3.2. MARINE VEGETATION AND INVERTEBRATES

3.2.1. Affected Environment

Marine vegetation communities include species of aquatic plants such as eelgrass and macroalgae. Benthic communities inhabit the bottom of a body of water such as a lake or ocean and include sea snails and worms, sea stars, and shellfish such as oysters, clams, crabs, and shrimp. Plankton are single-celled algae and multi-cellular animals that reside in the water column and form the foundation of the marine food web.

3.2.1.1. EXISTING CONDITIONS

3.2.1.1.1. NEARSHORE HABITATS

The nearshore marine environment extends from the upper intertidal to subtidal nonphotic zone (below a level supporting plant growth). Nearshore habitats include bluffs, beaches, mudflats, kelp and eelgrass beds, salt marshes, gravel spits, and estuaries. Bottom types in the nearshore include consolidated (rock) and unconsolidated (cobble, gravel, sand, and mud) substrate. For evaluating habitat impacts and mitigation in a regulatory context, the 30 feet [9 meters] below MLLW line is used to define nearshore habitat. Nearshore habitats are critical to biological resources, including shellfish, salmon, groundfish, seabirds, and marine mammals.

3.2.1.1.2. MARINE VEGETATION COMMUNITIES

Marine vegetation includes macrophytes and macroalgae. Macrophytes are aquatic rooted, flowering plants. Macrophyte genera that occur in the Pacific Northwest include *Salicornia* (sea asparagus), *Zostera* (eelgrasses), and *Phyllospadix* (surfgrasses). Algae are a diverse group of simple plants that are mainly aquatic. These organisms are capable of photosynthesis and range in size from single-celled organisms (i.e., phytoplankton, discussed in Section 3.2.1.1.4) to large plants often referred to as seaweeds. Macroalgae lack true roots, stems, and leaves. They are divided into three taxonomic groups based upon their dominant photosynthetic pigmentation: green, red, and brown (Lamb and Hanby 2005).

Aquatic marine vegetation of the NAVBASE Kitsap Bangor shoreline is composed of intertidal and subtidal species, as well as floating and attached species. Distribution maps of key species are presented below under Marine Vegetation Types. Eelgrass is high-quality habitat and is most abundant in low-energy areas in the lower intertidal and shallow subtidal photic zone where organic matter and nutrients are abundant (Johnson and O'Neil 2001). Dense to patchy bands of eelgrass are located in the vicinity of the north and south LWI project sites (Science Applications International Corporation [SAIC] 2009). Green algae grow mainly in the lower intertidal and subtidal zones and include common species, such as sea lettuce (*Ulva* spp.). Red algae are located in the cobble and gravel upper intertidal zone but also occur subtidally. Brown algae, which include understory kelps (*Saccharina* sp.[1]) and the non-native Sargasso weed, or wireweed (*Sargassum muticum*), are found in nearshore environments of the Bangor shoreline from lower intertidal to subtidal zones (SAIC 2009). Additionally, algae that become detached can form

[1] *Laminaria* in the Pacific Northwest have recently been reclassified as *Saccharina* sp. except for *L. yezoensis*, which does not occur in Washington waters.

floating mats that drift with the currents and support a variety of marine life including juvenile fish and zooplankton.

MARINE VEGETATION TYPES

Marine vegetation within the NAVBASE Kitsap Bangor shoreline includes eelgrass; kelp; *Sargassum*; and green, red, and brown algae (Table 3.2–1). Marine vegetation in the vicinity of the north and south LWI project sites includes primarily eelgrass, green and red algae, and kelp (a type of brown algae that includes *Saccharina* sp.). Most forms of macroalgae were documented in the shallow subtidal zone between 0 and 10 feet (0 and 3 meters) below MLLW, often growing with eelgrass (SAIC 2009; Leidos and Grette Associates 2013a).

A survey of the Bangor shoreline was conducted in 2007 to characterize and document the presence and relative abundance of marine vegetation (SAIC 2009). The 2007 survey area extended to a depth of approximately 50 feet (15 meters) below MLLW. Eelgrass beds and macroalgae communities were mapped and relative densities were determined along the entire shoreline. In 2012, a focused survey was conducted of the SPE project area (Anchor QEA 2012). This survey documented the distribution of eelgrass and eelgrass shoot density, and reported general observations of macroflora and macrofauna in the project area, but did not map the extent of macroalgae or determine macroalgae densities. In 2013, a focused survey was conducted of the areas within 25 feet (8 meters) on each side of the centerlines of the proposed north and south LWI structures (Leidos and Grette Associates 2013a). This survey documented the distribution of eelgrass and macroalgae, eelgrass shoot density, and relative abundance of macroalgae in the project areas.

Table 3.2–1. Abundance of Marine Vegetation Classified as Percent of Linear Shoreline, NAVBASE Kitsap Bangor

Vegetation Type	Percent Linear Shoreline[1]	Acreage (hectares)[2,3]
Eelgrass (*Zostera* sp.)	81.9	37.7 (15.3)
Green Algae (e.g., *Ulva* spp.)	97.4	202.1 (82)
Red Algae (e.g., *Gracilaria* spp.)	76.8	73.8 (30)
Brown Algae		
(*Fucus*-Barnacle Assemblage)[2]	60.4	Not determined
Kelp (*Saccharina* sp.)	75.8	58.4 (23.6)
Sargassum muticum	15.9	11.8 (4.8)

Sources: Washington Department of Natural Resources (WDNR) 2006; SAIC 2009

1. Percent represented by proportionate amount in sampled area.
2. Macroalgae coverage data collected by Science Applications International Corporation (SAIC) in 2007 were concentrated in the lower intertidal and shallow (less than 70 feet [21 meters]) zones along the Bangor shoreline. *Fucus* occurrence in the upper intertidal of the Bangor shoreline is based on the Washington State Shorezone Inventory (WDNR 2006). These data are not included in algal distribution figures.
3. Eelgrass and macroalgae overlap in their occurrence along the Bangor shoreline; therefore, the total shoreline length or acreage of marine vegetation cannot be calculated by simply summing the values for each vegetation type.

EELGRASS

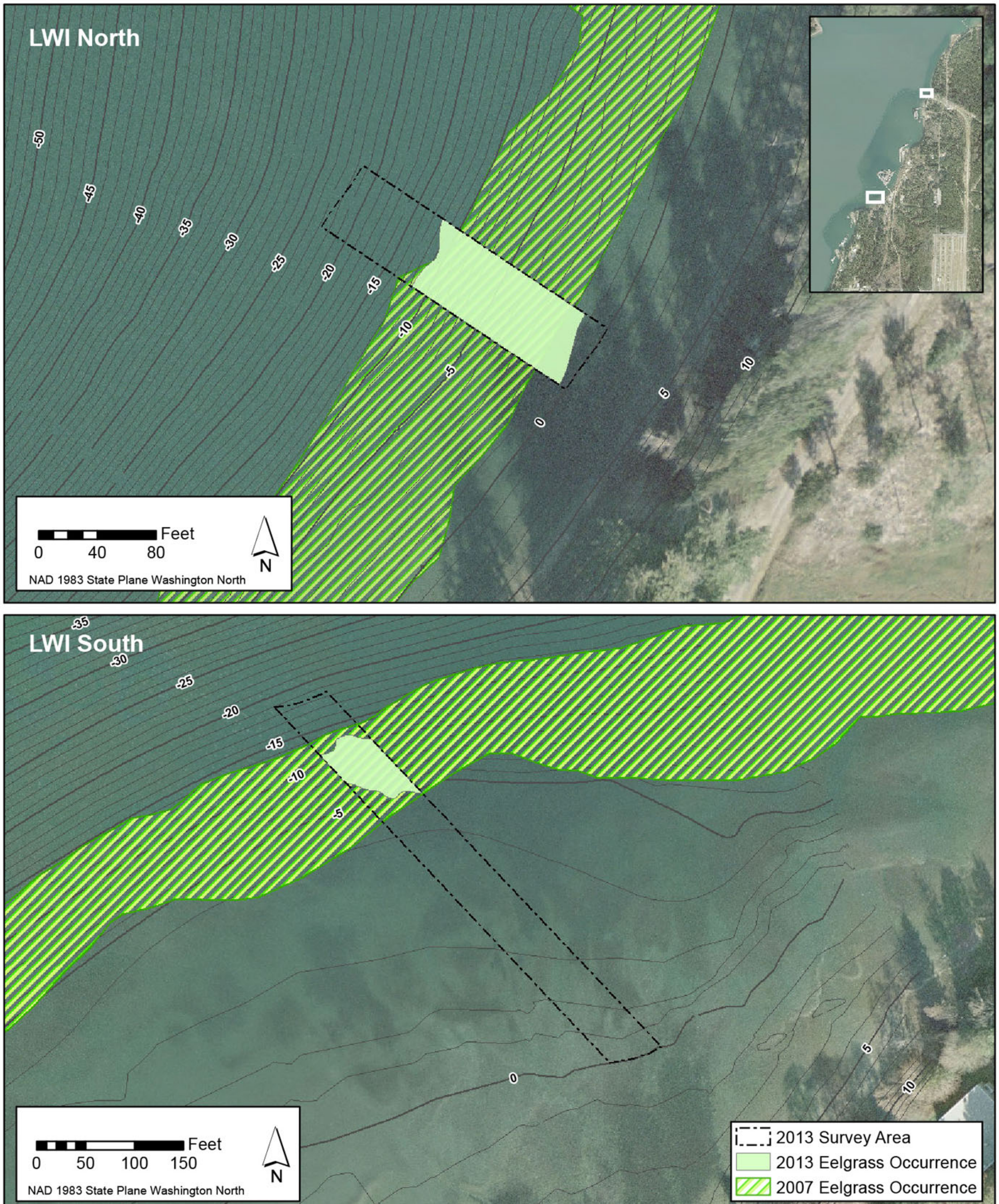
Eelgrass is one of the most important vegetation types in the marine ecosystem because eelgrass beds produce large amounts of carbon that fuel nearshore food webs and offer habitat to many marine species (Mumford 2007). Eelgrass beds build up in the spring and summer and decay in the fall and winter (Puget Sound Water Quality Action Team 2001). Shellfish, such as crabs and bivalves, use eelgrass beds for habitat and nursery areas. Eelgrass is an important habitat for juvenile salmonids, which use eelgrass beds as migratory corridors, for protection from predators, and for foraging (review in Mumford 2007). Kitsap County has one of the state's highest percentages of estuary and nearshore marine habitats occupied by eelgrass (WDNR 2006). Eelgrass depth distributions are related to water clarity, and in Hood Canal eelgrass can be found at maximum depths of about 24 feet (7 meters) (review in Mumford 2007). Well-established eelgrass beds were documented in 2007 in all survey areas along the Bangor shoreline in shallow water depths ranging from 0 to 20 feet (0 to 6 meters) below MLLW (SAIC 2009).

Eelgrass at the LWI Project Sites

North LWI Project Site. Based on the results of the 2007 surveys, an eelgrass bed of just over 12 acres (4.9 hectares) occurs in a continuous, narrow band along the shoreline north of EHW-1, ending at the Magnetic Silencing Facility (MSF) (SAIC 2009). The upper limits of this eelgrass bed corresponded to the MLLW line and extended out to water depths of about 14 feet (4 meters) below MLLW (Figure 3.2-1). In 2013 this bed was approximately 120 feet (37 meters) wide and extended to just over 12 feet (4 meters) below MLLW at the north LWI location (Leidos and Grette Associates 2013a). Average shoot density of the eelgrass in 2013 was 9.8 shoots per square foot (105.5 shoots per square meter). In 2013 a narrow band (approximately 15 feet [4.5 meters wide]) of *Z. japonica* was present along the shallow edge of the eelgrass bed at depths between 0 and 5 feet (1.5 meters) below MLLW.

Given that viable eelgrass habitat is limited to the zone between the MLLW line and the photocompensation depth (the depth where photosynthesis is unable to meet the metabolic demands of the plant to sustain net growth), the narrow width of this eelgrass bed is a result of the steep profile of the coastline in this area (SAIC 2009) as well as wave action in this exposed location (Leidos and Grette Associates 2013a). The continuous bed extends south from Floral Point and then broadens within the suitable substrate into a large area of dense coverage where the physical conditions (light, substrate type, etc.) can support many large-bladed plants. As the eelgrass bed continues south toward EHW-1, it narrows again to a swath of moderate to dense coverage, more consistent with the beds typical of Hood Canal.

South LWI Project Site. Based on the results of the 2007 surveys, a large eelgrass bed covering 7.6 acres (3.1 hectares) occurs in the shallow waters south of Delta Pier (SAIC 2009). This bed is restricted to water depths between 0 and 20 feet (0 to 6 meters) below MLLW. Bathymetry data indicated the presence of a large subtidal flat (0 to 5 feet [0 to 1.5 meters] below MLLW) occupying much of that area, which likely represents an outwash plain associated with sediment discharged from Devil's Hole. In addition to sediment, this inland pond and wetland also discharges fresh water into the shallow area between Delta Pier and the point at KB Dock.



Source: SAIC 2009; Leidos and Grette Associates 2013a

Figure 3.2–1. Eelgrass Distribution within the LWI Alignments

This freshwater discharge gradually mixes with the saline Hood Canal water, creating a mixing zone of brackish water along the immediate coast that likely decreases the salinity over the subtidal flat to a concentration too low to support eelgrass growth. As a result, the direct input of fresh water may have a role in preventing the eelgrass bed from expanding inshore and exploiting most of the shallow, subtidal seabed. At the location of the proposed south LWI, the bed is narrow, approximately 40 to 80 feet (12 to 24 meters) wide, and extends from 5 to 17 feet (1.5 to 5.2 meters) below MLLW (Leidos and Grette Associates 2013a). Average shoot density of the eelgrass in 2013 was 8.4 shoots per square foot (90.7 shoots per square meter). No *Z. japonica* was observed in this area during the 2013 survey.

Eelgrass at the SPE Project Site

Two small eelgrass beds were documented to the south and southwest of the existing Service Pier in a September 2012 survey (Figure 3.2–2; Anchor QEA 2012). The beds covered 0.25 and 0.14 acre (0.10 and 0.057 hectare), respectively. The 2012 survey did not extend beyond the area delineated for the southwest bed and so the total extent of that bed is unknown. Based on the 2007 survey (SAIC 2009), these two beds were one continuous band that continued to the southwest and ended just beyond Carlson Spit, covering a total of 0.69 acre (0.28 hectare). The apparent gap between the two areas of eelgrass shown in Figure 3.2–2 indicates that the more extensive eelgrass bed observed in 2007 fragmented during the years between surveys. It is unknown if the fragmentation is an artifact of inter-annual or inter-survey variability or an actual loss of eelgrass coverage at this location. In 2012, eelgrass bed elevations varied from approximately 3 to 15 feet (1 to 5 meters) below MLLW. Eelgrass shoot densities were high, ranging from 7.1 to 12.6 shoots per square foot (76 to 136 shoots per square meter) with an average density of 9.5 shoots per square foot (102 shoots per square meter) and a median density of 9.7 shoots per square foot (104 shoots per square meter). There was a slight trend of increasing shoot density in the deeper water.

MACROALGAE

Green Macroalgae

Sea lettuce (*Ulva* spp.) is the most common green algae at the Bangor shoreline. It grows from the lower-intertidal subzone to depths of more than 50 feet (15 meters) below MLLW in protected areas. However, the *Ulva* community is concentrated at depths less than about 30 feet (9 meters) below MLLW and occurs only sparsely (less than 10 percent coverage) at greater depths (Pentec 2003; SAIC 2009). Boulders in the nearshore marine habitats are typically encrusted with sea lettuce (Pentec 2003). Sea lettuce has a high nutrient content (Kirby 2001) which, when it dies and decomposes, provides an important source of nitrogen, as detritus, that supports eelgrass growth. Another green macroalga, *Ulvaria,* tends to occur in more subtidal waters in Puget Sound than does *Ulva* (Nelson et al. 2003). This macroalga was observed in only one survey quadrat in 2013, within deeper waters of the south LWI project site.

Red Macroalgae

Red algae of the genera *Endocladia*, *Mastocarpus*, *Ceramium, Porphyra*, *Gracilaria*, *Chondracanthus*, *Gracilariopsis*, *Smithora*, *Polyneura*, and *Sparlingia* are present on NAVBASE Kitsap Bangor in the intertidal zones (Pentec 2003; SAIC 2009; Leidos and Grette Associates 2013a). *Smithora naidum* is a thin, short, epiphytic red macroalgae that was observed

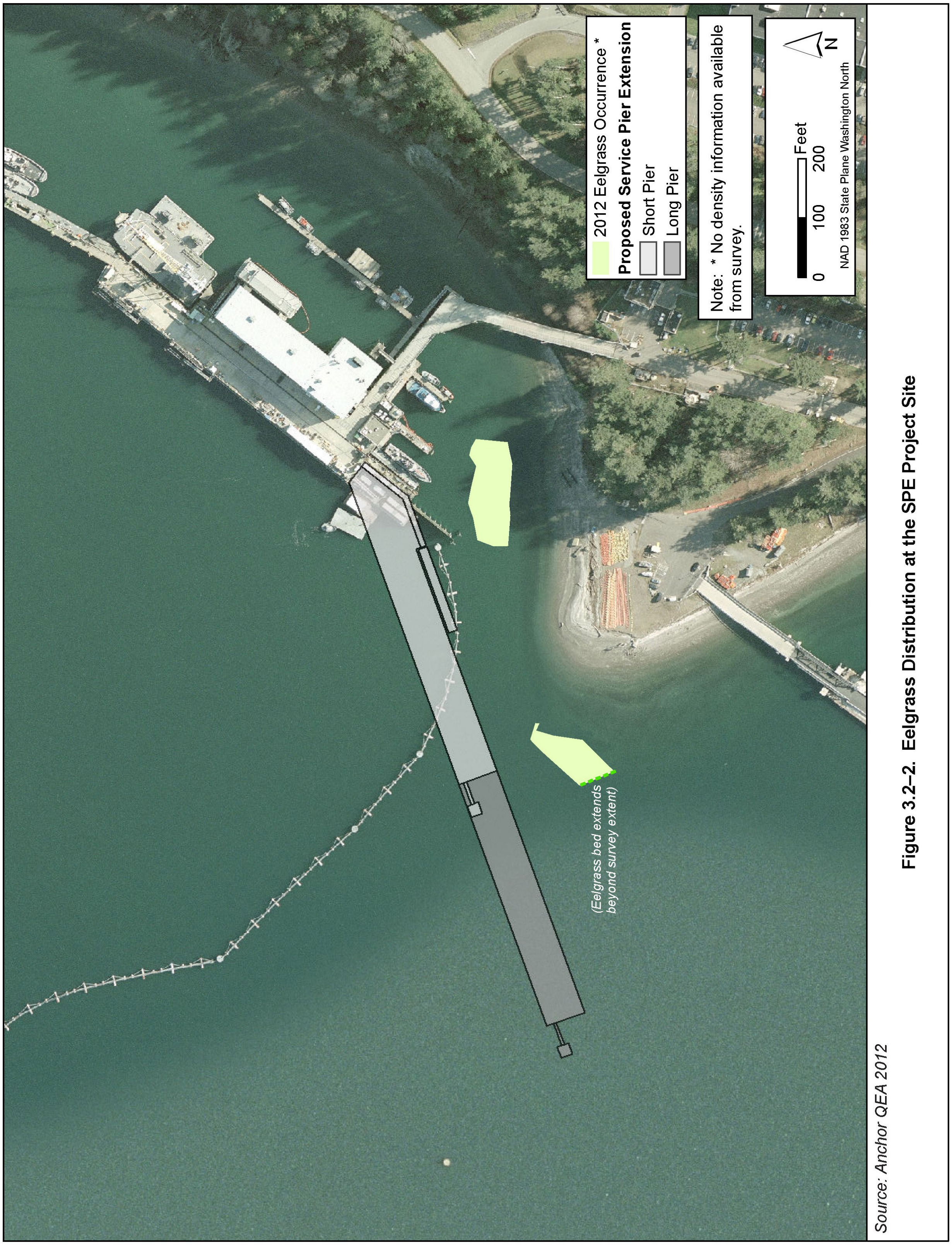


Figure 3.2–2. Eelgrass Distribution at the SPE Project Site

on eelgrass in 2013 (Leidos and Grette Associates 2013a). Red algae such as those found on NAVBASE Kitsap Bangor are ecologically important as primary producers and for providing habitat for other marine organisms.

Brown Macroalgae

Brown algae occur in a variety of forms, including encrusting, filamentous, and leafy varieties, on rocks and boulders. A key brown alga, the understory kelp *Saccharina* sp., is discussed below under Kelp. Several leafy brown algae species (e.g., *Egregia* and *Desmarestia*) are present on NAVBASE Kitsap Bangor (Pentec 2003; Leidos and Grette Associates 2013a). Rock weed (*Fucus* spp.) attached to rocks and cobble in the intertidal barnacle zone is common in the project areas (Pentec 2003) (Table 3.2–1).

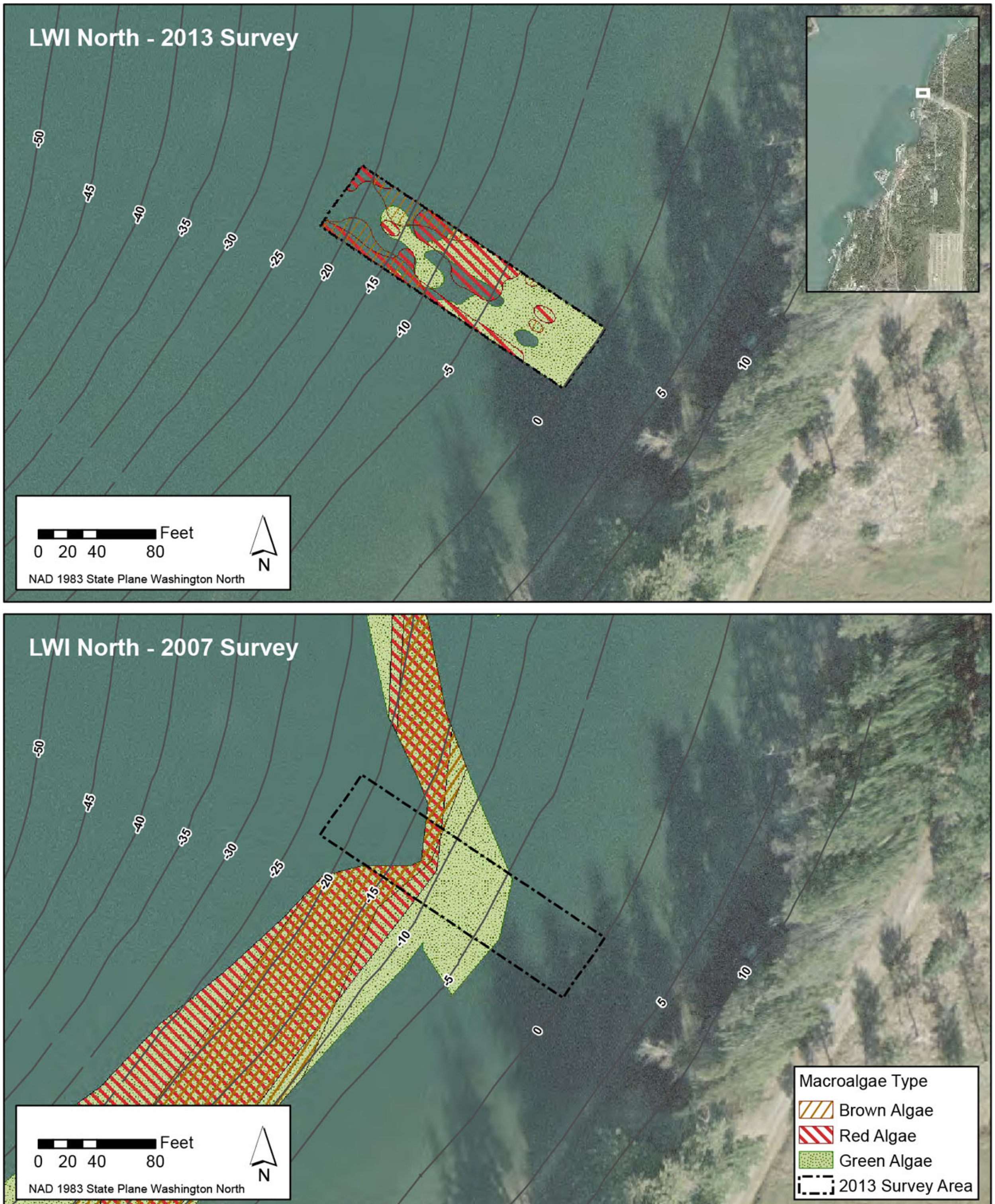
Kelp. Understory kelp (*Saccharina* sp.) provide an important source of nutrients to the seafloor (from fragmentation and decomposition) and multi-species vertical habitat in deeper marine waters (Mumford 2007). The kelp beds on NAVBASE Kitsap Bangor occur to depths of about 25 feet (8 meters) below MLLW. Most kelp in the lower-intertidal subzone and the nearshore marine habitats of NAVBASE Kitsap Bangor are *Saccharina* sp., but traces of the genera *Desmarestia* and *Pilayella* also have been documented (Pentec 2003; SAIC 2009). No attached, canopy-forming kelp beds (e.g., bull kelp) occur at the Bangor shoreline (SAIC 2009).

