat collisions, human disturbance, and are subject to bioaccumulation of toxins. Scientists have found a strong correlation between dolphins with elevated levels of PCBs and illness, indicating certain pollutants may weaken their immune system (ACSonline 2004). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as "non-strategic" (Waring et al. 2004).

Short-Beaked Common Dolphin (Delphinus delphis)

Short-beaked common dolphins are very colorful, with an hourglass pattern on the side of their body. They are 6 to 8 feet (1.8 to 2.4 meters) long and can either be short- or long-beaked (ACSonline 2004). They can be found either along the 200- to-2,000 meter (650-to-6,500-foot) isobaths over the continental shelf and in pelagic waters of the Atlantic and Pacific Oceans. They are present in the western Atlantic from Newfoundland to Florida. The short-beaked common dolphin is especially common along shelf edges and in areas with sharp bottom relief such as seamounts and escarpments (Reeves et al. 2002). They show a strong affinity for areas with warm, saline surface waters. Off the coast of the eastern U.S., they are particularly abundant in continental slope waters from Georges Bank southward to about 35 degrees North (Reeves et al. 2002). They are only occasional visitors to the Massachusetts Bay area; they usually inhabit tropical and warm-temperate waters (Waring et al. 2004). The long-beaked dolphin is more common in coastal waters, where the short-beaked dolphin inhabits offshore waters. If they do come to the Massachusetts Bay area to feed, it is usually during the fall and winter (NMFS 1993). According to the species stock report, the population estimate for the western North Atlantic common dolphin is 30,768 individuals (Waring et al. 2004).

These dolphins typically gather in schools of hundreds of thousands, although the schools generally consist of smaller groups of 30 or fewer. They are eager bow riders and are active at the surface (Reeves et al. 2002).

The short-beaked common dolphin feeds on small schooling fish and squid. They have been known to feed on fish escaping from fishermen's nets or fish that are discarded from boats (NMFS 1993). The short-beaked common dolphin produces the following three types of signals: whistles, at a dominant frequency of 2 to 18 hertz; chirps, at a dominant frequency of 8 to 14 hertz; and, barks, at a dominant frequency of less than 0.5 to 3 hertz (Richardson et al. 1995).

The short-beaked common dolphin is also subject to bycatch. It has been caught in gillnets, pelagic trawls, and during longline fishery activities. During 1997 to 2000, 190 dolphins were killed each year by human activities. Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as "non-strategic" (Waring et al. 2004).

Harbor Porpoise (Phocoena phocoena)

This dark gray/dark brown porpoise has a blunt snout and is 4 to 6 feet (1.2 to 1.8 meters) long. They inhabit shallow, coastal waters, often found in bays, estuaries, and harbors. In the western Atlantic, they are found from Cape Hatteras north to Greenland. They are common visitors to Massachusetts Bay during September through April. During the spring, they are found from the Bay of Fundy to south of Cape Cod. They concentrate in southwestern Gulf of Maine, Great South Channel, Jeffrey's Ledge, and coastal Maine during the mid-spring months. After April, they migrate north towards the Gulf of Maine and Bay of Fundy. They generally eat small schooling fishes such as mackerel, herring, and cod, as well as worms, squid, and sand eel (ACSonline 2004; NMFS 1993). Harbor porpoises are known to vocalize through clicks, which are produced at a frequency range of 0.5 to 25 kilohertz, with a dominant frequency of 1 to 6 kilohertz and a source level of 160 dB re 1 μPa at 1m (Richardson et al. 1995). According to the species stock report, the population estimate for the Gulf of Maine/Bay of Fundy harbor porpoise is 89,700 individuals (Waring et al. 2004).

The most common threat to the harbor porpoise is from incidental mortality from fishing activities, especially from bottom-set gillnets. It has been demonstrated that the porpoise echolocation system is capable of detecting net fibers but they must not have the "system activated" or else they fail to recognize the nets (Reeves et al. 2002). Roughly 365 harbor porpoises are killed by human-related activities each year. In 1999, a Take Reduction Plan to reduce harbor porpoise bycatch in United States Atlantic gillnets was implemented. The plan that pertains to the Gulf of Maine focuses on sink gillnets and other gillnets that can catch groundfish in New England waters. The ruling implements time and area closures, some of which are complete closures, as well as requiring pingers on multispecies gillnets. In 2001, the harbor porpoise was removed from the candidate species list for the Endangered Species Act of 1973; a review of the biological status of the stock indicated that a classification of "Threatened" was not warranted (Waring et al. 2004). The species was recently downgraded in 2002 from a NMFS rating of "strategic" to "non-strategic" because its current average annual fishery-related mortality and serious injury does not exceed its potential biological removal (Waring et al. 2002).

Killer Whale (Orcinus orca)

The black-and-white killer whale is the largest member of the dolphin family, roughly 22 to 30 feet (6.7 to 9.1 meters) long and nearly 9,000 pounds (4,080 kilograms), and is found in all of the oceans in the world with highest densities in the high latitudes Wilson and Ruff 1999). They do not maintain a regular migration route because they generally migrate towards viable food supplies, which is likely to be schools of bluefin tuna. They are seen in the southwestern Gulf of Maine from mid-July to September. Killer whales have been found to overwinter in the Gulf of Maine and are frequently seen on Jeffreys Ledge, between the Isles of Shoals and Stellwagen Bank (NMFS 1993). They feed on a variety of fish, including tuna, herring, and mackerel, and have also been known to attack seals, seabirds, and other cetaceans such as large baleen and sperm whales (NMFS 1993, Blaylock et al. 1995). According to the species stock report, the population estimate for the western North Atlantic stock of killer whales is unknown (Baylock et al. 1995).

Killer whales produce two types of signals, whistles and pulsed calls. Whistles are produced at a frequency range of 1.5 to 18 kilohertz, with a dominant frequency of 6 to 12 kilohertz. Pulsed calls are produced at a frequency range of 0.5 to 25 kilohertz, with a dominant frequency of 1 to 6 kilohertz and a source level of 160 dB re 1 µPa at 1m (Richardson et al. 1995).

The killer whale is not endangered, although whaling or live-capture operations have depleted some regional populations. They are threatened by pollution, heavy ship traffic, and possibly reduced prey abundance. "There have been no observed mortalities or serious injuries by NMFS Sea Samplers in the pelagic drift gillnet, pelagic longline, pelagic pair trawl, New England multispecies sink gillnet, mid-Atlantic coastal sink gillnet, and North Atlantic bottom trawl fisheries" (Blaylock et al. 1995). Recent evidence has also indicated that they are subject to biomagnification of toxic substances (ACSonline 2004). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as "non-strategic" (Blaylock et al. 1995).

Long-Finned Pilot Whale (Globicephala melas)

The long-finned pilot whale is black to coal gray, 10 to 20 feet long, and has a distinct rounded head with a slight beak. They generally stay along the continental shelf edge (a depth of 330 to 3,300 feet; 100 to 1000 meters), choosing areas of high relief or submerged banks in cold or temperate shoreline waters. The Southern subspecies is circumpolar with northern limits of Brazil and South Africa. The North Atlantic subspecies ranges from North Carolina to Greenland (Reeves et al. 2002, Wilson et al. 1999). In the western North Atlantic, long-finned pilot whales are pelagic, occurring in especially high densities in winter and spring over the continental slope, then moving inshore and onto the shelf in summer and autumn following squid and mackerel populations (Reeves et al. 2002). They frequently travel into the central and northern Georges Bank, Great South Channel, and Gulf of Maine areas during the summer and early fall (May and October) (NMFS 1993). According to the species stock report, the population estimate for the Gulf of Maine/Bay of Fundy harbor porpoise is 14,524 individuals (Waring et al. 2004).

They feed preferentially on squid but will eat fish (e.g., herring) and invertebrates (e.g., octopus, cuttlefish) if squid are not available. They also ingest shrimp (particularly younger whales) and various other fish species occasionally. These whales probably take most of their prey at depths of 600 to 1,650 feet (200 to 500 meters), although they can forage deeper if necessary (Reeves et al. 2002).

They are a very social species and swim in pods of roughly 20 individuals. These small pods are thought to be formed around adult females and their offspring. Behaviors of long-finned pilot whales range from quiet rafting or milling on the surface, to purposeful diving, to bouts of playfulness. Long-finned pilot whales produce two types of signals, whistles and clicks. Whistles are produced at a frequency range of 1 to 8 kilohertz, with a dominant frequency of 1.6 to 6.7 kilohertz. Clicks are produced at a frequency range of 1 to 18 kilohertz (Richardson et al. 1995).

The long-finned pilot whales are subject to bycatch during gillnet fishing, pelagic trawling, longline fishing, and purse seine fishing. Approximately 215 pilot whales were killed or seriously injured each year by human activities during 1997 to 2001. Strandings involving hundreds of individuals are not unusual and demonstrate that these large schools have a high degree of social cohesion (Reeves et al. 2002). The species is rated as "strategic" by NMFS because the 1997 to 2001 estimated average annual fishery-related mortality exceeds the potential biological removal (Waring et al. 2004).

Risso's Dolphin (Grampus griseus)

Risso's dolphins are dark gray with extensive white scarring. They are 9 to 13 feet (2.7 to 4.0 meters) long and are usually found in offshore warm temperate and tropical waters of all oceans and large seas. In some areas, or possibly seasonally, they occupy a very narrow niche of the steep upper continental slope, where water depths usually exceed 1,000 feet (300 meters) (Reeves et al. 2002). They also move onto the shelf occasionally in response to squid availability. Although seasonal shifts in density occur, clear migratory patterns have not been defined. They normally stay outside of the 100-foot (30-meter) contour, south of Cape Cod, and are only occasional visitors to Massachusetts Bay. According to the species stock report, the population estimate for the western North Atlantic stock of Risso's dolphin is 29,110 (Waring et al. 2002).

Risso's dolphins are usually seen in groups of 12 to 40 individuals. Loose aggregations of 100 to 200, or even several thousand, are seen occasionally (Reeves et al. 2002). They can be playful and acrobatic during interludes of rest near the surface, with breaching and tail slapping fairly common.

They are squid specialists but occasionally consume other cephalopods (octopus and cuttlefish) but they will eat fish or crustaceans if squid is not available (ACSonline 2004; NMFS 1993; Waring et al. 2002; Reeves et al. 2002). Much of their feeding takes place at night, possibly because some prey species migrate toward the surface at that time.

Risso's dolphins produce two types of signals, whistles and rasp/pulsed burst. Whistles are produced at a dominant frequency of 3.5 to 4.5 kilohertz. Rasp/pulsed bursts are produced at a frequency range of 0.1 to 8 plus kilohertz, with a dominant frequency of 2 to 5 kilohertz (Richardson et al. 1995).

Risso's dolphin appears abundant, widely distributed, and not immediately threatened globally (Reeves et al. 2002). The biggest threats to Risso's dolphins are entanglement in fishing gear and pollution from coastal development (ACSonline 2004). They are also subject to bycatch by getting caught in gillnets and during trawling activities. During the years 1996 to 2000, 51 Risso's dolphins were killed or seriously injured (Waring et al. 2002). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as "non-strategic" (Waring et al. 2004).

Striped Dolphin (Stenella coeruleoalba)

The striped dolphin is dark blue gray with black stripes running the body length; is 6 to 8 feet (1.8 to 2.4 meters) long; and is found in warm, temperate, tropical, and subtropical waters. Its northern limits are Newfoundland and southern Greenland. There are numerous populations of striped dolphins that are more or less isolated from one another. The species prefers pelagic waters along the edge of the continental shelf. They are not seen often, or in large numbers, landward of the continental shelf edge but become common in deeper slope waters. They are only occasional visitors to Massachusetts Bay. According to the species stock report, the population estimate for the western North Atlantic stock of striped dolphins is 61,546 (Waring et al. 2000).

Striped dolphins travel in dense schools that average about 100 animals but can contain as many as 500 (Reeves et al. 2002). Some schools have only adults, some only juveniles, and some both adults and juveniles. They have a fairly diverse diet but generally feed on fish less than 5 inches (13 centimeters) long and cephalopods less than 8 inches (20 centimeters) long (in dorsal mantle length) (NMFS 1993; Ward 2000; Reeves et al. 2002). They take prey anywhere in the water column as long as it occurs in large, dense schools. Striped dolphins communicate through whistles, which are produced at a frequency range of 6 to about 24 hertz, with a dominant frequency of 8 to 12.5 hertz (Richardson et al. 1995).

Striped dolphins remain abundant on a global scale but there is concern about the species impacts from fishing activities including overfishing and habitat degradation, and stress from food shortages. The biggest threats to striped dolphins are entanglements in gillnets and trawling nets. Approximately seven striped dolphins were killed each year by fishery-related incidents during 1994 to 1998 (Waring et al. 2000). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2000).