Sargassum muticum. Sargassum muticum is a brown macroalga native to the Sea of Japan, but it now occurs in most areas of the Pacific Coast of North America. It was first documented in Washington State waters in the 1950s and was likely introduced when Pacific oysters were planted in the early 1900s. The complex branching of *Sargassum* plants provides habitat for amphipods and other invertebrates and their predators; however, where *Sargassum* overlaps with native marine vegetation (such as eelgrass, kelp, and other macroalgae), it outcompetes those species by shading (Whatcom County Marine Resources Committee 2005). Further, *Sargassum* "may negatively affect water movement, light penetration, sediment accumulation, and [DO concentrations] at night" (Williams et al. 2001). Two large beds of *Sargassum* occur along the Bangor shoreline between the outlet of Devil's Hole and Carlson Spit. Other pockets of *Sargassum* on the base are small and isolated.

Macroalgae at the LWI Project Sites

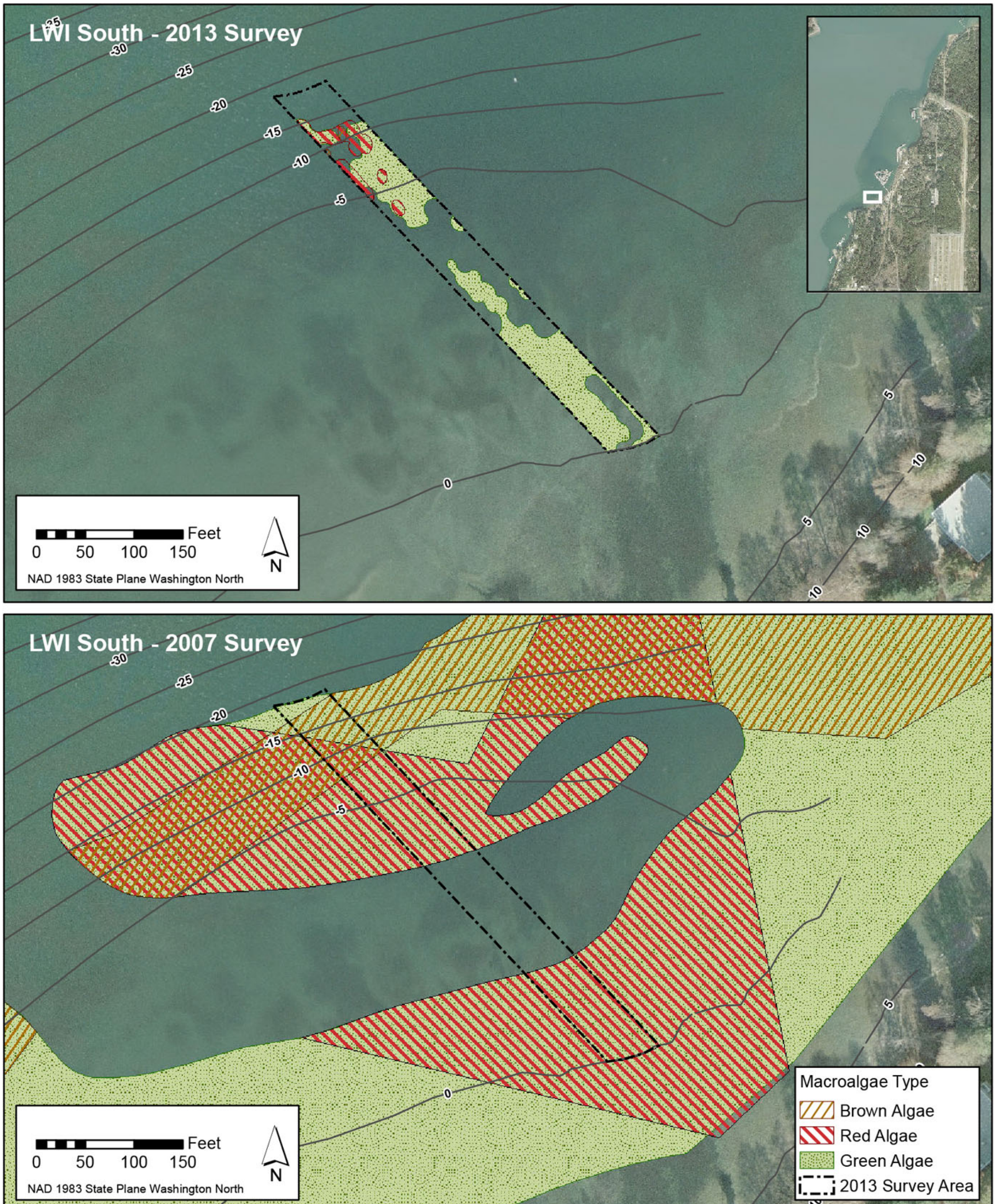
North LWI Project Site. Based on the 2007 surveys, the predominant algae type documented in this area is *Ulva*, often accompanied by *Saccharina* and *Gracilaria* (SAIC 2009) (Figure 3.2–3). In 2013, *Ulva* spp. and *Saccharina latissima* were the dominant macroalgae species where eelgrass was absent (Leidos and Grette Associates 2013a). No *Sargassum* was detected in the vicinity of the north LWI project site in 2007 or 2013. Rockweed was attached to rocks and cobble in this area during the 2008 shellfish survey (Delwiche et al. 2008). The full extent of macroalgae coverage may not have been surveyed during 2007 since many transects did not extend to the MLLW line due to insufficient water depth for the survey vessel.

South LWI Project Site. Based on the 2007 and 2013 surveys, the predominant algae in this area are *Ulva*, *Saccharina*, and *Gracilaria* (SAIC 2009; Leidos and Grette Associates 2013a), although no *Saccharina* was observed in 2013 (Figure 3.2–4). There were mats of *Ulva* on the



Source: SAIC 2009; Leidos and Grette Associates 2013a

Figure 3.2–3. Macroalgae Distribution within the North LWI Alignment



Source: SAIC 2009; Leidos and Grette Associates 2013a

Figure 3.2–4. Macroalgae Distribution within the South LWI Alignment

flats and oyster beds in this area during the 2008 shellfish survey (Delwiche et al. 2008). In 2007, *Sargassum* was detected only on the southwest side of the Devil's Hole outflow, more than 1,000 feet (300 meters) from this project area (SAIC 2009). In 2013, *Sargassum* was observed in four of the 130 survey quadrats in the south LWI project area (Leidos and Grette Associates 2013a). This species generally occurred as an individual plant, with percent coverage ranging from 1 to 5 percent in each of the four quadrats in which it was detected.

Macroalgae at the SPE Project Site

In the 2007 survey, green macroalgae (primarily *Ulva*) and kelp (*Saccharina*) were documented to the north and south and shoreward of the Service Pier (SAIC 2009) (Figure 3.2–5). Red macroalgae (primarily *Gracilaria*) were only observed to the south of the Service Pier. A long *Sargassum* bed was observed from just south of the KB Dock, running parallel to the shoreline and shoreward of the Service Pier and terminating north of the trestle, and a small pocket was observed west of the Service Pier trestle. High-percentage macroalgae coverage was limited to small areas behind the western portion of the Service Pier and at the tip of the point to the west (SAIC 2009). Species observed during the 2012 eelgrass survey included *Ulva*, *Saccharina*, *Desmarestia*, *Gracilaria*, *Sarcodiotheca*, and *Palmaria* (Anchor QEA 2012). No *Sargassum* was observed west of the Service Pier trestle within the construction area during the 2012 eelgrass survey.

3.2.1.1.3. BENTHIC COMMUNITIES

Benthic organisms, including both infaunal and epifaunal species, are abundant and diverse along the NAVBASE Kitsap Bangor waterfront (Pentec 2003; Weston 2006; Delwiche et al. 2008; Leidos and Grette Associates 2013b). Oyster beds occur along approximately 72 percent of the Bangor shoreline and occasionally co-occur with beds of mussels (Delwiche et al. 2008). Five beaches on NAVBASE Kitsap Bangor were open to shellfish harvest by residents until 2002 when increased security measures closed the beaches to shellfish gathering. The exception is that American Indian tribes continue to harvest oysters and clams on NAVBASE Kitsap Bangor at the shellfish bed at the proposed south LWI project site, off the Devil's Hole outlet (Section 3.14).

BENTHIC ABUNDANCE AND DIVERSITY

Local patterns of benthic community structure are influenced by physical and chemical characteristics; therefore, benthic organisms are useful indicators of habitat differences and quality. Hood Canal has been divided into nine biotic subregions based on soft-bottom benthic community structure, dominant taxa, sediment fines (i.e., the percent of silt and clay material), TOC content of bottom sediments, and depth (WDOE 2007). NAVBASE Kitsap Bangor and the LWI and SPE project sites are within the north Hood Canal biotic subregion, which is characterized by coarser sediment, lower TOC, and higher DO values than the other biotic subregions of Hood Canal. These conditions support a relatively more abundant and diverse benthic community, including stress-sensitive species such as the seed-shrimp, a small ostracod crustacean (WDOE 2007). Table 3.2–2 provides a list of some of the benthic invertebrates and shellfish occurring on NAVBASE Kitsap Bangor. In a 2005 survey of four locations along the Bangor shoreline, abundance and diversity of benthic organisms increased from intertidal to subtidal depths (Weston 2006).

Source: SAIC 2009

Figure 3.2–5. Macroalgae Distribution at the SPE Project Site

Table 3.2–2. Benthic Invertebrates along the NAVBASE Kitsap Bangor Shoreline

Phylum	Major Taxa	Genus or Species	Typical Location	Common Name or Description
Mollusca	**Gastropods**	*Alvania compacta*	Sand, silt, clay or mixed substrate, vegetated shallow subtidal	Snail
		Lirularia acuticostata	Mixed substrate, intertidal-subtidal	Sharp-keeled lirularia
	Bivalves	*Macoma* sp.	Mixed substrate, intertidal-subtidal	Macoma clam
		Nutricola spp.	Sandy subtidal	Clam
		Saxidomus gigantea	Sandy subtidal	Butter clam
		Panopea generosa	Sandy intertidal-subtidal	Geoduck clam
		Venerupis philippinarum	Gravel, sand, mud above half-tide	Manila clam
		Rochefortia tumida	Sandy intertidal-subtidal	Robust mysella
		Axinopsida serricata	Sandy or mixed substrate with organic enrichment subtidal	Silky axinopsid
		Leukoma staminea	Sandy intertidal-subtidal	Native littleneck clam
		Tellina carpenteri	Sandy or mixed sand/silt intertidal-subtidal	Clam
		Mytilus spp. [prob. *M. trossulus*]	Intertidal-subtidal, hard substrates	Blue mussel
		Pododesmus macroschisma	Hard substrates	Jingle shell
		Crassidoma gigantea	Rocky substrates subtidal, rarely intertidal under boulders	Giant rock scallop
		Crassostrea gigas	Rocky substrates	Pacific oyster
Crustaceans	**Ostracods**	*Euphilomedes carcharodonta*	All soft substrates	Seed-shrimp
	Tanaids	*Leptochelia dubia*	Mixed substrate, vegetated habitat, manmade structures	Tanaid
	Barnacles	*Balanus* sp. could also include *Semibalanus* spp.	Rocky, manmade structures	Barnacle
	Amphipods	*Protomedeia* sp.	All soft substrates	Gammarid
		Aoroides spp.	Detritus, sand, vegetated habitats	Corophiid
		Rhepoxynius boreovariatus	Sandy subtidal	Gammarid
		Corophium and *Monocorophium* spp.	Sandy subtidal, manmade structures	Corophiid

Table 3.2–2. Benthic Invertebrates at the Bangor Shoreline (continued)

Phylum	Major Taxa	Genus or Species	Typical Location	Common Name or Description
Crustaceans (continued)	**Crabs**	*Hemigrapsus oregonensis*	Quiet water, rocky habitats, gravel	Yellow shore crab
		Pagurus granosimanus	Mixed substrate, eelgrass, subtidal	Hermit crab
		Pugettia spp.	Sand/silt/clay subtidal, eelgrass	Kelp crab
		Cancer gracilis	Intertidal and subtidal, eelgrass	Graceful crab
		Cancer magister	Intertidal and subtidal, eelgrass	Dungeness crab
		Cancer oregonensis	Rocky and manmade structures, intertidal-subtidal	Oregon Cancer crab
		Cancer productus	Sandy, protected rocky areas, eelgrass, intertidal-subtidal	Red rock crab
	Shrimp	*Crangon* sp.	Shallow waters, sandy substrates	True shrimp
		Pandalus sp.	Mixed sand substrate intertidal and shallow subtidal	Spot shrimp
		Neotrypaea sp.	Mixed sand substrate intertidal and shallow subtidal	Ghost shrimp
Annelida	***Polychaetes***	*Platynereis bicanaliculata*	Mixed substrates, manmade structures, eelgrass	Nereidae
		Pectinaria californiensis	Sandy, low intertidal and subtidal	Cone worm
		Owenia collaris	Sandy, intertidal-subtidal	Oweniidae
Echino-dermata	***Echinoderms***	*Pisaster brevispinus*	Subtidal eelgrass	Pink sea star
		Pisaster ochraceus	Lower intertidal, hard structures	Purple star
		Amphiodia urtica/periercta	Subtidal silty mud	Burrowing brittle star
		Pycnopodia helianthoides	Lower intertidal to subtidal soft substrates	Sunflower star
		Dendraster excentricus	Flat, sandy subtidal	Sand dollar
Chordata	***Tunicates***	*Corella willmeriana*	Subtidal to deep water	Transparent tunicate
		Distaplia occidentalis	Intertidal to subtidal	Mushroom compound tunicate

Sources: Abbott and Reish 1980; Barnard et al. 1980; Lee and Miller 1980; Kozloff 1983; URS 1994; WDOE 1998; Pentec 2003; Weston 2006; Leidos and Grette Associates 2013b

BENTHIC ABUNDANCE AND DIVERSITY AT THE LWI AND SPE PROJECT SITES

Surveys indicate the intertidal benthic community at the north LWI project site is dominated by the clam *Rochefortia tumida*, oligochaetes, the tanaid *Leptochelia dubia*, nematodes, and the polychaete *Owenia collaris* (Weston 2006). The subtidal benthic community at the north LWI project site is dominated by the gastropod *Alvania compacta*, the polychaete *Platynereis bicanaliculata*, the clam *Axinopsida serricata*, and nematodes. The intertidal benthic community at the south LWI project site is dominated by the nemertean *Anopla*, the clam *R. tumida*, the tanaid *L. dubia*, nematodes, and the snail *Haminoae vesicula*. The subtidal benthic community at the south LWI project site is dominated by the gastropod *A. compacta*, the ostracod *Euphilomedes carcharodonta*, the polychaete *P. bicanaliculata*, *Nutricola* clams, the clam *A.*

serricata, and nematodes. Substrates behind the Service Pier on the north side in the intertidal are cobble and large gravel in sand and did not contain any evidence of clams in the 2008 shellfish survey (Delwiche et al. 2008). In the 2007 eelgrass survey, no bivalve siphons were seen extending from sediments shoreward of this pier (SAIC 2009).

Several factors likely contribute to local variability in benthic communities, including proportions of relatively coarser to finer sediment fractions associated with mixed sand and gravel substrates. Organic content of sediments is low along the shoreline but may range higher in depositional areas near wharves (Section 3.1.1.1.3) and would be expected to be greater in areas with submerged aquatic vegetation. In addition, proximity to freshwater tributaries influences the composition of the benthic community along the shoreline (Weston 2006).

MOLLUSCS

Molluscs are invertebrates that have soft, unsegmented bodies and are usually protected by a shell. Those occurring at NAVBASE Kitsap Bangor include two major classes: gastropods (slugs and snails) and bivalves (having two-part shells, such as clams, oysters, and mussels). In contrast to mussels and oysters, which attach to hard substrate, clams live fully buried in the substrate and gastropods live on the substrate surface. Oysters and many species of clams are filter feeders on plankton. Some clams also feed on organic matter at the sediment surface. Gastropods feed on vegetation and organic matter at the sediment surface and/or prey on other invertebrates.

The gastropod snail *Alvania compacta* was a numerical dominant of shallow subtidal waters at both LWI project sites (Weston 2006); it is commonly found in mixed sediments including fine gravels (Kozloff 1983). Other snails (e.g., sharp-keeled lirularia) are associated with eelgrass beds, and limpets occur intertidally on hard substrates (e.g., docks, cobble, and rocks). Common species on hard substrates (manmade structures and rocks) include blue mussels, jingle shell, rock scallop, and Pacific oyster (Navy 1988; Washington Department of Fish and Wildlife [WDFW] 2013a).

Bivalves are ecologically important because, as filter feeders, they uptake and recycle organic matter, help control phytoplankton levels, and improve water clarity, thereby allowing greater light penetration for the growth of seagrass and other marine vegetation. Molluscs are an important food source for some fish species (WDOE 2007).

MOLLUSCS AT THE LWI PROJECT SITES

A variety of bivalves occur within the proposed LWI project sites, ranging from intertidal to subtidal depths (Table 3.2–2). Common intertidal species include Macoma clams, robust mysella, butter clams, littleneck clams, horse clams, and soft-shelled clams (Pentec 2003; Weston 2006; Delwiche 2008). In 2005, the most abundant species in subtidal waters include silky axinopsid, various dwarf venus clams, fine-lined lucine, and robust mysella (Weston 2006). Robust mysella live in semi-permanent burrows and can be an indicator of a more stable habitat (Ockelmann and Muus 1978). Based on the 2013 shellfish survey of the north LWI site (Leidos and Grette Associates 2013b), bent nose clams were the most abundant clams in the intertidal region, followed by butter clams and native little necks (Table 3.2–3). At the south LWI project site, bent nose clams were the most abundant clams in the intertidal region, followed by Manila clams and native little necks. Other species were present in lesser numbers. In the 2013 subtidal survey, only 9 percent of the north LWI survey locations contained clam siphons. All were identified as horse clams. Similarly, in the 2013 subtidal survey of the south LWI project site, only 9 of 130 sample locations (7 percent) contained infaunal shellfish. These included geoduck, false geoduck (*Zirfaea pilsbryii*), horse clam, and cockle (*Clinocardium nuttallii*).

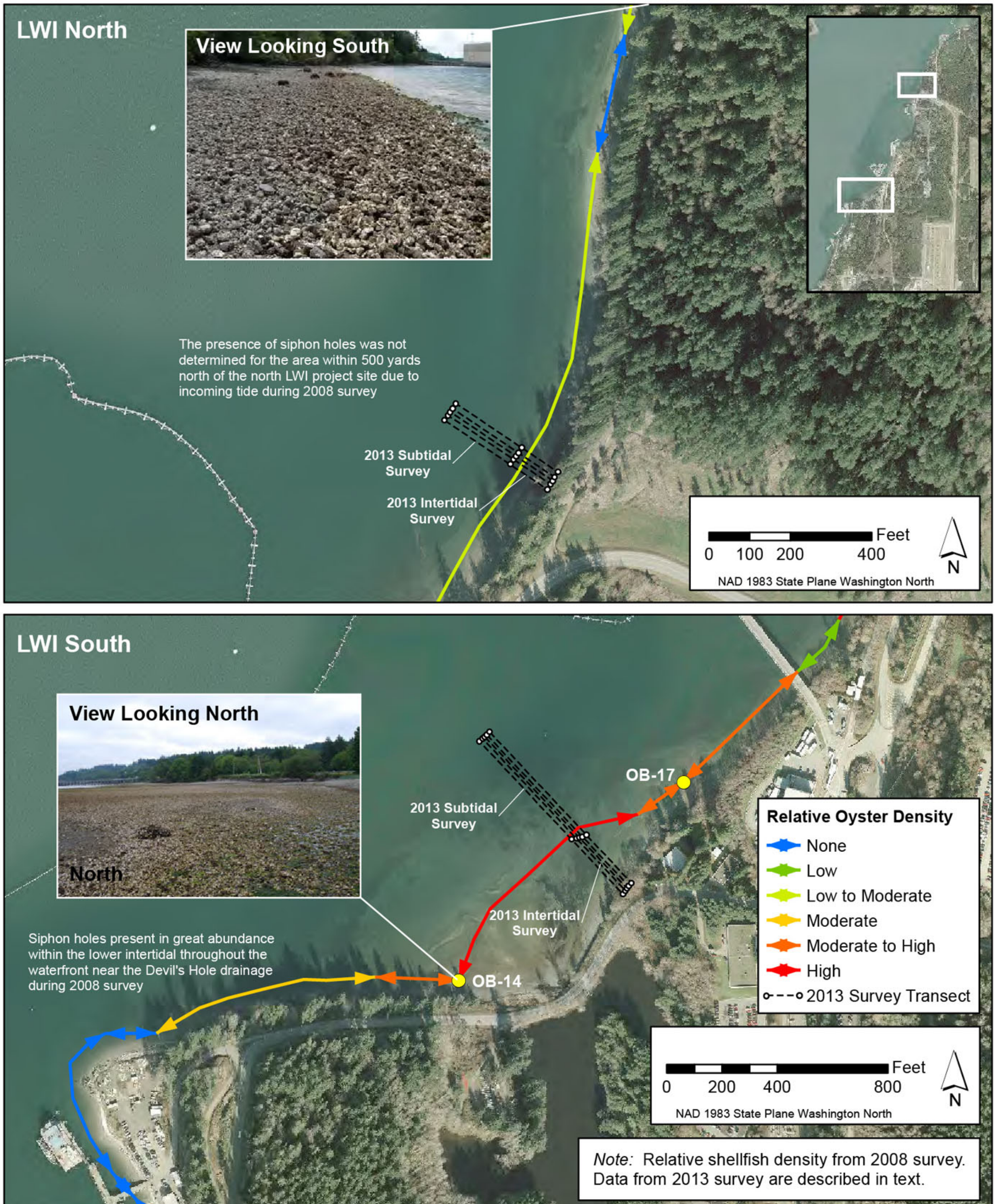
Table 3.2–3. Average Intertidal Shellfish Densities (number per square feet) at the North and South LWI Project Sites

Location	Oyster	Bent Nose Macoma	Manila Clam	Butter Clam	Horse Clam	Native Little Neck	Eastern Softshell Clam	Purple Varnish Clam	Cockle
North LWI	1.7	6.6	0.14	2.2	1.1	1.7	NA	NA	NA
South LWI	2.3	4.0	1.2	0.26	0.06	0.95	0.03	0.76	0.14

Source: Leidos and Grette Associates 2013b
NA = species not observed at location.

During the 2007 comprehensive eelgrass survey, bivalve siphons were generally detected at the north LWI project site at depths greater than 15 feet (5 meters) below MLLW and at the south LWI project site at depths greater than 20 feet (6 meters) below MLLW (SAIC 2009). In general, the siphons associated with geoduck clams occurred in both sand and silt substrate within each survey area, but the occurrence of bivalve siphons was higher in both deeper water and siltier sediment than in the sand and gravel material in the shallow depths. The north LWI project site contained a higher concentration of geoduck clams than the south LWI project site, possibly due to the siltier nature of the sediments at the north site compared to the sandier sediments at the south site (SAIC 2009). Based on the 2013 subtidal surveys (Leidos and Grette Associates 2013b), no geoducks were observed at the north LWI project site and three geoducks were observed at the south LWI project site. However, these surveys only extended to depths of approximately 22 feet (6.7 meters) and 20 feet (6 meters) below MLLW at the north and south LWI sites, respectively – depths where geoducks would not be expected to be abundant based on data obtained from the 2007 survey (SAIC 2009). Figure 3.2–6 presents the distribution of oysters and clams from a 2008 survey of the shoreline at the north and south LWI project sites and shows the 2013 survey locations (Delwiche et al. 2008; Leidos and Grette Associates 2013b).

A 1971 WDFW survey for the commercial tract (#21150), on which both LWI project sites would be located, reported geoduck densities of 0.09 per square foot (0.9 per square meter) (Sizemore et al. 2003). This tract is inactive and no recent survey information is available. Surveys conducted at NAVBASE Kitsap Bangor in support of the 1974 TRIDENT Fleet Ballistic Missile (TRIDENT) Final Environmental Impact Statement (FEIS) found geoduck densities of 0.15 per square foot (1.5 per square meter) near the outlet from Hunter's Marsh, which is approximately 1,300 feet (400 meters) south of the north LWI project site (Navy 1974). No other geoduck survey data are available for the Bangor waterfront. More recent WDFW geoduck studies conducted in Hood Canal from 2004 to 2007 found densities ranging from 0.0029 per square foot at Quatsap (approximately 10 miles [16 kilometers] southwest of the south LWI project site) to 0.676 per square foot at Lofall/Vinland (1.5 to 5.5 miles [2.4 to 8.9 kilometers] north of the north LWI project site) (Sizemore et al. 2007).



Source: Delwiche et al. 2008

Figure 3.2–6. Shellfish Resources near the LWI Project Sites

Oysters have a limited elevational distribution at the north LWI project site, representing a band across the intertidal habitat (Delwiche et al. 2008; Leidos and Grette Associates 2013b). Tidal heights over which this band occurred ranged from 2.5 to 7 feet (0.8 to 2.1 meters) above MLLW, with no oysters detected in the subtidal region. Though not a dense band, the average width of the oyster bed at this location is approximately 40 feet (12 meters). This bed runs from the EHW-1 north trestle to the north for a distance of about 1,700 feet (518 meters). A total of 102 oysters were detected at the north LWI project site in the 2013 survey, equating to an average density of 1.7 oysters per square foot (18.3 per square meter).

Oysters at the south LWI project site occur as a dense band across the intertidal and shallow subtidal habitat (Delwiche et al. 2008; Leidos and Grette Associates 2013b). Tidal heights over which this band occurs range from 0.5 feet (0.12 meter) below to 4 feet (1.2 meters) above MLLW. This bed runs approximately 440 feet (134 meters) across the Devil's Hole outfall delta. The average width of the oyster bed at this location is approximately 140 feet (43 meters). A total of 291 oysters were detected at the south LWI site in the 2013 survey, equating to an average density of 2.35 oysters per square foot (25.3 per square meter).

MOLLUSCS AT THE SPE PROJECT SITE

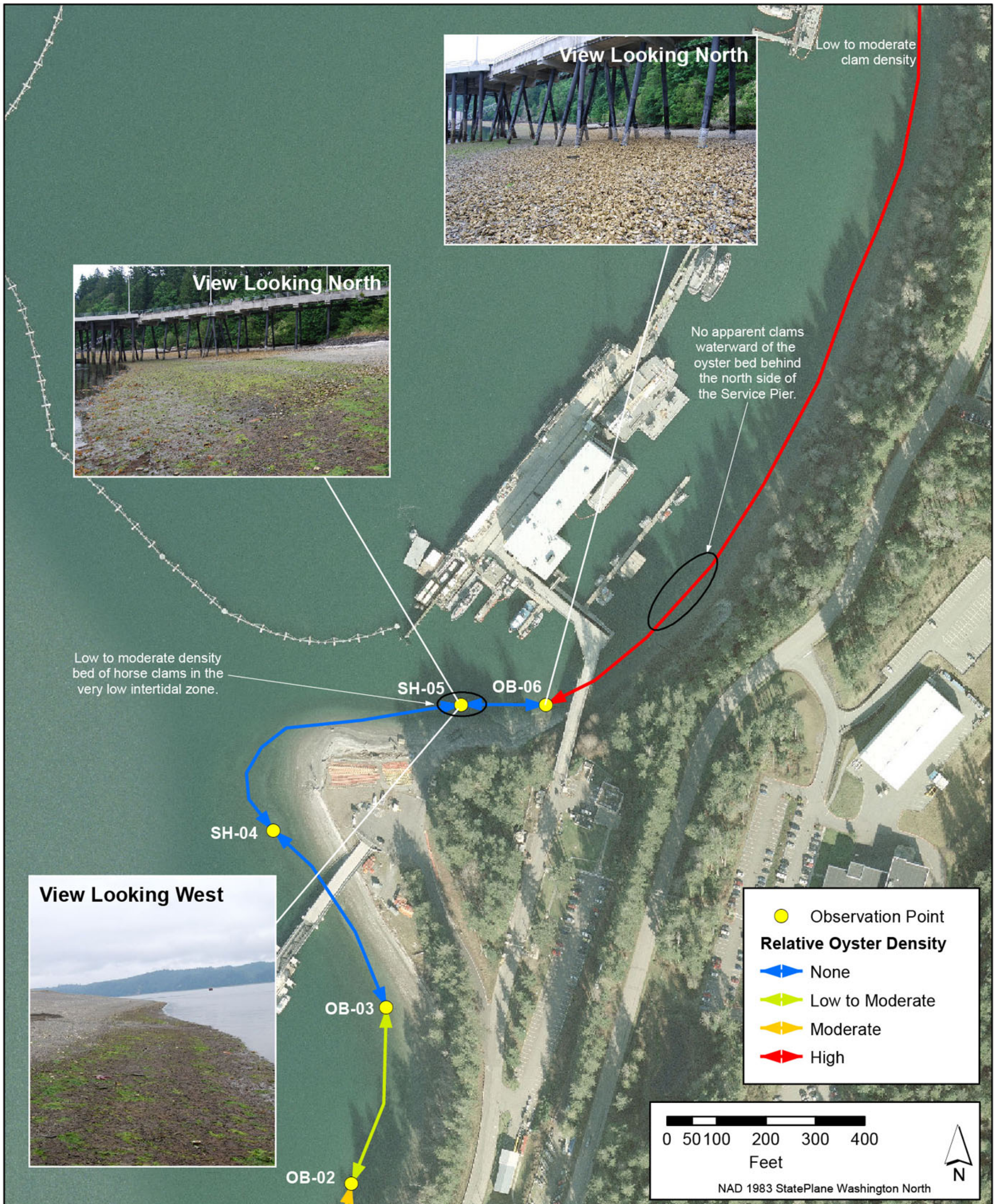
An approximately 63-foot wide (19-meter) dense oyster bed runs from just south of the Service Pier trestle to the north approximately 1,800 feet (550 meters), ending just south of KB Dock (Figure 3.2–7; Delwiche et al. 2008). There is a moderate to low-density bed of horse clams in the very low intertidal zone just south of the Service Pier. The 2007 eelgrass survey did not detect bivalve siphons behind the Service Pier (SAIC 2009). Opalescent nudibranchs (*Hermissenda crassicornis*, a gastropod mollusc) were observed at this site during the 2012 eelgrass survey (Anchor QEA 2012).

There are no recent geoduck survey data for the SPE project site. The 1971 WDFW survey for the commercial tract (#21150), on which the SPE project site would be located, reported geoduck densities of 0.09 per square foot (0.9 per square meter) (Sizemore et al. 2003). The 1974 survey for TRIDENT near the mouth of Hunters Marsh (approximately 1.8 miles [2.9 kilometers] north of the SPE project site) found geoduck densities of 0.15 per square foot (Navy 1974).

The Quatsop survey site, which found geoduck densities of 0.0029 per square foot, is approximately 8 miles (13 kilometers) southwest of the SPE site (Sizemore et al. 2007). Similarly, the Lofall/Vinland survey site, which found geoduck densities of 0.676 per square foot, is approximately 4 to 8 miles (6.4 to 13 kilometers) north of the SPE project site.

CRUSTACEANS

Crustaceans are aquatic arthropods with an exoskeleton or shell, a pair of appendages on each segment, and two pairs of antennae. Examples are shrimps, crabs, barnacles, and amphipods. Crustaceans are associated with all soft-bottom and hard substrate habitats (rocky outcrops, manmade structures) and also occur in the water column. Crustaceans, particularly small epibenthic species, provide a primary ecological value as an important food source for fish, birds, marine mammals, and other animals. For example, gammarid amphipods (small,



Source: Delwiche et al. 2008; SAIC 2009

Figure 3.2–7. Shellfish Resources near the SPE Project Site

shrimp-like crustaceans) are the primary food source for chum salmon along the Bangor shoreline (Simenstad and Kinney 1978). Dungeness crabs and spot prawns are WDFW-regulated species that are subject to commercial and sport harvest in Hood Canal.

Small epibenthic crustaceans (such as amphipods, copepods, cumaceans, isopods, ostracods, and tanaids) are associated with soft-bottom habitat. Benthic ostracods are minute crustaceans that are protected by a bivalve-like shell and typically feed on detritus in the subtidal nearshore marine habitats. Based on 2005 benthic sediment sampling along the Bangor shoreline the seed-shrimp, an ostracod, is the most abundant species (Weston 2006). Seed-shrimp comprised almost 30 percent of the individual benthic organisms in the sandy deltaic subtidal zones along the shoreline (Weston 2006). In previous studies (WDOE 1998), this species was numerically dominant in other areas of the north Hood Canal biotic subregion. Other common species in soft-bottom habitats include amphipods and tanaids (Weston 2006). Most amphipods are detritus-feeders or scavengers, and tanaids are associated with vegetated habitats and/or organic detritus (Barnard et al. 1980; Lee and Miller 1980).

Barnacles, amphipods, copepods, cumaceans, and isopods are common members of marine fouling communities (organisms that attach to and live on manmade structures such as docks). Amphipods often account for the greatest variety of crustaceans on manmade structures. Several of these fouling species are non-native in Puget Sound (e.g., *Ampithoe valida*, *Corophium acherusicum*, and *Parapleustes derzhavini*) (Cohen et al. 1998). During the 2008 survey, barnacles were frequently seen attached to cobble, oyster shells, and pier structures throughout the intertidal areas of the Bangor shoreline (Delwiche et al. 2008).

CRUSTACEANS AT THE LWI AND SPE PROJECT SITES

Larger crabs and shrimps, which are mobile and evasive during sampling, are not well quantified near the proposed LWI or SPE project sites. Several species have been commonly observed (Pentec 2003; Weston 2006). Dungeness crabs range from intertidal to subtidal depths in sandy habitats and may use eelgrass beds as nursery areas (LFR 2004). Hermit crabs, *Cancer* crabs, kelp crabs, and shore crabs occur in rocky and/or vegetated habitats (Table 3.2–2). Red rock crabs, kelp crabs, graceful crabs, and Dungeness crabs were observed during the 2013 LWI shellfish surveys (Leidos and Grette Associates 2013b). Red rock crabs, hermit crabs, kelp crabs, and ghost shrimp were observed during the 2012 SPE eelgrass survey (Anchor QEA 2012).

ANNELIDS

Annelids are segmented worms that occur in soils (e.g., earthworms) and freshwater and marine environments (e.g., leeches and polychaetes). Polychaetes are a major component of the benthic community and occupy intertidal and subtidal soft- and hard-bottom habitats (Weston 2006). Sessile polychaetes are often tube-building while other species may be active burrowers (Kozloff 1983). Polychaetes are typically more abundant in the nearshore subtidal zone than in the intertidal zone (Weston 2006; WDOE 2007). Several species of polychaetes live among fouling organisms on manmade structures. Suspension-deposit spionids, herbivorous nereids, predatory syllids, and scale worms were found during rapid assessment of several marinas in Puget Sound (Cohen et al. 1998).

ANNELIDS AT THE LWI AND SPE PROJECT SITES

The polychaete *Platynereis bicanaliculata* was abundant in subtidal samples at all three stations at the north LWI project site and at one of three stations at the south LWI project site (Weston 2006). No benthic invertebrate surveys have been conducted in the vicinity of Service Pier. However, annelids in this area would likely include those typical of Puget Sound hard and soft-bottom habitats, as noted for the LWI project sites.

ECHINODERMS

Echinoderms are a group of marine invertebrates that usually have a symmetry of five and skin typically covered in spines. Examples include sea stars (starfish), sea urchins, and sea cucumbers.

ECHINODERMS AT THE LWI AND SPE PROJECT SITES

Echinoderms contributed up to 6 percent of benthic organisms in sediment sampling conducted in 2005 along the shoreline, but they represented less than 1 percent of the abundance of benthic organisms at the LWI project sites (Weston 2006). Echinoderms at the LWI project sites include brittle stars and green sea urchins (Navy 1988; Weston 2006). However, sea stars have also been observed at many locations along the shoreline (Navy 1988; Delwiche et al. 2008). Purple stars are found primarily in the lower-intertidal zone on piles where they feed on mussels. Pink sea stars are often found in subtidal eelgrass beds (Pentec 2003). Sunflower, pink, and false ochre sea stars were observed at the SPE project site during the 2012 eelgrass survey (Anchor QEA 2012).

The red sea urchin has not been documented near the LWI or SPE project sites but typically lives in rocky areas, which have not been extensively surveyed at the shoreline. Red sea urchin habitat ranges from protected shallow subtidal zones to marine deeper water and nearshore marine habitats.

OTHER MINOR PHYLA

Other minor phyla at the Bangor shoreline include Nemertea (ribbon worms), Nematoda (round worms), Platyhelminthes (flat worms, which are mostly oyster leaches), Chordata (e.g., transparent tunicate and mushroom compound tunicate), Cnidaria (jellyfish, polyps, the frilled anemone *Metridium senile*), and Sipuncula (unsegmented worms) (Navy 1988, 1992; Weston 2006).

OTHER MINOR PHYLA AT THE LWI AND SPE PROJECT SITES

During the 2007 comprehensive eelgrass survey, frilled anemones were less prevalent at the proposed LWI and SPE project sites than at the more central area of the shoreline (SAIC 2009).

3.2.1.1.4. PLANKTON

Plankton are often divided into two groups: photosynthetic species that transform light energy from the sun into chemical energy (phytoplankton) and heterotrophic species that derive nutrition by consuming other organisms (zooplankton). Zooplankton are an important part of the food chain for other marine organisms, such as threatened and endangered salmon species.

The plankton community in Hood Canal includes phytoplankton (e.g., diatoms and dinoflagellates), zooplankton such as calanoid copepods, hyperiid amphipods, and euphausiids (krill), larval life stages of some invertebrate species, and fish larvae and eggs (called ichthyoplankton) (Schreiner 1977; Simenstad and Kinney 1978; Salo et al. 1980; Llansó 1998; WDOE 1998). Crustacean larvae are the most common type of zooplankton in Hood Canal. Phytoplankton and zooplankton are critical components of the Hood Canal food web, but their abundance and distribution are not well known or characterized (Puget Sound Action Team [PSAT] 2007a).

PHYTOPLANKTON

In Hood Canal, phytoplankton are composed mainly of diatoms (unicellular algae with silica shells) and dinoflagellates (microscopic organisms with self-propulsion) (Strickland 1983). Diatoms account for most of the phytoplankton biomass in Hood Canal (PSAT 2007a).

Phytoplankton abundance in the Puget Sound region follows a seasonal pattern. In the summer, increased abundance is influenced by weak tidal mixing, reduced circulation, and increased heat from the sun, which contributes to strong stratification in the upper water column. In the fall, local wind events or strong tidal exchange can mix the stratified water and upwell nutrients from lower in the water column, causing a phytoplankton bloom. Phytoplankton abundance then decreases as winter approaches due to decreased sunlight and increased mixing and outflow from heavy rains (Newton and Mote 2005). Between 2001 and 2005, blooms were recorded in the waters adjacent to NAVBASE Kitsap Bangor from February through June (PSAT 2007a).

Phytoplankton populations may become problematic during bloom periods because, once they die off, DO levels can decrease dramatically as bacteria consume the organic materials. Only a few dozen species are associated with harmful algal blooms (Boesch et al. 1997; Horner 1998; PSAT 2007a). Examples of toxic species that occur in Hood Canal include diatoms in the genus *Pseudo-nitzschia*, which produce domoic acid that causes shellfish poisoning in humans (domoic acid acts as a neurotoxin, causing permanent short-term memory loss, brain damage, and death in severe cases), and dinoflagellates in the genus *Alexandrium* that can produce a toxin (saxitoxin, a neurotoxin) that causes paralytic shellfish poisoning (Boesch et al. 1997; Newton 2006). Poisoning of humans and wildlife can occur when filter-feeding shellfish concentrate these toxins to dangerous levels. There are usually periods each year when clam and/or oyster harvest at the Devil's Hole shellfish beach is curtailed due to saxitoxin or *Vibrio* (a bacterium) contamination (Kalina 2012, personal communication). In addition, several diatom species of the genus *Chaetoceros* have barbed spines that can damage fish gills and can cause fish kills during bloom conditions (Boesch et al. 1997).

ZOOPLANKTON

The most abundant types of zooplankton in Hood Canal are crustaceans (including various types of copepods, amphipods, ostracods, isopods, shrimp, and cumaceans) and crustacean larvae (Simenstad and Kinney 1978; Strickland 1983). Some zooplankton spend their entire life as planktonic organisms (resident plankton) while some spend only a portion of their life cycle as plankton (meroplankton) such as in egg or larval stages of development. The larvae of many fish are planktonic. Zooplankton do not occur in blooms, but their populations increase with phytoplankton abundance (PSAT 2007a).

Zooplankton depend on the availability of phytoplankton as a food source, which fluctuates seasonally, annually, and geographically. An increase in the abundance of zooplankton occurs locally near fish and invertebrate spawning sites, with the emergence of large clouds of meroplankton (planktonic larvae) during the winter and spring months. Other species contribute to the meroplankton population during other times of the year, such as bivalves and sand dollars that spawn in the summer (Strickland 1983; WDFW 2000; Snow et al. 2005). Zooplankton may remain in the meroplankton stage for up to 7 weeks.

3.2.1.2. CURRENT REQUIREMENTS AND PRACTICES

3.2.1.2.1. EELGRASS POLICIES

The Washington Department of Natural Resources (WDNR) monitors the status and trends of eelgrass abundance and depth throughout Puget Sound, including in Hood Canal. The policy of WDNR and the other agencies is to prevent loss and promote expansion of eelgrass in Hood Canal and Puget Sound. Specific regulatory protections for eelgrass are discussed in the following section.

3.2.1.2.2. REGULATORY COMPLIANCE

VEGETATION COMMUNITIES

Eelgrass is protected under several federal laws. The Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 USC 1801-1881 et seq.) established procedures designed to identify, conserve, and enhance Essential Fish Habitat (EFH) including eelgrass for those species regulated under a federal Fisheries Management Plan (FMP). The MSA requires federal agencies to consult with National Marine Fisheries Service (NMFS) on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (MSA 305(b)(2)). EFH protects waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity for federally managed (commercially harvested) fisheries. In addition to EFH designations, Habitat Areas of Particular Concern (HAPCs) are also designated by the regional Fishery Management Councils (FMCs). Designated HAPCs are discrete subsets of EFH that provide important ecological functions or are especially vulnerable to degradation (50 Code of Federal Regulations [CFR] 600.805-600.815). The seagrasses HAPC for Pacific coast groundfish includes eelgrass beds in estuaries (Pacific Fishery Management Council [PFMC] 2008). EFH existing conditions and impacts are evaluated in the Marine Fish resource (Section 3.3).

Under the provisions of CWA Section 404 implemented by USACE and USEPA, eelgrass beds are also considered Special Aquatic Sites that receive special protection. Section 404 pertains to discharges of dredged or fill material in waters of the U.S., which include areas suitable for supporting eelgrass. The jurisdictional limit for Section 404 in tidal waters is the high tide line. Construction of the LWI abutments would require excavation below MHHW and the abutment stair landings and portions of the riprap below the abutment walls would be below MHHW, thus requiring a CWA Section 404 permit from USACE. In accordance with USEPA Section

404(b)(1) guidelines, permits for discharges of dredged or fill material in eelgrass beds may not be issued if practicable alternatives would avoid such impacts. Loss of eelgrass habitat due to construction of the LWI project would require compensatory mitigation as described in the Mitigation Action Plan (Appendix C).

Section 404 activities permitted by USACE require that a Section 401 water quality certification be issued or waived by WDOE. Thus, separate Section 401 water quality certification would be required for the in-water work for both the proposed LWI and SPE project. The Navy has applied for a Section 404 permit (LWI project only) and Section 401 certifications (LWI and SPE projects) by submitting a JARPA for review by USACE and state agencies. The WDFW regulates non-federal, in-water construction actions through the State Hydraulic Code (RCW 77.55) and specifically protects eelgrass and kelp (*Saccharina* sp.) resources through WAC 220-660-080, which requires no-net-loss of habitat that supports fish life. Eelgrass and kelp are also considered saltwater habitats of special concern (WAC 220-660-320(3)). However, NAVBASE Kitsap Bangor is exempt from these requirements because it is a federal installation.

WDFW and WDNR may comment and provide recommendations on federal construction projects through the JARPA and National Environmental Policy Act (NEPA) processes. Permitting agencies (USACE and WDOE) may incorporate these comments and recommendations into permits and authorizations.

Section 10 of the Rivers and Harbors Act (33 USC 401 et seq.) requires authorization from USACE for the development of any structure in or over any navigable water of the United States. The Navy requested separate Section 10 permits for construction of the overwater portions of the LWI and for the SPE. The permit process for Section 10 of the Rivers and Harbors Act of 1899 results in an evaluation of project impacts on eelgrass beds. While not subject to specifications of the CWA 404(b)(1) guidelines, USACE considers impacts on eelgrass (as part of the public interest review) in their evaluation of permit applications for structures or work in navigable waters pursuant to Section 10. This applies to non-fill activities such as pile-supported structures, moorings, floats, excavation, and other structures or work conducted beyond mean high water in tidal waters.

Under Kitsap County's Shoreline Management Plan (SMP), Section 22.28.030, General Policies (which is applicable under the CZMA), development activities are directed to avoid eelgrass, kelp, and estuarine ecosystems because of their high ecological value. As a federal agency, the Navy prepares a CCD in compliance with the CZMA explaining how their action would be "consistent to the maximum extent practicable" with the state's Coastal Zone Management Plan (CZMP), which in Washington invokes the applicable local shorelines management program (i.e., Kitsap County's program). WDOE reviews the CCD and make a federal consistency determination in the form of concurrence, conditional concurrence, or objection.

BENTHIC COMMUNITIES

No federally listed benthic species within the vicinity of the LWI and SPE project sites are subject to regulation under the Endangered Species Act (ESA). However, benthic invertebrates that constitute food for salmon listed under the ESA are indirectly protected. Activities that alter or eliminate benthic invertebrates or their habitats are evaluated for their significance to federally listed species during ESA consultations with NMFS. The MSA, through the EFH provision, protects substrate necessary for federally managed fisheries. In this context, "substrate" includes the associated benthic communities that make these areas suitable fish habitats. USACE also considers protection of shellfish under Section 404 of the CWA (e.g., Nationwide Permit regional conditions prohibit construction in special aquatic sites, which include oyster beds).

At the state level, WDFW is tasked with providing protection to benthic organisms, including shellfish, as required under the Washington State Hydraulic Code (RCW 77.55). The code is implemented through WAC 220-660, which states that there should be no net-loss of fish life (which includes shellfish) and habitat that supports fish life. Settlement areas for native shellfish (i.e., Olympia oysters) are considered saltwater habitats of special concern (WAC 220-660-320). However, NAVBASE Kitsap Bangor is exempt from these requirements because it is a federal installation.

WDOH monitors beaches in Hood Canal, including those at the Bangor shoreline, for shellfish contamination to protect consumers from illness caused by eating shellfish contaminated by fecal pathogens, biotoxins, or other pollutants. The shellfish bed at the south LWI project site off the Devil's Hole outfall is harvested for oysters and clams by tribes (Kalina 2012, personal communication). The beach areas at the north LWI and SPE project sites (Figures 3.2–6 and 3.2–7) are closed to any shellfish harvest due to security restrictions.

PLANKTON

There are no federal or state regulations pertaining directly to plankton or requirements for regulatory consultation. Regulations indirectly affecting plankton include water quality criteria for parameters related to excessive nutrient loading, which can cause algal blooms (larger accumulations of phytoplankton) that can adversely affect water quality (Section 3.1.1.1.2).

3.2.1.2.3. CONSULTATION AND PERMIT COMPLIANCE STATUS

The Navy included impacts on marine vegetation and benthic communities as part of its consultation with the NMFS West Coast Region office under the ESA and MSA. A biological assessment and EFH assessment were submitted to the NMFS West Coast Region Office and the USFWS Washington Fish and Wildlife Office on March 10, 2015. A revised biological assessment was submitted to NMFS and USFWS on June 10, 2015. NMFS issued a Letter of Concurrence on November 13, 2015, concurring with the Navy's ESA effect determination for fish (*not likely to adversely affect*) and MSA effect determination (*may adversely affect*) for the LWI preferred alternative, and indicating formal ESA consultation will be needed for the SPE project. In a concurrence letter dated March 4, 2016, USFWS stated that for both the LWI and SPE projects impacts to bull trout are not measurable and therefore insignificant, and impacts to marbled murrelets are discountable. In addition, the Navy submitted a JARPA to USACE and other regulatory agencies, requesting permits under CWA Section 401 and Section 404, and Rivers and Harbors Act Section 10 for the LWI project. In accordance with the CZMA, the Navy submitted a CCD to WDOE for the LWI project. When the SPE project is programmed and scheduled, the Navy will submit an application for permits under the CWA and Rivers and Harbors Act for the SPE project to USACE and WDOE and a CCD to WDOE.