White-Beaked Dolphin (Lagenorhynchus albirostris)

The white-beaked dolphin is black with gray and white patches, 8 to 10 feet (2.4 to 3.0 meters) long, and is only found in the North Atlantic from the waters of southern New England north to western and southern Greenland and Davis Straits. They are more common in European than American waters. Populations in eastern and western Atlantic waters are morphologically distinct and therefore probably do not often mix. In summer, they are found in subarctic and artic waters that are ice-covered or at least ice-infested, but in winter, they move away from enclosed areas and away from shore by winter ice formation. They are often victims of ice entrapment in Newfoundland. According to the species stock report, the current abundance for the western North Atlantic stock of white-beaked dolphins is unknown, because the species has not been sighted during stock assessment surveys (Waring et al. 2004).

They usually utilize the northern end of Stellwagen Bank between April to November, feeding on sand eels and squid. They were once more common in the Gulf of Maine but in the mid-1970s, were displaced by Atlantic white-sided dolphins (Kenney et al. 1996). They are typically seen in groups of 5 to 50 and occasionally in schools of several hundred (Reeves et al. 2002). White-beaked dolphins are attracted to powered vessels, are active bow riders, and can be acrobatic above the surface. They frequently associate with feeding Fin and Humpback Whales, and sometimes with other dolphins (Reeves et al. 2002). White-beaked dolphins communicate through squeals, which are known to be produced at a dominant frequency of 8 to 12 hertz (Richardson et al. 1995).

A pronounced decrease in abundance has occurred since the early 1970s off the northeastern United States, while there seem to be increases in some areas off northwestern Europe (Reeves et al. 2002). The biggest threat to white-beaked dolphins is entanglement in gillnets. All of these incidents were recorded in Canada; there is no evidence of fishery-related mortality or serious injury to this stock in the United States Exclusive Economic Zone (EEZ) (Waring et al. 2004). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2004).

Non-Endangered or Threatened Baleen Whales

Minke Whale (Balaenoptera acutorostrata)

Minke whales, black to dark gray on top and white on the bottom, are 15 to 30 feet (4.5 to 9.0 meters) long and are the smallest of the baleen whales. They are among the most widely distributed of all the baleen whales. They occur in the North Atlantic and North Pacific, from tropical to polar waters. Currently, scientists recognize two subspecies of the so-called “common” Minke whale: the North Atlantic Minke and the North Pacific Minke. Generally, they inhabit warmer waters during winter and travel north to colder regions in summer, with some animals migrating as far as the ice edge. They are frequently observed in coastal or shelf waters and in the Massachusetts area, have been recorded in the shallow waters of Stellwagen Bank and southern Jeffrey’s Ledge from April until October. According to the species stock report, the population estimate for the Canadian east coast stock of minke whales is 4,018 individuals (NMFS 1993; Waring et al. 2004; Weinrich et al 2005; Wilson et al. 1999).

Minke whale abundances reach their highest level in late summer/early fall and is commonly associated with a rise in the fin whale population. As is typical of the baleen whales, Minke whales are usually seen either alone or in small groups, although large aggregations sometimes occur in feeding areas (Reeves et al. 2002). Minke populations are often segregated by sex, age, or reproductive condition. Known for the curiosity, Minkes often approach boats.

They feed on schooling fish (i.e., herring, sand eel, capelin, cod, pollack, and mackerel), invertebrates (squid and copepods), and euphausiids. Minke whales basically feed below the surface of the water and calves are usually not seen in adult feeding areas.

Minke whales utilize many different types of vocalizations such as, down sweeps, upsweeps, grunts, clicks, thump trains, and ratchet sounds. Thump trains are believed to contain individual signature information. They last over one minute, are composed of 50 to 70 millisecond thumps, and have energy

Table 4.8-2. Sounds Produced by Minke Whales

Signal Type	Frequency Range (Hz)	Dominant Frequency (Hz)	Source Level (dB re 1 μPa at 1 m)
Down sweeps	60 to 130		165
Moans, grunts	60 to 140	60-140	151 to 175
Ratchet	850 to 6000	850	
Clicks	3300 to 20,000	<12,000	151
Thump trains	100 to 2000	100-200	

Source: Richardson et al. 1995.

at 100 to 200 hertz. They are believed to use sounds to help identify each other and to maintain spacing (Richardson et al. 1995). Typical sounds produced by minke whales are listed in Table 4.8-2.

Minke whales are impacted by ship strikes and bycatch from gillnet and purse seine fisheries. Approximately four minke whales were killed or seriously injured per year by human means during 1997 to 2001, with an average annual mortality from ship strikes of 0.2 (Waring et al. 2004). In addition, hunting for Minke whales continues today, by Norway in the northeastern North Atlantic and by Japan in the North Pacific and Antarctic (Reeves et al. 2002). International trade in the species is currently banned. Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2004).

Non-Endangered or Threatened Seals

Gray Seal (Halichoerus grypus)

Gray seals are gray, brown, and silver in coloration and inhabit both sides of the North Atlantic in both the temperate and subarctic waters (Morris 2004). Scientists recognize three primary populations of this species, all in the northern Atlantic Ocean. The gray seals that reside in Nantucket Sound are part of the eastern Canada stock, which can be found from northernmost Cape Chidley in Labrador to most recently Long Island Sound (Katona et al. 1993). Gray seals form colonies on rocky island or mainland beaches, though some seals give birth in sea caves or on sea ice, especially in the Baltic Sea. Gray seals prefer haulout and breeding sites that are surrounded by rough seas and riptides where boating is hazardous. Pupping colonies have been identified at Muskegat Island (Nantucket Sound), Monomoy National Wildlife Refuge, and in eastern Maine (Rough 1995). According to the species stock report, the population estimate for the western North Atlantic stock of gray seals is 143,000, but the Massachusetts population was reported as greater than 5,600 in 1999 (NMFS 1993; Waring et al. 2004).

Gray seals are gregarious, gathering to breed, molt, and rest in groups of several hundred or more at island coasts and beaches or on land-fast ice and pack-ice floes. They are thought to be solitary when feeding and telemetry data indicates that some seals may forage seasonally in waters close to colonies, while others may migrate long distances from their breeding areas to feed in pelagic waters between the breeding and molting seasons (Reeves et al. 2002). Gray seals molt in late spring or early summer and may spend several weeks ashore during this time. When feeding, most seals remain within 45 miles (72 kilometers) of their haulout sites. They generally feed on fish (i.e., skates, alewife, sand eel, and herring) and invertebrates.

Gray seals utilize vocalizations to establish and maintain the mother-pup bond. Gray seals produce two types of sounds, clicks and underwater call sounds. Two types of clicks are produced, isolated and cluster, at 0 to 30 kilohertz and hisses at 0 to 40 kilohertz. In addition, seven underwater call types are produced during the breeding season. Six of the calls are 0.1 to 5 kilohertz with a dominant frequency of 0.1 to 3 kilohertz, and knocks up to 16 kilohertz, with a dominant frequency of up to 10 kilohertz (Richardson et al. 1995).

The biggest threats to gray seals are entanglements in gillnets or plastic debris (Waring et al. 2004). Approximately 300 gray seals were killed each year by human activities during 1997 to 2001 (Waring et al. 2004). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2004).

Harbor Seal (Phoca vitulina)

Harbor seals are the most abundant seals in eastern United States waters. They have spotted coats that can be silver-gray to black or dark brown. They are found in all nearshore waters of the Atlantic Ocean and adjoining seas above northern Florida, however their “normal” range is probably only south to New Jersey. In the western North Atlantic, they inhabit the waters from the eastern Canadian Arctic and Greenland, south to southern New England and New York, and occasionally as far south as South Carolina. Some seals spend all year in eastern Canada and Maine, while others migrate to southern New England in late September and stay until late May. According to the species stock report, the population estimate for the western North Atlantic stock of harbor seals is 99,340 (Marine Mammal Center 2002; NMFS 1993; Waring et al. 2004).

Harbor seals forage in a variety of marine habitats, including deep fjords, coastal lagoons and estuaries, and high-energy, rocky coastal areas. They may also forage at the mouths of freshwater rivers and streams, occasionally traveling several hundred miles upstream (Reeves et al. 2002). They haul out on sandy and pebble beaches, intertidal rocks and ledges, and sandbars, and occasionally on ice floes in bays near calving glaciers.

Except for the strong bond between mothers and pups, harbor seals are generally intolerant of close contact with other seals. Nonetheless, they are gregarious, especially during the molting season, which occurs between spring and autumn, depending on geographic location. They may haul out to molt at a tide bar, sandy or cobble beach, or exposed intertidal reef. During this haulout period, they spend most of their time sleeping, scratching, yawning, and scanning for potential predators such as humans, foxes, coyotes, bears, and raptors (Reeves et al. 2002). In late autumn and winter, harbor seals may be at sea continuously for several weeks or more, presumably feeding to recover body mass lost during the reproductive and molting seasons and to fatten up for the next breeding season (Reeves et al. 2002).

Harbor seals are opportunistic feeders feeding on squid and small schooling fish (i.e., herring, alewife, flounder, redfish, cod, yellowtail flounder, sand eel, and hake). They spend about 85 percent of the day diving, and much of the diving is presumed to be active foraging in the water column or on the seabed. They dive to depths of about 30 to 500 feet (10 to 150 meters), depending on location.

Male harbor seals are usually silent when alone or with pups but will vocalize when they are within a group. Sexually mature males are more vocal than females. Air vocalizations coupled with visual signals are used to establish dominance and to protect their territory. Airborne and underwater calls are individually distinct and are used by the mother to recognize and maintain contact with her pup. The frequency of the airborne calls is 350 hertz. Underwater calls are similar; however, the lower harmonics are absent and there is a shift to higher frequencies (Richardson et al. 1995).

Historically, these seals have been hunted for several hundred to several thousand years. Harbor seals are still killed legally in Canada, Norway, and the United Kingdom to protect fish farms or local fisheries (Reeves et al. 2002). According to the stock assessment reports, 955 seals are taken in gillnets each year. The other human-caused mortalities, in order of frequency, were "other" (6.1), non-observed fishery-related (4.8), power plant entrainment (4.4), and boat strikes (1.6).

Approximately 1,000 harbor seals were killed each year by these during 1997 to 2001 (Waring et al. 2004). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as "non-strategic" (Waring et al. 2004).

4.8.3 Impact Analysis

4.8.3.1 Construction

Many of the activities proposed for the Project, including most of the Pipeline Lateral activities, occurred during the recent construction of the HubLine. During the permitting process for the HubLine, Algonquin undertook extensive consultation with NOAA-Fisheries staff to ensure that the project would not adversely affect marine mammals. As a result of that consultation and the understanding of offshore pipeline construction procedures, the HubLine Project was not subject to extensive mitigation measures for items such as anchor cables, vessel speeds, or continuous monitoring. Northeast Gateway and Algonquin have initiated similar consultation processes for the Project.

Port construction will occur about two miles to the west of the federally designated SBNMS. Pipeline construction will occur in two of the Massachusetts State Ocean Sanctuaries, North Shore Ocean Sanctuary (NSOS) and South Essex Ocean Sanctuary (SEOS), and less than three miles to the west of the SBNMS. These areas have been designated because of the habitats they provide to many species, including marine mammals.

Physical Impacts

During the establishment of the mooring anchors, flowline, and PLEM, the seafloor will be disturbed throughout a 5.4-acre (2.2-hectare) portion of the seafloor for the two buoys. Pipeline construction activities that disrupt the sea floor include laying the pipeline, trenching, backfilling, and completing the final tie-ins to the HubLine and to the Port flowlines. This disruption may temporarily increase the water turbidity in the Project area (see Section 4.4.3). However, the turbidity increase is likely to be limited to the lower portion of the water column and will not rise in significant amounts to the photic zone. No increase in surface water turbidity is expected, therefore no impacts are expected on phytoplankton production or zooplankton in the area (see Section 4.5.3). Because turbidity levels will not impact primary production in surface waters, no decrease in production at higher tropic levels such as zooplankton and pelagic fish, upon which the marine mammals feed, is expected**.** Alterations of mid-water turbidity are expected to be minor and short-lived, comparable to the water column turbidity caused by a winter storm, from which phytoplankton communities recover rapidly. Therefore, it is unlikely that turbidity alteration due to Project construction will have a significant harmful effect on the food chain leading to marine mammals.

During construction there is also a potential to disturb contaminated bottom sediments (see Section 4.4.3), rendering a fraction of the chemical contaminants available to water-column organisms. The only possible route of uptake of contaminants by marine mammals is through food consumption; contaminants are not absorbed through the skin and marine mammals do not drink large quantities of seawater. Contaminants that may be mobilized by construction activities may accumulate in the food chain, leading to the marine mammals, but this is expected to have a very low probability of occurrence.