3.2.1.2.4. Best Management Practices and Current Practices

BMPs and current practices that would avoid or minimize impacts of the proposed projects on marine vegetation and invertebrates would include those described in Section 3.1.1.2.3 for protection of marine water resources including hydrography, water quality, and sediments. Specifically, prevention of vessel and barge grounding, minimization of propeller wash, prevention of line and anchor drag, and protection of water quality all would minimize impacts to marine vegetation and invertebrates. BMPs and current practices to minimize and avoid impacts on marine vegetation and invertebrates include the following:

- Construction of the LWI will be conducted from barges in deep waters during high tides, from land, from a temporary trestle (south LWI only), and/or from already constructed parts of the LWI itself. Construction of the SPE will be conducted from barges in deep water.
- Spuds will be used to prevent barges from grounding in shallow areas including eelgrass beds.
- Vessel traffic will be excluded from the shallow areas outside of the 100-foot (30-meter) construction zones, which will be demarcated with clearly visible markers.
- Vessel operators will be provided maps of the project sites with eelgrass beds clearly marked so that the beds can be avoided.
- The Navy will require the construction contractor to prepare and implement debris management procedures for preventing discharge of debris to marine water and retrieving and cleaning up any accidentally discharged spills.
- The existing NAVBASE Kitsap Bangor fuel spill prevention and response plans (the *Commander Navy Region Northwest Oil and Hazardous Substance Integrated Contingency Plan* and the *NAVBASE Kitsap Bangor Spill Prevention, Control, and Countermeasure Plan* [COMNAVREGNWINST 5090.1, Integrated Contingency Plan, Annex G]) will apply to construction and operation of the proposed projects.
- The Navy will require the construction contractor to comply with RCW 77.15.290 (*Unlawful transportation of fish or wildlife — Unlawful transport of aquatic plants — Penalty*) and U.S. Coast Guard regulations to ensure vessels do not transport invasive aquatic plants.

In addition, the vessels used during construction would comply with U.S. Coast Guard regulations designed to minimize the spread of exotic species such as *Sargassum*. Mitigation measures are described in Appendix C, Mitigation Action Plan.

3.2.2. Environmental Consequences

3.2.2.1. APPROACH TO ANALYSIS

3.2.2.1.1. Vegetation Communities

The evaluation of impacts on marine vegetation considers whether there would be loss or degradation of marine vegetation including eelgrass or kelp, which are protected under federal or state law, or if there would be introduction of an exotic species, such as *Sargassum*, that would impact the growth of protected or native species. Construction activities that significantly degrade or eliminate marine vegetation habitat would be considered a direct impact on marine vegetation communities. Construction impacts include a 100-foot (30-meter) area of potential disturbance; actual impacts would likely be less. Operational changes to marine vegetation habitat, such as the introduction of shading over these habitats, would also be considered direct impacts on marine vegetation communities. The evaluation assumes that project construction and operation are in accordance with applicable regulations (Section 3.2.1.2.2) as well as permit conditions, BMPs, and current practices (Section 3.2.1.2.4).

3.2.2.1.2. Benthic Communities

The evaluation of impacts on benthic communities and shellfish considered whether the conditions resulting from project construction and operation would cause significant loss of benthic habitat or decreases in habitat value for benthic invertebrates or decreases in benthic invertebrate populations over the life of the project. The analysis considered the habitat displaced by new structures, potentially disturbed by construction vessels and activities, shaded by new structures, or otherwise altered. The evaluation assumes that project construction and operation are in accordance with applicable regulations (Section 3.2.1.2.2) as well as permit conditions, BMPs, and current practices (Section 3.2.1.2.4).

3.2.2.1.3. Plankton

The evaluation of impacts on plankton considers whether an increase of phytoplankton blooms or a decrease in plankton abundance would impact the aquatic organisms dependent on this food supply. The evaluation assumes that project construction and operation are in accordance with applicable regulations (Section 3.2.1.2.2) as well as permit conditions, BMPs, and current practices (Section 3.2.1.2.4).

3.2.2.2. LWI PROJECT ALTERNATIVES

3.2.2.2.1. LWI Alternative 1: No Action

Under the No Action Alternative, the LWI would not be built and operations in the area would not change from current levels. Therefore, there would be no impacts on marine vegetation, benthic communities, or plankton.

3.2.2.2.2. LWI Alternative 2: Pile-Supported Pier

VEGETATION COMMUNITIES FOR LWI ALTERNATIVE 2

The total area of habitat potentially disturbed during construction of LWI Alternative 2 would be 6.2 acres (2.5 hectares) in the nearshore (shallower than 30 feet [9 meters] below MLLW) and 6.9 acres (2.8 hectares) in deep water (deeper than 30 feet below MLLW) (Figure 3.2–8). Of those 13.1 acres (5.3 hectares), approximately 3 acres (1.2 hectares) support marine vegetation communities. Construction activities for Alternative 2 would result in impacts on approximately 1.1 acres (0.43 hectare) of eelgrass beds (approximately 3 percent of the eelgrass at the NAVBASE Kitsap shoreline), 2.6 acres (1.1 hectares) of green macroalgae community, 2 acres

(0.81 hectare) of red macroalgae community, and 0.57 acre (0.23 hectare) of kelp beds (Table 3.2–4; Figures 3.2–8, 3.2–9, and 3.2–10). Areas with less than 10 percent coverage of a particular vegetation type were not considered beds or communities of that type. The various types of macroalgae are expected to return to the area following construction. The hard substrate associated with the pier piles and steel plate anchors would provide habitat for marine vegetation species such as *Ulva*. The Mitigation Action Plan (Appendix C) describes the compensatory aquatic habitat mitigation action that the Navy would undertake as part of the Proposed Action. This habitat mitigation action, including mitigation for eelgrass, would compensate for the impacts of the Proposed Action to marine habitat and species.

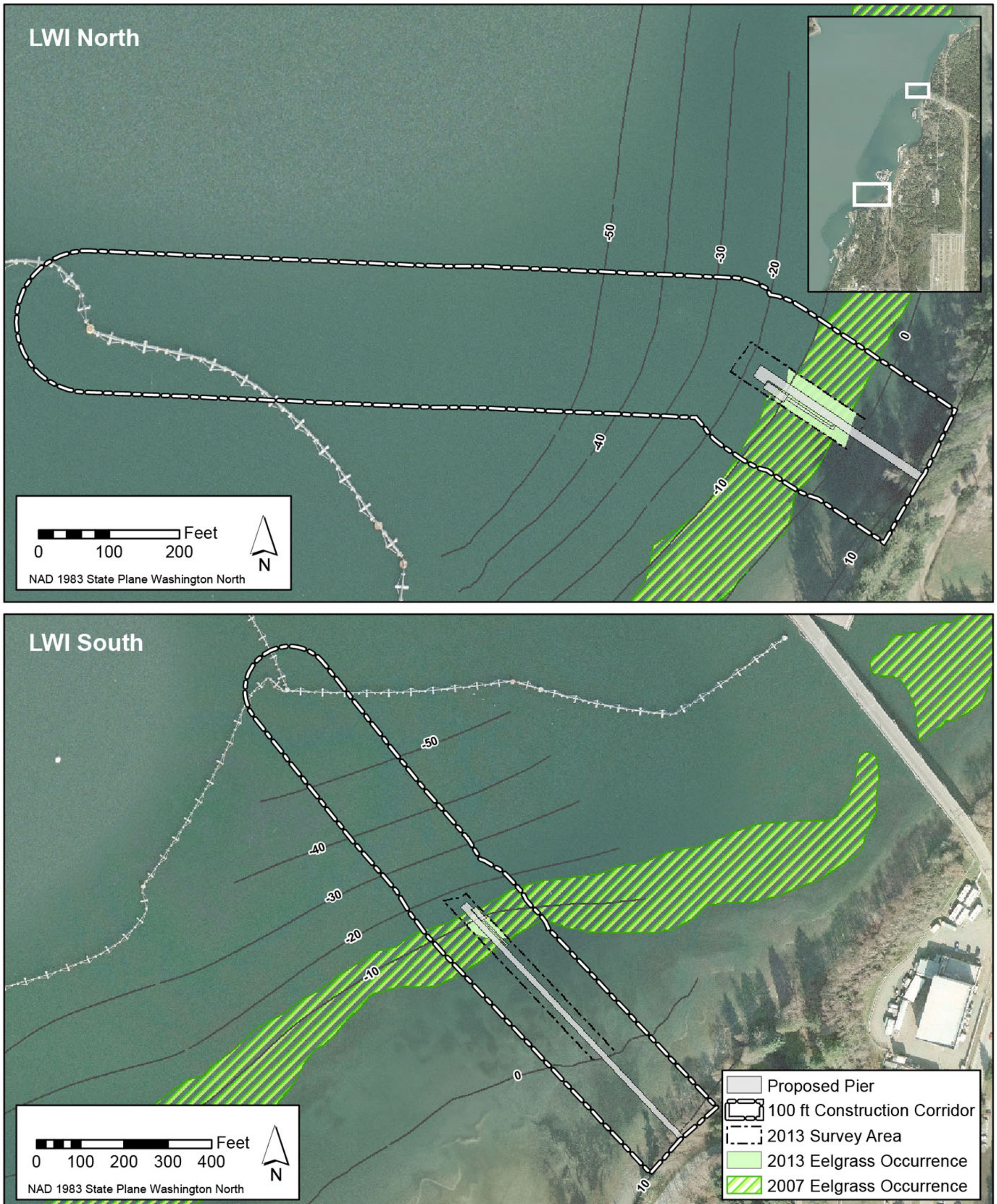
Table 3.2–4. Marine Habitat Impacted by LWI Alternative 2

Habitat Type	Potential Temporary Construction Disturbance Area in Acres (Hectares)[1]	Area Permanently Displaced by Structures[2] in Acres (Hectares)[3]	Operational Full Shading Area in Acres (Hectares)[3]	Operational Partial Shading Area in Acres (Hectares)[3]
Nearshore[4]	6.2 (2.5)	0.14 (0.056)	0.0029 (0.0012)	0.34 (0.14)
Deep Water[5]	6.9 (2.8)	0	0	0
Vegetation Type[6]				
Eelgrass[7]	1.1 (0.43)	0.024 (0.01)	0	0.076 (0.031)
Green Macroalgae	2.6 (1.1)	0.069 (0.028)	0	0.14 (0.058)
Red Macroalgae	2.0 (0.81)	0.016 (0.0066)	0	0.038 (0.015)
Brown Macroalgae (Kelp)	0.57 (0.23)	0.0025 (0.0010)	0	0.0072 (0.0029)

1. The potential construction disturbance area includes the LWI structure footprints and the areas within 100 feet (30 meters) of the proposed LWI structures. Areas actually disturbed by construction are likely to be substantially less. Calculated based on 2007 survey, which covered the entire 100-foot corridor.
2. Structures include piles, steel plate anchors, and the concrete pads supporting the abutment stairs.
3. Operational impacts on marine vegetation were calculated based on results of the 2013 survey, which covered the area 25 feet (7.6 meters) to either side of the centerline of the proposed LWI structures. Partially shaded areas would be the areas under the piers, gangways, and floating docks, which would be built with grating. Fully shaded areas would be those under the dolphin platforms, which are not vegetated.
4. Nearshore = the area shallower than 30 feet (9 meters) below mean lower low water (MLLW).
5. Deep water = the area deeper than 30 feet below MLLW.
6. Eelgrass and macroalgae overlap in their occurrence along the Bangor shoreline (e.g., Figure 3.2–3). Therefore, the total acreage of marine vegetation potentially impacted cannot be calculated by summing the values for each vegetation type.
7. Barges would avoid placing spuds or anchors in eelgrass beds wherever possible.

CONSTRUCTION OF LWI ALTERNATIVE 2

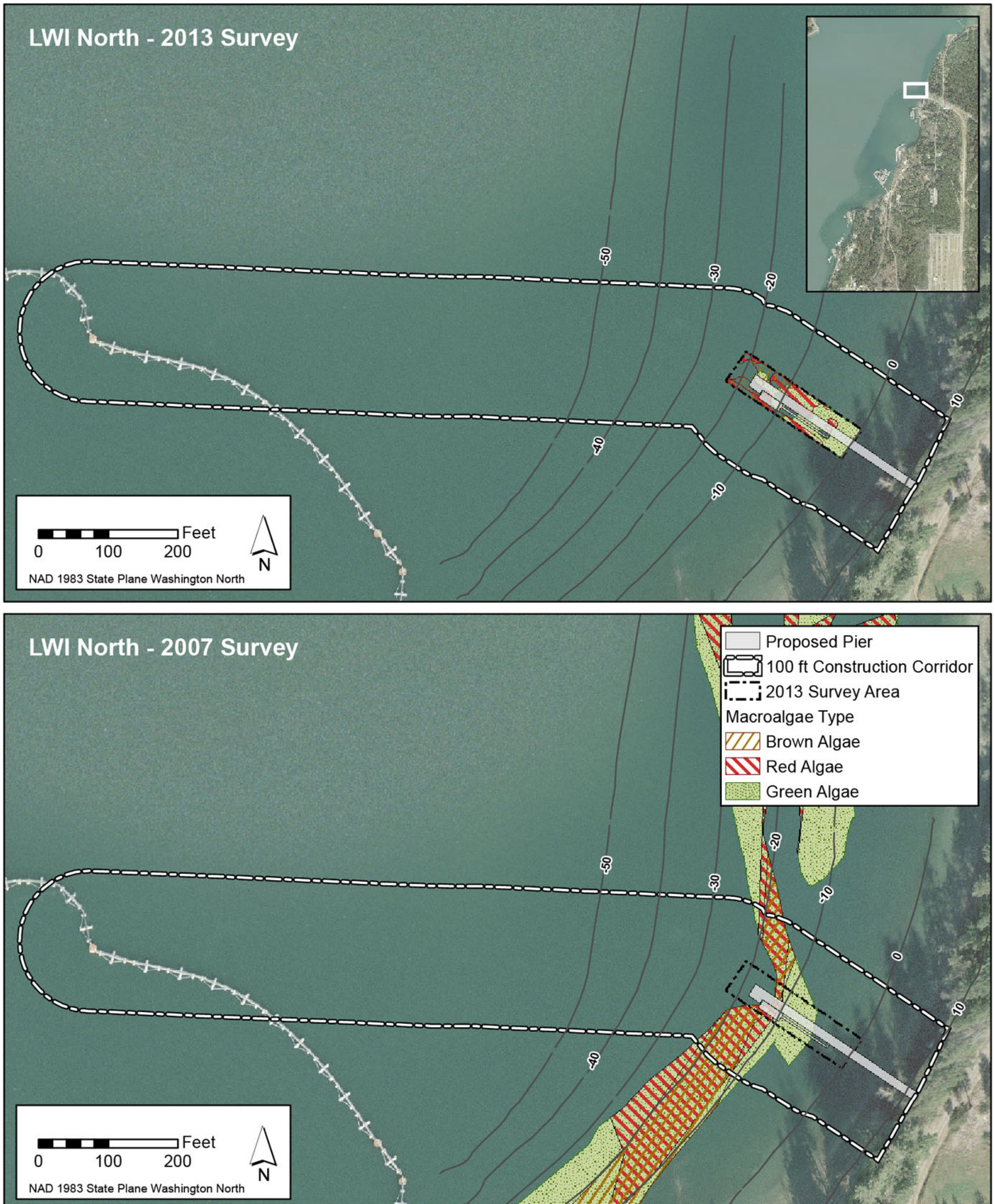
Barges, tugboats, and other vessels (e.g., skiffs) would be stationed at the LWI project sites during construction. Tugboats would bring in and position barges and then leave the sites. While the vessels would be directed to avoid grounding and damaging marine vegetation on the seafloor, the vegetation would be directly impacted by seafloor disturbance from anchor, spud, and steel plate anchor placement, pile installation, and vessel shading. Measures would be implemented to avoid underwater line drag and anchor drag (Appendix C). The impact area



Source: SAIC 2009; Leidos and Grette Associates 2013a

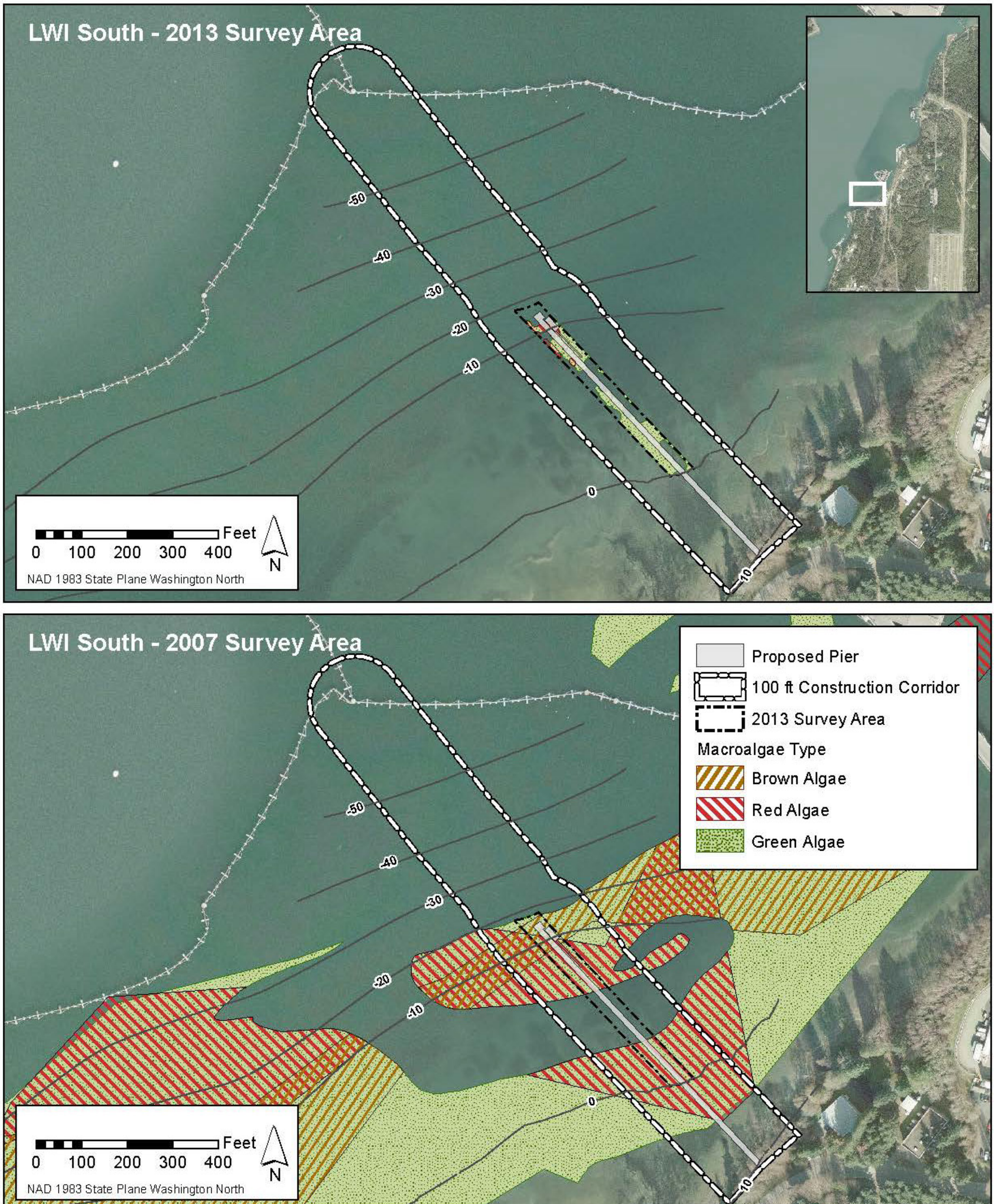
Figure 3.2–8. Disturbance Areas for Eelgrass near the LWI Alignments, Alternative 2

Figure 3.2–8. Disturbance Areas for Eelgrass near the LWI Alignments, Alternative 2



Source: SAIC 2009; Leidos and Grette Associates 2013a

Figure 3.2–9. Disturbance Area for Macroalgae near the North LWI Alignment, Alternative 2



Source: SAIC, 2009; Leidos and Grette Associates, 2013a

Figure 3.2-10. Disturbance Area for Macroalgae near the South LWI Alignment, Alternative 2

would consist of the LWI footprints where piles would be driven and pier construction would occur, as well as a 100-foot (30-meter) wide corridor where barges would be stationed and tugboats would maneuver the barges during pile installation and steel plate anchor placement. A possible source for construction-related impacts on marine vegetation would be from accidental debris spills from barges or construction platforms into Hood Canal. Debris spills could smother bottom vegetation. The Navy would require the construction contractor to prepare and implement debris management procedures for preventing discharge of debris to marine water and retrieving and cleaning up any accidental spills. Following completion of in-water construction activities, an underwater survey would be conducted to remove any remaining construction materials that may have been missed during previous cleanups.

As shown in Table 3.2–4, the potential construction disturbance area for Alternative 2 would include 1.1 acres (0.43 hectare) of eelgrass beds, 2.6 acres (1.1 hectares) of green macroalgae community, 2 acres (0.81 hectare) of red macroalgae community, and 0.57 acre (0.23 hectare) of brown macroalgae (primarily kelp). Potential impacts for north and south LWI sites are given under each vegetation type. Because vegetated communities comprise a mixture of vegetation types, the acreages are not additive. The total marine vegetation area potentially impacted by in-water construction activities would be 3 acres (1.2 hectares) (0.74 and 2.2 acres [0.3 and 0.91 hectare] for the north and south LWI project sites, respectively). Reconfiguration of the PSBs would require removing some existing PSB segments and their associated anchors and repositioning them to connect with the new LWI piers. As described in Chapter 2, there would be a net reduction of two PSB buoys and their associated mooring anchors.

While construction activities would be limited to the LWI piers and 100-foot (30-meter) surrounding area, not all of the seafloor within the 100-foot corridor would be disturbed. The areas likely to be highly disturbed during construction of Alternative 2 would be where the steel plate anchors are placed under the piers (approximately 0.035 acre [0.014 hectare] at the north LWI and 0.092 acre [0.037 hectare] at the south LWI) and where the permanent and temporary piles are placed (approximately 0.0039 acre [0.0016 hectare] at the north LWI and 0.0087 acre [0.0035 hectare] at the south LWI). (Pile disturbance contributes less than 10 percent of the total permanent seafloor displacement shown in Table 3.2–4.). The area of riprap placed at the base of the LWI abutments would be 4,100 square feet (381 square meters). The total length of riprap would be 410 feet (125 meters) and the width would be approximately 10 feet (3 meters). The riprap would extend from the MHHW elevation to approximately 10 feet above MLLW at the north LWI and 9 feet (2.7 meters) above MLLW at the south LWI. In addition, the riprap would be covered with native beach material. Therefore, construction impacts to marine vegetation communities that would occur within the 100-foot corridor identified in this section are conservative; the actual impact is expected to be substantially less.

Eelgrass

The north LWI would cross the southern portion of the eelgrass bed located immediately north of EHW-1 (Figure 3.2–8). A maximum of 0.51 acre (0.21 hectare) of the 12-acre (4.9-hectare) north LWI eelgrass bed would be impacted during construction. The south LWI would cross the northeastern portion of the eelgrass bed located immediately south of Delta Pier. A maximum of 0.54 acre (0.22 hectare) of the 7.6-acre (3.1-hectare) south LWI bed would be impacted during construction. These areas include eelgrass directly under the proposed piers, as well as within

100 feet (30 meters) of the structures. None of the temporary trestle piles would be installed within the south LWI eelgrass bed. The PSB anchoring systems installed at the end of the LWI piers would not be installed within eelgrass beds. The total eelgrass potentially disturbed during construction would be 1.1 acres (0.43 hectare).

Approximately 0.014 and 0.0075 acre (0.0057 and 0.003 hectare) of the north and south LWI eelgrass habitat, respectively, would be permanently eliminated when the steel plate anchors are installed. An additional 0.0017 and 0.00073 acre (0.00067 and 0.00029 hectare) would be permanently eliminated by the piles. Eelgrass is a rooted aquatic plant that depends on biogeochemical processes in sediment to maintain growth (Hart Crowser 1997; Thom et al. 1998; review in Mumford 2007). Sediments also protect the roots from drying out and being eaten by herbivores. Repeated disturbance around individual plants, such as would occur from pile driving, can result in death or shifting of the bed location (Hart Crowser 1997). Over time, events causing erosion would remove sediments from the root system and expose below-ground plant parts to degradative processes. In addition, vessel propeller wash can scour and redistribute sediments and reduce the amount of light energy reaching the plants at the sea floor (Thom et al. 1998). Barges and boats involved in pile installation and steel plate anchor placement would be expected to impact existing eelgrass beds (e.g., by anchor and spud placement) in those areas where the proposed pier structures would cross existing beds, extending 100 feet laterally from the pier footprints to include areas where the vessels would be stationed and most boat movement activities would occur. Propeller wash impacts on marine vegetation would be limited to shallower waters.

Eelgrass is sensitive to low light levels (reviews in Nightingale and Simenstad 2001a and Mumford 2007), and marine plant communities in Washington, including eelgrass, can be limited by light availability (Thom and Albright 1990). Portions of the eelgrass beds at the north and south LWI project sites disturbed by the construction activities would be expected to lose individual plants and become less dense but would be expected to recover after construction is completed.

Eelgrass within the 100-foot (30-meter) wide construction corridor that is not directly impacted would potentially experience reduced growth due to increased turbidity and particle settlement on individual plant blades, as well as between the plants. In the shallow areas where eelgrass occurs, sediment resuspension would be associated with pile installation, steel plate anchor placement, and barge operations. Due to the sandy composition of the surficial sediments, the nature of the water column currents in those areas, and the shallow depths at the sites, the majority of the sediment particles would quickly fall out of suspension (see discussion of impacts on water quality in Section 3.1.2.2.2). Resuspended, fine-grained sediments would be subject to rapid dilution by currents and eventual flushing during subsequent tidal exchanges. Therefore, the duration and spatial extent of turbidity plumes generated by in-water construction activities would be minimal and there would be minimal settling of fines on eelgrass. In addition, eelgrass would experience lower irradiance during construction due to vessel shading. The eelgrass area subject to shading by construction vessels and barges during the construction period is assumed to be equal to that within the 100-foot construction area (0.51 and 0.55 acre [0.21 and 0.22 hectare] at the north and south LWI project sites, respectively); however, this is a highly conservative estimate because the vessels would not be stationary for the entire construction period and would be positioned to avoid eelgrass beds to the extent possible (Appendix C, Section 5.1.2).

Studies of seagrass recoveries in natural systems following clearing or declines due to turbidity plumes found full recoveries ranging from 2 to 6 years (Rasheed 1999; review in Erftemeijer and Lewis 2006). Factors that would influence the rate and success of eelgrass recovery include the extent of sediment disturbance and competition from macroalgae such as *Ulva*.

Oil spills could potentially occur during construction, which could result in the loss of eelgrass. As described in Section 3.1.2.2.2, under Water Quality, the existing facility response and prevention plans for the Bangor shoreline provide guidance that would be used in the event of a spill, including a response procedures, notification, and communication plan; roles and responsibilities; and response equipment availability. The contractor would also prepare and implement a spill response plan (e.g., an SPCC Plan) to clean up fuel or fluid spills. In the event of an accidental spill, response measures would be implemented immediately to reduce the potential for exposure to the environment.

In summary, placement of the steel plate anchors and piles would permanently eliminate an estimated 0.016 and 0.0083 acre (0.0064 and 0.0034 hectare) of eelgrass from the north and south LWI eelgrass beds, respectively. In addition, some disturbances to eelgrass beds would occur within the construction corridor, potentially affecting up to 0.51 acre (0.21 hectare) of the 12-acre (4.9-hectare) north LWI eelgrass bed and 0.55 acre (0.22 hectare) of the south LWI 7.6-acre (3.1-hectare) eelgrass bed. Eelgrass is expected to recover in disturbed areas within 2 to 6 years, depending on the extent of the disturbance. The permanent and temporary losses of eelgrass would be mitigated as described in the Mitigation Action Plan (Appendix C).

Macroalgae

Macroalgae, which occur at a greater range of depths than eelgrass at the LWI project sites (SAIC 2009), require lower light levels than eelgrass for growth (Frankenstein 2000; Nightingale and Simenstad 2001a), and would be expected to recruit back to the seafloor following construction. As described in above in Section 3.2.1.1.2, green macroalgae, such as sea lettuce, have rapid growth rates during summer and early fall months when light intensity is highest in the Pacific Northwest (Nelson et al. 2003). Macroalgae communities in the construction zones would be at their maximum biomass prior to the onset of pile driving activities in August, which would contribute to rapid recovery after construction is completed.

A maximum of 2.6 acres of seafloor supporting green macroalgae (0.40 and 2.2 acres [0.16 and 0.9 hectare] at the north and south LWI project sites, respectively), 2 acres (0.81 hectare) of red macroalgae (0.21 and 1.8 acres [0.086 and 0.72 hectare] at the north and south LWI project sites, respectively), and 0.57 acre (0.23 hectare) of seafloor supporting brown macroalgae (0.19 and 0.39 acre [0.075 and 0.16 hectare] at the north and south LWI project sites, respectively) would be impacted during construction (Table 3.2–4; Figures 3.2–9 and 3.2–10). The impact area would primarily occur within 100 feet (30 meters) of the LWI project sites where most direct (e.g., vessel shading), and indirect (e.g., turbidity, sedimentation) impacts would occur. Installation of the steel plate anchors on the seafloor would eliminate approximately 0.065, 0.015, and 0.0024 acre (0.026, 0.0062, and 0.001 hectare) of green, red, and brown macroalgae community, respectively. Installation of the temporary trestle piles at the south LWI would impact approximately 0.009 acre (0.0035 hectare) of green and red macroalgae.

Reconfiguration of the PSBs would result in the net reduction of two PSB buoys and their associated mooring anchors, one at each of the LWI project sites. This action would result in a minimal loss of macroalgae fouling community associated with anchors that are removed entirely, elimination of the community where anchors are relocated, and recolonization of areas where anchors are removed. Bottom-disturbing activities during construction could dislodge macroalgae, creating drifting algal mats. Drift algae are important sources of food and habitat for some fish and invertebrates. Drifting algal mats have the potential to shade and smother eelgrass. However, it is not anticipated that algae would be detached in sufficient quantities during construction to create large mats that would negatively affect eelgrass.

Propeller wash impacts on marine vegetation would be limited to shallower waters. No impacts on macroalgae would be expected beyond the 100-foot (30-meter) areas. Oil spills could also potentially occur during construction, which could result in the loss of macroalgae. In the event of an accidental spill, response measures as noted above would be implemented immediately to reduce potential exposure to the environment.

Operation/Long-term Impacts of LWI Alternative 2

The total area of marine habitat impacted by operation of LWI Alternative 2 would be 0.15 acre (0.061 hectare) in the nearshore (Table 3.2–4), which is the total area displaced by the piles, steel plates, and abutment stair landings (0.14 acre [0.055 hectare]), a total of 0.07 acre (0.028 hectare) of which is vegetated. Marine habitats in deep water (deeper than 30 feet [9 meters] below MLLW) would not be impacted by the LWI structures. Operational activities would primarily impact marine vegetation through the habitat fragmentation that would occur from the piles and steel plate anchors in eelgrass (total of 0.024 acre), although the piles and steel plates would serve as attachment sites for macroalgae species. Partially shaded areas would continue to support eelgrass and macroalgae. The relocated PSB systems at the end of the LWI piers would be located beyond the eelgrass beds.

Maintenance of the LWI piers would include routine inspections, repair, and replacement of facility components as required. These activities would not directly affect marine vegetation; however, fouling organisms, including macroalgae, would be periodically cleared from the below-pier mesh and PSB guard panels. Debris released by mesh and PSB guard panel cleaning would be small and dispersed by currents such that it would not smother underlying or nearby marine vegetation. Measures such as those documented under Section 3.1.2, would be employed to avoid discharges of contaminants to the marine environment during LWI operations. Propeller wash from small boat operations at the floating docks would have the potential to cause scour and suspension of bottom sediments, but these operations would be infrequent.

Eelgrass

The seafloor areas shaded by the piers would be minimized by the use of grating in the piers that allows 65 percent of light to pass through, restriction of pier widths to the minimum necessary to meet structural and program requirements, and the height of the piers over the water (approximately 17 feet [5 meters] above MLLW). The gangways and floating docks also would be constructed using grating. An increased structure height over the water diminishes the degree of shading by providing a greater distance for light to diffuse and refract around its surface as the sun arcs across the sky (review in Nightingale and Simenstad 2001a). The shading effect of the piers would be greatest at higher tides when the pier heights over water would range from 1 to 5 feet (0.3 to 1.5 meters). This daytime shadow effect would occur during less than 1 percent of all daylight hours throughout the year. During the rest of the time, the pier clearances would be 5 feet (1.5 meters) or more over the water. An overwater trestle at Indian Island, Washington, constructed with grating material allows approximately 50 percent of the light to pass through. Eelgrass and other marine vegetation continue to be present under this trestle, which is nearly four times as wide as the proposed LWI piers (approximately 45 feet [14 meters] wide) (Kalina 2011, personal communication). Therefore, it is expected that the areas under the piers, floating docks, and gangways outside of the steel plate and pile footprints would continue to support eelgrass growth.

As described in Section 3.1.2.2.2, support piles installed for the in-water barriers would alter current flows and wave propagation locally, which would cause localized erosion of fine-grained sediments near the base of some piles and settling and accumulation of fine-grained sediments at the base of other piles (Chiew and Melville 1987). Turbulence associated with tidal current flows around the piles would result in a gradual coarsening of surface sediments and thin scouring initially around the perimeter of each pile and groups of piles (Sumer et al. 2001). Where eelgrass occurs under the piers, the presence of the beds would retard erosion to some degree due to the eelgrass root systems and the slowing of water velocities over eelgrass beds (reviews in Davison and Hughes 1998 and Bos et al. 2007). Further, shells and barnacles that accumulate on the piles would also slough off over time and contribute to the sediment content below the piles. The loss of fine-grained sediment would be offset by the accumulation of shell and barnacle particles. Similar effects on the bathymetric setting would be expected from the mesh. The presence of these structures would promote temporary sediment accumulation on one side, which could vary depending on the direction of storm-related waves and strength of wave-induced turbulence. While these changes would occur gradually over time, the presence of the steel plates and mesh would result in some fragmentation of the eelgrass beds in which they are placed.

The PSBs and associated anchoring systems for the segments connected to the north and south LWI piers would lie outside of, and therefore would not impact, the existing eelgrass beds.

The floating dock would be located in shallow waters and there would be a potential for propeller wash from the security boats to disturb eelgrass due to periodic increases in turbidity associated with resuspended bottom sediments. However, small boat operations would be infrequent. No mitigation measures beyond current practices in place would be required.

Macroalgae

The north and south LWI structures would partially shade approximately 0.042 acre (0.017 hectare) and 0.1 acre (0.041 hectare) of green macroalgae, respectively. The north and south LWI structures would each partially shade approximately 0.019 acre (0.0078 hectare) of red macroalgae. The north LWI and south LWI structures would partially shade approximately 0.005 acre (0.002 hectare) and 0.0024 acre (0.001 hectare) of brown macroalgae, respectively. As with eelgrass, the extent of macroalgae shading by the overwater structures would be minimized by the design of the structures: the use of light transmitting materials, the height of the piers over water, and the narrow width of the piers. Because macroalgae have considerably lower light requirements than eelgrass (Frankenstein 2000; Nightingale and Simenstad 2001a), macroalgae under the piers, gangways, and floating docks also would not be expected to die off, and these areas would not be negatively impacted for this marine vegetation type.

The piles and other underwater structures such as anchors would support algae common to marine fouling communities, such as sea lettuce (*Ulva*) and acid weeds (*Desmarestia*) (Goyette and Brooks 2001) (Figure 3.2–11). Colonization would vary among piles and water depth associated with light availability and overwater shading (e.g., Navy 1988). Macroalgae would colonize the piles within months (Kozloff 1983) and should be well established within a year (Goyette and Brooks 2001). Drift algae may accumulate on the mesh, PSB guard panels, and piles. In the short term, the drift algae would provide food and habitat for invertebrate and fish species. Macroalgae colonizing the mesh and PSB guard panels and drift algae accumulated on these structures, however, would be periodically removed during maintenance.

Figure 3.2–11. Green Macroalgae (*Ulva*) Attached to a Shoreline Pier on NAVBASE Kitsap Bangor

The floating docks would be located in shallow waters and there would be a potential for propeller wash from the security boats to disturb macroalgae due to increased turbidity from resuspended sediments. However, small boat operations would be infrequent.

BENTHIC COMMUNITIES FOR LWI ALTERNATIVE 2

Construction of the pile-supported piers would result in several impacts on the benthic community, including loss of soft-bottom habitat from pile and steel plate anchor placement, disturbance to the soft-bottom habitat from propeller wash, increased turbidity and suspended solids, and increased noise and vibration during pile placement. Operational impacts would include overwater shading and permanent replacement of soft-bottom habitat with hard-bottom habitat due to the installation of piles, steel plate anchors, and riprap. These changes would adversely impact some species and benefit others, resulting in some localized changes in the number and composition of benthic species. The impacts of the riprap would be minimized by covering the riprap with native beach material.

CONSTRUCTION OF LWI ALTERNATIVE 2

The benthic and shellfish communities would be directly impacted by substrate disturbance by anchor, spud, and steel plate anchor placement, and pile installation. Benthic communities would also be impacted by turbidity and sediment redeposition resulting from these activities and vessel propeller wash, as well as by vessel shading. The impact area would consist of the north and south LWI footprints where piles would be driven, steel plate anchors placed, and new pier construction would occur, as well as a 100-foot (30-meter) wide area surrounding the sites where barges would be stationed, tugboats would maneuver the barges during pile installation and steel anchor placement, and other boat-based construction activity would occur. In addition, there would be additional pile installation and pile removal of a temporary trestle at the south LWI pier. There would also be some benthic community disturbance during the PSB reconfiguration where the anchors are removed and repositioned. Long-term conversion of these areas from soft to hard bottom is discussed below under Operation/Long-term Impacts.

It is expected that benthic and shellfish communities would be disturbed and partially eliminated in the direct construction areas and the 100-foot (30-meter) wide corridors around these areas. Total potential disturbance area for the benthic community would be approximately 13.1 acres (5.3 hectares) (Table 3.2–5), including 6.2 acres (2.5 hectares) at the north LWI project site and 6.9 acres (2.8 hectares) at the south LWI project site. Areas beyond the 100-foot wide corridors would be protected by limiting construction equipment and activities to the construction corridor. The only areas potentially highly disturbed during construction of Alternative 2 would be where the piles and steel plate anchors are placed under the piers, and where excavation for the abutments is conducted. The areas covered by the piles, steel plate anchors, and concrete pads for the north and south LWI piers, and abutment stairs would be approximately 0.039 and 0.1 acre (0.016 and 0.04 hectare), respectively. Therefore, the 100-foot wide corridor construction impacts identified in this section are conservative; the actual impact is expected to be substantially less. The abutment stair landings would be located above the elevations where shellfish have been observed (above 9 feet [2.7 meters] above MLLW versus maximum elevations of 7 feet [2.1 meters] above MLLW at the north LWI and 4 feet [1.2 meters) above MLLW at the south LWI).

Repositioning of the PSB anchors would be conducted using a barge-mounted crane and result in minor increases in turbidity at those sites. Installation of the cofferdams and excavation for the abutments would be conducted above the oyster beds at both locations and would not impact oysters or other shellfish below in the intertidal zones. Potential impacts on the benthic community from erosion and turbidity during abutment construction would be reduced by limiting construction activities to low tides (i.e., constructing in the dry only). The abutments themselves would be located above MHHW, which is above the benthic community habitats. Both the abutment stair landings (12 square feet [2 square meters] at each LWI) and a portion of the riprap at the base of the abutments would be placed below MHHW. The area of riprap placed at the LWI abutments would be 4,100 square feet (381 square meters). The length of

Table 3.2–5. Benthic Community Resources Impacted by LWI Alternative 2

Impact Type	Benthic Community Area in Acres (Hectares)	Oyster Bed Area in Acres (Hectares)
Potential Temporary Construction Disturbance[1]	13.1 (5.3)	0.88 (0.35)
Permanent loss under piles	0.01 (0.004)	0.00058 (0.00023)
Permanent loss under steel plates, and concrete pads[2]	0.13 (0.051)	0.023 (0.0092)
Operational Partial Shading[3]	0.34 (0.14)	0.054 (0.022)
Operational Full Shading[3]	0.0029 (0.0012)	0

1. The area within the 100-foot (30-meter) wide construction corridor.
2. The impact area for the benthic community would include the oyster beds and the areas in the pile footprints; thus, the oyster bed impact areas are subsets of the benthic community impact areas. The oyster bed area lost under steel plates was calculated using the width of the steel plates and average width of the north and south LWI oyster beds of 40 and 140 feet (12 and 43 meters), respectively.
3. Partially shaded areas would be the areas under the piers, floating docks, and gangways, which would be built with grating; fully shaded areas would be those areas under the dolphin platforms.

riprap would be 410 feet (125 meters) and the width would be approximately 10 feet (3 meters). The riprap would extend from the MHHW elevation to approximately 10 feet above MLLW at the north LWI and 9 feet (2.7 meters) above MLLW at the south LWI. Since no benthic communities occur in this zone, no impact would occur to benthic communities from the placement of riprap at base of abutment structures.

The increased potential for spills during construction, spill response, and debris cleanup would be as described above for marine vegetation under Vegetation Communities.

Disturbance from Placement of Piles, Anchors, and Steel Plate Anchors

Construction of LWI Alternative 2 would impact benthic communities through disruption of the sediment surface, which would result in at least partial loss of the community, including geoducks, in the affected areas. Barges used during construction typically have drafts (amount of barge below the water surface) up to 3 feet (1 meter) and would normally operate in water depths of 6 feet (2 meters) or more to prevent grounding. The barges would be at the construction site for up to 2 years and would cause shading under the barges, which could impact survival of the benthic community. An extensive oyster bed occurs at the south LWI Site (average width approximately 140 feet [43 meters]), and a more narrow, fringe oyster bed occurs north of EHW-1 at the north LWI site (average width approximately 40 feet [12 meters]) (Figure 3.2–5). Piles and steel plate anchors for the piers for Alternative 2 would be placed in these beds, and oysters and other benthic organisms in the footprints would be permanently lost. Assuming 100-foot (30-meter) wide construction corridors, up to 0.19 acre (0.079 hectare) of the north LWI oyster bed and 0.68 acre (0.28 hectare) of the south LWI oyster bed could be disturbed during construction. However, impacts on shellfish, including geoducks, due to sediment disturbance and increases in turbidity most likely would be within the narrower zone where the piles and steel plate anchors are installed; there would be fewer impacts on shellfish in the larger 100-foot wide corridor.

Some benthic organisms in the footprints of the barge anchors and spuds, as well as the temporary and permanent piles and steel plate anchors, would be physically crushed. Construction activities would also cause turbidity and sediment redeposition that would impact the benthic community. The areas within the 100-foot (30-meter) wide construction corridors would have higher levels of turbidity and disturbed sediments that would settle on top of the existing benthic community (see discussion of turbidity and suspended sediments in Section 3.1.2.2.2, under Water Quality). Suspension and surface deposit feeders would be the most susceptible to burial. Mobile infaunal deposit feeders would be more likely to survive burial due to their ability to burrow upward through the newly deposited material. Based on various studies of critical burial depths for different benthic organisms, critical burial depths appear to range from 2 inches (5 centimeters) for suspension and surface deposit feeders, to 12 inches (30 centimeters) for active burrowers (Maurer et al. 1978; Nichols et al. 1978). Turbidity plumes would be short lived and settling of resuspended fines on benthic communities would be minimal. Burial depths in the 100-foot wide construction corridor may exceed 2 inches (5 centimeters) in limited areas but would not approach 12 inches (30 centimeters) except in localized areas, such as where anchors and spuds would be placed and where temporary piles are installed and then pulled. The only areas potentially highly disturbed during construction of Alternative 2 would be the areas where the steel plate anchors for the mesh would be installed under the piers and where the temporary trestle piles would be installed at the south LWI project site.

Filter- and suspension-feeding invertebrates (e.g., bivalves, tunicates, crustaceans, and some polychaetes) may close their shells, suspend feeding, or increase feeding rates in response to turbidity increases (LaSalle et al. 1991; Cruz-Rodriguez and Chu 2002). Marine invertebrates have been shown to be tolerant of relatively high suspended solid concentrations over periods of hours to days, with adverse impacts limited to prolonged exposures (e.g., continuously up to 21 days) and/or to high concentrations (e.g., fluid mud) (reviews in LaSalle et al. 1991; O’Connor 1991; Clarke and Wilber 2000; and Wilber and Clarke 2001, 2010). However, the length of time for construction (5 to 6 days per week for up to 6 months for construction of the pier plus up to another 6 months for installation of the mesh) and the increased turbidity levels would likely result in short- to long-term loss of localized areas of the benthic community, including geoducks, within 100 feet of the project site.

Complete loss, however, would be limited to highly disturbed areas such as the small areas disturbed by anchor and spud placement, and the areas where the permanent and temporary piles and steel plate anchors are installed. Most affected areas would experience some reduction in diversity and abundance of benthic species. Opportunistic species, such as small tubiculous, surface-dwelling polychaetes, would be favored for recolonization where sediments accumulate.

Previous studies of dredged, sediment capped, and other disturbed sites show that many benthic and epibenthic invertebrates rapidly recolonize disturbed bottom areas within 2 years of disturbance (CH2M Hill 1995; Romberg et al. 1995; Parametrix 1994a, 1999; Anchor Environmental 2002; Vivan et al. 2009). Dredging and placement of clean sediment caps at contaminated sites provide extreme examples of benthic recovery from disturbance, demonstrating how benthic organisms have the capability to recover from habitat perturbations and recolonize disturbed areas over time. Many benthic organisms lost due to turbidity and bottom disturbances by barges, tugboats, anchors, and spuds would recolonize the construction areas quickly, for example, mobile species such as crabs and short-lived species such as polychaetes, and become reestablished over a 3-year period after sediment disturbance at the sites have ceased. Less mobile, longer-lived benthic species such as clams can take 2 to 3 years to reach sexual maturity (Chew and Ma 1987; Goodwin and Pease 1989) and may require 5 years to recover from disturbance such as smothering by sediment (study discussed in Chew and Ma 1987). Therefore, shellfish beds impacted by LWI construction would be expected to recover within approximately 5 years after construction. Ecological productivity would be reduced during the 5-year recovery period.

Noise

Indirect impacts associated with increased underwater sound and vibration during pile driving would occur during construction. No studies have been identified that document invertebrate responses to pile driving sound. Although there are few studies of underwater sound impacts on invertebrates, available information suggests a variety of species (crabs, shrimp, clams, mussels, squid, sea cucumbers) tolerate temporary exposures to increased sound levels within the range expected with pile driving without long-term adverse impacts (Stocker 2001; Christian et al. 2003; Moriyasu et al. 2004; Kent and McCauley 2006).

Sound thresholds associated with sublethal physiological or behavioral responses are not well understood and apparently vary among invertebrate species. For example, egg development of snow crabs was delayed by exposure to seismic air gun peak sound decibel (dB) levels of 201 to 227 dB peak (Christian et al. 2003), but no impacts on Dungeness crab larvae were observed at mean sound pressures as high as 231 dB (Root Mean Square [RMS]) (Pearson et al. 1994). Continuous exposure of sand shrimp in aquaria to a high sound-level increase (30 dB in the 25 to 400 hertz [Hz] bandwidth) resulted in sublethal behavioral changes and reduced growth and reproduction (review in Moriyasu et al. 2004). Consequently, invertebrates may experience acoustic stress and disturbance as a result of impact hammer pile driving. Based on evidence from the limited scientific studies conducted to date, reproductive impairment of some invertebrate species, in the form of delayed egg maturity, could result from pile driving for Alternative 2. These impacts would not be expected to extend beyond the duration of pile driving (up to 80 days), and the peak sound levels with the potential to cause these impacts would occur only within the 33-foot (10-meter) radius around any pile being proofed with an impact hammer. As described in Chapter 2 and Appendix D (Noise Analysis), most of the piles would be driven using the vibratory method, which would result in much lower noise levels that are not expected to result in impacts on benthic species.