In addition, it is expected that contaminant mobilization by sediment disturbance during buoy and anchor construction will be minimal. This assumption will be verified with the analysis of sediment cores taken throughout the area (see Section 4.2.3). The only indication that disposal of dredged material has occurred along the Pipeline Lateral route are two locations with mounds of coarse rocky material in the MP 13 to 16 area which is north of and beyond the Port buoy anchor arrays. A sediment chemistry sampling and analysis effort has been undertaken and results are expected to be available by mid-summer 2005 (see Section 4.3). If results reveal elevated levels of contaminants in sediments in Port area or along the Pipeline Lateral, Northeast Gateway or Algonquin will consult with NMFS and MDEP to determine an acceptable course of action.

Marine mammal behavior modification during construction is likely to be minimal because the changes in the environment in the immediate vicinity of the Port are minimal and do not impact migration cues (e.g., topography of ocean floor, chemical changes in the water, and magnetic sensing; LTG Limited n.d.).

The principal construction process for the Pipeline Lateral involves creation of a trench using a plow that will turn over bottom sediments and push them to the sides of the trench while the pipeline lowers in the trench. After the pipeline has been lowered in the trench it will be backfilled. In short sections where the pipeline cannot be buried, imported rock, concrete mats, or sand/cement bags will be used to cover the pipeline. There will be some physical alteration of bottom texture and topography, but this is expected to be localized and mimic the variety of substrates and topography found within western Massachusetts Bay, and therefore will not likely affect marine mammal navigation in these shallow, near-shore waters.

Habitat Loss

The marine mammals that frequent the proposed Project area do not use seafloor habitat at the depths of the Port installation. Therefore, there will be no direct loss of habitat for marine mammals. Marine mammals which normally feed in the water column of the Project area will likely be disturbed by the construction activities and avoid the area during construction (Richardson et al. 1995).

The marine mammals that frequent the proposed Pipeline Lateral might temporarily experience a loss of a small amount of habitat during the construction of the pipeline, but these habitats are expected to recover from construction activities and the marine mammals are expected to return once the construction is completed. The water column habitat these marine mammals primarily use will not be affected by construction other than some short term and localized bottom-oriented increased turbidity. The marine mammals will have full access to nearby habitats, therefore, this temporary loss will not affect them.

Noise

Most marine animals can perceive underwater sounds over a broad range of frequencies from about ten hertz to more than 10,000 hertz (ten kilohertz). Many of the dolphins and porpoises use even higher frequency sound for echolocation and perceive these high frequency sounds with high acuity. Marine mammals respond to low-frequency sounds with broadband intensities of more than about 120 dB re 1 μPa, or about 10 to 20 decibels above natural ambient noise at the same frequencies (Richardson *et al.* 1991).

Installation of Port facilities will involve three vessels during construction and one during backfilling of the trench (see Section 2.3.9, Construction Vessel Traffic). All three vessels will continuously produce a low level of engine noise because they are dynamically positioned and not anchored during construction. Pipeline construction will involve multiple vessels such as tugs, barges, plow vessels, and lay vessels (see Section 2.4.14). The barges, which should be the largest vessels used during pipeline construction, do not have engines and are towed by tugs. The tugs used during pipeline construction for barge handling will increase the amount of underwater noise while pulling the barges. The frequency and source level of noise will increase as the tug pulls heavier barges (those that are loaded vs. unloaded) (Richardson et al. 1995).

In addition, the machines (cranes, winches, and stingers), construction activities (welding and sand blasting), and living activities (lights and cooking) on the vessels and on the barges will require generators, which create their own level of noise, a small fraction of which is transferred into the water column.

Vessel noises, caused by the turning of the screws, engine noises, and noises of operating machinery on board, generally fall in the frequency (pitch) range of 5 to 2,000 hertz, with highest intensities below 100 hertz (Scrimger and Heitmeyer 1991). Pipeline Lateral construction activities, such as post-lay jetting, have been recorded in the past to create broadband sounds; the strongest was below ten hertz and reaching frequencies as high as 500 hertz (Richardson et al. 1995). Vessels the size of the Port AHV and DSV and the tugs used during Pipeline Lateral construction and their onboard machinery usually generate sound intensities of 160 dB re 1 µPa at 1 meter or less. Marine mammals within a few kilometers of Project construction activities will be able to detect the underwater sounds produced by these operations.

The intensity of these sounds is well below the intensity associated with injury to the hearing of cetaceans, but is sufficient to cause temporary behavior modification. Most marine mammals expected to be found within the Project area were found to habituate rapidly to low-level underwater sounds and were able to distinguish the sounds they generate for communication from noise generated by human activities (Richardson et. al. 1995).

Recent studies have documented a change in the distribution of marine mammals in areas with increased whale-watching activities (Jelinski et al. 2002; Erbe 2002). Therefore, the increase in noise level is expected to have the same impact and will dissuade marine mammals from entering the Project area. The intensity of underwater sounds from Project construction is expected to be too low to interfere significantly with communication among the marine mammals. There is a possibility that the AHV, DSV, or tugs will produce the same noise levels usually produced with fishing boats. Thus, there is a possibility that these vessels might attract marine mammals to the area, especially those that have learned to follow fishing boats for their discards. If these vessels produce noises similar to those of whale-watching vessels, the noise could dissuade marine mammals from coming into the area (Jelinski et al. 2002).

Although not anticipated, if blasting is determined to be required along the Pipeline Lateral route as a result of ongoing geophysical and geotechnical surveys, Algonquin will prepare a Blasting Mitigation Plan in consultation with NOAA-Fisheries. Algonquin prepared this type of plan as part of the recent HubLine and this program was successfully implemented during blasting operations. No blasting is expected to be required for Port installation.

Vessel Collision

It has been documented that two ships operating in proximity induce hydrodynamic forces on each other that can lead to collisions. These forces increase with ship speed and size. Some studies have indicated that whales, when exposed to the hydrodynamic forces of large ships, may be drawn into the path, thus colliding with the ship (Knowlton et al. 1995). Project construction vessels are expected to make approximately 209 round trips between the construction sites and local ports. However, no large ships will be used during Project construction, and these forces are highly unlikely to develop.

Vessel collisions are more of a threat to baleen whales than any other marine species (Wiley et al. 1995). Research indicates that most vessel collisions with whales resulting in serious injury or death, occur when a ship is traveling over speeds of 14 knots (Laist et al. 2001). Ship speed, which seems to be the greatest factor in vessel collisions, is likely to be low during construction activities using barges and tugboats, (except for the smaller crew/supply boats which can travel at speeds up to 15 knots). Thus, considering most whale species will easily be able to maneuver around the vessels being used for construction of the Project, and their habit of avoiding areas with vessels due to increased ambient noise, the likelihood of a collision is low.

During construction of the Project, marine mammal activity in the Project area will be monitored to ensure that the chances for possible collisions are minimized. Environmental training of construction personnel will stress individual responsibility for marine mammal awareness and reporting. All personnel onboard construction vessels will receive training, a component of which will be training on marine mammal sighting and reporting. Sightings will be reported to the environmental inspector for a determination of the appropriate response.

Entanglements

Entanglement in gear is another possible threat to marine mammals. However, marine mammals are not expected to become entangled in the buoy mooring lines because the anchor cable is 6 inches (15 cm) in diameter and the retrieval line is 4 inches (10 centimeters) in diameter. If guidelines or other smaller lines are used during construction, entanglements could occur. Based on the expected period of construction and the present plan of construction, it is not likely that entanglements will occur.

Most whale entanglements have occurred with set nets, lobster trap lines, and long lines. Studies show that entanglement in bottom trawls is rare and non-endangered species of whales have not been found entangled because of bottom trawl activities. The Pipeline Lateral construction (PLP and BFP) activities mimic bottom trawl fishery activities. During construction, the plow will be dragged across the sea floor by a towing cable and control umbilical that travel from the plow to the towing vessel. The cross-section and configuration of this steel cable (3 to 4 inches; 7 to 10 centimeters) will make it easier to detect by whales than lines from bottom trawls. In addition, the plow and BFP cable is typically less than 100 to 300 tons of pulling force and in this taut condition is unlikely to result in entanglement. Similarly, the 8 to 12 steel anchor cables used on the pipelay, plow, and BFP barges are typically 2 to 3 inches (5 to 7 centimeters) in diameter and also typically under significant tension while deployed, thereby minimizing the potential for entanglement.

Fuel Spills

Fuel spills, resulting from refueling during construction, were they to occur, will be relatively small. If a fuel spill occurs, marine mammals will likely move away from the most concentrated areas and the presence of the vessels involved in spill control and cleanup will discourage the presence of marine mammals.

Both Northeast Gateway and its contractors and Algonquin and its contractors will maintain individual SPCC Plans in place during construction.

4.8.3.2 Operation

The Pipeline Lateral will not result in any operational impacts unless maintenance is required.

EBRV Approach and Departure

Port operation is expected to result in approximately one EBRV trip inbound and outbound per week. Additional support vessels trips from Boston Harbor or Gloucester, Massachusetts are also expected at a rate of one to two per week. Vessel speed is limited in the vicinity of the Port to 3 knots from 1.86 miles out (3 kilometers) and to less than 1 knot from 1,640 feet (500 meters) in to the Port. Vessel speed outside the 3-kilometer limit and within identified critical North Atlantic Right Whale critical habitat will not exceed 13 knots. Vessel collisions with marine mammals are thus much less likely to occur, since most vessel collisions have been shown to occur over speeds of 14 knots (Laist et al. 2001). The Port is located directly to the east of the South Essex Ocean Sanctuary and to the west of Stellwagen Bank National Marine Sanctuary. On their way to the Port, EBRVs will travel through areas that are highly utilized by marine mammals. This will likely increase the possibility of a marine mammal vessel strike, but reduced vessel speeds and trained marine mammal observers on the vessels will be used to reduce this possibility.

NOAA is currently working towards a Ship Strike Reduction Strategy, which would directly impact the speeds of the vessels within the Massachusetts Bay area. Northeast Gateway is willing to voluntarily comply with the following two measures that are proposed by NOAA for reducing ship strikes to whales:

If ship is routed in through the Off Race Point area (ORP), including a portion of the Boston TSS, then from April 1 to May 15, ship speed will be held in the ORP to 13 knots or less; and

Route ships around the Great South Channel (GSC) area April 1 to July 31 each year.

If a vessel collision is observed with any marine animal, it is the Master's responsibility to report the accident to the USCG.

Training of EBRV personnel will stress individual responsibility for marine mammal awareness and reporting as required by IMO regulations. All individuals onboard the EBRVs will receive training, a component of which will be training on marine mammal sighting and reporting.

Entanglements

When the EBRV arrives onsite, it will use a grapnel hook to recover the line from the sea surface buoy. The grapnel hook is attached to a traction winch located on the bow of the EBRV adjacent to and above the STL turret compartment. Once retrieved, the buoy is winched into the turret compartment and locked into place. A flexible riser and the connected flowline will be raised along with the mooring chains and wire rope.

The design of the STL™ buoy system includes anchor lines and recovery lines throughout the water column. Marine mammals are not expected to become entangled in these lines because the anchor chain is 18 inches (46 centimeters) in diameter, the anchor cable is 6 inches (15 centimeters) in diameter, and the retrieval line is 4 inches (10 centimeters) in diameter. In addition, it is the responsibility of the crew on the EBRV to watch for marine mammals in the area to avoid any possibilities of entrapping a marine mammal.

Habitat Disturbance

While the EBRV is on buoy, constant natural gas offloading will occur along with normal vessel operations. During the time that each EBRV is on buoy, a maximum of about 42 acres of seafloor habitat will be disturbed by the anchor chain sweep. The seafloor is fine sediment in the vicinity of the Port and is 270 to 290 feet (82 to 88 meters) deep. This is below the photic zone and does not serve as habitat for prey species of any marine mammal. Therefore, this seafloor disturbance will not adversely impact marine mammals (see Sections 4.5.3, 4.6.3, and Appendix 4.6-1).

It is expected that up to 54 million gallons of seawater will be pumped aboard and subsequently discharged daily after use for normal vessel operations not associated with the regasification process by each EBRV at the Port. An additional 13 million gallons of seawater will be taken aboard as ballast water during the 7-day regasification process and not discharged in the Project area. Phytoplankton and zooplankton populations will be entrained into the water from the area surrounding the vessel, but this effect is expected to be minimal (see Section 4.5.3). Species that feed on phytoplankton and zooplankton will likely disperse from the area directly around the vessel in search of food. Therefore, this loss in plankton is expected to have an insignificant impact on marine mammals.

The design of the buoy system may make movement around the area difficult for larger marine mammals because they are not as dexterous as the smaller and medium-sized cetaceans. However, due to increases in noise levels in the surrounding area (see Noise section below), marine mammals are expected to avoid the buoy area.