OPERATION/LONG-TERM IMPACTS OF LWI ALTERNATIVE 2

The overwater structures of Alternative 2 would introduce limited shading in the immediate area of 0.34 acre (0.14 hectare) (Table 3.2–5), including 0.012 acre (0.0048 hectare) of the oyster bed at the north LWI and 0.042 acre (0.017 hectare) of the oyster bed at the south LWI. Regional studies have shown that light-blocking overwater structures can directly impact benthic productivity (Simenstad et al. 1999). For Alternative 2, the shaded area would be functionally minimized due to design elements incorporated into the structure, including the use of grating or other light-transmitting materials in the piers, floating docks, and gangways, the height of the piers over the water (approximately 17 feet [5 meters] above MLLW, which allows more sunlight to pass under the pier as the sun arcs across the sky), and the relatively narrow width.

Only the areas under the dolphin platforms would be fully shaded; however, these structures would not be located above the oyster beds. Therefore, there would be no shading impacts on oysters and very limited full shading impacts (0.0029 acre [0.0012 hectare]) on the rest of the benthic community.

Because there would be no vehicular traffic associated with the LWIs, there would be no requirement to collect and treat runoff from the LWI structures, and drainage would be to Hood Canal. Small boat operations at the floating docks would be infrequent (estimated two per day), minimizing the potential for propeller wash to cause suspension of bottom sediments. The risk of spills during operation would be minimized through adherence to COMNAVREGNWINST 5090.1, Integrated Contingency Plan, Annex G. Containment practices would be consistent with the existing Bangor shoreline structures, including the use of in-water containment booms and response plans (for more detail on impact reducing measures see Section 2.3.4 and Appendix C). Therefore, operation of the LWIs would not degrade water quality or impact benthic and shellfish communities.

Placement of piles and steel plate anchors would result in the long-term conversion of up to 0.038 acre (0.016 hectare) and 0.098 acre (0.04 hectare) of soft-bottom to hard-bottom habitat at the north and south LWIs, respectively. The abutment stair landings and riprap would be placed below MHHW, resulting in conversion of a total of 4,124 square feet (383 square meters) of soft-bottom habitat, but these would be located at elevations well above shellfish habitats. The impacts of the riprap would be minimized by covering the riprap with native beach material. Reconfiguration of the PSB anchors would result in the net gain of soft-bottom habitat where existing anchors are removed. The piles and anchors would become colonization sites for hard-bottom species such as mussels (*Mytilus* sp.), tunicates, and sea anemones that would attach to the piles and anchors (the fouling community). Fouling communities support other species such as amphipods, annelids, gastropods, and predatory sea stars that feed and take refuge in these habitats (Kozloff 1983; Cohen et al. 1998; Brooks 2004; Cordell 2006; PSAT 2006). The decrease in soft-bottom habitat and increase in hard substrate habitat would result in a localized change in species composition (Glasby 1999; Atilla et al. 2003), particularly in the areas where eelgrass abundance is reduced. Colonization of new hard surfaces would begin within months (Schoener and Schoener 1981; Kozloff 1983; Goyette and Brooks 2001; Brooks 2004). A study of wooden piles at a Pacific Northwest location found that the pile community had twice as many species and nearly eight times the density as is typically found in Pacific Northwest sediments (Brooks 2004). However, steel piles would not be expected to attain the same epifaunal diversity as wood piles because steel loses more heat than wood during cold winter conditions, resulting in possible unfavorable conditions for the animals (Brooks 2009, personal communication).

The habitat value of the LWI sites would be significantly reduced in the steel plate anchor areas for species that utilize eelgrass. For example, Dungeness and red rock crabs use eelgrass for larval settlement, as refuge from predators, and as feeding sites (review in Mumford 2007). Macroalgae such as kelp, which also provide some habitat value for benthic organisms, would be expected to recover and to colonize the surface of the anchors.

As discussed for hydrography and sediment impacts in Section 3.1.2.2.2, the presence of the mesh would promote settling of suspended particles and accumulation on the seafloor (snow-fence effect). These changes would occur gradually over time, would be localized at the piles and mesh, and would not adversely impact benthic communities. The placement of riprap at the base of the abutments would prevent scour at the structure base, but effects to circulation below MHHW may occur. However, because the base of the riprap would be submerged infrequently and covered with native beach material, water flow would not be restricted and hydrological conditions would not be affected at the project site except on a very localized basis (i.e., within meters of the structures). Further, because this riprap is located very high in the intertidal zone, no significant impacts to benthic communities would be expected.

Maintenance of the LWIs would include routine inspections, repair, and replacement of facility components (no pile replacement) as required. Measures would be employed to minimize the likelihood of discharging contaminants to the marine environment (Section 3.1.2.2.2, under Water Quality). Any benthic fouling community that established on the underwater mesh and PSB guard panels would be scraped free during annual maintenance and carried on currents until they sink to the bottom. Most of these organisms would not survive due to their need for attachment and/or for specific water depths for habitat (e.g., mussels). There would be periodic impacts on turbidity and DO when the pier mesh and PSB guard panels are cleaned during maintenance activities. Any reductions in DO as a result of mesh and guard panel cleaning activities would be localized and transient, and would not impact benthic communities. Debris released by mesh and guard panel cleaning would be small and dispersed by currents such that it would not smother underlying or nearby benthic organisms.

PLANKTON FOR LWI ALTERNATIVE 2

During construction and operation of Alternative 2, there would be minimal changes in plankton distribution and abundance.

CONSTRUCTION OF LWI ALTERNATIVE 2

No direct impacts on plankton would occur during construction because plankton are not sessile and subject to impacts associated with placement of the piles and other in-water structures for the LWI. However, as described for construction impacts on water quality in Section 3.1.2.2.2, pile installation and propeller wash from construction vessels would result in suspension of bottom sediments and formation of a turbidity plume. Turbid conditions would be short-term and localized, and suspended sediments would disperse and/or settle rapidly (within a period of minutes to hours) after construction activities cease (see discussion of impacts on water quality in Section 3.1.2.2.2). Increases in turbidity associated with dredging, backfilling, or other large-scale bottom disturbances, can temporarily alter phytoplankton communities (Hanson et al. 2003). However, sediment disturbances from pile installation and anchor movement would not create such high levels of turbidity. Pile driving would occur between August and mid-January, outside of the most productive period for phytoplankton in Puget Sound (May) (Strickland 1983). Further, because Alternative 2 would not increase nutrients in Hood Canal, construction of the LWI piers and PSB connections would not cause increases in toxin-associated species such as *Pseudo-nitzschia*, which could harm other aquatic organisms.

Potential impacts of increased water column turbidity on zooplankton include entrapment and sinking of plankton due to particle ingestion or adhesion, and decreased survival, growth rates, and body weight resulting from clogged and damaged feeding appendages (Pequegnat et al. 1978; O’Connor 1991; USACE 1993). However, the majority of zooplankton are filter-feeders and are well adapted to suspended materials in the water. Studies in freshwater and marine systems have found that some zooplankton actively migrate to areas of turbidity (review in O'Connor 1991). Some non-selective, filter-feeding zooplankton, including calanoid copepods commonly found in Puget Sound, may decrease their feeding rates in response to high TSS (O'Connor 1991).

The increased potential for spills during construction, spill response, and debris cleanup would be as described above for marine vegetation under Vegetation Communities. Sediments at the north and south LWI project sites have low organic carbon levels (Section 3.1.1.1.3), which correspond to low levels of organic nutrients. Therefore, releases of nutrients to the water column due to sediment resuspension during construction would not be of sufficient magnitude to cause an increase in phytoplankton blooms, including harmful algal blooms, along the Bangor shoreline. Construction of LWI Alternative 2 would not decrease the existing plankton abundance or alter the plankton community.

Operation/Long-term Impacts of LWI Alternative 2

Piles supporting the piers would become colonization sites for common marine fouling communities, including filter-feeders that prey on plankton. The effect would be to increase predation on plankton but the impact would be minimal. Hard surfaces are known to support a variety of planktonic organisms including protozoa, foraminiferans (Kozloff 1983), and benthic diatoms (Stark et al. 2000). Planktonic harpacticoid copepods, ostracods, amphipods, and isopods are often abundant around docks and piers that provide a habitat and food source of algae, diatoms, and hydroids (Kozloff 1983).

LWI Alternative 2 would increase overwater shading at the project site by approximately 0.34 acre (0.14 hectare). However, the use of grating in the pier decks, floating docks, and gangways would permit light transmission to the water. Other design elements of the structures (e.g., height of the piers over the water and narrow width) would also minimize the area shaded. The only areas fully shaded would be those under dolphin platforms (total of 0.0029 acre [0.0012 hectare]). In aquatic systems with static water, such as lakes, overwater shading can substantially reduce the productivity of plankton (review in Kahler et al. 2000). However, given surface currents of approximately 0.07 to 0.1 foot (2 to 3 centimeters) per second (Section 3.1.1.1.1) in the project vicinity, potential residence times for plankton under either of the LWI piers would be on the order of minutes, depending on local variations in flow direction. Therefore, although the LWI structures would create new overwater shading, no appreciable reduction in primary production of phytoplankton communities would occur due to the localized nature of the shading; the design of the structures, which would minimize shading (use of light transmitting materials in the piers, floating docks, and gangways, height of the piers over water, narrow width); and the short residence time of plankton under structures.

Observed effects of artificial nighttime lighting on plankton include increased feeding opportunities by predators, including salmonids (Nightingale and Simenstad 2001a). Studies of freshwater plankton in a lake setting found potential inhibition of grazing of zooplankton that migrate toward the water surface at night to feed (Moore et al. 2006). However, as described above, surface currents would quickly move planktonic organisms through the area. Further, the pier security lighting directed at the water would not operate constantly, but on an as-needed basis, such as during security responses. Therefore, artificial lighting of the LWIs would not significantly impact plankton resources.

Small boat operations at the floating docks would be infrequent, minimizing the potential for propeller wash to resuspend bottom sediments. Maintenance of the LWI piers would include routine inspections, repair, and replacement of facility components as required. Planktonic organisms residing amongst the fouling vegetation and other organisms on the underwater mesh and PSB guard panels would be periodically removed during maintenance when the mesh is cleaned. Measures would be employed to avoid discharge of contaminants to the marine environment (Section 3.1.2.2.2).

3.2.2.2.3. LWI Alternative 3: PSB Modifications (Preferred)

VEGETATION COMMUNITIES FOR LWI ALTERNATIVE 3

As described in Chapter 2, Alternative 3 differs from Alternative 2 in that pile-supported piers would not be installed and PSBs would be extended all the way to shore.

Construction of LWI Alternative 3

Construction impacts on marine vegetation would be much less under this alternative than Alternative 2, due to the less intensive nature of in-water construction required to place PSB buoy anchors compared to installing piles used to construct the piers in Alternative 2. Also, less substrate would be disturbed in this alternative compared to Alternative 2 and only one in-water construction season would be required.

As shown in Table 3.2–6, an estimated 0.46 acre (0.19 hectare) and 0.5 acres (0.2 hectare) of eelgrass potentially would be impacted within the 100-foot (30-meter) wide construction corridors of the north and south LWI, respectively (Figure 3.2–12). Similarly, an estimated 0.36 acre (0.15 hectare) and 2.1 acres (0.84 hectares) of green macroalgae, 0.18 acre (0.075 hectare) and 1.7 acres (0.68 hectare) of red macroalgae, and 0.16 acre (0.065 hectare) and 0.35 acre (0.14 hectare) of brown macroalgae potentially would be impacted within the 100-foot wide construction corridors of the north and south LWI, respectively (Figures 3.2–13 and 3.2–14). The observation posts would be located above the areas of marine vegetation. Construction of the observation posts would be done in the dry at low tides, and would not impact marine vegetation.

Because vegetated communities comprise a mixture of vegetation types, the acreages are not additive and the total marine vegetation area potentially impacted by in-water construction activities would be 2.8 acres (0.67 and 2.1 acres [0.27 and 0.85 hectare] for the north and south LWI project sites, respectively). As with Alternative 2, construction impacts in the 100-foot wide construction corridor identified in this section are conservative; the actual impact are expected to be substantially less. The eelgrass beds would be avoided when placing the PSB buoy mooring anchors.

As described in Section 3.1.2.2.3, installation of the LWI PSBs would temporarily increase suspended sediment concentrations and turbidity levels as a result of resuspension of bottom sediments during relocation and placement of PSB mooring anchors. Propeller wash impacts

Table 3.2–6. Marine Habitat Impacted by LWI Alternative 3

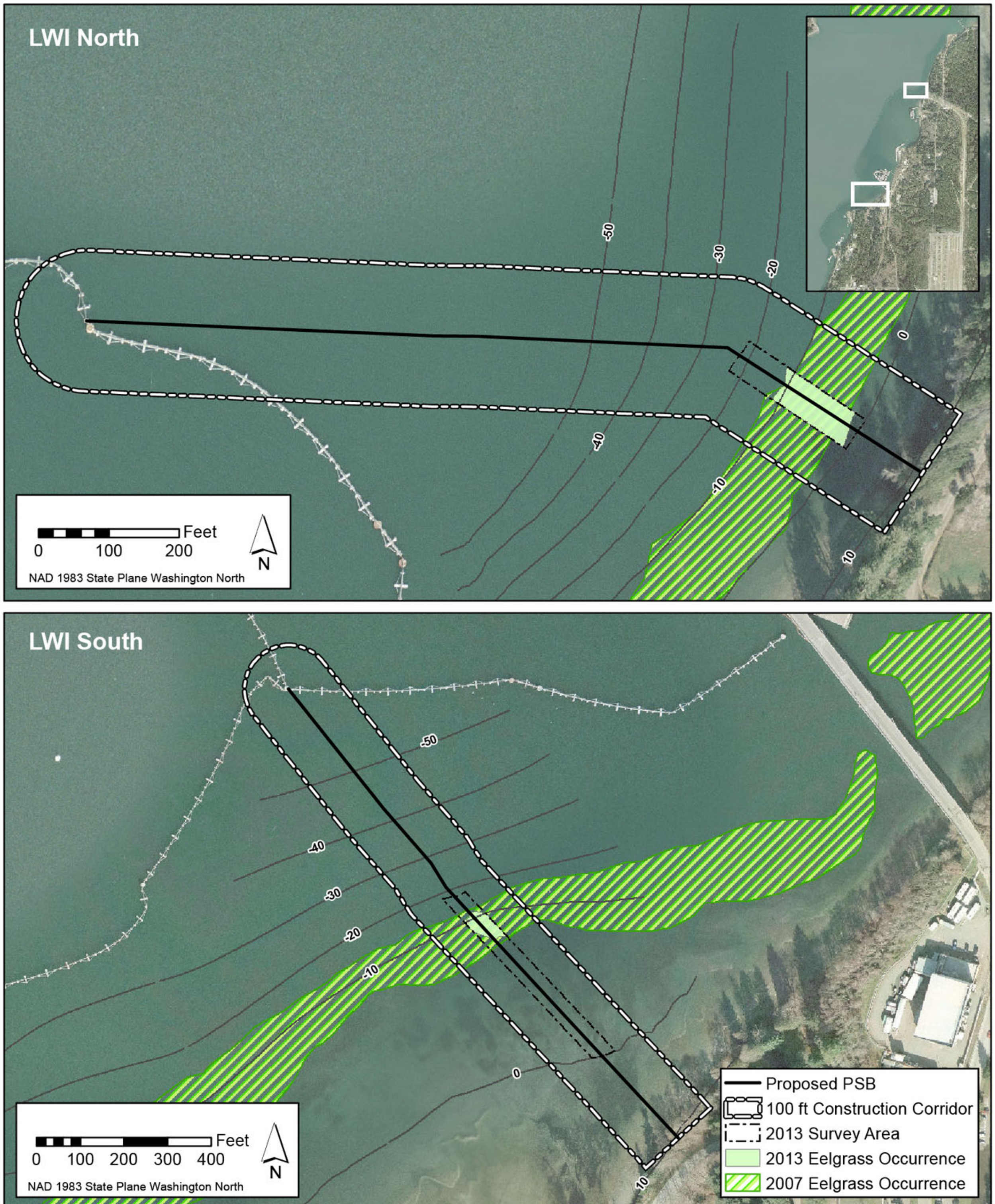
Habitat Type	Potential Temporary Construction Disturbance Area in Acres (Hectares)[1]	Operational Full Shading in Acres (Hectares)[2]	Operational Partial Shading in Acres (Hectares)[2]	Permanent Losses due to PSB & Buoy Grounding in Acres (Hectares)[3]
Nearshore	5.9 (2.4)	0.046 (0.019)	0.07 (0.029)	0.06 (0.024)
Deep Water	6.8 (2.8)	0	Reduction[4]	0
Vegetation Type[5]				
Eelgrass[6]	1.0 (0.39)	0	0.01 (0.0039)	0.013 (0.0054)
Green Macroalgae	2.4 (1.0)	0	0.027 (0.011)	0.043 (0.018)
Red Macroalgae	1.9 (0.75)	0	0.0072 (0.0029)	0.01 (0.0039)
Brown Macroalgae (Kelp)	0.51 (0.21)	0	Negligible	Negligible

1. The potential construction disturbance area includes the structure footprint and the area within 100 feet of the proposed LWI structures. Calculated based on results of the 2007 survey, which covered the entire 100-foot (30-meter) construction corridor.
2. Full shading would be from the observation posts. Partial shading includes contributions from nearshore PSB pontoons (estimated 8 modules at the north LWI project site and 18 modules at the south LWI project site; shade from each module is 105 square feet) and the observation post stairs. Operational impacts on marine vegetation were calculated based on results of the 2013 survey, which covered the area 25 feet (7.6 meters) to either side of the centerline of the proposed LWI structures.
3. There would be some overlap in the areas partially shaded by the PSB pontoons and the areas impacted by grounded PSBs. Impact calculations for vegetated habitats include relocated and/or new PSB mooring anchors; the nearshore habitat calculation does not include mooring anchors because there would be an overall net reduction in the area of mooring anchors.
4. There would be a net reduction in deep water PSB mooring anchors and shading due to relocation of some PSB segments to nearshore waters. The amount of reduction was not calculated due to the variability in deep-water pontoon positions as tides change.
5. Eelgrass and macroalgae overlap in their occurrence along the Bangor shoreline. Therefore, the total acreage of marine vegetation potentially impacted cannot be calculated by summing the values for each vegetation type.
6. Barges would avoid placing spuds or anchors in eelgrass beds wherever possible.

could occur in shallow waters, although current practices would be employed to prevent or minimize these effects. Construction activities would not result in persistent increases in turbidity levels, and increases in turbidity levels would be short-term and localized as suspended sediments would disperse and/or settle rapidly (within a period of minutes to hours) after construction activities cease. Therefore, turbidity impacts on marine vegetation would be localized and temporary.

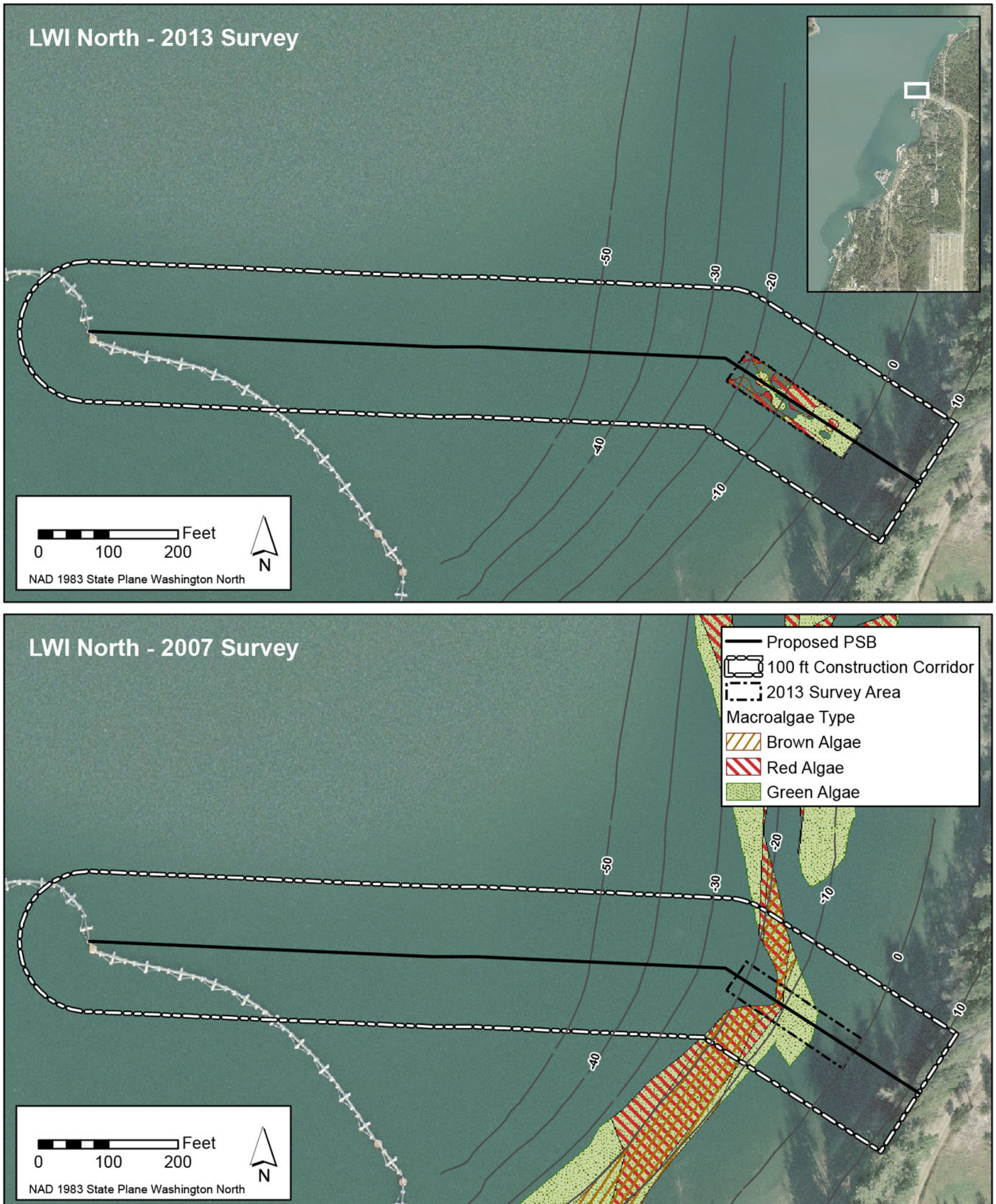
OPERATION/LONG-TERM IMPACTS OF LWI ALTERNATIVE 3

It is anticipated that during lower low water conditions, no more than 5 PSB modules on the north LWI and 13 on the south LWI would “ground out” (i.e., touch the bottom). On average, however, between mean high and MLLW, approximately 11 PSB units including a total of 33 pontoons would ground out in the intertidal zone. To minimize the resulting disturbance of



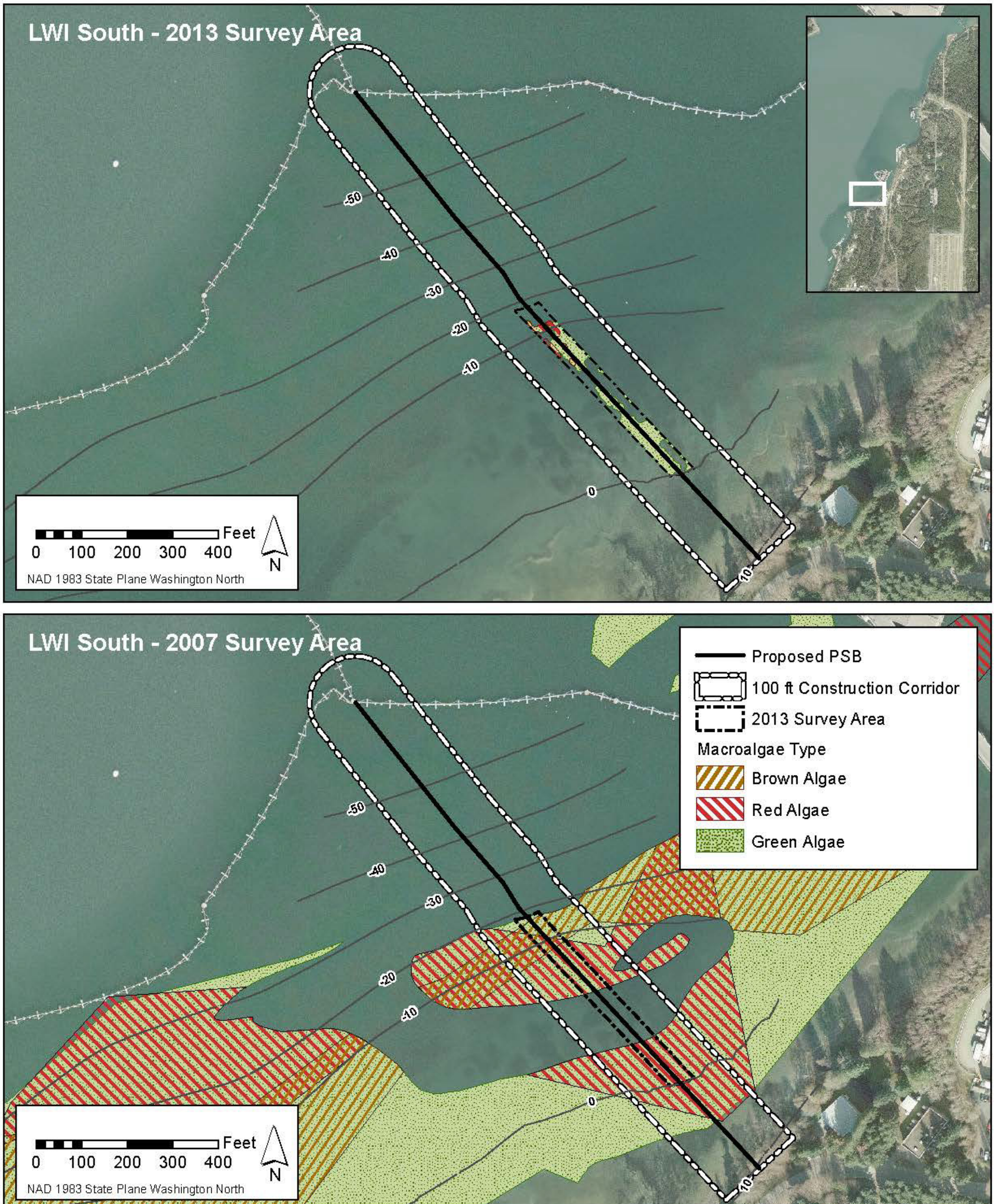
Source: SAIC 2009; Leidos and Grette Associates 2013a

Figure 3.2–12. Disturbance Areas for Eelgrass near the LWI Alignments, Alternative 3



Source: SAIC 2009; Leidos and Grette Associates 2013a

Figure 3.2–13. Disturbance Area for Macroalgae near the North LWI Alignment, Alternative 3



Source: SAIC, 2009; Leidos and Grette Associates, 2013a

Figure 3.2-14. Disturbance Area for Macroalgae near the South LWI Alignment, Alternative 3

the intertidal zone, each pontoon would be fitted with metal “feet” that would prevent the entire pontoon from contacting the surface. The PSB sections and buoys would be moored to minimize side to side movement. Combined with the local bathymetry and predictable flood and ebb influence on PSB pontoon position, this is expected to result in clean grounding with little to no scouring. Over the long term, it is estimated that PSB feet and buoys would disturb approximately 2,594 square feet (241 square meters) of the intertidal zone.

During very low tides, up to two PSB units and one buoy are anticipated to ground out in the north LWI eelgrass bed and one PSB unit would ground out in the south LWI eelgrass bed. Up to 0.013 acre (0.0054 hectare) of eelgrass habitat, 0.043 acre (0.018 hectare) of green macroalgae, and lesser amounts of red and brown macroalgae habitat would be eliminated under PSB buoy mooring anchors and over time due to PSB and buoy grounding. The anchors, however, would support macroalgae colonization. Drift algae may accumulate on the PSB guard panels. However, macroalgae colonizing the panels and drift algae accumulated on these structures would be periodically removed during maintenance.

Partial shading effects from Alternative 3 on marine vegetation would be from the nearshore PSB units. Each PSB unit would create 0.0024 acre (0.00098 hectare) of shading, for a total of approximately 0.063 acre (0.025 hectare) of shading in the nearshore area. However, the PSBs would move with the tides and currents and would not continually shade or limit marine vegetation growth at the depths where there is no grounding. There would be a net reduction in shading of deep water due to the relocation of PSB units from deep water to nearshore areas. The observation posts would be located above the areas of marine vegetation; the post on Marginal Wharf would not create new over-water coverage. Therefore, operation of these posts would not impact marine vegetation.

BENTHIC COMMUNITIES FOR LWI ALTERNATIVE 3

As described in Chapter 2, Alternative 3 would not construct piers, but would construct and install new floating PSB systems that would connect to new shoreline abutments and the existing but reconfigured floating PSB systems. The alignments and lengths of the LWIs would be the same as for Alternative 2, but substrate disturbance would be less in Alternative 3.

Construction of LWI Alternative 3

Construction impacts on benthic communities would be less under this alternative because of the slightly smaller construction corridor (12.7 acres for Alternative 3 vs. 13.1 acres for Alternative 2), and the less intensive construction required to place buoy anchors and a small number of piles in the upper intertidal that would be installed from land (Table 3.2–7). Further, LWI Alternative 3 would require only one in-water construction season versus two in-water seasons for Alternative 2. An estimated 6.1 acres (2.5 hectares) and 6.6 acres (2.7 hectares) of benthic habitat potentially would be impacted within the 100-foot (30-meter) wide construction corridors of the north and south LWI, respectively. The benthic communities in the footprints of the PSB anchors used to moor the eight buoys (total of 236 square feet [22 square meters] for each 3-anchor leg buoy and 139 square feet [13 square meters] for each 2-anchor leg buoy) would be eliminated when they are installed. Assuming 100-foot wide construction corridors, up to 0.18 acre (0.074 hectare) of the north LWI oyster bed and 0.64 acre

(0.26 hectare) of the south LWI oyster bed, for a total of 0.83 acre (0.33 hectare) could be disturbed during construction.

Table 3.2–7. Benthic Community Resources Impacted by LWI Alternative 3

Impact Type	Benthic Community Area[1] in Acres (Hectares)	Oyster Bed Area[2] in Acres (Hectares)
Potential Temporary Construction Disturbance	12.7 (5.2)	0.83 (0.33)
Permanent Loss under Piles and Concrete Pads[3]	0.0033 (0.0013)	0
Nearshore Operational Shading	0.12 (0.047)	0.0027 (0.0011)
Operational Substrate Disturbance (under pontoon feet and buoys)	0.06 (0.024)	0.013 (0.0052)

1. Benthic community area in the 100-foot (30-meter) wide construction corridor around the PSB system area.
2. The impact area for the benthic community includes the oyster bed; thus, the oyster bed is a subset of the benthic community.
3. The piles for the observation posts and the concrete pads for the abutment stairs would be located in the high intertidal above benthic habitats.

As described in Section 3.1.2.2.3, construction of LWI Alternative 3 would temporarily increase suspended sediment concentrations and turbidity levels as a result of resuspension of bottom sediments during relocation and placement of PSB mooring anchors. Propeller wash impacts could occur in shallow waters, although current practices would be employed to prevent or minimize these effects. There would be less potential for sedimentation impacts for Alternative 3 than for Alternative 2 because no piles would be driven in the water and only one in-water construction season would be required.

There would be little potential for noise impacts because there would be no in-water pile driving for this alternative. The observation post piles, with a total footprint of 0.0027 acre (0.0011 hectare), would be located in the upper intertidal zone above the oyster beds and driven in the dry. While construction equipment and boats would emit noise, this would be temporary and generally of the same magnitude as other industrial activities along the Bangor shoreline.

The area of riprap placed at the LWI abutments would be 4,100 square feet (381 square meters). The length of riprap would be 410 feet (125 meters) and the width would be approximately 10 feet (3 meters). The riprap would extend from MHHW to approximately 10 feet above MLLW at the north LWI and 9 feet (2.7 meters) above MLLW at the south LWI. Since no benthic communities occur in this zone no impact would occur to benthic communities from the placement of riprap at base of abutment structures.

OPERATION/LONG-TERM IMPACTS OF LWI ALTERNATIVE 3

Under Alternative 3 there would be a small net decrease in the number of PSB anchors and in the amount of seafloor disturbed by anchor chains. The observation post piles and PSB anchors would be colonized by hard-bottom species and common fouling communities and would effectively result in soft-bottom benthos converted to hard-bottom benthos. These communities are known to support a variety of organisms including a number of green and red algae species, mussels (*Mytilus* spp.), copepods, and amphipods. This conversion from soft-bottom benthos to hard-bottom substrate would result in minor localized faunal and floral changes, but it would not result in any loss of biological productivity.

Up to 18 PSB pontoon units and 3 buoys would touch the intertidal substrates during lower low tides, 5 PSBs and 1 buoy at the north LWI and 13 PSBs and 2 buoys at the south LWI. Over time, each pontoon foot would disturb an area approximately 10 times its size, given shifts of the PSB systems during tidal cycles and buoys would disturb an area approximately five times their size. The total area disturbed is estimated at 0.06 acre (0.024 hectare), with 0.017 acre (0.0067 hectare) at the north LWI project site and 0.043 acre (0.0017 hectare) at the south LWI project site. Repeated disturbance to the sediment surface in these localized areas would substantially reduce the habitat value for benthic organisms.

The total area of nearshore benthic habitats shaded by the PSB pontoons in Alternative 3 would be considerably less than the shading from Alternative 2 (0.063 acre vs. 0.34 acre [0.025 vs. 0.14 hectare]), although nearly all of the LWI Alternative 2 shading would be by grated piers, floating docks, and gangways that would transmit some light. Observation posts would contribute a total of 0.046 acre (0.019 hectare) of full shading in the upper intertidal zone under LWI Alternative 3. Benthic habitat conversion (4,266 square feet [396 square meters]) due to placement of the abutment stair landings, observation post piles, and riprap below MHHW would occur from LWI Alternative 3 (impacts of the riprap would be minimized by covering it with native beach material). There would be no net gain in deep water shading due to relocation of existing PSB units from deep water to nearshore areas when the LWI is constructed.

PLANKTON FOR LWI ALTERNATIVE 3

As described in Chapter 2, LWI Alternative 3 would not construct piers, but would construct and install new floating PSB systems that would connect to new shoreline abutments and the existing but reconfigured floating PSB systems. The alignments and lengths of the LWIs would be the same as for LWI Alternative 2.

Construction of LWI Alternative 3

Potential impacts on plankton from construction of LWI Alternative 3 would be similar to those described for LWI Alternative 2. The construction disturbance area would be slightly smaller under LWI Alternative 3 due to the slightly smaller construction corridor (12.7 vs. 13.1 acres [5.2 vs. 5.3 hectares]) and less intensive construction, and only one in-water construction season would be required versus two for LWI Alternative 2.

As described in Section 3.1.2.2, construction of the PSBs would temporarily increase suspended sediment concentrations and turbidity levels as a result of resuspension of bottom sediments during relocation and placement of PSB mooring anchors. Propeller wash impacts could occur in shallow waters, although current practices would be employed to prevent or minimize these effects. Releases of nutrients to the water column due to sediment resuspension during construction would not be of sufficient magnitude to cause an increase in phytoplankton blooms, including harmful algal blooms, along the Bangor shoreline.

OPERATION/LONG-TERM IMPACTS OF LWI ALTERNATIVE 3

Operational impacts on plankton from LWI Alternative 3would be primarily due to impacts from shading. Potential impacts on plankton from artificial lighting would be minimal and similar to those described for Alternative 2. Operational shading from this alternative would be limited to the observation posts, which would be located high in the intertidal zone, and the pontoons in the PSB units in the nearshore where horizontal movement is limited. Observation post shading would be minimized by the height of these structures over the water and the use of grating for the stairs and walkways. Planktonic organisms residing among the fouling vegetation and other organisms on the PSB guard panels would be periodically removed during maintenance when the guard panels are cleaned.

3.2.2.2.4. SUMMARY OF IMPACTS FOR LWI PROJECT ALTERNATIVES

Impacts on marine vegetation and invertebrates during the construction and operation phases of the LWI project alternatives, along with mitigation and consultation and permit status, are summarized in Table 3.2–8.

Table 3.2–8. Summary of LWI Impacts on Marine Vegetation and Invertebrates

Alternative	Environmental Impacts on Marine Vegetation and Invertebrates
LWI Alternative 1: No Action	No impact.
LWI Alternative 2: Pile-Supported Pier	**Marine Vegetation** *Construction:* Would temporarily disturb marine vegetation in a localized area. Potential disturbance of 6.2 acres (2.5 hectares) of shallow water habitat including 1.1 acres (0.43 hectare) of eelgrass, 2.6 acres (1.1 hectare) of green macroalgae, 2.0 acres (0.81 hectare) of red macroalgae, and 0.57 acre (0.23 hectare) of brown macroalgae (primarily kelp). Construction would be conducted over two in-water work seasons: one to build the piers and one to install the mesh. *Operation/Long-term Impacts:* Permanent loss of eelgrass (0.024 acre [0.01 hectare]) in steel plate anchor and pile footprints. This represents less than 0.13 percent of the existing eelgrass beds at those locations. No full shading in areas of marine vegetation; partial shading from grated structures not expected to impact marine vegetation. **Benthic Invertebrates** *Construction:* Temporary disturbance of community in maximum of 13.1 acres (5.3 hectares); loss of 0.14 acre (0.055 hectare) of benthic organisms in footprints (piles, steel plate anchors, and abutment stair landings); construction would be conducted over two in-water work seasons, with no more than 80 days of in-water pile driving in the first season and mesh installation in the second season. *Operation/Long-term Impacts:* Full overwater shading (0.0029 acre [0.0012 hectare]) may slightly affect sessile benthic organism productivity but would primarily be located high in the intertidal zone above oyster beds; steel piles, plate anchors, and abutment stair landings would result in permanent loss of 0.14 acre (0.055 hectare) of soft-bottom habitat and an increase in hard surface habitat. **Plankton** *Construction:* Indirect and localized effects from increased turbidity and settling of resuspended sediments from in-water construction and vessel activity. Construction would be conducted over two in-water work seasons. *Operation/Long-term Impacts:* No appreciable reduction in primary production of phytoplankton.

Table 3.2–8. Summary of LWI Impacts on Marine Vegetation and Invertebrates (continued)

<table>
<tr><th>Alternative</th><th>Environmental Impacts on Marine Vegetation and Invertebrates</th></tr>
<tr><td>LWI Alternative 3:
PSB Modifications
(Preferred)</td><td>Marine Vegetation
Construction: Slightly smaller area of potential construction disturbance in shallow water (5.9 acres [2.4 hectares]) including 1 acre (0.39 hectare) of eelgrass, 2.4 acres (1 hectare) of green macroalgae, 1.9 acres (0.75 hectare) of red macroalgae, and 0.51 acre (0.21 hectare) of brown macroalgae (primarily kelp). Construction would be conducted over one in-water work season.
Operation/Long-term Impacts: No full shading in areas with marine vegetation. PSB anchors, and PSB and buoy grounding would impact 0.013 acre (0.0054 hectare) of eelgrass, and less than 0.05 acre (0.02 hectare) of macroalgae habitat.
Benthic Invertebrates
Construction: Slightly smaller area of potential construction disturbance of 12.7 acres (5.2 hectares) (versus 13.1 acres [5.3 hectares]) of benthic habitat; loss of 0.0016 acre (0.00063 hectare) of benthic organisms in pile and abutment stair landing footprints; no in-water pile driving; construction would be conducted over one in-water work season.
Operation/Long-term Impacts: Smaller permanent loss of 0.0033 acre (0.0013 hectare) of soft-bottom habitat from piles and abutment stair landings; however, grounding of pontoon feet and buoys would scour small areas of intertidal habitat (estimated 0.06 acre [0.024 hectare]) over time. Full overwater shading from observation posts in the upper intertidal zone (0.046 acre [0.019 hectare]), more than Alternative 2.
Plankton
Construction: Lower potential for impacts than Alternative 2 due to less intensive construction required, less turbidity, and one less in-water work season.
Operation/Long-term Impacts: No appreciable reduction in primary production of phytoplankton.</td></tr>
<tr><td colspan="2">Mitigation: BMPs and current practices to reduce and minimize impacts on marine vegetation and invertebrates are described in Section 3.2.1.2.4 under Current Requirements and Practices. Under either alternative, proposed compensatory aquatic mitigation (Appendix C, Section 6.0) would compensate for the remaining impacts of the LWI.</td></tr>
<tr><td colspan="2">Consultation and Permit Status:
The Navy included impacts on marine vegetation and benthic communities as part of its consultation with the NMFS West Coast Region office under the ESA and MSA. A biological assessment and EFH assessment were submitted to the NMFS West Coast Region office and the USFWS Washington Fish and Wildlife Office on March 10, 2015. A revised biological assessment was submitted to NMFS and USFWS on June 10, 2015. NMFS issued a Letter of Concurrence on November 13, 2015, concurring with the Navy’s ESA and MSA effect determinations for the preferred alternative. In a concurrence letter dated March 4, 2016, USFWS stated that LWI project impacts to bull trout are not measurable and therefore insignificant, and impacts to marbled murrelets are discountable.
The Navy submitted a JARPA to USACE and other regulatory agencies, requesting permits under CWA Sections 401 and 404, and Rivers and Harbors Act Section 10. Alternative 3 is the Least Environmentally Damaging Practicable Alternative according to the CWA Section 404(b)(1) guidelines.
The Navy submitted a CCD to WDOE.</td></tr>
</table>

BMP = best management practice; CCD = Coastal Consistency Determination; CWA = Clean Water Act; EFH = Essential Fish Habitat; ESA = Endangered Species Act; JARPA = Joint Aquatic Resources Permit Application; MSA = Magnuson-Stevens Fishery Conservation and Management Act; NMFS = National Marine Fisheries Service; USACE = U.S. Army Corps of Engineers; WDOE = Washington Department of Ecology

3.2.2.3. SPE PROJECT ALTERNATIVES

3.2.2.3.1. SPE ALTERNATIVE 1: NO ACTION

Under the No Action Alternative, the SPE would not be built and operations in the area would not change from current levels. Therefore, there would be no impacts on marine vegetation, benthic communities, or plankton.

3.2.2.3.2. SPE ALTERNATIVE 2: SHORT PIER (PREFERRED)

VEGETATION COMMUNITIES FOR SPE ALTERNATIVE 2

CONSTRUCTION OF SPE ALTERNATIVE 2

The total area of habitat in the potentially disturbed construction area for SPE Alternative 2 would be 1 acre (0.42 hectare) in the nearshore and 2.9 acres (1.2 hectares) in deep water (Table 3.2–9; Figures 3.2–15 and 3.2–16). Of those 3.9 acres (1.6 hectares), approximately 0.45 acre (0.18 hectare) (11 percent) supports marine vegetation communities, primarily green macroalgae. However, construction activities would largely be restricted to deep waters (30 feet [9 meters] below MLLW and deeper) beyond the depths where marine vegetation occurs. The impact area would consist of the SPE footprint where existing piles would be removed and new piles would be driven and a 100-foot (30-meter) wide corridor where barges would be stationed and tugboats would maneuver the barges during construction. The only seafloor areas that would be highly disturbed would be where the piles are removed or installed, which are located beyond the depths where marine vegetation occurs at the site. Most of the sediments at the SPE site are coarse grained and resuspended sediments would settle close to the disturbance area

Table 3.2–9. Marine Habitat Impacted by SPE Alternative 2

Habitat Type	Potential Temporary Construction Disturbance Area in Acres (Hectares)[1]	Area Permanently Displaced by Piles in Acres (Hectares)[2]	Operational Shading in Acres (Hectares)
Nearshore	1.0 (0.42)	0	0
Deep Water	2.9 (1.2)	0.045 (0.018)	1.0 (0.41)
Vegetation Type[3]			
Eelgrass[4]	Negligible	0	0
Green Macroalgae	0.27 (0.11)	0	0
Red Macroalgae	Negligible	0	0
Brown Macroalgae (Kelp)	Negligible	0	0

1. The potential temporary construction disturbance area includes the structure footprint and the area within 100 feet (30 meters) of the proposed SPE structure.
2. Includes the area displaced by the proposed pier extension piles minus the area of piles being removed from the existing Service Pier.
3. Eelgrass and macroalgae overlap in their occurrence along the Bangor shoreline. Therefore, the total acreage of marine vegetation potentially impacted cannot be calculated by summing the values for each vegetation type.
4. No piles would be installed in eelgrass and barges would avoid anchoring in eelgrass beds wherever possible.

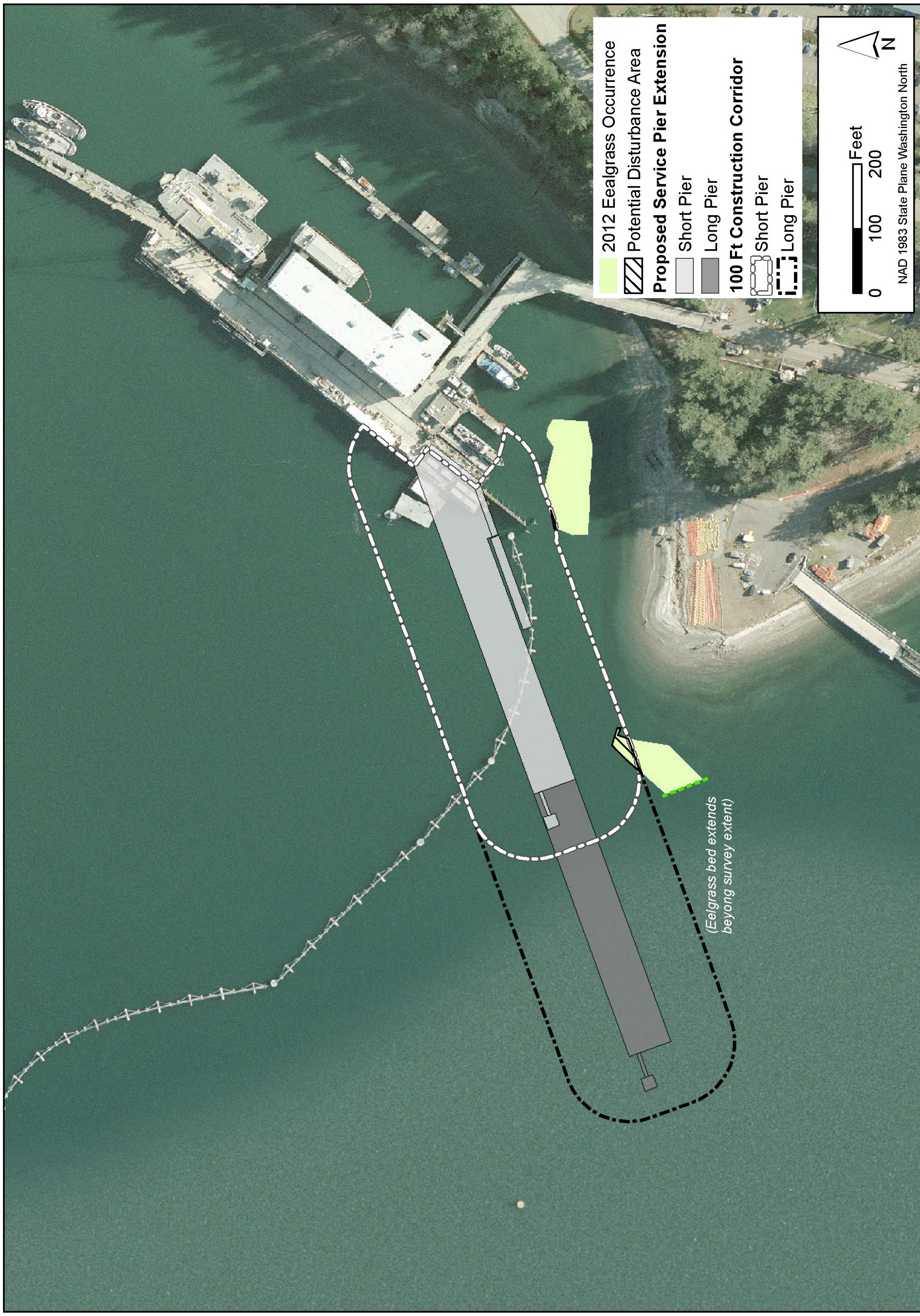
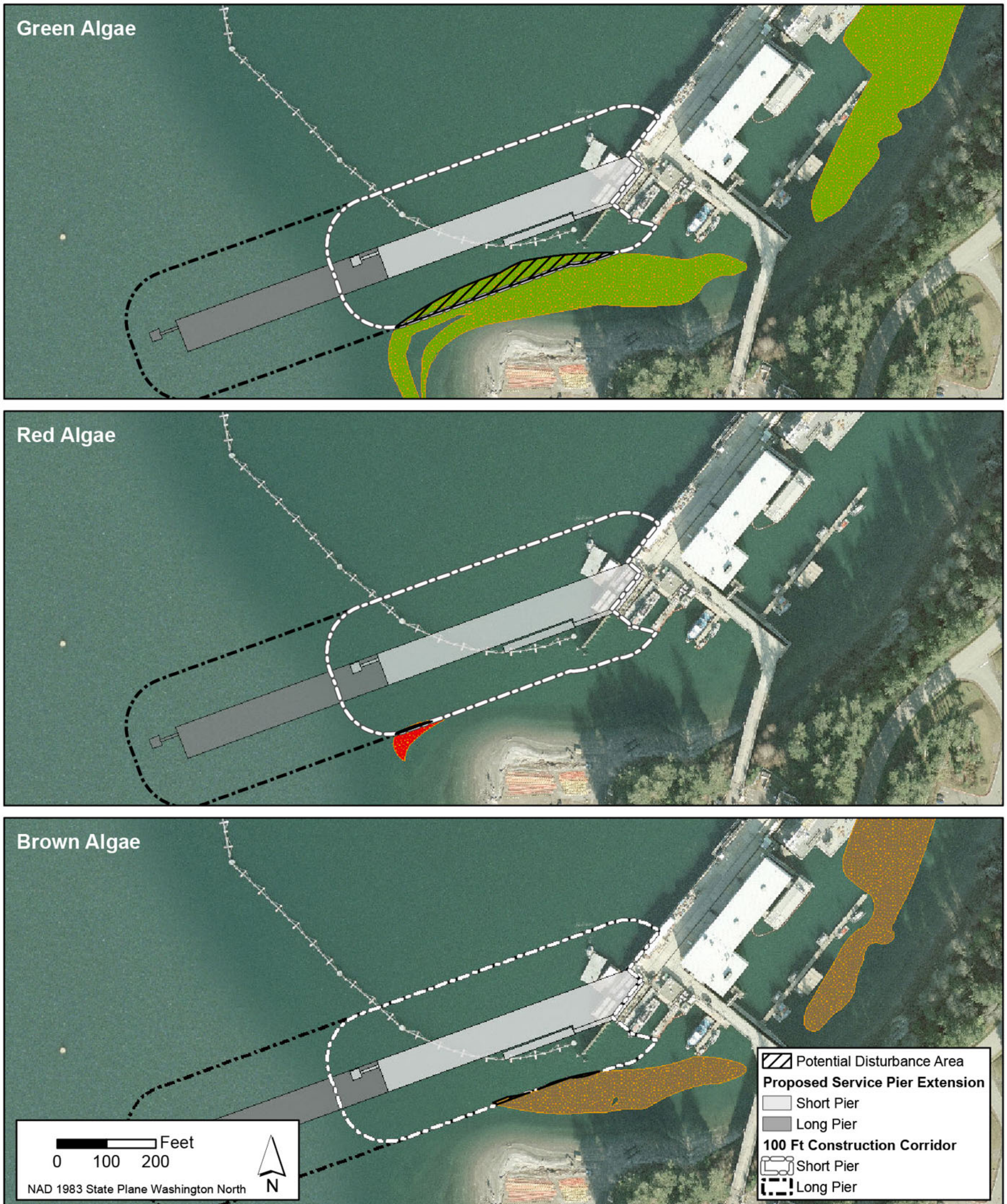


Figure 3.2–15. Disturbance Area for Eelgrass near SPE Alternatives 2 and 3

Source: Anchor QEA 2012



Source: SAIC 2009

Figure 3.2–16. Disturbance Area for Macroalgae near SPE Alternatives 2 and 3

(Section 3.1.2.2.2, under Water Quality). Given the distance of the site to marine vegetation and the low percentage of fines, turbidity plumes would be short-lived and settling of resuspended fines on submerged vegetation is expected to be minimal.