Noise

As stated in Sections 4.15.3.1 and 4.15.3.2, it is expected that the ambient noise level will increase due to the increase in ship traffic. This will result in an increase in avoidance of the area by marine mammals. Studies have reported a change in the distribution and behavior of marine mammals in areas with increased whale-watching activities and vessel traffic (Erbe 2002; Jelinski et al. 2002; Nowacek 2004). This could prove beneficial for these species because they are less likely to be struck by oncoming vessels if they are not within the buoy area.

Noises produced by EBRVs, while regasifying LNG at the Port, will be above normal ambient noise levels (Section 4.1.3.2) throughout the waters within one kilometer of the EBRV, with the highest levels occurring off the bow. Some of these levels are slightly above the designated MMPA harassment for continuous sound (120 dB) (NMFS et al. 2005). Therefore, the noise produced by offloading EBRV is high enough to expect a disruption in the behavior of marine mammals, with avoidance of the area being the biggest impact.

Marine Debris

It is expected that it will take approximately 7 days to offload a full EBRV, increasing the chances that some marine debris may enter the environment. During this time, each member of the crew will be responsible for ensuring that debris is not discharged into the marine environment.

Fuel Spill

The EBRV cargo tank is a double containment tank. Based on the LNG carrier operator history (Section 4.17.2.1 and EBRV design (Section 4.17.2), a failure of one of the containment tanks is highly improbable. There are Standard Operating Procedures in place to prevent/mitigate any LNG leaks. While LNG is being regasified or while regasified natural gas is pumped into the pipeline, there is a slight possibility of leaks, spills, and ruptures. Section 2.5.9 describes emergency response procedures in place. Section 2.5.11 describes monitoring, lead detection, and spill prevention measures.

The density of natural gas is lower than that of seawater and air; therefore, a layer of natural gas on the sea surface would not form or remain for very long. LNG spilled on water would also vaporize quickly and disperse, but could temporarily pool. The likelihood of this event occurring is very small because there is a very small possibility of a leak of size sufficient to form a pool of LNG on the surface of the water. If a fuel spill occurs, marine mammals will likely move away from the most concentrated areas and the presence of the vessels involved in the spill control and cleanup will discourage the presence of marine mammals.

There is also the possibility that fuel used for EBRV propulsion or auxiliary/emergency generators could spill or leak. Fuel on EBRVs is protected by the vessel's double hull. All vents on the EBRVs fuel tanks are fitted with spill containment systems to prevent the discharge of fuel during offloading. The low likelihood of fuel spills minimizes the risk of this type of impact. Refueling will occur only at specialized fueling or bunkering docks and not at sea or at the Northeast Port. In addition each EBRV will maintain a SOPEP as required by international convention.

4.8.4 Mitigation Measures

Northeast Gateway

- During construction, individual crew members will be responsible for ensuring that debris is not discharged into the marine environment.
- Northeast Gateway and its contractors will maintain individual SPCCPs in place for construction vessels during construction.
- Refueling will not occur while the EBRV is on buoy. In addition each EBRV will maintain a SOPEP as required by international convention.

- Prior to initiation of construction work, all crew members on barges, tugs and support vessels, will undergo environmental training, a component of which will be to review the procedures regarding sighting of marine mammals and sea turtles.
- Northeast Gateway and Algonquin commit to having at least one full time environmental inspector on the project during construction. The individual will be experienced with offshore construction and will have experience with marine mammal and sea turtle issues. This environmental inspector will be notified immediately if any marine mammal or sea turtle is sighted in the area.
- During construction of the Pipeline Lateral, the environmental inspector will have stop work authority through the "chief inspector" or vessel "superintendent."
- If a marine mammal or sea turtle is sighted by a crew member, an immediate notification is made to the vessel superintendent and to Algonquin's or Northeast Gateway's craft inspector (present on every major vessel). The environmental inspector will then be notified to ensure that the required reporting procedures are followed.
- While under way, all construction vessels will remain 500 yards (457 meters) away from right whales and 100 yards (91 meters) away from all other whales to the extent physically feasible given navigational constraints as required by NMFS.
- Since the Northeast Gateway Project Area is within the Mandatory Ship Reporting Area, all construction and support vessels will report their activities to the mandatory reporting section of the U.S. Coast Guard to remain apprised of North Atlantic right whale movements within the area. All vessels entering the MSRA will report their activities to WHALESNORTH. Table 4-2 describes the information requested by the Coast Guard. Vessels can contact the Coast Guard by email- RightWhale.MSR@noaa.gov or Telex: 236737831. If they are unable to use satellite communications equipment, they should contact the U.S. Coast Guard Communication Area Master Station Chesapeake VA via SITOR/NBDP on 8426.3 kilohertz, 12590.8 kilohertz, or 16817.8 kilohertz 24 hours per day, or 6314.3 kilohertz from 2300 GMT until 1100 GMT and 22387.8 kilohertz from 1100 GMT until 2300 GMT.
- Research indicates that most vessel collisions with whales resulting in serious injury or death occur when a ship is traveling over speeds of 14 knots (Laist et al. 2001). To minimize the chances of a ship strike, all construction vessels greater than 300 gross tons will maintain a speed of 13 knots or less. The speed of the construction vessels (i.e., tugs and barges) is expected to be low during construction activities; therefore, speed should not be an issue for these vessels. Crew/supply boats, which move at up to 15 knots, are smaller than 300 gross tons and will not be restricted to 13 knots.
- In times of inclement weather and low visibility (including nighttime), speeds will be kept as low as reasonable for the safe operation of the vessel and its crew.