Sargassum is an invasive algal species that can be introduced to new areas by distribution on the hulls of barges, tugboats, and other boats, and on propellers or anchors (review in Josefsson and Jansson 2007). Given the existing *Sargassum* in the SPE construction area, contractors constructing the SPE would be required to comply with RCW 77.15.290 (*Unlawful transportation of fish or wildlife — Unlawful transport of aquatic plants — Penalty*), which imposes penalties for transporting invasive aquatic plants and requires recreational and commercial boats be decontaminated. The piles and other materials for the structures would be new and therefore would not be sources of attached exotic organisms. In addition, the vessels used during construction would also be required to comply with U.S. Coast Guard regulations designed to minimize the spread of exotic species. As a result, construction of the SPE would not introduce exotic species from foreign water bodies or increase the prevalence of existing exotic species in Hood Canal.

The potential for spills during construction is described for Other Contaminants in Section 3.1.2.3.2. The existing facility response and prevention plans for the Bangor shoreline provide guidance that would be used in a spill response, such as a response procedures, notification, and communication plan; roles and responsibilities; and response equipment inventories. In the event of an accidental spill, response measures would be implemented immediately to minimize potential impacts on the surrounding environment. Following completion of in-water construction activities, an underwater survey would be conducted to remove any remaining construction materials that may have been missed during previous cleanups. Therefore, overall construction activities associated with SPE Alternative 2 would not cause long-term impacts on marine vegetation.

Given the water depths at the project site and restriction of construction vessels to the construction corridor and deep waters, there would be no significant impacts on marine vegetation from construction of SPE Alternative 2.

OPERATION/LONG-TERM IMPACTS OF SPE ALTERNATIVE 2

While the SPE would shade 1.0 acre (0.41 hectare), this shading would be in deep waters that do not support marine vegetation as of the 2007 survey (Table 3.2–9). The piles would support colonization of algae common to marine fouling communities, such as *Ulva*.

Operation of SPE Alternative 2 would not increase the risk of accidental spills of fuel, explosives, cleaning solvents, and other contaminants that, if spilled, would impact marine vegetation. This is because the existing NAVBASE Kitsap Bangor spill prevention and response plans would help prevent fuel spills. In the event of an accidental spill, emergency cleanup measures would be implemented immediately in accordance with state and federal regulations. The cleanup would minimize impacts on the surrounding environment. Therefore, there would be no operational impacts on marine vegetation from SPE Alternative 2.

BENTHIC COMMUNITIES FOR SPE ALTERNATIVE 2

CONSTRUCTION OF SPE ALTERNATIVE 2

Construction impacts of SPE Alternative 2 on the benthic community would be due primarily to pile removal and installation activities, with disruption of the sediment and at least partial loss of the community in the affected area. There would be some minor loss of encrusting species (e.g., mussels) on the piles removed from the existing Service Pier.

Potential noise impacts (e.g., reproductive impairment of some invertebrate species, in the form of delayed egg maturity [Christian et al. 2003]) would be limited to the immediate area around piles being driven by impact hammer and to the period of construction. However, most of the piles would be driven using the vibratory method, which would result in noise levels that are not expected to result in impacts on benthic species.

An estimated 3.9 acres (1.6 hectares) of benthic habitat potentially would be impacted within the 100-foot (30-meter) wide construction corridor of SPE Alternative 2 (Table 3.2–10). The benthic communities in the footprints of the piles (0.046 acre [0.019 hectare]) would be eliminated when the piles are installed. A total of 0.0012 acre (0.00051 hectare) of piles would be removed, for a net conversion of 0.045 acre (0.018 hectare) of benthic habitat. There would be some disturbance to sediments and benthic community from pile removal and vessel anchors, but there would be little potential disturbance from propeller wash and no potential for barge grounding due to the water depths at the site. Intertidal habitats, including clam and oyster beds, would be outside the 100-foot wide construction zone and would not be impacted by construction of SPE Alternative 2. The potential for releases of creosote from treated piles removed during construction of SPE Alternative 2 would be managed by BMPs and current practices (Section 3.1.1.2.3) that would minimize the potential for releases of creosote to the water column, which could affect benthic organisms.

Table 3.2–10. Benthic Community Resources Impacted by SPE Alternative 2

Impact Type	Benthic Community Area in Acres (Hectares)
Potential Temporary Construction Disturbance	3.9 (1.6)
Permanent loss under piles[1]	0.045 (0.018)
Operational Shading	1.0 (0.41)

1. Includes the area displaced by the proposed pier extension piles minus the area of piles being removed from the existing Service Pier.

Previous studies of dredged, sediment capped, and other disturbed sites show that many benthic and epibenthic invertebrates rapidly recolonize disturbed bottom areas within 2 years of disturbance (CH2M Hill 1995; Romberg et al. 1995; Parametrix 1994a, 1999; Anchor Environmental 2002; Vivan et al. 2009). Dredging and placement of clean sediment caps at contaminated sites provide extreme examples of benthic recovery from disturbance, demonstrating how benthic organisms have the capability to recover from habitat perturbations and recolonize disturbed areas over time. Many benthic organisms lost due to turbidity and bottom disturbances by barges, tugboats, and anchors would recolonize the construction areas quickly, for example, mobile species such as crabs and short-lived species such as polychaetes, and become reestablished over a 3-year period after sediment disturbance at the site has ceased. Less mobile, longer-lived benthic species such as clams can take 2 to 3 years to reach sexual maturity (Chew and Ma 1987; Goodwin and Pease 1989) and may require 5 years to recover from disturbance such as smothering by sediment (study discussed in Chew and Ma 1987). Therefore, shellfish communities under the SPE impacted by construction would be expected to recover within approximately 5 years after construction. Ecological productivity would be reduced during the 5-year recovery period. Any geoduck or other clams lost in the pile footprints during construction would no longer be available to contribute as seed stock for future generations. Effects would not likely be measurable due to the small amount of habitat affected compared to the amount of available habitat in this part of Hood Canal.

The increased potential for spills during construction, spill response, and debris cleanup would be as described above for marine vegetation, under Vegetation Communities.

OPERATION/LONG-TERM IMPACTS OF SPE ALTERNATIVE 2

Operation impacts of the SPE on the benthic community would be due primarily to the conversion of soft-bottom habitat to hard-bottom habitat (0.045 acre [0.018 hectare]). The piles would be colonized by hard-bottom species such as mussels (*Mytilus* sp.) and sea anemones that would attach to the piles (the fouling community). The fouling community also would support other species such as amphipods, annelids, gastropods, and predatory sea stars (Kozloff 1983; Cohen et al. 1998; Brooks 2004; Cordell 2006; PSAT 2006). The decrease in soft-bottom habitat and increase in hard substrate habitat would result in a localized change in species composition (Glasby 1999; Atilla et al. 2003). Impacts due to shading of benthic habitat would be unlikely due to the depth of the water at the pier site.

Impacts on the physical properties of sediments are discussed in Section 3.1.2.3.2, under Sediment Quality; as noted in that section, the SPE would have a minor localized effect on sediment texture due to scouring and deposition related to flow patterns around the individual piles. However, these changes would occur gradually over time, would be localized at the piles, and would not adversely impact benthic communities.

As described for Marine Water Resources (Section 3.1), operation of the SPE would not impact water quality near the project site. The slight increase in potential for spills during operations would be as described in Section 3.1.2.3.2.

PLANKTON FOR SPE ALTERNATIVE 2

CONSTRUCTION OF SPE ALTERNATIVE 2

Construction impacts on plankton from SPE Alternative 2 would be related to localized and temporary increases in turbidity levels. Turbidity plumes would be short-lived (minutes to hours). Turbidity increases would occur during the in-water work season, which is outside of the period of greatest phytoplankton productivity in Puget Sound (May). Sediments at the SPE project site have low organic carbon levels (less than 2 percent) (Section 3.1.1.1.3, under Physical and Chemical Properties of Sediments). Therefore, releases of nutrients to the water column due to sediment resuspension during SPE construction would not be of sufficient magnitude to cause an increase in phytoplankton productivity, including harmful algal blooms, along the Bangor shoreline. The increased potential for spills during construction, spill response, and debris cleanup would be as described above for marine vegetation, under Vegetation Communities.

OPERATION/LONG-TERM IMPACTS OF SPE ALTERNATIVE 2

Impacts on plankton from SPE Alternative 2 operations would be due primarily to artificial lighting and shading, and the creation of habitat for both planktonic species and predators that feed on plankton. Shading created by SPE Alternative 2 would be approximately 1.0 acre (0.41 hectare) (Table 3.2–10). Security lighting directed at the water would come on only when needed, and surface currents would quickly move planktonic organisms through the area. Therefore, shading and artificial lighting from the SPE pier would not significantly impact plankton resources. Due to water depth at the site, turbidity resulting from propeller wash would be minimal. The potential for spills during operations would be as described in Section 3.1.2.3.2. Therefore, there would be no operational impacts on plankton from SPE Alternative 2.

3.2.2.3.3. SPE ALTERNATIVE 3: LONG PIER

VEGETATION COMMUNITIES FOR SPE ALTERNATIVE 3

CONSTRUCTION OF SPE ALTERNATIVE 3

Potential construction impacts on marine vegetation from SPE Alternative 3 would be the same as described for Alternative 2 (Table 3.2–11; Figures 3.2–15 and 3.2–16) except that there would be slightly less substrate disturbance due to the smaller diameter of piles installed under this alternative. Although the area of potential impacts would be greater (6.6 acres vs. 3.9 acres [2.7 vs. 1.6 hectares] for SPE Alternative 2) due to the increased length of the pier extension, the only seafloor areas that would be highly disturbed would be where the existing piles would be removed and new piles would be installed, which are at depths beyond where marine vegetation occurs in this area.

Table 3.2–11. Marine Habitat Impacted by SPE Alternative 3

Habitat Type	Potential Temporary Construction Disturbance Area in Acres (Hectares)[1]	Area Permanently Displaced By Piles in Acres (Hectares)[2]	Operational Shading in Acres (Hectares)
Nearshore	1.0 (0.42)	0	0
Deep Water	5.5 (2.2)	0.043 (0.017)	1.6 (0.65)
Vegetation Type[3]			
Eelgrass[4]	Negligible	0	0
Green Macroalgae	0.27 (0.11)	0	0
Red Macroalgae	Negligible	0	0
Brown Macroalgae (Kelp)	Negligible	0	0

Table 3.2–11. Marine Habitat Impacted by SPE Alternative 3 (continued)

1. The potential temporary construction disturbance area includes the structure footprint and the area within 100 feet (30 meters) of the proposed SPE structures.
2. Includes the area displaced by the proposed pier extension piles minus the area of piles being removed from the existing Service Pier.
3. Eelgrass and macroalgae overlap in their occurrence along the Bangor shoreline. Therefore, the total acreage of marine vegetation potentially impacted cannot be calculated by summing the values for each vegetation type.
4. No piles would be installed in eelgrass and barges would avoid anchoring in eelgrass beds wherever possible.

There would be some minor loss of fouling vegetation on the piles removed from the existing Service Pier. As with SPE Alternative 2, contractors would be required to comply with RCW 77.15.290 (*Unlawful transportation of fish or wildlife — Unlawful transport of aquatic plants — Penalty*) and U.S. Coast Guard regulations designed to minimize the spread of exotic species including *Sargassum*, which has been documented in the area.

OPERATION/LONG-TERM IMPACTS OF SPE ALTERNATIVE 3

The operation and long-term impacts of SPE Alternative 3 would be similar to those described for SPE Alternative 2, including shading and localized effects of the piles on the substrate. The piles and the shaded areas would be in depths of 30 to 100 feet (9 to 30 meters) below MLLW or deeper, which is beyond the depths where marine vegetation occurs in this area of the shoreline. Therefore, there would be no operational impacts on marine vegetation.

BENTHIC COMMUNITIES FOR SPE ALTERNATIVE 3

CONSTRUCTION OF SPE ALTERNATIVE 3

Benthic community impacts from construction of SPE Alternative 3 would be the same as described for SPE Alternative 2 except that the potential disturbance area would be larger (6.6 vs. 3.9 acres [1.6 vs. 2.7 hectares]), the benthic community lost in the pile footprints would be slightly less (0.043 vs. 0.045 acre [0.017 vs. 0.018 hectare]), and the duration of pile driving would be greater (up to 205 days vs. up to 161 days for Alternative 2) (Table 3.2–12).

Table 3.2–12. Benthic Community Resources Impacted by SPE Alternative 3

Impact Type	Benthic Community Area in Acres (Hectares)
Potential Temporary Construction Disturbance	6.6 (2.7)
Permanent loss under piles[1]	0.043 (0.017)
Operational Shading	1.6 (0.65)

1. Includes the area displaced by the proposed pier extension piles minus the area of piles being removed from the existing Service Pier.

OPERATION/LONG-TERM IMPACTS OF SPE ALTERNATIVE 3

Benthic community impacts from operation of SPE Alternative 3 would be the same as described for SPE Alternative 2 except that the area of operational shading would be greater (1.6 vs. 1.0 acres [0.65 vs. 0.41 hectare]) and the amount of soft-bottom lost in the pile footprints would be greater (660 vs. 385 piles). As noted for SPE Alternative 2, shading would be limited to deeper waters and would not be expected to impact the benthic community. Sediment changes would be as described for SPE Alternative 2, would occur gradually over time, and would not adversely impact benthic communities.

PLANKTON FOR SPE ALTERNATIVE 3

CONSTRUCTION OF SPE ALTERNATIVE 3

Construction impacts on plankton for SPE Alternative 3 would be similar to those described for SPE Alternative 2, but the area of potential impacts would be greater (6.6 acres vs. 3.9 acres [2.7 vs. 1.6 hectares]) due to the larger structural footprint of this alternative.

OPERATION/LONG-TERM IMPACTS OF SPE ALTERNATIVE 3

Operational impacts of SPE Alternative 3 (increased feeding opportunities for plankton predators due to pier lighting) would be similar to those described for SPE Alternative 2 but the area of potential impacts would be greater due to the larger structural footprint of this alternative (1.6 vs. 1.0 acres [0.65 vs. 0.41 hectare]).

3.2.2.3.4. SUMMARY OF IMPACTS FOR SPE PROJECT ALTERNATIVES

Impacts on marine vegetation and invertebrates during the construction and operation phases of the SPE project alternatives, along with mitigation and consultation and permit status, are summarized in Table 3.2–13.

Table 3.2–13. Summary of SPE Impacts on Marine Vegetation and Invertebrates

Alternative	Environmental Impacts on Marine Vegetation and Invertebrates
SPE Alternative 1: No Action	No impact.
SPE Alternative 2: Short Pier (Preferred)	**Marine Vegetation** *Construction:* Small areas of marine vegetation (primarily green macroalgae) potentially would be disturbed in the construction corridor, but construction would largely occur in water depths that are greater than macroalgae habitat. Construction would be conducted over two in-water work seasons. *Operation/Long-term Impacts:* No overwater shading of existing marine vegetation communities; increase in hard-surface habitat for encrusting species (e.g., *Ulva*). **Benthic Resources** *Construction:* Temporary disturbance of community in maximum of 3.9 acres (1.6 hectares); loss of 0.045 acre (0.018 hectare) of benthic habitat in pile footprints; construction would be conducted over two in-water work seasons, with no more than 161 days of in-water pile driving. *Operation/Long-term Impacts:* Overwater shading (1.0 acre [0.41 hectare]) unlikely to impact sessile benthic organism productivity; permanent loss of 0.045 acre (0.018 hectare) of soft-bottom habitat, increase in hard surface habitat on piles. **Plankton** *Construction:* Indirect and localized effects from increased turbidity and settling of resuspended sediments from in-water construction and vessel activity. *Operation/Long-term Impacts:* No appreciable reduction in primary production of phytoplankton; increased feeding opportunities for plankton predators due to pier lighting.

Table 3.2–13. Summary of SPE Impacts on Marine Vegetation and Invertebrates (continued)

Alternative	Environmental Impacts on Marine Vegetation and Invertebrates
SPE Alternative 3: Long Pier	**Marine Vegetation** *Construction:* Same areas of marine vegetation (primarily green macroalgae) potentially disturbed in the construction corridor as SPE Alternative 2. Construction would be conducted over two in-water work seasons. *Operation/Long-term Impacts:* Same as SPE Alternative 2, but larger increase in hard-surface habitat due to greater number of piles (660 vs. 385). **Benthic Resources** *Construction:* Greater temporary disturbance of community than SPE Alternative 2 in maximum of 6.6 acres (2.7 hectares); loss of 0.043 acre (0.017 hectare) of benthic organisms in pile footprints; construction would be conducted over two in-water work seasons, with no more than 205 days of in-water pile driving. *Operation/Long-term Impacts:* Overwater shading (1.6 acres [0.65 hectare]) unlikely to impact sessile benthic organism productivity; permanent loss of 0.043 acre (0.017 hectare) of soft-bottom habitat, increase in hard surface habitat on piles. **Plankton** *Construction:* Greater potential for impacts than SPE Alternative 2 due to 68 percent larger construction area. *Operation/Long-term Impacts:* No appreciable reduction in primary production of phytoplankton; increased feeding opportunities for plankton predators due to pier lighting.
Mitigation: BMPs and current practices to reduce and minimize impacts on marine vegetation and invertebrates are described in Section 3.2.1.2.4 under Current Requirements and Practices. Under either alternative, proposed compensatory aquatic mitigation (Appendix C, Section 6.0) would compensate for the remaining impacts of the SPE.	
Consultation and Permit Status: The Navy included impacts on marine vegetation and benthic communities as part of its consultation with the NMFS West Coast Region office under the ESA and MSA. A biological assessment and EFH assessment were submitted to the NMFS West Coast Region office and the USFWS Washington Fish and Wildlife Office on March 10, 2015. A revised biological assessment was submitted to NMFS and USFWS on June 10, 2015. ESA consultation with NMFS is ongoing. In a concurrence letter dated March 4, 2016, USFWS stated that SPE project impacts to bull trout are not measurable and therefore insignificant, and impacts to marbled murrelets are discountable. The Navy will submit a JARPA to USACE and other regulatory agencies, requesting permits under CWA Section 401 and Rivers and Harbors Act Section 10. Alternative 2 is the Least Environmentally Damaging Practicable Alternative according to the CWA Section 404(b)(1) guidelines. The Navy will submit a CCD to WDOE.	

BMP = best management practice; CCD = Coastal Consistency Determination; CWA = Clean Water Act; EFH = Essential Fish Habitat; ESA = Endangered Species Act; JARPA = Joint Aquatic Resources Permit Application; MSA = Magnuson-Stevens Fishery Conservation and Management Act; NMFS = National Marine Fisheries Service; USACE = U.S. Army Corps of Engineers; WDOE = Washington Department of Ecology

3.2.2.4. COMBINED IMPACTS OF LWI AND SPE PROJECTS

3.2.2.4.1. MARINE VEGETATION

The LWI would impact up to 3 acres (1.2 hectares) of marine vegetation during construction and would contribute up to 0.024 acre (0.01 hectare) loss of eelgrass in Hood Canal during operation. Macroalgae losses would total approximately 0.08 acre (0.032 hectare) for LWI (much less for LWI Alternative 3), but this amount would be functionally decreased by the hard surface attachment habitat of the steel plates, piles, and anchors. The introduction of hard surfaces is not considered to be mitigation for soft-bottom habitat loss. Both SPE alternatives would contribute only minor (0.28 acre [0.1 hectare]) impacts on marine vegetation (primarily green macroalgae), during construction only, due to the deep project bottom depths. There would be no operational contribution of the SPE to marine vegetation impacts.

3.2.2.4.2. Benthic Communities

The LWI pier piles (Alternative 2) and observation post piles (Alternative 3), steel plate anchors (LWI Alternative 2), and abutment stair landings (either alternative) would contribute 0.0033 to 0.14 acre (0.0013 to 0.055 hectare) of soft-bottom habitat conversion in Hood Canal, and the SPE piles would contribute 0.043 to 0.045 acre (0.017 to 0.018 hectare), depending on the alternative, of soft-bottom habitat conversion, for a combined total of up to 0.18 acre (0.074 hectare). Both projects would increase hard surfaces that would support benthic species adapted to these surfaces, such as mussels and anemones. The introduction of hard surfaces is not considered to be mitigation for soft-bottom habitat loss.

3.2.2.4.3. Plankton

Individually and combined, the LWI and SPE projects would have minimal, localized impacts on plankton through shading, artificial lighting, and creation of habitat for filter feeders on plankton.

The combined impacts of the LWI and SPE projects on marine vegetation, benthic communities, and plankton are summarized below in Table 3.2–14.

Table 3.2–14. Summary of Combined LWI/SPE Impacts for Marine Vegetation, Benthic Communities, and Plankton

Resource	Combined LWI/SPE Impacts
Marine Vegetation	The combined effects of the LWI and SPE projects on marine vegetation would be minor and localized, except for eelgrass losses, which would be up to 0.024 acre (0.01 hectare) and require mitigation.
Benthic Communities	Construction and operation of the LWI and SPE projects combined would result in primarily localized and temporary impacts on benthic communities, with the exception of the permanent conversion of up to 0.18 acre (0.074 hectare) of soft-bottom benthic habitat to hard-bottom habitat for both projects combined.
Plankton	Construction of the LWI and SPE projects would result in temporary impacts on plankton that would be localized and immeasurable. Therefore, the combined effects of the two projects on plankton would be no greater than localized and temporary.