- Crew/supply vessels will not cross directly in front of or in the immediate vicinity of moving or stationary whales. When moving parallel to whales, vessels will operate at a constant speed and no faster than the animal. If a vessel strike does occur, the Coast Guard will be notified and the crew will follow the procedures provided.
- Research indicates that most vessel collisions with whales resulting in serious injury or death, occur when a ship is traveling over speeds of 14 knots (Laist et al. 2001). To minimize the chances of a ship strike and subsequent whale death, all vessels greater than 300 gross tons will maintain a speed of 13 knots or less when within identified critical North Atlantic right whale habitat. In addition, Northeast Gateway is willing to voluntarily comply with the following two measures that are proposed by NOAA for reducing ship strikes to whales:
    1. If the vessel is routed through the "Off Race Point" area (ORP), including a portion of the Boston TSS, then from April 1 to May 15, ship speed will be held in the ORP to 13 knots or less.
    2. Route ships around the Great South Channel (GSC) area April 1 to July 31 each year.
- Crew training of EBRV personnel will stress individual responsibility for marine mammal awareness and reporting. All individuals onboard the EBRVs will receive training, a component of which will be training on marine mammal sighting and reporting, as required by International Maritime Organization (IMO) standards. The IMO is the United Nations' specialized agency responsible for improving maritime safety and preventing pollution from ships.
- All vessels will attempt to remain 500 yards (457 meters) away from North Atlantic right whales and 100 yards (91 meters) away from all other whales when navigational limitations permit, as required by NMFS.
- In times of inclement weather and low visibility (including nighttime), speeds will be kept as low as reasonable for the safe operation of the vessel and its crew.
- If a vessel strike is observed, the Coast Guard will be notified and the crew will follow the procedures provided.
- All EBRVs will report their activities to the mandatory reporting Section of the U.S. Coast Guard to remain apprised of North Atlantic right whale movements within the area. All EBRVs entering the MSRA will report their activities to WHALESNORTH. Table 4-2 describes the information requested by the Coast Guard. EBRVs can contact the Coast Guard by email-RightWhale.MSR@noaa.gov or Telex: 236737831. If they are unable to use satellite communications equipment, they should contact the U.S. Coast Guard Communication Area Master Station Chesapeake VA via SITOR/NBDP on 8426.3 kilohertz, 12590.8 kilohertz, or 16817.8 kilohertz 24 hours per day, or 6314.3 kilohertz from 2300 GMT until 1100 GMT and 22387.8 kilohertz from 1100 GMT until 2300 GMT.

NOAA is currently working towards a Ship Strike Reduction Strategy which would directly impact the speeds of the vessels within the Massachusetts Bay area. By following the speeds listed above, the

EBRVs will be within the recommended guidelines as outlined in the Advance Notice of Proposed Rulemaking (DOC 2004).

Pipeline Lateral

Impacts to non-endangered marine mammals have been minimized through the development and implementation of the same minimization measures discussed in Section 4.4.4 for the Pipeline Lateral. The following mitigation measures will be used:

- Algonquin and its contractors will maintain a SPCC Plan in place during construction.
- Although not anticipated, if blasting is determined to be required as a result of ongoing geophysical and geotechnical surveys, Algonquin will prepare a Blasting Mitigation Plan in consultation with NOAA-Fisheries. Algonquin prepared this type of plan as part of the recent HubLine and this program was successfully implemented during blasting operations.
- Algonquin is planning to construct the Pipeline Lateral beginning in September 2006 extending into May 2007. The main construction activities including pipelay, plowing, backfill plowing, and jetting are planned to occur during the winter months. The schedule for these activities will occur during a period, when on balance, impacts to marine mammals occurring along the Pipeline Lateral will be minimized. Based on available information, possible impacts to non-endangered marine mammals will be reduced because the major construction procedures are expected to be completed prior to April when the presence of whales begins to increase in the Pipeline Lateral area.
- Prior to initiation of construction work, all crew members on barges, tugs and support vessels, will undergo environmental training, a component of which will be to review the procedures regarding sighting of marine mammals and sea turtles.
- Northeast Gateway and Algonquin commit to having at least one full time environmental inspector on the project during construction. The individual will be experienced with offshore construction and will have experience with marine mammal and sea turtle issues. This environmental inspector will be notified immediately if any marine mammal or sea turtle is sighted in the area.
- During construction of the Pipeline Lateral, the environmental inspector will have stop work authority through the “chief inspector” or vessel “superintendent.”
- If a marine mammal or sea turtle is sighted by a crew member, an immediate notification is made to the vessel superintendent and to Algonquin's or Northeast Gateway’s craft inspector (present on every major vessel). The environmental inspector will then be notified to ensure that the required reporting procedures are followed.
- While under way, all construction vessels will remain 500 yards (457 meters) away from right whales and 100 yards (91 meters) away from all other whales to the extent physically feasible given navigational constraints as required by NMFS.

- Since the Northeast Gateway Project Area is within the Mandatory Ship Reporting Area, all construction and support vessels will report their activities to the mandatory reporting section of the U.S. Coast Guard to remain apprised of North Atlantic right whale movements within the area. All vessels entering the MSRA will report their activities to WHALESNORTH. Table 4-2 describes the information requested by the Coast Guard. Vessels can contact the Coast Guard by email- RightWhale.MSR@noaa.gov or Telex: 236737831. If they are unable to use satellite communications equipment, they should contact the U.S. Coast Guard Communication Area Master Station Chesapeake VA via SITOR/NBDP on 8426.3 kilohertz, 12590.8 kilohertz, or 16817.8 kilohertz 24 hours per day, or 6314.3 kilohertz from 2300 GMT until 1100 GMT and 22387.8 kilohertz from 1100 GMT until 2300 GMT.
- Research indicates that most vessel collisions with whales resulting in serious injury or death occur when a ship is traveling over speeds of 14 knots (Laist et al. 2001). To minimize the chances of a ship strike, all construction vessels greater than 300 gross tons will maintain a speed of 13 knots or less. The speed of the construction vessels (i.e., tugs and barges) is expected to be low during construction activities; therefore, speed should not be an issue for these vessels. Crew/supply boats, which move at up to 15 knots, are smaller than 300 gross tons and will not be restricted to 13 knots.
- In times of inclement weather and low visibility (including nighttime), speeds will be kept as low as reasonable for the safe operation of the vessel and its crew.
- Crew/supply vessels will not cross directly in front of or in the immediate vicinity of moving or stationary whales. When moving parallel to whales, vessels will operate at a constant speed and no faster than the animal. If a vessel strike does occur, the Coast Guard will be notified and the crew will follow the procedures provided.

NOAA is currently working towards a Ship Strike Reduction Strategy which would directly impact the speeds of the vessels within the Massachusetts Bay area. By following the speeds listed above, the larger construction barges and vessels will be within the recommended guidelines as outlined in the Advance Notice of Proposed Rulemaking (DOC 2004).

4.8.5 Alternatives

4.8.5.1 No Action Alternative

Under this alternative, the Project would not proceed and existing conditions would remain. Means to satisfy the nation's energy demands might result in increased use of existing land-based terminals, greater reliance on declining domestic oil and gas resources, or development of alternate means of importing LNG.

4.8.5.2 Port Alternative

The use of Buoys B and C rather than Buoys A and B would result in impacts essentially similar to those discussed for the Project. The Port would be located slightly farther away from the Stellwagen Bank National Marine Sanctuary, but the reduction in impact to the Sanctuary and the resources it was designed to protect would not be substantial. The biological habitats, including ocean depth and seafloor type, are very similar at the two sites. The moderate difference in location would not be expected to materially alter the impacts to marine mammals.